

THEORY OF OPERATION SECTION

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1. RAID Architecture Overview

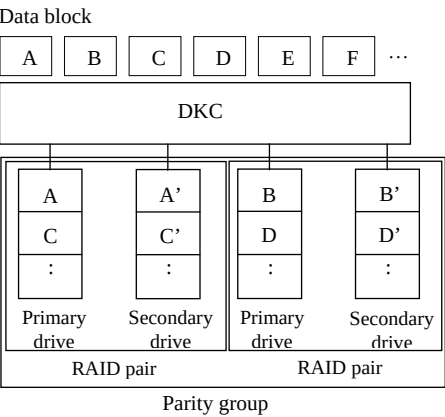
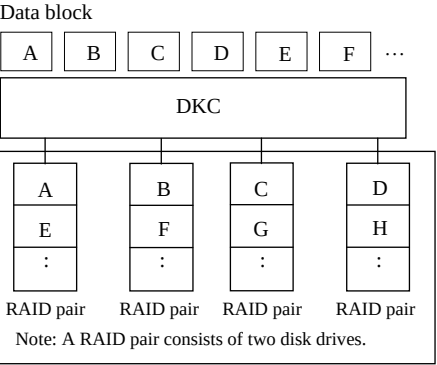
The objectives of the RAID technology are the low cost, high reliability, and high I/O performance of disk storage devices. To achieve these objectives, this subsystem supports levels 1, 5 and 6 of RAID technologies (in this section, part of level 3 RAID technology is explained to make the outline of RAID5 more understandable). The features of the levels of RAID technologies are described below.

1.1 Outline of RAID Systems

The concept of disk array was announced in 1987 by the research group of University of California at Berkeley.

The research group called the disk array RAID (Redundant Array of Inexpensive Disks: A disk subsystem that has redundancy by employing multiple inexpensive and small disk drives), classified the RAID systems into five levels, that is, RAID 1 to RAID 5, and added RAID 0 and RAID 6 later. Since the DKC710I disk subsystem supports RAID 1, RAID 5, and RAID 6, the method, advantage, and disadvantage of each of them are explained below.

Table 1.1-1 Outline of RAID Systems

Level	Configuration		Characteristics
RAID 1 (2D+2D) configuration		Outline	Mirror disks (duplicated writing) Two disk drives, primary and secondary disk drives, compose a RAID pair (mirroring pair) and the identical data is written to the primary and secondary disk drives. Further, data is scattered on the two RAID pairs.
		Advantage	RAID 1 is highly usable and reliable because of the duplicated data. It has higher performance than ordinary RAID 1 (when it consists of two disk drives) because it consists of the two RAID pairs.
		Disadvantage	A disk capacity twice as large as user data capacity is required.
RAID 1 (4D+4D) configuration (Two concatenation of RAID1 (2D+2D))		Outline	Mirror disks (duplicated writing) The two parity groups of RAID 1 (2D+2D) are concatenated and data is scattered on them. In the each RAID pair, data is written in duplicate.
		Advantage	This configuration is highly usable and reliable because of the duplicated data. It has higher performance than the 2D+2D configuration because it consists of the four RAID pairs.
		Disadvantage	A disk capacity twice as large as user data capacity is required.

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RAID5	Data block A B C D E F ... DKC A B C P0 E F P1 D ⋮ ⋮ ⋮ ⋮ Data disks + Parity disk Note: There are two configurations of RAID 5: 3D+1P configuration (four disk drives) and 7D+1P configuration (eight disk drives). The above diagram shows the 3D+1P configuration. In the 7D+1P configuration, data is arranged in the same way.	Outline Data is written to multiple disks successively in units of block (or blocks). Parity data is generated from data of multiple blocks and written to optional disk. Advantage RAID 5 fits the transaction operation mainly uses small size random access because each disk can receive I/O instructions independently. It can provide high reliability and usability at a comparatively low cost by virtue of the parity data. Disadvantage Write penalty of RAID 5 is larger than that of RAID 1 because pre-update data and pre-update parity data must be read internally because the parity data is updated when data is updated.
RAID6	Data block A B C D E F ... DKC A B C P0 Q0 E F P1 Q1 D ⋮ ⋮ ⋮ ⋮ ⋮ Data disks + Parity disks P and Q Note: RAID 6 (6D+2P) configuration practically consists of eight disk drives. RAID 6 (14D+2P) configuration practically consists of sixteen disk drives. In the above diagram, three disk drives are omitted.	Outline Data blocks are scattered to multiple disks in the same way as RAID 5 and two parity disks, P and Q, are set in each row. Therefore, data can be assured even when failures occur in up to two disk drives in a parity group. Advantage RAID 6 is far more reliable than RAID 1 and RAID 5 because it can restore data even when failures occur in up to two disks in a parity group. Disadvantage Because the parity data P and Q must be updated when data is updated, RAID 6 is imposed write penalty heavier than that on RAID 5, performance of the random writing is lower than that of RAID 5 in the case where the number of drives makes a bottleneck.

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RAID5 concatenation	Data block D₀ D₁ D₂ D₃ D₄ D₅ DKC D₀ ~ D₆, P₀ D₇ ~ D₁₃, P₁ D₁₄ ~ D₂₀, P₂ D₂₁ ~ D₂₇, P₃ D₂₈ ~ D₃₄, P₄ D₃₅ ~ D₄₁, P₅ D₄₂ ~ D₄₈, P₆ D₄₉ ~ D₅₅, P₇ ⋮ ⋮ ⋮ ⋮ Parity group Note: The above-mentioned figure is four concatenation cofiguration, but it is the same in the case of two concatenation.	Outline In the case of RAID5 (7D+1P), two or four parity groups (eight drives) are concatenated, and the data is distributed and arranged in 16 drives or 32 drives.
	Advantage When the parity group becomes a performance bottleneck, the performance improvement can be attempted because it is configured with twice and four times the number of drives in comparison with RAID5 (7D+1P).	
	Disadvantage The influence level when two drives are blocked is large because twice and four times LDEVs are arranged in comparison with RAID5 (7D+1P). However, the probability that the read of the single block in the parity group becomes impossible due to the failure is the same as that of RAID5 (7D+1P).	

THEORY01-40**1.2 Comparison of RAID levels****(1) Space efficiency**

RAID level	Space efficiency (User area/Disk capacity)	Remarks
RAID1 2D+2D	50.0%	Because of the mirroring
RAID1 4D+4D	50.0%	Because of the mirroring
RAID5 3D+1P	75.0%	Ratio of the number of parity disks to the number of data disks The space efficiency of the 6D+2P is the same as that of the 3D+1P. Two concatenation and four concatenation of 7D+1P are also the same.
RAID5 7D+1P	87.5%	
RAID6 6D+2P	75.0%	
RAID6 14D+2P	87.5%	

(2) Comparison of performance limits of parity groups (When supposing the marginal efficiency of the RAID 1 (2D+2D) to be 100%)

RAID level	Random and sequential reading	Sequential writing	Random writing
RAID1 2D+2D	100%	100%	100%
RAID1 4D+4D	200%	200%	200%
RAID5 3D+1P	100%	150%	50%
RAID5 7D+1P	200%	350%	100%
RAID6 6D+2P	200%	300%	66.7% (The efficiency is lowered by 33% compared with the 7D+1P.)
RAID6 14D+2P	400%	700%	133.4%
Remarks	Proportionate to the number of HDDs	Proportionate to the number of data HDDs	See the explanation below.

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- In the case of two concatenation and four concatenation RAID5 (7D+1P), it becomes the value twice and four times the above-mentioned.
- The reason why the efficiency is lowered by 33% in the case of RAID 6 (6D+2P) in comparison with RAID 5 (7D+1P) is as follows.

When RAID 5 executes random writing, it issues a total of four I/Os, that is, reading of old data, reading of old parity data, writing of new data, and writing of new parity data to disk drives.

In the case of RAID 6, on the other hand, it issues a total of six I/Os, that is, reading of old data, reading of old parity data (P), reading of old parity data (Q), writing of new data, writing of new parity data (P), and writing of new parity data (Q) to disk drives.

The number of I/Os that RAID 5 issues is four, whereas those that RAID 6 issues is six; the latter is 1.5 times as many as the former. Therefore, the random writing performance of RAID 6 is lowered by 33% in comparison with RAID 5.

However, unless RAID 6 is in an environment in which the number of drives makes a bottleneck, the write penalty is absorbed by the cache memory, so that the performance is not lowered.

THEORY01-60**(3) Reliability**

RAID level	Conditions of data assurance
RAID1 2D+2D	When a failure occurs in one of the mirroring pair of disk drives, data can be restored through use of data of the other disk drives.
RAID1 4D+4D	When failures occur in both of the mirroring pair of disk drives, an LDEV blockade is caused.
RAID5 3D+1P	When a failure occurs in one disk drive in a parity group, data can be restored through use of the parity data.
RAID5 7D+1P	When failures occur in two disk drives, an LDEV blockade is caused.
RAID6 6D+2P	When the failure(s) occur(s) in one or two disk drive(s) in a parity group, data can be restored through use of the parity data. When three disk drives fail, an LDEV blockade is caused.
RAID6 14D+2P	

In the case of RAID 6, data can be assured when up to two drives in a parity group fail, as explained above. Therefore, RAID 6 is the most reliable in the RAID levels.

2. Hardware Specifications

2.1 General

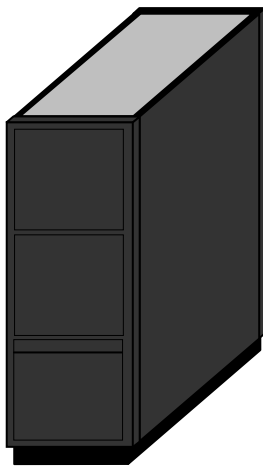
DKC710I is a high performance and large capacity disk storage system at the high-end that follows the architecture of the DKC610I and has improved Hi-Star Net Architecture and speeded up microprocessor.

DKC710I has single DKC model and twin DKC model.

DKC710I contains the configuration from a single rack to six racks, and the racks contain the configuration from a diskless configuration to a maximum of 2,048 disk drives installed, to meet customer's needs.

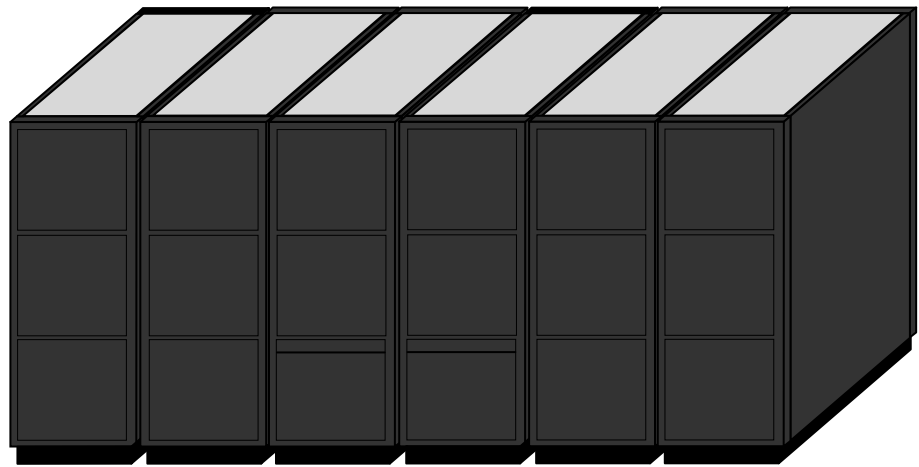
DKC710I supports the single-phase AC power supply equipment that enables to connect both the mainframe and the open system.

Single Rack configuration



DKC Rack
(RACK-00)

Six Racks configuration



DKU Rack (RACK-12) DKU Rack (RACK-11) DKC Rack (RACK-10) DKC Rack (RACK-00) DKU Rack (RACK-01) DKU Rack (RACK-02)

Fig. 2.1-1 Disk Storage System

2.1.1 Features

(1) Scalability

DKC710I provides variations of the storage system configuration according to the kinds and the numbers of selected options: channel adapter, cache memory, disk drive, flash drive (SSD) and flash module drive (FMD).

- Number of installed channel options: 1 to 8 sets (Up to 12 sets when the DKA slot is used)
- Capacity of cache memory: 16GB to 1,024GB
- Number of drives: Up to 2,048 (2.5-inch HDD), 1,280 (3.5-inch HDD) or 192 (FMD)

(2) High-performance

- DKC710I supports three kinds of high-speed disk drives at the speed of 7.2kmin^{-1} , 10kmin^{-1} and 15kmin^{-1}
- DKC710I supports flash drives (SSD) with ultra high-speed response.
- DKC710I supports Flash Module Drive (FMD) with ultra high-speed response and high capacity.
- It realizes high-speed data transfer between DKA and HDDs at a rate of 6Gbps with the SAS interface.
- The performance of processor newly-adopted on the dedicated MP board is improved three times better compared to DKC610I.

(3) Large Capacity

- DKC710I supports disk drive with capacities of 146GB, 300GB, 500GB, 600GB, 900GB, 1.2TB, 1TB, 2TB, 3TB and 4TB.
- DKC710I supports flash drive with capacities of 200GB, 400GB and 800GB.
- DKC710I supports Flash Module Drive (FMD) with capacities of 1.6TB and 3.2TB.
- DKC710I controls up to 65,280 logical volumes and up to 2,048 disk drives, and provides a physical disk capacity of approximately 5,012TB per storage system.

(4) Flash Module Drive (FMD)

The FMD is a flash drive with large capacity which has been accomplished by adopting the Hitachi original package.

Its interface is 6Gbps SAS same as that of the HDD/SDD.

The FMD uses MLC-NAND Flash Memory and features high performance, long service life and superior cost performance by virtue of its original control methods.

THEORY02-30**(5) Connectivity**

DKC710I supports OS's for various UNIX servers, PC servers, and mainframes, so that it conforms to heterogeneous system environment in which those various OS's coexist.

The platforms that can be connected are shown in the following table.

Table 2.1.1-1 Support OS Type

Mainframe		Open system	
Maker	OS	Maker	OS
Hitachi	VOS3/AS, VOS3/FS, VOS3/LS	HP	HP-UX
IBM	MVS/XA, MVS/ESA		Tru64
	OS/390, z/OS & z/OS.e		OpenVMS
	VSE/ESA, z/VSE	Sun	Solaris
	VM/ESA, z/VM	IBM	AIX 5L
	LINUX for S/390 & z-Series	Microsoft	Windows
		NOVELL	NetWare
			SUSE Linux
		Red Hat	Red Hat Linux
		VMware	ESX Server

Host interfaces supported by the DKC710I are shown below. They can mix within the storage system.

- Mainframe: fibre channel (FICON)
- Open system: fibre channel, Fibre Channel over Ethernet (FCoE)
(A volume cannot be shared with a fibre channel and FCoE)

(6) High reliability

- DKC710I supports RAID6 (6D+2P/14D+2P), RAID5 (3D+1P/7D+1P), and RAID1 (2D+2D/4D+4D).
- Main components are implemented with a duplex or redundant configuration, so even when single point of the component failure has occurred, the storage system can continue the operation.

(7) Non-disruptive Service and Upgrade

- Main components can be added, removed, and replaced without shutting down a device while the storage system is in operation.
- A Service Processor (SVP) mounted on the DKC monitors the running condition of the storage system. Connecting the SVP with a service center enables remote maintenance.
- The microcode can be upgraded without shutting down the storage system.

2.2 Architecture

2.2.1 Outline

The DKC710I consists of Controller Chassis with various control boards, and Drive Chassis with drives.

In the DKC rack, one Controller Chassis and two Drive Chassis can be mounted, and in a DKU rack, three Drive Chassis can be mounted. A Controller Chassis controls up to eight Drive Chassis. The maximum configuration of the storage system is a 6-rack configuration that consists of 2 DKC racks and 4 DKU racks, and it contains the combination of 2 Controller Chassis and 16 Drive Chassis.

The outline of components of the DKC710I storage system is shown below.

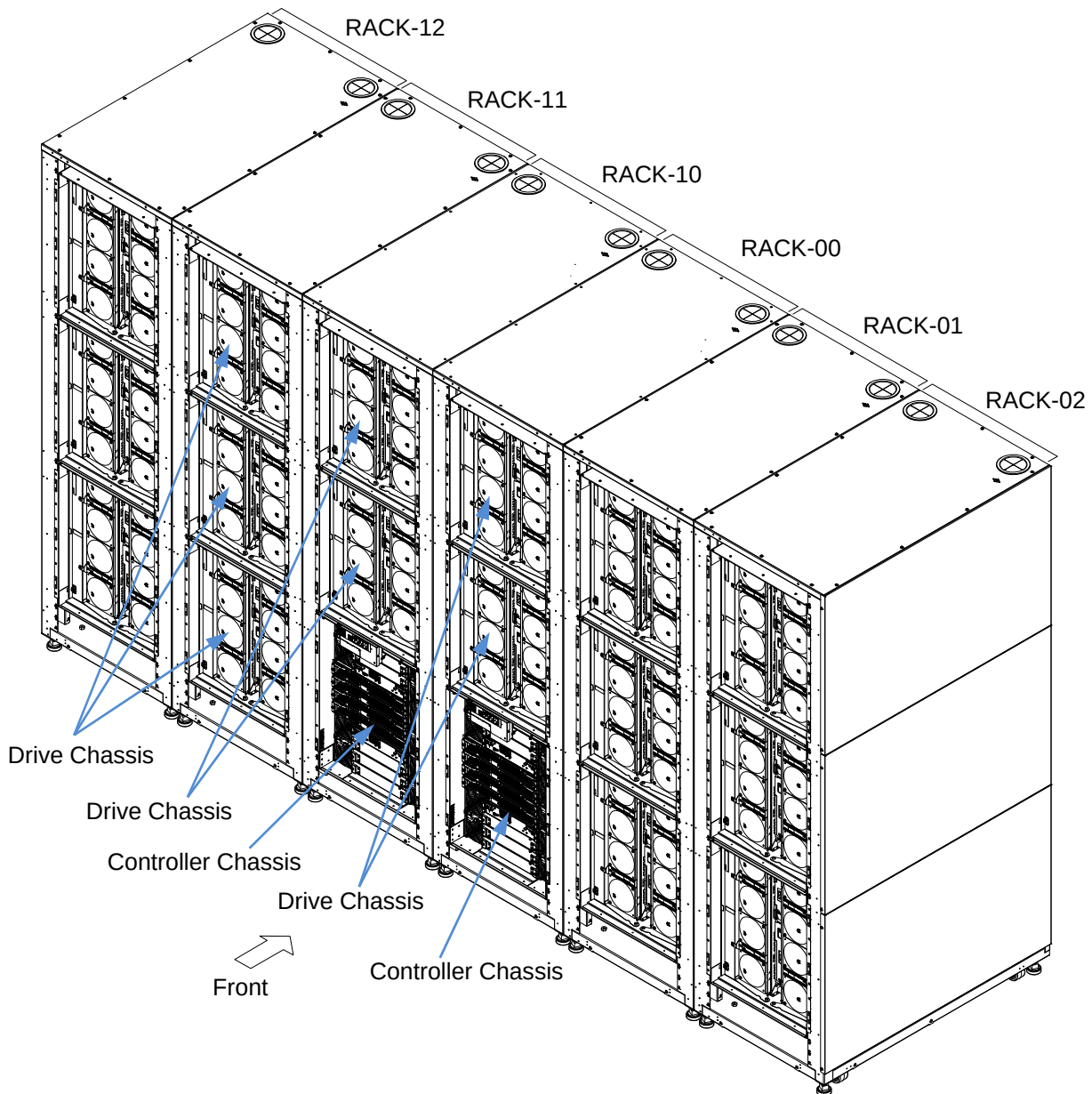


Fig. 2.2.1-1 DKC710I Outline

2.2.2 Hardware Architecture

(1) Controller Chassis (DKC)

The Controller Chassis (DKC) consists of Channel Adapter (CHA), the Disk Adapter (DKA), Cache Memory Adapter (CPC), PCI-Express Switch Adapter (ESW), Processor Blades (MPB), Service Processor (SVP), Cooling Fan, and AC-DC Power Supply that supplies the power to the components. The battery and the Cache Flash Memory are also installed in the CPC to prevent data loss by the occurrence of power outage or the like.

The storage system continues to operate when a single point of failure occurred, by adopting a duplexed configuration for each control board (CHA, DKA, CPC, ESW and MPB) and the AC-DC power supply, and a redundant configuration for the AC-DC power supply and the cooling fan. The addition and the replacement of the components and the upgrading of the microcode can be processed while the storage system is in operation.

The SVP implements a setting and a modification of the storage system configuration information, and observes the operational status. Connecting this SVP to Service Center enables the remote maintenance of the storage system.

(2) Drive Chassis (DKU)

Three types of Drive Chassis are available: SFF Drive Chassis for 2.5-inch drives, LFF Drive Chassis for 3.5-inch drives, and Flash Module Drive Chassis for Flash Module Drives (FMD). The SFF/LFF Drive Chassis (DKU) is a chassis to install the disk drives and the flash drives, and consists of SSW board, HDDPWR board, the cooling fan and the AC-DC power supply.

The duplex configuration is adopted in SSW, HDDPWR and AC-DC power supply, and the redundant configuration is adopted in AC-DC power supply and the cooling fan. All the components can be replaced and added while the storage system is in operation.

The Flash Module Drive Chassis (DKU) is a chassis to install Flash Module Drives, and consists of SSW board and the AC-DC power supply equipped with cooling fans. The duplex configuration is adopted in SSW and AC-DC power supply, and the redundant configuration is adopted in AC-DC power supply. All the components can be replaced and added while the storage system is in operation.

A maximum of 128 drives can be installed in the SFF Drive Chassis, and 80 drives can be installed in the LFF Drive Chassis. Up to 48 drives can be installed in the Flash Module Drive Chassis.

(3) Power Supply

The AC input method of DKC710I adopts the duplex and the redundant configurations as well as the conventional products, and continues to operate when a failure occurs in either of the power systems.

In case of 2 DKC module configuration, power failure of 1 DKC module makes whole system stop.

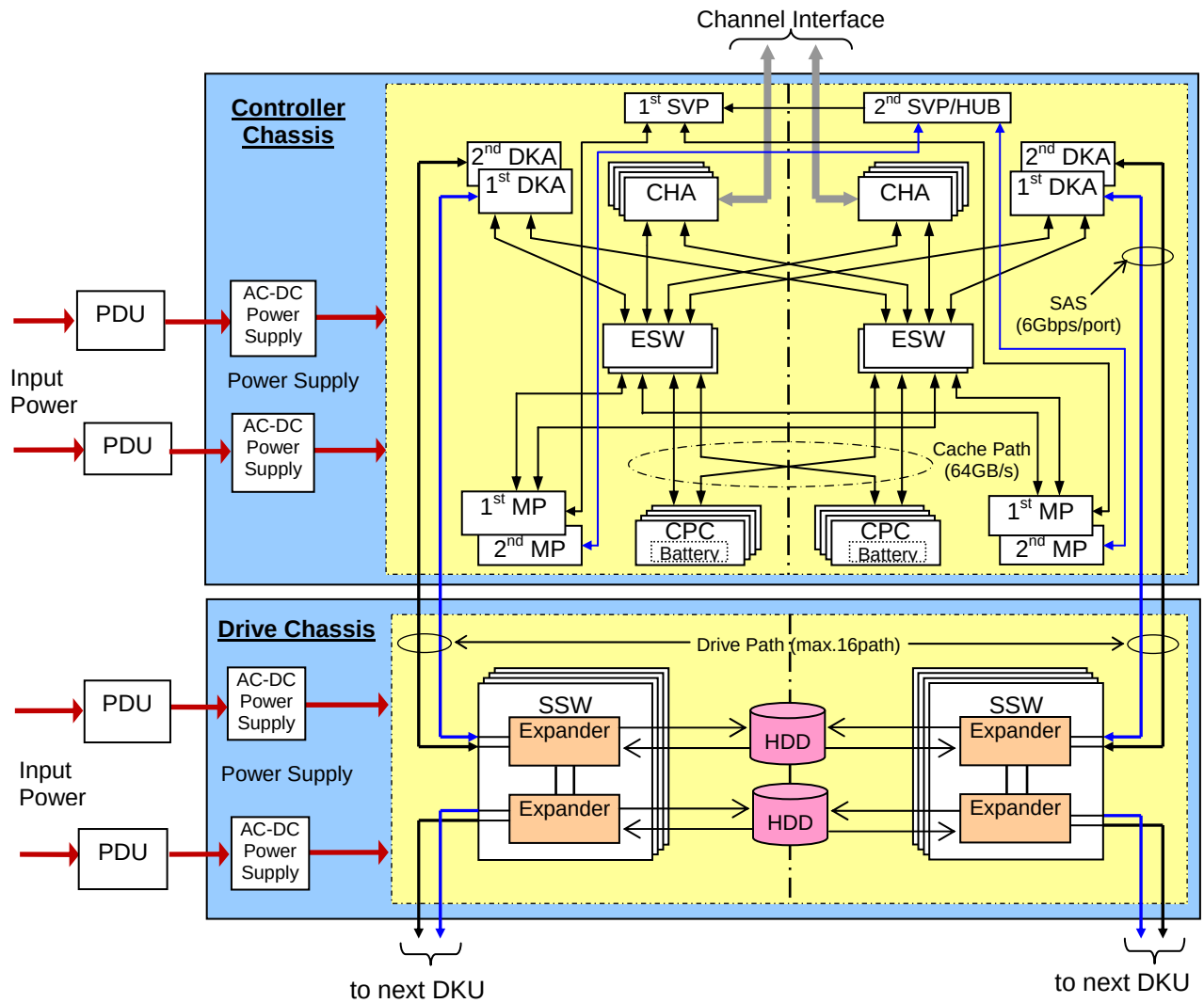


Fig. 2.2.2-1 DKC710I Hardware Architecture Outlines

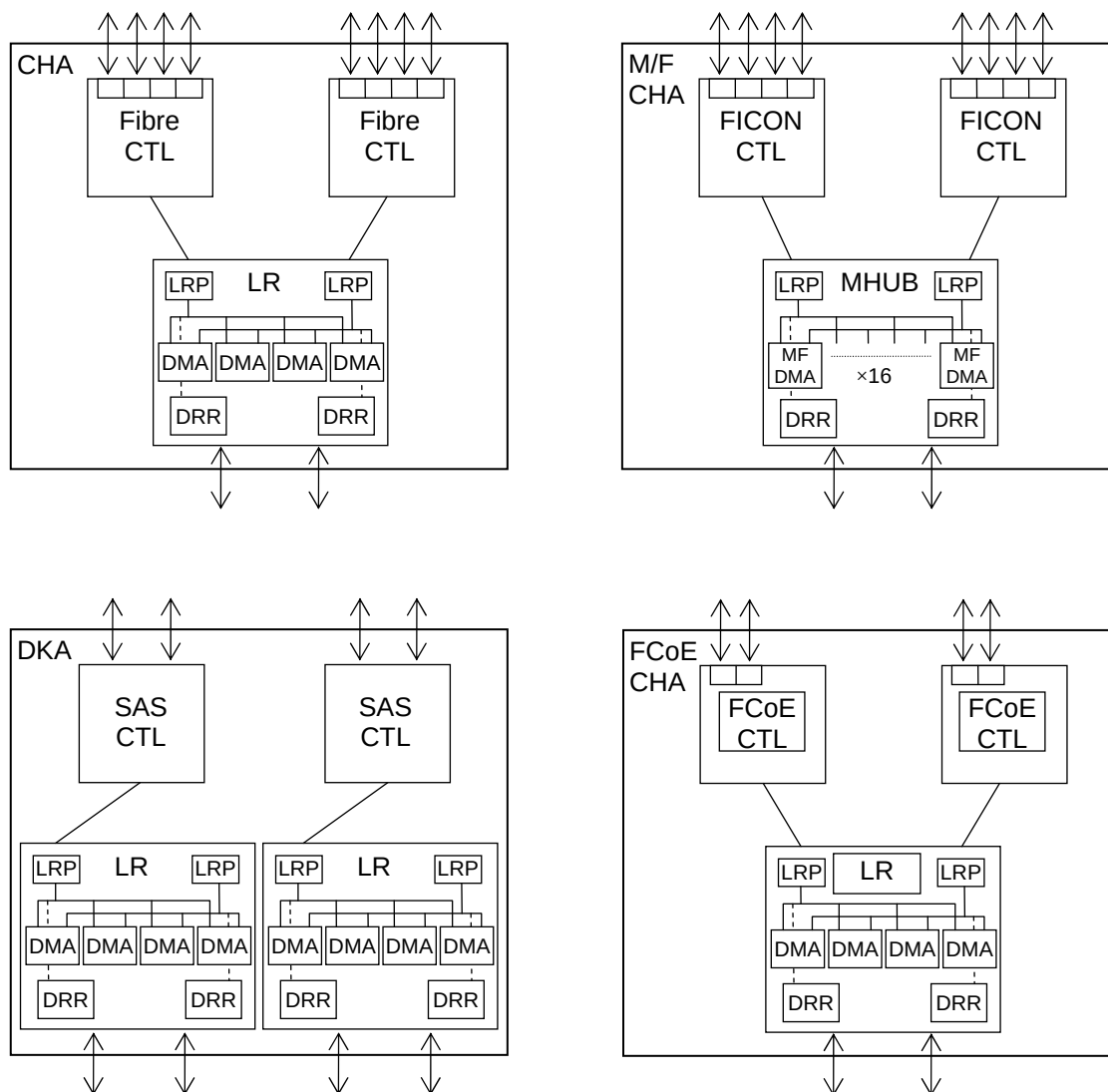


Fig. 2.2.2-1A CHA/DKA Function Outlines

Table 2.2.2-1 Description of Functions

Parts	Description
LR/MHUB	Dedicated ASIC for data transfer to distribute commands from each port to processor in the MPB.
DMA	Offer a high-performance by controlling data transfer with four DMAs in each LR.
MFDMA	Offer a high-performance by controlling data transfer with 16 virtual DMAs in the MHUB.
DRR	Two DRRs are installed in the LR/MHUB for the parity operation.

(4) Cache Path

The access performance to cache memory is determined by a combination of the number of installed CPC and ESW.

When the maximum number of CPC and ESW is installed in a controller chassis, the maximum cache path bandwidth of 64GB/s is performed. Moreover, when the maximum number of CPC and ESW is installed in two controller chassis, the maximum cache path bandwidth of 128GB/s is performed.

Table 2.2.2-2 Bandwidth Performances with ESW and CPC Combination (per controller chassis)

CPC \ ESW	1 set	2 sets
1 set	8GB/s	16GB/s
2 sets	16GB/s	32GB/s
3 sets	24GB/s	48GB/s
4 sets	32GB/s	64GB/s

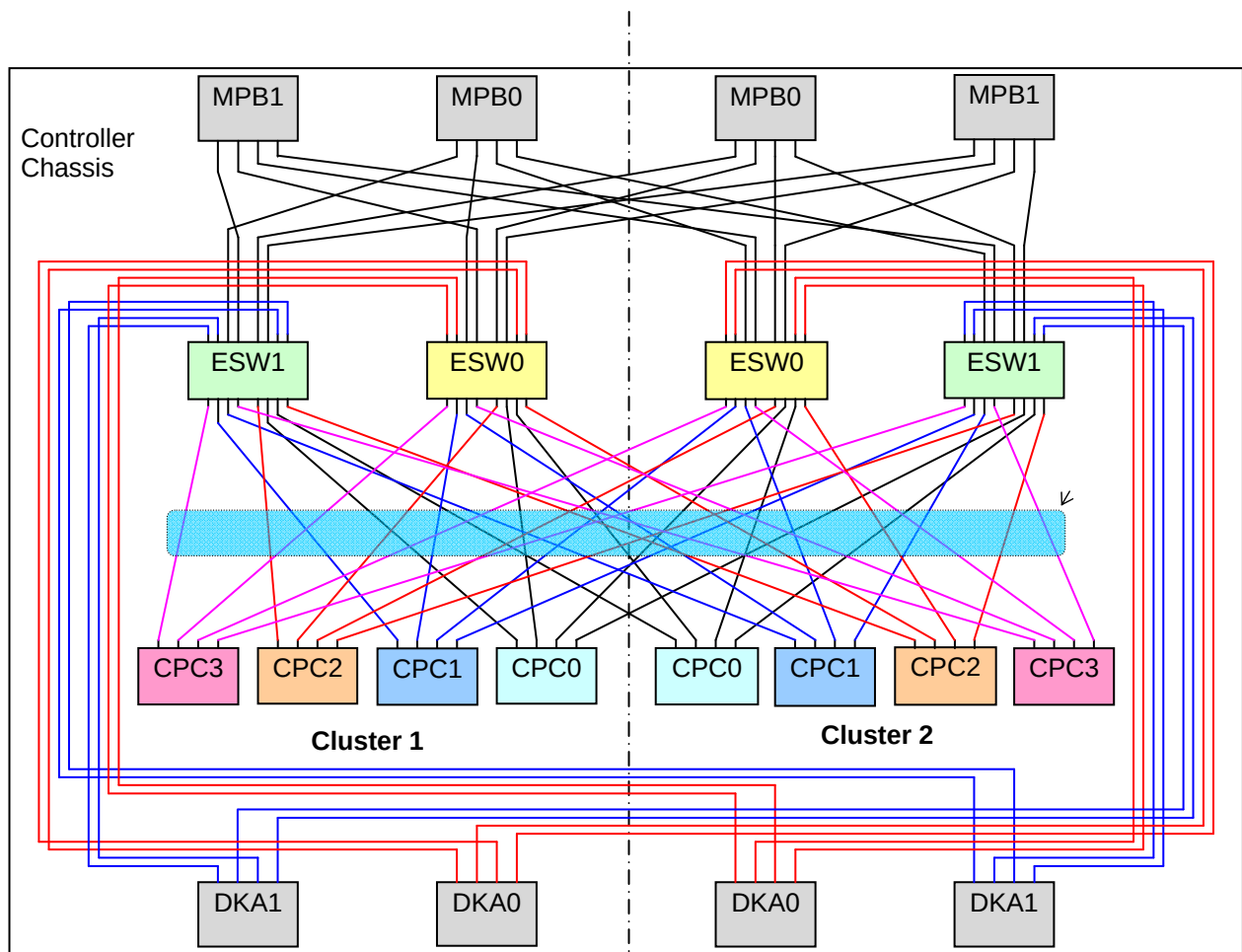


Fig. 2.2.2-2 Cache Path Connection Outlines

(5) Drive Path

(a) When using 2.5-inch HDD

DKC710I controls 1,024 HDDs with 8 paths for a standard model, and with 16 paths for a high performance model.

Note: When DKA-1 is installed for high performance model, all of the SAS cables must be connect.

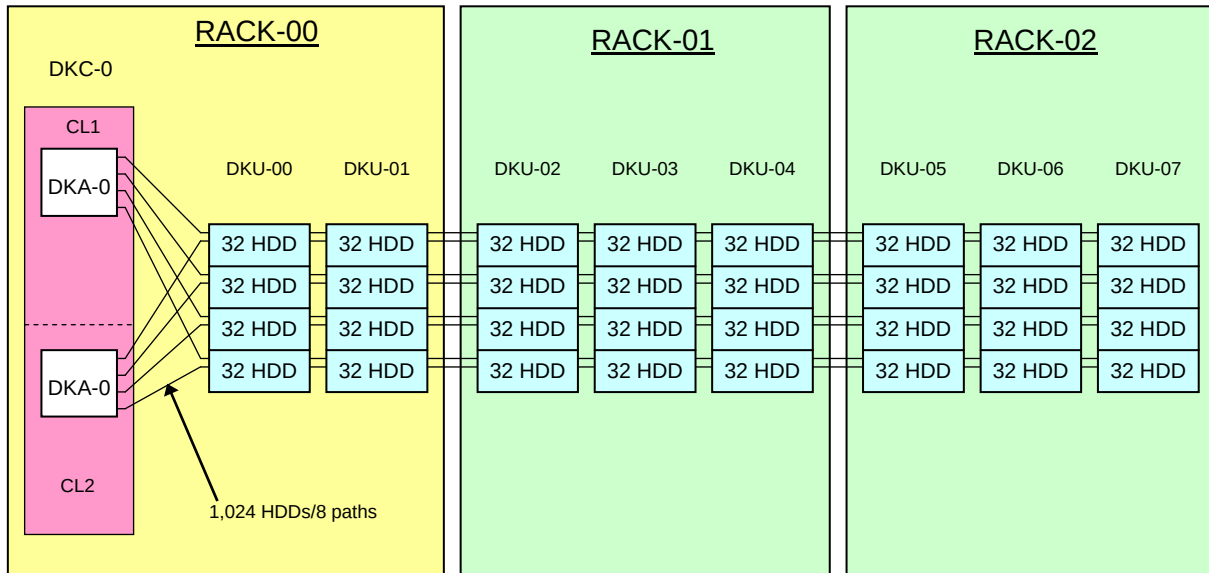


Fig. 2.2.2-3 Drive Path Connection Outlines of 2.5-inch Standard Model

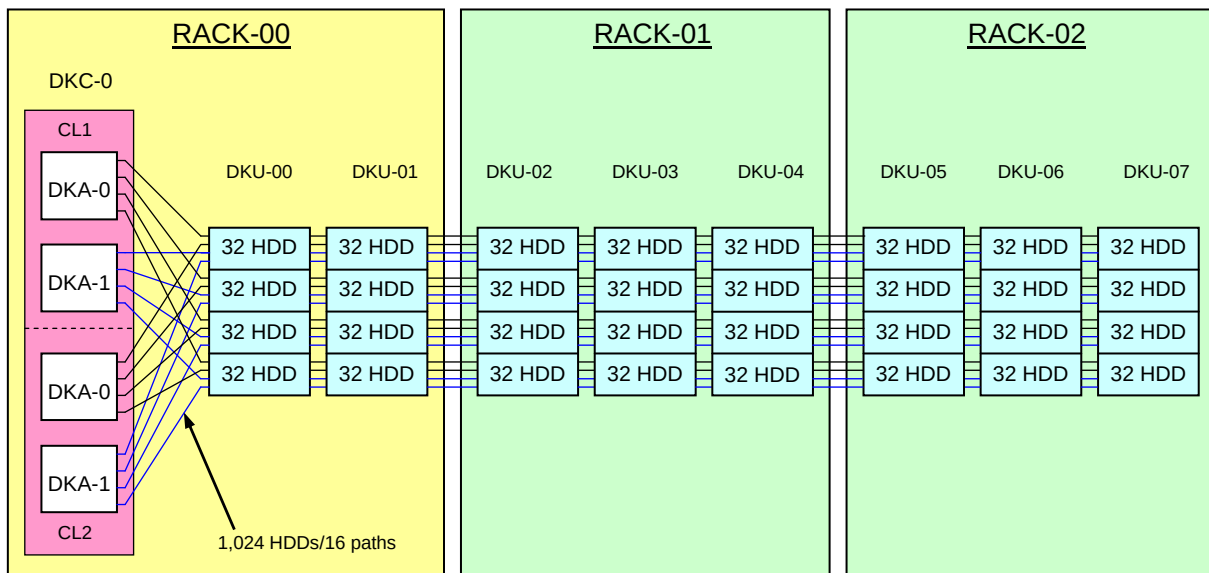


Fig. 2.2.2-4 Drive Path Connection Outlines of 2.5-inch High-Performance Model

(b) When using 3.5-inch HDD

DKC710I controls 640 HDDs with 8 paths for a standard model, and with 16 paths for a high performance model.

Note: When DKA-1 is installed for high performance model, all of the SAS cables must be connect.

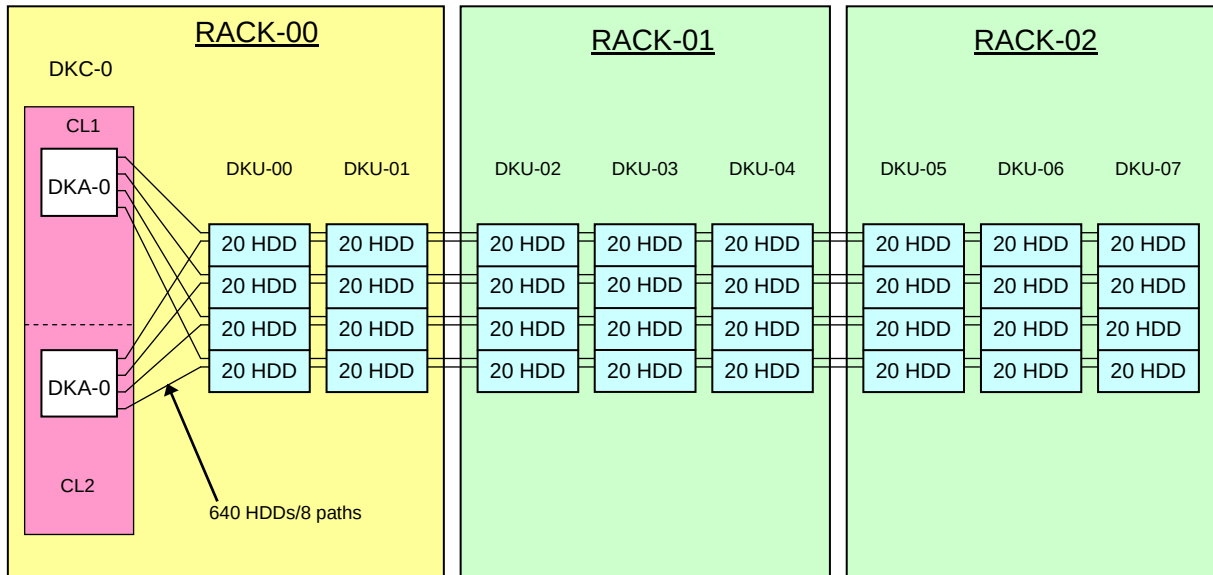


Fig. 2.2.2-5 Drive Path Connection Outlines of 3.5-inch Standard Model

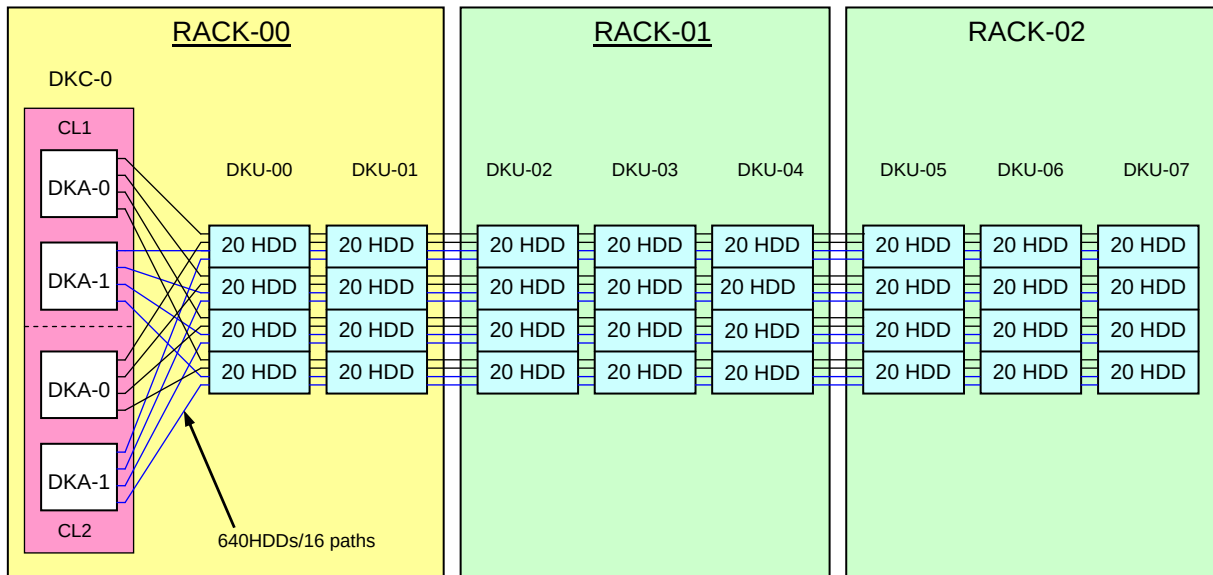


Fig. 2.2.2-6 Drive Path Connection Outlines of 3.5-inch High-Performance Model

(c) When using FMD

DKC710I controls 96 FMDs with 8 paths for a standard model, and with 16 paths for a high performance model.

A maximum of two DKC-F710I-FBX can be controlled by a single DKC.

Note: When DKA-1 is installed for high performance model, all of the SAS cables must be connect.

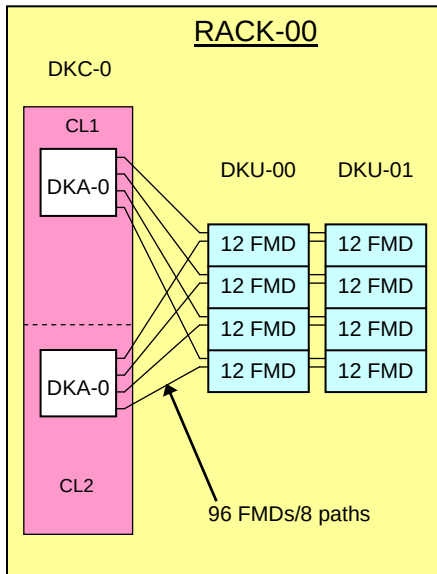


Fig. 2.2.2-7 Drive Path Connection Outlines of FMD Standard Model

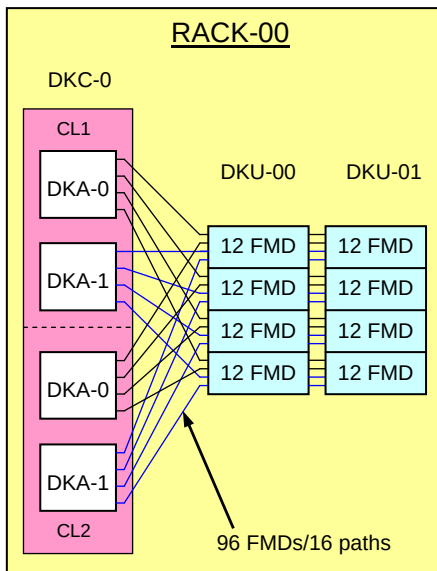


Fig. 2.2.2-8 Drive Path Connection Outlines of FMD High-Performance Model

THEORY02-100**2.2.3 Hardware Component****(1) Channel Adapter (CHA)**

The Channel Adapter (CHA) controls data transfer between the upper host and the cache memory.

DKC710I supports two kinds of CHAs for the mainframe and for the open system.

Table 2.2.3-1 Mainframe Connection CHA Specifications

	Mainframe Fibre 4Gbps		Mainframe Fibre 8Gbps	
	Shortwave	Longwave	Shortwave	Longwave
Model number	DKC-F710I-16MFS	DKC-F710I-16MFL	DKC-F710I-16MUS/ DKC-F710I-16MUSR	DKC-F710I-16MUL
Host interface	FICON	FICON	FICON	FICON
Data transfer rate (MB/s)	100/200/400	100/200/400	200/400/800	200/400/800
Number of options installed (): DKA slot used	1/2/3/4/5/6/7/8 (9/10/11/12)	1/2/3/4/5/6/7/8 (9/10/11/12)	1/2/3/4/5/6/7/8 (9/10/11/12)	1/2/3/4/5/6/7/8 (9/10/11/12)
Number of ports per Option	16	16	16	16
Number of ports per storage system (): DKA slot used	16/32/48/64/80/96/112/128 (144/160/176/192)		16/32/48/64/80/96/112/128 (144/160/176/192)	
Maximum cable length	860m/500m/380m (*1)	10km	500m/380m/150m (*1)	10km

*1: Indicates when 50/125μm laser optimized multi-mode fiber cable (OM3) is used. When using other cable types, it is limited to the length shown in Table 2.2.3-3.

Table 2.2.3-2 Open System Connection CHA Specifications

	Fibre 8Gbps		FCoE 10Gbps
	8port	16port	8port
Model number	DKC-F710I-8UFC/ DKC-F710I-8UFRCR (*2)	DKC-F710I-16UFC/ DKC-F710I-16UFRCR (*2)	DKC-F710I-8FOE
Host interface	FCP	FCP	FCoE
Data transfer rate	200/400/800 MB/s	200/400/800 MB/s	10 Gb/s
Number of options installed (): DKA slot used	1/2/3/4/5/6/7/8 (9/10/11/12)	1/2/3/4/5/6/7/8 (9/10/11/12)	1/2/3/4/5/6/7/8 (9/10/11)
Number of ports per Option	8	16	8
Number of ports per storage system (): DKA slot used	8/16/24/32/40/48/56/64 (72/80/88/96)	16/32/48/64/80/96/112/128 (144/160/176/192)	8/16/24/32/40/48/56/64 (72/80/88)
Maximum cable length	Shortwave	500m/380m/150m (*1)	500m/380m/150m (*1)
	Longwave	10km	10km

*1: Indicates when 50/125μm laser optimized multi-mode fiber cable (OM3) is used. When using other cable types, it is limited to the length shown in Table 2.2.3-3.

*2: The CHA for the fibre channel connection can conform to either Shortwave or Longwave by selecting a transceiver installed on each port. However, DKC-F710I-1UL (SFP for 8Gbps Longwave) must be installed for the Longwave, because the Shortwave transceiver is included in the CHA as a standard.

THEORY02-110**Table 2.2.3-3 Maximum cable length (Shortwave)**

Data Transfer Rate	Maximum cable length		
	OM1 (62.5/125μm multi-mode fiber)	OM2 (50/125μm multi-mode fiber)	OM3 (50/125μm laser optimized multi-mode fiber)
100MB/s	300m	500m	860m
200MB/s	150m	300m	500m
400MB/s	70m	150m	380m
800MB/s	21m	50m	150m
10Gb/s (FCoE)	33m	82m	300m

(2) Disk Adapter (DKA)

The Disk Adapter controls data transfer between the drive and cache memory.

Table 2.2.3-4 Disk Adapter Specifications

Model Number	DKC-F710I-SCA
PCB Name	WP720-A
Number of PCB	2
Maximum Number of Options per storage system	4
Performance of SAS Port	6Gbps/3Gbps
Number of SAS Port per PCB	4
Maximum number of Drive Paths per storage system	32
Maximum number of Disk Drives per SAS Port	128 (2.5-inch HDD) 80 (3.5-inch HDD)

(3) Processor Blades (MPB)

The MP-board that used to be installed in each CHA and DKA board in the conventional model became independent as Processor Blades in DKC710I.

This option is a MP-board that consists of a processor including chip set and DIMM, and controls the CHA and the DKA, PCI-express interface, local memory, and the communication between the SVPs on Ethernet.

Each CHA and DKA can be flexibly controlled.

Table 2.2.3-5 Processor Blades Specifications

Model Number	DKC-F710I-MP	DKC-F710I-MPR
PCB Name	WP752-A	WP752-B
Number of PCB	2	
Maximum Number of Options per storage system	4	
Performance of Processor	2.33GHz	
Processor Type	Xeon L5410 (Quad-core)	
Number of Processor per PCB	1	
Local Memory Capacity per PCB	4GB (2GB DIMM × 2)	

(4) Cache Memory Adapter (CPC)

The Cache Memory Adapter (CPC) is a board to install the cache memory (CM-DIMM), the cache flash memory, and the battery for the cache flash memory. The CPC is equipped with a cache flash memory of 32GB as a standard. The maximum of eight CM-DIMMs and two cache flash memories can be installed on a board.

When the cache memory capacity for a CPC option is 64GB/96GB, DKC-F710I-BM64 is required to add. When the cache memory capacity for a CPC option is 128GB, DKC-F710I-BM128 is required to add.

Table 2.2.3-6 Cache Memory Capacity per CPC Option

Number of Cache Memory Adapter	Cache Memory Capacity (GB)	
	DKC-F710I-C16G/C16GR is used	DKC-F710I-C32G/C32GR is used
1	16 to 64	32 to 128
2	32 to 128	64 to 256
3	48 to 192	96 to 384
4	64 to 256	128 to 512
5	80 to 320	160 to 640
6	96 to 384	192 to 768
7	112 to 448	224 to 896
8	128 to 512	256 to 1024

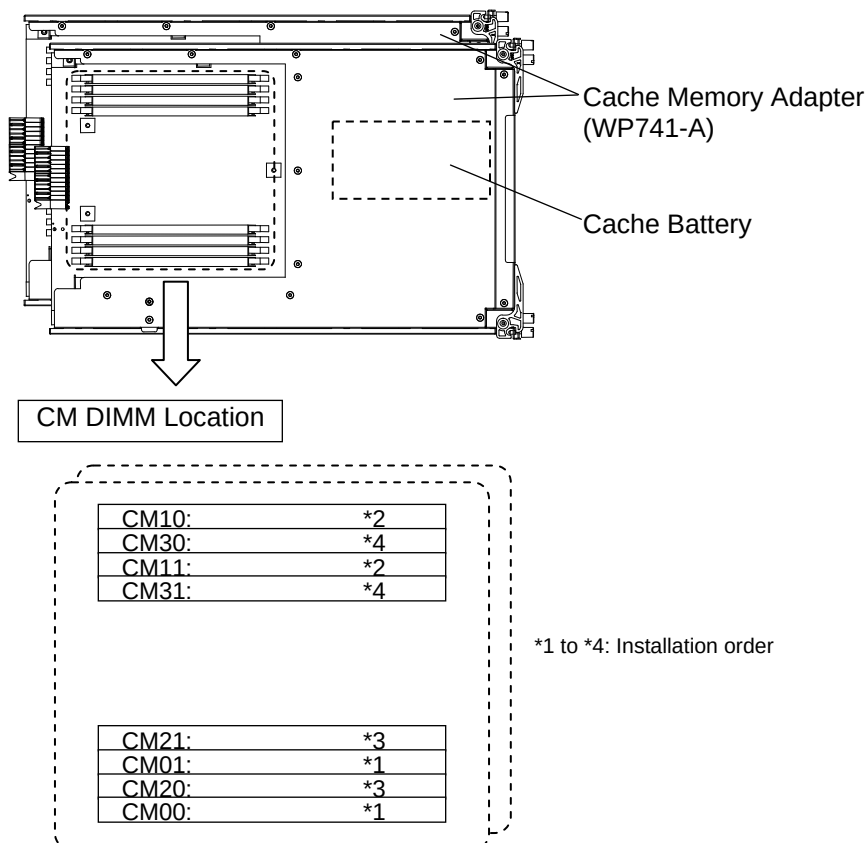


Fig. 2.2.3-1 Top of Cache Memory Adapter (DKC-F710I-CPC)

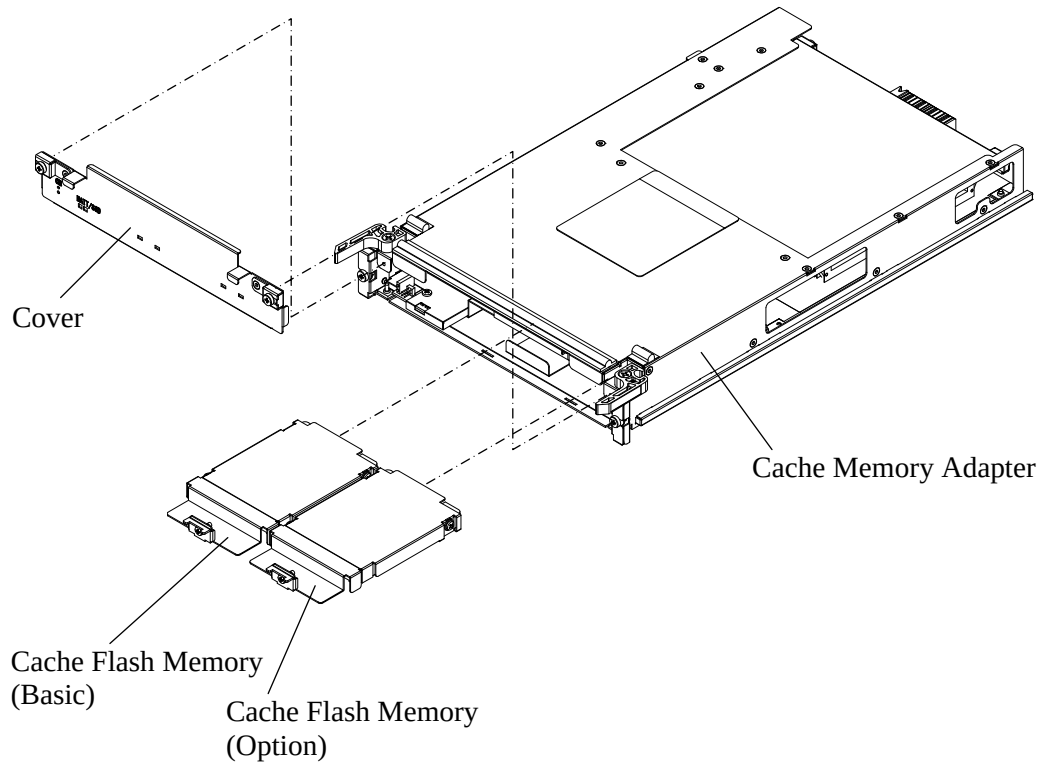


Fig. 2.2.3-2 Front of Cache Memory Adapter (DKC-F710I-CPC)

(5) Cache Memory Module (CM-DIMM)

Cache memory is using the memory shown in the following table.

Table 2.2.3-7 Cache Memory Module specifications

Model Number	Capacity	Component	Memory Chip type
DKC-F710I-C16G/C16GR	16GB	4GB-DIMM × 4	1Gbit DRAM
DKC-F710I-C32G/C32GR	32GB	8GB-DIMM × 4	2Gbit DRAM

(6) Cache Flash Memory (Cache FM)

The Cache Flash Memory saves the cache memory data when a power failure occurs. The required capacity of the Cache Flash Memory is determined depending on the installed cache memory capacity.

Table 2.2.3-8 Cache Flash Memory Specifications

Model Number	Capacity	Component	Installation Requirements
DKC-F710I-BM64	64GB	32GB SSD × 2	When the installation capacity of the cache memory per Cache Memory Adapter is 64GB and 96GB.
DKC-F710I-BM128	128GB	64GB SSD × 2	When the installation capacity of the cache memory per Cache Memory Adapter is 128GB. This option can be used when capacity of the cache memory per Cache Memory Adapter is 64GB or 96GB instead of DKC-F710I-BM64.

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(7) Disk Drive, Flash Drive, and Flash Module Drive

The disk drive, the flash drive, and the flash module drive supported by DKC710I are shown below.

Table 2.2.3-9 Drive Support List

Group	I/F	Size (inch)	Transfer Rate (Gbps)	Revolution Speed (min ⁻¹)/ Flash Memory Technology	Capacity
Disk Drive	SAS	2.5	6	10,000	300GB, 600GB, 900GB, 1.2TB
		2.5	6	15,000	146GB, 300GB
		2.5	6	7,200	500GB, 1TB
		3.5	6	7,200	2TB, 3TB, 4TB
	SATA	3.5	3	7,200	2TB
		3.5	6	7,200	2TB
Flash Drive	SAS	2.5	3	SLC	200GB
		2.5	6	MLC	200GB, 400GB, 800GB
		2.5	6	SLC	200GB, 400GB
		3.5	3	SLC	400GB
		3.5	6	SLC	400GB
Flash Module Drive	SAS	—	6	MLC	1.6TB, 3.2TB

Table 2.2.3-10 LFF Disk Drive Specifications (1/2)

Item		2TB / 7.2kmin ⁻¹ (SATA)			
Disk Drive Model Name	Seagate	—	—	—	
	HGST	R2C-H2R0AT	R2D-H2R0AT	R2E-H2R0AT	
Capacity/HDD		1969.62GB	1969.62GB	1969.62GB	
Number of heads		10	7	6	
Number of disks		5	4	4	
Seek Time (ms) (Read/Write)	Average ^{*1}	8.2/9.2	8.2/9.2	8.0/9.0	
Average latency time (ms)		4.17	4.16	4.16	
Revolution speed (min ⁻¹)		7,200	7,200	7,200	
Interface data transfer rate (Gbps)		3	6	6	
Internal data transfer rate (MB/s)		Max. 202.63	—	Max. 179.13	

THEORY02-151**Table 2.2.3-10 LFF Disk Drive Specifications (2/2)**

Item		2TB / 7.2kmin ⁻¹ (SAS)			
Disk Drive Model Name	Seagate	S2C-H2R0SS	S2D-H2R0SD	S2D-H2R0SS	S2P-H2R0SS
	HGST	—	—	—	—
Capacity/HDD		1958.07GB	1958.07GB	1958.07GB	1958.07GB
Number of heads		8	8/7	8	8
Number of disks		4	5	4	4
Seek Time (ms) (Read/Write)	Average ^{*1}	8.3/9.3	8.3/9.3	8.3/9.3	8.3/9.3
Average latency time (ms)		4.16	4.16	4.16	4.16
Revolution speed (min ⁻¹)		7,200	7,200	7,200	7,200
Interface data transfer rate (Gbps)		6	6	6	6
Internal data transfer rate (MB/s)		Max. 95 to 212	68.7 to 155	68.7 to 155	95 to 212

Item		2TB / 7.2kmin ⁻¹ (SAS)		3TB / 7.2kmin ⁻¹ (SAS)	
Disk Drive Model Name	Seagate	S2E-H2R0SS	—	S2D-H3R0SS	S2E-H3R0SS
	HGST	—	W2E-H2R0SS	—	—
Capacity/HDD		1958.07GB	1958.07GB	2937.11GB	2937.11GB
Number of heads		5	6	10	8
Number of disks		3	4	5	4
Seek Time (ms) (Read/Write)	Average ^{*1}	7.8/8.5	8.2/8.2	8.3/9.3	7.8/8.5
Average latency time (ms)		4.16	4.2	4.16	4.16
Revolution speed (min ⁻¹)		7,200	7,200	7,200	7,200
Interface data transfer rate (Gbps)		6	6	6	6
Internal data transfer rate (MB/s)		Max. 276	103 to 203	68.7 to 155	Max. 276

Item		3TB / 7.2kmin ⁻¹ (SAS)	4TB / 7.2kmin ⁻¹ (SAS)		
Disk Drive Model Name	Seagate	—	S2E-H4R0SS	—	
	HGST	W2E-H3R0SS	—	W2E-H4R0SS	
Capacity/HDD		2937.11GB	3916.14GB	3916.14GB	
Number of heads		8	10	10	
Number of disks		4	5	5	
Seek Time (ms) (Read/Write)	Average ^{*1}	8.2/8.2	7.8/8.5	8.2/8.2	
Average latency time (ms)		4.2	4.16	4.2	
Revolution speed (min ⁻¹)		7,200	7,200	7,200	
Interface data transfer rate (Gbps)		6	6	6	
Internal data transfer rate (MB/s)		103 to 203	Max. 276	103 to 203	

*1: Not including controller overhead

*2: min⁻¹ = rpm

THEORY02-160**Table 2.2.3-11 SFF Disk Drive Specifications (1/2)**

Item		146GB / 15kmin ⁻¹			
Disk Drive Model Name	Seagate	S5B-K146SS	S5C-K146SS		
	HGST	—	—		
Capacity/HDD		143.76GB	143.76GB		
Number of heads		4	2		
Number of disks		2	1		
Seek Time (ms) (Read/Write)	Average* ¹	2.9/3.3	2.7/3.1		
Average latency time (ms)		2.0	2.0		
Revolution speed (min ⁻¹)		15,000	15,000		
Interface data transfer rate (Gbps)		6	6		
Internal data transfer rate (MB/s)		176.1 to 242	194.3 to 283.4		

Item		300GB / 10kmin ⁻¹				
Disk Drive Model Name	Seagate	S5B-J300SS	—	S5D-J300SS	—	S5E-J300SS
	HGST	—	R5C-J300SS	—	R5D-J300SS	—
Capacity/HDD		288.20GB	288.20GB	288.20GB	288.20GB	288.20GB
Number of heads		4	3	2	2	2
Number of disks		2	2	1	1	1
Seek Time (ms) (Read/Write)	Average* ¹	4.0/4.4	3.7/4.2	3.4/3.8	3.8/4.2	3.6/4.1
Average latency time (ms)		3.0	3.0	3.0	3.0	2.9
Revolution speed (min ⁻¹)		10,000	10,000	10,000	10,000	10,000
Interface data transfer rate (Gbps)		6	6	6	6	6
Internal data transfer rate (MB/s)		106.25 to 197.25	152.4 to 253.6	125 to 238.8	164.9 to 279	180 to 293.8

Item		300GB / 15kmin ⁻¹		500GB / 7.2kmin ⁻¹	
Disk Drive Model Name	Seagate	S5C-K300SS	—	S5A-H500SS	S5B-H500SS
	HGST	—	R5C-K300SS	—	—
Capacity/HDD		288.20GB	288.20GB	492.31	492.31
Number of heads		4	3	6	4
Number of disks		2	2	3	2
Seek Time (ms) (Read/Write)	Average* ¹	2.7/3.1	2.9/3.1	8.0/8.4	7.5/8.5
Average latency time (ms)		2.0	1.996	4.16	4.16
Revolution speed (min ⁻¹)		15,000	15,000	7,200	7,200
Interface data transfer rate (Gbps)		6	6	6	6
Internal data transfer rate (MB/s)		194.3 to 283.4	187 to 267	75 to 142	84 to 163

THEORY02-170**Table 2.2.3-11 SFF Disk Drive Specifications (2/2)**

Item		600GB / 10kmin ⁻¹				
Disk Drive Model Name	Seagate	S5C-J600SS	—	S5D-J600SS	—	S5E-J600SS
	HGST	—	R5C-J600SS	—	R5D-J600SS	—
Capacity/HDD		576.39GB	576.39GB	576.39GB	576.39GB	576.39GB
Number of heads		6	6	4	4	4
Number of disks		3	3	2	2	2
Seek Time (ms) (Read/Write)	Average* ¹	3.8/4.4	3.7/4.2	3.4/3.8	3.8/4.2	3.6/4.1
Average latency time (ms)		3.0	3.0	3.0	3.0	2.9
Revolution speed (min ⁻¹)		10,000	10,000	10,000	10,000	10,000
Interface data transfer rate (Gbps)		6	6	6	6	6
Internal data transfer rate (MB/s)		—	152.4 to 253.6	125 to 238.8	164.9 to 279	180 to 293.8

Item		900GB / 10kmin ⁻¹			1TB / 7.2kmin ⁻¹
Disk Drive Model Name	Seagate	S5D-J900SS	—	S5E-J900SS	S5B-H1R0SS
	HGST	—	R5D-J900SS	—	—
Capacity/HDD		864.64GB	864.64GB	864.64GB	984.62
Number of heads		6	6	6	8
Number of disks		3	3	3	4
Seek Time (ms) (Read/Write)	Average* ¹	3.7/4.1	3.9/4.2	3.6/4.1	7.5/8.5
Average latency time (ms)		3.0	3.0	2.9	4.16
Revolution speed (min ⁻¹)		10,000	10,000	10,000	7,200
Interface data transfer rate (Gbps)		6	6	6	6
Internal data transfer rate (MB/s)		125 to 238.8	164.9 to 279	180 to 293.8	84 to 163

Item		1.2TB / 10kmin ⁻¹			
Disk Drive Model Name	Seagate	—	S5F-J1R2SS		
	HGST	R5E-J1R2SS	—		
Capacity/HDD		1152.79GB	1152.79GB		
Number of heads		8	8		
Number of disks		4	4		
Seek Time (ms) (Read/Write)	Average* ¹	4.6/5.0	3.7/4.3		
Average latency time (ms)		3.0	3.0		
Revolution speed (min ⁻¹)		10,000	10,000		
Interface data transfer rate (Gbps)		6	6		
Internal data transfer rate (MB/s)		161.1 to 279	180 to 293.8		

*1: Not including controller overhead

*2: min⁻¹ = rpm

Table 2.2.3-12 Flash Drive Specifications

Item		SFF 200GB			
Flash Drive Model Name	STEC	T5A-S200SS	T5C-S200SS	—	—
	HGST	—	—	R5A-S200SS	R5B-S200SS
Form Factor		2.5 inch	2.5 inch	2.5 inch	2.5 inch
Capacity		196.92GB	196.92GB	196.92GB	196.92GB
Flash memory technology		SLC	SLC	SLC	SLC
Interface data transfer rate (Gbps)		3	6	6	6

Item		SFF 400GB			
Flash Drive Model Name	STEC	—	—		
	HGST	R5A-S400SS	R5B-S400SS		
Form Factor		2.5 inch	2.5 inch		
Capacity		393.85GB	393.85GB		
Flash memory technology		SLC	SLC		
Interface data transfer rate (Gbps)		6	6		

Item		LFF 400GB			
Flash Drive Model Name	STEC	T2A-S400SS	T2C-S400SS		
	HGST	—	—		
Form Factor		3.5 inch	3.5 inch		
Capacity		393.85GB	393.85GB		
Flash memory technology		SLC	SLC		
Interface data transfer rate (Gbps)		3	6		

Item		SFF 200GB		SFF 400GB	
Flash Drive Model Name	Toshiba	—	B5A-M200SS	—	B5A-M400SS
	HGST	R5B-M200SS	—	R5B-M400SS	—
Form Factor		2.5 inch	2.5 inch	2.5 inch	2.5 inch
Capacity		196.92GB	196.92GB	393.85GB	393.85GB
Flash memory technology		MLC	MLC	MLC	MLC
Interface data transfer rate (Gbps)		6	6	6	6

Item		SFF 800GB			
Flash Drive Model Name	Toshiba	B5A-M800SS			
	HGST	—			
Form Factor		2.5 inch			
Capacity		787.69GB			
Flash memory technology		MLC			
Interface data transfer rate (Gbps)		6			

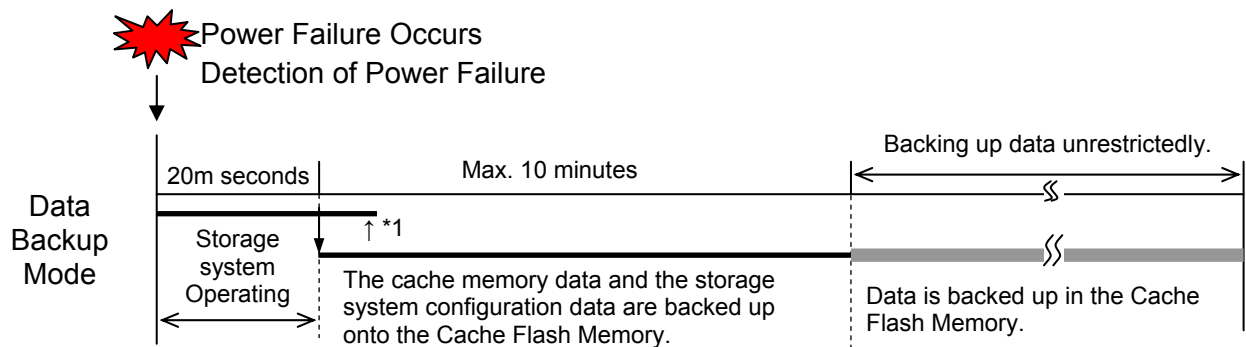
THEORY02-172**Table 2.2.3-12A Flash Module Drive Specifications**

Item	1.6TB		3.2TB	
Flash Module Drive Model Name	H1A-P1R6SS	H1C-P1R6SS	H1B-P3R2SS	H1C-P3R2SS
Form Factor	—	—	—	—
Capacity	1759.2GB	1759.2GB	3518.4GB	3518.4GB
Flash memory technology	MLC	MLC	MLC	MLC
Interface data transfer rate (Gbps)	6	6	6	6

(8) Battery

The battery for the data saving is installed on each Cache Memory Adapter board in DKC710I. When the power failure continues more than 20 milliseconds, the storage system uses power from the batteries to backup the cache memory data and the storage system configuration data onto the Cache Flash Memory. Environmentally friendly nickel hydride battery is used for the storage system.

DKC710I supports neither the UPS function for a minute nor the de-stage function.



*1: The data backup processing is continued when the power outage recovered while the data is being backed up.

Fig. 2.2.3-3 Data Backup Process

(8)-1 Relation between Battery Charge Level and System Start up Action

No.	Power Status	Battery Charge Level	SATA-E	System Start up Action
1	PS ON	<Case1> The battery charge level of some CPC is below 25% in both the clusters.	SATA-E exists or does not exist.	The system does not start up until the battery charge level of all the CPC becomes 25% or more in either or both of the clusters. (It takes a maximum of 45 minutes (*2).) (*1)
2		<Case2> The battery charge level of some CPC is below 50% in both the clusters. (In the case other than Case1)	SATA-E exists.	The system does not start up until the battery charge level of all the CPC becomes 50% or more in either or both of the clusters. (It takes a maximum of 90 minutes (*2).) (*1)
3			SATA-E does not exist.	SIM that shows the lack of battery charge is reported and the system starts up. I/O is executed by the pseudo through operation until the battery charge level of all the CPC becomes 50% or more in either or both of the clusters. (It takes a maximum of 45 minutes (*2).)
4		<Case3> Other than Case1, 2. The battery charge level of all the CPC is 50% or more in either or both of the clusters.	SATA-E exists or does not exist.	The system starts up normally. If the condition changed from Case2 to Case3 during start up, SIM that shows the completion of battery charge is reported.

(*1) Action when System Option Mode 885 is off. (default setting)

(*2) Battery charge time: A maximum of 45 minutes to charge 25%. 3 hours to charge from 0% to 100%.

(8)-2 Relation between Power Status and SM/CM Data Backup Methods

No.	Power Status		SM/CM Data Backup Methods	Data Restore Methods during Restart
1	PS OFF (planned power off)		SM data (including CM directory information) is stored in CM-SSD before PS OFF is completed. If PIN data exists, all the CM data including PIN data is also stored.	SM data is restored from CM-SSD. If CM data was stored, CM data is also restored from CM-SSD.
2	When power outage occurs	Instant power outage	If power is recovered in a moment, SM/CM data remains in memory and is not stored in CM-SSD.	SM/CM data in memory is used.
3		Power outage while the system is in operation	All the SM/CM data is stored in CM-SSD. If a power outage occurred after the system started up in the condition of Case2 (the battery charge level of some CPC had been below 50% in both the clusters), only SM data is stored.	All the SM/CM data is restored from CM-SSD. If CM data was not stored, only CM data is volatilized and the system starts up.
4		Power outage while the system is starting up	Data storing in CM-SSD is not done. (The latest backup data that was successfully stored remains.)	The data that was stored in the latest power off operation or power outage is restored from CM-SSD.

(8)-3 Action When CM-SSD Error Occurs

No.	DKC Status	Description of Error	Action When Error Occurs
1	In operation	CM-SSD error or data comparing error was detected at the time of CM-SSD health check (*1).	SSD warning SIMRC = FFFB0X (Cache error: SSD Warning) is generated.
2	Planned power off or power outage	CM-SSD error was detected, and moreover, retry failed four times during data storing. Data storing error is managed in a per module group (MG) basis and is classified into data storing error only in the MG concerned and data storing error in all the MG depending on the location of the failed memory.	(1) DKC power off process is executed. (2) Blockage occurs in Cache area, CPC, or MG in CPC depending on the location of the failed memory. For details, see THEORY03-12-70 .
3	When powered on -1 (In the case that data storing was successfully done in No.2)	CM-SSD error or protection code (*2) error occurred during data restoring.	(1) Blockage occurs in Cache area, CPC, or MG in CPC depending on the location of the failed memory. (2) If the failed memory is in the CPC in Basic location (CACHE-1CA, CACHE-1CB), the CACHE concerned becomes blocked. If the failed memory is in the CPC other than in Basic Location, the CACHE concerned is volatilized and the system starts up. (If data in the CPC in the other cluster can be restored, the data in the CACHE concerned is not lost.)
4	When powered on -2 (In the case that data storing failed in No.2)	—	(1) Blockage occurs in Cache area, CPC, or MG in CPC depending on the location of data storing error. (2) Same as No.3 (2)

(*1) CM-SSD health check: Function that executes the test of reading and writing of a certain amount of data at specified intervals to CM-SSD while the DKC is in operation.

(*2) Protection code: The protection code (CRC) is generated and saved onto CM-SSD at the time of data storing in CM-SSD and is checked at the time of data restoring.

(Note) CM-SSD handles only the data in the CPC in which it is installed.

Example: Cache data in the CPC#1 is not stored in CM-SSD which is installed in another CPC other than the CPC#1.
Similarly, CM-SSD data in the CPC#1 is not restored to cache memory in another CPC other than the CPC#1.

(9) Service Processor (SVP)

The Service Processor (SVP) mainly performs a setting and a modification of the storage system configuration, a device availability statistical information acquisition, and maintenance. The modem card is not used in DKC710I.

When the 2nd SVP Kit is installed and the SVP is duplicated, the primary SVP that installed as a standard becomes the activated SVP, and the secondary SVP becomes the hot standby SVP with activated Windows.

When the primary SVP fails, the hot standby SVP is switched automatically into operation with approximately six minutes of switching time. By the employing this configuration, in the event of the SVP failure, it can be prevent the system outage such as the failure monitoring function or the like of the storage system.

Table 2.2.3-13 SVP Specifications

Item		Specifications
OS		Windows Vista Business
CPU		Core2 Duo T7500 2.2GHz
Internal Memory		4GB
Key board		— (*1)
Display		— (*1)
Disk Drive		300GB (3.5-inch HDD)
LAN-1		On-Board 10Base-T / 100Base-TX / 1000Base-T × 2 Port
LAN-2		On-Board 10Base-T / 100Base-TX / 1000Base-T × 9 Port
Modem (*2)		Not use
Device	FDD	None
	CD-ROM	None
Serial Port		RS232C
USB		Version 2 × 4 ports
PC Card Slot		PC Card Standard (release 7.1) Type 2 × 2 Slots

*1: The maintenance PC with exact specification must be prepared and connects with SVP, to implement the installation or maintenance of the storage system, because the exclusive SVP for DKC710I has neither a display nor a keyboard.

*2: To obtain information regarding HDS Hi-Track connectivity including HDS supported USB Modems that can interface with the SVP, please obtain the Hi-Track Installation Guide.

Table 2.2.3-14 Specification of maintenance PC

Item	Specifications
OS	Windows 2000 ^{*1} / Windows XP / Windows Vista
CPU	Pentium/Celeron 300MHz or more
Memory	Memory 128MB or more
Disk Drive	Available hard disk space: 100MB or more
Display	800x600(SVGA) or higher-resolution 1280X1024(SXGA) Recommendation
CD Drive	DVD-R/W
LAN	Ethernet 1000Base-T, 10Base-T/100Base-TX
USB	Need

*1: Remote Desktop Connection Software is required.

(10) Drive Chassis

Three types of Drive Chassis are available for DKC710I: SFF Drive Chassis for 2.5-inch disk drives and flash drives, LFF Drive Chassis for 3.5-inch disk drives and flash drives, and Flash Module Drive Chassis for Flash Module Drives (FMD). In the same drive chassis, 2.5-inch drives, 3.5-inch drives, and Flash Module Drives cannot be mixed.

Up to 128 drives can be installed in the SFF Drive Chassis (64 drives each on the front and back). Up to 80 drives can be installed in the LFF Drive Chassis (40 drives each on the front and back). Up to 48 drives can be installed in the Flash Module Drive Chassis (48 drives on the front). DKC710I can control SFF Drive Chassis, LFF Drive Chassis and Flash Module Drive Chassis at the same time.

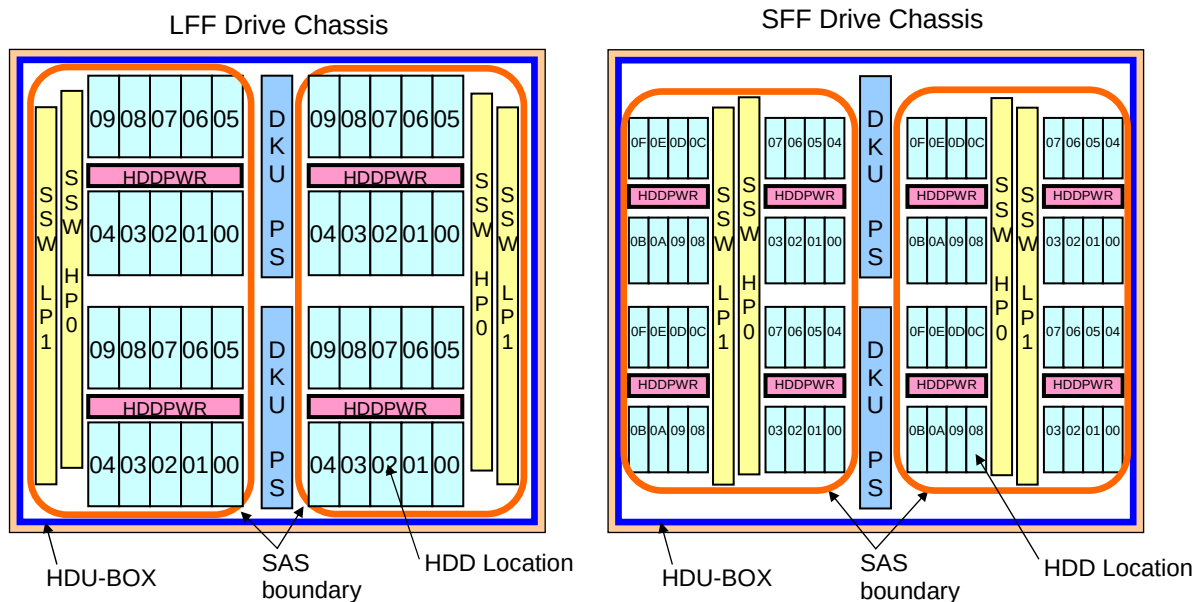


Fig. 2.2.3-4 Structures of Drive Chassis

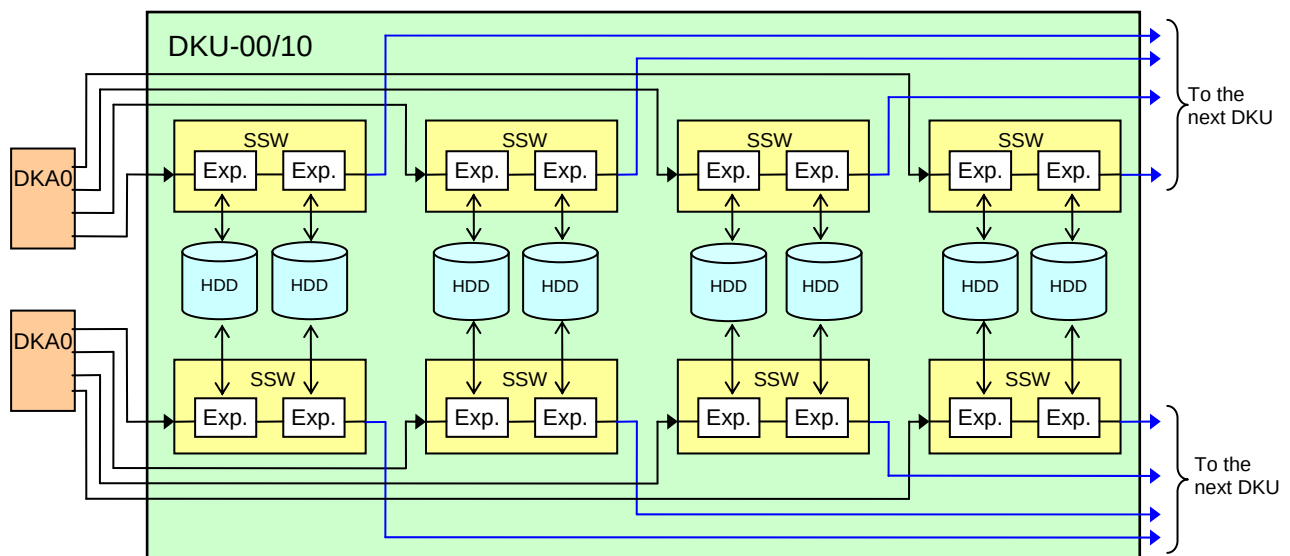


Fig. 2.2.3-5 Connections Diagram of Drive Chassis

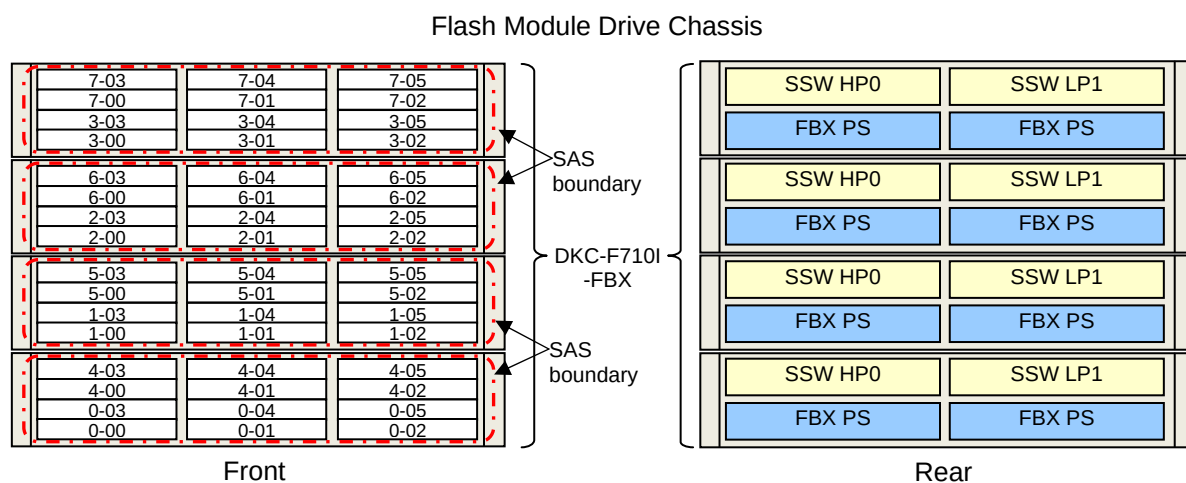


Fig. 2.2.3-6 Structures of Flash Module Drive Chassis

(11) FMD

FMD has 27.75Wh Li-ion battery in it.

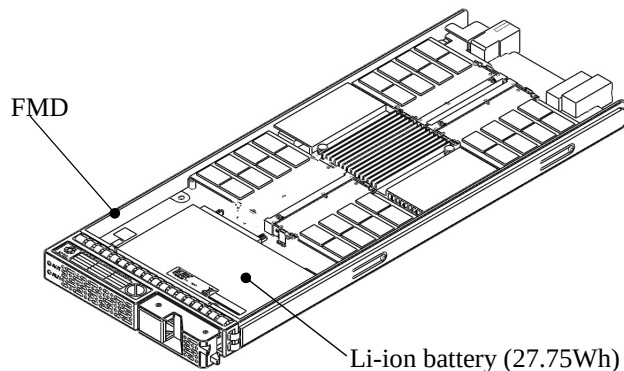


Fig. 2.2.3-7 Location of Li-ion Battery

Package with over 100Wh battery should be handled as DG (Dangerous Goods) in IATA regulation when it is transported by airplane. DG freight requires additional freight fee. So, if you ship multiple FMDs installed in FBX, it will be handled as DG.

In order not to be handled as DG, please transport FMD in single module package.

If you ship FMDs installed in FBX as DG, you have to display “DG Mark label” below in outer package. And the package must be the one specified by U. N, but the present package does not satisfy it.

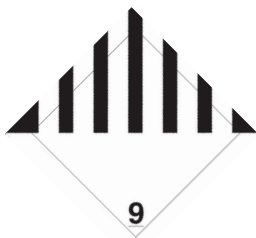


Fig. 2.2.3-8 DG Mark label

Even if it is the case that multiple single module packages are put into one exterior package and it is transported by air, you have to display “Battery label” below in outer package.



Fig. 2.2.3-9 Battery label

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However, the interpretation of IATA regulation is a little different by each airline companies. So, although it depends on the number of FMDs, even if FMDs are installed in FBX, when using the airline which does not treat as a DG article, then the treatment in this clause is unnecessary.

Also, even if multiple single module packages are put into one exterior package, when using the airline which does not treat the package as “Battery label” necessary article, then the treatment in this clause is unnecessary.

2.3 Storage system Specifications

Storage system specifications are shown in the following table.

Table 2.3-1 Storage system specifications

Item			Specifications
System	Number of Disk Drives	Minimum	4 (disk-in model) / 0 (diskless model)
		Maximum	2,048 (2.5-inch HDD) 1,280 (3.5-inch HDD) 192 (FMD)
	RAID Level		RAID6/RAID5/RAID1
	RAID Group Configuration	RAID6	6D+2P, 14D+2P
		RAID5	3D+1P, 7D+1P
		RAID1	2D+2D, 4D+4D
	Maximum Number of Spare Drives		128 ^{*1}
	Maximum Number of Volumes		65,280
	Maximum Storage System Capacity (Physical Capacity)		2,360TB (2.5-inch 1.2TB HDD) 5,012TB (3.5-inch 4TB HDD)
Internal Path	Architecture		Hierarchical Star Net
	Maximum Bandwidth	Cache Path	128GB/s
		Control Path	64GB/s
Memory	Cache Memory Capacity		16GB to 1,024GB
	Cache Flash Memory Capacity		64GB to 1,024GB
Device I/F	DKC-DKU Interface		SAS/Dual Port
	Data Transfer Rate		Max. 6Gbps
	Maximum Number of HDD per SAS I/F		256 (2.5-inch HDD) 160 (3.5-inch HDD)
	Maximum Number of DKA		4
Channel I/F	Support Channel Type	Mainframe	1/2/4Gbps Fibre channel: 16MFS/16MFL 2/4/8Gbps Fibre channel: 16MUS/16MUSR/16MUL
		Open System	2/4/8Gbps Fibre Shortwave ^{*2} : 8UFC/8UFCR/16UFC/ 16UFCR 10Gbps FCoE Shortwave: 8FOE
	Data Transfer Rate	MF Fibre Channel	100 / 200 / 400 / 800 MB/s
		Fibre Channel	200 / 400 / 800 MB/s
		FCoE	10 Gb/s
	Maximum Number of CHA		12
Power	AC Input	Single Phase	60Hz : 200V to 240V 50Hz : 200V to 240V
Acoustic Level ^{*3}	Operating	-CBXA/-CBXG/ -CBXB/-CBXH	60dB (24°C or less), 62dB (32°C)
		-SBX/-UBX	54dB (24°C or less), 60dB (32°C)
	Standby ^{*4}	-CBXA/-CBXG/ -CBXB/-CBXH	60dB (24°C or less), 62dB (32°C)
		-SBX/-UBX	54dB

(To be continued)

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(Continued from preceding page)

Item			Specifications
Dimension	W × D × H (mm)	Single Rack	610 × 1100 × 2006
		Six Rack	3610 × 1100 × 2006
Non Stop Maintenance	Control PCB		Support
	Cache Memory Module		Support
	Cache Flash Memory		Support
	Power Supply, Fan		Support
	Microcode		Support
	Disk Drive, Flash Drive		Support

*1: Available as spare or data disks.

*2: By the replacing SFP transceiver of the fibre port on the CHA to the DKC-F710I-1UL, the port can be used for the Longwave.

*3: Measurement Condition: The point 1m far from floor and surface of the product.

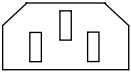
*4: Even if Storage system is in a power-off state, the cooling fan continues to rotate in a standby mode.

2.4 Power Specifications

2.4.1 Storage system Power Specifications

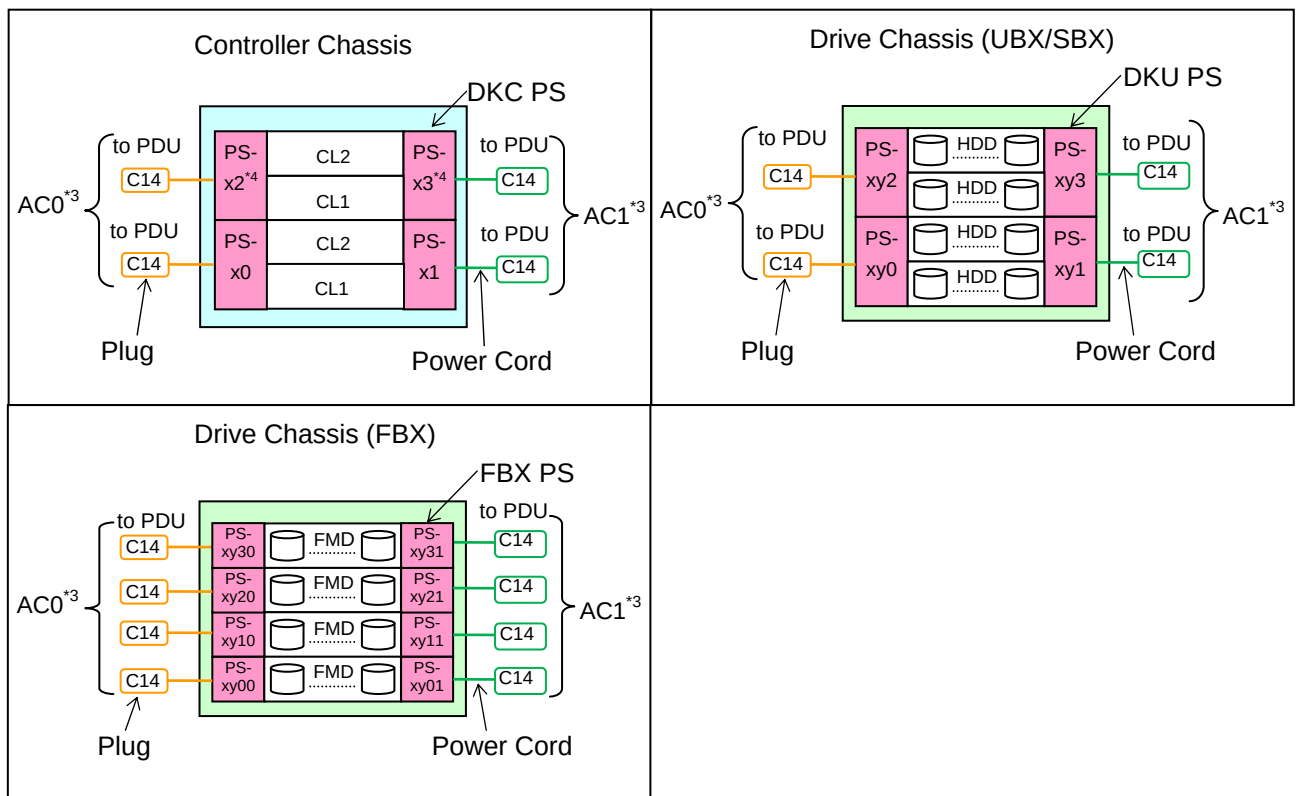
DKC710I input power specifications are shown as each power supply.

Table 2.4.1-1 Input Power Specifications

Item	Input Power	Input Current *1	Steady Current *2	Leakage Current	Inrush Current			Power Cord Plug Type
					1st (0-p)	2nd (0-p)	1st (0-p) Time (-25%)	
DKC PS	1-phase, AC200V to AC240V	7.18A	3.59A	0.28mA	20A	15A	80ms	IEC60320 C14 
DKU PS		6.52A	3.26A					
FBX PS		2.83A	1.42A					

*1: The maximum current in case AC input is not a redundant configuration (in case of 184V [200V -8%]).

*2: The maximum current in case AC input is a redundant configuration (in case of 184V [200V -8%]).



*3: Need to separate AC0 and AC1 for AC redundant.

*4: Optional parts

Fig. 2.4.1-1 Power Supply Locations

2.4.2 Notes of Power Supply

(1) Breakers

AC power for both racks is supplied to each PDU from the breaker. Fig. 2.4.2-1 and Fig. 2.4.2-2 show the breaker configurations for the DKC and DKU racks, respectively.

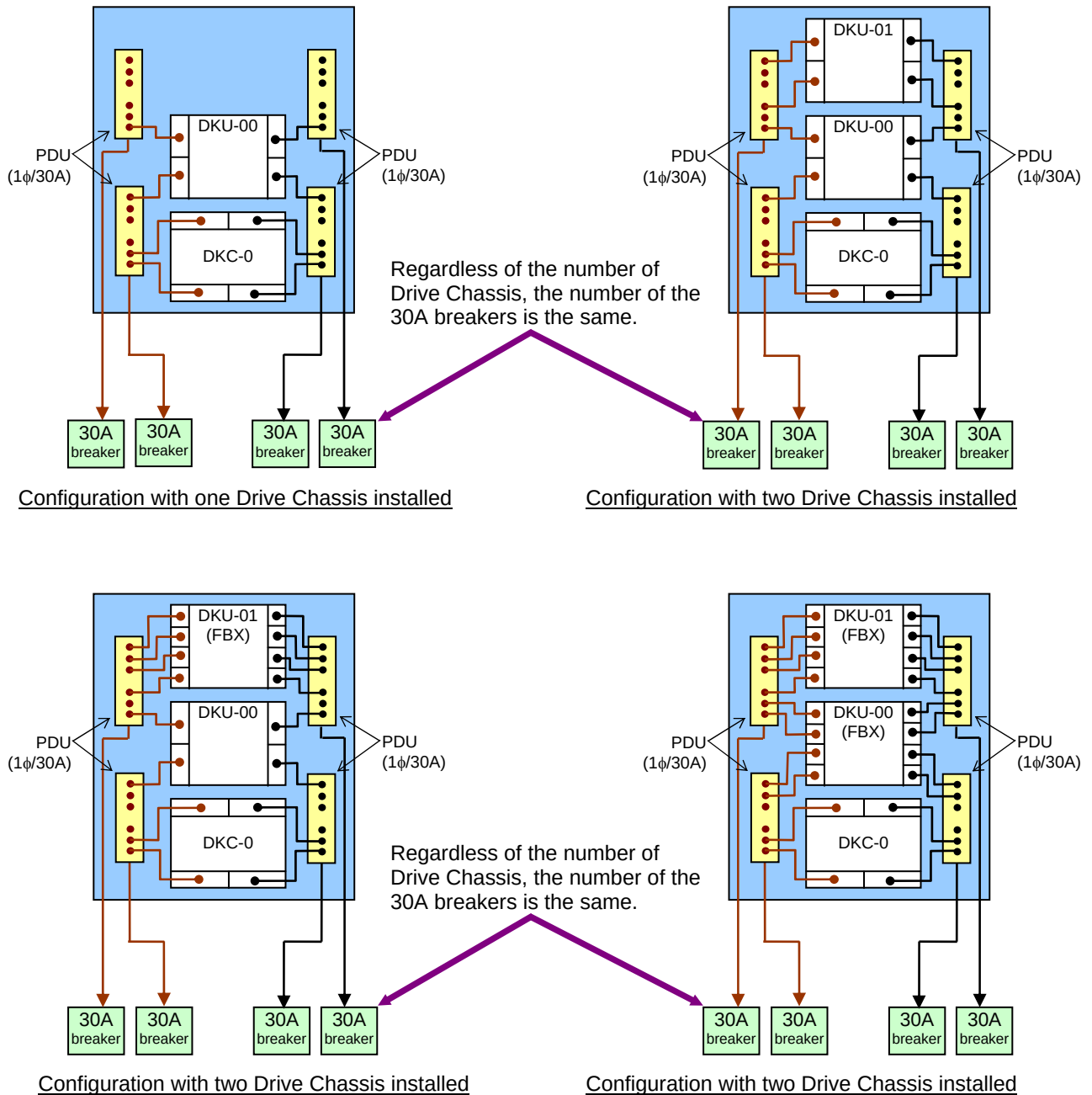


Fig. 2.4.2-1 Breaker Configurations for the DKC Rack (RACK-00/10)

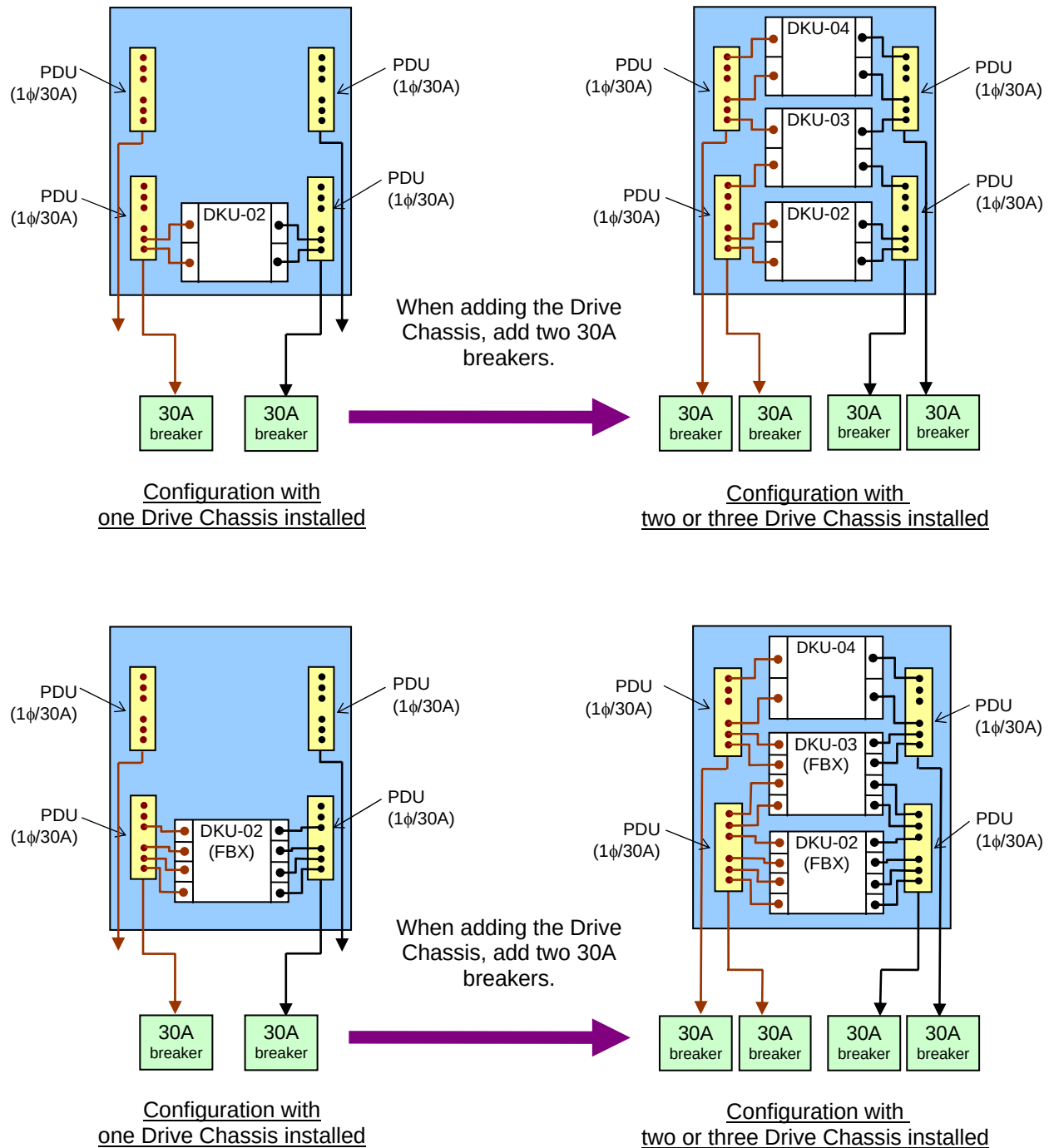


Fig. 2.4.2-2 Breaker Configurations for the DKU Rack (RACK-01/02)

(2) Power Connection

The AC power input for the DKC710I has the duplex PDU structure. This duplex structure enables the entire rack to remain powered on if AC power is removed from one of the two PDP (Power Distribution Panel).

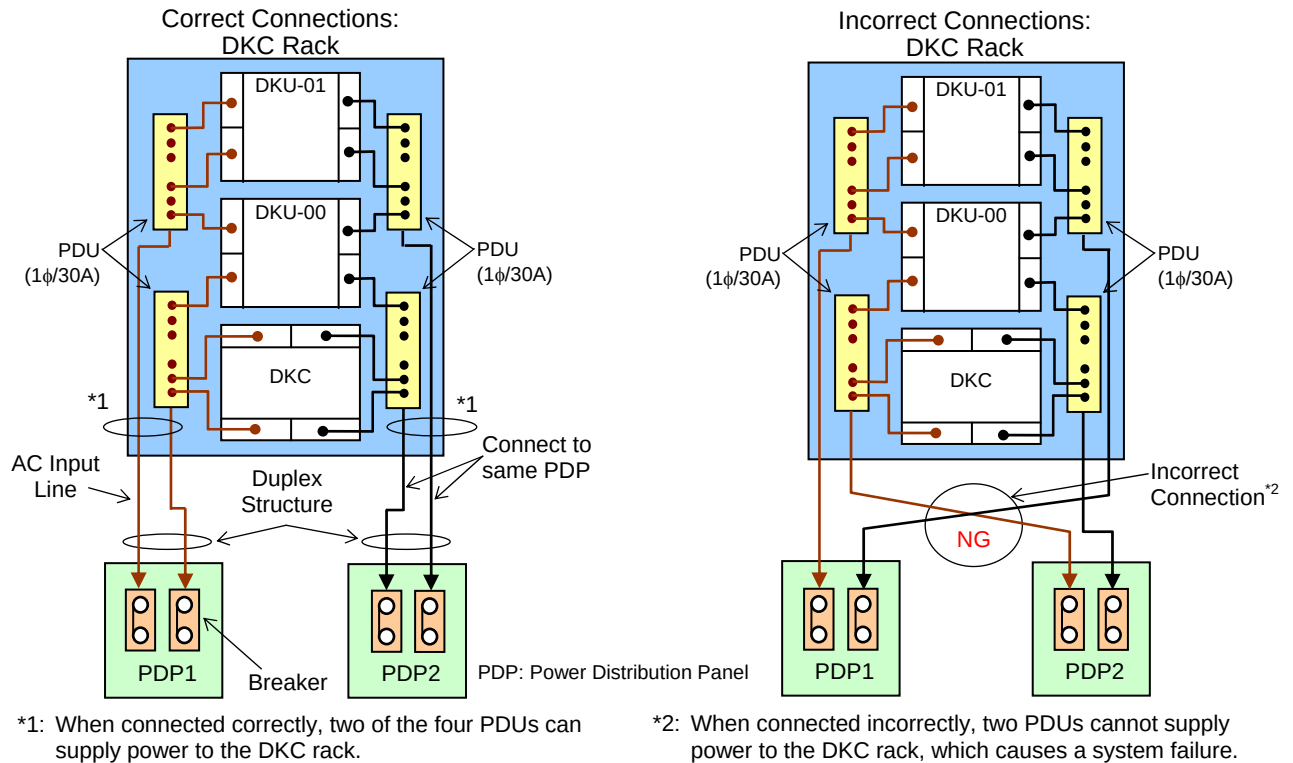


Fig. 2.4.2-3 Direct Power Connection

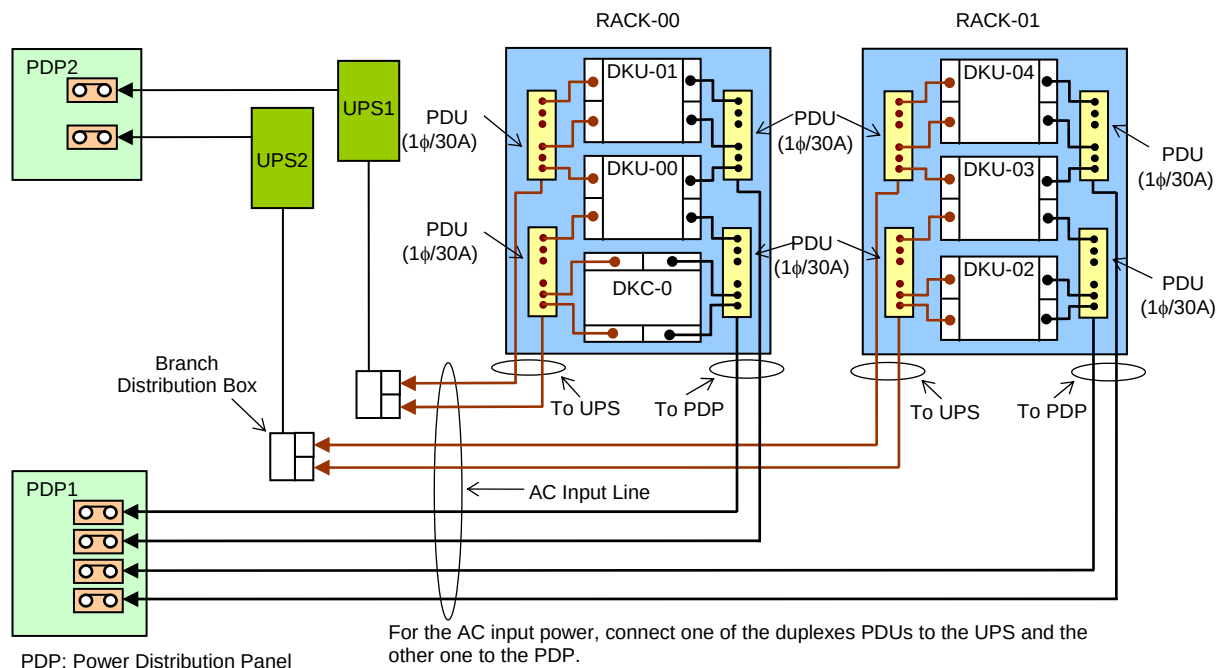


Fig. 2.4.2-4 Power Connection via UPS

2.5 Environmental Specifications

The environmental specifications are shown in the following table.

Item	Condition		
	Operating (*1)	Non-operation (*2)	Shipping & Storage (*3)
Temperature (°C)	16 to 32	-10 to 43	-25 to 60
Relative Humidity (%) (*4)	20 to 80	8 to 90	5 to 95
Max. Wet Bulb (°C)	26	27	29
Temperature Deviation (°C/hour)	10	10	20
Vibration (*5)	5 to 10Hz: 0.25mm 10 to 300Hz: 0.49m/s ²	5 to 10Hz: 2.5mm 10 to 70Hz: 4.9m/s ² 70 to 99Hz: 0.05mm 99 to 300Hz: 9.8m/s ²	Sine Vibration: 4.9m/s ² , 5min. At the resonant frequency with the highest displacement found between 3 to 100Hz (*6)
			Random Vibration: 0.147m ² /s ³ , 30min, 5 to 100Hz (*7)
Earthquake resistance (m/s ²)	up to 2.5 (*10)	—	—
Shock	—	78.4m/s ² , 15ms	Horizontal: Incline Impact 1.22m/s (*8)
			Vertical: Rotational Edge 0.15m (*9)
Altitude	-60 to 3,000m		—

- *1: Environmental specification for operating condition should be satisfied before the disk subsystem is powered on. Maximum temperature of 32°C should be strictly satisfied at air inlet portion.
Recommended temperature range is 21 to 24°C.
- *2: Non-operating condition includes both packing and unpacking conditions unless otherwise specified.
- *3: On shipping/storage condition, the product should be packed with factory packing.
- *4: No condensation in and around the drive should be observed under any conditions.
- *5: The above specifications of vibration are applied to all three axes.
- *6: See ASTM D999-01 The Methods for Vibration Testing of Shipping Containers.
- *7: See ASTM D4728-01 Test Method for Random Vibration Testing of Shipping Containers.
- *8: See ASTM D5277-92 Test Method for Performing Programmed Horizontal Impacts Using an Inclined Impact Tester.
- *9: See ASTM D6055-96 Test Methods for Mechanical Handling of Unitized Loads and Large Shipping Cases and Crates.
- *10: Time is 5 seconds or less in case of the testing with device resonance point (6 to 7Hz).

3. Internal Operation

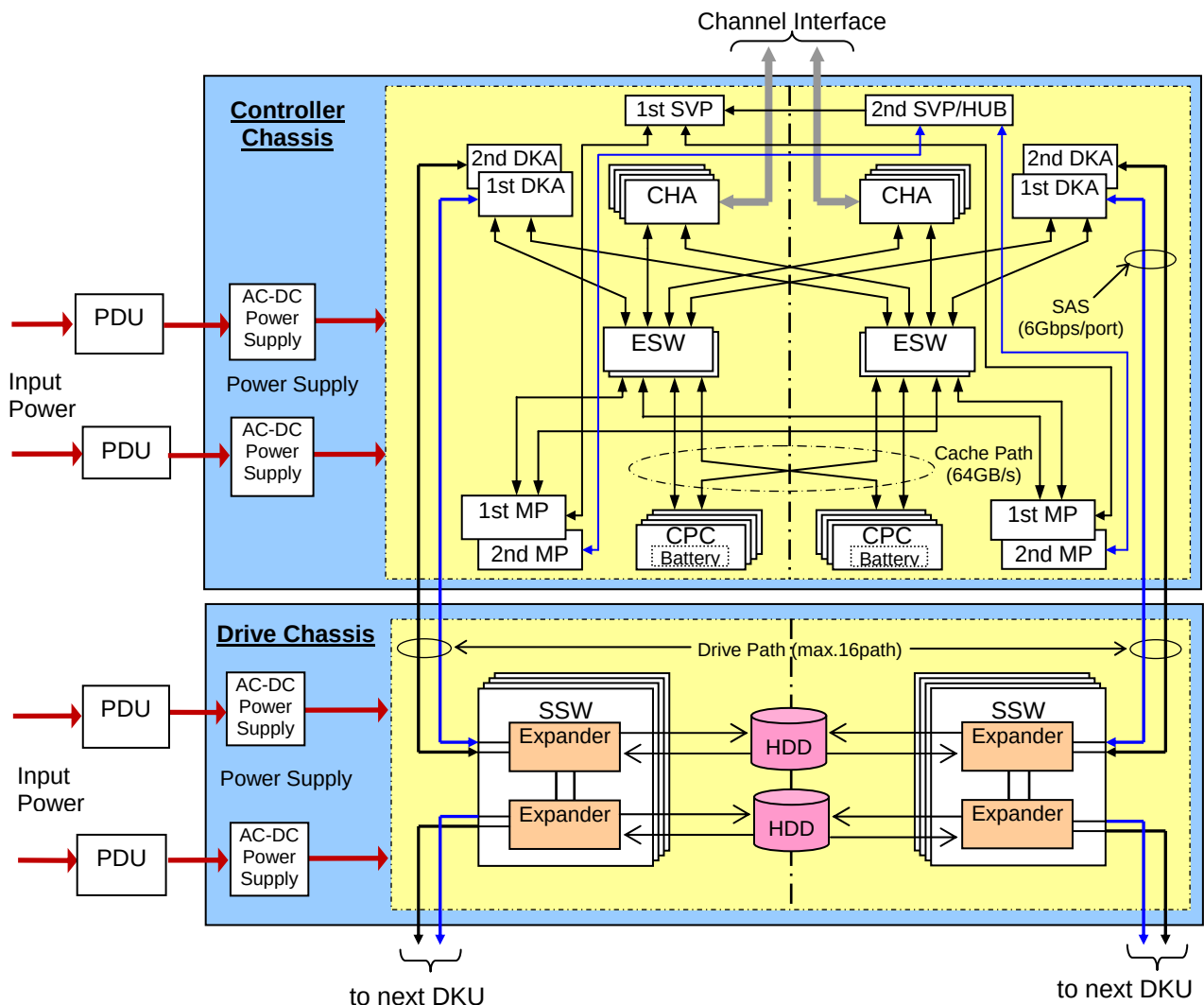
3.1 Hardware Block Diagram

The DKC710I consists of Controller Chassis (DKC) and Drive Chassis (DKU).

The Controller Chassis (DKC) consists of channel adapter (CHA), disk adapter (DKA), cache memory adapter (CPC), PCI-Express switch adapter (ESW), process blades (MP), service process (SVP), Cooling Fan and AC-DC power supply that supplies the power to the components.

The Drive Chassis (DKU) is a chassis to install the disk drives and the flash drives, and consists of SSW board, HDDPWR board, the cooling fan and the AC-DC power supply.

Hardware block diagram of subsystem is shown below.



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The connection of each CHAs, DKAs, CPCc, ESWs in the DKC is shown in “5.8 Connection Diagram of DKC” ([THEORY05-2010](#)).

In case of CHA or DKA, connected ESWs is different according to the installed location. Therefore, when the load of the cache access path is high, by regulating the number of CHAs, DKAs connecting with each ESW pair, the load on each ESWs or on the cache path becomes equal. As a result, this may improve the throughput of the system.

The details refer to “5.8 Connection Diagram of DKC” ([THEORY05-2010](#)).

3.2 Software Organization

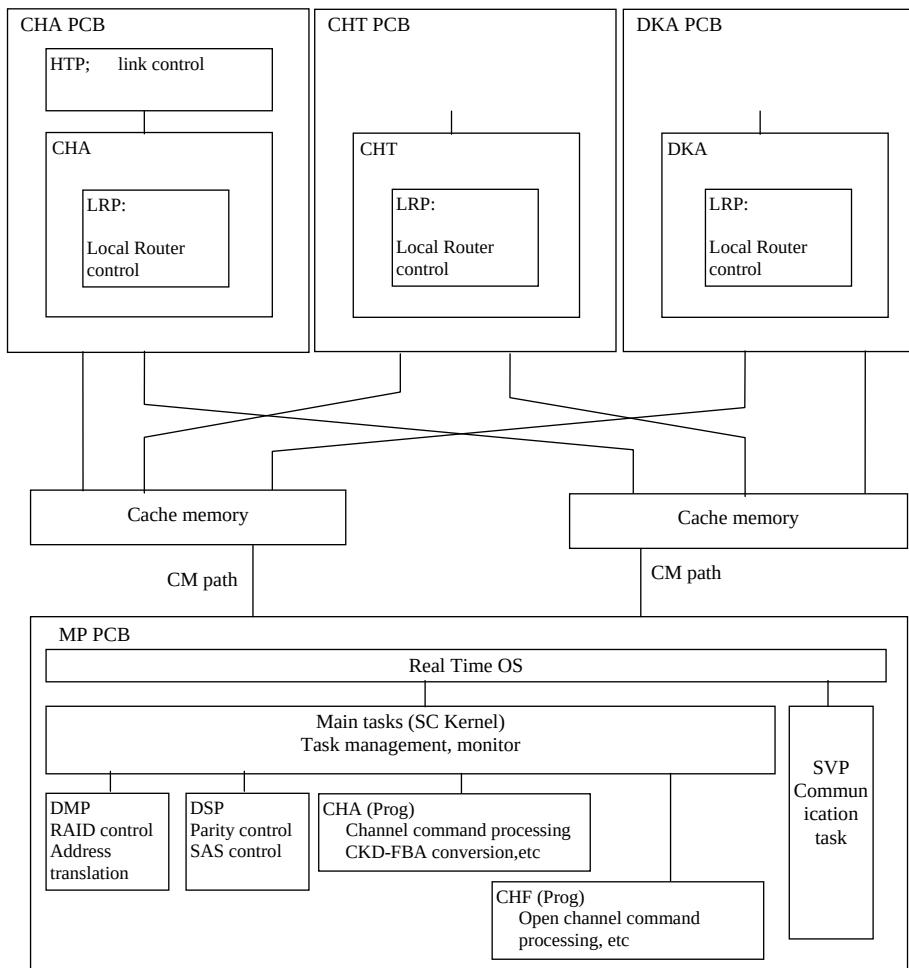


Fig. 3.2-1 Software Organization

Real Time OS:

A basic OS for controlling the RISC processor. Its primary tasks are to control and switch between the main tasks and SVP communication tasks.

Main tasks:

Made up of DKC control tasks (CHA Prog, CHF Prog, DMP, DSP) and the SC kernel tasks that supervise the DKC control tasks. They switch the control tasks by making use of the SC kernel's task switching facility.

SVP communication task:

Controls the communication with the SVP.

HTP (Hyper Transfer Program):

Controls the FICON channel links.

CHA (Prog):

Is a channel command control layer that processes channel commands and controls cache and data transfer operations. It is located in the CHA. CHA Prog is recognized by the logical volume number and logical block number.

CHF (Prog):

Is a open channel command control layer that processes open channel commands and controls cache and data transfer operations. It is located in the CHF. CHF Prog is recognized by the logical volume number and logical block number.

DMP (Disk Master Program):

RAID control functions. DMP is located in the DKA. DMP is recognized by the logical volume number and logical block number.

DSP (Disk Slave Program):

Is a Fibre drive control layer and provides Fibre control, drive data transfer control, and parity control functions. It is located in the DKA. DSP is recognized by the physical volume number and LBA number.

Cache memory:

Stores the shared information about the subsystem and the cache control information (director names). This type of information is used for the exclusive control of the subsystem. The Cache memory is controlled as two areas of memory and is fully non-volatile (time sustained during power failure dependant on configuration, de-stage or backup mode).

Cache PATH (Cache Memory Access Path):

Access Path from the processors of CHA, CHF, DKA, MP PCB to Cache Memory.

3.3 Data Formats

(1) Data Conversion Overview

Since the disk subsystem uses SCSI drives, data in the CKD format are converted to the FBA format on an interface before being written on the drives. The data format is shown in Fig. 3.3-1.

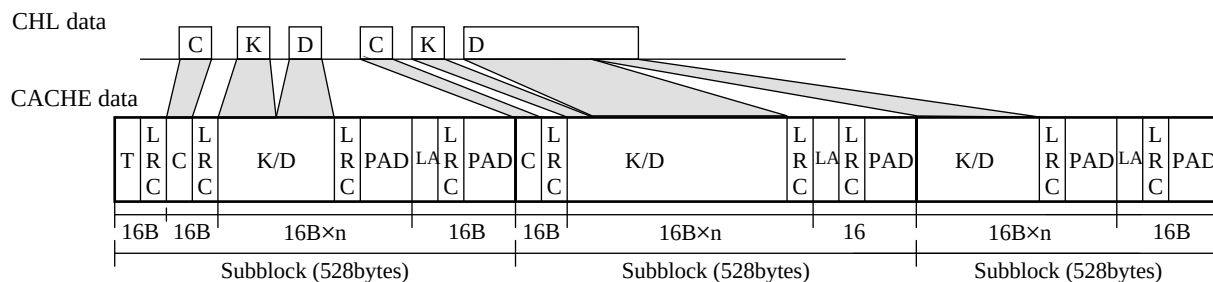
CKD-to-FBA conversion is carried out by the CHA. Data is stored in cache (in the DKC) in the FBA format. Consequently, the drive need not be aware of the data format when transferring to and receiving data from cache.

Each field of the CKD-format record is left-justified and the data is controlled in units of 528-byte subblocks (because data is transferred in 16-byte units). Each field is provided with data integrity code (LRC). An address integrity code (LA: logical address) is appended to the end of each subblock. A count area (C area) is always placed at the beginning of the subblock.

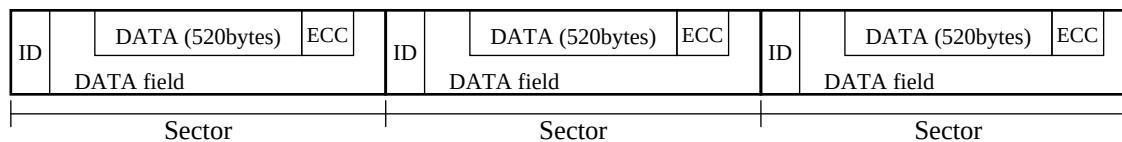
Four subblocks make up a single block. The first subblock of a block is provided with T information (record position information).

If a record proves not to fit in a subblock during CKD-to-FBA conversion, a field is split into the next subblock when it is recorded. If a record does not fill a subblock, the subblock is padded with 00s, from the end of the last field to the LA.

On a physical drive, data is recorded data fields in 520-byte units (physical data format). The format of the LA in the subblock in cache is shown in Fig. 3.3-1. The last 8 bytes of the LA area are padding data which is insignificant (the reason for this is because data is transferred to cache in 16 byte units). When data is transferred to a drive from cache, the last 8 bytes of each LA area are discarded and 520 bytes are transferred.

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Drive data



Subblock format

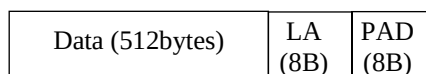


Fig. 3.3-1 Data Format

(2) Block format

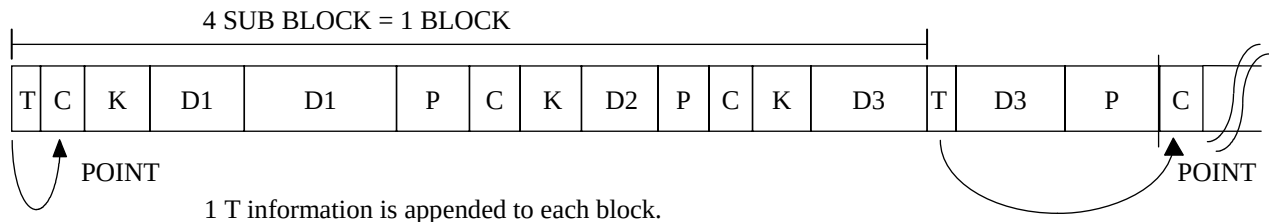


Fig. 3.3-2 Block Format

The RAID system records T information for each block of 4 subblocks as positional information that is used during record search. This unit of data is called a block.

1 block = 4 subblocks = 2 KB

The T information is 16 bytes long. However, only two bytes have meaning and the remaining 14 byte positions are padded with 0s. The reason for this is the same as that for the LA area. Unlike the LA, the insignificant bytes are also stored on the drive as are.

As seen from Fig. 3.3-2, the T information points to the closest count area in its block in the form of an SN (segment number). The drive computes the block number from the sector number with the SET SECT and searches the T information for the target block. From the T information, the drive computes the location of the closest count area and starts processing the block at the count area. This means that the information plays the role of the AM of the conventional disk storage.

(3) Data integrity provided

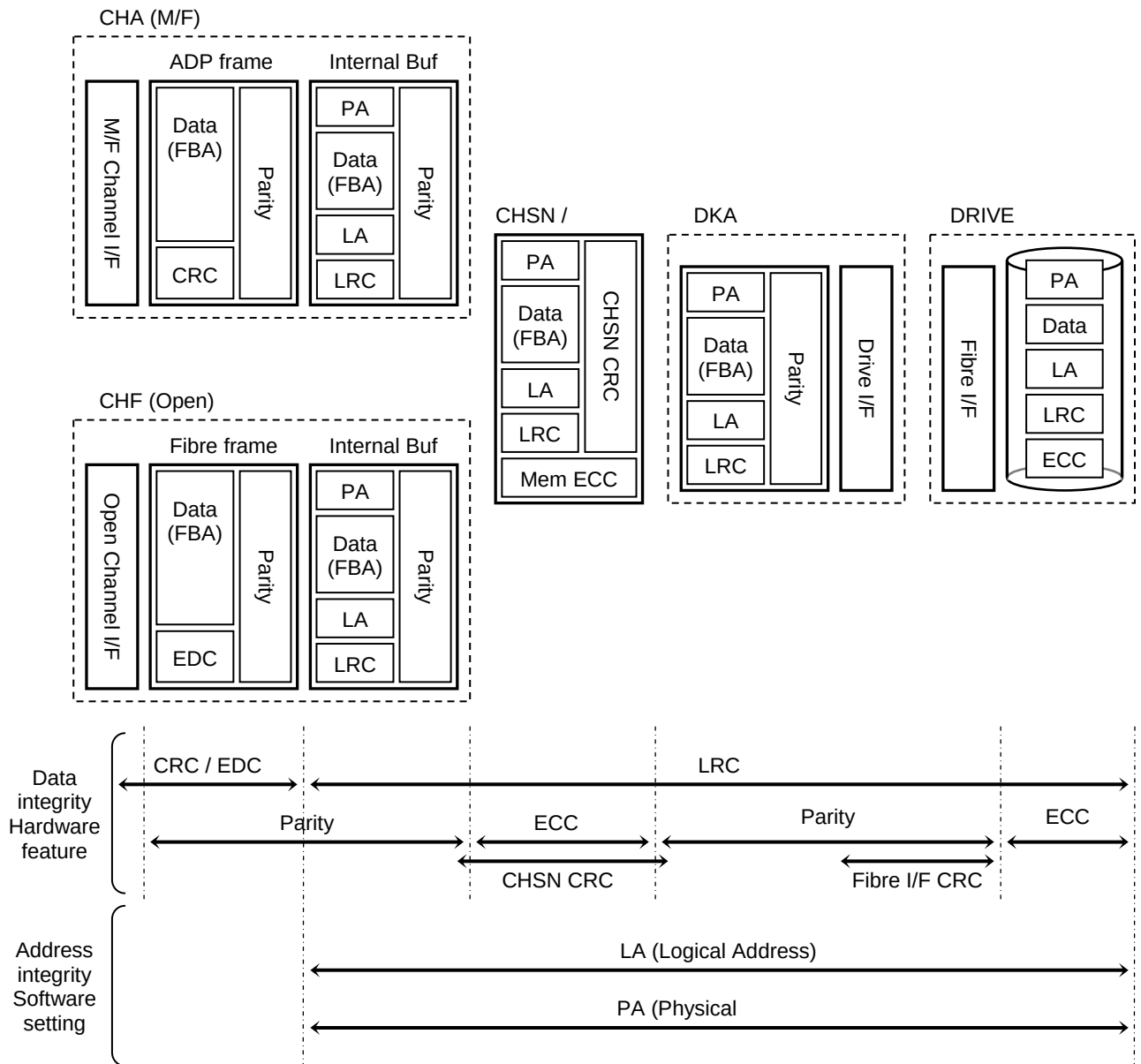


Fig. 3.3-3 Outline of Data Integrity

In the DKC and DKU system, a data integrity code is appended to the data being transferred at each component as shown in Fig. 3.3-3. Since data is striped onto two or more disk devices and the address integrity code is also appended. The data integrity codes are appended by hardware and the address integrity codes by software.

3.4 Cache Management

Since the DKC requires no through operation, its cache system is implemented by two memory areas called cache A and cache B so that write data can be duplexed. To prevent data loss due to power failures, cache is made non-volatile by storing SSD on cache PCB. This dispenses with the need for the conventional NVS.

The minimum unit of cache is the segment. Cache is destaged in segment units. Emulation Disk type at one or four segments make up one slot. The read and write slots are always controlled in pair. Cache data is enqueued and dequeued usually in slot units. In real practice, the segments of the same slot are not always stored in a contiguous area in cache, but are stored in discreet areas. These segments are controlled suing CACHE-SLCB and CACHE-SGCB so that the segments belonging to the same slot are seemingly stored in a contiguous area in cache.

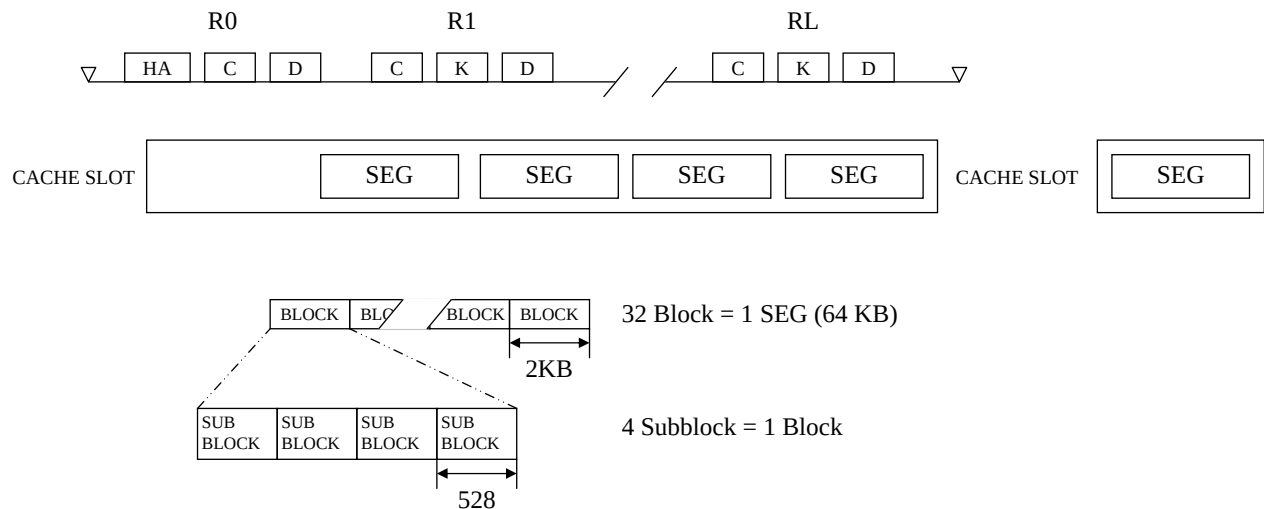


Fig. 3.4-1 Cache Data Structure

For increased directory search efficiency, a single virtual device (VDEV) is divided into 16-slot groups which are controlled using VDEV-GRPP and CACHE-GRPT.

1 cache segment = 32 blocks = 128 subblocks = 64 KB

1 slot = 1 stripe = 1 segment = 48 KB = OPEN-X (where X is other than OPEN-V)

1 segment = 58 KB = 3390-X mainframe volume

4 segments = 256 KB = OPEN-V

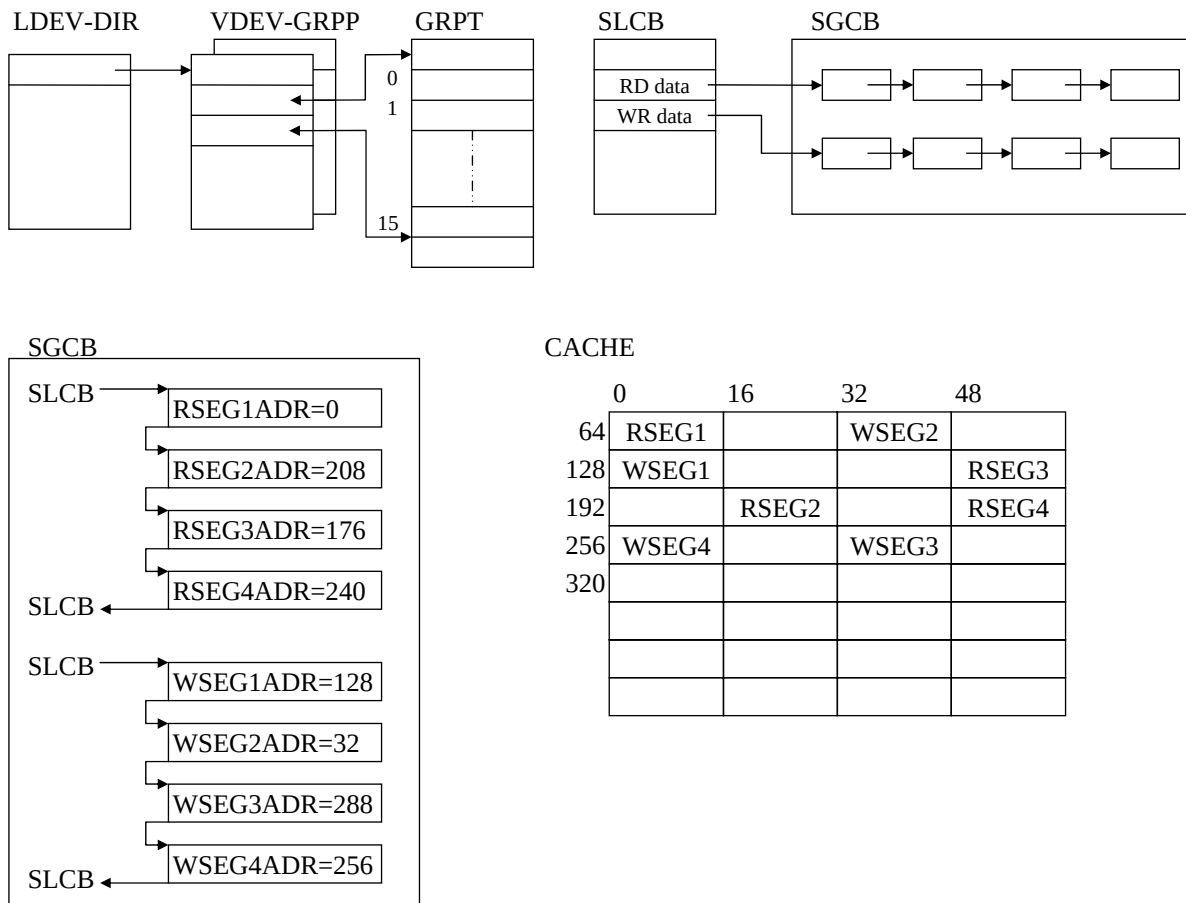
The directories VDEV-GRPP, CACHE-GRPT, CACHE-SLCB, and CACHE-SGCB are used to identify the cache hit and miss conditions. These control tables are stored in the shared memory.

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In addition to the cache hit and miss control, the shared memory is used to classify and control the data in cache according to its attributes. Queues are something like boxes that are used to classify data according to its attributes.

Basically, queues are controlled in slot units (some queues are controlled in segment units). Like SLCB-SGCB, queues are controlled using a queue control table so that queue data of the seemingly same attribute can be controlled as a single data group. These control tables are briefly described below.

(1) Cache control tables (directories)

**LDEV-DIR (Logical DEV-directory):**

Contains the shared memory addresses of VDEV-GRPPs for an LDEV. LDEV-DIR is located in the local memory in the CHA.

VDEV-GRPP (Virtual DEV-group Pointer):

Contains the shared memory addresses of the GRPTs associated with the group numbers in the VDEV.

GRPT (Group Table):

A table that contains the shared memory address of the SLCBs for 16 slots in the group. Slots are grouped to facilitate slot search and to reduce the space for the directory area.

SLCB (Slot Control Block):

Contains the shared memory addresses of the starting and ending SGCBs in the slot. One or more SGCBs are chained. The SLCB also stores slot status and points to the queue that is connected to the slot. The state transitions of clean and dirty queues occur in slot units. The processing tasks reserve and release cache areas in this unit.

SGCB (Segment Control Block):

Contains the control information about a cache segment. It contains the cache address of the segment. It is used to control the staged subblock bit map, dirty subblock bitmap, and other information. The state transitions of only free queues occur in segment units.

(2) Cache control table access method (hit/miss identification procedure)

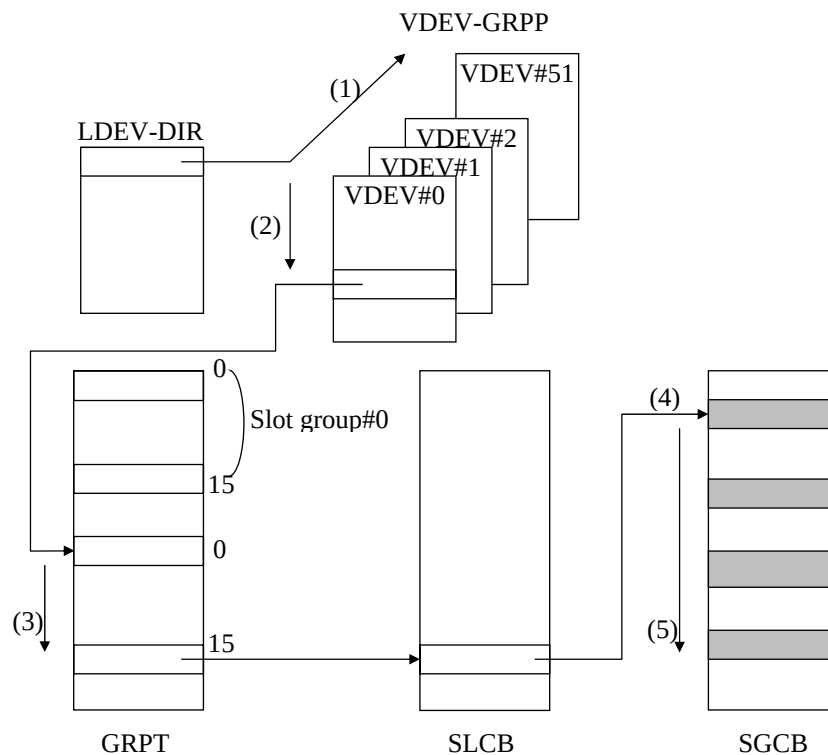


Fig. 3.4-2 Outline of Cache Control Table Access

1. The current VDEV-GRPP is referenced through the LDEV-DIR to determine the hit/miss condition of the VDEV-groups.
2. If a VDEV-group hits, CACHE-GRPT is referenced to determine the hit/miss condition of the slots.
3. If a slot hits, CACHE-SLCB is referenced to determine the hit/miss condition of the segments.
4. If a segment hits, CACHE-SGCB is referenced to access the data in cache.

If a search miss occurs during the searches from 1. through 4., the target data causes a cache miss.

Definition of VDEV number

Since the host processor recognizes addresses only by LDEV, it is unaware of the device address of the parity device. Accordingly, the RAID system is provided with a VDEV address which identifies the parity device associated with an LDEV. Since VDEVs are used to control data devices and parity devices systematically, their address can be computed using the following formulas:

Data VDEV number = LDEV number

Parity VDEV number = 1024 + LDEV number

From the above formulas, the VDEV number ranges from 0 to 2047.

(3) Queue structures

The DKC and DKU uses 10 types of queues to control data in cache segments according to its attributes. These queues are explained below.

- CACHE-GRPT free queue

This queue is used to control segments that are currently not used by CACHE-GRPT (free segments) on an FIFO (First-In, First-Out) basis. When a new table is added to CACHE-GRPT, the segment that is located by the head pointer of the queue is used.

- CACHE-SLCB free queue

This queue is used to control segments that are currently not used by CACHE-SLCB (free segments) on an FIFO basis. When a new slot is added to CACHE-SLCB, the segment that is located by the head pointer of the queue is used.

- CACHE-SGCB free queue

This queue is used to control segments that are currently not used by CACHE-SGCB (free segments) on an FIFO basis. When a new segment is added to CACHE-SGCB, the segment that is located by the head pointer of the queue is used.

- Clean queue

This queue is used to control the segments that are reflected on the drive on an LRU basis.

- Bind queue

This queue is defined when the bind mode is specified and used to control the segments of the bind attribute on an LRU basis.

- Error queue

This queue controls the segments that are no longer reflected on the drive due to some error (pinned data) on an LRU basis.

- Parity in-creation queue

This queue controls the slots (segments) that are creating parity on an LRU basis.

- DFW queue (host dirty queue)

This queue controls the segments that are not reflected on the drive in the DFW mode on an LRU basis.

- CFW queue (host dirty queue)

This queue controls the segments that are not reflected on the drive in the CFW mode on an LRU basis.

- PDEV queue (physical dirty queue)

This queue controls the data (segments) that are not reflected on the drive and that occur after a parity is generated. Data is destaged from this queue onto the physical DEV. There are 32 PDEV queues per physical DEV.

The control table for these queues is located in the shared memory and points to the head and tail segments of the queues.

(4) Queue state transitions

Fig. 3.4-3 shows the state transitions of the queues used in. A brief description of the queue state transitions follows.

- State transition from a free queue

When a read miss occurs, the pertinent segment is staged and enqueued to a clean queue. When a write miss occurs, the pertinent segment is temporarily staged and enqueued to a host dirty queue.

- State transition from a clean queue

When a write hit occurs, the segment is enqueued to a host dirty queue. Transition from clean to free queues is performed on an LRU basis.

- State transition from a host dirty queue

The host dirty queue contains data that reflects no parity. When parity generation is started, a state transition occurs to the parity in-creation queue.

- State transition from the parity in-creation queue

The parity in-creation queue contains parity in-creation data. When parity generation is completed, a transition to a physical dirty queue occurs.

- State transition from a physical dirty queue

When a write hit occurs in the data segment that is enqueued in a physical dirty queue, the segment is enqueued into the host dirty queue again. When destaging of the data segment is completed, the segment is enqueued into a queue (destaging of data segments occur asynchronously on an LRU basis).

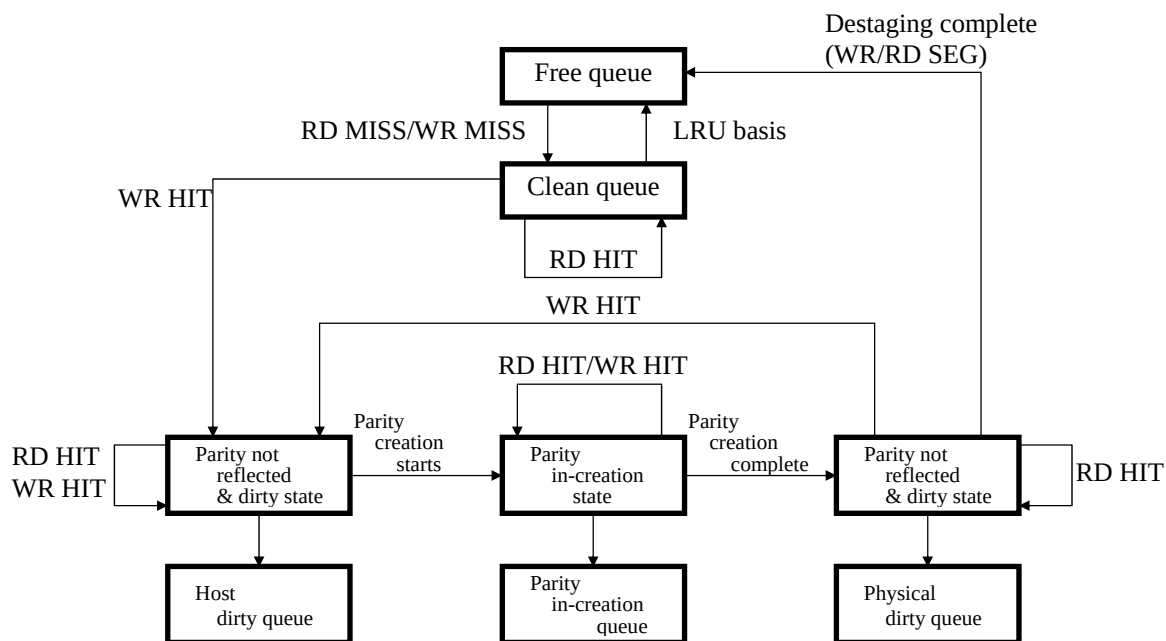
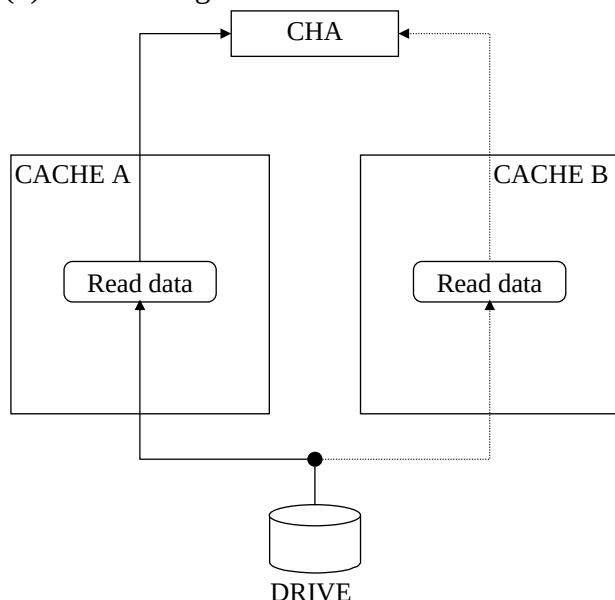


Fig. 3.4-3 Queue Segment State Transition Diagram

(5) Cache usage in the read mode



The cache area to be used for destaging read data is determined depending on whether the result of evaluating the following expression is odd or even:

$$(\text{CYL\#} \times 15 + \text{HD\#}) / 16$$

The read data is destaged into area A if the result is even and into area B if the result is odd.

Fig. 3.4-4 Cache Usage in the Read Mode

Read data is not duplexed and its destaging cache area is determined by the formula shown in Fig. 3.4-4. Staging is performed not only on the segments containing the pertinent block but also on the subsequent segments up to the end of track (for increased hit ratio). Consequently, one track equivalence of data is prefetched starting at the target block. This formula is introduced so that the cache activity ratios for areas A and B are even. The staged cache area is called the cache area and the other area NVS area.

(6) Cache usage in the write mode

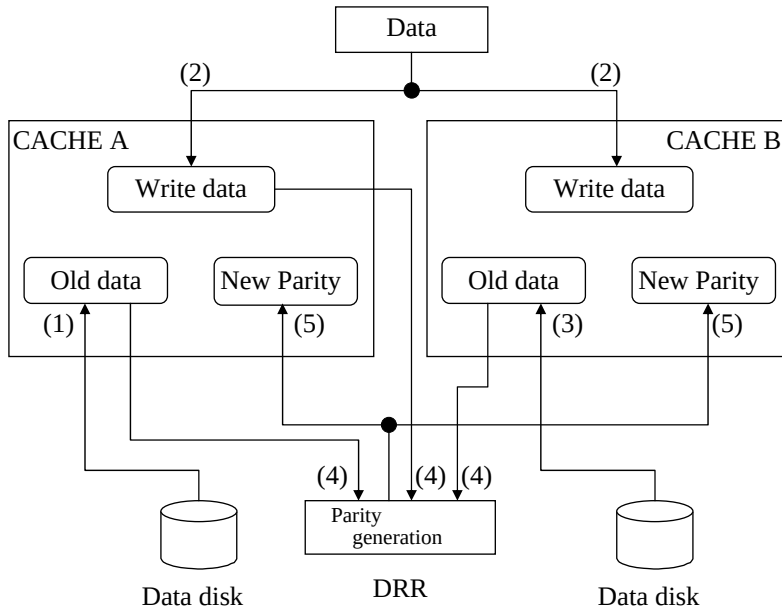


Fig. 3.4-5 Cache Usage in the Write Mode

This system handles write data (new data) and read data (old data) in separate segments as shown in Fig. 3.4-5 (not overwritten as in the conventional systems), whereby compensating for the write penalty.

- (1) If the write data in question causes a cache miss, the data from the block containing the target record up to the end of the track is staged into a read data slot.
- (2) In parallel with step (1), the write data is transferred when the block in question is established in the read data slot.
- (3) The parity data for the block in question is checked for a hit or miss condition and, if a cache miss condition is detected, the old parity is staged into a read parity slot.
- (4) When all data necessary for generating new parity is established, it is transferred to the DRR circuit in the DKA.
- (5) When the new parity is completed, the DRR transfers it into the write parity slots for cache A and cache B (the new parity is handled in the same manner as the write data).

The reason for writing the write data into both cache areas is that data will be lost if a cache error occurs when it is not yet written on the disk.

Although two cache areas are used as explained above, the read data (including parity) is staged into either cache A or cache B simply by duplexing only the write data (including parity) (in the same manner as in the read mode).

(7) CFW-inhibited write-operation (with Cache single-side error)

The non RAID-type Disk systems write data directly onto disk storage in the form of cache through, without performing a DFW, when a cache error occurs. In this system, cache must always be passed, which fact disables the through operation. Consequently, the write data is duplexed, and a CFW-inhibited write-operation is performed; that is, when one cache subsystem goes down, the end of processing status is not reported until the data write in the other cache subsystem is completed. This process is called CFW-inhibited write-operation.

The control information necessary for controlling cache is stored in the shared memory.

3.5 Destaging Operations

(1) Cache management in the destage mode (RAID5)

Destaging onto a drive is deferred until parity generation is completed. Data and parity slot transitions in the destage mode occur as shown in Fig. 3.5-1.

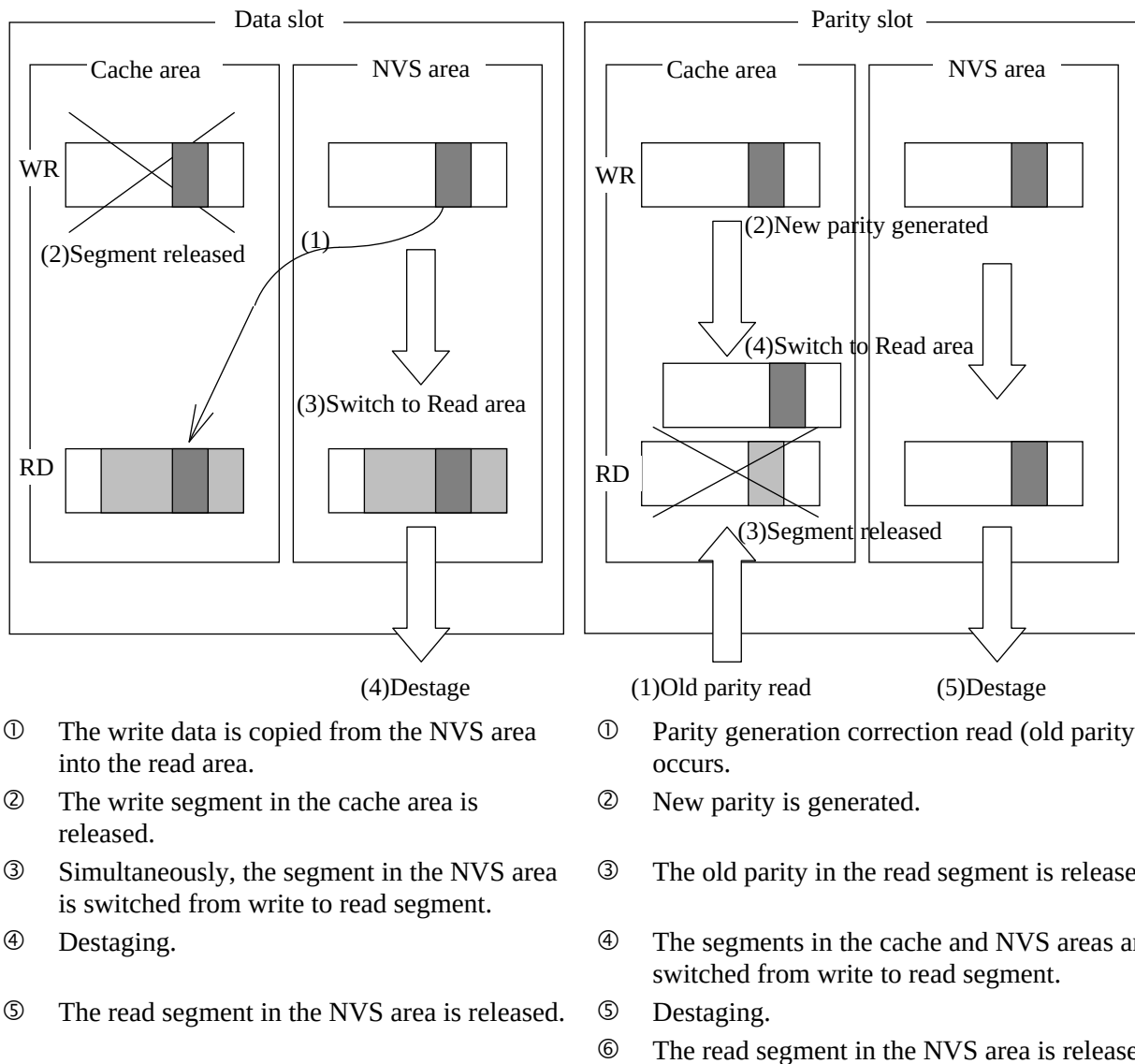


Fig. 3.5-1 Cache Operation in the Destage Mode

Write data is stored in write segments before parity is generated but stored in read segments after parity is generated. When drive data is stored, therefore, the data from the read segment is transferred.

(2) Cache management in the destage mode (RAID1)

Data slot is destaged to primary/secondary drive.

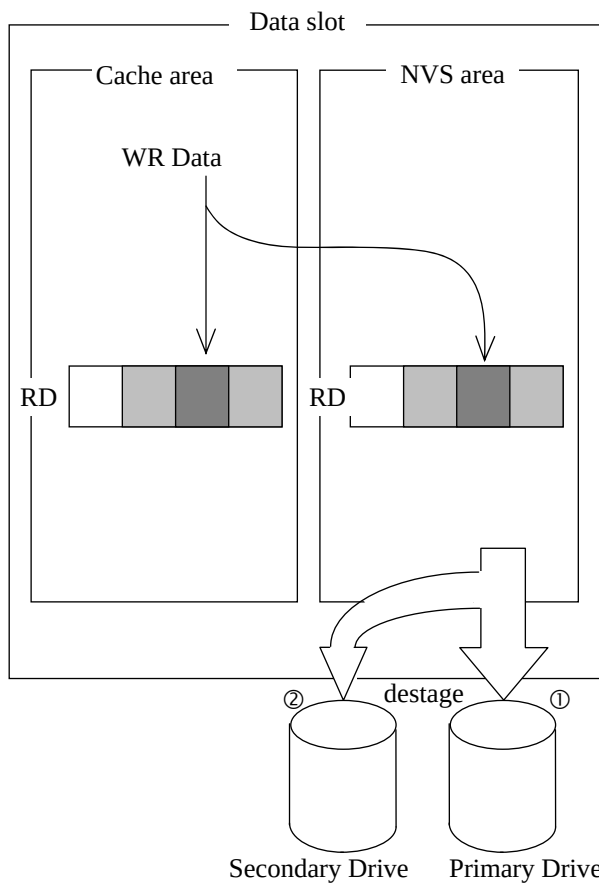


Fig. 3.5-2 RAID1 asynchronous destage

- ① Destage to primary drive.
- ② Destage to secondary drive.
- ③ The data read segment in the NVS area is released.

(3) Blocked data write

The purpose of blocked data write is to reduce the number of accesses to the drive during destaging, whereby increasing the subsystem performance. There are three modes of blocked data write: single-stripe blocking, multiple-stripe blocking, and drive blocking. These modes are briefly explained below.

- Single-stripe blocking

Two or more dirty segments in a stripe are combined into a single dirty data block. Contiguous dirty blocks are placed in a single area. If an unloaded block exists between dirty blocks, the system destages the dirty blocks separately at the unloaded block. If a clean block exists between dirty blocks, the system destages the blocks including the clean block.

- Multiple-stripe blocking

The sequence of stripes in a parity group are blocked to reduce the number of write penalties. This mode is useful for sequential data transfer.

- Drive blocking

In the drive blocking mode, blocks to be destaged are written in a block with a single drive command if they are contiguous when viewed from a physical drive to shorten the drive's latency time.

The single- and multiple-stripe blocking modes are also called in-cache blocking modes. The DMP determines which mode to use. The drive blocking mode is identified by the DSP.

3.6 Operations Performed when Drive Errors Occur

(1) I/O operations performed when drive errors occur

This system can recover target data using parity data and data stored on normal disk storage even when it cannot read data due to errors occurring on physical drives. This feature ensures non-disruptive processing of applications in case of drive errors. This system can also continue processing for the same reason in case errors occur on physical drives while processing write requests.

Fig. 3.6-1 shows the outline of data read processing in case a drive error occurs.

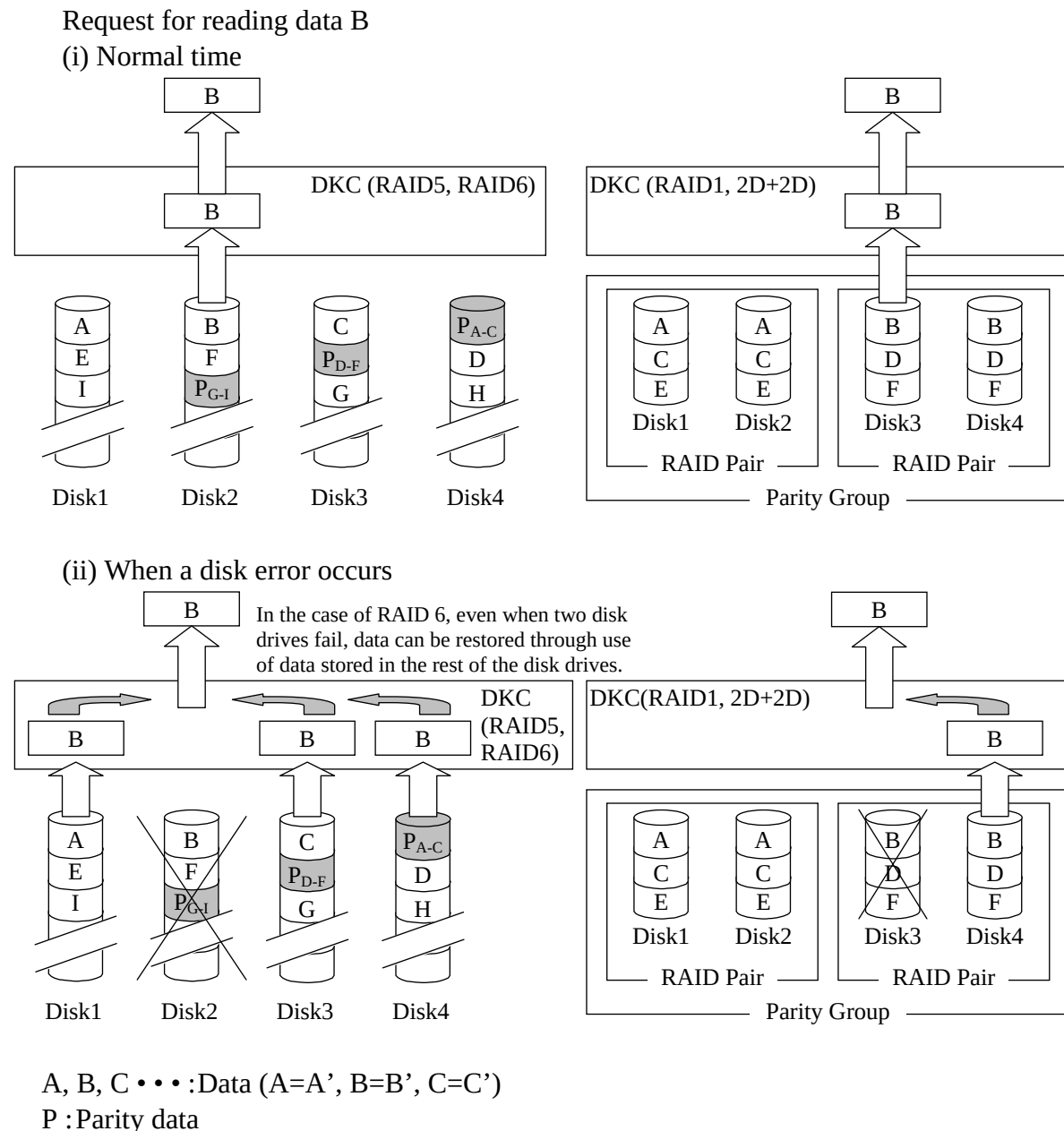


Fig. 3.6-1 Outline of Data Read Processing

(2) Data integrity feature and drive errors

This system uses spare disk drives and reconfigures any drives that are blocked due to errors or drives whose error count exceeds a specified limit value using spare disks. (Drives belonging to a Parity Group with no LDEVs defined are not reconfigured.)

Since this processing is executed on the host in the background, this system can continue to accept I/O requests. The data saved on spare disks are copied into the original location after the error drives are replaced with new ones.

1. Dynamic sparing

This system keeps track of the number of errors that occurred, for each drive, when it executes normal read or write processing. If the number of errors occurring on a certain drive exceeds a predetermined value, this system considers that the drive is likely to cause unrecoverable errors and automatically copies data from that drive to a spare disk. This function is called dynamic sparing. In RAID1 method, this system is same as RAID5 dynamic sparing.

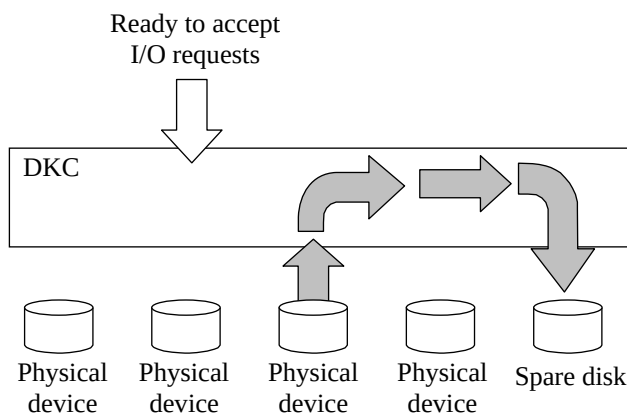


Fig. 3.6-2 Outline of the Dynamic Sparing Function

2. Correction copy

When this system cannot read or write data from or to a drive due to an error occurring on that drive, it regenerates the original data for that drive using data from the other drives and the parity data, and copies it onto a spare disk. In RAID1 method, this system copies data from the another drive to a spare disk.

In the case of RAID 6, the correction copy can be made to up to two disk drives in a parity group.

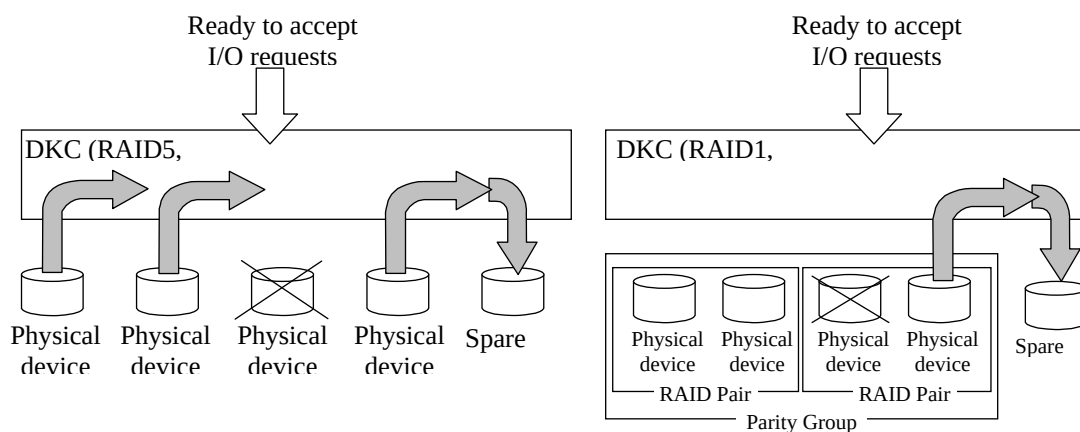


Fig. 3.6-3 Outline of the Correction Copy Function

3. Allowable number of copying operations

Table 3.6-1 Allowable number of copying operations

RAID level	Allowable number of copying operations
RAID1	Either the dynamic sparing or correction copy can be executed within a RAID pair.
RAID5	Either the dynamic sparing or correction copy can be executed within a parity group.
RAID6	The dynamic sparing and/or correction copy can be executed up to a total of twice within a parity group.

3.7 Inter Mix of Drives and Emulation types

3.7.1 Drives to be Connected

The models of disk units which are connectable with the DKC710I disk subsystem and the specifications of each disk unit are shown in Table 2.3-1 ([THEORY02-220](#)).

The DKC710I disk subsystem can connect up to 1152 disk drives mentioned above, though the number of connectable disk drives varies with the emulation types and the RAID configuration. These will be explained in detail in Section 3.7.2.

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SVP displays each drive model as the following table.

Disk drive model	SVP screen	Drive Form Factor
DKS5B-K146SS	DKS5B-K146SS	2.5 inch SAS HDD
DKS5C-K146SS	DKS5C-K146SS	2.5 inch SAS HDD
SDT5A-S200SS	SDT5A-S200SS	2.5 inch SSD
SDT5C-S200SS	SDT5C-S200SS	2.5 inch SSD
SFB5A-M200SS	SFB5A-M200SS	2.5 inch SSD
SLR5A-S200SS	SLR5A-S200SS	2.5 inch SSD
SLR5B-S200SS	SLR5B-S200SS	2.5 inch SSD
SLR5B-M200SS	SLR5B-M200SS	2.5 inch SSD
SLR5C-M200SS	SLR5C-M200SS	2.5 inch SSD
DKR5C-J300SS	DKR5C-J300SS	2.5 inch SAS HDD
DKR5D-J300SS	DKR5D-J300SS	2.5 inch SAS HDD
DKS5B-J300SS	DKS5B-J300SS	2.5 inch SAS HDD
DKS5D-J300SS	DKS5D-J300SS	2.5 inch SAS HDD
DKS5E-J300SS	DKS5E-J300SS	2.5 inch SAS HDD
DKS5C-K300SS	DKS5C-K300SS	2.5 inch SAS HDD
SFB5A-M400SS	SFB5A-M400SS	2.5 inch SSD
SLR5A-S400SS	SLR5A-S400SS	2.5 inch SSD
SLR5B-S400SS	SLR5B-S400SS	2.5 inch SSD
SLR5B-M400SS	SLR5B-M400SS	2.5 inch SSD
SLR5C-M400SS	SLR5C-M400SS	2.5 inch SSD
SDT2A-S400SS	SDT2A-S400SS	3.5 inch SSD
SDT2C-S400SS	SDT2C-S400SS	3.5 inch SSD

(To be continued)

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(Continued from the preceding page)

Disk drive model	SVP screen	Drive Form Factor
DKS5A-H500SS	DKS5A-H500SS	2.5 inch SAS HDD
DKS5B-H500SS	DKS5B-H500SS	2.5 inch SAS HDD
DKR5C-J600SS	DKR5C-J600SS	2.5 inch SAS HDD
DKR5D-J600SS	DKR5D-J600SS	2.5 inch SAS HDD
DKS5C-J600SS	DKS5C-J600SS	2.5 inch SAS HDD
DKS5D-J600SS	DKS5D-J600SS	2.5 inch SAS HDD
DKS5E-J600SS	DKS5E-J600SS	2.5 inch SAS HDD
SFB5A-M800SS	SFB5A-M800SS	2.5 inch SSD
SLR5C-M800SS	SLR5C-M800SS	2.5 inch SSD
DKR5D-J900SS	DKR5D-J900SS	2.5 inch SAS HDD
DKS5D-J900SS	DKS5D-J900SS	2.5 inch SAS HDD
DKS5E-J900SS	DKS5E-J900SS	2.5 inch SAS HDD
DKS5B-H1R0SS	DKS5B-H1R0SS	2.5 inch SAS HDD
DKR5E-J1R2SS	DKR5E-J1R2SS	2.5 inch SAS HDD
DKS5F-J1R2SS	DKS5F-J1R2SS	2.5 inch SAS HDD
NFH1A-P1R6SS	NFH1A-P1R6SS	Flash Module Drive
NFH1C-P1R6SS	NFH1C-P1R6SS	Flash Module Drive
DKR2C-H2R0AT	DKR2C-H2R0AT	3.5 inch SATA HDD
DKR2D-H2R0AT	DKR2D-H2R0AT	3.5 inch SATA HDD
DKR2E-H2R0AT	DKR2E-H2R0AT	3.5 inch SATA HDD
DKS2C-H2R0SS	DKS2C-H2R0SS	3.5 inch SAS HDD
DKS2D-H2R0SD	DKS2D-H2R0SS	3.5 inch SAS HDD
DKS2D-H2R0SS	DKS2D-H2R0SS	3.5 inch SAS HDD
DKS2E-H2R0SS	DKS2E-H2R0SS	3.5 inch SAS HDD
DKS2P-H2R0SS	DKS2P-H2R0SS	3.5 inch SAS HDD
DKW2E-H2R0SS	DKW2E-H2R0SS	3.5 inch SAS HDD
DKS2D-H3R0SS	DKS2D-H3R0SS	3.5 inch SAS HDD
DKS2E-H3R0SS	DKS2E-H3R0SS	3.5 inch SAS HDD
DKW2E-H3R0SS	DKW2E-H3R0SS	3.5 inch SAS HDD
NFH1B-P3R2SS	NFH1B-P3R2SS	Flash Module Drive
NFH1C-P3R2SS	NFH1C-P3R2SS	Flash Module Drive
DKS2E-H4R0SS	DKS2E-H4R0SS	3.5 inch SAS HDD
DKW2E-H4R0SS	DKW2E-H4R0SS	3.5 inch SAS HDD

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When a disk drive to be installed (the same rotation speed and the same capacity) is different from the setting model of the SVP, refer to the following chart to select a recommended setting model.

Disk drive model	Recommendation setting
DKS5x-K146SS	DKS5B-K146SS
DKS5x-K300SS	DKS5C-K300SS
DKR5x-J300SS	DKR5C-J300SS
DKS5x-J300SS	
DKR5x-J600SS	DKR5C-J600SS
DKS5x-J600SS	
DKR5x-J900SS	DKS5D-J900SS
DKS5x-J900SS	
DKR5x-J1R2SS	DKR5E-J1R2SS
DKS5x-J1R2SS	
DKS5x-H500SS	DKS5A-H500SS
DKS5x-H1R0SS	DKS5B-H1R0SS
DKR2x-H2R0AT	DKR2C-H2R0AT
SDT5x-S200SS	SDT5A-S200SS
SLR5x-S200SS	
SLR5x-S400SS	SLR5A-S400SS
SDT2x-S400SS	SDT2A-S400SS
SFB5x-M200SS	SLR5B-M200SS
SLR5x-M200SS	
SFB5x-M400SS	SLR5B-M400SS
SLR5x-M400SS	
SFB5x-M800SS	SFB5A-M800SS
SLR5x-M800SS	
DKS2x-H2R0SS	DKS2C-H2R0SS
DKS2x-H2R0SD	
DKW2x-H2R0SS	
DKS2x-H3R0SS	DKS2D-H3R0SS
DKW2x-H3R0SS	
DKS2x-H4R0SS	DKS2E-H4R0SS
DKW2x-H4R0SS	
NFH1x-P1R6SS	NFH1A-P1R6SS
NFH1x-P3R2SS	NFH1B-P3R2SS

x: A, B, C...

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When the HDD is replaced, the HDD which has the compatibility is following.

Before replacing	After replacing
DKS5x-K146SS	DKS5x-K146SS
DKS5x-K300SS	DKS5x-K300SS
DKR5x-J300SS	DKR5x-J300SS DKS5x-J300SS
DKS5x-J300SS	DKR5x-J300SS DKS5x-J300SS
DKR5x-J600SS	DKR5x-J600SS DKS5x-J600SS
DKS5x-J600SS	DKR5x-J600SS DKS5x-J600SS
DKR5x-J900SS	DKR5x-J900SS DKS5x-J900SS
DKS5x-J900SS	DKR5x-J900SS DKS5x-J900SS
DKR5x-J1R2SS	DKR5x-J1R2SS DKS5x-J1R2SS
DKS5x-J1R2SS	DKR5x-J1R2SS DKS5x-J1R2SS
DKS5x-H500SS	DKS5x-H500SS
DKS5x-H1R0SS	DKS5x-H1R0SS
DKR2x-H2R0AT	DKR2x-H2R0AT
SDT5x-S200SS	SDT5x-S200SS SLR5x-S200SS
SDT2x-S400SS	SDT2x-S400SS
SLR5x-S200SS	SDT5x-S200SS SLR5x-S200SS
SLR5x-S400SS	SLR5x-S400SS
SFB5x-M200SS	SFB5x-M200SS SLR5x-M200SS
SLR5x-M200SS	SFB5x-M200SS SLR5x-M200SS
SFB5x-M400SS	SFB5x-M400SS SLR5x-M400SS
SLR5x-M400SS	SFB5x-M400SS SLR5x-M400SS
SFB5x-M800SS	SFB5x-M800SS SLR5x-M800SS
SLR5x-M800SS	SFB5x-M800SS SLR5x-M800SS

(To be continued)

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(Continued from the preceding page)

Before replacing	After replacing
DKS2x-H2R0SS	DKS2x-H2R0SS DKS2x-H2R0SD DKW2x-H2R0SS
DKS2x-H2R0SD	DKS2x-H2R0SS DKS2x-H2R0SD DKW2x-H2R0SS
DKW2x-H2R0SS	DKS2x-H2R0SS DKS2x-H2R0SD DKW2x-H2R0SS
DKS2x-H3R0SS	DKS2x-H3R0SS DKW2x-H3R0SS
DKW2x-H3R0SS	DKS2x-H3R0SS DKW2x-H3R0SS
DKS2x-H4R0SS	DKS2x-H4R0SS DKW2x-H4R0SS
DKW2x-H4R0SS	DKS2x-H4R0SS DKW2x-H4R0SS
NFH1x-P1R6SS	NFH1x-P1R6SS
NFH1x-P3R2SS	NFH1x-P3R2SS

x: A, B, C...

3.7.2 Emulation Device Type

Refer to 3.5 Volume Specification in OPENPLATFORM SECTION about OPEN Volume Type.

The emulation types of disk controller and disk units of the DKC710I are shown in Tables 3.7.2-1 to 3.7.2-5.

Table 3.7.2-1 List of DKC710I Model number (1/2)

Model Number	Disk drive model	RAID Level
DKC-F710I-146KCM	DKS5B-K146SS DKS5C-K146SS	RAID1 (2D+2D) RAID5 (3D+1P, 7D+1P) RAID6 (6D+2P, 14D+2P)
DKC-F710I-200SAM	SDT5A-S200SS SDT5C-S200SS	
DKC-F710I-200SCM	SDT5A-S200SS SDT5C-S200SS SLR5A-S200SS SLR5B-S200SS	
DKC-F710I-200MCM	SFB5A-M200SS SLR5B-M200SS SLR5C-M200SS	
DKC-F710I-300JCM	DKR5C-J300SS DKR5D-J300SS DKS5B-J300SS DKS5D-J300SS DKS5E-J300SS	
DKC-F710I-300KCM	DKS5C-K300SS	
DKC-F710I-400SCM	SLR5A-S400SS SLR5B-S400SS	
DKC-F710I-400S1M	SDT2A-S400SS SDT2C-S400SS	
DKC-F710I-400S3M	SDT2A-S400SS SDT2C-S400SS	
DKC-F710I-400MCM	SFB5A-M400SS SLR5B-M400SS SLR5C-M400SS	
DKC-F710I-500HCM	DKS5A-H500SS DKS5B-H500SS	
DKC-F710I-600JCM	DKR5C-J600SS DKR5D-J600SS DKS5C-J600SS DKS5D-J600SS DKS5E-J600SS	
DKC-F710I-800MCM	SFB5A-M800SS SLR5C-M800SS	
DKC-F710I-900JCM	DKR5D-J900SS DKS5D-J900SS DKS5E-J900SS	

Table 3.7.2-1 List of DKC710I Model number (2/2)

Model Number	Disk drive model	RAID Level
DKC-F710I-1R0HCM	DKS5B-H1R0SS	RAID1 (2D+2D) RAID5 (3D+1P, 7D+1P) RAID6 (6D+2P, 14D+2P)
DKC-F710I-1R2JCM	DKR5E-J1R2SS DKS5F-J1R2SS	
DKC-F710I-1R6FM	NFH1A-P1R6SS NFH1C-P1R6SS	
DKC-F710I-2R0H2M	DKR2C-H2R0AT DKR2D-H2R0AT DKR2E-H2R0AT	
DKC-F710I-2R0H3M	DKS2C-H2R0SS DKS2D-H2R0SD DKS2D-H2R0SS DKS2E-H2R0SS DKS2P-H2R0SS DKW2E-H2R0SS	
DKC-F710I-3R0H3M	DKS2D-H3R0SS DKS2E-H3R0SS DKW2E-H3R0SS	
DKC-F710I-3R2FM	NFH1B-P3R2SS NFH1C-P3R2SS	
DKC-F710I-4R0H3M	DKS2E-H4R0SS DKW2E-H4R0SS	

Note: As for RAID1, the two concatenation of a parity groups is possible (8HDDs).

In this case the number of volume become doubled.

Two concatenation and four concatenation (16HDDs and 32HDDs) of the RAID Group are possible for RAID5 (7D+1P).

Table 3.7.2-2 List of DKC710I Emulation Types for RAID5 (3D+1P) (1/4)

Emulation Type		3380-3	3390-3 /3R	3390-9	3390-L	3390-M
Storage capacity(GB/volume)		2,377	2,838	8,510	27.8	55.6
Number of volumes /parity groups	DKC-F710I-146KCM	174	144	48	14	7
	DKC-F710I-300JCM/KCM	350	290	96	29	14
	DKC-F710I-600JCM	700	580	193	59	29
	DKC-F710I-900JCM	1000	870	289	88	44
	DKC-F710I-1R2JCM	—	—	—	—	59
	DKC-F710I-200SAM/SCM/MCM	239	198	66	20	10
	DKC-F710I-400SCM/S1M/S3M/MCM	478	396	132	40	20
	DKC-F710I-800MCM	957	792	264	80	40
	DKC-F710I-500HCM	598	495	165	50	25
	DKC-F710I-1R0HCM	—	—	—	—	50
	DKC-F710I-2R0H2M	—	—	—	—	100
	DKC-F710I-2R0H3M	—	—	—	—	100
	DKC-F710I-3R0H3M	—	—	—	—	150
	DKC-F710I-4R0H3M	—	—	—	—	201
	DKC-F710I-1R6FM	—	—	—	—	90
	DKC-F710I-3R2FM	—	—	—	—	180
Maximum number of parity groups	DKC-F710I-146KCM	375	453	511	511	511
	DKC-F710I-300JCM/KCM	186	225	511	511	511
	DKC-F710I-600JCM	93	112	338	511	511
	DKC-F710I-900JCM	65	75	225	511	511
	DKC-F710I-1R2JCM	—	—	—	—	511
	DKC-F710I-200SAM/SCM/MCM	64	64	64	64	64
	DKC-F710I-400SCM/S1M/S3M/MCM	64	64	64	64	64
	DKC-F710I-800MCM	64	64	64	64	64
	DKC-F710I-500HCM	109	131	395	511	511
	DKC-F710I-1R0HCM	—	—	—	—	511
	DKC-F710I-2R0H2M	—	—	—	—	319
	DKC-F710I-2R0H3M	—	—	—	—	319
	DKC-F710I-3R0H3M	—	—	—	—	319
	DKC-F710I-4R0H3M	—	—	—	—	319
	DKC-F710I-1R6FM	—	—	—	—	47
	DKC-F710I-3R2FM	—	—	—	—	47
Maximum number of volumes	DKC-F710I-146KCM	65,250	65,232	24,528	7,154	3,577
	DKC-F710I-300JCM/KCM	65,100	65,250	49,056	14,819	7,154
	DKC-F710I-600JCM	65,100	64,960	65,234	30,149	14,819
	DKC-F710I-900JCM	65,000	65,250	65,025	44,968	22,484
	DKC-F710I-1R2JCM	—	—	—	—	30,149
	DKC-F710I-200SAM/SCM/MCM	15,296	12,672	4,224	1,280	640
	DKC-F710I-400SCM/S1M/S3M/MCM	30,592	25,344	8,448	2,560	1,280
	DKC-F710I-800MCM	64,248	50,688	16,896	5,120	2,560
	DKC-F710I-500HCM	65,182	64,845	65,175	25,550	12,775
	DKC-F710I-1R0HCM	—	—	—	—	25,550
	DKC-F710I-2R0H2M	—	—	—	—	31,900
	DKC-F710I-2R0H3M	—	—	—	—	31,900
	DKC-F710I-3R0H3M	—	—	—	—	47,850
	DKC-F710I-4R0H3M	—	—	—	—	64,119
	DKC-F710I-1R6FM	—	—	—	—	4,230
	DKC-F710I-3R2FM	—	—	—	—	8,460

Table 3.7.2-2 List of DKC710I Emulation Types for RAID5 (3D+1P) (2/4)

Emulation Type		3380-3	3390-3 /3R	3390-9	3390-L	3390-M
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	414 - 155,099	409 - 185,128	408 - 208,733	389 - 198,881	389 - 198,881
	DKC-F710I-300JCM/KCM	832 - 154,743	823 - 185,180	817 - 417,467	806 - 411,968	778 - 397,762
	DKC-F710I-600JCM	1,664 - 154,743	1,646 - 184,356	1,642 - 555,141	1,640 - 838,142	1,612 - 823,936
	DKC-F710I-900JCM	2,377 - 154,505	2,469 - 185,180	2,459 - 553,363	2,446 - 1,250,110	2,446 - 1,250,110
	DKC-F710I-1R2JCM	—	—	—	—	3,286 - 1,678,968
	DKC-F710I-200SAM/SCM/MCM	568 - 36,359	562 - 35,963	562 - 35,946	556 - 35,584	556 - 35,584
	DKC-F710I-400SCM/S1M/S3M/MCM	1,136 - 72,717	1,124 - 71,926	1,123 - 71,892	1,112 - 71,168	1,112 - 71,168
	DKC-F710I-800MCM	2,275 - 145,586	2,248 - 143,853	2,247 - 143,785	2,224 - 142,336	2,224 - 142,336
	DKC-F710I-500HCM	1,421 - 154,938	1,405 - 184,030	1,404 - 554,639	1,390 - 710,290	1,390 - 710,290
	DKC-F710I-1R0HCM	—	—	—	—	2,780 - 1,420,580
	DKC-F710I-2R0H2M	—	—	—	—	5,560 - 1,773,640
	DKC-F710I-2R0H3M	—	—	—	—	5,560 - 1,773,640
	DKC-F710I-3R0H3M	—	—	—	—	8,340 - 2,660,460
	DKC-F710I-4R0H3M	—	—	—	—	11,193 - 3,570,723
	DKC-F710I-1R6FM	—	—	—	—	5,004 - 235,188
	DKC-F710I-3R2FM	—	—	—	—	10,008 - 470,376

Note: The Emulation type 3390-3 and 3390-3R cannot be intermixed in the subsystem.

THEORY03-07-61**Table 3.7.2-2 List of DKC710I Emulation Types for RAID5 (3D+1P) (3/4)**

Emulation Type		3390-A	3390-A (3 type)	3390-A (9 type)	3390-A (L type)	3390-A (M type)	3390-V
Storage capacity(GB/volume)		223.257	2.838	8.514	27.844	55.689	712.062
Number of volumes /parity groups	DKC-F710I-146KCM	1	144	48	14	7	1
	DKC-F710I-300JCM/KCM	3	288	96	28	14	1
	DKC-F710I-600JCM	7	493	192	57	29	2
	DKC-F710I-900JCM	11	866	288	86	44	3
	DKC-F710I-1R2JCM	14	—	—	—	58	4
	DKC-F710I-200SAM/SCM/MCM	2	197	65	19	10	1
	DKC-F710I-400SCM/S1M/S3M/MCM	5	394	131	39	20	1
	DKC-F710I-800MCM	10	789	263	78	40	3
	DKC-F710I-500HCM	6	493	164	49	25	1
	DKC-F710I-1R0HCM	12	—	—	—	50	3
	DKC-F710I-2R0H2M	25	—	—	—	100	7
	DKC-F710I-2R0H3M	24	—	—	—	99	7
	DKC-F710I-3R0H3M	37	—	—	—	149	11
	DKC-F710I-4R0H3M	49	—	—	—	199	15
	DKC-F710I-1R6FM	22	—	—	—	89	7
	DKC-F710I-3R2FM	44	—	—	—	179	14
Maximum number of parity groups	DKC-F710I-146KCM	511	453	511	511	511	511
	DKC-F710I-300JCM/KCM	511	226	511	511	511	511
	DKC-F710I-600JCM	511	132	340	511	511	511
	DKC-F710I-900JCM	511	75	226	511	511	511
	DKC-F710I-1R2JCM	511	—	—	—	511	511
	DKC-F710I-200SAM/SCM/MCM	64	64	64	64	64	64
	DKC-F710I-400SCM/S1M/S3M/MCM	64	64	64	64	64	64
	DKC-F710I-800MCM	64	64	64	64	64	64
	DKC-F710I-500HCM	511	132	398	511	511	511
	DKC-F710I-1R0HCM	511	—	—	—	511	511
	DKC-F710I-2R0H2M	319	—	—	—	319	319
	DKC-F710I-2R0H3M	319	—	—	—	319	319
	DKC-F710I-3R0H3M	319	—	—	—	319	319
	DKC-F710I-4R0H3M	319	—	—	—	319	319
	DKC-F710I-1R6FM	47	—	—	—	47	47
	DKC-F710I-3R2FM	47	—	—	—	47	47
Maximum number of volumes	DKC-F710I-146KCM	511	65,232	24,528	7,154	3,577	511
	DKC-F710I-300JCM/KCM	1,533	65,088	49,056	14,308	7,154	511
	DKC-F710I-600JCM	3,577	65,076	65,280	29,127	14,819	1,022
	DKC-F710I-900JCM	5,621	64,950	65,088	43,946	22,484	1,533
	DKC-F710I-1R2JCM	7,154	—	—	—	29,638	2,044
	DKC-F710I-200SAM/SCM/MCM	128	12,608	4,160	1,216	640	64
	DKC-F710I-400SCM/S1M/S3M/MCM	320	25,216	8,384	2,496	1,280	64
	DKC-F710I-800MCM	640	50,496	16,832	4,992	2,560	192
	DKC-F710I-500HCM	3,066	65,076	65,272	25,039	12,775	511
	DKC-F710I-1R0HCM	6,132	—	—	—	25,550	1,533
	DKC-F710I-2R0H2M	7,975	—	—	—	31,900	2,233
	DKC-F710I-2R0H3M	7,656	—	—	—	31,581	2,233
	DKC-F710I-3R0H3M	11,803	—	—	—	47,531	3,509
	DKC-F710I-4R0H3M	15,631	—	—	—	63,481	4,785
	DKC-F710I-1R6FM	1,034	—	—	—	4,183	329
	DKC-F710I-3R2FM	2,068	—	—	—	8,413	658

Table 3.7.2-2 List of DKC710I Emulation Types for RAID5 (3D+1P) (4/4)

	Emulation Type	3390-A	3390-A (3 type)	3390-A (9 type)	3390-A (L type)	3390-A (M type)	3390-V
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	223 - 114,084	409 - 185,128	409 - 208,831	390 - 199,196	390 - 199,200	712 - 363,864
	DKC-F710I-300JCM/KCM	670 - 342,253	817 - 184,720	817 - 417,663	780 - 398,392	780 - 398,399	712 - 363,864
	DKC-F710I-600JCM	1,563 - 798,590	1,399 - 184,686	1,635 - 555,794	1,587 - 811,012	1,615 - 825,255	1,424 - 727,727
	DKC-F710I-900JCM	2,456 - 1,254,928	2,458 - 184,328	2,452 - 554,159	2,395 - 1,223,632	2,450 - 1,252,111	2,136 - 1,091,591
	DKC-F710I-1R2JCM	3,126 - 1,597,181	—	—	—	3,230 - 1,650,511	2,848 - 1,455,455
	DKC-F710I-200SAM/SCM/MCM	447 - 28,577	559 - 35,782	553 - 35,418	529 - 33,858	557 - 35,641	712 - 45,572
	DKC-F710I-400SCM/S1M/S3M/MCM	1,116 - 71,442	1,118 - 71,563	1,115 - 71,381	1,086 - 69,449	1,114 - 71,282	712 - 45,572
	DKC-F710I-800MCM	2,233 - 142,884	2,239 - 143,308	2,239 - 143,308	2,172 - 138,997	2,228 - 142,564	2,136 - 136,716
	DKC-F710I-500HCM	1,340 - 684,506	1,399 - 184,686	1,396 - 555,726	1,364 - 697,186	1,392 - 711,427	712 - 363,864
	DKC-F710I-1R0HCM	2,679 - 1,369,012	—	—	—	2,784 - 1,422,854	2,136 - 1,091,591
	DKC-F710I-2R0H2M	5,581 - 1,780,475	—	—	—	5,569 - 1,776,479	4,984 - 1,590,034
	DKC-F710I-2R0H3M	5,358 - 1,709,256	—	—	—	5,513 - 1,758,714	4,984 - 1,590,034
	DKC-F710I-3R0H3M	8,261 - 2,635,102	—	—	—	8,298 - 2,646,954	7,833 - 2,498,626
	DKC-F710I-4R0H3M	10,940 - 3,489,730	—	—	—	11,082 - 3,535,193	10,681 - 3,407,217
	DKC-F710I-1R6FM	4,912 - 230,848	—	—	—	4,956 - 232,947	4,984 - 234,268
	DKC-F710I-3R2FM	9,823 - 461,695	—	—	—	9,968 - 468,512	9,969 - 468,537

Table 3.7.2-3 List of DKC710I Emulation Types for RAID5 (7D+1P) (1/4)

Emulation Type		3380-3	3390-3 /3R	3390-9	3390-L	3390-M
Storage capacity(GB/volume)		2,377	2,838	8,510	27.8	55.6
Number of volumes /parity groups	DKC-F710I-146KCM	407	337	112	34	17
	DKC-F710I-300JCM/KCM	817	676	225	69	34
	DKC-F710I-600JCM	1,634	1,353	450	138	69
	DKC-F710I-900JCM	2,000	2,000	676	207	103
	DKC-F710I-1R2JCM	—	—	—	—	138
	DKC-F710I-200SAM/SCM/MCM	558	462	154	47	23
	DKC-F710I-400SCM/S1M/S3M/MCM	1,116	925	308	94	47
	DKC-F710I-800MCM	2,000	1,850	616	188	94
	DKC-F710I-500HCM	1,395	1,156	385	117	58
	DKC-F710I-1R0HCM	—	—	—	—	117
	DKC-F710I-2R0H2M	—	—	—	—	235
	DKC-F710I-2R0H3M	—	—	—	—	234
	DKC-F710I-3R0H3M	—	—	—	—	351
	DKC-F710I-4R0H3M	—	—	—	—	469
	DKC-F710I-1R6FM	—	—	—	—	210
	DKC-F710I-3R2FM	—	—	—	—	421
Maximum number of parity groups	DKC-F710I-146KCM	160	193	255	255	255
	DKC-F710I-300JCM/KCM	79	96	255	255	255
	DKC-F710I-600JCM	39	48	145	255	255
	DKC-F710I-900JCM	32	32	96	255	255
	DKC-F710I-1R2JCM	—	—	—	—	255
	DKC-F710I-200SAM/SCM/MCM	32	32	32	32	32
	DKC-F710I-400SCM/S1M/S3M/MCM	32	32	32	32	32
	DKC-F710I-800MCM	32	32	32	32	32
	DKC-F710I-500HCM	46	56	169	255	255
	DKC-F710I-1R0HCM	—	—	—	—	255
	DKC-F710I-2R0H2M	—	—	—	—	159
	DKC-F710I-2R0H3M	—	—	—	—	159
	DKC-F710I-3R0H3M	—	—	—	—	159
	DKC-F710I-4R0H3M	—	—	—	—	139
	DKC-F710I-1R6FM	—	—	—	—	23
	DKC-F710I-3R2FM	—	—	—	—	23
Maximum number of volumes	DKC-F710I-146KCM	65,120	65,041	28,560	8,670	4,335
	DKC-F710I-300JCM/KCM	64,543	64,896	57,375	17,595	8,670
	DKC-F710I-600JCM	63,726	64,944	65,250	35,190	17,595
	DKC-F710I-900JCM	64,000	64,000	64,896	52,785	26,265
	DKC-F710I-1R2JCM	—	—	—	—	35,190
	DKC-F710I-200SAM/SCM/MCM	17,856	14,784	4,928	1,504	736
	DKC-F710I-400SCM/S1M/S3M/MCM	35,712	29,600	9,856	3,008	1,504
	DKC-F710I-800MCM	64,000	59,200	19,712	6,016	3,008
	DKC-F710I-500HCM	64,170	64,736	65,065	29,835	14,790
	DKC-F710I-1R0HCM	—	—	—	—	29,835
	DKC-F710I-2R0H2M	—	—	—	—	37,365
	DKC-F710I-2R0H3M	—	—	—	—	37,206
	DKC-F710I-3R0H3M	—	—	—	—	55,809
	DKC-F710I-4R0H3M	—	—	—	—	65,191
	DKC-F710I-1R6FM	—	—	—	—	4,830
	DKC-F710I-3R2FM	—	—	—	—	9,683

Table 3.7.2-3 List of DKC710I Emulation Types for RAID5 (7D+1P) (2/4)

Emulation Type		3380-3	3390-3 /3R	3390-9	3390-L	3390-M
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	967 - 154,790	956 - 184,586	953 - 243,046	945 - 241,026	945 - 241,026
	DKC-F710I-300JCM/KCM	1,942 - 153,419	1,918 - 184,175	1,915 - 488,261	1,918 - 489,141	1,890 - 482,052
	DKC-F710I-600JCM	3,884 - 151,477	3,840 - 184,311	3,830 - 555,278	3,836 - 978,282	3,836 - 978,282
	DKC-F710I-900JCM	4,754 - 152,128	5,676 - 181,632	5,753 - 552,265	5,755 - 1,467,423	5,727 - 1,460,334
	DKC-F710I-1R2JCM	—	—	—	—	7,685 - 1,959,696
	DKC-F710I-200SAM/SCM/MCM	1,326 - 42,444	1,311 - 41,957	1,311 - 41,937	1,307 - 41,811	1,279 - 40,922
	DKC-F710I-400SCM/S1M/S3M/MCM	2,653 - 84,887	2,625 - 84,005	2,621 - 83,875	2,613 - 83,622	2,613 - 83,622
	DKC-F710I-800MCM	4,754 - 152,128	5,250 - 168,010	5,242 - 167,749	5,226 - 167,245	5,226 - 167,245
	DKC-F710I-500HCM	3,316 - 152,532	3,281 - 183,721	3,276 - 553,703	3,253 - 829,413	3,225 - 822,324
	DKC-F710I-1R0HCM	—	—	—	—	6,505 - 1,658,826
	DKC-F710I-2R0H2M	—	—	—	—	13,066 - 2,077,494
	DKC-F710I-2R0H3M	—	—	—	—	13,010 - 2,068,654
	DKC-F710I-3R0H3M	—	—	—	—	19,516 - 3,102,980
	DKC-F710I-4R0H3M	—	—	—	—	26,118 - 3,630,422
	DKC-F710I-1R6FM	—	—	—	—	11,676 - 268,548
	DKC-F710I-3R2FM	—	—	—	—	23,408 - 538,375

Note: The Emulation type 3390-3 and 3390-3R cannot be intermixed in the subsystem.

THEORY03-07-71**Table 3.7.2-3 List of DKC710I Emulation Types for RAID5 (7D+1P) (3/4)**

Emulation Type		3390-A	3390-A (3 type)	3390-A (9 type)	3390-A (L type)	3390-A (M type)	3390-V
Storage capacity(GB/volume)		223.257	2.838	8.514	27.844	55.689	712.062
Number of volumes /parity groups	DKC-F710I-146KCM	4	336	112	33	17	1
	DKC-F710I-300JCM/KCM	8	673	224	67	34	2
	DKC-F710I-600JCM	17	1347	449	134	68	5
	DKC-F710I-900JCM	25	2000	673	202	102	8
	DKC-F710I-1R2JCM	34	—	—	—	137	10
	DKC-F710I-200SAM/SCM/MCM	5	460	153	46	23	1
	DKC-F710I-400SCM/S1M/S3M/MCM	11	921	307	92	46	3
	DKC-F710I-800MCM	23	1,842	614	184	93	7
	DKC-F710I-500HCM	14	1151	383	115	58	4
	DKC-F710I-1R0HCM	29	—	—	—	117	9
	DKC-F710I-2R0H2M	58	—	—	—	233	18
	DKC-F710I-2R0H3M	58	—	—	—	232	18
	DKC-F710I-3R0H3M	87	—	—	—	349	27
	DKC-F710I-4R0H3M	116	—	—	—	465	36
	DKC-F710I-1R6FM	52	—	—	—	209	16
Maximum number of parity groups	DKC-F710I-3R2FM	104	—	—	—	418	32
	DKC-F710I-146KCM	255	194	255	255	255	255
	DKC-F710I-300JCM/KCM	255	96	255	255	255	255
	DKC-F710I-600JCM	255	48	145	255	255	255
	DKC-F710I-900JCM	255	32	96	255	255	255
	DKC-F710I-1R2JCM	255	—	—	—	255	255
	DKC-F710I-200SAM/SCM/MCM	32	32	32	32	32	32
	DKC-F710I-400SCM/S1M/S3M/MCM	32	32	32	32	32	32
	DKC-F710I-800MCM	32	32	32	32	32	32
	DKC-F710I-500HCM	255	56	170	255	255	255
	DKC-F710I-1R0HCM	255	—	—	—	255	255
	DKC-F710I-2R0H2M	159	—	—	—	159	159
	DKC-F710I-2R0H3M	159	—	—	—	159	159
	DKC-F710I-3R0H3M	159	—	—	—	159	159
	DKC-F710I-4R0H3M	159	—	—	—	140	159
Maximum number of volumes	DKC-F710I-1R6FM	23	—	—	—	23	23
	DKC-F710I-3R2FM	23	—	—	—	23	23
	DKC-F710I-146KCM	1,020	65,184	28,560	8,415	4,335	255
	DKC-F710I-300JCM/KCM	2,040	64,608	57,120	17,085	8,670	510
	DKC-F710I-600JCM	4,335	64,656	65,105	34,170	17,340	1,275
	DKC-F710I-900JCM	6,375	64,000	64,608	51,510	26,010	2,040
	DKC-F710I-1R2JCM	8,670	—	—	—	34,935	2,550
	DKC-F710I-200SAM/SCM/MCM	160	14,720	4,896	1,472	736	32
	DKC-F710I-400SCM/S1M/S3M/MCM	352	29,472	9,824	2,944	1,472	96
	DKC-F710I-800MCM	736	58,944	19,648	5,888	2,976	224
	DKC-F710I-500HCM	3,570	64,456	65,110	29,325	14,790	1,020
	DKC-F710I-1R0HCM	7,395	—	—	—	29,835	2,295
	DKC-F710I-2R0H2M	9,222	—	—	—	37,047	2,862
	DKC-F710I-2R0H3M	9,222	—	—	—	36,888	2,862
	DKC-F710I-3R0H3M	13,833	—	—	—	55,491	4,293
	DKC-F710I-4R0H3M	18,444	—	—	—	65,100	5,724
	DKC-F710I-1R6FM	1,196	—	—	—	4,807	368
	DKC-F710I-3R2FM	2,392	—	—	—	9,614	736

Table 3.7.2-3 List of DKC710I Emulation Types for RAID5 (7D+1P) (4/4)

	Emulation Type	3390-A	3390-A (3 type)	3390-A (9 type)	3390-A (L type)	3390-A (M type)	3390-V
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	893 - 227,722	954 - 184,992	954 - 243,160	919 - 234,307	947 - 241,412	712 - 181,576
	DKC-F710I-300JCM/KCM	1,786 - 455,444	1,910 - 183,992	1,907 - 486,320	1,866 - 475,715	1,893 - 482,824	1,424 - 363,152
	DKC-F710I-600JCM	3,795 - 967,819	3,823 - 183,494	3,823 - 554,304	3,731 - 951,429	3,787 - 965,647	3,560 - 907,879
	DKC-F710I-900JCM	5,581 - 1,423,263	5,676 - 181,632	5,730 - 550,073	5,624 - 1,434,244	5,680 - 1,448,471	5,696 - 1,452,606
	DKC-F710I-1R2JCM	7,591 - 1,935,638	—	—	—	7,629 - 1,945,495	7,121 - 1,815,758
	DKC-F710I-200SAM/SCM/MCM	1,116 - 35,721	1,305 - 41,775	1,303 - 41,685	1,281 - 40,986	1,281 - 40,987	712 - 22,786
	DKC-F710I- 400SCM/S1M/S3M/MCM	2,456 - 78,586	2,614 - 83,642	2,614 - 83,642	2,562 - 81,973	2,562 - 81,974	2,136 - 68,358
	DKC-F710I-800MCM	5,135 - 164,317	5,228 - 167,283	5,228 - 167,283	5,123 - 163,945	5,179 - 165,730	4,984 - 159,502
	DKC-F710I-500HCM	3,126 - 797,027	3,267 - 182,926	3,261 - 554,347	3,202 - 816,525	3,230 - 823,640	2,848 - 726,303
	DKC-F710I-1R0HCM	6,474 - 1,650,986	—	—	—	6,516 - 1,661,481	6,409 - 1,634,182
	DKC-F710I-2R0H2M	12,949 - 2,058,876	—	—	—	12,976 - 2,063,110	12,817 - 2,037,921
	DKC-F710I-2R0H3M	12,949 - 2,058,876	—	—	—	12,920 - 2,054,256	12,817 - 2,037,921
	DKC-F710I-3R0H3M	19,423 - 3,088,314	—	—	—	19,435 - 3,090,238	19,226 - 3,056,882
	DKC-F710I-4R0H3M	25,898 - 4,117,752	—	—	—	25,895 - 3,625,354	25,634 - 4,075,843
	DKC-F710I-1R6FM	11,609 - 267,015	—	—	—	11,639 - 267,697	11,393 - 262,039
	DKC-F710I-3R2FM	23,219 - 534,031	—	—	—	23,278 - 535,394	22,786 - 524,078

Table 3.7.2-4 List of DKC710I Emulation Types for RAID1 (2D+2D) (1/4)

Emulation Type		3380-3	3390-3 /3R	3390-9	3390-L	3390-M
Storage capacity(GB/volume)		2.377	2.838	8.510	27.8	55.6
Number of volumes /parity groups	DKC-F710I-146KCM	116	96	32	9	4
	DKC-F710I-300JCM/KCM	233	193	64	19	9
	DKC-F710I-600JCM	467	386	128	39	19
	DKC-F710I-900JCM	700	580	193	59	29
	DKC-F710I-1R2JCM	—	—	—	—	39
	DKC-F710I-200SAM/SCM/MCM	159	132	44	13	6
	DKC-F710I-400SCM/S1M/S3M/MCM	319	264	88	26	13
	DKC-F710I-800MCM	638	528	176	53	26
	DKC-F710I-500HCM	399	330	110	33	16
	DKC-F710I-1R0HCM	—	—	—	—	33
	DKC-F710I-2R0H2M	—	—	—	—	67
	DKC-F710I-2R0H3M	—	—	—	—	67
	DKC-F710I-3R0H3M	—	—	—	—	100
	DKC-F710I-4R0H3M	—	—	—	—	134
	DKC-F710I-1R6FM	—	—	—	—	60
	DKC-F710I-3R2FM	—	—	—	—	120
Maximum number of parity groups	DKC-F710I-146KCM	511	511	511	511	511
	DKC-F710I-300JCM/KCM	280	338	511	511	511
	DKC-F710I-600JCM	139	169	510	511	511
	DKC-F710I-900JCM	93	112	338	511	511
	DKC-F710I-1R2JCM	—	—	—	—	511
	DKC-F710I-200SAM/SCM/MCM	64	64	64	64	64
	DKC-F710I-400SCM/S1M/S3M/MCM	64	64	64	64	64
	DKC-F710I-800MCM	64	64	64	64	64
	DKC-F710I-500HCM	163	197	511	511	511
	DKC-F710I-1R0HCM	—	—	—	—	511
	DKC-F710I-2R0H2M	—	—	—	—	319
	DKC-F710I-2R0H3M	—	—	—	—	319
	DKC-F710I-3R0H3M	—	—	—	—	319
	DKC-F710I-4R0H3M	—	—	—	—	319
	DKC-F710I-1R6FM	—	—	—	—	47
	DKC-F710I-3R2FM	—	—	—	—	47
Maximum number of volumes	DKC-F710I-146KCM	59,276	49,056	16,352	4,599	2,044
	DKC-F710I-300JCM/KCM	65,240	65,234	32,704	9,709	4,599
	DKC-F710I-600JCM	64,913	65,234	65,280	19,929	9,709
	DKC-F710I-900JCM	65,100	64,960	65,234	30,149	14,819
	DKC-F710I-1R2JCM	—	—	—	—	19,929
	DKC-F710I-200SAM/SCM/MCM	10,176	8,448	2,816	832	384
	DKC-F710I-400SCM/S1M/S3M/MCM	20,416	16,896	5,632	1,664	832
	DKC-F710I-800MCM	40,832	33,792	11,264	3,392	1,664
	DKC-F710I-500HCM	65,037	65,010	56,210	16,863	8,176
	DKC-F710I-1R0HCM	—	—	—	—	16,863
	DKC-F710I-2R0H2M	—	—	—	—	21,373
	DKC-F710I-2R0H3M	—	—	—	—	21,373
	DKC-F710I-3R0H3M	—	—	—	—	31,900
	DKC-F710I-4R0H3M	—	—	—	—	42,746
	DKC-F710I-1R6FM	—	—	—	—	2,820
	DKC-F710I-3R2FM	—	—	—	—	5,640

Table 3.7.2-4 List of DKC710I Emulation Types for RAID1 (2D+2D) (2/4)

Emulation Type		3380-3	3390-3 /3R	3390-9	3390-L	3390-M
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	276 - 140,899	272 - 139,221	272 - 139,156	250 - 127,852	222 - 113,646
	DKC-F710I-300JCM/KCM	554 - 155,075	548 - 185,134	545 - 278,311	528 - 269,910	500 - 255,704
	DKC-F710I-600JCM	1,110 - 154,298	1,095 - 185,134	1,089 - 555,533	1,084 - 554,026	1,056 - 539,820
	DKC-F710I-900JCM	1,664 - 154,743	1,646 - 184,356	1,642 - 555,141	1,640 - 838,142	1,612 - 823,936
	DKC-F710I-1R2JCM	—	—	—	—	2,172 - 1,109,826
	DKC-F710I-200SAM/SCM/MCM	378 - 24,188	375 - 23,975	374 - 23,964	361 - 23,130	334 - 21,350
	DKC-F710I-400SCM/S1M/S3M/MCM	758 - 48,529	749 - 47,951	749 - 47,928	723 - 46,259	723 - 46,259
	DKC-F710I-800MCM	1,517 - 97,058	1,498 - 95,902	1,498 - 95,857	1,473 - 94,298	1,446 - 92,518
	DKC-F710I-500HCM	948 - 154,593	937 - 184,498	936 - 478,347	917 - 468,791	890 - 454,586
	DKC-F710I-1R0HCM	—	—	—	—	1,835 - 937,583
	DKC-F710I-2R0H2M	—	—	—	—	3,725 - 1,188,339
	DKC-F710I-2R0H3M	—	—	—	—	3,725 - 1,188,339
	DKC-F710I-3R0H3M	—	—	—	—	5,560 - 1,773,640
	DKC-F710I-4R0H3M	—	—	—	—	7,462 - 2,380,482
	DKC-F710I-1R6FM	—	—	—	—	3,336 - 156,792
	DKC-F710I-3R2FM	—	—	—	—	6,672 - 313,584

Note: The Emulation type 3390-3 and 3390-3R cannot be intermixed in the subsystem.

Table 3.7.2-4 List of DKC710I Emulation Types for RAID1 (2D+2D) (3/4)

Emulation Type		3390-A	3390-A (3 type)	3390-A (9 type)	3390-A (L type)	3390-A (M type)	3390-V
Storage capacity(GB/volume)		223.257	2,838	8,514	27,844	55,689	712,062
Number of volumes /parity groups	DKC-F710I-146KCM	1	96	32	9	4	1
	DKC-F710I-300JCM/KCM	2	192	64	19	9	1
	DKC-F710I-600JCM	4	385	128	38	19	1
	DKC-F710I-900JCM	7	577	192	57	29	2
	DKC-F710I-1R2JCM	9	—	—	—	39	3
	DKC-F710I-200SAM/SCM/MCM	1	131	43	13	6	1
	DKC-F710I-400SCM/S1M/S3M/MCM	3	263	87	26	13	1
	DKC-F710I-800MCM	6	526	176	52	26	2
	DKC-F710I-500HCM	4	328	109	32	16	1
	DKC-F710I-1R0HCM	8	—	—	—	33	2
	DKC-F710I-2R0H2M	16	—	—	—	66	5
	DKC-F710I-2R0H3M	16	—	—	—	66	5
	DKC-F710I-3R0H3M	24	—	—	—	99	7
	DKC-F710I-4R0H3M	33	—	—	—	133	10
	DKC-F710I-1R6FM	14	—	—	—	59	4
	DKC-F710I-3R2FM	29	—	—	—	119	9
Maximum number of parity groups	DKC-F710I-146KCM	511	511	511	511	511	511
	DKC-F710I-300JCM/KCM	511	340	511	511	511	511
	DKC-F710I-600JCM	511	169	510	511	511	511
	DKC-F710I-900JCM	511	113	340	511	511	511
	DKC-F710I-1R2JCM	511	—	—	—	511	511
	DKC-F710I-200SAM/SCM/MCM	64	64	64	64	64	64
	DKC-F710I-400SCM/S1M/S3M/MCM	64	64	64	64	64	64
	DKC-F710I-800MCM	64	64	64	64	64	64
	DKC-F710I-500HCM	511	199	511	511	511	511
	DKC-F710I-1R0HCM	511	—	—	—	511	511
	DKC-F710I-2R0H2M	319	—	—	—	319	319
	DKC-F710I-2R0H3M	319	—	—	—	319	319
	DKC-F710I-3R0H3M	319	—	—	—	319	319
	DKC-F710I-4R0H3M	319	—	—	—	319	319
	DKC-F710I-1R6FM	47	—	—	—	47	47
	DKC-F710I-3R2FM	47	—	—	—	47	47
Maximum number of volumes	DKC-F710I-146KCM	511	49,056	16,352	4,599	2,044	511
	DKC-F710I-300JCM/KCM	1,022	65,280	32,704	9,709	4,599	511
	DKC-F710I-600JCM	2,044	65,065	65,280	19,418	9,709	511
	DKC-F710I-900JCM	3,577	65,201	65,280	29,127	14,819	1,022
	DKC-F710I-1R2JCM	4,599	—	—	—	19,929	1,533
	DKC-F710I-200SAM/SCM/MCM	64	8,384	2,752	832	384	64
	DKC-F710I-400SCM/S1M/S3M/MCM	192	16,832	5,568	1,664	832	64
	DKC-F710I-800MCM	384	33,664	11,200	3,328	1,664	128
	DKC-F710I-500HCM	2,044	65,272	55,699	16,352	8,176	511
	DKC-F710I-1R0HCM	4,088	—	—	—	16,863	1,022
	DKC-F710I-2R0H2M	5,104	—	—	—	21,054	1,595
	DKC-F710I-2R0H3M	5,104	—	—	—	21,054	1,595
	DKC-F710I-3R0H3M	7,656	—	—	—	31,581	2,233
	DKC-F710I-4R0H3M	10,527	—	—	—	42,427	3,190
	DKC-F710I-1R6FM	658	—	—	—	2,773	188
	DKC-F710I-3R2FM	1,363	—	—	—	5,593	423

THEORY03-07-82**Table 3.7.2-4 List of DKC710I Emulation Types for RAID1 (2D+2D) (4/4)**

	Emulation Type	3390-A	3390-A (3 type)	3390-A (9 type)	3390-A (L type)	3390-A (M type)	3390-V
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	223 - 114,084	272 - 139,221	272 - 139,221	251 - 128,055	223 - 113,828	712 - 363,864
	DKC-F710I-300JCM/KCM	447 - 228,169	545 - 185,265	545 - 278,442	529 - 270,337	501 - 256,114	712 - 363,864
	DKC-F710I-600JCM	893 - 456,337	1,093 - 184,654	1,090 - 555,794	1,058 - 540,675	1,058 - 540,685	712 - 363,864
	DKC-F710I-900JCM	1,563 - 798,590	1,638 - 185,040	1,635 - 555,794	1,587 - 811,012	1,615 - 825,255	1,424 - 727,727
	DKC-F710I-1R2JCM	2,009 - 1,026,759	—	—	—	2,172 - 1,109,826	2,136 - 1,097,591
	DKC-F710I-200SAM/SCM/MCM	223 - 14,288	372 - 23,794	366 - 23,431	362 - 23,166	334 - 21,385	712 - 45,572
	DKC-F710I- 400SCM/S1M/S3M/MCM	670 - 42,865	746 - 47,769	741 - 47,406	724 - 46,332	724 - 46,333	712 - 45,572
	DKC-F710I-800MCM	1,340 - 85,731	1,493 - 95,538	1,490 - 95,357	1,448 - 92,665	1,448 - 92,666	1,424 - 91,144
	DKC-F710I-500HCM	893 - 456,337	931 - 185,242	928 - 474,221	891 - 455,305	891 - 455,313	712 - 363,864
	DKC-F710I-1R0HCM	1,786 - 912,675	—	—	—	1,835 - 937,583	1,424 - 727,727
	DKC-F710I-2R0H2M	3,572 - 1,139,504	—	—	—	3,675 - 1,172,476	3,560 - 1,135,739
	DKC-F710I-2R0H3M	3,572 - 1,139,504	—	—	—	3,675 - 1,172,476	3,560 - 1,135,739
	DKC-F710I-3R0H3M	5,358 - 1,709,256	—	—	—	5,513 - 1,758,714	4,984 - 1,590,034
	DKC-F710I-4R0H3M	7,367 - 2,350,226	—	—	—	7,407 - 2,362,717	7,121 - 2,271,478
	DKC-F710I-1R6FM	3,126 - 146,903	—	—	—	3,286 - 154,426	2,848 - 133,868
	DKC-F710I-3R2FM	6,474 - 304,299	—	—	—	6,627 - 311,469	6,409 - 301,202

Table 3.7.2-5 List of DKC710I Emulation Types for RAID6 (6D+2P) (1/4)

Emulation Type		3380-3	3390-3 /3R	3390-9	3390-L	3390-M
Storage capacity(GB/volume)		2,377	2,838	8,510	27.8	55.6
Number of volumes /parity groups	DKC-F710I-146KCM	349	289	96	29	14
	DKC-F710I-300JCM/KCM	700	579	193	59	29
	DKC-F710I-600JCM	1,401	1,159	386	118	59
	DKC-F710I-900JCM	2,000	1,739	579	177	88
	DKC-F710I-1R2JCM	—	—	—	—	118
	DKC-F710I-200SAM/SCM/MCM	478	396	132	40	20
	DKC-F710I-400SCM/S1M/S3M/MCM	957	792	264	80	40
	DKC-F710I-800MCM	1,915	1,584	528	161	80
	DKC-F710I-500HCM	1,196	990	330	101	50
	DKC-F710I-1R0HCM	—	—	—	—	101
	DKC-F710I-2R0H2M	—	—	—	—	201
	DKC-F710I-2R0H3M	—	—	—	—	201
	DKC-F710I-3R0H3M	—	—	—	—	301
	DKC-F710I-4R0H3M	—	—	—	—	402
	DKC-F710I-1R6FM	—	—	—	—	180
	DKC-F710I-3R2FM	—	—	—	—	361
Maximum number of parity groups	DKC-F710I-146KCM	187	225	255	255	255
	DKC-F710I-300JCM/KCM	93	112	255	255	255
	DKC-F710I-600JCM	46	56	169	255	255
	DKC-F710I-900JCM	32	37	112	255	255
	DKC-F710I-1R2JCM	—	—	—	—	255
	DKC-F710I-200SAM/SCM/MCM	32	32	32	32	32
	DKC-F710I-400SCM/S1M/S3M/MCM	32	32	32	32	32
	DKC-F710I-800MCM	32	32	32	32	32
	DKC-F710I-500HCM	54	65	197	255	255
	DKC-F710I-1R0HCM	—	—	—	—	255
	DKC-F710I-2R0H2M	—	—	—	—	159
	DKC-F710I-2R0H3M	—	—	—	—	159
	DKC-F710I-3R0H3M	—	—	—	—	159
	DKC-F710I-4R0H3M	—	—	—	—	159
	DKC-F710I-1R6FM	—	—	—	—	23
	DKC-F710I-3R2FM	—	—	—	—	23
Maximum number of volumes	DKC-F710I-146KCM	65,263	65,025	24,480	7,395	3,570
	DKC-F710I-300JCM/KCM	65,100	64,848	49,215	15,045	7,395
	DKC-F710I-600JCM	64,446	64,904	65,234	30,090	15,045
	DKC-F710I-900JCM	64,000	64,343	64,848	45,135	22,440
	DKC-F710I-1R2JCM	—	—	—	—	30,090
	DKC-F710I-200SAM/SCM/MCM	15,296	12,672	4,224	1,280	640
	DKC-F710I-400SCM/S1M/S3M/MCM	30,624	25,344	8,448	2,560	1,280
	DKC-F710I-800MCM	61,280	50,688	16,896	5,152	2,560
	DKC-F710I-500HCM	64,584	64,350	65,010	25,755	12,750
	DKC-F710I-1R0HCM	—	—	—	—	25,755
	DKC-F710I-2R0H2M	—	—	—	—	31,959
	DKC-F710I-2R0H3M	—	—	—	—	31,959
	DKC-F710I-3R0H3M	—	—	—	—	47,859
	DKC-F710I-4R0H3M	—	—	—	—	63,918
	DKC-F710I-1R6FM	—	—	—	—	4,140
	DKC-F710I-3R2FM	—	—	—	—	8,303

Table 3.7.2-5 List of DKC710I Emulation Types for RAID6 (6D+2P) (2/4)

Emulation Type		3380-3	3390-3 /3R	3390-9	3390-L	3390-M
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	830 - 155,130	820 - 184,541	817 - 208,325	806 - 205,581	778 - 198,492
	DKC-F710I-300JCM/KCM	1,664 - 154,743	1,643 - 184,039	1,642 - 418,820	1,640 - 418,251	1,612 - 411,162
	DKC-F710I-600JCM	3,330 - 153,188	3,289 - 184,198	3,285 - 555,141	3,280 - 836,502	3,280 - 836,502
	DKC-F710I-900JCM	4,754 - 152,128	4,935 - 182,605	4,927 - 551,856	4,921 - 1,254,753	4,893 - 1,247,664
	DKC-F710I-1R2JCM	—	—	—	—	6,571 - 1,675,682
	DKC-F710I-200SAM/SCM/MCM	1,136 - 36,359	1,124 - 35,963	1,123 - 35,946	1,112 - 35,584	1,112 - 35,584
	DKC-F710I- 400SCM/S1M/S3M/MCM	2,275 - 72,793	2,248 - 71,926	2,247 - 71,892	2,224 - 71,168	2,224 - 71,168
	DKC-F710I-800MCM	4,552 - 145,663	4,495 - 143,853	4,493 - 143,785	4,476 - 143,226	4,448 - 142,336
	DKC-F710I-500HCM	2,843 - 153,516	2,810 - 182,625	2,808 - 553,235	2,808 - 715,989	2,780 - 708,900
	DKC-F710I-1R0HCM	—	—	—	—	5,616 - 1,431,978
	DKC-F710I-2R0H2M	—	—	—	—	11,176 - 1,776,920
	DKC-F710I-2R0H3M	—	—	—	—	11,176 - 1,776,920
	DKC-F710I-3R0H3M	—	—	—	—	16,736 - 2,660,960
	DKC-F710I-4R0H3M	—	—	—	—	22,387 - 3,559,530
	DKC-F710I-1R6FM	—	—	—	—	10,008 - 230,184
	DKC-F710I-3R2FM	—	—	—	—	20,072 - 461,647

Note: The Emulation type 3390-3 and 3390-3R cannot be intermixed in the subsystem.

Table 3.7.2-5 List of DKC710I Emulation Types for RAID6 (6D+2P) (3/4)

Emulation Type		3390-A	3390-A (3 type)	3390-A (9 type)	3390-A (L type)	3390-A (M type)	3390-V
Storage capacity(GB/volume)		223.257	2.838	8.514	27.844	55.689	712.062
Number of volumes /parity groups	DKC-F710I-146KCM	3	288	96	28	14	1
	DKC-F710I-300JCM/KCM	7	577	192	57	29	2
	DKC-F710I-600JCM	14	1,155	385	115	58	4
	DKC-F710I-900JCM	22	1,733	577	173	88	6
	DKC-F710I-1R2JCM	29	—	—	—	117	9
	DKC-F710I-200SAM/SCM/MCM	5	394	131	39	20	1
	DKC-F710I-400SCM/S1M/S3M/MCM	10	789	263	78	40	3
	DKC-F710I-800MCM	20	1,578	526	157	80	6
	DKC-F710I-500HCM	12	986	328	98	50	3
	DKC-F710I-1R0HCM	25	—	—	—	101	7
	DKC-F710I-2R0H2M	50	—	—	—	200	15
	DKC-F710I-2R0H3M	49	—	—	—	199	15
	DKC-F710I-3R0H3M	74	—	—	—	299	23
	DKC-F710I-4R0H3M	99	—	—	—	399	31
	DKC-F710I-1R6FM	44	—	—	—	179	14
	DKC-F710I-3R2FM	89	—	—	—	358	28
Maximum number of parity groups	DKC-F710I-146KCM	255	226	255	255	255	255
	DKC-F710I-300JCM/KCM	255	113	255	255	255	255
	DKC-F710I-600JCM	255	56	169	255	255	255
	DKC-F710I-900JCM	255	37	113	255	255	255
	DKC-F710I-1R2JCM	255	—	—	—	255	255
	DKC-F710I-200SAM/SCM/MCM	32	32	32	32	32	32
	DKC-F710I-400SCM/S1M/S3M/MCM	32	32	32	32	32	32
	DKC-F710I-800MCM	32	32	32	32	32	32
	DKC-F710I-500HCM	255	66	199	255	255	255
	DKC-F710I-1R0HCM	255	—	—	—	255	255
	DKC-F710I-2R0H2M	159	—	—	—	159	159
	DKC-F710I-2R0H3M	159	—	—	—	159	159
	DKC-F710I-3R0H3M	159	—	—	—	159	159
	DKC-F710I-4R0H3M	159	—	—	—	159	159
	DKC-F710I-1R6FM	23	—	—	—	23	23
	DKC-F710I-3R2FM	23	—	—	—	23	23
Maximum number of volumes	DKC-F710I-146KCM	765	65,088	24,480	7,140	3,570	255
	DKC-F710I-300JCM/KCM	1,785	65,201	48,960	14,535	7,395	510
	DKC-F710I-600JCM	3,570	64,680	65,065	29,325	14,790	1,020
	DKC-F710I-900JCM	5,610	64,121	65,201	44,115	22,440	1,530
	DKC-F710I-1R2JCM	7,395	—	—	—	29,835	2,295
	DKC-F710I-200SAM/SCM/MCM	160	12,608	4,192	1,248	640	32
	DKC-F710I-400SCM/S1M/S3M/MCM	320	25,248	8,416	2,496	1,280	96
	DKC-F710I-800MCM	640	50,496	16,832	5,024	2,560	192
	DKC-F710I-500HCM	3,060	65,076	65,272	24,990	12,750	765
	DKC-F710I-1R0HCM	6,375	—	—	—	25,755	1,785
	DKC-F710I-2R0H2M	7,950	—	—	—	31,800	2,385
	DKC-F710I-2R0H3M	7,791	—	—	—	31,641	2,385
	DKC-F710I-3R0H3M	11,766	—	—	—	47,541	3,657
	DKC-F710I-4R0H3M	15,741	—	—	—	63,441	4,929
	DKC-F710I-1R6FM	1,012	—	—	—	4,117	322
	DKC-F710I-3R2FM	2,047	—	—	—	8,234	644

THEORY03-07-91A**Table 3.7.2-5 List of DKC710I Emulation Types for RAID6 (6D+2P) (4/4)**

	Emulation Type	3390-A	3390-A (3 type)	3390-A (9 type)	3390-A (L type)	3390-A (M type)	3390-V
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	670 - 170,792	817 - 184,720	817 - 208,423	780 - 198,806	780 - 198,810	712 - 181,576
	DKC-F710I-300JCM/KCM	1,563 - 398,514	1,638 - 185,040	1,635 - 416,845	1,587 - 404,713	1,615 - 411,820	1,424 - 363,152
	DKC-F710I-600JCM	3,126 - 797,027	3,278 - 183,562	3,278 - 553,963	3,202 - 816,525	3,230 - 823,640	2,848 - 726,303
	DKC-F710I-900JCM	4,912 - 1,252,472	4,918 - 181,975	4,913 - 555,121	4,817 - 1,228,338	4,901 - 1,249,661	4,272 - 1,089,455
	DKC-F710I-1R2JCM	6,474 - 1,650,986				6,516 - 1,661,481	6,409 - 1,634,182
	DKC-F710I-200SAM/SCM/MCM	1,116 - 35,721	1,118 - 35,782	1,115 - 35,691	1,086 - 34,749	1,114 - 35,641	712 - 22,786
	DKC-F710I- 400SCM/S1M/S3M/MCM	2,233 - 71,442	2,239 - 71,654	2,239 - 71,654	2,172 - 69,499	2,228 - 71,282	2,136 - 68,358
	DKC-F710I-800MCM	4,465 - 142,884	4,478 - 143,308	4,478 - 143,308	4,372 - 139,888	4,455 - 142,564	4,272 - 136,716
	DKC-F710I-500HCM	2,679 - 683,166	2,798 - 184,686	2,792 - 555,725	2,729 - 695,821	5,624 - 1,434,270	2,136 - 544,727
	DKC-F710I-1R0HCM	5,581 - 1,423,263	—	—	—	5,616 - 1,431,978	4,984 - 1,271,031
	DKC-F710I-2R0H2M	11,163 - 1,774,893	—	—	—	11,138 - 1,770,910	10,681 - 1,698,268
	DKC-F710I-2R0H3M	10,940 - 1,739,395	—	—	—	11,082 - 1,762,056	10,681 - 1,698,268
	DKC-F710I-3R0H3M	16,521 - 2,626,842	—	—	—	16,651 - 2,647,511	16,377 - 2,604,011
	DKC-F710I-4R0H3M	22,102 - 3,514,288	—	—	—	22,220 - 3,532,966	22,074 - 3,509,754
	DKC-F710I-1R6FM	9,823 - 225,936	—	—	—	9,968 - 229,272	9,969 - 229,284
	DKC-F710I-3R2FM	19,870 - 457,007	—	—	—	19,937 - 458,543	19,938 - 458,568

Table 3.7.2-6 List of DKC710I Emulation Types for RAID6 (14D+2P) (1/4)

Emulation Type		3380-3	3390-3 /3R	3390-9	3390-L	3390-M
Storage capacity(GB/volume)		2.377	2.838	8.510	27.8	55.6
Number of volumes /parity groups	DKC-F710I-146KCM	—	—	—	—	34
	DKC-F710I-300JCM/KCM	—	—	—	—	69
	DKC-F710I-600JCM	—	—	—	—	138
	DKC-F710I-900JCM	—	—	—	—	207
	DKC-F710I-1R2JCM	—	—	—	—	276
	DKC-F710I-200SAM/SCM/MCM	—	—	—	—	47
	DKC-F710I-400SCM/S1M/S3M/MCM	—	—	—	—	94
	DKC-F710I-800MCM	—	—	—	—	188
	DKC-F710I-500HCM	—	—	—	—	117
	DKC-F710I-1R0HCM	—	—	—	—	235
	DKC-F710I-2R0H2M	—	—	—	—	471 (470) (*1)
	DKC-F710I-2R0H3M	—	—	—	—	469
	DKC-F710I-3R0H3M	—	—	—	—	703
	DKC-F710I-4R0H3M	—	—	—	—	938
	DKC-F710I-1R6FM	—	—	—	—	421
	DKC-F710I-3R2FM	—	—	—	—	843
Maximum number of parity groups	DKC-F710I-146KCM	—	—	—	—	127
	DKC-F710I-300JCM/KCM	—	—	—	—	127
	DKC-F710I-600JCM	—	—	—	—	127
	DKC-F710I-900JCM	—	—	—	—	127
	DKC-F710I-1R2JCM	—	—	—	—	127
	DKC-F710I-200SAM/SCM/MCM	—	—	—	—	16
	DKC-F710I-400SCM/S1M/S3M/MCM	—	—	—	—	16
	DKC-F710I-800MCM	—	—	—	—	16
	DKC-F710I-500HCM	—	—	—	—	127
	DKC-F710I-1R0HCM	—	—	—	—	127
	DKC-F710I-2R0H2M	—	—	—	—	79
	DKC-F710I-2R0H3M	—	—	—	—	79
	DKC-F710I-3R0H3M	—	—	—	—	79
	DKC-F710I-4R0H3M	—	—	—	—	69
	DKC-F710I-1R6FM	—	—	—	—	11
	DKC-F710I-3R2FM	—	—	—	—	11
Maximum number of volumes	DKC-F710I-146KCM	—	—	—	—	4,318
	DKC-F710I-300JCM/KCM	—	—	—	—	8,763
	DKC-F710I-600JCM	—	—	—	—	17,526
	DKC-F710I-900JCM	—	—	—	—	26,289
	DKC-F710I-1R2JCM	—	—	—	—	35,052
	DKC-F710I-200SAM/SCM/MCM	—	—	—	—	752
	DKC-F710I-400SCM/S1M/S3M/MCM	—	—	—	—	1,504
	DKC-F710I-800MCM	—	—	—	—	3,008
	DKC-F710I-500HCM	—	—	—	—	14,859
	DKC-F710I-1R0HCM	—	—	—	—	29,845
	DKC-F710I-2R0H2M	—	—	—	—	37,209 (37,130) (*1)
	DKC-F710I-2R0H3M	—	—	—	—	37,051
	DKC-F710I-3R0H3M	—	—	—	—	55,537
	DKC-F710I-4R0H3M	—	—	—	—	64,722
	DKC-F710I-1R6FM	—	—	—	—	4,631
	DKC-F710I-3R2FM	—	—	—	—	9,273

Table 3.7.2-6 List of DKC710I Emulation Types for RAID6 (14D+2P) (2/4)

Emulation Type		3380-3	3390-3 /3R	3390-9	3390-L	3390-M
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	—	—	—	—	1,890 - 240,081
	DKC-F710I-300JCM/KCM	—	—	—	—	3,836 - 487,223
	DKC-F710I-600JCM	—	—	—	—	7,673 - 974,446
	DKC-F710I-900JCM	—	—	—	—	11,509 - 1,461,668
	DKC-F710I-1R2JCM	—	—	—	—	15,370 - 1,952,011
	DKC-F710I-200SAM/SCM/MCM	—	—	—	—	2,613 - 41,811
	DKC-F710I- 400SCM/S1M/S3M/MCM	—	—	—	—	5,226 - 83,622
	DKC-F710I-800MCM	—	—	—	—	10,453 - 167,245
	DKC-F710I-500HCM	—	—	—	—	6,505 - 826,160
	DKC-F710I-1R0HCM	—	—	—	—	13,066 - 1,659,382
	DKC-F710I-2R0H2M	—	—	—	—	26,188 (26,132) (*1) - 2,068,820 (2,064,428) (*1)
	DKC-F710I-2R0H3M	—	—	—	—	26,076 - 2,060,036
	DKC-F710I-3R0H3M	—	—	—	—	39,087 - 3,087,857
	DKC-F710I-4R0H3M	—	—	—	—	52,236 - 3,604,303
	DKC-F710I-1R6FM	—	—	—	—	23,408 - 257,484
	DKC-F710I-3R2FM	—	—	—	—	46,870 - 515,578

Note: The Emulation type 3390-3 and 3390-3R cannot be intermixed in the subsystem.

Table 3.7.2-6 List of DKC710I Emulation Types for RAID6 (14D+2P) (3/4)

Emulation Type		3390-A	3390-A (3 type)	3390-A (9 type)	3390-A (L type)	3390-A (M type)	3390-V
Storage capacity(GB/volume)		223.257	2.838	8.514	27.844	55.689	712.062
Number of volumes /parity groups	DKC-F710I-146KCM	8	—	—	—	34	2
	DKC-F710I-300JCM/KCM	17	—	—	—	64	5
	DKC-F710I-600JCM	34	—	—	—	137	10
	DKC-F710I-900JCM	51	—	—	—	205	16
	DKC-F710I-1R2JCM	68	—	—	—	274	21
	DKC-F710I-200SAM/SCM/MCM	11	—	—	—	46	3
	DKC-F710I-400SCM/S1M/S3M/MCM	23	—	—	—	93	7
	DKC-F710I-800MCM	46	—	—	—	187	14
	DKC-F710I-500HCM	29	—	—	—	117	9
	DKC-F710I-1R0HCM	58	—	—	—	234	18
	DKC-F710I-2R0H2M	116	—	—	—	466	36
	DKC-F710I-2R0H3M	116	—	—	—	465	36
	DKC-F710I-3R0H3M	174	—	—	—	698	55
	DKC-F710I-4R0H3M	232	—	—	—	931	73
Maximum number of parity groups	DKC-F710I-1R6FM	104	—	—	—	418	32
	DKC-F710I-3R2FM	209	—	—	—	836	65
	DKC-F710I-146KCM	127	—	—	—	127	127
	DKC-F710I-300JCM/KCM	127	—	—	—	127	127
	DKC-F710I-600JCM	127	—	—	—	127	127
	DKC-F710I-900JCM	127	—	—	—	127	127
	DKC-F710I-1R2JCM	127	—	—	—	127	127
	DKC-F710I-200SAM/SCM/MCM	16	—	—	—	16	16
	DKC-F710I-400SCM/S1M/S3M/MCM	16	—	—	—	16	16
	DKC-F710I-800MCM	16	—	—	—	16	16
	DKC-F710I-500HCM	127	—	—	—	127	127
	DKC-F710I-1R0HCM	127	—	—	—	127	127
	DKC-F710I-2R0H2M	79	—	—	—	79	79
	DKC-F710I-2R0H3M	79	—	—	—	79	79
	DKC-F710I-3R0H3M	79	—	—	—	79	79
Maximum number of volumes	DKC-F710I-4R0H3M	79	—	—	—	70	79
	DKC-F710I-1R6FM	11	—	—	—	11	11
	DKC-F710I-3R2FM	11	—	—	—	11	11
	DKC-F710I-146KCM	1,016	—	—	—	4,318	254
	DKC-F710I-300JCM/KCM	2,159	—	—	—	8,128	635
	DKC-F710I-600JCM	4,318	—	—	—	17,399	1,270
	DKC-F710I-900JCM	6,477	—	—	—	26,035	2,032
	DKC-F710I-1R2JCM	8,636	—	—	—	34,798	2,667
	DKC-F710I-200SAM/SCM/MCM	176	—	—	—	736	48
	DKC-F710I-400SCM/S1M/S3M/MCM	368	—	—	—	1,488	112
	DKC-F710I-800MCM	736	—	—	—	2,992	224
	DKC-F710I-500HCM	3,683	—	—	—	14,859	1,143
	DKC-F710I-1R0HCM	7,366	—	—	—	29,718	2,286
	DKC-F710I-2R0H2M	9,164	—	—	—	36,814	2,844
	DKC-F710I-2R0H3M	9,164	—	—	—	36,735	2,844
	DKC-F710I-3R0H3M	13,746	—	—	—	55,142	4,345
	DKC-F710I-4R0H3M	18,328	—	—	—	65,170	5,767
	DKC-F710I-1R6FM	1,144	—	—	—	4,598	352
	DKC-F710I-3R2FM	2,299	—	—	—	9,196	715

Table 3.7.2-6 List of DKC710I Emulation Types for RAID6 (14D+2P) (4/4)

Emulation Type		3390-A	3390-A (3 type)	3390-A (9 type)	3390-A (L type)	3390-A (M type)	3390-V
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	1,786 - 226,829	—	—	—	1,893 - 240,465	1,424 - 180,864
	DKC-F710I-300JCM/KCM	3,795 - 482,012	—	—	—	3,564 - 452,640	3,560 - 452,159
	DKC-F710I-600JCM	7,591 - 964,024	—	—	—	7,629 - 968,933	7,121 - 904,319
	DKC-F710I-900JCM	11,386 - 1,446,036	—	—	—	11,416 - 1,449,863	11,393 - 1,446,910
	DKC-F710I-1R2JCM	15,181 - 1,928,047	—	—	—	15,259 - 1,937,866	14,953 - 1,899,069
	DKC-F710I-200SAM/SCM/MCM	2,456 - 39,293	—	—	—	2,562 - 40,987	2,136 - 34,179
	DKC-F710I- 400SCM/S1M/S3M/MCM	5,135 - 82,159	—	—	—	5,179 - 82,865	4,984 - 79,751
	DKC-F710I-800MCM	10,270 - 164,317	—	—	—	10,414 - 166,621	9,969 - 159,502
	DKC-F710I-500HCM	6,474 - 822,256	—	—	—	6,516 - 827,483	6,409 - 813,887
	DKC-F710I-1R0HCM	12,949 - 1,644,511	—	—	—	13,031 - 1,654,966	12,817 - 1,627,774
	DKC-F710I-2R0H2M	25,898 - 2,045,927	—	—	—	25,951 - 2,050,135	25,634 - 2,025,104
	DKC-F710I-2R0H3M	25,898 - 2,045,927	—	—	—	25,895 - 2,045,735	25,634 - 2,025,104
	DKC-F710I-3R0H3M	38,847 - 3,068,891	—	—	—	38,871 - 3,070,803	39,163 - 3,093,909
	DKC-F710I-4R0H3M	51,796 - 4,091,854	—	—	—	51,846 - 3,629,252	51,981 - 4,106,462
	DKC-F710I-1R6FM	23,219 - 255,406	—	—	—	23,278 - 256,058	22,786 - 250,646
	DKC-F710I-3R2FM	46,660 - 513,267	—	—	—	46,556 - 512,116	46,284 - 509,124

*1: The number in parentheses is the value in SATA-Enhance method

Specifications for coexistence of elements

Table 3.7.2-6 shows permitted coexistence of RAID levels, HDD types, and emulation types respectively.

Table 3.7.2-6 Specifications for Coexistence of Elements

Item	Specification	Remarks
Coexistence of RAID levels	RAID1/RAID5/RAID6 can exist in the system.	
Coexistence of numbers of HDDs composing ECC group (coexistence of configurations 7D+1P, 3D+1P, 2D+2D, 6D+2P and 14D+2P)	- The numbers of HDDs inside an ECC group are 4 HDDs or 8 HDDs and they are applicable to RAID5 (7D+1P, 3D+1P), RAID1 (2D+2D) and RAID6 (6D+2P, 14D+2P). - All HDD types support RAID5 (7D+1P, 3D+1P), RAID1 (2D+2D) and RAID6 (6D+2P, 14D+2P) configuration. 7D+1P, 3D+1P, 2D+2D, 6D+2P and 14D+2P can coexist in the system.	
Coexistence of HDD types	- HDD types can coexist in each ECC group. - The specification for selecting the spare HDD can be common in following cases. - More than the same capacity - In the case of HDD, the same rotation speed. In the case of SSD, the same memory method. (The mixture of SLC and MLC is impossible.) In the case of FMD, only FMD is available. - The same transfer rate of the DKA Note: Spare drives under a normal disk adapter cannot be used as drives under an encryption disk adapter (and vice versa).	
Coexistence of emulation types	- Emulation types can coexist in each ECC group. - LDEV ID addressing must be of the same emulation type (3380-3, 3390-V/A/M/L/9/3, or 3390-3R) for every 32-address boundary.	An emulation of the same system should be set for every 32 addressings due to generation restriction by the host.

3.8 65280 logical addresses

The host connection interface specification are outlined in Tables 3.8-1 and 3.8-2.

Table 3.8-1 List of Allowable Maximum Values of Host Connection Interface Items on the DKC Side

	Fibre channel
Maximum number of CUs	255
Maximum number of SSIDs	1020
Maximum number of LDEVs	65280

Table 3.8-2 Allowable Range of Host Connection Interface Items on DKC Side

	Fibre channel
CU address	0 to FE ^{*1}
SSID	0004 to FFFD ^{*2}
Number of logical volumes	1 to 65280 ^{*3}

*1: Number of CUs connectable to the one FICON channel (CHPID) is 64 or 255. In case of 2105-F20 emulation, the CU addresses in the interface with a host are 00 to 3F for the FICON channel. In case of 2107 emulation, the CU addresses in the interface with a host are 00 to FE for the FICON channel.

*2: In case of 2105/2107 emulation, the SSID in the interface with a host is 0x0004 to 0xFEFF.

*3: Number of logical volumes connectable to the one FICON channel (CHPID) is 16384.

Notice: If you use PPRC command and specify 0xFFXX as SSID of MCU and RCU, the command may be rejected. Please specify 0x0004 0xFEFF as SSID of MCU and RCU.

P9500 cannot assign from 0x0001 to 0x0003. Because, P9500 is using them for internally. If you will set SSID for mainframe, please follow mainframe to hand range of SSID.

Detailed numbers of logical paths of the main frame fibre and serial channels are shown in Table 3.8-3.

Table 3.8-3 List of Numbers of Connectable Logical Paths

Item	Fibre channel
Number of channel ports	8 to 112
Max. number of logical paths per CU	2048
Max. number of logical paths per port	$65536^{*4} / 261120^{*5} \times 6^{*6}$
Max. number of logical paths per channel adapter	$65536^{*4} / 261120^{*5}$
Max. number of logical paths per system	$131072^{*4} / 522240^{*5}$

*4: In case of 2105-F20 emulation.

*5: In case of 2107 emulation.

*6: The maximum number of paths for connection to a host per fibre channel port is 1024 (1024 host paths $\times$ 64 CUs = 65536 logical paths for 2105-F20 emulation. 1024 host paths $\times$ 255 CUs = 261120 logical paths for 2107 emulation.).

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The SAID values at 2105/2107 emulation are shown in Table 3.8-4 and Table 3.8-5.

Note: SAID required for CESTPATH command are shown in [THEORY03-13-70](#), Table 3.11.1-2.

Table 3.8-4 SAID values (CL1)

Module#0						Module#1					
Package Location	Port	SAID	Package Location	Port	SAID	Package Location	Port	SAID	Package Location	Port	SAID
1EU	CL1-A	x'0000'	1AU	CL9-A	x'0040'	1GU	CL1-J	x'0020'	1LU	CL9-J	x'0060'
	CL3-A	x'0001'		CLB-A	x'0041'		CL3-J	x'0021'		CLB-J	x'0061'
	CL5-A	x'0002'		CLD-A	x'0042'		CL5-J	x'0022'		CLD-J	x'0062'
	CL7-A	x'0003'		CLF-A	x'0043'		CL7-J	x'0023'		CLF-J	x'0063'
	CL1-B	x'0004'		CL9-B	x'0044'		CL1-K	x'0024'		CL9-K	x'0064'
	CL3-B	x'0005'		CLB-B	x'0045'		CL3-K	x'0025'		CLB-K	x'0065'
	CL5-B	x'0006'		CLD-B	x'0046'		CL5-K	x'0026'		CLD-K	x'0066'
	CL7-B	x'0007'		CLF-B	x'0047'		CL7-K	x'0027'		CLF-K	x'0067'
1EL	CL1-C	x'0010'	1AL	CL9-C	x'0050'	1GL	CL1-L	x'0030'	1LL	CL9-L	x'0070'
	CL3-C	x'0011'		CLB-C	x'0051'		CL3-L	x'0031'		CLB-L	x'0071'
	CL5-C	x'0012'		CLD-C	x'0052'		CL5-L	x'0032'		CLD-L	x'0072'
	CL7-C	x'0013'		CLF-C	x'0053'		CL7-L	x'0033'		CLF-L	x'0073'
	CL1-D	x'0014'		CL9-D	x'0054'		CL1-M	x'0034'		CL9-M	x'0074'
	CL3-D	x'0015'		CLB-D	x'0055'		CL3-M	x'0035'		CLB-M	x'0075'
	CL5-D	x'0016'		CLD-D	x'0056'		CL5-M	x'0036'		CLD-M	x'0076'
	CL7-D	x'0017'		CLF-D	x'0057'		CL7-M	x'0037'		CLF-M	x'0077'
1FU	CL1-E	x'0008'				1HU	CL1-N	x'0028'			
	CL3-E	x'0009'					CL3-N	x'0029'			
	CL5-E	x'000A'					CL5-N	x'002A'			
	CL7-E	x'000B'					CL7-N	x'002B'			
	CL1-F	x'000C'					CL1-P	x'002C'			
	CL3-F	x'000D'					CL3-P	x'002D'			
	CL5-F	x'000E'					CL5-P	x'002E'			
	CL7-F	x'000F'					CL7-P	x'002F'			
1FL	CL1-G	x'0018'				1HL	CL1-Q	x'0038'			
	CL3-G	x'0019'					CL3-Q	x'0039'			
	CL5-G	x'001A'					CL5-Q	x'003A'			
	CL7-G	x'001B'					CL7-Q	x'003B'			
	CL1-H	x'001C'					CL1-R	x'003C'			
	CL3-H	x'001D'					CL3-R	x'003D'			
	CL5-H	x'001E'					CL5-R	x'003E'			
	CL7-H	x'001F'					CL7-R	x'003F'			

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Table 3.8-5 SAID values (CL2)

Module#0						Module#1					
Package Location	Port	SAID	Package Location	Port	SAID	Package Location	Port	SAID	Package Location	Port	SAID
2QU	CL2-A	x'0080'	2MU	CLA-A	x'00C0'	2TU	CL2-J	x'00A0'	2XU	CLA-J	x'00E0'
	CL4-A	x'0081'		CLC-A	x'00C1'		CL4-J	x'00A1'		CLC-J	x'00E1'
	CL6-A	x'0082'		CLE-A	x'00C2'		CL6-J	x'00A2'		CLE-J	x'00E2'
	CL8-A	x'0083'		CLG-A	x'00C3'		CL8-J	x'00A3'		CLG-J	x'00E3'
	CL2-B	x'0084'		CLA-B	x'00C4'		CL2-K	x'00A4'		CLA-K	x'00E4'
	CL4-B	x'0085'		CLC-B	x'00C5'		CL4-K	x'00A5'		CLC-K	x'00E5'
	CL6-B	x'0086'		CLE-B	x'00C6'		CL6-K	x'00A6'		CLE-K	x'00E6'
	CL8-B	x'0087'		CLG-B	x'00C7'		CL8-K	x'00A7'		CLG-K	x'00E7'
2QL	CL2-C	x'0090'	2ML	CLA-C	x'00D0'	2TL	CL2-L	x'00B0'	2XL	CLA-L	x'00F0'
	CL4-C	x'0091'		CLC-C	x'00D1'		CL4-L	x'00B1'		CLC-L	x'00F1'
	CL6-C	x'0092'		CLE-C	x'00D2'		CL6-L	x'00B2'		CLE-L	x'00F2'
	CL8-C	x'0093'		CLG-C	x'00D3'		CL8-L	x'00B3'		CLG-L	x'00F3'
	CL2-D	x'0094'		CLA-D	x'00D4'		CL2-M	x'00B4'		CLA-M	x'00F4'
	CL4-D	x'0095'		CLC-D	x'00D5'		CL4-M	x'00B5'		CLC-M	x'00F5'
	CL6-D	x'0096'		CLE-D	x'00D6'		CL6-M	x'00B6'		CLE-M	x'00F6'
	CL8-D	x'0097'		CLG-D	x'00D7'		CL8-M	x'00B7'		CLG-M	x'00F7'
2RU	CL2-E	x'0088'				2UU	CL2-N	x'00A8'			
	CL4-E	x'0089'					CL4-N	x'00A9'			
	CL6-E	x'008A'					CL6-N	x'00AA'			
	CL8-E	x'008B'					CL8-N	x'00AB'			
	CL2-F	x'008C'					CL2-P	x'00AC'			
	CL4-F	x'008D'					CL4-P	x'00AD'			
	CL6-F	x'008E'					CL6-P	x'00AE'			
	CL8-F	x'008F'					CL8-P	x'00AF'			
2RL	CL2-G	x'0098'				2UL	CL2-Q	x'00B8'			
	CL4-G	x'0099'					CL4-Q	x'00B9'			
	CL6-G	x'009A'					CL6-Q	x'00BA'			
	CL8-G	x'009B'					CL8-Q	x'00BB'			
	CL2-H	x'009C'					CL2-R	x'00BC'			
	CL4-H	x'009D'					CL4-R	x'00BD'			
	CL6-H	x'009E'					CL6-R	x'00BE'			
	CL8-H	x'009F'					CL8-R	x'00BF'			

3.9 LDEV Formatting

3.9.1 High-Speed Format

3.9.1.1 Outlines

DKC can LDEV-Format to two or more ECC at the same time by providing the HDD^{*1} and Flash Module Drive with the LDEV formatting function.

*1: The HDD type of DKx-xxxxSS has the LDEV formatting function.

Table 3.9.1.1-1

Item No.	Item	Contents
1	SVP operation	The operation is performed by selecting functions from the Maintenance menu.
2	Display of execution status	Display of the execution progress in the SVP message box (%)
3	Execution result	Normal/abnormal LDEV: Same indications as the conventional ones are displayed. Normal/abnormal PDEV: STATUS is displayed.
4	Recovery action when a failure occurs	Same as the conventional one. However, a retry is to be executed in units of ECC. (Because the LDEV-FMT is terminated abnormally in units of ECC when a failure occurs in the HDD.)
5	Operation of the SVP which is a high-speed LDEV-FMT object	When an LDEV-FMT of more than one ECC is instructed, the high-speed processing is performed.
6	PS/OFF or powering off	The LDEV formatting is suspended. No automatic restart is executed.
7	SVP PC powering off during execution of an LDEV-FMT	After the SVP is rebooted, the indication before the PC powering off is displayed in succession.
8	Execution of a high-speed LDEV-FMT in the status that the spare is saved	ECC of HDD which the spare is saved fails the high-speed LDEV-FMT, and changes to a low-speed format. (Because the low-speed format is executed after the high-speed format is completed, the format time becomes long.) After the high-speed LDEV-FMT is completed, execute the copy back of HDD which the spare is saved from SIM log and restore it.

THEORY03-09-20**3.9.1.2 Estimation of LDEV Formatting Time****(1) DKxxx-JxxxSS/KxxxSS/HxxxSS****(a) High speed LDEV formatting**

The format time of DKxxx-JxxxSS/KxxxSS/HxxxSS doesn't depend on number of ECC, and be decided by capacity and the rotational speed of HDD.

It is an aim to the last in the standard time required, and the real format time may be different by RAID GROUP, an emulation type the generation and a drive type.

Formatting time is indicated as follows.

Table 3.9.1.2-1

HDD Capacity/rotation Speed	Formatting Time (*5)	Time Out Value (*1)
4TB/7.2Krpm	approx. 650min	910min
3TB/7.2Krpm	approx. 620min	730min
2TB/7.2Krpm	approx. 450min	640min
1TB/7.2Krpm	approx. 250min	400min
500GB/7.2Krpm	approx. 130min	215min
1.2TB/10Krpm	approx. 150min	220min
900GB/10Krpm	approx. 120min	200min
600GB/10Krpm	approx. 130min	215min
300GB/10Krpm	approx. 75min	130min
300GB/15Krpm	approx. 45min	100min
146GB/15Krpm	approx. 35min	75min

(b) Slow LDEV formatting

The format time of DKxxx-JxxxSS/KxxxSS/HxxxSS is indicated as follows (*2).

LDEV formatting is performed by slow LDEV formatting only.

Rough formatting time without host I/O is indicated as follows (be include Encrypt RAID Group) (*3).

Table 3.9.1.2-2 15Krpm

Drive capacity/Number of ECC	Formatting Time (*4, *5)
100GB/1ECC	35min
100GB/32ECC	70min
100GB/64ECC	135min
100GB/128ECC	300min

Other capacity becomes time proportional to 100GB.

Table 3.9.1.2-3 10Krpm

Drive capacity/Number of ECC	Formatting Time (*4, *5)
100GB/1ECC	35min
100GB/32ECC	70min
100GB/64ECC	135min
100GB/128ECC	300min

Other capacity becomes time proportional to 100GB.

Table 3.9.1.2-4 7.2Krpm

Drive capacity/Number of ECC	Formatting Time (*4, *5)
100GB/1ECC	57min
100GB/32ECC	110min
100GB/64ECC	220min
100GB/128ECC	490min

Other capacity becomes time proportional to 100GB.

(2) DKxxx-HxxxAT

DKCxxx-HxxxAT doesn't have the self LDEV formatting function.

LDEV formatting is performed by slow LDEV formatting only.

Rough formatting time without host I/O is indicated as follows (be include Encrypt RAID Group) (*3).

Table 3.9.1.2-5

Drive capacity/Number of ECC	Formatting Time (*4, *5)
2TB/1ECC	18hour
2TB/40ECC	40hour
2TB/80ECC	80hour

(3) Flash Drive

Flash Drive doesn't have the self LDEV formatting function.

LDEV formatting is performed by slow LDEV formatting only.

Rough formatting time without host I/O is indicated as follows (be include Encrypt RAID Group) (*3).

Table 3.9.1.2-6

Drive capacity/Number of ECC	Formatting Time (*4, *5)
200GB/1ECC	70min
200GB/2ECC	70min
200GB/4ECC	70min

Other capacity becomes time proportional to 200GB.

When Flash Drive is used, the Formatting time becomes the same in one ECC and as many as four ECC because the transmission of the format data doesn't arrive even at the limit of passing.

(4) NFxxx-PxRxSS

(a) High speed LDEV formatting

The format time of NFxxx-PxRxSS doesn't depend on number of ECC, and be decided by capacity.

It is an aim to the last in the standard time required, and the real format time may be different by RAID GROUP, an emulation type the generation and a drive type.

Formatting time is indicated as follows.

Table 3.9.1.2-7

Drive Capacity	Formatting Time (*5)	Time Out Value (*1)
1.6TB	60min	100min
3.2TB	120min	190min

(b) Slow LDEV formatting

The format time of NFxxx-PxRxSS is indicated as follows (*2).

LDEV formatting is performed by slow LDEV formatting only.

Rough formatting time without host I/O is indicated as follows (be include Encrypt RAID Group) (*3).

Table 3.9.1.2-8

Drive capacity/Number of ECC	Formatting Time (*4, *5)
200GB/1ECC	40min
200GB/2ECC	40min
200GB/4ECC	40min

Other capacity becomes time proportional to 200GB.

- *1: The progress rate on SVP is displays as “99%” during the “Formatting Time” and the “Time Out Value”.
Because HDD and Flash Module Drive execute the formatting, and the progress rate to the total capacity is not understood, the ratio at the elapsed time from the format beginning to the Formatting time required is displayed.
- *2: The standard time of the slow LDEV formatting based the time in 7D+1P OPEN-V.
- *3: If there is an I/O operation, the minimum formatting time is over 6 times as long as the discrete value, depending on the I/O load.
In this case, if any parity group of DKxxx-HxxxAT exists in the raid group under the encryption RAID Group, the formatting takes the maximum time.
- *4: Depending on the RAID level of the parity group, the number of Drive that make up the parity group, or the emulation type of LDEV defined to the parity group, formatting time varies.
In the case of RAID6 (14D+2P configuration), formatting time varies between +5% and +100%.
In the case of RAID6 (6D+2P configuration), formatting time varies between -10% and -30%.
In the case of RAID5 (3D+1P configuration) and RAID1 (2D+2D), formatting time varies between -30% and -70%.
- *5: The format time varies according to the generation of the drive in standard time distance.

Note:

- If the Drive types and configurations mentioned in above (1) ~ (4) coexist, the format time required matches the one of the Drive type whose standard time required is the longest. As a result, the time required to start using the logical volumes is longer than the case of adding Drive one by one.
Therefore, when adding Drives in the cases of above (1) ~ (4), it is recommended to start the operation one by one from the Drive type whose standard time required is the shortest.
- If the emulation type of LDEV is for Mainframe, Mainframe Fibre for CHA is necessary.
- If the emulation type of LDEV is for OPEN, Open Fibre for CHA is necessary.

3.9.2 Quick Format

3.9.2.1 Outlines

Quick Format provides the function to format in the background by making the volumes usable without waiting for the completion of the format when starting the format. The support specifications are shown below.

Table 3.9.2.1-1 Quick Format Specifications

Item No.	Item	Contents
1	Prerequisite	The previous model is required to create the system disk in advance before executing Quick Format. But this model need not create the system disk. Refer to “3.9.2.2 Data security of volumes during Quick Format” for the detail.
2	Support HDD type	All HDD type support
3	Emulation type	All emulation types
4	Number of parity groups	The number of parity groups that Quick Format is possible at the same time is up to 36. The number of volumes is not limited if it is within 36 parity groups. In the case of four concatenations, the number of parity groups is four. In the case of two concatenations, the number of parity groups is two.
5	Combination with various PP	It is operable in combination with all PP.
6	Execution opportunity	When performing a format from SVP or Web Console, you can select either Quick Format or the normal format.
7	Additional start in execution	Quick format can be executed additionally within a total of 36 parity groups including the parity group during execution during Quick Format execution.
8	Preparing Quick Format	Create management information first when executing Quick Format. I/O access cannot be executed in the same way as the normal format in this period. In case of OPEN volume, it takes up to about one minute for one parity group, and up to about 36 minutes in case of 36 parity groups for the preparation. In case of M/F volume, it takes the same time as above with the addition of the time described in Table 3.9.2.3-1.

(To be continued)

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(Continued from the preceding page)

Item No.	Item	Contents
9	Blocking and restoring the volume	- When the volume during Quick Format execution is blocked for maintenance, the status of the volume (during Quick Format execution) is stored in the disk subsystem. When the volume is restored afterwards, the volume status becomes "Normal (Quick Format)". - When all of the volumes during Quick Format in the parity group are blocked, the number of parity groups that are during Quick Format displayed in the 'Logical Device' window of Storage Navigator and 'Maintenance' window of SVP decreases equally to the number of the blocked parity groups. However, the number of parity groups that can additionally execute Quick Format will not increase. The number of parity groups that can additionally execute Quick Format can be calculated with the following calculating formula; $36 - X - Y$. (Legend) X: The number of parity groups during Quick Format execution displayed in the window. Y: The number of parity groups with all of the volumes in the parity group blocked during Quick Format execution.
10	Operation at the time of PS OFF/ON	After P/S ON, Quick Format restarts.
11	Restrictions	- Quick Format cannot be executed to the journal volume of Universal Replicator, external volume, and virtual volume. - Volume Migration and Quick Restore of ShadowImage cannot be executed to a volume during Quick Format. - The Prestaging of Cache Residency Manager cannot be executed to the volume during Quick Format.

3.9.2.2 Data security of volumes during Quick Format

The Quick Format control table is kept on SM, but it is also stored in SSD in case SM volatilizes so that it recovers from SSD in the case of volatilization start. Because SSD doesn't volatilize, the system disk is unnecessary in this model.

3.9.2.3 Control information format time of M/F VOL

In case of M/F VOL, the control information at the terminal of each volume is initialized and then the volume status becomes usable. Therefore, it is required to wait for the format, as well as the conventional format, until completing the creation processing of the control information. The time required at this time changes depending on the emulation type and the number of volumes as shown in the following table.

Table 3.9.2.3-1 Control Information Format Time of M/F VOL (Per 1K Volume)

Emulation type	Format time (minute)
3390-A	144
3390-M/MA/MB/MC	36
3390-L/LA/LB/LC	18
3390-9/9A/9B/9C	6
Others	2

The above is the time required when formatting 1K volumes and it is proportional to the number of volumes.

*: When SATA-Enhance method (Refer to [THEORY03-30-30](#)) is applied, the formatting time takes 2 more minutes than that shown in the above table.

3.9.2.4 Quick Format time

Quick Format executes the format in background while executing I/O from HOST. Therefore, the Quick Format time may change significantly depending on the number of I/O from HOST or other conditions.

The following table shows the Quick Format time without I/O. The Quick Format time with I/O may be twice or three times of the following time.

Table 3.9.2.4-1 Quick Format Time

Drive capacity	Format time (hour)
146GB	4
200GB	5
300GB	8
400GB	10
500GB	12
600GB	15
800GB	20
900GB	22
1TB	26
1.2TB	30
1.6TB	40
2TB	50
2TB (SATA-W/V)	150
3TB	75
3.2TB	80
4TB	100

- The time above shows the time when Quick Format is executed to all areas of the parity group, and when Quick Format is executed to a part of LDEV in the parity group, the time will be faster in proportion to the capacity of LDEV.
- The Quick Format time with I/O may be over five times of the time above.
- When Quick Format is executed to multiple parity groups, the time becomes slower than the time above depending on the number of parity groups. The proportion of the time becoming slower is generally two times slower when the number of parity groups are 15, and three times slower when the number of parity groups are 30.
- The time above might be up to four times slower depending on the capacity of cache memories and the number of MPBs.
- When Quick Format is executed to parity groups with different drive capacities at the same time, calculate the time with the parity group of the largest capacity.
- When the RAID level is RAID1, the formatting time becomes about half compared with the above-mentioned time.

3.9.2.5 Performance during Quick Format

Quick Format executes the format in background while executing I/O from HOST. Therefore, it may influence the HOST performance. The following table shows the proportion of the performance influence. (However, this is only a rough standard, and it may change depending on the conditions.)

Table 3.9.2.5-1 Performance during Quick Format

I/O types	Performance when the ratio shows 100% at normal condition
Random read	80%
Random write to the unformatted area	20%
Random write to the formatted area	60%
Sequential read	90%
Sequential write	90%

NOTICE:

As Quick Format utilizes shared resources like MPs and cache paths, it may affect all host I/O performances active in the storage systems.

Particularly in the cases like the following (a) and (b), as workloads concentrate on specific components concurrently, host I/O performance is likely to be affected during Quick Format.

- (a) One or two module configurations start massive Quick Formats in parallel when having CPC, ESW, DKA and CHA as the minimal configuration.
- (b) The amount of mounted CPC, ESW, DKA and CHA are extremely unbalanced between configurations of respective modules. Or the amount of connected CPC, DKA and CHA are extremely unbalanced between ESW (Basic) and/or ESW (Option) in the modules.

When you have such minimal or unbalanced configurations, it is strongly recommended to start with a single LDEV Quick Format, and to increase the number of concurrent Quick Formats one by one while confirming host I/O performance is not affected. Regardless of the configurations, it is recommended to start with no more than 8 concurrent Quick Formats, and to gradually add 4 Quick Formats at a time while watching host I/O impact.

3.9.2.6 Combination with other maintenance

Table 3.9.2.6-1 Combination with Other Maintenance

Item No.	Maintenance Operation	Operation during Quick Format
1	Drive copy/correction copy	The processing is possible as well as the normal volumes, but unformatted area is skipped.
2	Conventional format	The conventional format is executable for the volumes that Quick Format is not executed.
3	Volume maintenance blockade	It is possible to block the volumes instructed by SVP for the volumes during Quick Format.
4	Volume forcible restore	If forcible restore is executed after the maintenance blockade, it returns to Quick Formatting.
5	Verify consistency check	Possible. However, the Verify consistency check for the unformatted area is skipped.
6	PDEV replacement	Possible as usual
7	P/K replacement	Possible as usual

3.9.2.7 SIM when Quick Format finished

After Quick Format is finished, SIM = 0x410100 is output when executing Quick Format from SVP.

When all Quick Format is finished, the above SIM is output if Quick Format is executed from Storage Navigator while executing Quick Format from SVP.

When Quick Format is executed only from Storage Navigator, SIM is not output.

3.10 (Blank)

3.11 Ownership Management

3.11.1 Confirmation and Definitions of requests and issues

Table 3.11.1-1 Confirmation and Definitions of requests and issues

#	Request	Case
1	Maximize system performance by using MP PK effectively	Initial set up (Define Configuration & Install) Ownership management resources are Installed. At performance tuning
2	Troubleshoot in the case of problems related to ownership	Troubleshoot
3	Confirm resources allocated to each MP PK	Ownership management resources are Installed. At performance tuning Troubleshoot
4	Maintain performance for resources allocated to specific MP PK	Ownership management resources are Installed. Installation of MP PK

3.11.1.1 Request #1

Request

Maximize system performance by using MP PK effectively.

Issue

Way to distribute resources to balance load of each MP PK.

How to realize

- (1) User directly allocates resources to each MP PK.
- (2) User does not allocate resources. Resources are allocated to each MP PK automatically.

Case

(A) Define Configuration & Install

Target resource: LDEV

Setting IF: SVP

(B) Ownership management resources are installed

Target resources: LDEV/External VOL/JNLG

Setting IF: SVP/Storage Navigator/CLI/RMLib

THEORY03-11-20**3.11.1.2 Request #2**

Request

Maximize system performance by using MP PK effectively.

Issue

Way to move resources to balance load of each MP PK.

How to realize

User directly requests to move resources.

Case

Performance tuning

Target resources: LDEV/External VOL/JNLG

Setting IF: Storage Navigator/CLI/RMLib

3.11.1.3 Request #3

Request

Troubleshoot in the case of problems related to ownership.

Issue

Way to move resources required for solving problems.

How to realize

Maintenance personnel directly requests to move resources.

Case

Troubleshoot

Target resources: LDEV/External VOL/JNLG

Setting IF: Storage Navigator/CLI/RMLib

3.11.1.4 Request #4

Request

Confirm resources allocated to each MP PK.

Issue

Way to reference resources allocated to each MP PK.

How to realize

User directly request to reference resources.

Case

(A) Before ownership management resources are installed

Target resources: LDEV/External VOL/JNLG

Referring IF: Storage Navigator/CLI/Report (XPDT)/RMLib

(B) Performance tuning

Target resources: LDEV/External VOL/JNLG

Referring IF: Storage Navigator/CLI/Report (XPDT)/RMLib

(C) Troubleshoot

Target resources: LDEV/External VOL/JNLG

Referring IF: Storage Navigator/CLI/Report (XPDT)/RMLib

3.11.1.5 Request #5

Request

Maintain performance for resources allocated to specific MP PK.

Issue

Way to move resources allocated to each MP PK automatically and, way to prevent movement of resources during Installation of MP PK.

How to realize

Resources are NOT allocated/ moved automatically to the MP PK that user specified.

Case

(A) When installing ownership management resources, preventing allocation of resources to the Auto Assignment “Disable” PK.

(B) When installing the MP PK specified above, preventing allocation of resources to the Auto Assignment “Disable” PK.

- (A) When installing ownership management resources, preventing allocation of resources to the Auto Assignment “Disable” PK.

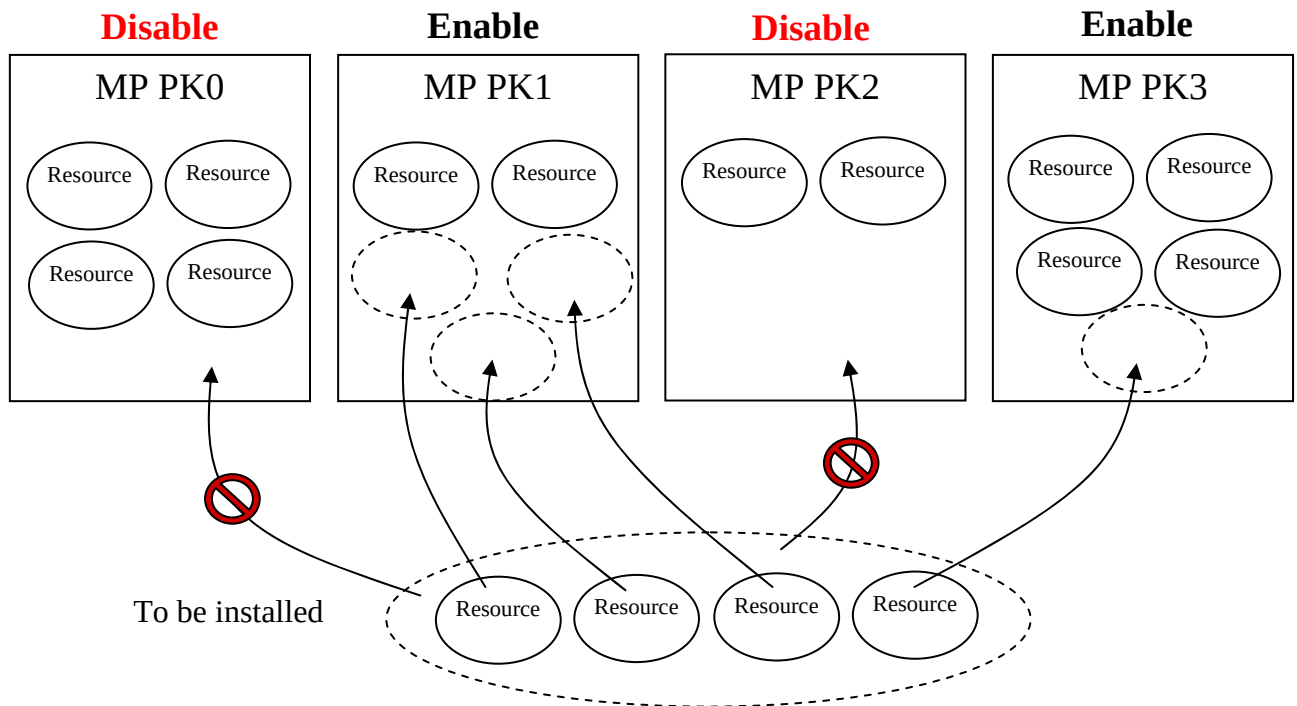
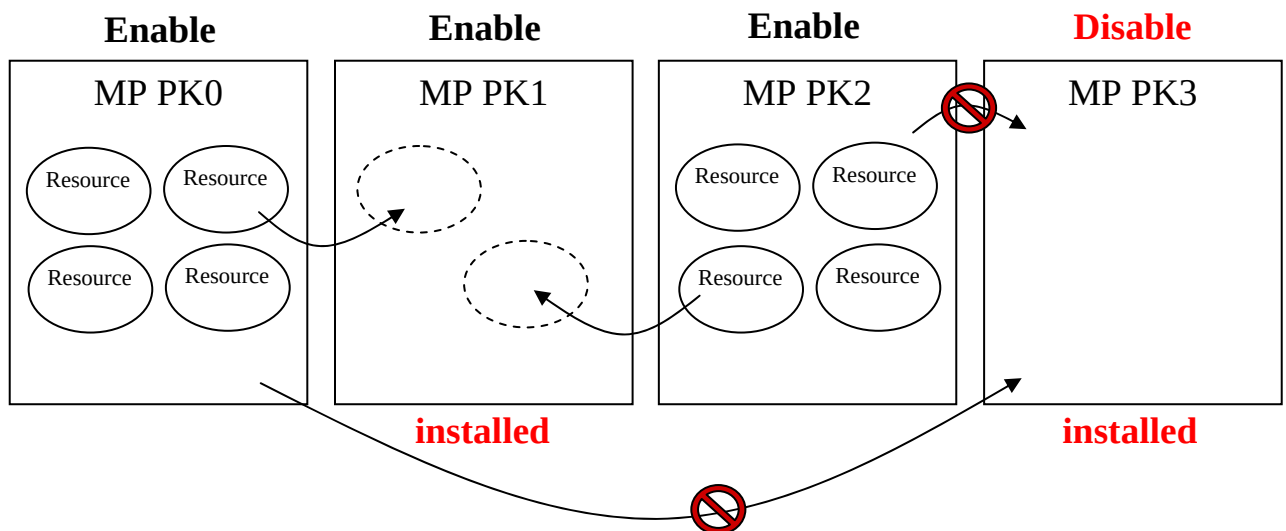


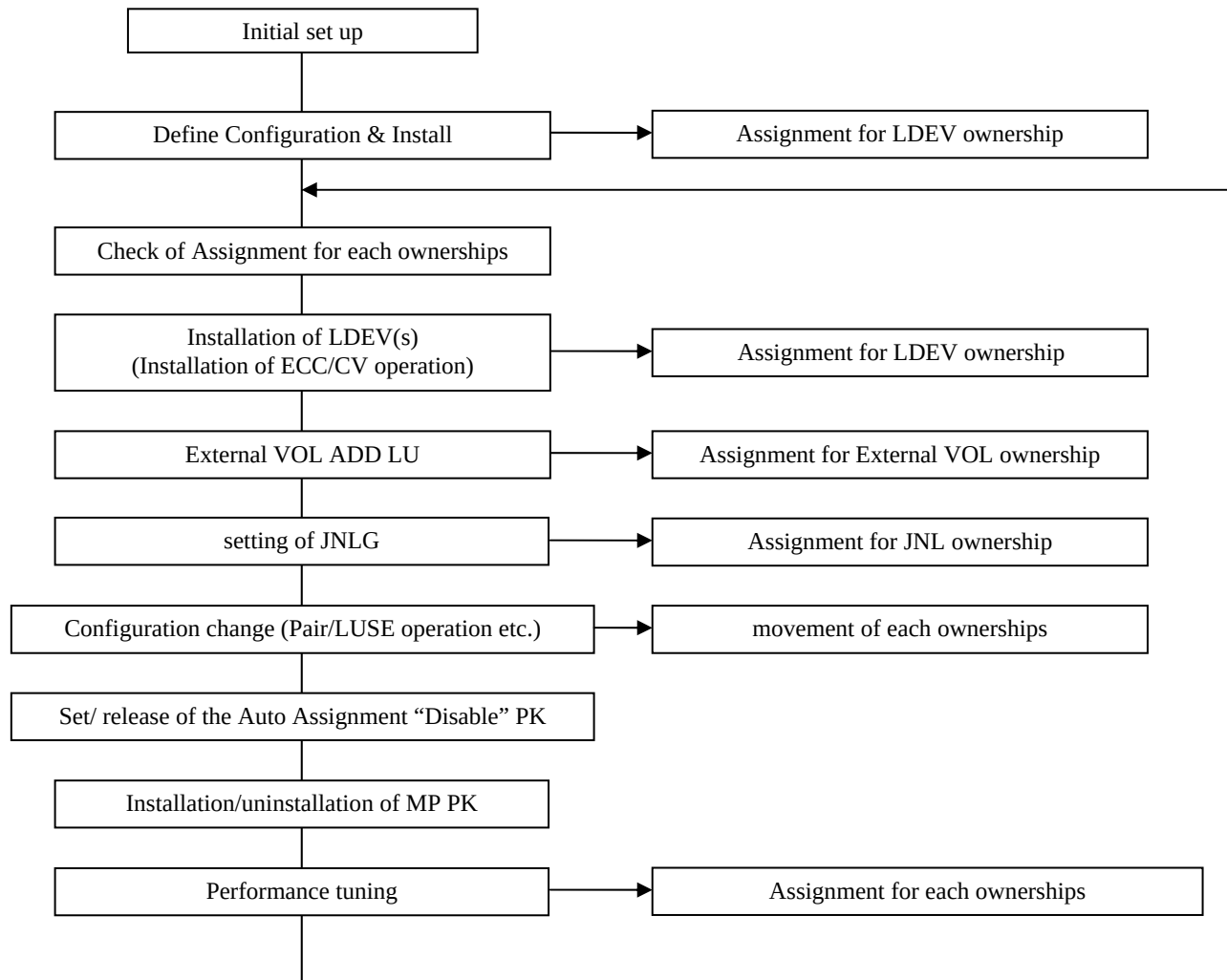
Fig. 3.11.1.5-1 Request #5 (A)

- (B) When installing the MP PK specified above, preventing allocation of resources to the Auto Assignment “Disable” PK.



Example) After MP PK installation completes, allocate resources to MP PK3.

Fig. 3.11.1.5-2 Request #5 (B)

THEORY03-11-50**3.11.1.6 Process flow****Fig. 3.11.1.6-1 Process flow**

3.11.2 Resource allocation Policy

- (1) Both User-specific and automation allocation based on common policy Allocate resources to each MP PK equally.

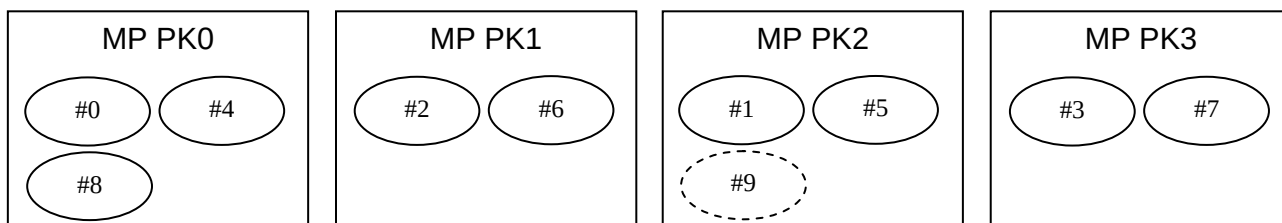


Fig. 3.11.2-1 Resource allocation Policy (1)

- (2) Additionally, user-specific allocation can consider the weight of each device.

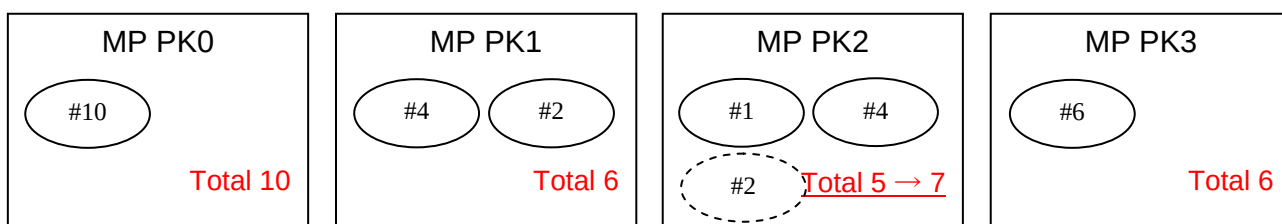


Fig. 3.11.2-2 Resource allocation Policy (2)

But, automation allocation cannot consider the weight of each device.

THEORY03-11-70**3.11.2.1 Automation allocation**

Allocate resources to each MP PK equally independently in each type.

Table 3.11.2.1-1 Automation allocation

Owner type	Device type	Unit	Leveling
LDEV	SAS/SATA	ECC Gr.	LDEV num.
	SSD/FMD	LDEV	LDEV num.
	DP VOL	LDEV	LDEV num.
Ext. VOL	—	Ext. VOL	Ext. VOL num.
JNLG	—	JNLG	JNLG num.

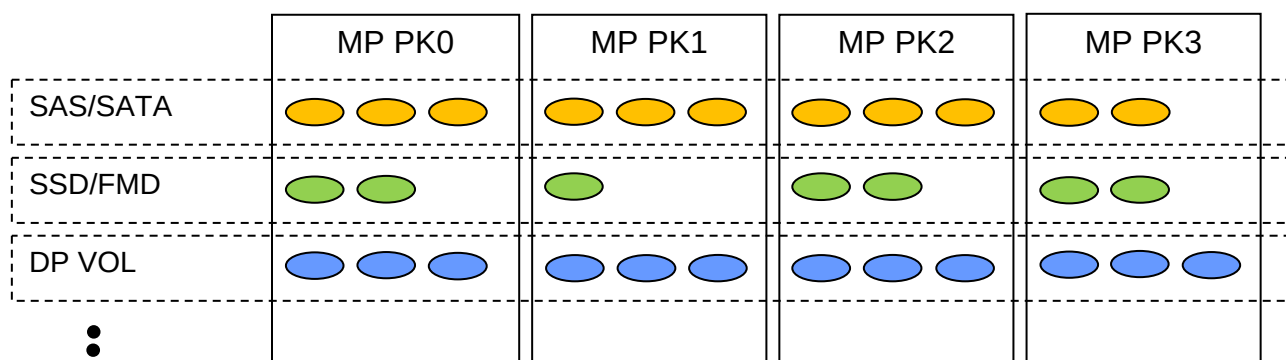


Fig. 3.11.2.1-1 Automation allocation

3.11.2.1.1 Automation allocation (SAS/SATA)

Unit: ECC Gr.

Leveling: LDEV num.

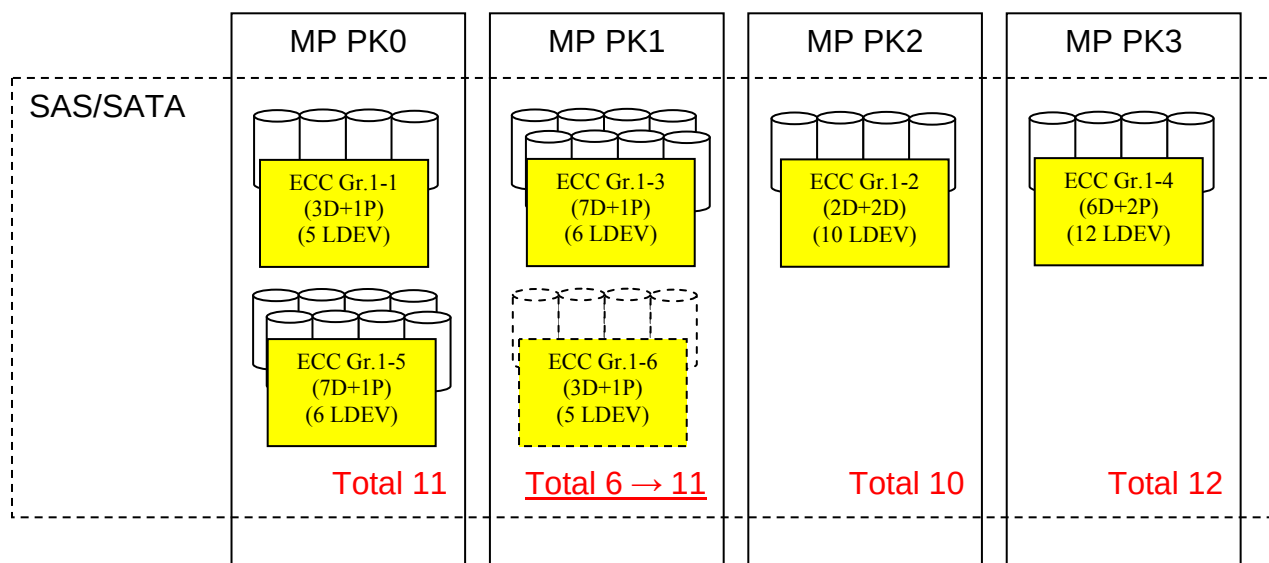


Fig. 3.11.2.1.1-1 Automation allocation (SAS/SATA)

3.11.2.1.2 Automation allocation (SSD, FMD/DP VOL)

Unit: ECC Gr.

Leveling: LDEV num.

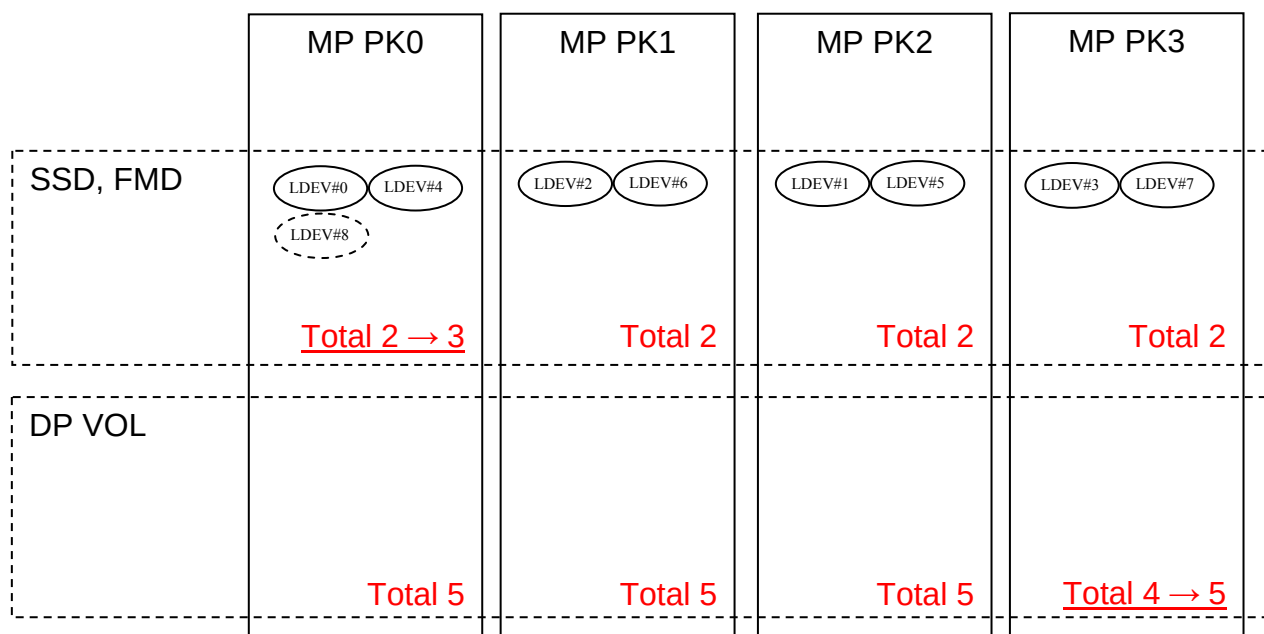


Fig. 3.11.2.1.2-1 Automation allocation (SSD, FMD/DP VOL)

THEORY03-11-90**3.11.2.1.3 Automation allocation (Ext. VOL)**

Unit: Ext. VOL

Leveling: Ext. VOL num. (not Ext. LDEV num.)

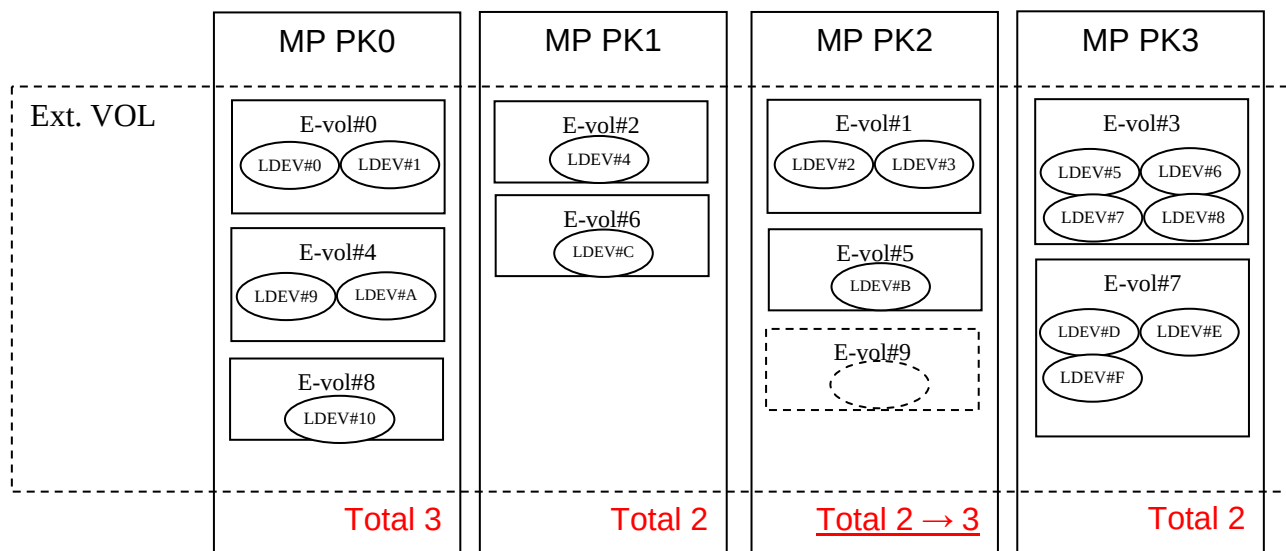


Fig. 3.11.2.1.3-1 Automation allocation (Ext. VOL)

3.11.2.1.4 Automation allocation (JNLG)

Unit: JNLG

Leveling: JNLG num. (not JNL VOL num.)

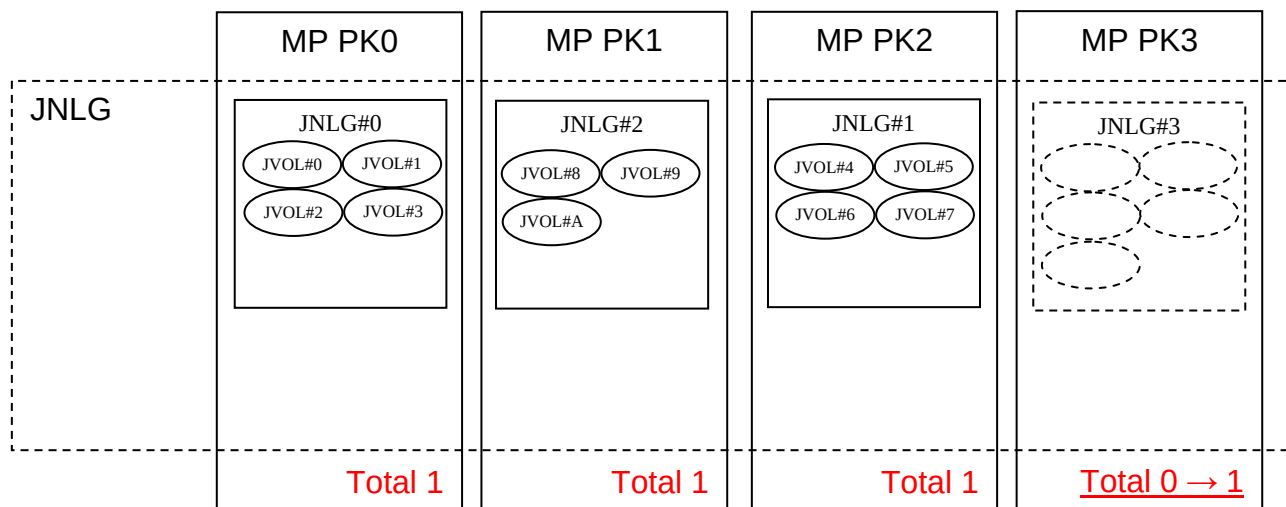


Fig. 3.11.2.1.4-1 Automation allocation (JNLG)

3.11.3 MP PK block

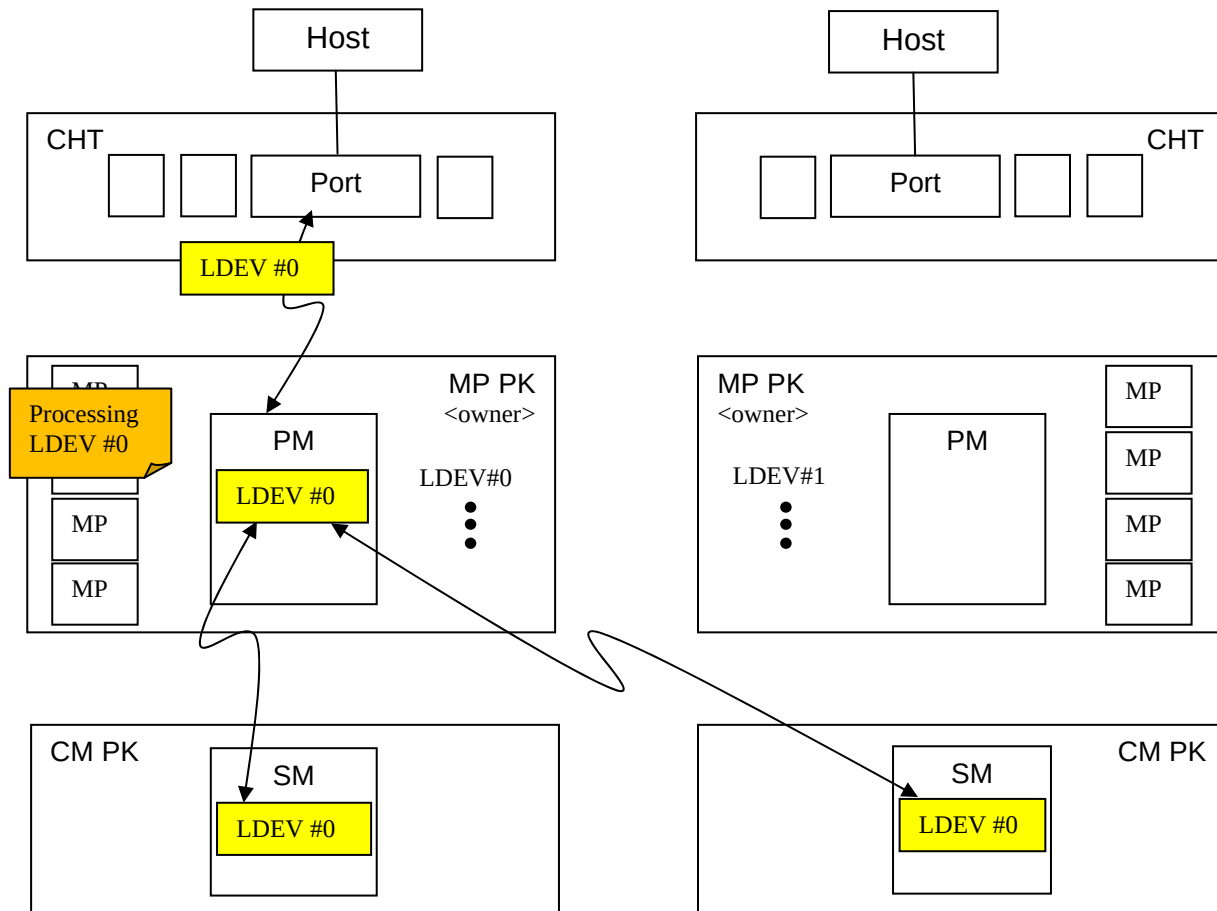


Fig. 3.11.3-1 MP PK block

Step2. Switch MP PK, to which I/O is issued, to the target MP PK (to which the ownership is moved).

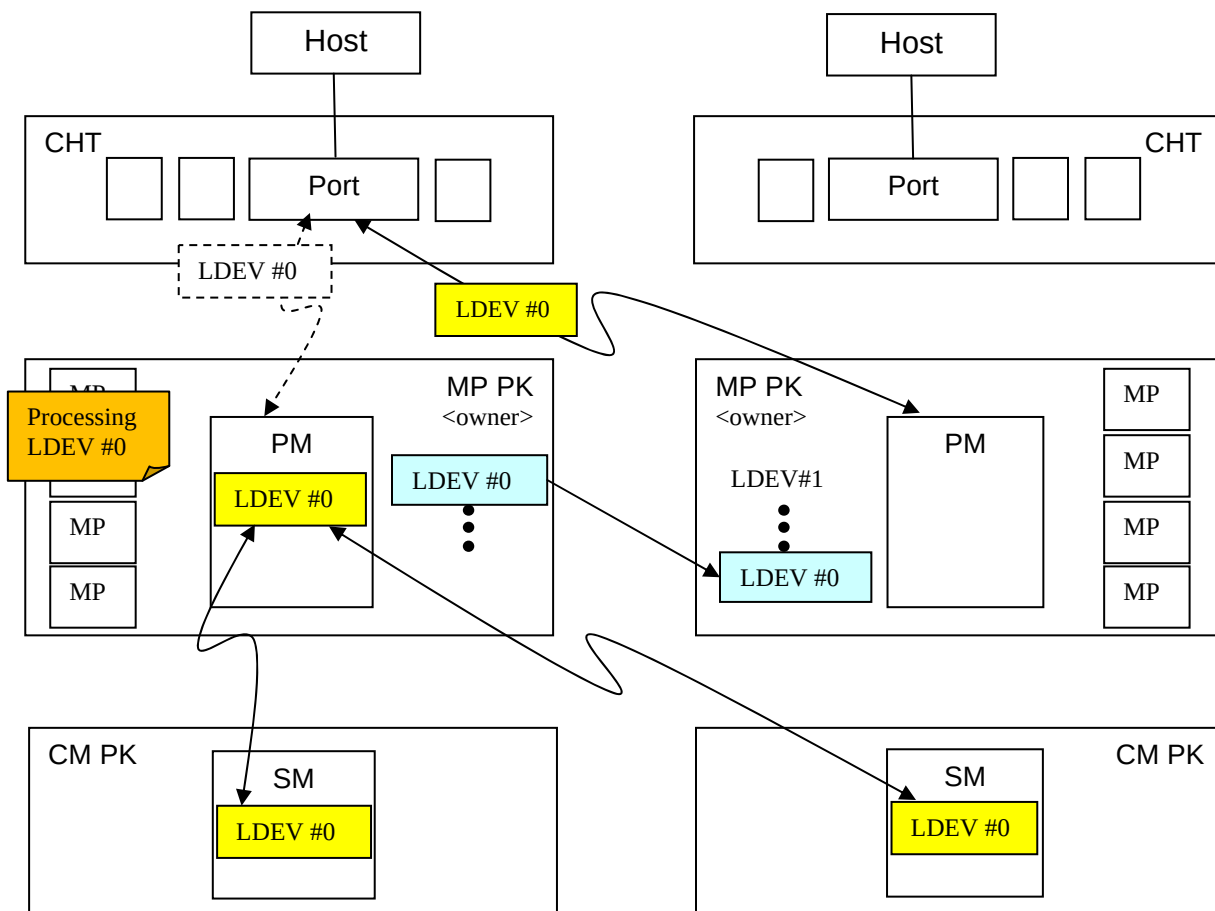


Fig. 3.11.3.1-2 MP PK block for maintenance (2)

Step3. Complete the ongoing processing in the source MP whose ownership is moved.
(New processing is not performed in the source MP.)

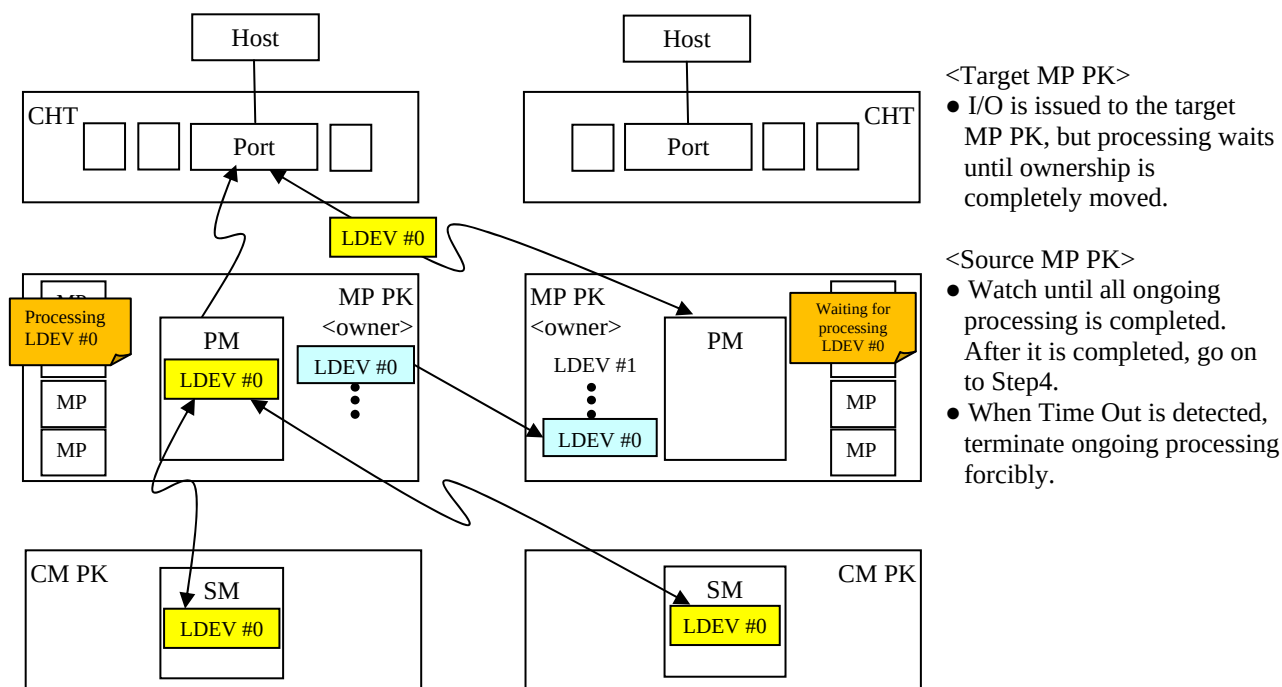


Fig. 3.11.3.1-3 MP PK block for maintenance (3)

Step4. Disable PM information in the source MP whose ownership is moved.

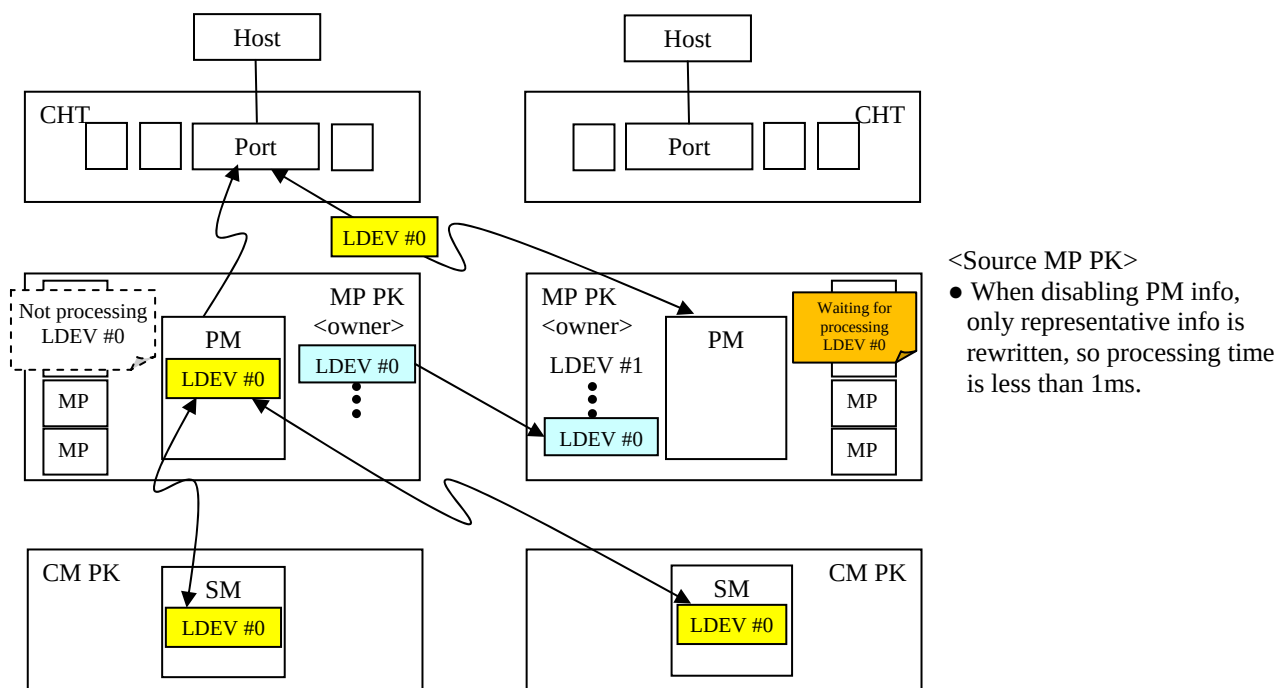


Fig. 3.11.3.1-4 MP PK block for maintenance (4)

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Step5. Moving ownership is completed, and the processing starts in the target MP PK.

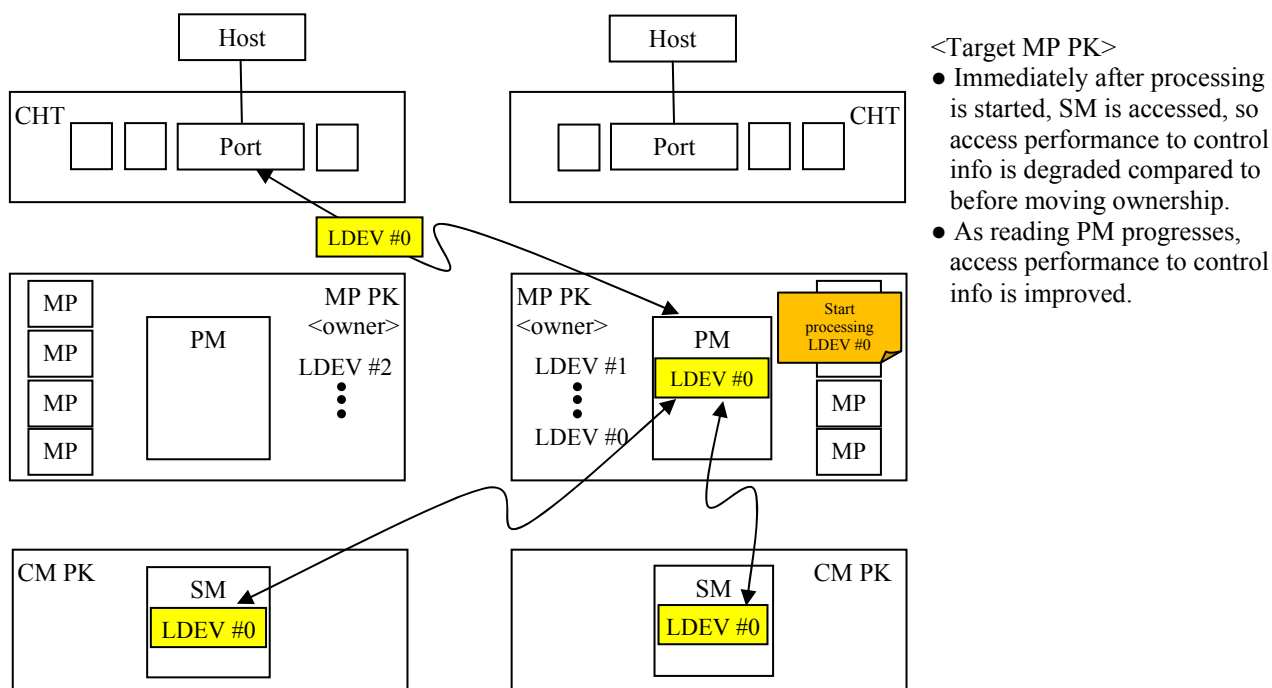


Fig. 3.11.3.1-5 MP PK block for maintenance (5)

Step6. Perform Step1. ~ Step5. for all resources under the MP PK blocked and after they are completed, block MP PK.

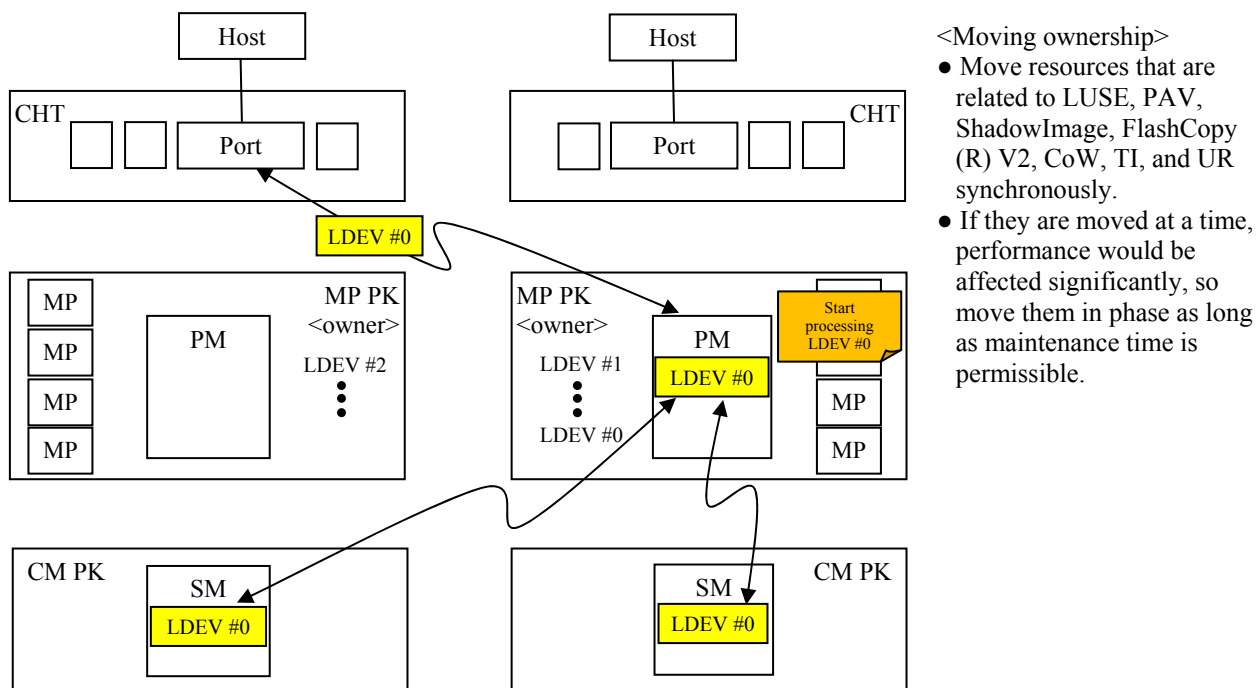


Fig. 3.11.3.1-6 MP PK block for maintenance (6)

3.11.3.2 MP PK blocked due to failure

Step1. Detect that all MPs in the MP PK are blocked, and choose MP PK that takes over the ownership.

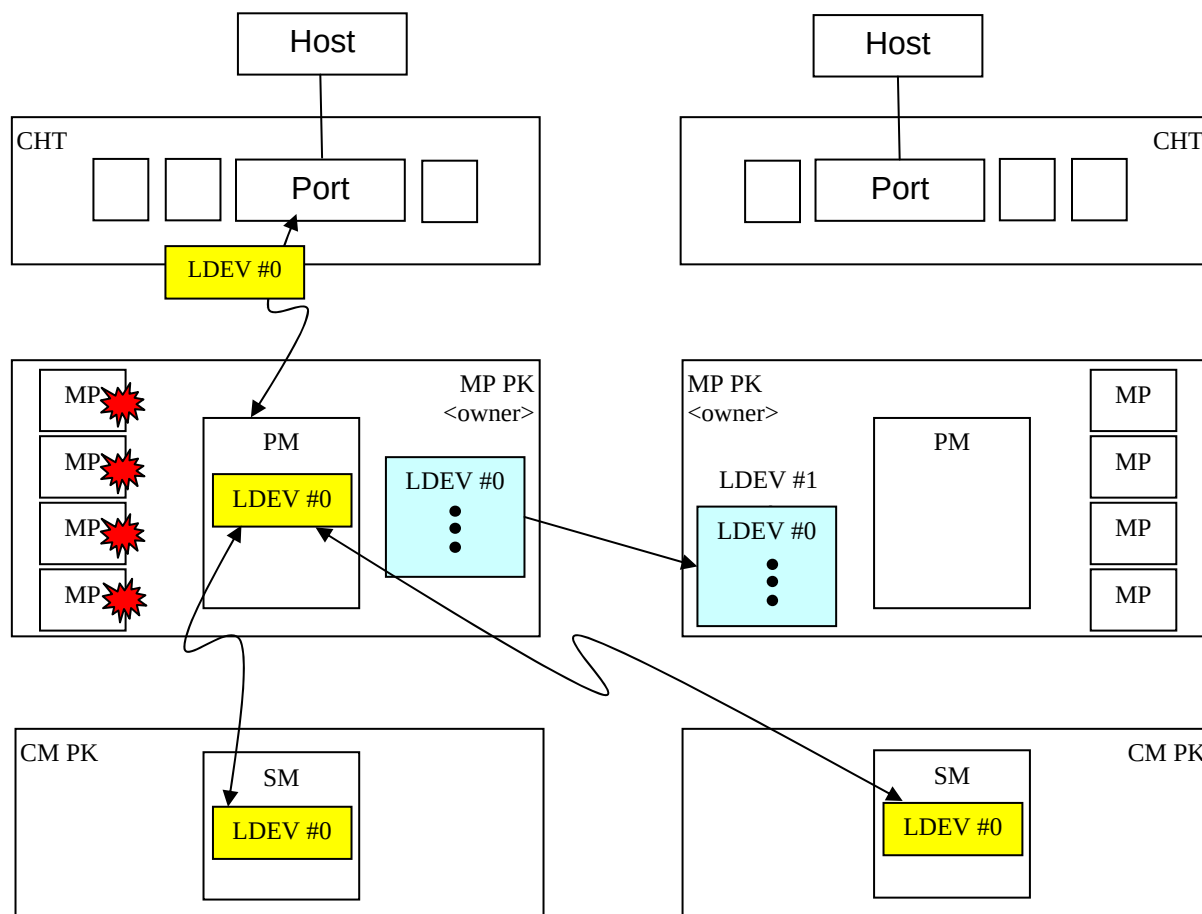


Fig. 3.11.3.2-1 MP PK blocked due to failure (1)

Step2. Switch MP PK, to which I/O is issued, to MP PK that takes over the ownership.

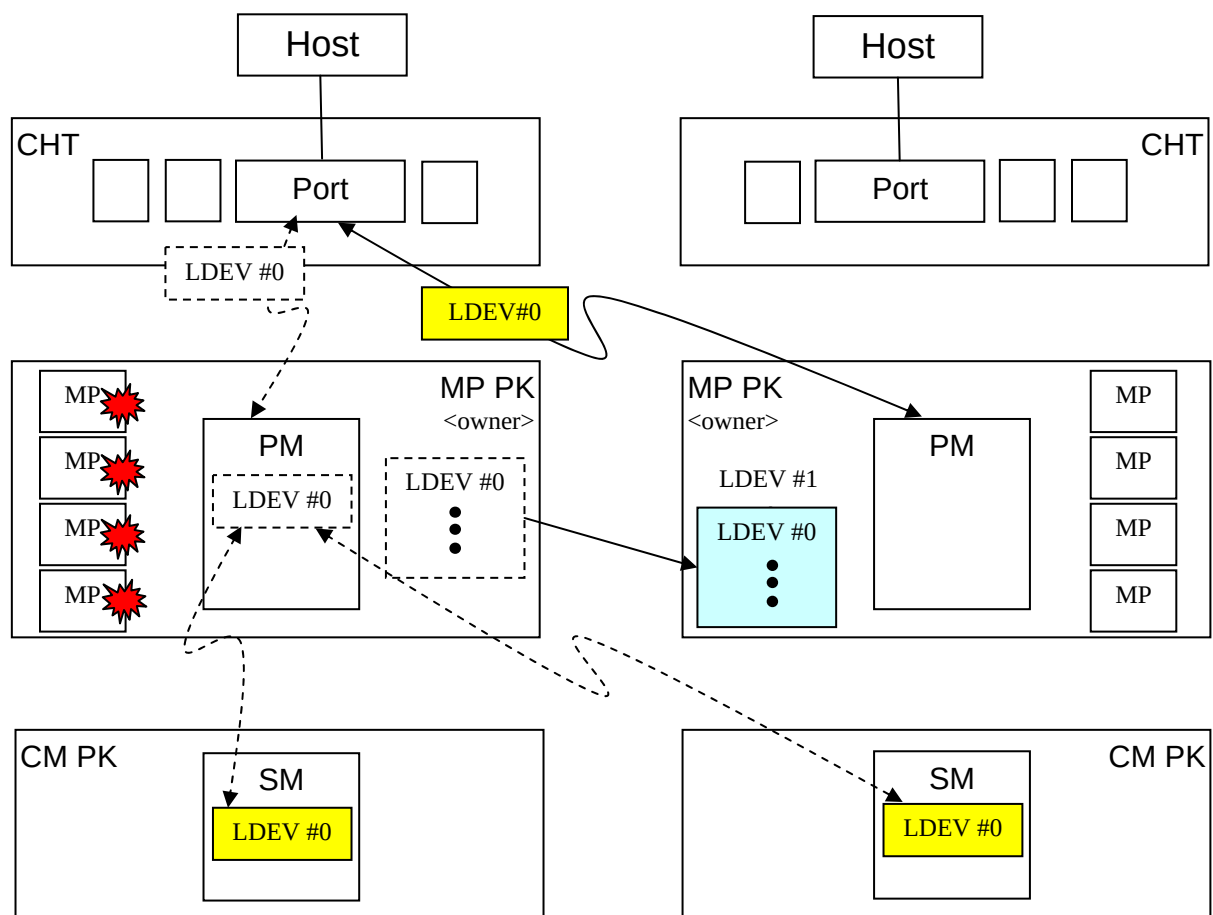


Fig. 3.11.3.2-2 MP PK blocked due to failure (2)

Step3. Perform WCHK1 processing at the initiative of MP PK that takes over the ownership.

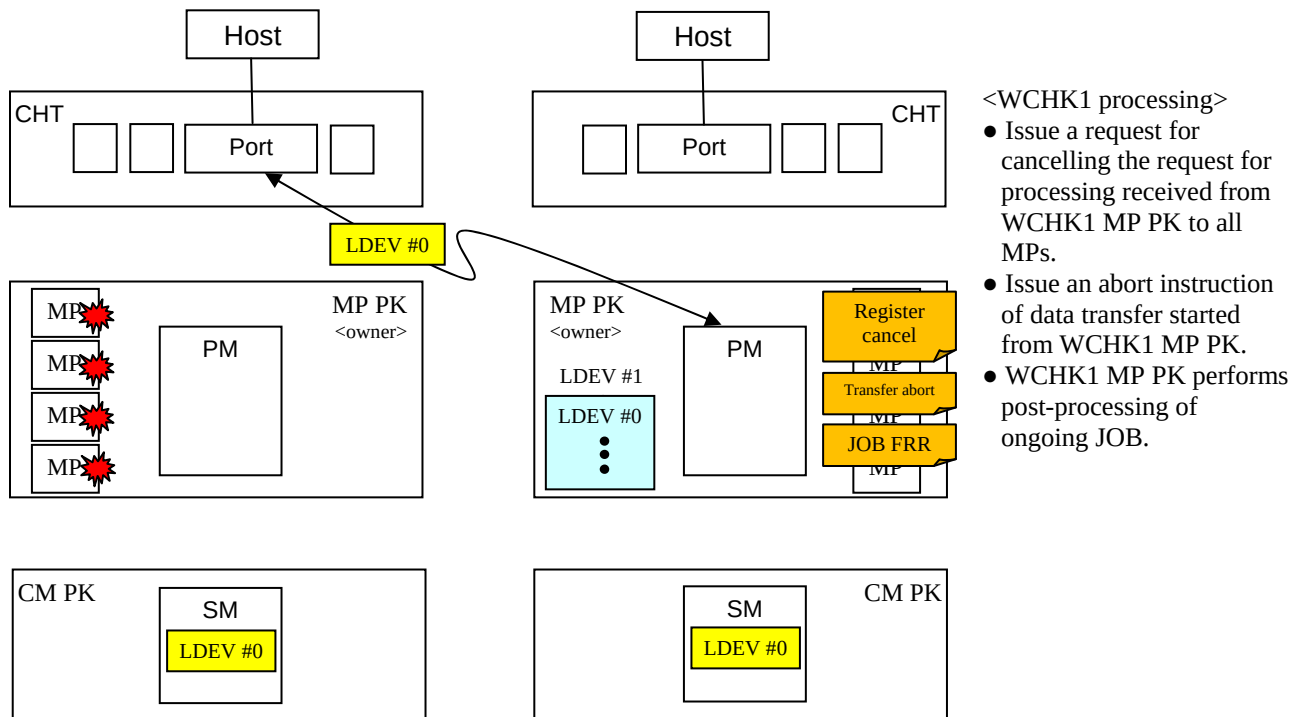


Fig. 3.11.3.2-3 MP PK blocked due to failure (3)

Step4. WCHK1 processing is completed, and the processing starts in the target MP PK.

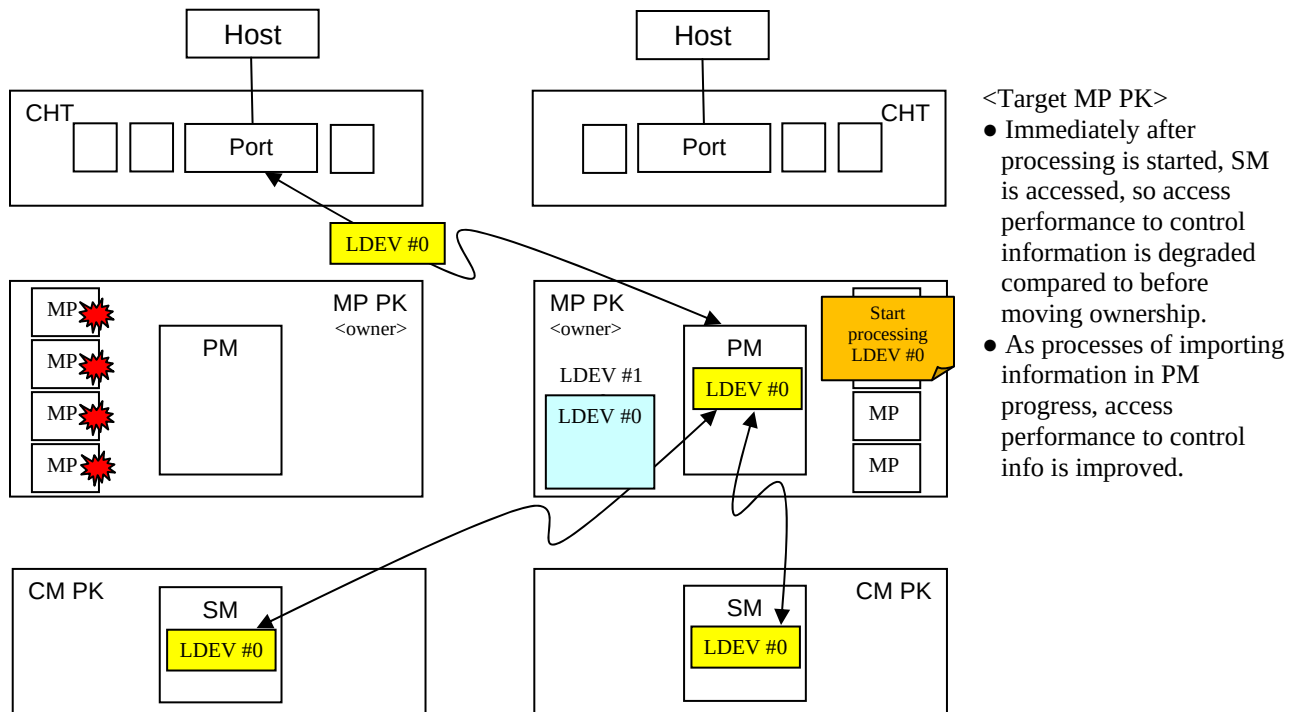


Fig. 3.11.3.2-4 MP PK blocked due to failure (4)

3.12 Cache Architecture

3.12.1 Overall

DKC710I changes on CACHE and policies dealing with these changes

Table 3.12.1-1 DKC710I changes on CACHE and policies dealing with these changes

Perspective	Changes	Policies
Hardware	Integration of SM and CM module	Mutual guard for SM/CM accessing for data validation
	CACHE PK equipped with SSD	Save SM contents into SSD at scheduled down, SM + CM into SSD at shutdown
	Obsolete mechanism for SM duplicate areas	duplicate by microcode
Software	Performance improvement for CACHE access	Apply CACHE DIR to LM
	Ease of maintenance	Expand for grain size in SM mapping, obsolete DIMM Mixture in PK
	Reduction of chance for Write Through	Consolidate management for Cache DIR and user data in the same PK

3.12.1.1 Physical installation of Cache PK/DIMM

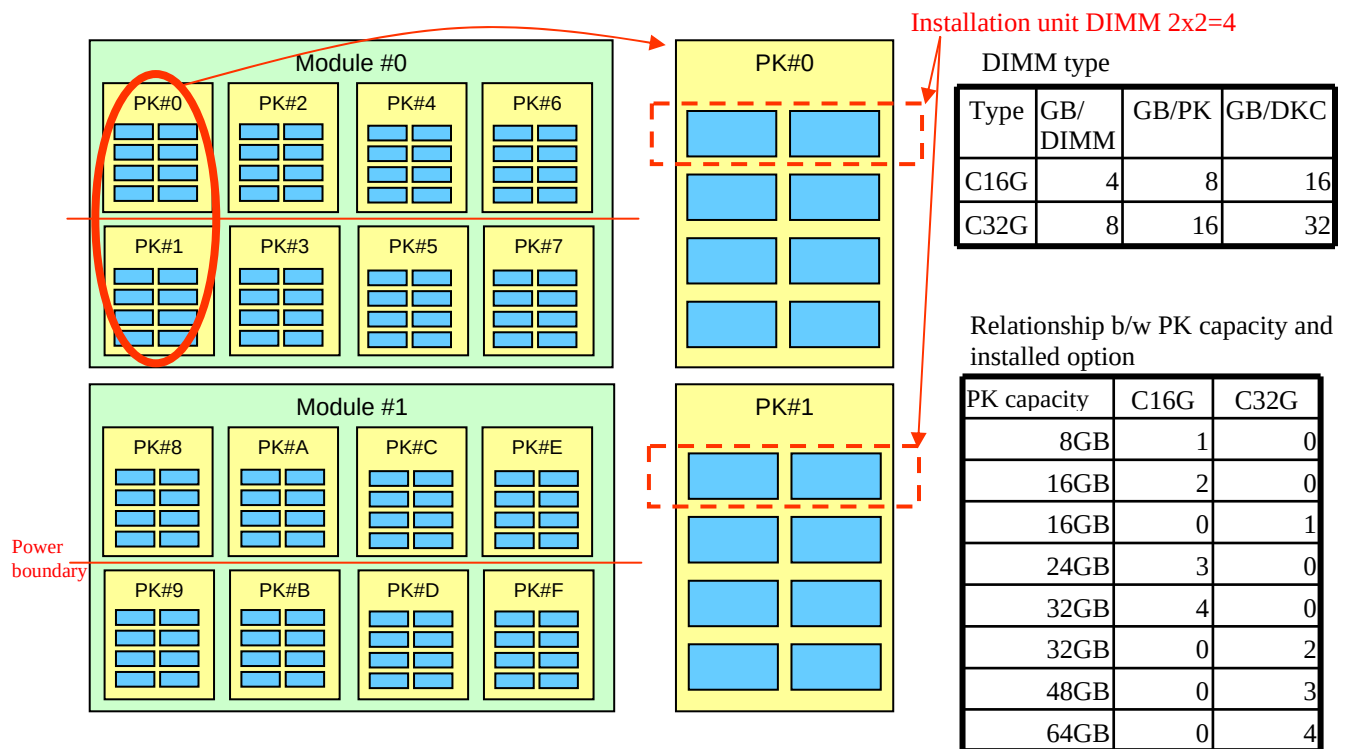


Fig. 3.12.1.1-1 Physical installation of Cache PK/DIMM

3.12.1.2 Role of Cache PK (Comparison with DKC610I)

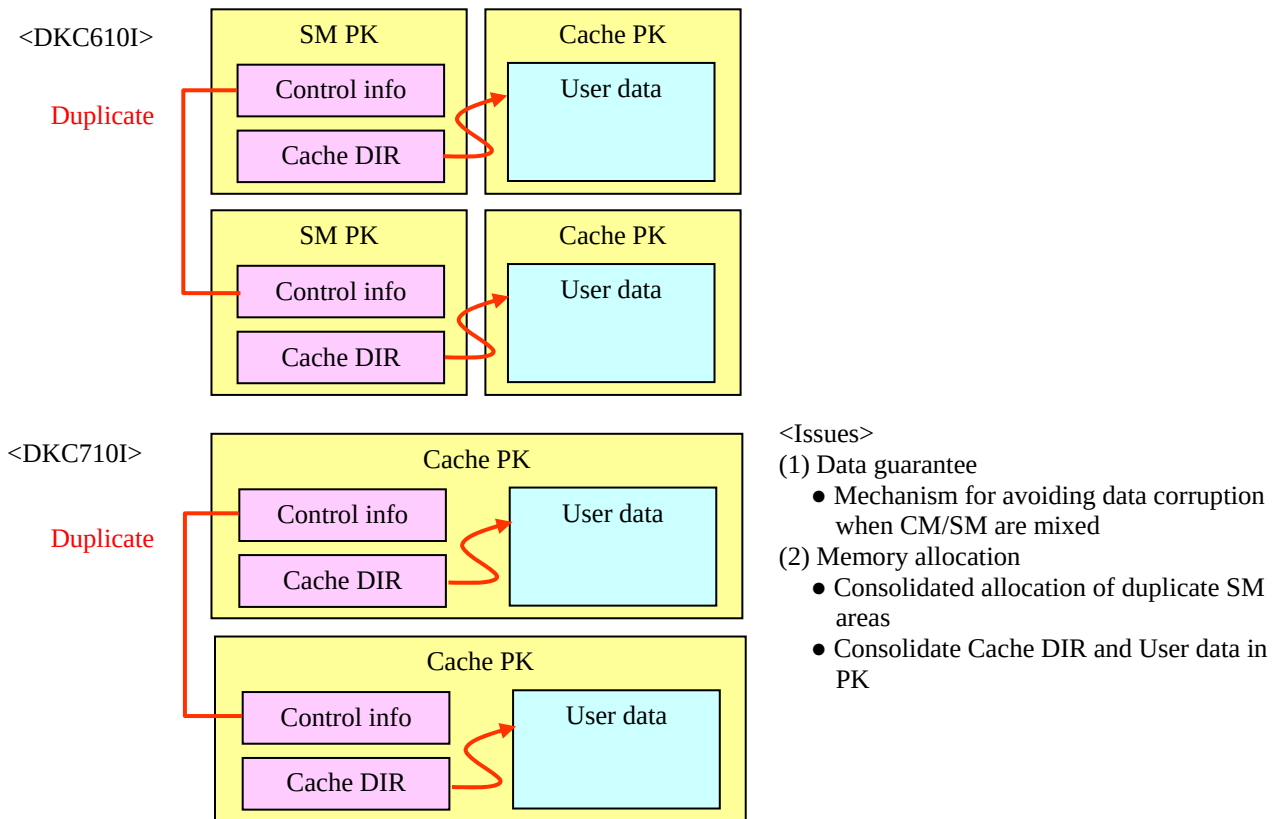


Fig. 3.12.1.2-1 Role of Cache PK (Comparison with DKC610I)

3.12.1.3 Mechanism for avoiding data corruption when CM/SM are mixed

On physical CM memory where logical CM/SM are mixed, routes that are accessible with areas are limited.

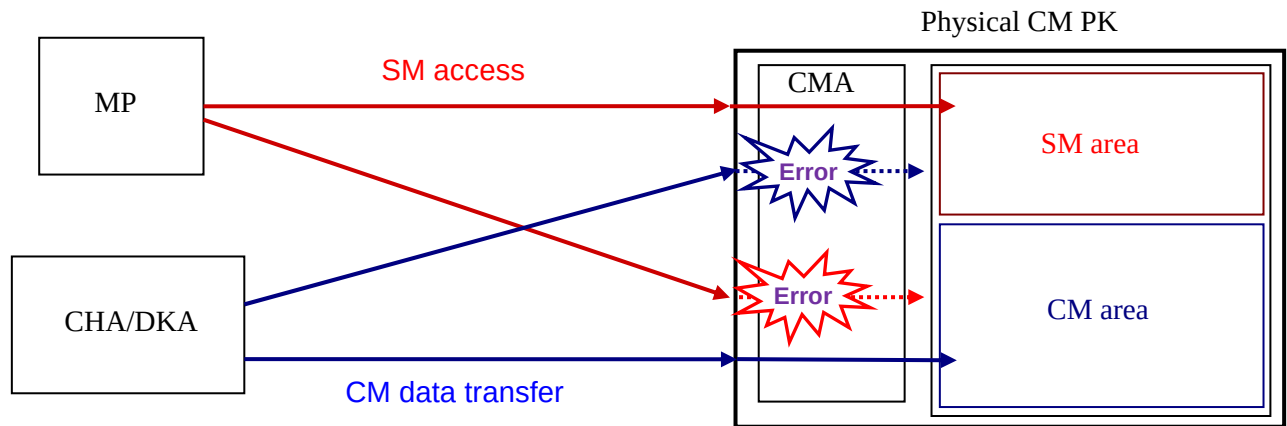


Fig. 3.12.1.3-1 Mechanism for avoiding data corruption when CM/SM are mixed

Purpose: In the case of illegal write to SM (Microcode failure or unexpected failure), prevent impact on CM data.

3.12.1.4 Consolidated allocation of SM duplicate areas

SM 2 duplicate areas are consolidated in CM PK #0, CM PK #1 in the basic module.

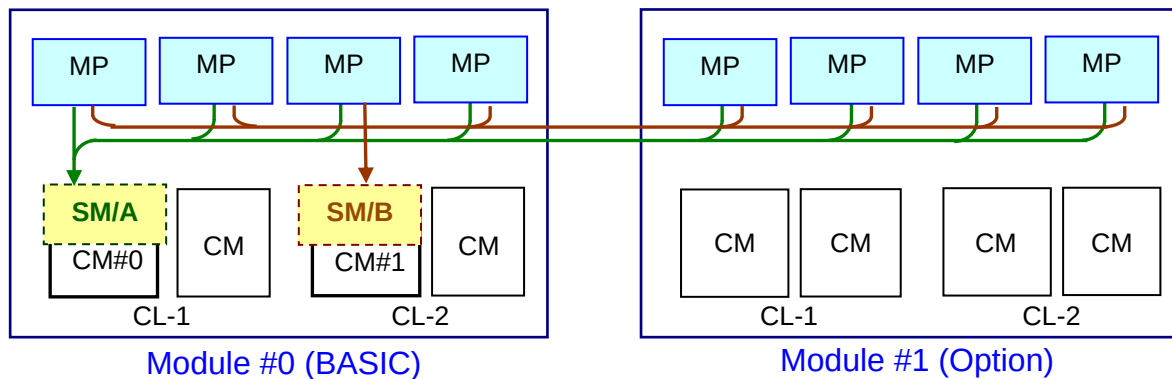


Fig. 3.12.1.4-1 Consolidated allocation of SM duplicate areas (1)

Reason: In the case of access to different CM PK, the order of storing data cannot be guaranteed. To maintain compatibility with predecessors, it is necessary to consolidate CM PK.

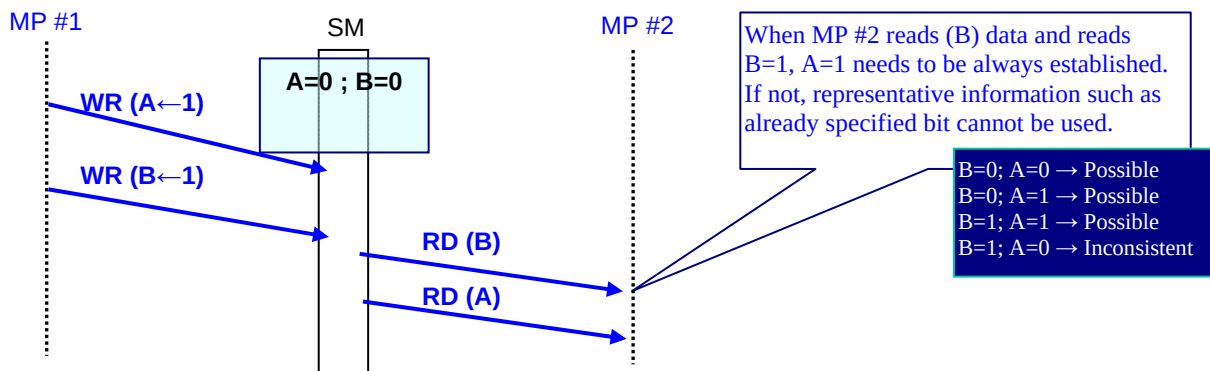


Fig. 3.12.1.4-2 Consolidated allocation of SM duplicate areas (2)

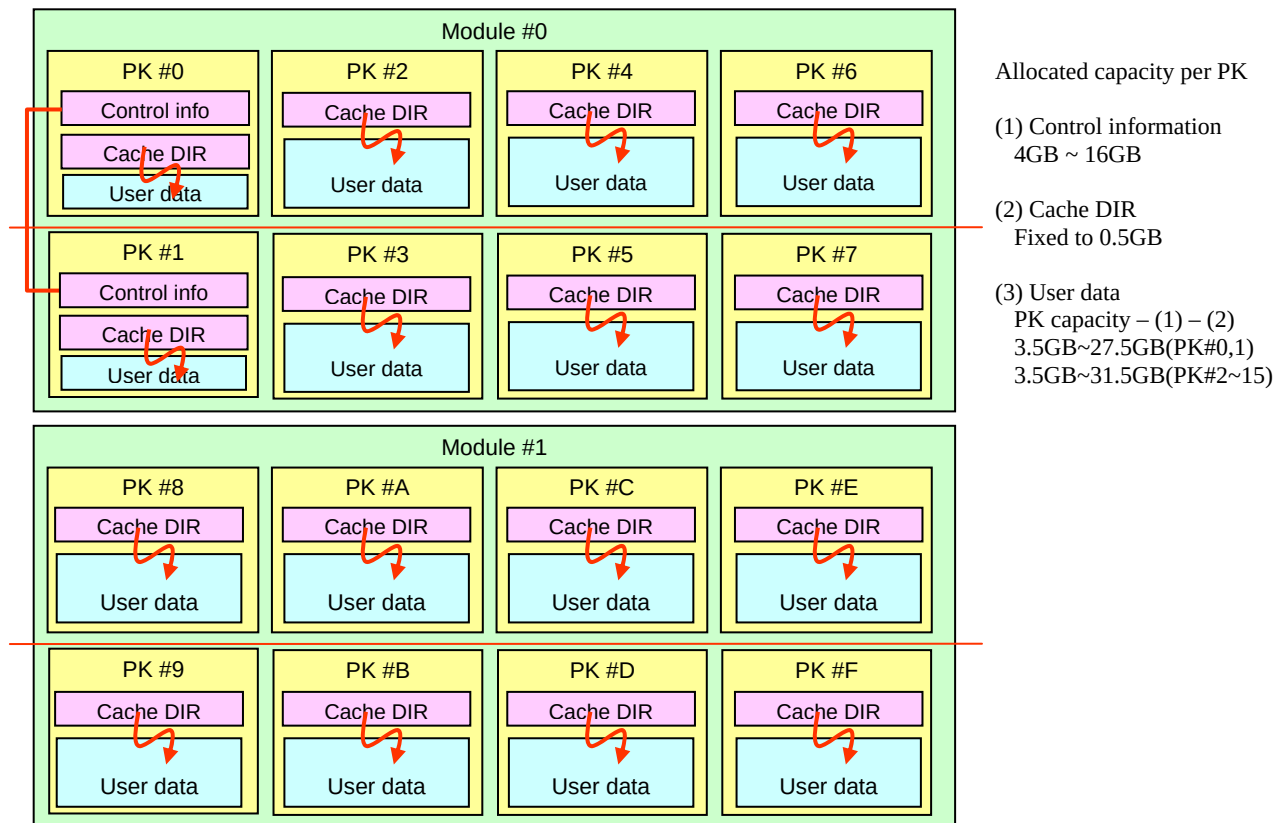
THEORY03-12-50**3.12.1.5 Consolidated Cache DIR and user data in PK**

Fig. 3.12.1.5-1 Consolidated Cache DIR and user data in PK

3.12.1.6 Usage of SSD on Cache PK

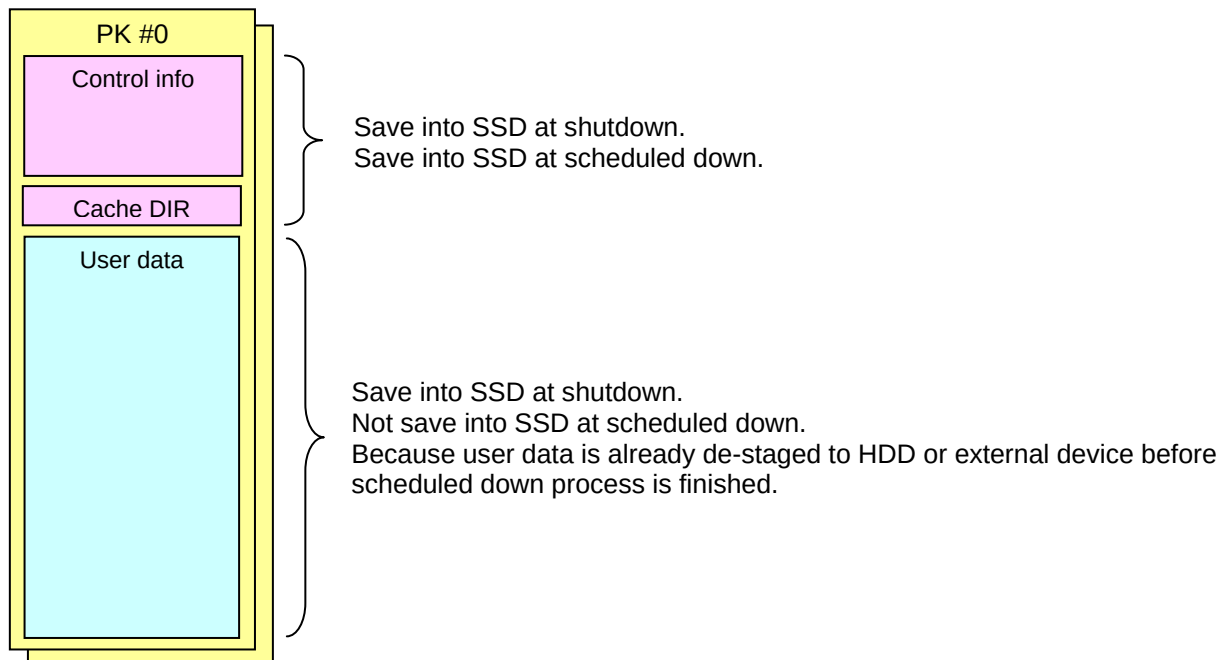


Fig. 3.12.1.6-1 Usage of SSD on Cache PK

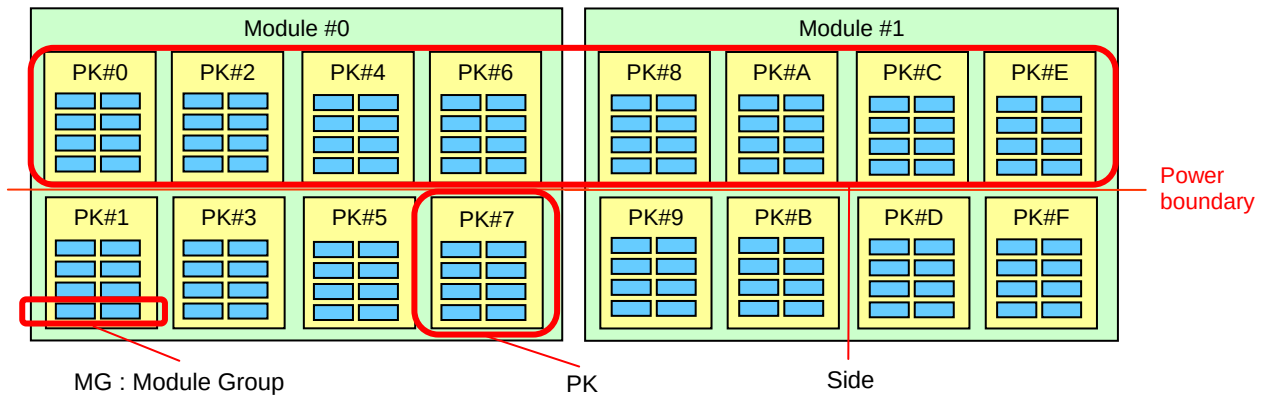
THEORY03-12-70**3.12.2 Maintenance/Failure Blockade Specification****3.12.2.1 Blockade Unit**

Fig. 3.12.2.1-1 Blockade Unit

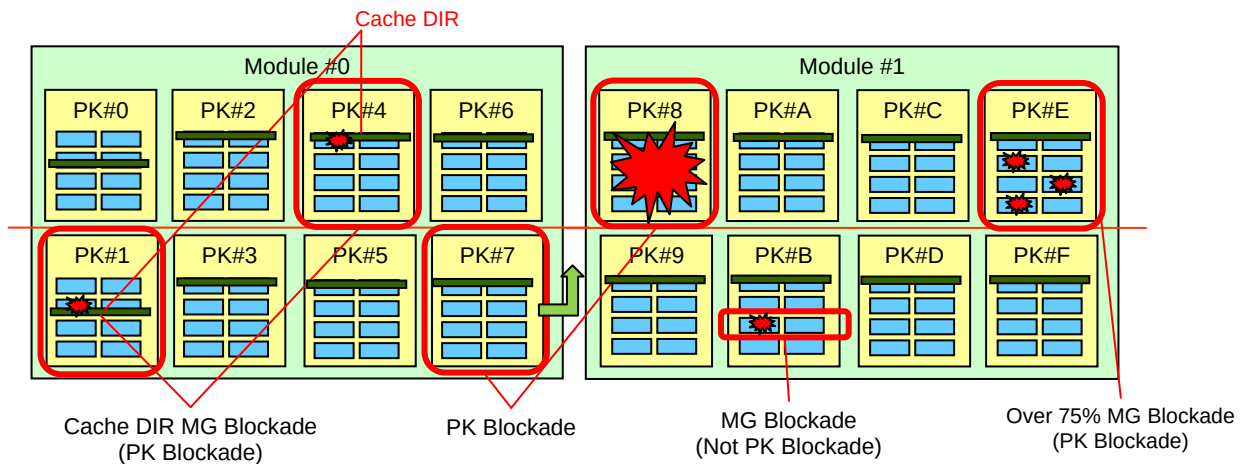
3.12.2.2 PK Blockade

Fig. 3.12.2.2-1 Blockade Unit

3.12.2.3 Side Blockade

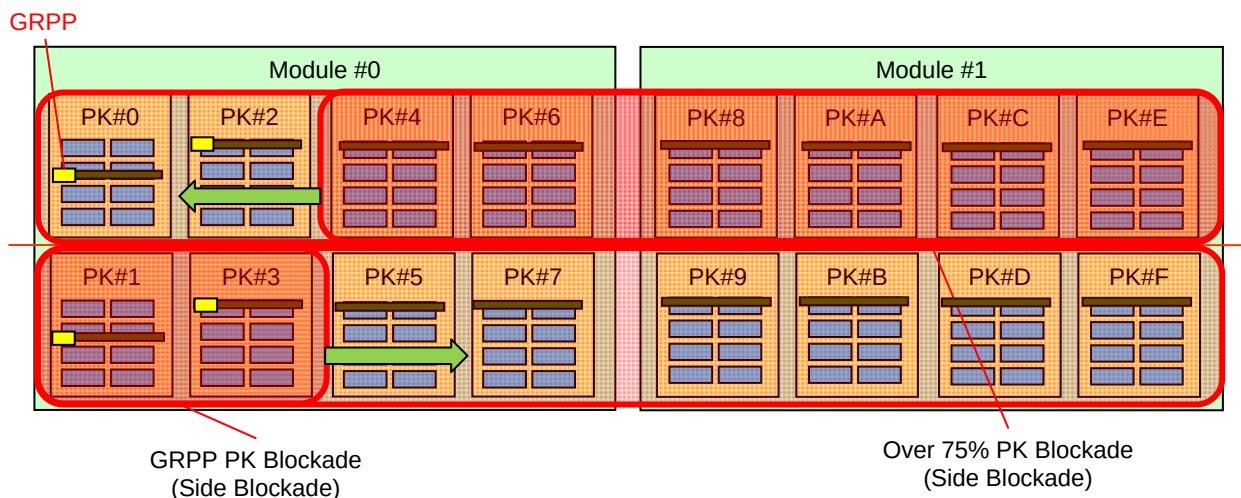


Fig. 3.12.2.3-1 Blockade Unit

3.12.2.4 SM Side Blockade (Logical)

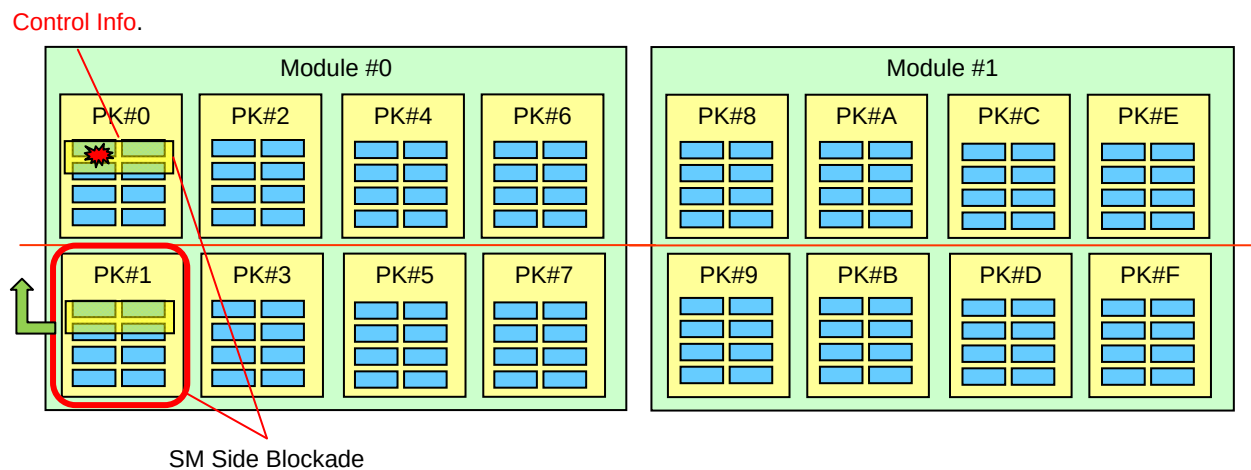


Fig. 3.12.2.4-1 SM Side Blockade (Logical)

3.12.3 Reduction of chance for Write Through

In DKC710I, conditions leading to Write Through at cache maintenance are reduced and the impact that cache maintenance gives to host I/O performance is drastically mitigated compared to DKC610I.

<Improvement in DKC710I>

- The Write Through does not take place at all during CM PCB installation.
- In other cache maintenance, the duration of Write Through is drastically reduced.

Table 3.12.3-1 shows the comparison of Write Through time between DKC610I and DKC710I.

Table 3.12.3-1 Specifications of Write Through time (1)

<DKC610I> Four SM PK, Four CM PK

	Blocked	Recovered
SM side/PK failure	Blocked ~ Recovered	
SM PK maintenance	Max.4hr	
CM side failure	Blocked ~ Recovered	
CM PK failure	Max.2min +(*2)	None
CM MG failure	Max.2min +(*2)	Max.4hr (*1)
CM PK maintenance	Max.4hr	None
SM installation/ uninstallation	Max.4hr	
CM installation/ uninstallation	Max.4hr	
Installation/ uninstallation of SM Size without adding/removing Cache Memory	Max.4hr	

<DKC710I> Four CM PK

	Blocked	Recovered
PK#0,1 failure	Max.2min +(*2)	None
PK#0,1 maintenance	(*2)	None
PK#0+2 or 1+3 failure	Blocked ~ Recovered	
PK#2,3 failure	Max.2min +(*2)	None
PK#2,3 MG failure	Max.2min +(*2)	None
PK#2,3 maintenance	(*2)	None
SM installation/ uninstallation	(*2)	None
CM uninstallation CM MG installation	(*2)	None
CM PK installation	—	None
Installation/ uninstallation of SM Size without adding/removing Cache Memory	(*2)	None

*1: With Mode685 ON, same spec as CM PK failure.

*2: See table 3.12.3-2.

In the case of Write Hit to area to which Async forced destaging is not performed, Write Through takes place.

In the case of Write Hit to area to which Async forced destaging is performed, Write After takes place.

In the case of Write Miss, Write After uniformly takes place.

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Table 3.12.3-2 Specifications of Write Through time (2)

		Blocked ~ Max.2min	~ Max.4hr	Max.4hr ~
DKC610I CM PK Maintenance	Write Hit	Write Through		Write After
	Write Miss			
DKC610I/ DKC710I CM PK Failure	Write Hit	Write Through Write After		
	Write Miss			
DKC710I CM PK Maintenance	Write Hit	Write Through Write After		
	Write Miss			

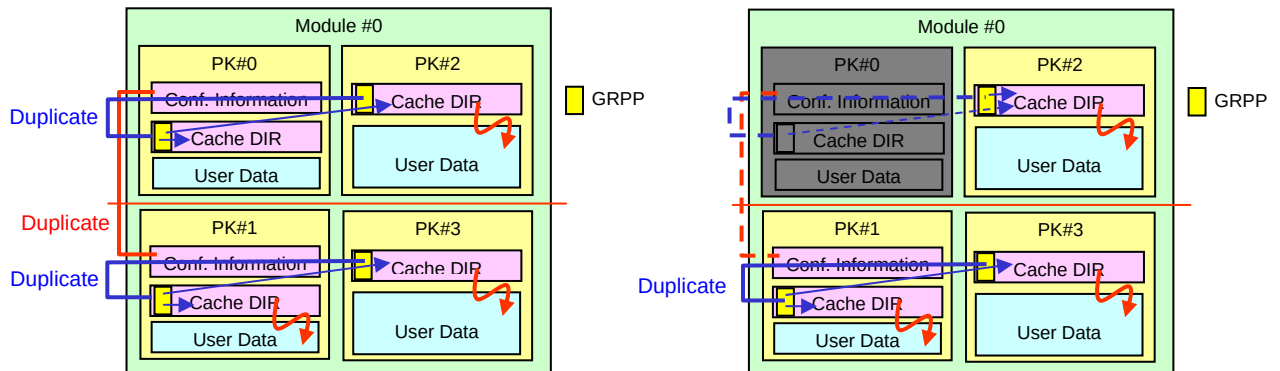


Fig. 3.12.3-1 Reduction of chance for Write Through (1)

In DKC710I, Cache DIR and User Data are stored in the same CM PK, so when any of one PK is blocked, there are two CM sides. By managing GRPP in the upper Index of DIR with 2PK per side, DIR search is possible in the case of Cache PK failure/maintenance.

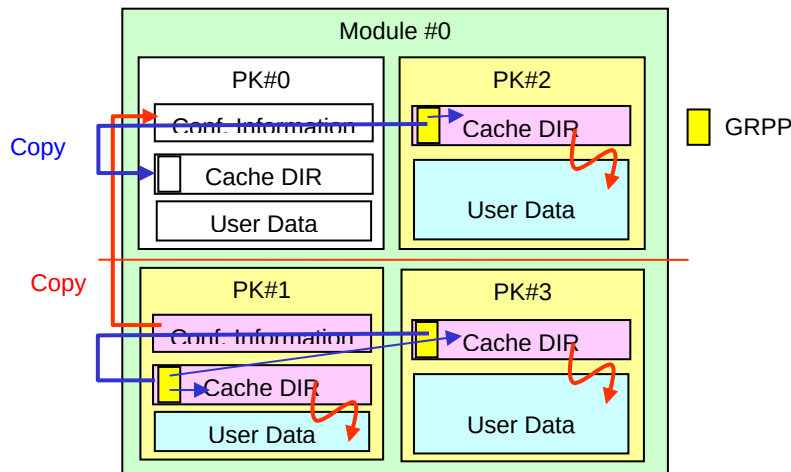


Fig. 3.12.3-2 Reduction of chance for Write Through (2)

To recover PK#0 in the example above, perform the following to duplicate information.

- Copy Configuration Information from PK#1
- Copy GRPP from PK#2

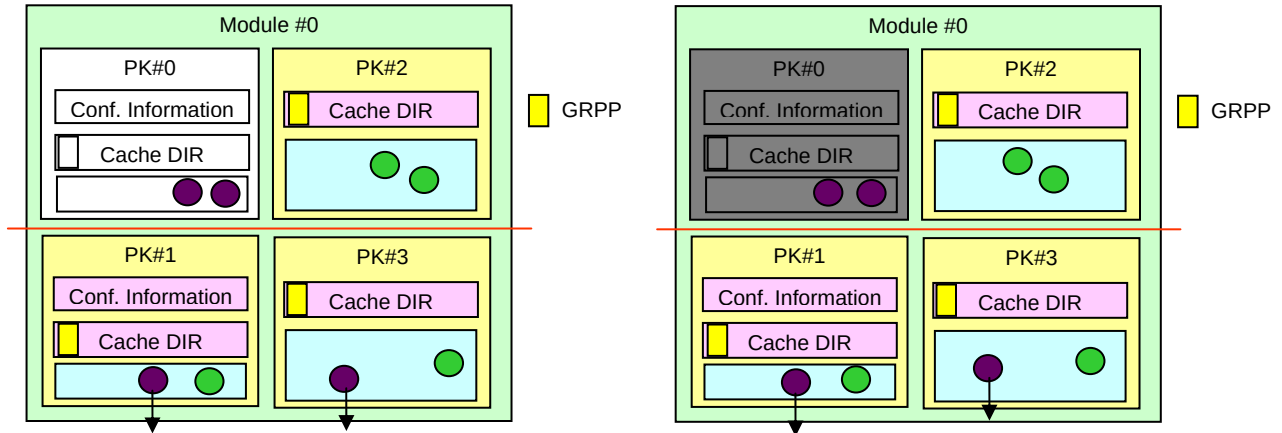


Fig. 3.12.3-3 Reduction of chance for Write Through (3)

- PK #0 is blocked for maintenance
 - Write after maintenance blockade starts can reserve two sides of CM (Write Through is not required).
 - Write Pending Data in the PK that is blocked for maintenance is forcibly destaged asynchronously to I/O process.

In the case of Write to the Write Pending Data above that is not destaged forcibly, Write Through takes place.

- PK #0 is blocked due to a failure
 - Write after the completion of cache DIR re-establishment following failure blockade can reserve two sides of CM (Write Through is not required).
 - Write Pending Data in the PK blocked due to a failure is single and forcibly destaged asynchronously.

In the case of Write to Write Pending Data above to which forced destaging is not performed, Write Through takes place.

After async forced destaging completes, Write Pending Data is no longer single.

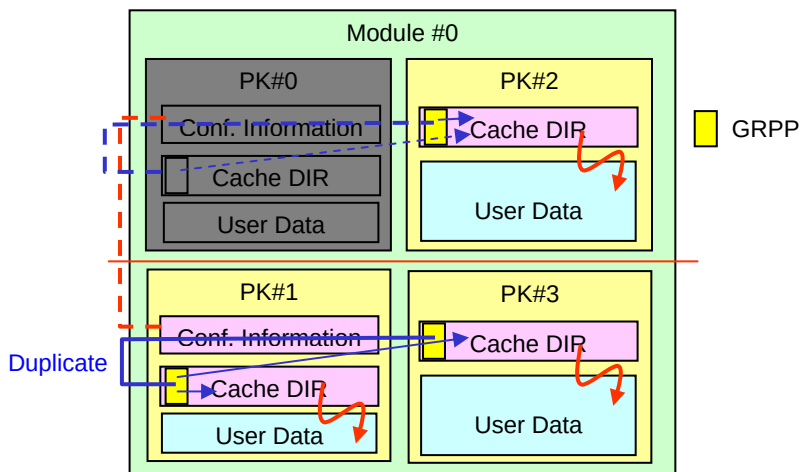


Fig. 3.12.3-4 Reduction of chance for Write Through (4)

Data guarantee of single Configuration Information (Subsystem is stopped)

Table 3.12.3-3 Data guarantee of single Configuration Information (Subsystem is stopped)

Case	DKC610I	DKC710I
Power failure	Recover configuration information from SVP. Because of Write Through, no WP.	Recover configuration information from SSD on PK#1. Recover WP from SSD on CPK #1, #2, #3.
PK #1 failure (LSI failure, memory failure, SSD failure etc.)	Recover configuration information from SVP. Because of Write Through, no WP.	Recover configuration information from SVP. Recover WP from configuration information recovered from SVP and SSD on CPK #2,#3.

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3.12.4 Cache Control

3.12.4.1 Cache DIR PM read and PM/SM write

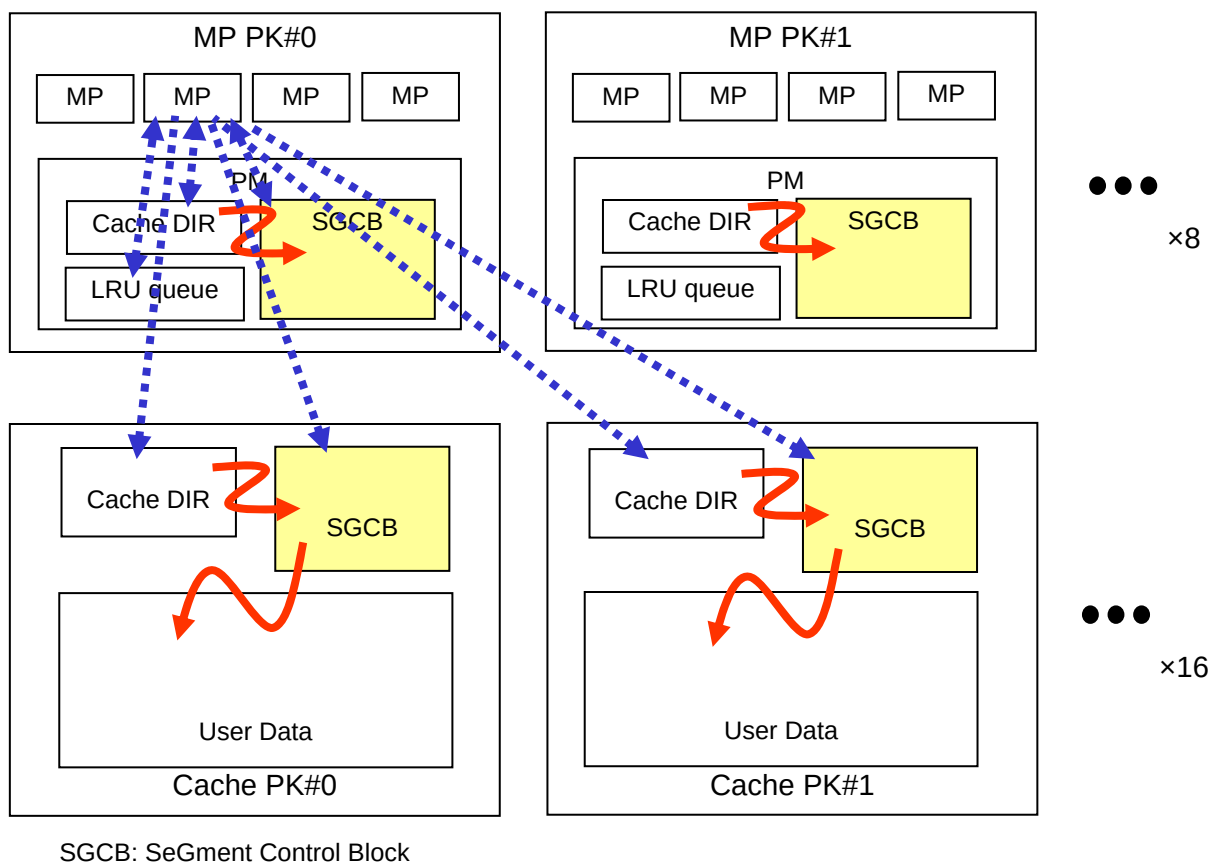


Fig. 3.12.4.1-1 Cache DIR PM read and PM/SM write

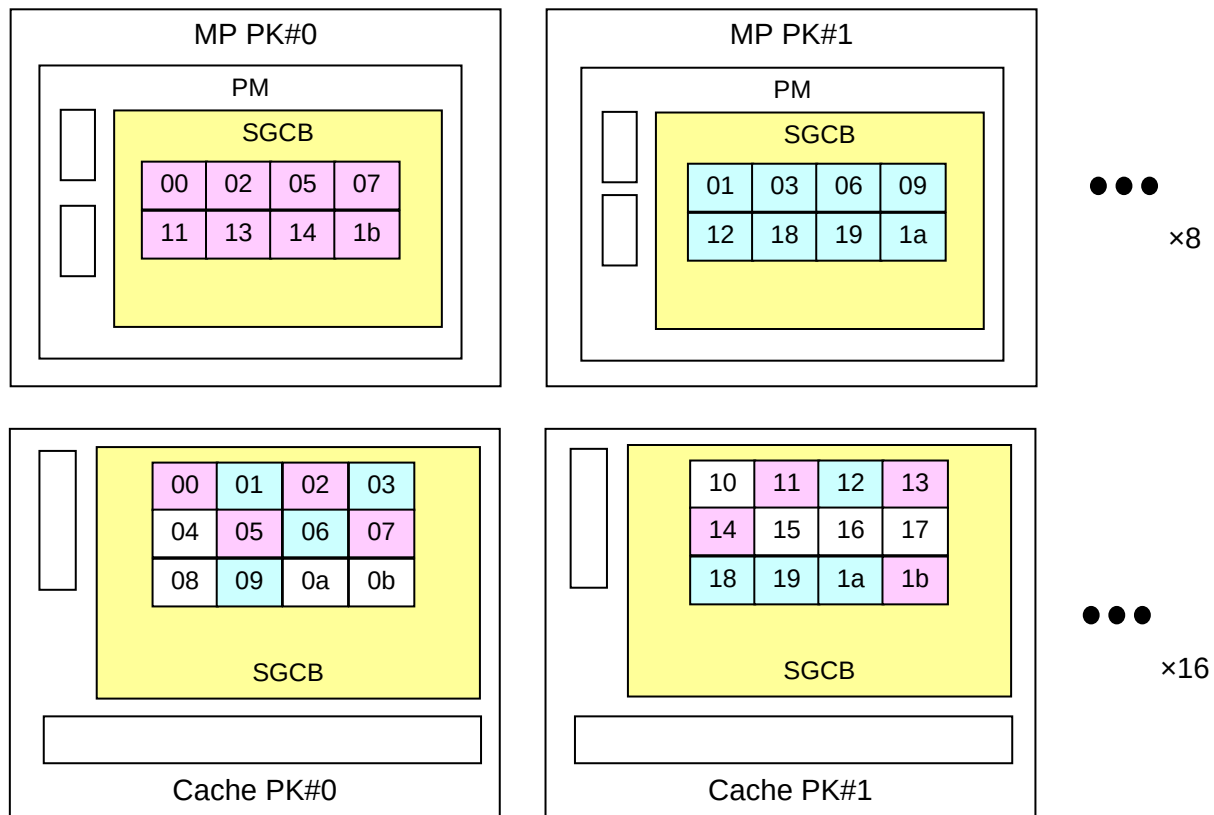
THEORY03-12-140**3.12.4.2 Cache Segment Control Image**

Fig. 3.12.4.2-1 Cache Segment Control Image

3.12.4.3 Initial Setting (Cache Volatile)

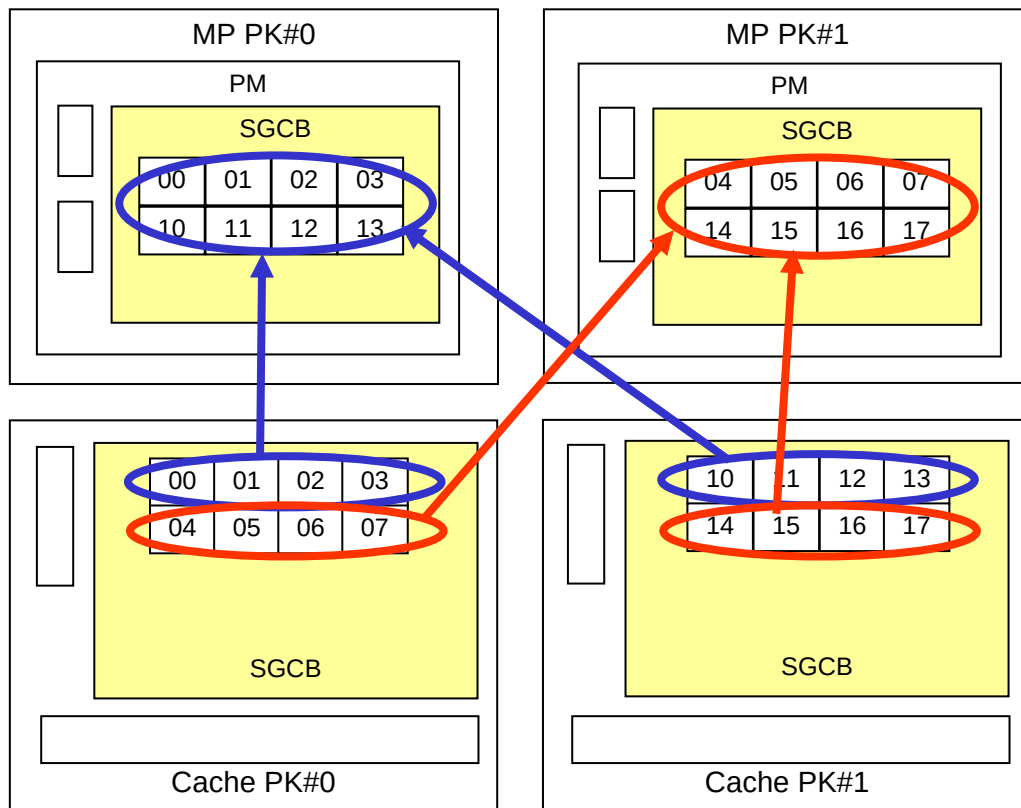


Fig. 3.12.4.3-1 Initial Setting (Cache Volatile)

3.12.4.4 Cache Replace

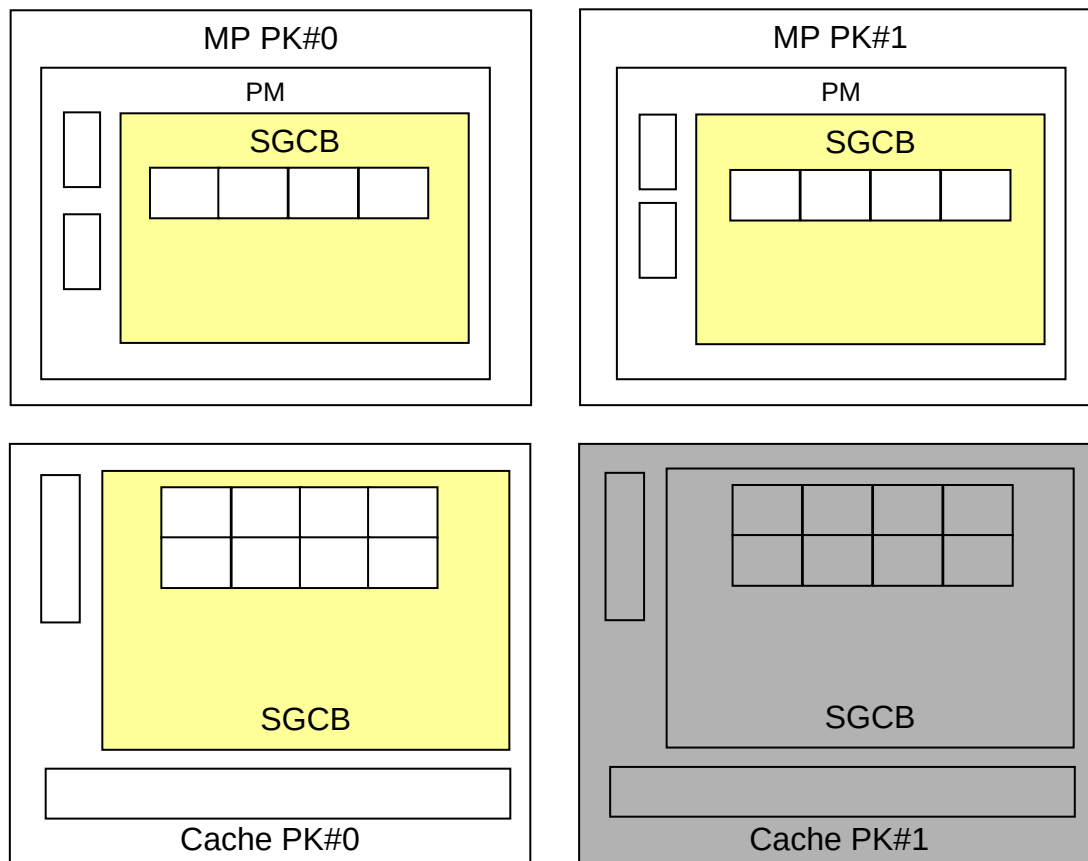


Fig. 3.12.4.4-1 Cache Replace (1)

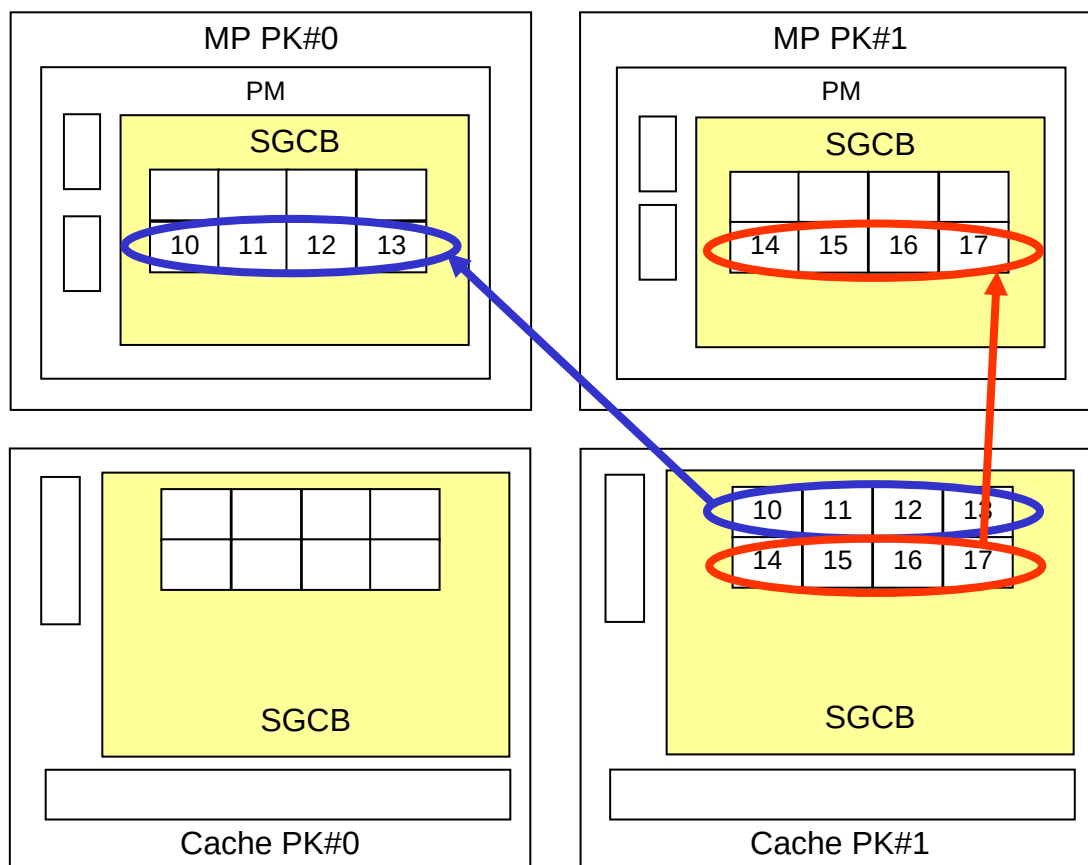


Fig. 3.12.4.4-2 Cache Replace (2)

3.12.4.5 Cache Installation

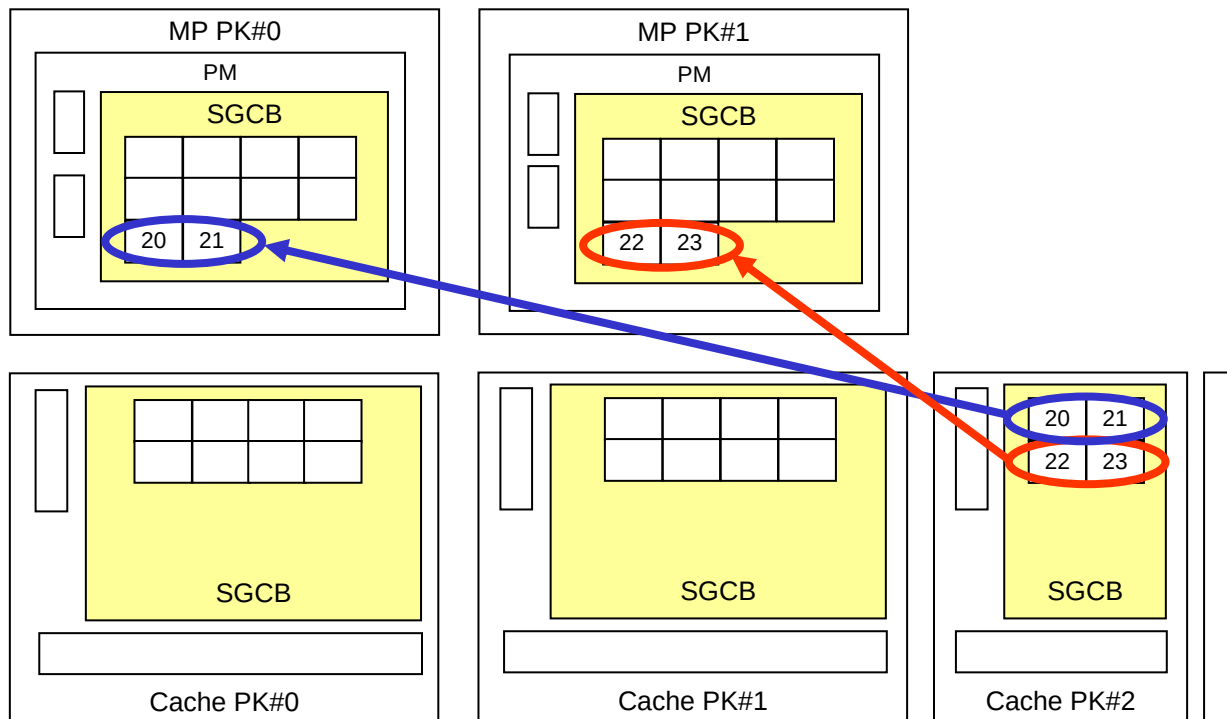


Fig. 3.12.4.5-1 Cache Installation (1)

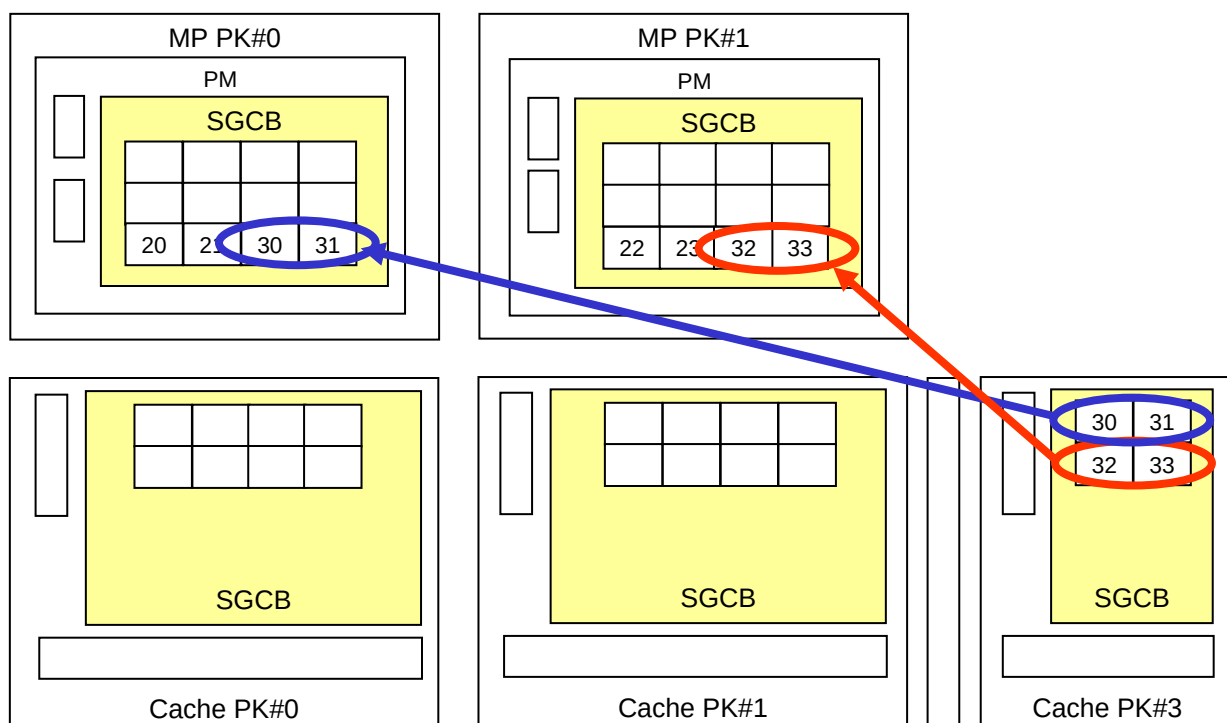


Fig. 3.12.4.5-2 Cache Installation (2)

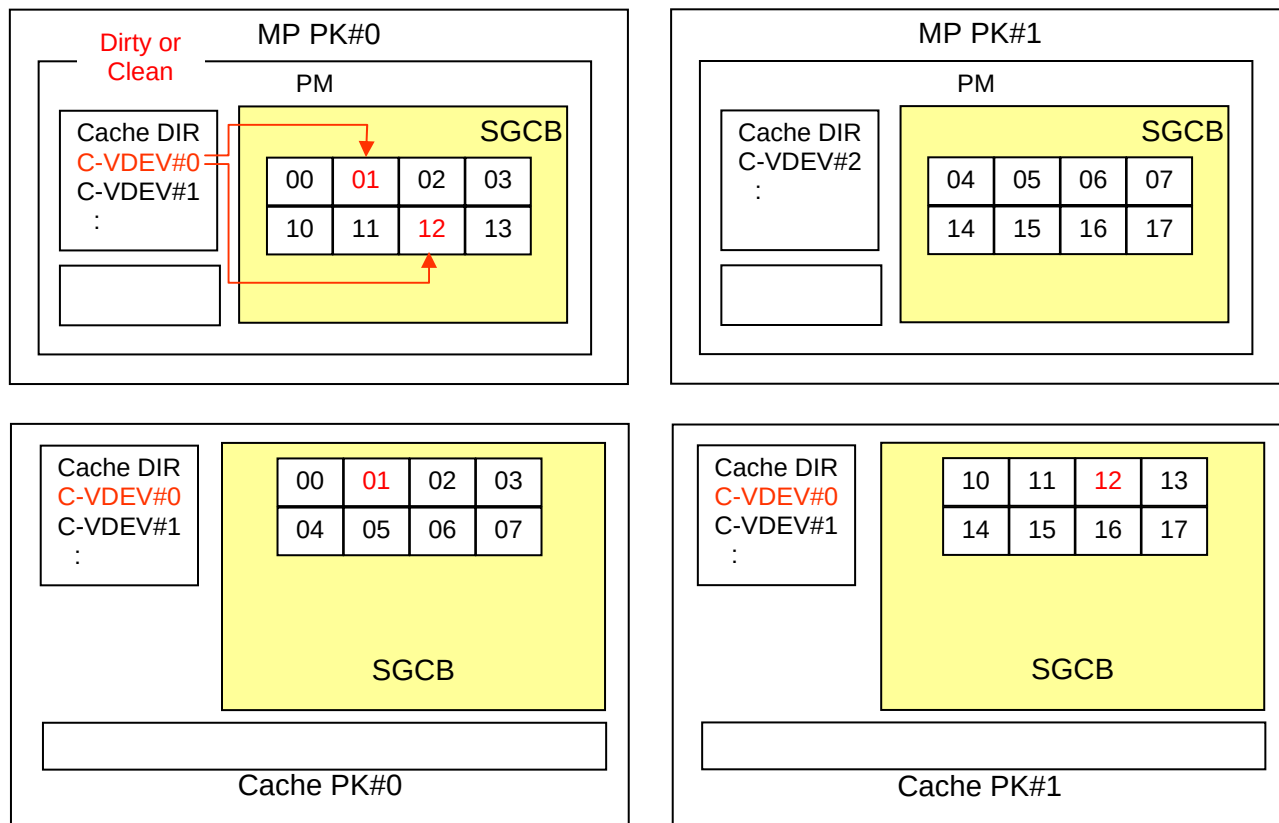
THEORY03-12-190**3.12.4.6 Ownership movement**

Fig. 3.12.4.6-1 Ownership movement (1)

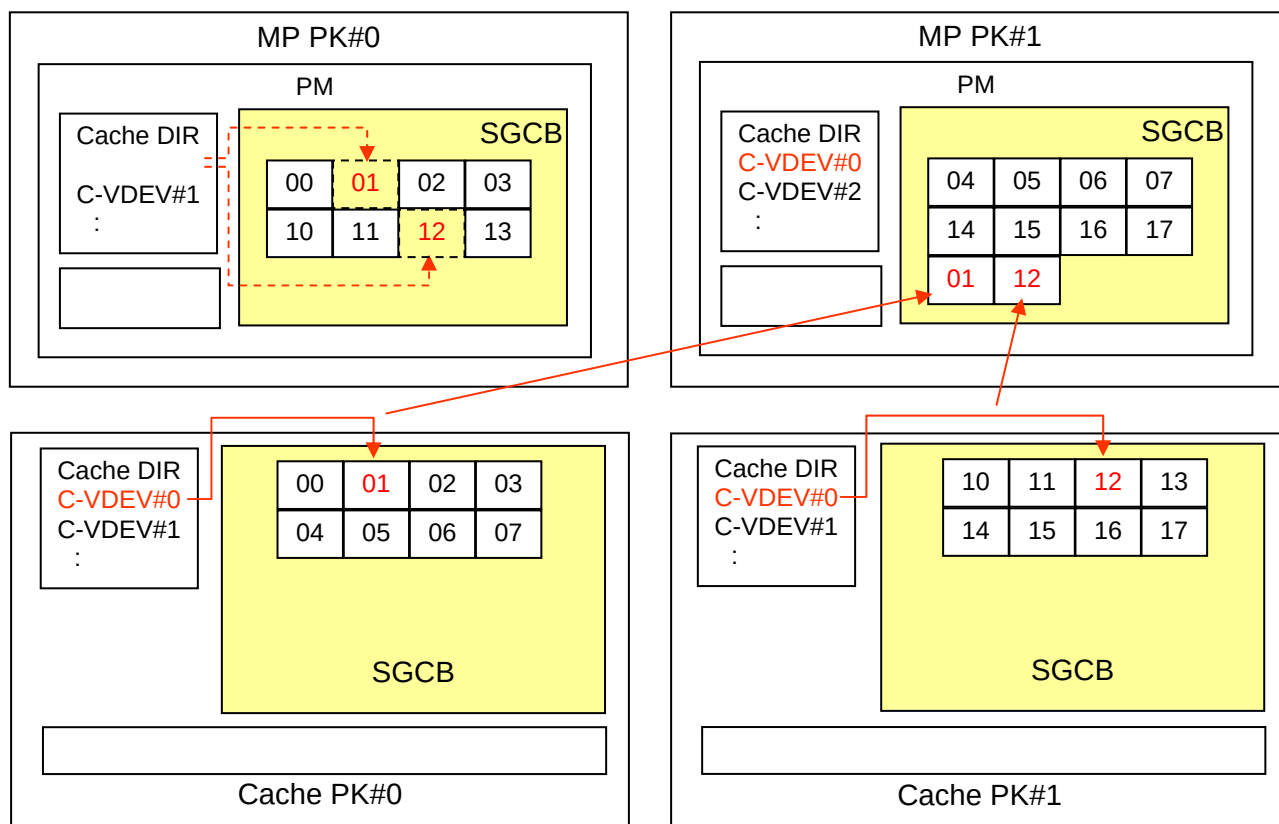


Fig. 3.12.4.6-2 Ownership movement (2)

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3.12.4.7 Cache Workload balance

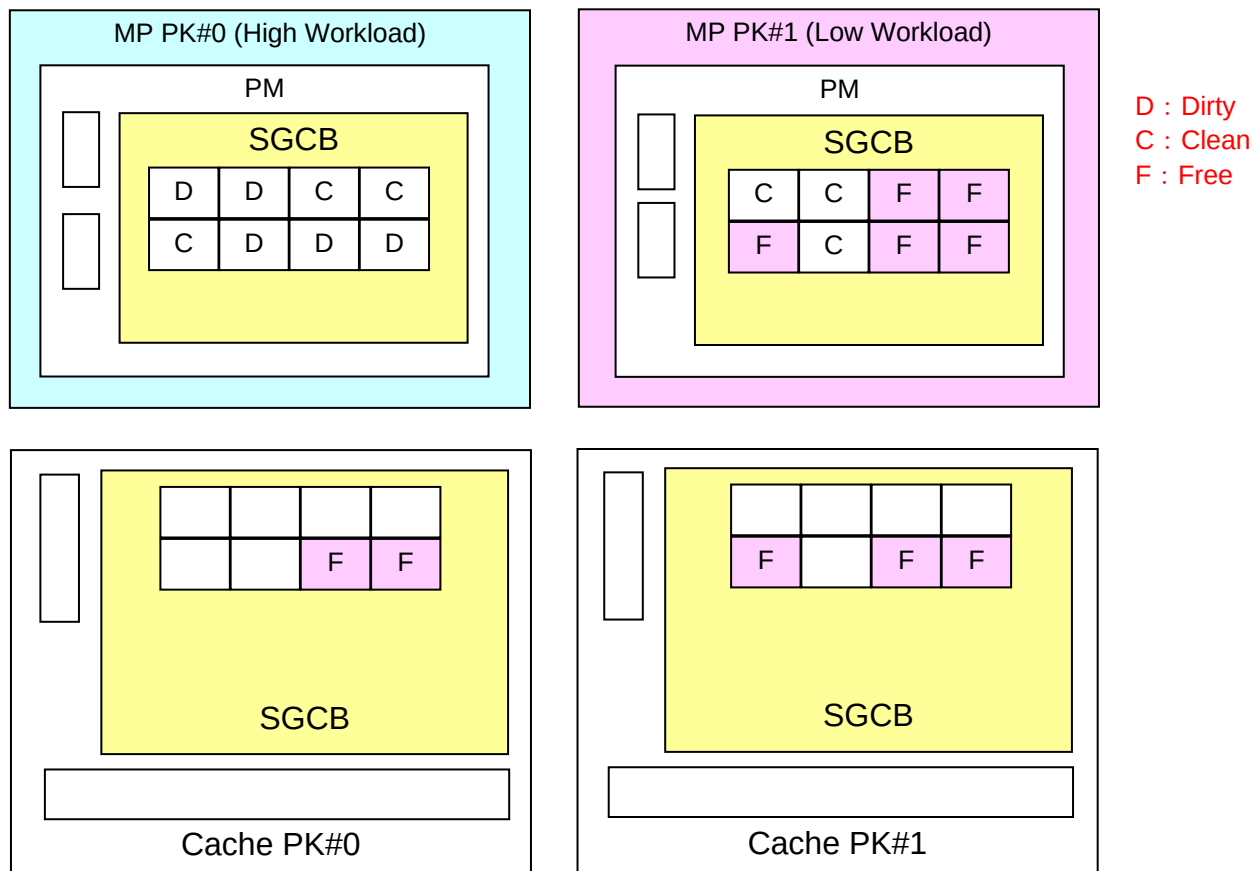


Fig. 3.12.4.7-1 Cache Workload balance (1)

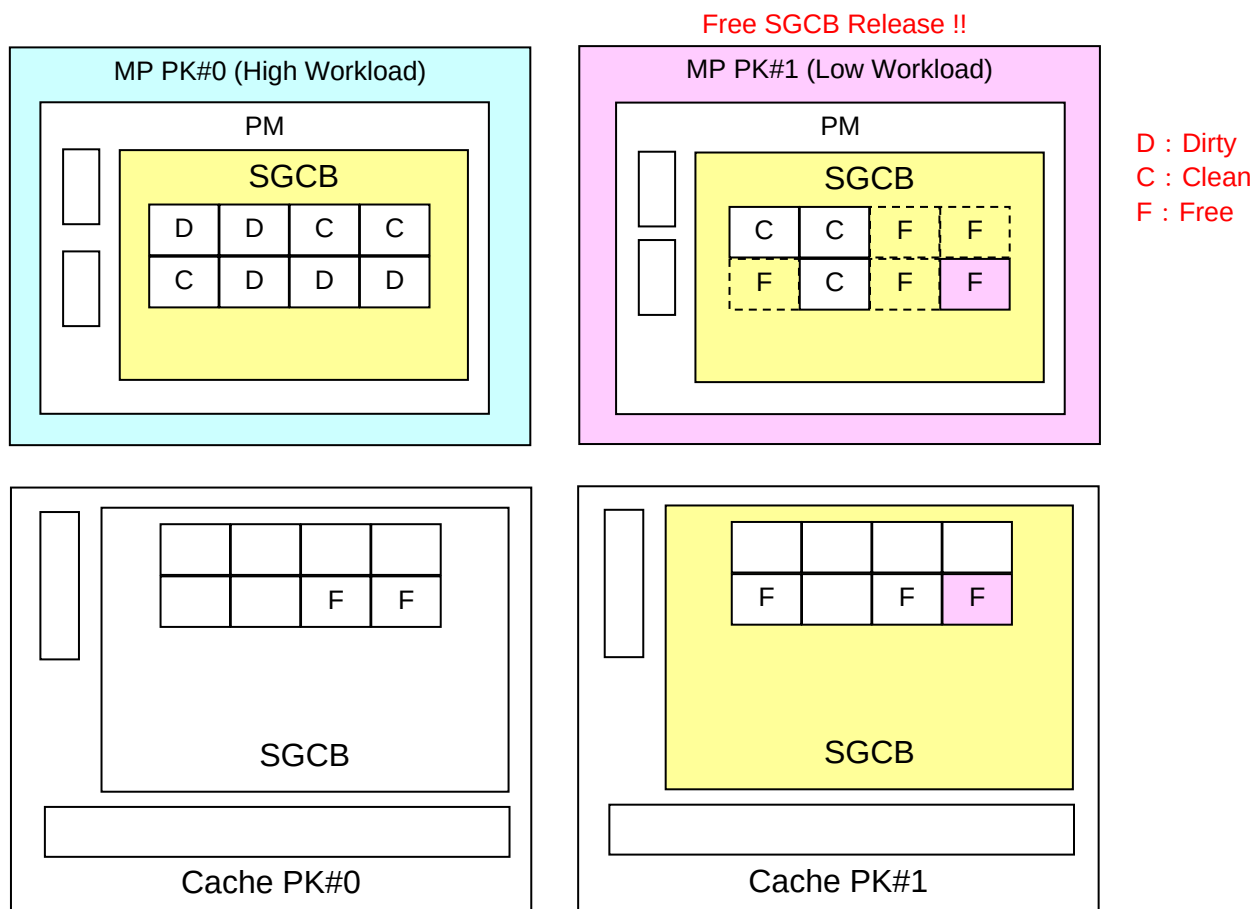


Fig. 3.12.4.7-2 Cache Workload balance (2)

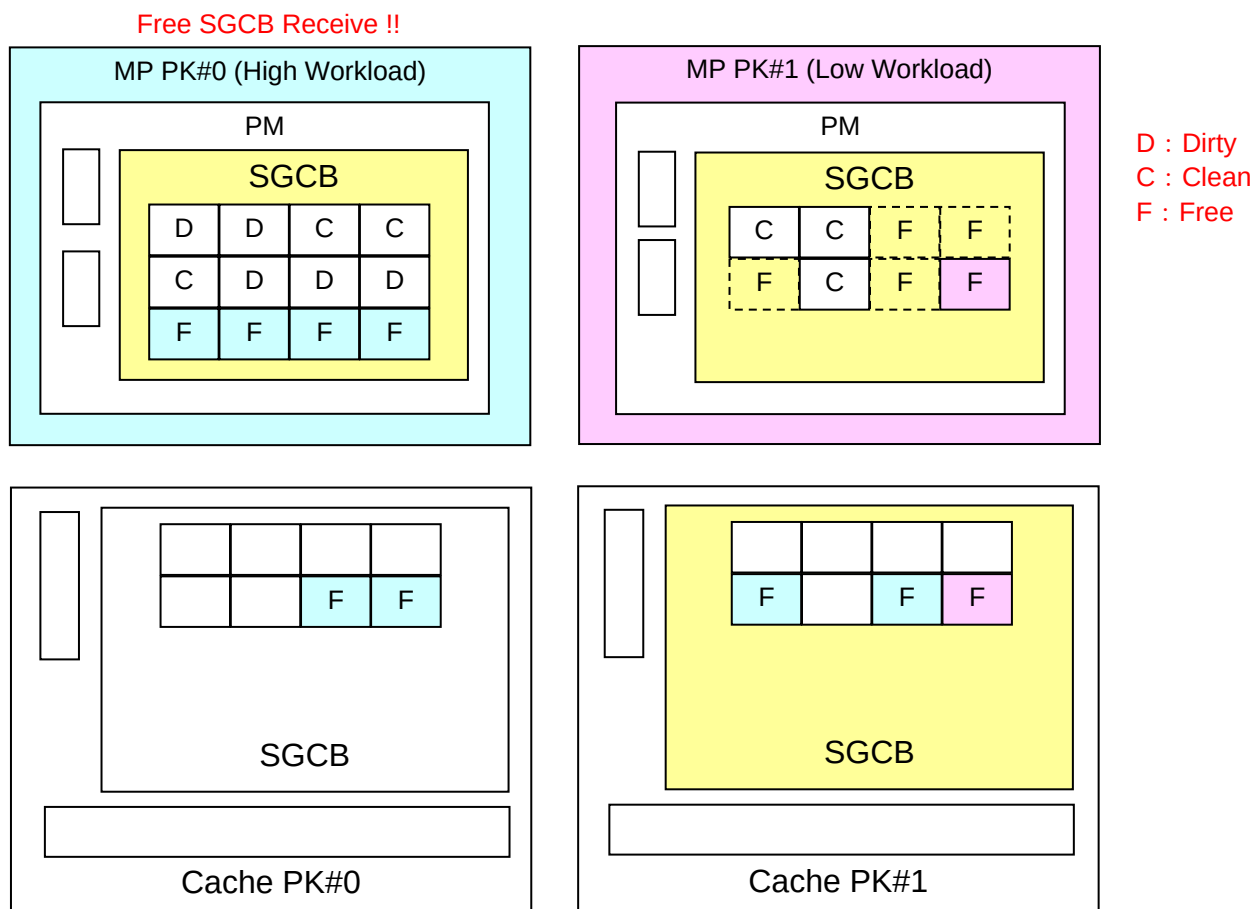


Fig. 3.12.4.7-3 Cache Workload balance (3)

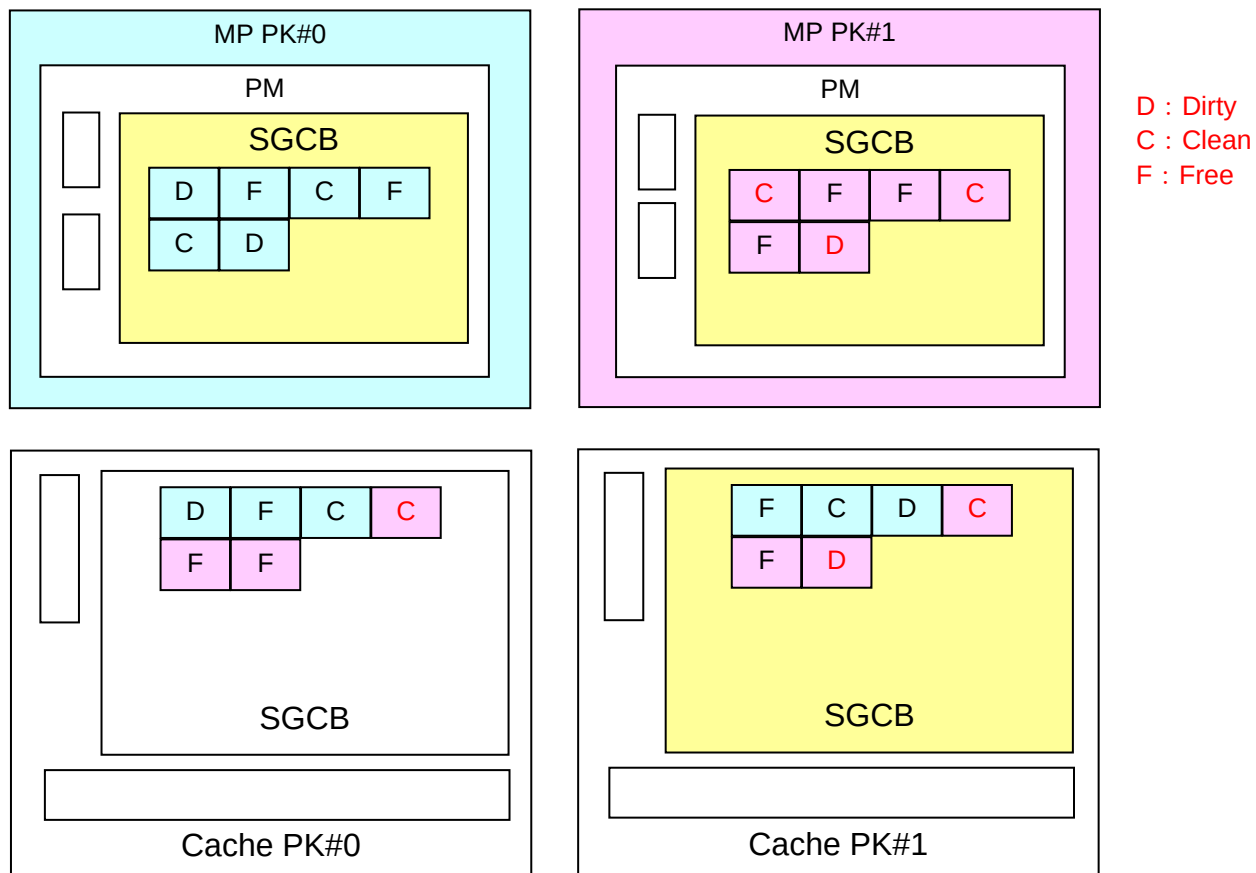
THEORY03-12-240**3.12.4.8 MP PK Replace**

Fig. 3.12.4.8-1 MP PK Replace (1)

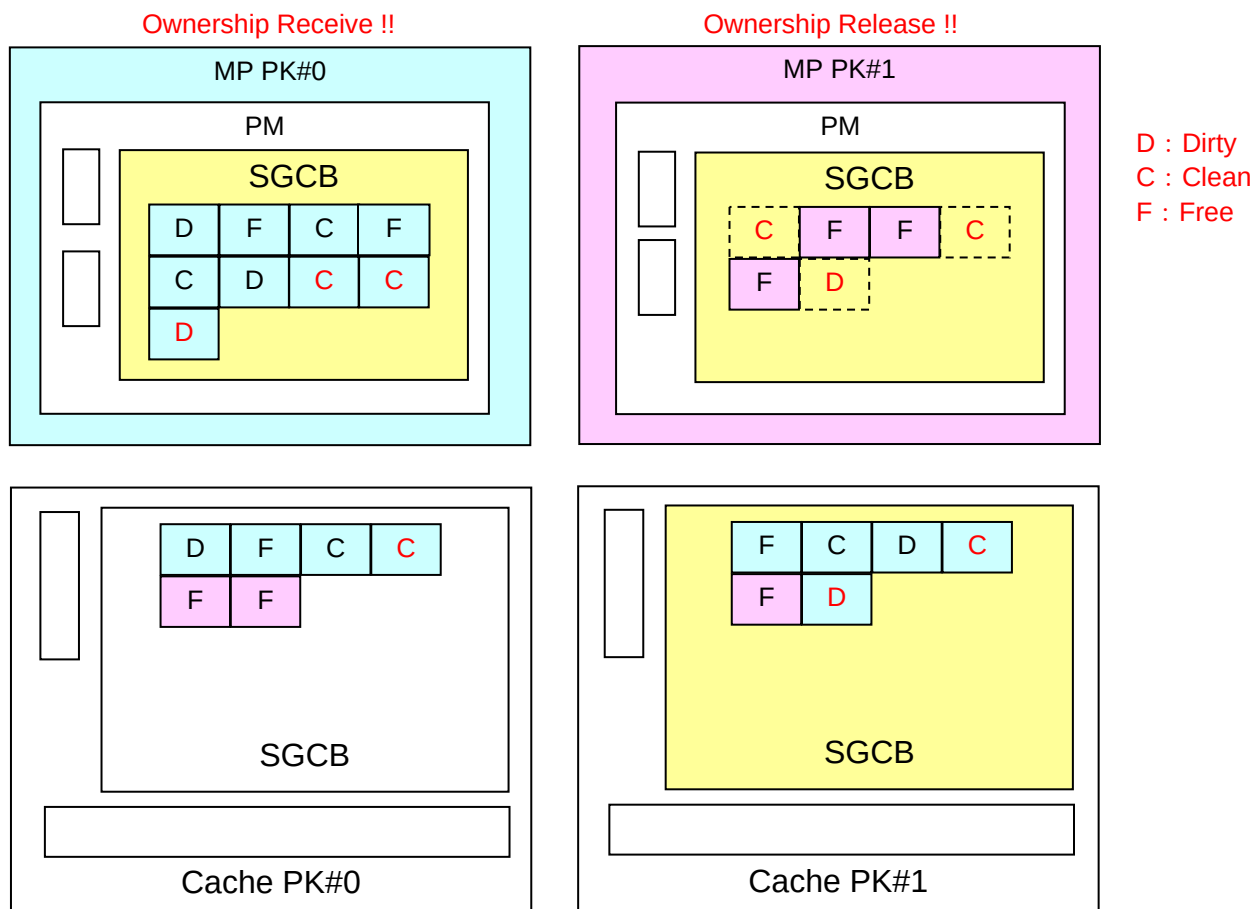


Fig. 3.12.4.8-2 MP PK Replace (2)

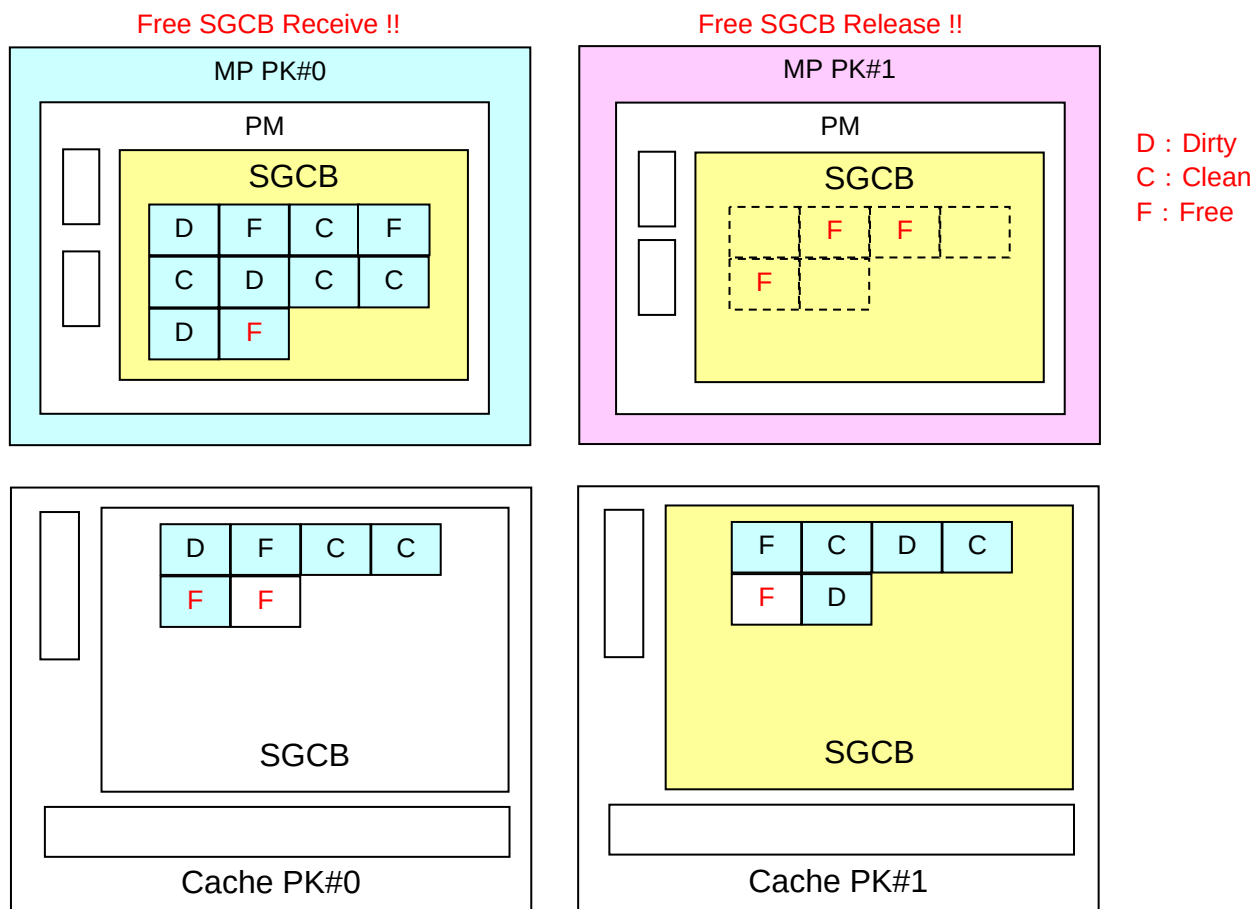


Fig. 3.12.4.8-3 MP PK Replace (3)

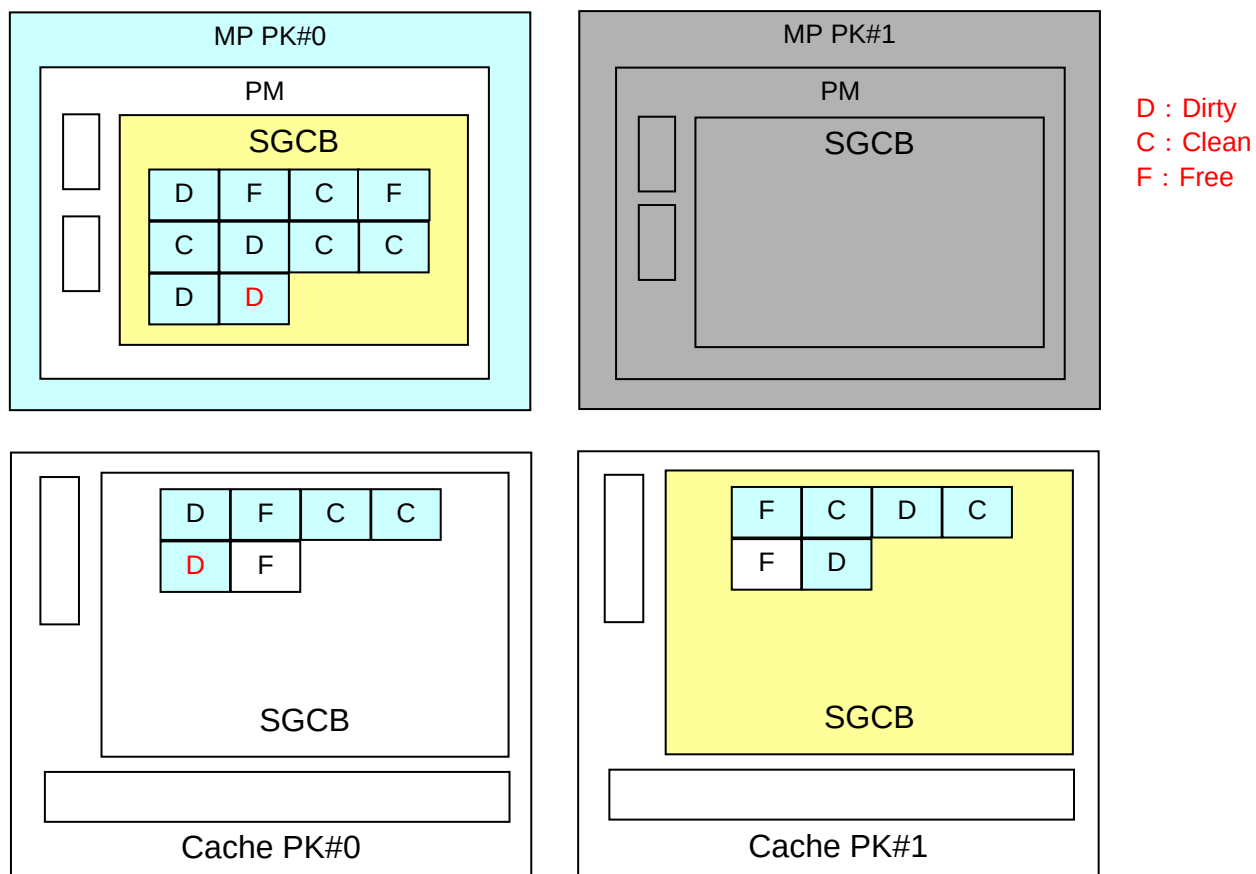


Fig. 3.12.4.8-4 MP PK Replace (4)

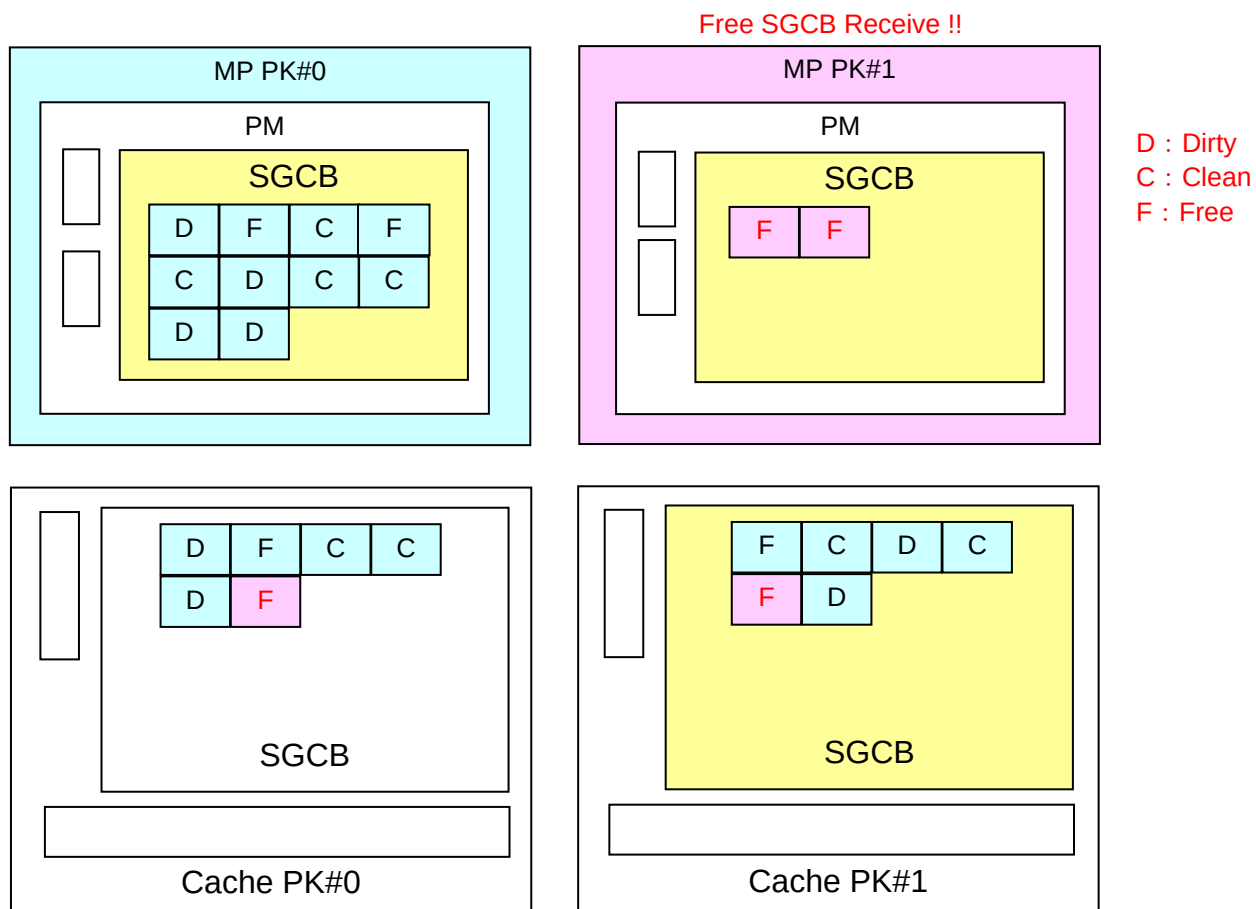


Fig. 3.12.4.8-5 MP PK Replace (5)

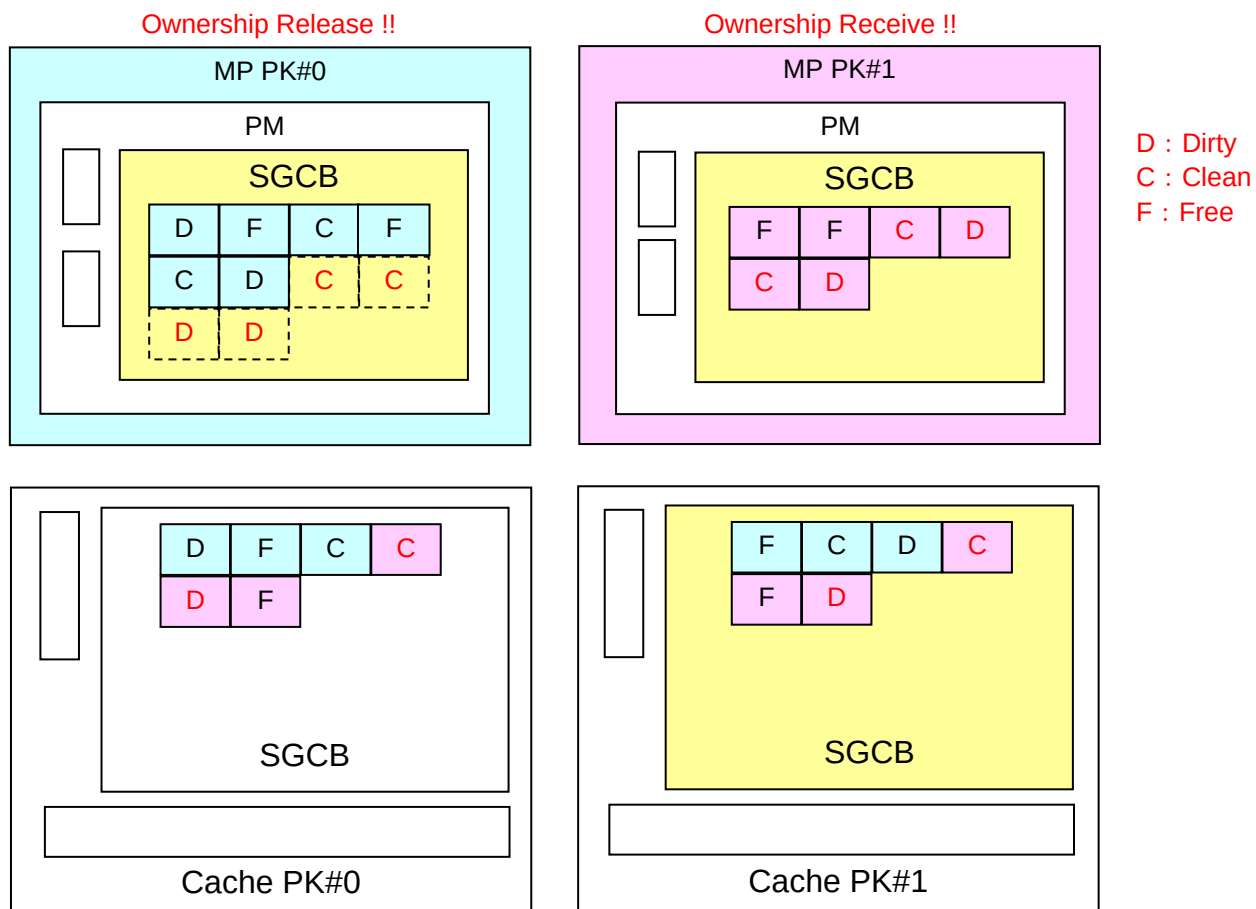


Fig. 3.12.4.8-6 MP PK Replace (6)

3.12.4.9 Queue/Counter Control

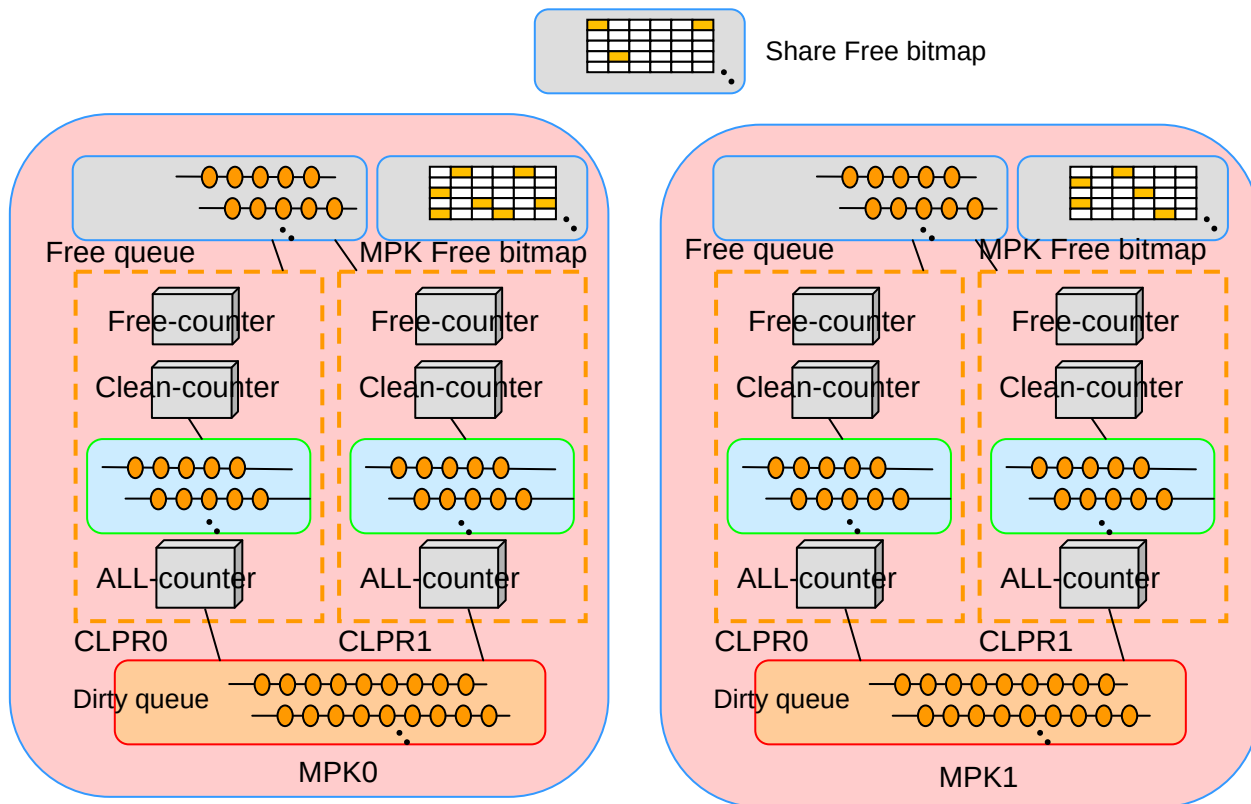


Fig. 3.12.4.9-1 Queue/Counter Control (1)

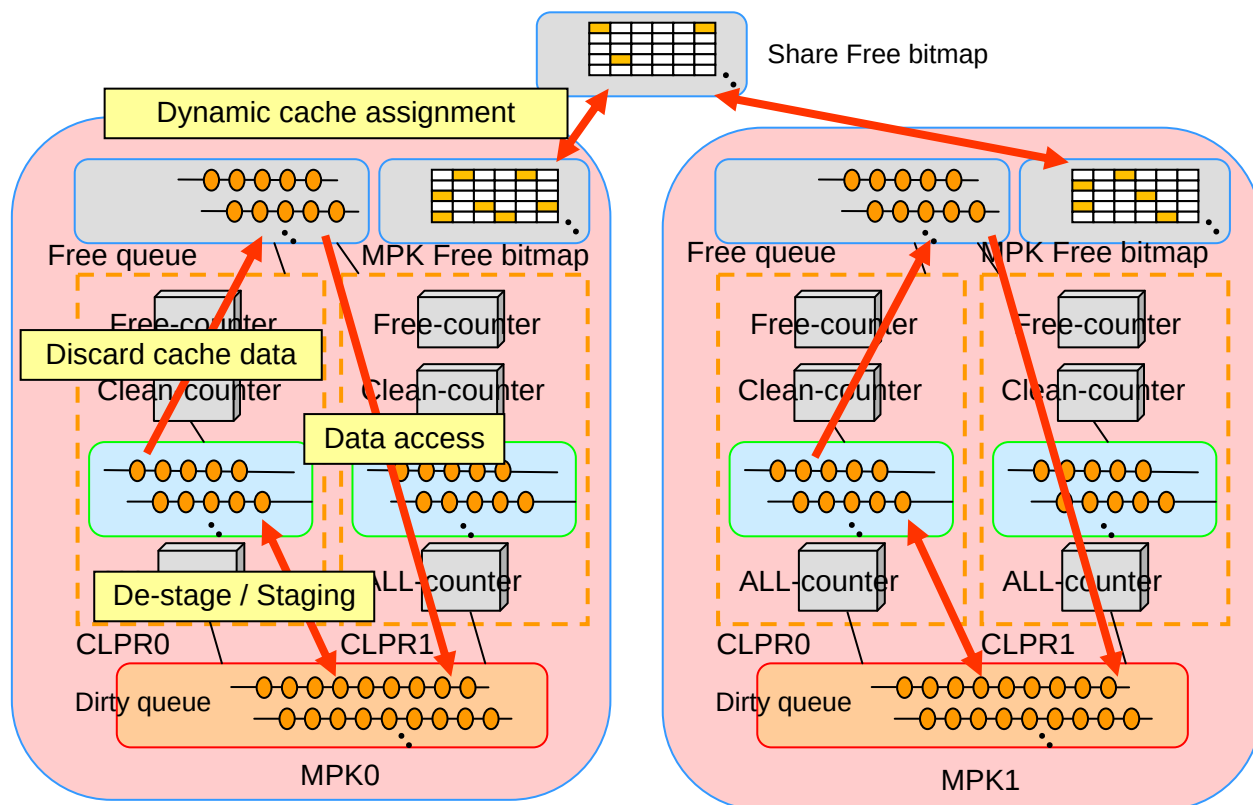


Fig. 3.12.4.9-2 Queue/Counter Control (2)

3.13 TrueCopy for Mainframe

3.13.1 TrueCopy for Mainframe Components

(1) TrueCopy for Mainframe Components

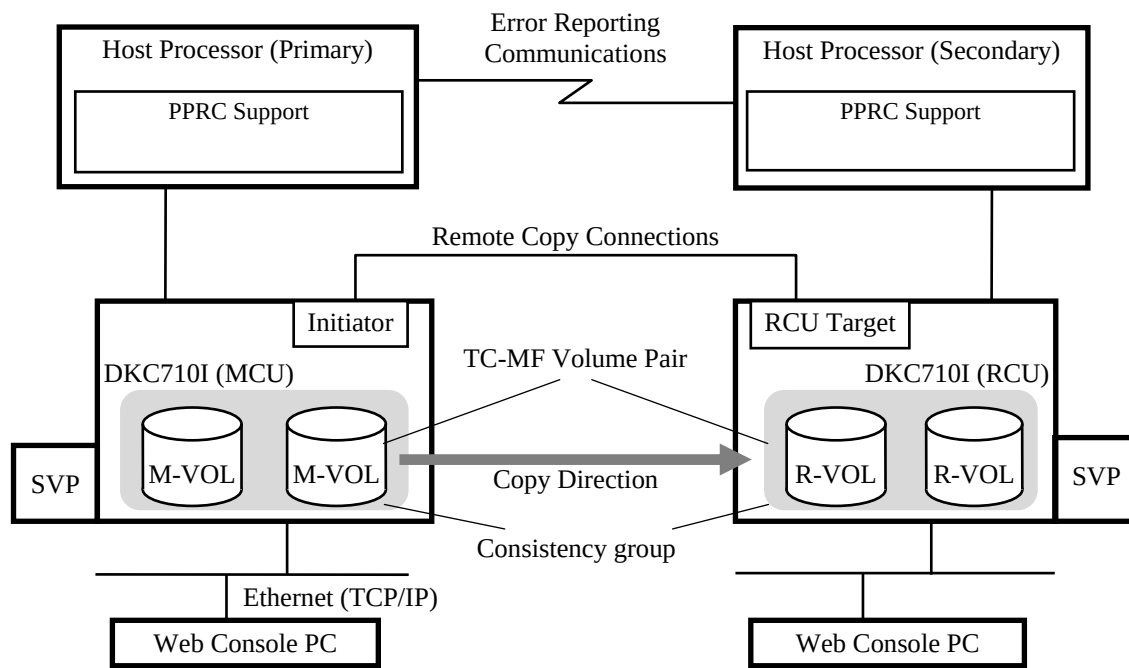


Fig. 3.13.1-1 TrueCopy for Mainframe Components for Fibre-Channel Interface Connection

(a) TrueCopy for Mainframe Volume Pair

An **TrueCopy for Mainframe volume pair** consists of two logical volumes, an M-VOL and an R-VOL, in different DKC710I subsystems.

An **M-VOL** (main volume) is a primary volume. It can be read or written by I/O operations from host processors.

An **R-VOL** (remote volume) is a secondary or a mirrored volume. Under control of the DKC710I subsystems, contents of an M-VOL and updates from host processors are copied to an R-VOL. Read or write I/O operations from host processors to R-VOLs are rejected.

Note : R-VOL Read Only function

TrueCopy for Mainframe has R-VOL Read Only function to accept read commands to R-VOL of suspended pairs of TrueCopy for Mainframe.

R-VOL Read Only function becomes effective with SVP system option setting for RCU of TrueCopy for Mainframe.

With this function, RCU accepts all RD commands including CTL/SNS commands and WR command to cylinder zero, head zero, record three of R-VOL. (It is necessary to change VOLSER of the volume.)

And, when it is combined with another system option, RCU accepts all RD commands including CTL/SNS commands and WR command to all tracks, and all records in cylinder zero of R-VOL. (It is necessary to change VOLSER and VTOC of the Volume.)

The RCU rejects some PPRC commands such as ADDPAIR to the R-VOL nevertheless the status of the R-VOL looks 'Simplex'. They must be controlled by system administration.

With this function, RCU displays the status of the R-VOL as 'Simplex' instead of 'Suspended'. It is necessary to accept I/O to R-VOL.

MCU copies cylinder zero of the pair at RESYNC copy unconditionally, besides the ordinary RESYNC copy.

With this function, if DKC Emulation type is 2105/2107, CSUSPEND command to R-VOL of suspended Pair of TrueCopy for Mainframe is rejected.

The M-VOLs of the TrueCopy for Mainframe volume pairs and the R-VOLs of other TrueCopy for Mainframe volume pairs can be intermixed in one DKC710I subsystem.

Note: Do not use M-VOLs or R-VOLs from hosts that have different CU emulation types (2105/2107 and 3990) at the same time. If you use the M-VOLs or R-VOLs from the 2105/2107 and 3990 hosts simultaneously, an MIH message might be reported to the 3990 host.

(b) MCU and RCU

An **MCU** (main disk control unit) and an **RCU** (remote disk control unit) are disk control units in the DKC710I subsystems to which the M-VOLs and the R-VOLs are connected respectively.

An MCU controls I/O operations from host processors to the M-VOLs and copy activities between the M-VOLs and the R-VOLs. An MCU also provides functions to manage TrueCopy for Mainframe status and configuration.

An RCU executes write operations directed by the MCU. The manner to execute write operations is almost same as that of I/O operations from host processors. An RCU also provides a part of functions to manage TrueCopy for Mainframe status and configuration.

Note that an MCU/RCU is defined on each TrueCopy for Mainframe volume pair basis. One disk control unit can operate as an MCU to control the M-VOLs and an RCU to control the R-VOLs.

(c) Remote Copy Connections

There Fibre channel interface of connection form.

At least two independent remote copy connections should be established between an MCU and an RCU.

(d) SVP and Web Console

An **SVP** provides functions to set up , modify and display TrueCopy for Mainframe configuration and status.

A **Web Console** is a personal computer compatible with the PC/AT. It should be connected to DKC710I subsystems with an Ethernet network (TCP/IP). Several DKC710I subsystems can be connected with one Ethernet network.

For Web Console, Hitachi provides only two software components, an TrueCopy for Mainframe application program and dynamic link library. Both of them require Microsoft Windows operating system. A personal computer, Ethernet materials and other software products are not provided by Hitachi.

(e) Error Reporting Communications

Error reporting communication is a communication means between host processors. An MCU generates the sense information when it fails in keeping synchronization of TrueCopy for Mainframe volume pair. The sense information causes the corresponding message to be displayed on the host processor console. For the reference during disaster recovery at the secondary (recovery) site, this console message should be transferred to the secondary site through the error reporting communication.

The error reporting communications may be configured by using channel-to-channel communications, Netview technology or other interconnect technologies, depending on installation. Hitachi does not provide any product for error reporting communications.

(f) PPRC Support

TrueCopy for Mainframe provides a host processor interface compatible with IBM PPRC. TSO commands, DSF commands and disaster recovery PTFs provided for PPRC can be used for TrueCopy for Mainframe.

(g) Initiator Port

An **Initiator Port** (remote control port) is a Fibre Channel interface port to which an RCU is connected. Any Fibre Channel interface port of the DKC710I subsystems can be configured as an Initiator Port.

But, as for the channel port of the host computer, it can't communicate. A path from the host computer must be connected with other Fibre Channel interface ports.

(h) RCU Target Port

An **RCU Target Port** (remote control port) is a Fibre Channel interface port to which an MCU is connected. Any Fibre Channel interface port of the DKC710I subsystems can be configured as an RCU Target Port.

It can be connected with the channel of the host computer by the Fibre Channel switch.

TrueCopy for Mainframe operations from an SVP or a Web Console and the corresponding TSO commands are shown in Table 3.13.1-1. Before using TSO commands or DSF commands for PPRC, the serial interface ports to which the RCU(s) will be connected must be set to the Initiator mode. Table 3.13.1-2 shows the value of the SAID (system adapter ID) parameters required for CESTPATH command. For full description on TSO commands or DSF commands for PPRC, refer to the appropriate manuals published by IBM corporation.

Table 3.13.1-1 TrueCopy for Mainframe operations and corresponding TSO commands for PPRC

Function	TC-MF operations	TSO commands
Registering an RCU and establishing remote copy connections	Add RCU	CESTPATH (note)
Adding or removing remote copy connection(s)	Edit Path	CESTPATH
Deleting an RCU registration	Delete RCU	CDELPATH
Establishing an TC-MF volume pair	Add Pair	CESTPAIR MODE (COPY)
Suspending an TC-MF volume pair	Suspend Pair	CSUSPEND
Disestablishing an TC-MF volume pair	Delete Pair	CDELPAIR
Recovering an TC-MF volume pair from suspended condition	Resume Pair	CESTPAIR MODE (RESYNC)
Controlling TC-MF volume groups	—	CGROUP

Note: Required Parameters

(How to set up LINK PARAMETER for CESTPATH command)

LINK PARAMETER

a	a	a	a	b	b	c	c

aaaa: SAID (refer to Table 3.13.1-2)

bb : destination address

cc : CUI# of RCU

THEORY03-13-70**Table 3.13.1-2 SAID (system adapter ID) required for CESTPATH command (1/2)****CL1**

Package Location	Port	SAID	Package Location	Port	SAID	Package Location	Port	SAID	Package Location	Port	SAID
1EU (Basic)	CL1-A	X'0000'	2QU (Basic)	CL2-A	X'0010'	1AU (DKA Basic)	CL9-A	X'0080'	2MU (DKA Basic)	CLA-A	X'0090'
	CL3-A	X'0020'		CL4-A	X'0030'		CLB-A	X'00A0'		CLC-A	X'00B0'
	CL5-A	X'0040'		CL6-A	X'0050'		CLD-A	X'00C0'		CLE-A	X'00D0'
	CL7-A	X'0060'		CL8-A	X'0070'		CLF-A	X'00E0'		CLG-A	X'00F0'
	CL1-B	X'0001'		CL2-B	X'0011'		CL9-B	X'0081'		CLA-B	X'0091'
	CL3-B	X'0021'		CL4-B	X'0031'		CLB-B	X'00A1'		CLC-B	X'00B1'
	CL5-B	X'0041'		CL6-B	X'0051'		CLD-B	X'00C1'		CLE-B	X'00D1'
	CL7-B	X'0061'		CL8-B	X'0071'		CLF-B	X'00E1'		CLG-B	X'00F1'
1EL (Add1)	CL1-C	X'0002'	2QL (Add1)	CL2-C	X'0012'	1AL (DKA Add1)	CL9-C	X'0082'	2ML (DKA Add1)	CLA-C	X'0092'
	CL3-C	X'0022'		CL4-C	X'0032'		CLB-C	X'00A2'		CLC-C	X'00B2'
	CL5-C	X'0042'		CL6-C	X'0052'		CLD-C	X'00C2'		CLE-C	X'00D2'
	CL7-C	X'0062'		CL8-C	X'0072'		CLF-C	X'00E2'		CLG-C	X'00F2'
	CL1-D	X'0003'		CL2-D	X'0013'		CL9-D	X'0083'		CLA-D	X'0093'
	CL3-D	X'0023'		CL4-D	X'0033'		CLB-D	X'00A3'		CLC-D	X'00B3'
	CL5-D	X'0043'		CL6-D	X'0053'		CLD-D	X'00C3'		CLE-D	X'00D3'
	CL7-D	X'0063'		CL8-D	X'0073'		CLF-D	X'00E3'		CLG-D	X'00F3'
1FU (Add2)	CL1-E	X'0004'	2RU (Add2)	CL2-E	X'0014'	Un- installed	—	—	Un- installed	—	—
	CL3-E	X'0024'		CL4-E	X'0034'		—	—		—	—
	CL5-E	X'0044'		CL6-E	X'0054'		—	—		—	—
	CL7-E	X'0064'		CL8-E	X'0074'		—	—		—	—
	CL1-F	X'0005'		CL2-F	X'0015'		—	—		—	—
	CL3-F	X'0025'		CL4-F	X'0035'		—	—		—	—
	CL5-F	X'0045'		CL6-F	X'0055'		—	—		—	—
	CL7-F	X'0065'		CL8-F	X'0075'		—	—		—	—
1FL (Add3)	CL1-G	X'0006'	2RL (Add3)	CL2-G	X'0016'	Un- installed	—	—	Un- installed	—	—
	CL3-G	X'0026'		CL4-G	X'0036'		—	—		—	—
	CL5-G	X'0046'		CL6-G	X'0056'		—	—		—	—
	CL7-G	X'0066'		CL8-G	X'0076'		—	—		—	—
	CL1-H	X'0007'		CL2-H	X'0017'		—	—		—	—
	CL3-H	X'0027'		CL4-H	X'0037'		—	—		—	—
	CL5-H	X'0047'		CL6-H	X'0057'		—	—		—	—
	CL7-H	X'0067'		CL8-H	X'0077'		—	—		—	—

Table 3.13.1-2 SAID (system adapter ID) required for CESTPATH command (2/2)

CL2

Package Location	Port	SAID	Package Location	Port	SAID	Package Location	Port	SAID	Package Location	Port	SAID
1GU (Add4)	CL1-J	X'0008'	2TU (Add4)	CL2-J	X'0018'	1LU (DKA Add2)	CL9-J	X'0088'	2XU (DKA Add2)	CLA-J	X'0098'
	CL3-J	X'0028'		CL4-J	X'0038'		CLB-J	X'00A8'		CLC-J	X'00B8'
	CL5-J	X'0048'		CL6-J	X'0058'		CLD-J	X'00C8'		CLE-J	X'00D8'
	CL7-J	X'0068'		CL8-J	X'0078'		CLF-J	X'00E8'		CLG-J	X'00F8'
	CL1-K	X'0009'		CL2-K	X'0019'		CL9-K	X'0089'		CLA-K	X'0099'
	CL3-K	X'0029'		CL4-K	X'0039'		CLB-K	X'00A9'		CLC-K	X'00B9'
	CL5-K	X'0049'		CL6-K	X'0059'		CLD-K	X'00C9'		CLE-K	X'00D9'
	CL7-K	X'0069'		CL8-K	X'0079'		CLF-K	X'00E9'		CLG-K	X'00F9'
1GL (Add5)	CL1-L	X'000A'	2TL (Add5)	CL2-L	X'001A'	1LL (DKA Add3)	CL9-L	X'008A'	2XL (DKA Add3)	CLA-L	X'009A'
	CL3-L	X'002A'		CL4-L	X'003A'		CLB-L	X'00AA'		CLC-L	X'00BA'
	CL5-L	X'004A'		CL6-L	X'005A'		CLD-L	X'00CA'		CLE-L	X'00DA'
	CL7-L	X'006A'		CL8-L	X'007A'		CLF-L	X'00EA'		CLG-L	X'00FA'
	CL1-M	X'000B'		CL2-M	X'001B'		CL9-M	X'008B'		CLA-M	X'009B'
	CL3-M	X'002B'		CL4-M	X'003B'		CLB-M	X'00AB'		CLC-M	X'00BB'
	CL5-M	X'004B'		CL6-M	X'005B'		CLD-M	X'00CB'		CLE-M	X'00DB'
	CL7-M	X'006B'		CL8-M	X'007B'		CLF-M	X'00EB'		CLG-M	X'00FB'
1HU (Add6)	CL1-N	X'000C'	2UU (Add6)	CL2-N	X'001C'	Un- installed	—	—	Un- installed	—	—
	CL3-N	X'002C'		CL4-N	X'003C'		—	—		—	—
	CL5-N	X'004C'		CL6-N	X'005C'		—	—		—	—
	CL7-N	X'006C'		CL8-N	X'007C'		—	—		—	—
	CL1-P	X'000D'		CL2-P	X'001D'		—	—		—	—
	CL3-P	X'002D'		CL4-P	X'003D'		—	—		—	—
	CL5-P	X'004D'		CL6-P	X'005D'		—	—		—	—
	CL7-P	X'006D'		CL8-P	X'007D'		—	—		—	—
1HL (Add7)	CL1-Q	X'000E'	2UL (Add7)	CL2-Q	X'001E'	Un- installed	—	—	Un- installed	—	—
	CL3-Q	X'002E'		CL4-Q	X'003E'		—	—		—	—
	CL5-Q	X'004E'		CL6-Q	X'005E'		—	—		—	—
	CL7-Q	X'006E'		CL8-Q	X'007E'		—	—		—	—
	CL1-R	X'000F'		CL2-R	X'001F'		—	—		—	—
	CL3-R	X'002F'		CL4-R	X'003F'		—	—		—	—
	CL5-R	X'004F'		CL6-R	X'005F'		—	—		—	—
	CL7-R	X'006F'		CL8-R	X'007F'		—	—		—	—

(i) DKC emulation type = 2105/2107

The RESETHP option of the CESTPATH command reset host's I/Os, so you have to stop them in advance.

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3.13.2 TrueCopy for Mainframe Software Requirements

Minimum level for TrueCopy for Mainframe is MVS/DFP 3.2.0 + PTF or VM/ESA 2.1.0 + PTF.

- Optional error recovery procedure (ERP) functions - MVS/DFP 3.2.0 or above.

3.13.3 TrueCopy for Mainframe Hardware Requirements

(1) TrueCopy for Mainframe Supported models

Refer to Specifications of “THEORY OF OPERATION SECTION” for the Support models.

- Emulation type of an MCU and RCU can be different.
- Emulation type of an M-VOL and R-VOL must be same.
- CVS/DCR is able to define on the M-VOL and R-VOL.
- The 2105/2107 DKC emulation supports only 3390 DKU emulation.
- The R-VOL must have the same track sizes, and the same or larger volume capacities, as the M-VOL. (Note)
- When T-VOL of ShadowImage for Mainframe is established as M-VOL of TrueCopy for Mainframe, the T-VOL must be “Split” state. If not so, an equipment check error will occur in establishing TrueCopy for Mainframe pair.

Note: When executing an TrueCopy for Mainframe between volumes with different capacities, take notice of the following.

- ① State of the subsystem when executing the TrueCopy for Mainframe
All M-VOL data including the VTOC is physically copied by executing the TrueCopy for Mainframe. Accordingly, the R-VOL is recognized as having the same capacity as that of the M-VOL in the TrueCopy for Mainframe execution.
- ② Expansion of the VTOC
It is needed to expand the VTOC to make the R-VOL simplex and be accessed as having the normal capacity by the host. The VTOC is expanded by issuing the ICKDSF REFORMAT (REFVTOC) command.
*: The system environment is required to support the REFVTOC parameter. This parameter can be executed only by the ICKDSF which supports the PPRC function.

(2) Web Station PC Requirements

An TrueCopy for Mainframe application software and dynamic link library require Microsoft Windows.

(3) Distance between MCU and RCU

(a) Fibre channel interface connection

You must connect MCU and RCU with Optical Fibre cable.

With ShortWave (Optical Multi Mode), the longest cable is 500 m. The longest cable is 10 km with LongWave (Optical Single Mode).

By connecting Switch, the longest cable for ShortWave is 1.5 km, and 30 km for LongWave. But the Switch can be connected with a maximum of two steps.

Channel Extender Connects MCU and RCU with no distance restriction.

In case of a direct connection between MCU and RCU, each Fibre channel port topology must be “Fabric:Off and FC-AL”.

In case of via FC-Switch connection between MCU and RCU, each Fibre channel port topology must be set the same as for the closest FC-Switch's topology.

(Eg.) “Fabric:On and FC-AL” or “Fabric:On and Point-to-Point” or “Fabric:Off and Point-to-Point”

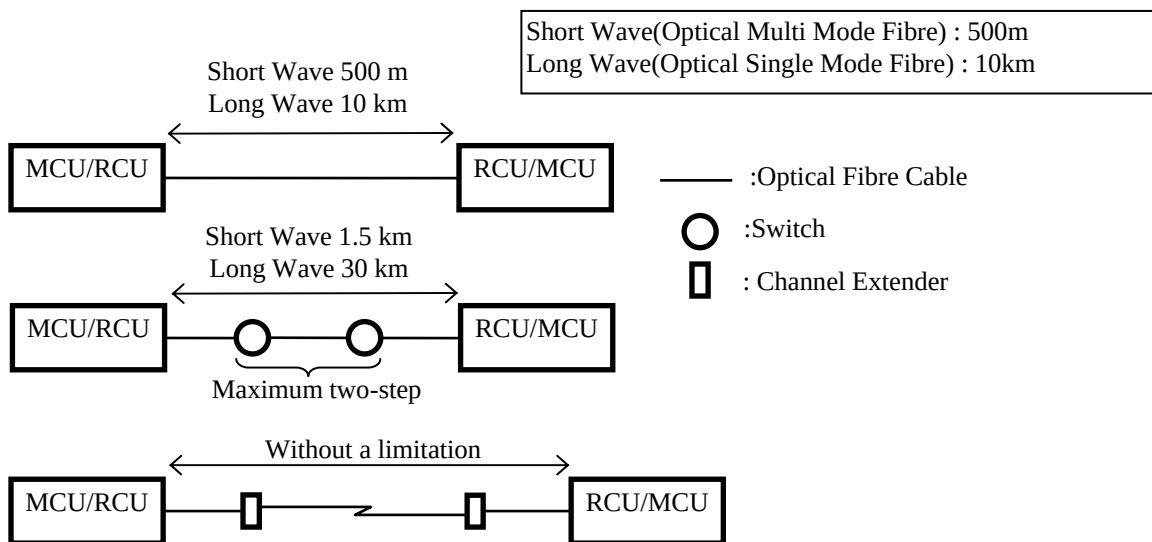


Fig. 3.13.3-1 Distance between Disk subsystems of Fibre channel interface connection

(4) Recommendation of MIH time and TrueCopy for Mainframe configuration

Recommendation of MIH time is 60 sec. for TrueCopy for Mainframe. In addition that, MIH time needs to be set with consideration of the following factors.

- The number of pair volumes
- Cable length between MCU and RCU
- Volume status (Initial copy status)
- Maintenance operation pending

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(5) Requirements for Track format, Cache, NVS, DASD Fast Write

Track format Cache, NVS, DASD Fast Write must satisfy following conditions for both of M-VOL and R-VOL of Remote Copy.

		TrueCopy for Mainframe	
		M-VOL	R-VOL
Track format	Track format of record zero	Standard format	
	Key length of record zero	Zero	
	Data length of record zero	Eight	
	CCHH of record zero	Identical to physical cylinder address and physical head address of a track	
	CCHH of each user records	Unique in a track	
Cache		Depends on TC-MF pair option*	Depends on TC-MF pair option*
NVS		Depends on TC-MF pair option*	Depends on TC-MF pair option*
DASD Fast Write		Depends on TC-MF pair option*	Depends on TC-MF pair option*

*: Required if “DFW to R-VOL” option is set.

(6) TrueCopy for Mainframe available CU image

CU#0 ~ CU#255 (In hexadecimal, CU#FF)

(7) Restriction for Connecting with Former Model of Storage System

When you connect the storage systems with the following combinations, the range you can specify for each model is restricted.

- DKC710I and DKC610I

When you connect DKC710I and DKC610I, you may specify the range as shown in Table 3.13.3-2.

Table 3.13.3-2 Range You Can Specify when You Connect DKC710I and DKC610I

Restriction Item	DKC710I *1	DKC610I*1,*2
Port number	From 1A to GR	From 1A to GR
LDKC*2:CU:LDEV	From 00:00:00 to 00:3F:FF	From 00:00 to 3F:FF

*1: It does not affect to the value whether the model connects as MCU or RCU.

*2: To connect with DKC610I, the microprogram version of the storage system must be 50-09-37-xx/xx or later.

AppendixA: TrueCopy for Mainframe Installation check list

Table 3.13.3-4 TrueCopy for Mainframe Installation Check List

No.	Item	Check
1	MCU/RCU emulation type must be correct.	
2	M_VOL/R_VOL emulation type must be correct.	
3	OS version must be as followed. • Optional error recovery procedure (ERP) functions - MVS/DFP 3.2.0 or above. • ICKDSF R16 + PTF functions - VM/ESA 2.1.0 or above.	
4	Initiator port must be set.	
5	Fiber channel cable between MCU and RCU must be connected.	
6	Fiber channel cable test between MCU and RCU must be executed.	

AppendixB: Guide for TrueCopy for Mainframe via EXTENDER(CHANNELink(CX5000), ULTRANET)

1. Preliminary remarks

This is the guide for TrueCopy for Mainframe operation via Computer Network Technology's (CNT's) CHANNELink and UltraNet Storage Director products. These two CNT products provide channel extension (store and forward functionality) between a Hitachi MCU and RCU used in an TrueCopy for Mainframe configuration. The channel extension provided by the CNT products allows the ESCON connection between the MCU(s) and the RCU(s) to be greater than the ESCON standard 43 km apart but still provide near native data transfer between the MCU and RCU.

3.13.4 TrueCopy for Mainframe Theory of Operations

(1) TrueCopy for Mainframe Copy Activities

TrueCopy for Mainframe executes two kinds of copy activities, initial copy and update copy.

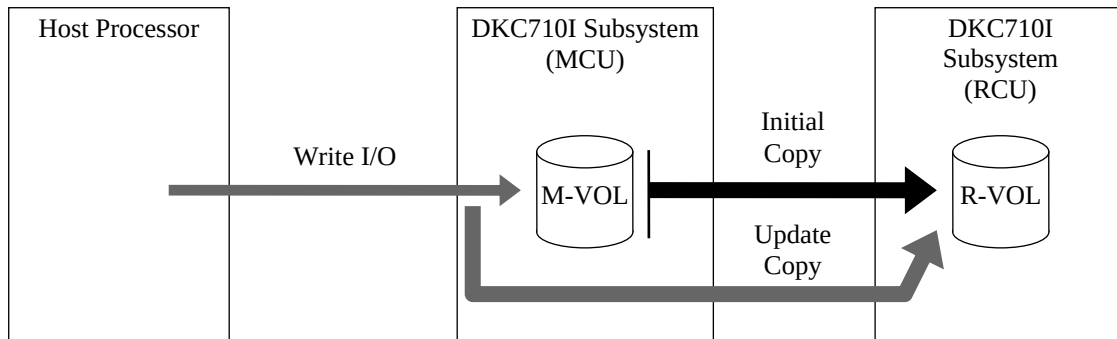


Fig. 3.13.4-1 TrueCopy for Mainframe Copy Activities

(a) Initial Copy

Responding to an Establish TC-MF Volume Pair operation from an SVP/Web Console or an ESTPAIR PPRC command, TC-MF begins initial copy. Data field of record zero and following records on all tracks, except for alternate and CE tracks, are copied from M-VOL to R-VOL. The initial copy operation is performed in ascending order of cylinder numbers.

“No copy” can be specified as a parameter to the initial copy. When “no copy” is specified, TC-MF will complete an Establish TC-MF Volume Pair operation without copying any data. An operator or a system administrator should be responsible for ensuring that data on the M-VOL and the R-VOL is already identical.

“Only out-of-sync cylinders” can also be specified as a parameter to the initial copy. This parameter is used to recover (re-establish) TC-MF volume pair from suspended condition. After suspending TC-MF volume pair, the MCU maintains a cylinder basis bit map which indicates the cylinders updated by I/O operations from the host processors. When this parameter is specified, TC-MF will copy only cylinders indicated by the bit map.

(b) Controlling Initial Copy

Number of tracks copied by one initial copy activity can be specified by an SVP/Web Console or an ESTPAIR PPRC command.

Number of volume pairs for which the initial copy are concurrently executed and priority of each volume pair can be specified from an SVP/Web Console.

(c) Update Copy

Responding to the write I/O operations from the host processors, TC-MF copies the records updated by the write I/O operation to the R-VOL.

The update copy is a synchronous remote copy. An MCU starts the update copy after responding only channel-end status to the host processor channel, and sends device-end status after completing the update copy. The MCU will start the update copy when it receives:

- The last write command in the current domain specified by preceding locate record command;
- A write command for which track switch to the next track is required;
- Each write command without being preceded by locate record command.

If many consecutive records are updated by single CCW chain which does not use locate record command, the third condition above may cause the significant impact on performance.

(d) Update Copy for Cache Fast Write Data

Cache fast write (CFW) data does not always have to be copied because CFW is used for temporary files, such as sort work data sets. These temporary files are not always necessary for disaster recovery.

In order to reduce update copy activities, TC-MF supports a parameter which specifies whether CFW data should be copied or not.

(e) Special Write Command for Initial Copy and Update Copy

In order to reduce overhead by the copy activities, TC-MF uses a special write command which is allowed only for copy activities between the DKC710I subsystems. The single write command transfers control parameters and an FBA formatted data which includes consecutive updated records in a track.

(2) TrueCopy for Mainframe Read I/O Operations

Responding to read I/O operations, an MCU transfers the requested records from an M-VOL to a host processor. Even if reading records from the M-VOL is failed, the R-VOL is not automatically read for recovery. The redundancy of the M-VOL itself provided by RAID5 or RAID1 technique would recover the failure.

(3) TrueCopy for Mainframe Volume Pair Status

All volumes in a DKC710I subsystem are in one of the states shown in Table 3.13.4-1.

Status of the M-VOLs or the R-VOLs are kept by the MCU and the RCU respectively. The MCU is responsible to keep status of the R-VOLs identical to status of the M-VOLs. However, in the case of communication failure between the MCU and the RCU, they could be different.

From an Web Console or by using an appropriate command for IBM PPRC, status of M-VOLs or status of R-VOLs can be obtained from the MCU or the RCU respectively.

Table 3.13.4-1 TrueCopy for Mainframe Volume Status

Status	Description
Simplex	This volume does not belong to TC-MF volume pair. When the initial copy is started by an Add Pair operation, the volume is changed to “pending duplex” state.
Pending Duplex	The initial copy is in progress. Data on TC-MF volume pair is not fully identical. When completing the initial copy, the volume will be changed to “duplex” state.
Duplex	Volumes in TC-MF volume pair are synchronized. All updates from the host processors to the M-VOL are duplicated to the R-VOL.
Suspended	Volumes in TC-MF volume pair are not synchronized. • When the MCU can not keep synchronization between TC-MF volume pair due to, for example, failure on the update copy, the MCU will put the M-VOL and the R-VOL in this state. • When the MCU or the RCU accepts a Suspend operation from an SVP/Web Console, the M-VOL and the R-VOL will be put in this state. • When the RCU accepts the Delete Pair operation from the SVP/Web Console, the MCU will detect the operation and put the M-VOL in this state.

Table 3.13.4-2 TrueCopy for Mainframe Volume Status - Sub-status of Suspended Volume

Cause of Suspension	Description
M-VOL by Operator	The Suspend operation with “M-VOL failure” option was issued to the M-VOL. This cause of suspension is defined only for the M-VOLs.
R-VOL by Operator	The Suspend operation with “R-VOL” option was issued to the M-VOL or the R-VOL. This cause of suspension is defined for both the M-VOLs and the R-VOLs.
by MCU	The RCU received a request to suspend the R-VOL from an MCU. This cause of suspension is defined for only the R-VOLs.
by RCU	The MCU detected an error condition of the RCU which caused TC-MF volume pair to be suspended. This cause of suspension is defined only for the M-VOLs.
Delete Pair to RCU	The MCU detected that the R-VOL had been changed to “simplex” state by the Delete Pair operation. This cause of suspension is defined only for the M-VOLs.
R-VOL Failure	The MCU detected an error condition on the communication between the RCU or I/O error on the update copy. This cause of suspension is defined only for the M-VOLs. The cause of suspension of the R-VOLs are usually set to “by MCU” in this situation.
MCU IMPL	The MCU could not find valid control information in its non-volatile memory during its IMPL procedure. This situation may occur after the power supply failure.
Initial Copy Failed	The volume pair was suspended before completing the initial copy. Even if no write I/O has been issued after being suspended, the data in the R-VOL is not completely identical to the M-VOL.

3.13.5 TrueCopy for Mainframe Control Operations

This section describes TrueCopy for Mainframe control operations from a Web Console.

(1) Add RCU Operation

(a) Fibre channel interface connection

The following parameters are necessary to register RCU as a Fibre Channel connection.

Port Type	Fibre: Fiber channel interface is used for the connection of MCU and RCU.
Controller ID	But, set it up with '04' when RCU is RAID500, and set it up with '05' when RCU is RAID600. Default is '06' fixed.
RIO MIH Time	A data transfer complete waiting time to RCU from MCU. Usual: 15[Sec]. Avail. range: 10[Sec] ~ 100[Sec]
MCU Port	An Initiator port of the DKC710I subsystem which set up a logic pass. You must set up a Fibre Channel interface port in Initiator port before this operation.
RCU Port	The Fibre Channel interface port of the place of the connection. You must specify a RCU target port.

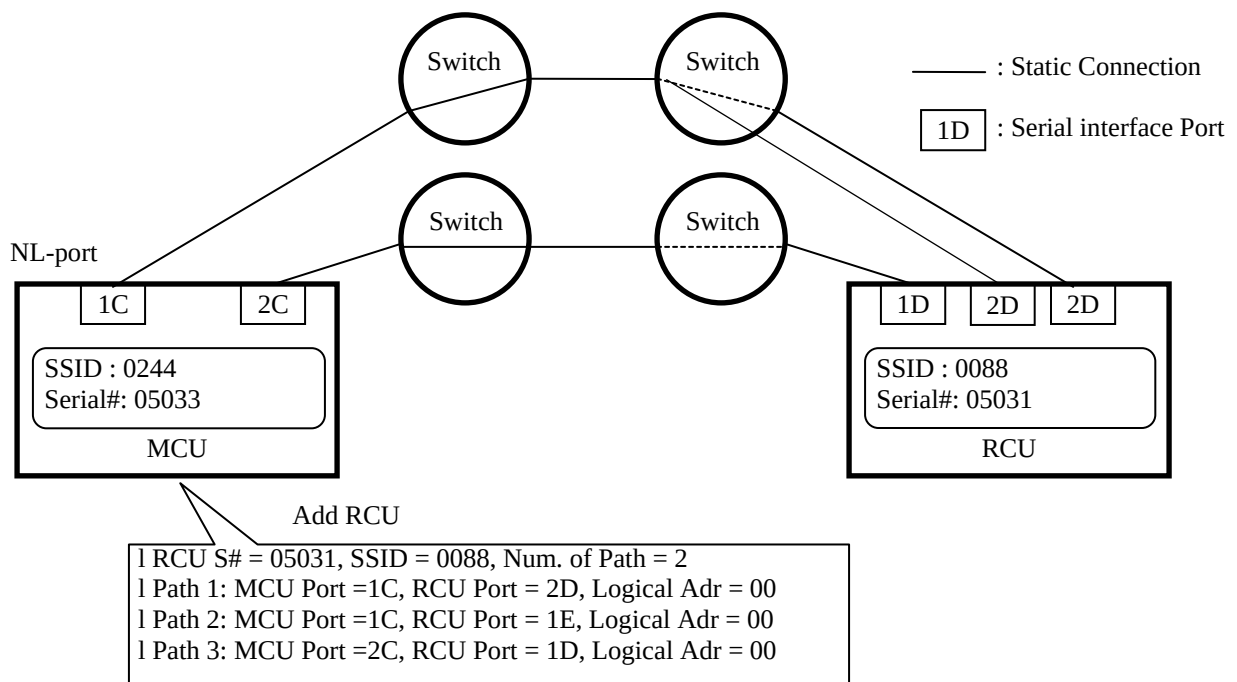


Fig. 3.13.5-1 Add RCU Operation

The following parameters modify the Remote Copy options which will be applied to all Remote Copy volume pairs in this subsystem.

Minimum Paths	When the MCU blocks the logical path due to communication failure, if the number of remaining paths becomes less than the number specified by this parameter, the MCU will suspend all of the Remote Copy volume pairs. The default value is set to “1”. If the installation requirements prefers the subsystem I/O performance to the continuation of Remote Copy, value between “2” and the number of the established logical paths can be specified.
Maximum Initial Copy Activities	It specifies how many TC-MF initial copies can be simultaneously executed by the MCU. If more Remote Copy volume pairs are specified by an Add Pair operation, the MCU will execute the initial copy for as many volumes as specified by this parameter. The initial copy for other volumes is delayed until one of the initial copies is completed. This parameter can control the performance impact caused by the initial copy activity. Note: Default value of this parameter is “64”.
PPRC supported by HOST	If “Yes” is specified, the MCU will generate the sense information which is compatible with IBM PPRC when the TC-MF volume pair is suspended. If “No” is specified, the MCU will generate only service information messages. Even if the SSB (F/M=FB) is specified by the Suspend Pair Operation, the x‘FB’ sense information will not be reported to the HOST.
Service SIM of Remote Copy	If “Report” is specified, the Remote Copy Service SIM will be reported to the HOST. If “Yes” is specified in PPRC supported by HOST option, DEV_SIM of TC-MF will not be reported. If “Not Report” is specified, the Remote Copy Service SIM reporting will be suppressed. Refer to “SIM Reference Codes Detected by the Processor for Remote Copy” in SIM-RC SECTION.

Note that these parameters will be applied to ALL RCUs registered to the MCU. If different parameters are specified, the last parameter will be applied.

(2) Edit Path Operation

An Edit Path operation makes the MCU add/delete the logical path to the registered RCU.

To add a logical path, the same path parameters as an Add RCU operation are required. The added logical path will be automatically used to execute the copy activities.

When deleting a logical path, pay attention to the number of remaining logical paths. If it becomes less than the number specified by “Minimum Paths”, Remote Copy volume pair could be suspended.

(3) RCU Option Operation

An RCU Option operation modifies the Remote Copy options described in “3.13.5(1) Add RCU operation”.

(4) Delete RCU Operation

A Delete RCU operation makes the MCU delete the specified RCU from RCU registration. All logical paths to the specified RCU will be removed.

If some volumes connected to the specified RCU are active R-VOLs, this operation will be rejected. All R-VOLs must be deleted by a Delete Pair operation before a Delete RCU operation.

(5) RCU Status Operation

An RCU Status operation makes the MCU display the status of RCU registration. It also provides the current status, time of registration and time of changing status for each logical path.

The current status of each logical path is defined as follows:

Normal	This logical path has been successfully established and can be used for the Remote Copy activities.
Initialization Failed	The link initialization procedure between the RCU is failed. It occurred due to Missing physical path connection between MCU and RCU, or connecting MCU with HOST as RCU.
Resource Shortage (RCU)	Establish Logical Path link control function has been rejected by the RCU. All logical path resources in the RCU might be used for other connections.
Serial Number Mismatch	The serial number of the control unit which is connected to this logical path does not match to the serial number specified by "RCU S#" parameter.

(6) Add Pair Operation

An Add Pair operation makes the MCU establish a new Remote Copy volume pair. It also provides function to modify the Remote Copy options which will be applied to the selected Remote Copy volume pair.

To establish Remote Copy volume pair, following parameters are required:

RCU	The disk control unit which controls the R-VOL of this Remote Copy volume pair. It must be selected from RCUs which have already been registered by Add RCU operations.
R-VOL	Device number of the R-VOL.
Priority	Priority (scheduling order) of the initial copy for this volume pair. When the initial copy for one volume pair has been terminated, the MCU selects and start the initial copy for another volume pair which has the lowest value of this parameter. For the Add Pair operations, the value “1” through “256” can be specified. For establishing TC-MF volume pair by TSO command or DSF command for PPRC, “0” is implicitly applied to. “0” is the highest priority, “256” is the lowest, and default value for the Add Pair operation is “32”. For the volume pairs to which the priority has been specified, the MCU prioritizes the volume pairs in the arrival order of the Add Pair operations or TSO/DSF commands. If the MCU are performing the initial copy for the number of volume pairs, as much as the value of “maximum initial copy activities”, and accepts further Add Pair operation, the MCU does not start other initial copy until one of the copy being performed will be completed. Note: When a time out occurs in this operation, a schedule may not be done as the priority parameter. The cause of the time-out is thought the problem of the configuration of DKC or Remote-copy connection path. Confirm configuration. After that, cancel a pair, and re-establish a pair.
Operation Mode	It specifies what kind of remote copy capability should be applied to this volume pair.
Initial Copy	It specifies what kind of initial copy activity should be executed for this TC-MF volume pair. The kind of the initial copy can be selected out of: - “Entire Volume” specifies that all cylinders excluding the alternate cylinder and the CE cylinders should be copied. - “None” specifies that the initial copy does not need to be executed. The synchronization between volume pair must have been ensured by the operator.

Remote Copy option parameters which will be applied to this Remote Copy volume pair are as follows:

Initial Copy Pace	It specifies how many tracks should be copied at once by the initial copy. “15 Tracks” or “3 Tracks” can be specified. When “15 Tracks” is selected, elapsed time to complete the initial copy becomes shorter, however, the subsystem I/O performance during the initial copy could become worse. Note: The default value of this parameter is “15”.
DFW to R-VOL	It specifies whether the DFW capability of the R-VOL is required or not. If “DFW required” is specified, the TC-MF volume pair will be suspended when the RCU can not execute the DFW due to, for example, cache failure. If the installation requirements prefers the continuation of TC-MF to the subsystem I/O performance, “DFW not required” is recommended.
CFW Data	It specifies whether the records updated by CFW should be copied to the R-VOL or not. “Only M-VOL”, which means that CFW updates are not copied, is recommended because CFW data is not always necessary for disaster recovery.
M-VOL Fence Level	It specifies by what conditions the M-VOL will be fenced (the MCU will reject the write I/O operations to the M-VOL). - “R-VOL Data”: The M-VOL will be fenced when the MCU can not successfully execute the update copy. - “R-VOL Status”: The M-VOL will be fenced when the MCU can not put the R-VOL into “suspended” state. If status of the R-VOL is successfully changed to “suspended”, the subsequent write I/O operations to the M-VOL will be permitted. - “Never”: The M-VOL will never be fenced. The subsequent write I/O operations after the TC-MF volume pair has been suspended will be permitted.

(7) Delete Pair Operation

A Delete Pair operation makes the specified Remote Copy volume pair being terminated. It can be operated on either the MCU or the RCU.

- When operated on the MCU, both the M-VOL and the R-VOL will be put into the “simplex” state.
- When operated on the RCU, only the R-VOL will be put into the “simplex” state. The M-VOL will be suspended when the MCU detects this operation. To complete deleting this volume pair, the MCU requires another Delete Pair operation.

When the MCU accepts this operation and it can not communicate with the RCU, this operation will be rejected. “Delete Pair by Force” option can make the MCU complete this operation, even if it can not communicate with the RCU.

For the purpose of the recovery operation simply, “Delete All Pairs” option is provided in the delete pair operation. This option is need to use “Delete Pair by Force” option together, and specifies that the all volume pairs in the same RCU (CU Image) should be deleted. In the case of the delete operation at the RCU, specifies that the all volume pairs in the same serial number of the MCU and the same CU image of the MCU should be deleted.

(8) Suspend Pair Operation

A Suspend Pair operation makes the MCU or the RCU suspend the specified Remote Copy volume pair.

The option parameters for this operation are as follows:

SSB (F/M=FB)	The MCU and the RCU will generate sense information to notify the suspension of this volume pair to the attached host processors. This option is valid only for TC-MF volume pairs.
M-VOL Failure	The subsequent write I/O operations to the M-VOL will be rejected regardless of the fence level parameter. This option can be selected only when operating on the MCU. This option is valid for only TC-MF volume pairs.
R-VOL	For TC-MF volume pairs. This option can be accepted by the MCU and the RCU.

(9) Pair Option Operation

A Pair Option operation modifies the Remote Copy option parameters which has been applied to the selected Remote Copy volume pair. Refer to “3.13.5(6) Add Pair Operation” for the option parameters.

(10) Pair Status Operation

A Pair Status operation makes the MCU or the RCU display the result of the Add Pair operation or the Pair Status operation to the specified Remote Copy volume pair, along with the following information:

Pair Synchronized	The value indicates the percent completion of the initial copy operation. This value is always 100% after the initial copy operation is complete. For a volume being queued, "Queuing" is displayed.
Pair Status	It indicates the status of the M-VOL or the R-VOL. Definition of the volume states is described in "3.13.4(3) TrueCopy for Mainframe Volume Pair Status".
Last Update	Indicates the time stamp when the volume pair status has been updated. Note that the time stamp value is obtained from an internal clock in the DKC710I subsystem.
Pair Established	It indicates the time stamp when the volume pair has been established by an Add Pair operation. Note that the time stamp value is obtained from an internal clock in the DKC710I subsystem.

(11) Resume Pair Operation

A Resume Pair operation restarts the suspended Remote Copy volume pair. It also provides function to modify the Remote Copy options which will be applied to the selected Remote Copy volume pair.

"Out-of-Sync Cylinders" are recorded in the form of cylinder-bit-map allocated in SM (shared memory) of the DKC710I. If the MCU is powered off and the cylinder-bit-map is not retained due to the battery being discharged, the MCU resumes the initial copy as follows:

- (a) For the TC-MF volume pair in "pending duplex" state, the initial copy is automatically resumed. Then all cylinders of this volume will be copied.
- (b) For the TC-MF volume pair in "suspended" state, then all cylinders of this volume will be copied responding to the Resume Pair operation.

(12) Port Operation

(a) Fibre channel interface connection

You must set up the connection port of MCU and RCU prior to the path formation in Initiator port or the RCU target port from the usual target port.

Port topology of Initiator port and the RCU target port must be set up as follows.

- Direct connection : Fabric = OFF, FC-AL
- A connection via Switch : Fabric = ON, FC-AL or Point to point
- A connection via CN2000 : Fabric = OFF, Point to point

In case of a direct connection between MCU and RCU, each Fibre channel port topology must be the same as “Fabric:Off and FC-AL”.

In case of via FC-Switch connection between MCU and RCU, each Fibre channel port topology must be set suitable for the closest FC-Switch’s topology.

(Eg.) “Fabric:On and FC-AL” or “Fabric:On and Point-to-Point” or “Fabric:Off and Point-to-Point”

(13) Remote Copy function Switch Operation

The Specification of a present function switches is displayed.

Moreover, the function switches which want to be specified/released can be set.

Number of function switches is 64.

This function is only SVP operation.

The function allocated in each switch is as follows.

00 ~ 06: Reserved.

07: Do not report SSB of F/M = FB to HOST.

08 ~10: Reserved.

11: When “15 Tracks” is selected in the Fibre Remote Copy option parameter and “Track” is selected in the Difference Management, a maximum of 32 tracks are copied by the initial copy. But a copy pace is set “4 Tracks” for OPEN-V.

12: When Add Pair or Resume Pair is operated from Mainframe Host/Raid Manager for TC-MF, Only M-VOL is set up in the CFW Data option.

Note: When ‘Only M-VOL’ to CFW Data Option at the time of the TC-MF pairs created, cannot be used the data set that updated in CFW in M-VOL for R-VOL.

When use this data set in R-VOL, please format data set after deleted TC-MF pairs.

13: Unused.

14: Reserved.

15: It is effective when function switch switch #17 is on. And the path failure threshold values are changed by combination of function switch switch #15 and switch #20. (Refer to 17: <The path failure threshold values>)

16: Reserved.

17: The path is blocked when the number of path failures (LIP, RSCN, Time Over) reaches the threshold within a certain period. And performance decrease of remote copy caused by using the trouble path is prevented. The path failure threshold values are changed by combination of function switch #15 and switch #20.

<The path failure threshold values>

Function Switch			The path failure threshold values		
Switch #17	Switch #15	Switch #20	LIP	RSCN	TOV
ON	OFF	OFF	15times	15times	5times
	OFF	ON	10times	10times	4times
	ON	OFF	7times	7times	3times
	ON	ON	3times	3times	2times

18: In the case where the switch switch #17 is turned on, the count of link failures that occur in the fibre path is also a factor that results in a detachment caused by an excess of a threshold value.

19: Unused.

20: It is effective when function switch switch #17 is on. And the path failure threshold values are changed by combination of function switch switch #15 and switch #20.

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- 21: When Add Pair or Resume Pair is operated with the Host command to DKC emulation type '2105' or '2107', PACE = 3 Tracks is set up in the Initial Copy Pace option.
- 22 ~ 29: Unused.
- 30: The following functions are supported.
- When the pair from Storage Navigator is formed, the pair is formed with SyncCTG#7F.
 - When all the connections from MCU-RCU PATH cut, S-VOL that belongs to SyncCTG#7F is suspended.
- 31 ~ 32: Unused.
- 33: In the cases that a PDCM function of McData ES3232 is being used on MCU-RCU path, when response of LOGIN response is late, path status of MCU is changed to non-normal.
- 34 ~ 35: Unused.
- 36: This bit specifies "Enable" in time stamp option at Add Pair/Resume Pair from GDPS/Raid Manager for TC-MF.
TC-MF/UR-MF cascade form makes time stamp option of TC-MF "Enable", and keeps Consistency of UR-MF.
But, the TC-MF pair formation or Resume Pair with GDPS/Raid Manager uses an optional time stamp and because "Enable" cannot be directed, this bit is used.
- 37 ~ 40: Unused.
- 41 ~ 42: The path is blocked when the number of RIO response time that exceeds the decided time reaches the threshold within a certain period. The decided time is changed by combination of function switch #41 and switch #42

<The threshold value of RIO response time delay>

Function Switch		RIO response time that is counted	The threshold value that path is blocked
Switch #41	Switch #42		
OFF	ON	10seconds or more	100times/10minutes
ON	OFF	5seconds or more	
ON	ON	2.5seconds or more	

- 43: In the function of switch #17 or switch #41 and switch #42, the path is blocked even if the number of path is less than that is set by minimum path. Remote copy pair is suspended when the number of path is less than that is set by minimum path. So switch #43 is set up when it gives priority to response time for host over maintenance of pair state of remote copy.

<Blockade of path less than minimum path>

Switch #43	Blockade of path
OFF	Not blocked
ON	blocked

- 44 ~ 63: Unused.

(14) Connection composition

Connection composition examples are shown below:

In case of a direct connection between MCU and RCU, each Fibre channel port topology must be the same as “Fabric:Off and FC-AL”.

In case of via FC-Switch connection between MCU and RCU, each Fibre channel port topology must be set suitable for the closest FC-Switch’s topology.

(Eg.) “Fabric:On and FC-AL” or “Fabric:On and Point-to-Point” or “Fabric:Off and Point-to-Point”

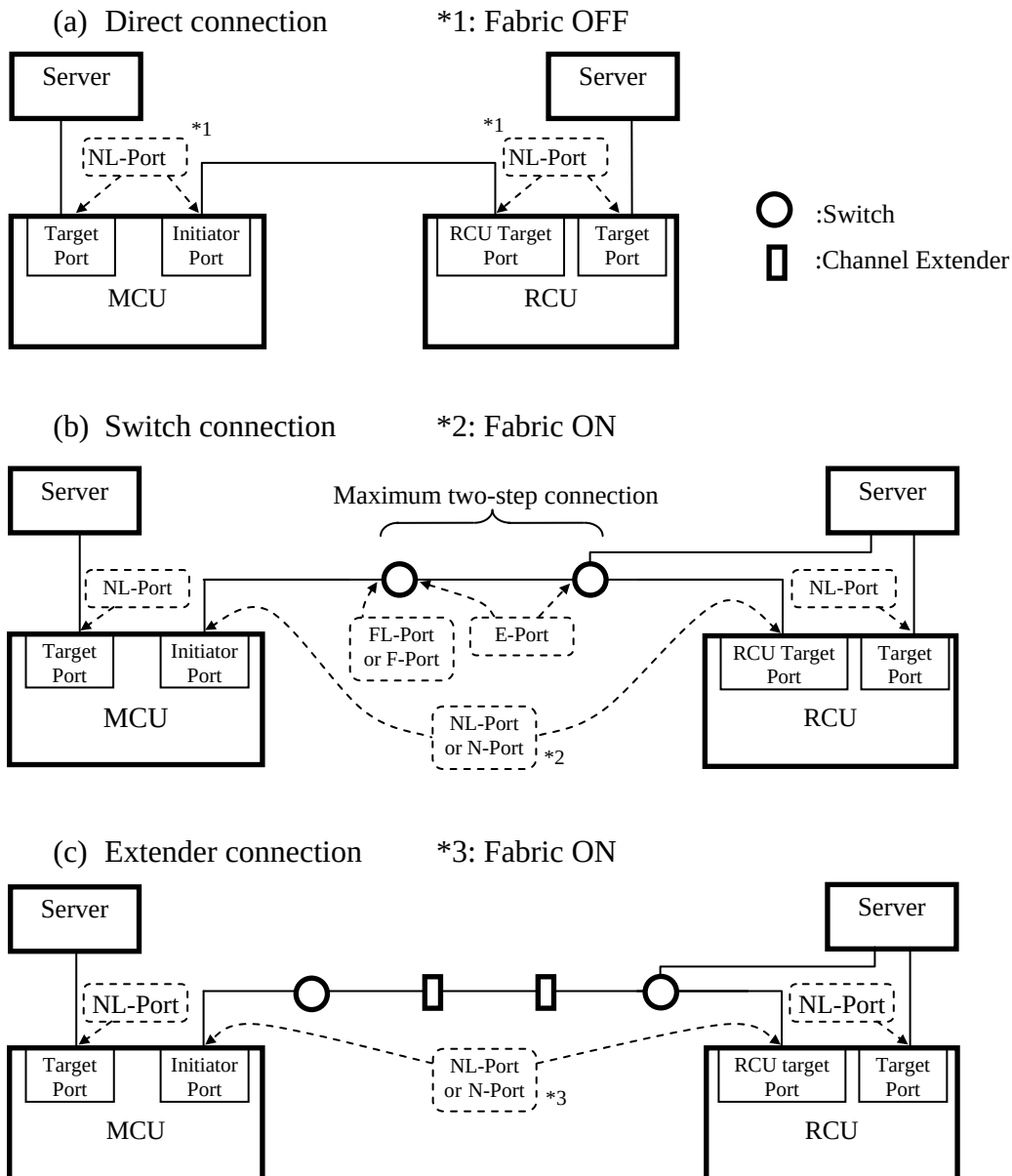


Fig. 3.13.5-2 Connection composition examples

3.13.6 Managing TrueCopy for Mainframe Environment

(1) Setting Up TrueCopy for Mainframe Volume Pairs

(a) Sequence of Operations

Sequence of operations to establish the TrueCopy for Mainframe volume pairs are shown below.

Table 3.13.6-1 Operations to Set Up TrueCopy for Mainframe Volume Pairs

Step		Operation	
		SVP *	Others
1	Set appropriate Fibre interface ports to the Initiator mode.	Port	
2	Establish logical paths between the DKC710I TC-MF subsystems	Add RCU	Before this step, remote copy connections must be established between DKC710I subsystems.
3	Ensure that the R-VOLs are offline from host processors		If necessary, perform the following system command. <In case of MVS system> • VARY OFFLINE <In case of VM system> • VARY OFFLINE from guest OS • VARY PATH OFFLINE from VM
4	Establish TC-MF volume pairs.	Add Pair	

* : Operations form the SVP/Web Console attached to the MCU.

Several volume pairs can be specified within one Add Pair Operation. After completing an Add Pair operation, another Add Pair operation can be executed to establish another TrueCopy for Mainframe volume pairs.

Be sure to vary the R-VOLs offline from the attached host processors before executing the Add Pair operation. The RCU will reject the write I/O operations to the R-VOLs once the Add RCU operation has been accepted.

(b) Considering TrueCopy for Mainframe Parameters

Setting of the “fence level” parameter to the Add Pair operation and the “PPRC supported by host” and “Service SIM of Remote Copy” option to the Add RCU operation depends on your disaster recovery planning. Refer to “3.13.7(1) Preparing for Disaster Recovery” for these parameters.

Setting of the “CFW data” and “DFW to R-VOL” parameters to the Add Pair operation and the “minimum paths” parameter to the Add RCU operation depends on your performance requirement to the DKC710I subsystem at the primary site. Refer to “3.13.5(6) Add Pair operation” and “3.13.5(1) Add RCU operation” for these parameters.

Setting of the “maximum initial copy activities” parameter to the Add RCU operation and the “priority” and the “initial copy pace” parameters can control performance effect from the initial copy activities. Refer to “3.13.6(1)(c) Controlling Initial Copy Activities” for more detailed description.

Refer to “3.13.5(1) Add RCU operation” and “3.13.5(6) Add Pair operation” for other parameters.

(c) Controlling Initial Copy Activities

To control performance effect from the initial copy activities, the “maximum initial copy activities” parameter and the “priority” and the “copy pace” parameters can be specified:

- The “maximum initial copy activities” parameter controls the number of volumes for which the initial copy are concurrently executed;
- The “priority” parameter specifies the executing order of the initial copy on volume pair basis;
- The “copy pace” parameter specifies how many tracks should be copied by each initial copy activity.

Refer to the following example for the “maximum initial copy activities” and the “priority” parameters.

Example

Conditions:

- The Add Pair operation specifies that devices 00~05 should be M-VOLs.
- “Maximum initial copy activities” is set to “4” (this is the default value).
- “Priority” parameters for devices 00~05 are set to “3”, “5”, “5”, “1”, “4”, and “2” respectively.

Under the above conditions, the MCU will perform the initial copy:

- for devices 00, 03, 04 and 05 immediately.
- for device 01 when one of the initial copy has been terminated.
- for device 02 when the initial copy for the second device has been terminated.

(2) Suspending and Resuming the TrueCopy for Mainframe Volume Pairs

This section describes the operations to suspend or resume the TC-MF volume pair, which are necessary for the following sections in this chapter.

The Suspend Pair operation with the “R-VOL” option parameters can suspend the specified TC-MF volume pairs while the M-VOLs are still accessed from the attached host processors. The “SSB” option should not be selected to prevent the sense information from being generated.

To resume the suspended TC-MF volumes pairs, the Resume Pair operation must be executed.

Refer to “3.13.5(8) Suspend Pair Operation” and “3.13.5(6) Add Pair Operation” for more detailed description.

(3) Managing Power On/Off of TrueCopy for Mainframe Components

(a) Cutting Power to TrueCopy for Mainframe component

Cutting power to the RCU or the Switch/Extender on the remote copy connections, or other equivalent events which make the MCU unable to communicate with the RCU should be controlled in order not to affect the remote copy activities. If the MCU detects these events when it intends to communicate with the RCU, it would suspend all TC-MF volume pairs.

To avoid this problem, the applications on the primary host processors must be terminated or all TC-MF volume pairs must be suspended or terminated, before performing these events.

Refer to “3.13.6(2) Suspending and Resuming the TC-MF Volume Pairs” for the operations to suspend and resume the TC-MF volume pairs.

(b) Power Control Interface at the Secondary Site

In the secondary site, It is not recommended to use the power control interface which remotely cuts the power to the RCU or the Switch/Extender on the remote copy connections in order to avoid the situation described in “3.13.6(3)(a) Cutting Power to TrueCopy for Mainframe components”.

(c) Power-on-sequence

The RCU and the Switch/Extender on the remote copy connections must become operable before the MCU accepts to first write I/O operation to the M-VOLs.

After the power-on-reset sequence of the MCU, It communicates with the RCU in order to confirm the status of the R-VOLs. If it is not possible, the MCU retries the confirmation until it is successfully completed or the MCU accepts the first write I/O operations to the M-VOLs.

If the MCU accepts the first write I/O operation before completing the confirmation, the MCU will suspend the TC-MF volume pair. This situation is critical because the status of the R-VOL can not be changed, that is, remains “duplex” state.

(4) Executing ICKDSF to TrueCopy for Mainframe Volume Pairs

The updates by the channel programs which specify “diagnostic authorization” or “device support authorization” are not reflected to the R-VOL. ICKDSF commands which issue the write I/O operations to the M-VOL must be controlled. The TC-MF volume pairs must be suspended or terminated before performing ICKDSF commands.

Refer to “3.13.6(2) Suspending and Resuming the TrueCopy for Mainframe Volume Pairs” for the operations to suspend and resume the TC-MF volume pairs.

3.13.7 TrueCopy for Mainframe Error Recovery

(1) Preparing for Disaster Recovery

(a) Considering Fence Level Parameter

Table 3.13.7-1 shows how the fence level parameter of the Add Pair operation has an effect on the write I/O operations to the M-VOL after the TC-MF volume pair has been suspended. You should select one of the fence level considering the “degree of the currency” of the R-VOL required by your disaster recovery planning. The SVP or Web Console, which is connected to either the MCU or the RCU, can display the fence level parameter which has been set to the TC-MF volume pairs.

Table 3.13.7-1 Effect of the Fence Level Parameter

Failure		Subsequent write I/O operations to the M-VOL will be ...		
		“Data”	“Status”	“Never”
1)	The update copy has failed,	Rejected *	—	—
2)	(1) & however the status of the R-VOL could have been successfully changed to “suspended” state.	Rejected *	accepted	accepted
3)	(1) & furthermore the status of the R-VOL could not have been changed to “suspended” state.	Rejected *	Rejected *	accepted

*: Sense bytes includes “command reject” and x’0F’ of format/message.

Note: “Data” and “Status” has an effect when an TC-MF volume pair of “duplex” state is suspended. For TC-MF volume pairs which are in “pending duplex” state, subsequent write I/O operations will not be rejected regardless of Fence Level parameter.

1) Fence Level = “Data”

The data of the R-VOL is always identical to the M-VOL if once the TC-MF volume pair has been successfully synchronized. You can reduce the time to analyze whether the R-VOL is current or not in your disaster recovery procedures.

However, this parameter will make the M-VOL not accessible from your applications whenever the TC-MF copy activity has failed. Therefore you should specify this parameter to the most critical volumes for your disaster recovery planning.

Most of the database system supports duplexing the critical files, for example log files of DB2, for its file recovering capability. It is recommended to locate the duplexed files on the volumes in the physically separated DKC710I subsystems, and establish TC-MF volume pairs for each volumes by using physically separated remote copy connections.

Note 1: If the failure has occurred before completing the initial copy, the R-VOL can not be used for disaster recovery because the data of the R-VOL is not fully consistent yet. You can become aware of this situation with referring status of the R-VOL in your disaster recovery procedures. Refer to “3.13.7(2)(b) Analyzing the Currency of R-VOLs” for more detailed description.

Note 2: Only the difference between the TC-MF volume pair must be the last update from the host processor. TC-MF is a synchronous remote copy. The MCU reports a “unit check” if it detects the failure on the write I/O operation including the update copy to the R-VOL. Therefore, the operating system and the application program does not regard the last (failed) I/O operation as successfully completed.

This parameter is functionally equivalent to “CRIT=YES” parameter for IBM PPRC.

2) Fence Level = Never

The subsequent write I/O operations to the M-VOL will be accepted even if the TC-MF volume pair has been suspended. Therefore the contents of the R-VOL can become “older” (behind the currency of corresponding M-VOL) if the application program continue updating the M-VOL. Furthermore, the status of the R-VOL which will be obtained from the RCU can not be in a “suspended” state.

To use this parameter, your disaster recovery planning must satisfy the following requirements:

- The currency of the R-VOL should be decided by referring the error message which might have been transferred through the error reporting communications or analyzing the R-VOL itself with other files which are confirmed to be current.
- The data of the R-VOL should be recovered by using other files which are ensured to be current.

This parameter is functionally equivalent to “CRIT=NO” parameter for IBM PPRC.

3) Fence Level = Status

The level of this parameter is between “Data” and “Never”. Only when the status of the R-VOL can be ensured, the subsequent write I/O operations to the M-VOL will be permitted. Therefore the disaster recovery procedure of deciding the currency of the R-VOL can be reduced.

(b) Transferring the Sense Information through Error Reporting Communications

When the TC-MF volume pair is suspended, the MCU generates the sense information which notifies the host processor of the failure. This will help in deciding the currency of the R-VOLs in the disaster recovery procedures by transferring the sense information, or the system console message caused by the sense information, with the system time stamp information.

The sense information can be selected out of:

- x'FB' of format/message. The sense information is compatible with IBM PPRC and result on a corresponding system console message, for example IEA491E of MVS, if the operating system supports it.
- service information message whose reference code means that the TC-MF volume pair has been suspended.

Note: The first version of TC-MF is not completely certified under the operating system which does not support IBM PPRC. Therefore the x 'FB' sense information must be selected.

The error reporting communications are essential if you use the fence level of "Status" or "Never".

(c) File Recovery Procedures Depending on Installations

TC-MF is a synchronous remote copy. All updates to the M-VOLs are copied to their R-VOLs before completing each channel program of the write I/O operations. When the TC-MF volume pairs have been suspended or the MCU has become inoperable due to a disaster, therefore, many data "in progress" could remain in the R-VOLs. That is, some data set might be still opened, or some transactions might not be committed yet. All breakdown cases should be previously considered.

Therefore, even if you have selected the fence level of "Data" for all TC-MF volume pairs, you should establish the file or volume recovery procedures. The situation which should be assumed is similar to that where the volumes have become not accessible due to the disk controller failure in non-remote copied environment.

If you use the fence level of “Status” or “Never”, the suspended R-VOLs could become “ancient” compared to other volumes. This situation might cause a data inconsistency problem among several volumes.

You should prepare, in your disaster recovery, for recovering some files or some volumes which have become “ancient” by using:

- files for file recovery, for example DB2 log files, which have been confirmed to be current. To ensure the currency of these files, it is recommended to use the fence level of “Data” for these critical volumes.
- the sense information with the system time stamp which have been transferred through the error reporting communications.
- full consistent file or volume backups, if the sense information and the system time stamp can not be used.

(d) CSUSPEND/QUIESCE for IBM PPRC

PPRC recommends to customers to establish their disaster recovery planning where the CSUSPEND/QUIESCE TSO command is programmed to be issued responding to the IEA491E system console messages. This procedure intentionally suspend the remaining volume pairs when some volume pairs have been suspended due to a disaster.

The CSUSPEND/QUIESCE TSO command will be supported as the enhancement to TC-MF.

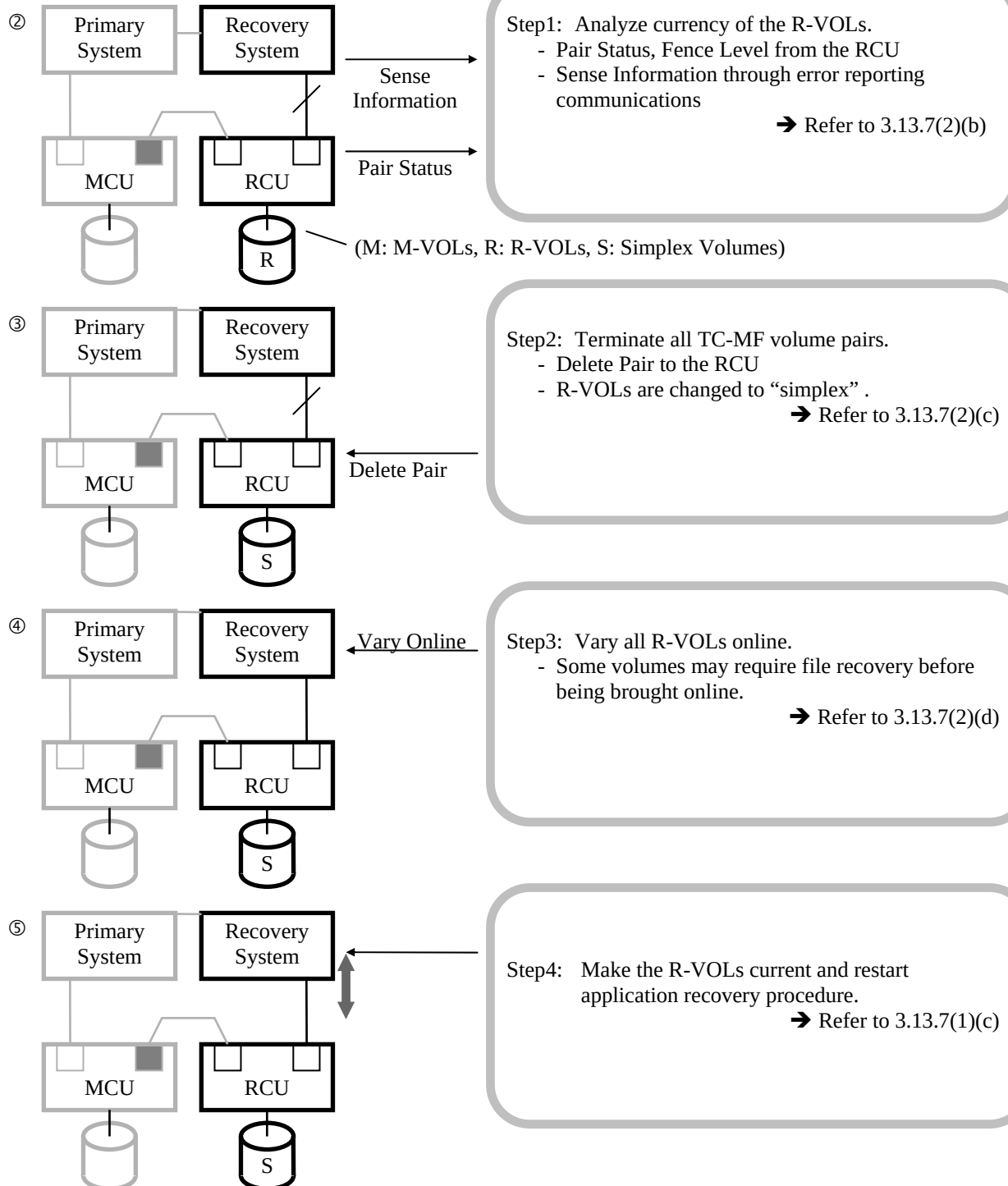
(e) All SIM of the TrueCopy for Mainframe clear option

For the purpose of the restrain to report the TC-MF SIM which should be generated at the disaster and the recovery operations during the OS IPL, “Clear SIM” button is provided on TC-MF Main Control Screen at the SVP and the RMC. This function is able to use for the disaster recovery operation, and specifies that the all Remote Copy SIM in the subsystem should be deleted.

(2) Disaster Recovery Procedures - Switching to the Recovery System

(a) Summary

① Primary system and MCU becomes inoperable due to disaster.



(b) Analyzing the Currency of R-VOLs (Step 1)

1) Analyzing Status of the R-VOLs and Fence Level Parameter

Table 3.13.7-2 Currency of the R-VOLs

Status of R-VOL	Fence Level for this TC-MF volume pair		
	Data	Status	Never
Simplex	To be confirmed	To be confirmed	To be confirmed
Pending Duplex	Inconsistent	Inconsistent	Inconsistent
Duplex	Current	Current	To be analyzed
Suspended (Initial Copy Failed)	Inconsistent	Inconsistent	Inconsistent
Suspended (by other reason)	Current	Suspected	Suspected

Table 3.13.7-2 shows how to analyze the currency of the R-VOLs referring the status of the R-VOLs and the fence level parameter which have been specified when establishing the TC-MF volume pairs.

The status of the R-VOLs must be obtained from the RCU in your disaster recovery procedures.

The fence level parameter must be previously field since it cannot be obtained From RCU.

The meaning of the results or further actions shown in each column of Table 3.13.7-2 are as follows:

To be confirmed This volume does not belong to any TC-MF volume pair. If you have certainly established the TC-MF volume pair for this volume and you have never deleted it, you should regard this volume as inconsistent.

Inconsistent The data on this volume is inconsistent because not all cylinders have successfully been copied to this volume yet. You can not use this volume for the applications unless this volume is initialized (or successfully copied from the M-VOL at later time).

Current The data on this volume is completely synchronized with the corresponding M-VOL.

To be analyzed The currency on this volume can not determined. To determine the currency, further analysis described in (2) of this section should be performed.

Suspected

The data on this volume must be “older”, behind the currency of corresponding M-VOL. You should restore the consistency of this volume at least, and the currency of this volume if required. The system time information which might have been transferred through the error reporting communications or time of suspension obtained from the Pair Status operation will help you decide the last time when this volume was current.

2) Further Analysis by Referring to Other Information

The M-VOLs, to which the fence level parameter has been set to “Never”, will accept the subsequent write I/O operations regardless of the result of communication to change the R-VOL into the “suspended” state. Therefore, the status of the R-VOL should be analyzed by referring to the following information:

- The sense information through the error reporting communications. If the sense information which denote the suspension of this volume is found, you can return to Table 3.13.7-2 with assumption of the “suspended” state.
- The status of the M-VOL obtained from the MCU, if possible. You should return to Table 3.13.7-2 with assumption of the same status as the M-VOL and fence level of “Status”.
- The other related files, for example DB2 log files, which have been confirmed to be current.

(c) Terminating TrueCopy for Mainframe Volume Pairs (Step 2)

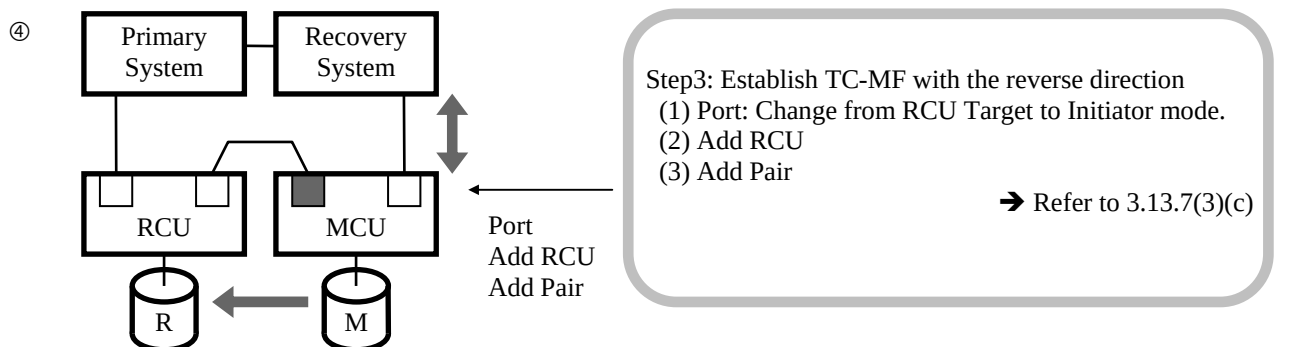
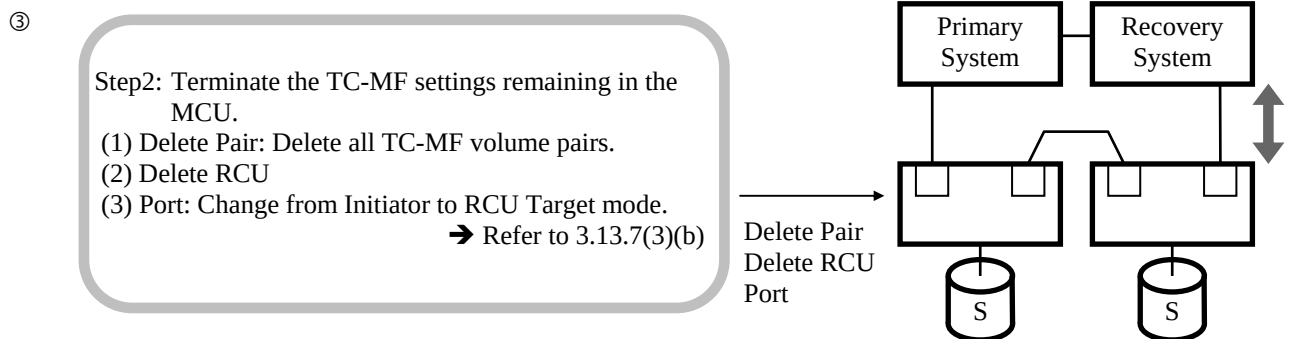
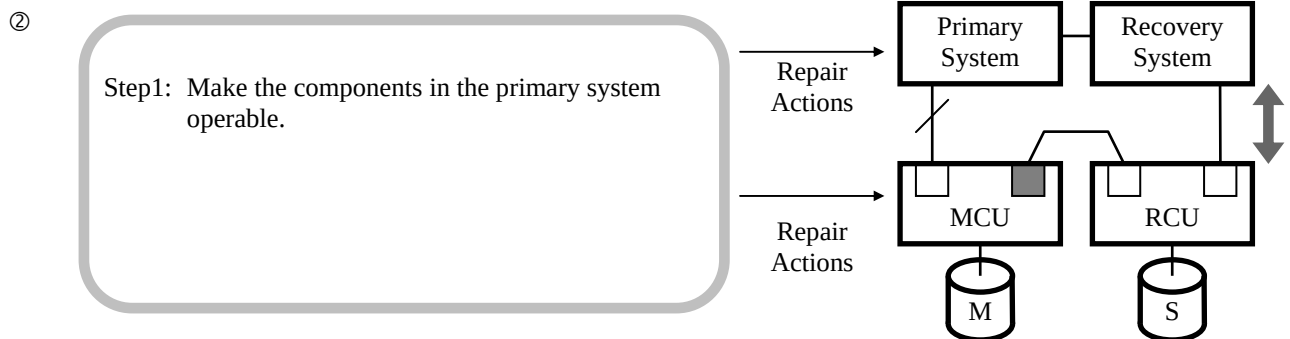
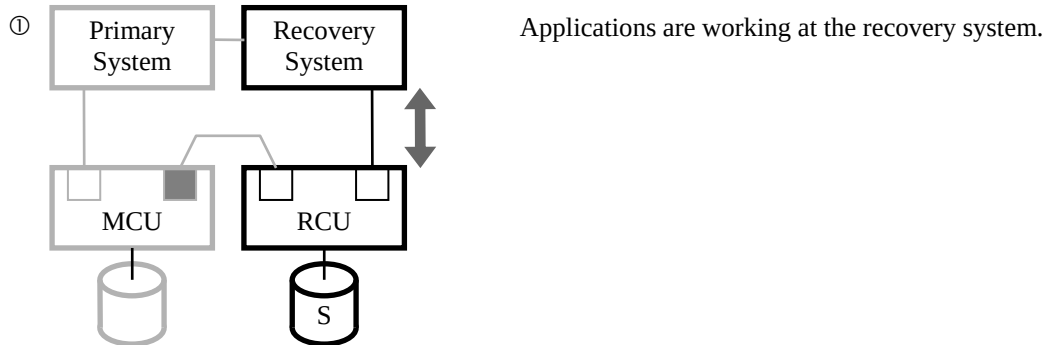
The “Delete Pair” operation to the RCU terminates the specified TC-MF volume pairs. These R-VOLs will be changed to “simplex” state. Specified “Delete Pair by Force” option and “Delete All Pairs” option the all volume pairs in the same serial number of the MCU and the same CU image of the MCU should be deleted. Refer to “3.13.5(7) Delete Pair Operation”.

(d) Vary all R-VOLs online (Step 3)

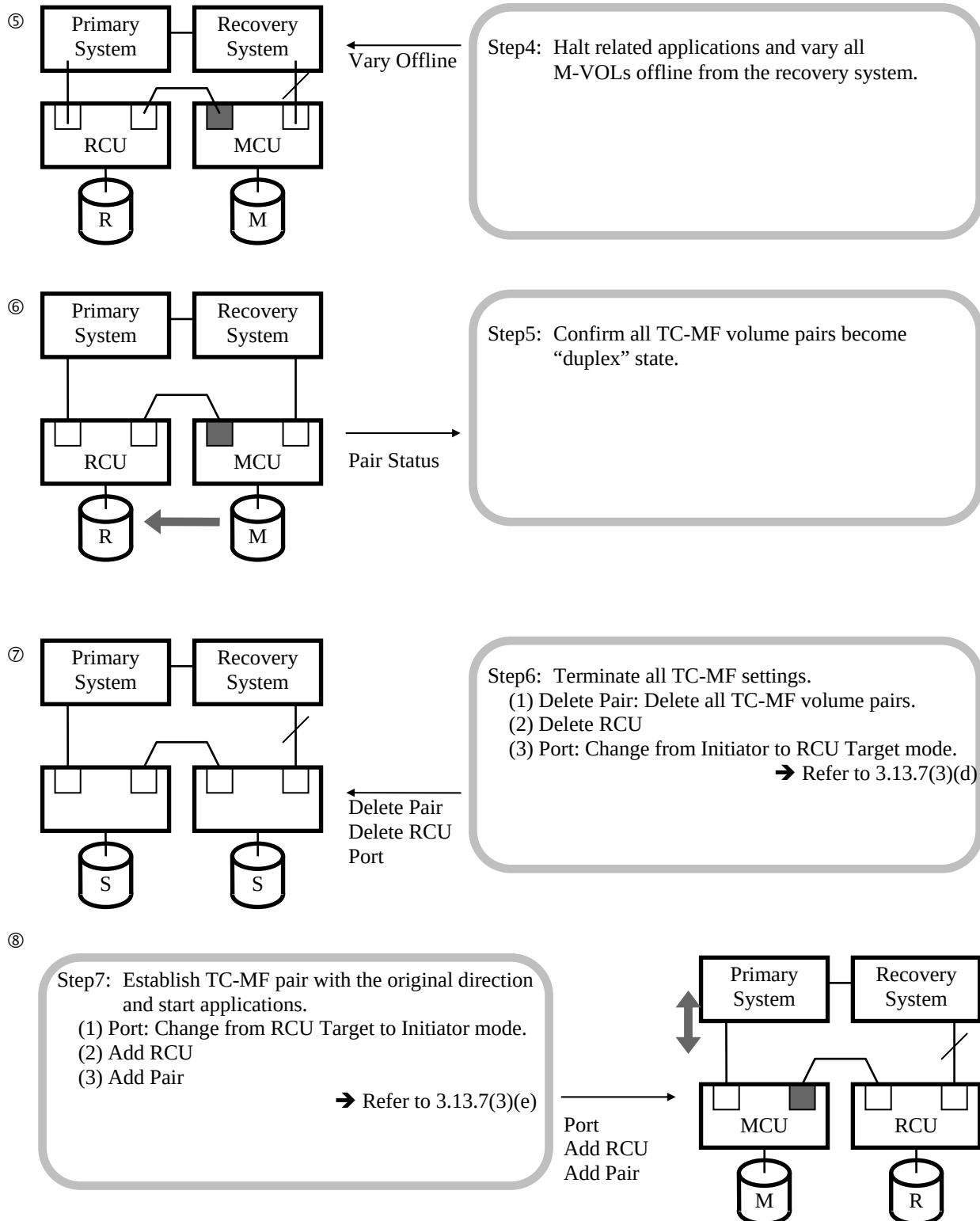
In the case of the OS IPL, execute the “Clear SIM” operation at the SVP or the RMC before OS IPL.

(3) Disaster Recovery Procedures - Returning to the Primary Site

(a) Summary



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(b) Terminating the TrueCopy for Mainframe Settings Remaining in the MCU (Step2)

After the DKC710I subsystem becomes operable, the remaining registration of the TC-MF volume pairs and the RCU should be deleted by performing the Delete Pair operation and Delete RCU operation respectively.

Specified “Delete Pair by Force” option and “Delete All Pairs” option the all volume pairs in the same RCU should be deleted.

Note that the status of M-VOLs may be “Suspended (Delete Pair to RCU)” because of Delete Pair operation issued to the RCU in step 2 of “3.13.7(2) Disaster Recovery Procedures - Switching to the Recovery System”. It is normal condition in this situation.

Before performing the Delete RCU operation, all TC-MF volume pairs must be deleted.

If you want to use same remote copy connections for step 3, the fibre interface ports which have been set to the Initiator mode should be changed to the RCU Target mode by the Port operation.

(c) Establish TrueCopy for Mainframe with the Reverse Direction (Step3)

The TC-MF volume pair should be established with the reverse direction to synchronize the original M-VOLs with the original R-VOLs. The procedures for this step are same as those described in “3.13.6(1) Setting Up TC-MF Volume Pairs”. Note that the DKC710I subsystems in the original primary site and the recovery site are treated as the RCUs/R-VOLs and the MCUs/M-VOLs respectively.

Do not select “none” parameter to the Add Pair operations. The volumes in the original primary site are now behind the volumes in the recovery site. Furthermore the updates to the volumes in the recovery site have not been accumulated in cylinder bit map.

- (d) Terminate Applications and TrueCopy for Mainframe Settings at the Recovery Site (Step 4~6)

TC-MF settings with the reverse direction must be deleted after halting the applications in the recovery site (step 4) and confirming that all TC-MF volume pairs are in “duplex” state (step 5).

Specified “Delete Pair by Force” option and “Delete All Pairs” option the all volume pairs in the same RCU should be deleted.

If you want to use same remote copy connections for step 7, the fibre interface ports which have been set to the Initiator mode should be changed to the RCU Target mode by the Port operation.

- (e) Establish TrueCopy for Mainframe Pair with the Original Direction and Start Applications (Step 7)

The TC-MF volume pair should be established with the original direction to synchronize the original M-VOLs with the original R-VOLs. The procedures for this step are same as those described in “3.13.6(1) Setting Up TC-MF Volume Pairs”.

Do not select “none” parameter to the Add Pair operations. The volumes in the original primary site are now behind the volumes in the recovery site. Furthermore the updates to the volumes in the recovery site have not been accumulated in cylinder bit map.

3.14 ShadowImage for Mainframe & ShadowImage

Note: In this section, the following abbreviations may be used to indicate Program Product names.

- SI: Abbreviation for “ShadowImage”
- SIMF (SI-MF): Abbreviation for “ShadowImage for Mainframe”

3.14.1 Overview

(1) Main object

- 1) Reduce Backup time.
- 2) Easy testing before system upgrade with the data whose applications are actually used on the system.

(2) Function Outline

- 1) Making duplicated volumes.
- 2) There is no conflict on volume because the duplicated volumes are on another physical storage subsystem.
- 3) Three destination volumes can be with one master volume.
Those three pairs can be split independently.
- 4) ShadowImage for Mainframe can be controlled by PPRC Command interface.
- 5) ShadowImage can be controlled from RAID Manager.

THEORY03-14-20**Table 3.14.1-1 Outline of ShadowImage for Mainframe & ShadowImage**

No.	Items	Specification
1	Coupling object	One logical volume (LDEV)
2	Support emulation type of LDEV	SI-MF: 3390-3/3A/3B/3C/3R/9/9A/9B/9C/L/LA/LB/LC/M/MA/MB/MC/A, 3380-3/3A/3B/3C, Emulation types and CVSs of them SI: OPEN-3/8/9/E/L/V, emulation types and CVSs (except OPEN-L emulation type) and LUSE of them (*1)
3	Requirement for create a pair	(1) Pair LDEVs have to be a same track format and same capacity. (2) Pair LDEVs have to exist in a same subsystem. (3) It is not possible to share a destination volume at same time.
4	Support of Customized Volume Size (CVS)	SI-MF : Supported SI : Supported
5	Combination of RAID level between master volume and destination volume	RAID1(2D+2D)←→RAID1(2D+2D) RAID5(3D+1P or 7D+1P)←→RAID5(3D+1P or 7D+1P) RAID5(3D+1P or 7D+1P)←→RAID1(2D+2D) RAID6(6D+2P)←→RAID6(6D+2P) RAID6(6D+2P)←→RAID1(2D+2D) RAID6(6D+2P)←→RAID5(3D+1P or 7D+1P)
6	Data protection	There is a parity protection for both master volume and destination volume.
7	RESYNC pattern	SI-MF/SI supports 2 types of RESYNC pattern. From Master Volume data to Destination volume and from Destination Volume to Master Volume
8	Time for transition from Duplex to Split.	3 min./VOL (3390-3) without I/O (Depend on the number of pairs and the load of DKC)
9	When the destination volume can be accessed from HOST.	The destination volume can be accessed at only Split status.
10	Cooperation with TrueCopy for Mainframe/XRC	SI-MF : Supported The master volume of SI-MF can be an M-VOL or R-VOL of TC-MF. A secondary volume can be an M-VOL of TC-MF. • TC-MF volumes are shared with Universal Replicator for Mainframe volumes can be SI-MF pair volumes.

(To be continued)

*1: "0" is added to the emulation type of the V-VOLs (e.g. OPEN-0V).

When you create a Copy-on-Write Snapshot/Thin Image pair, specify the volume whose emulation type is displayed with "0" like OPEN-0V as the S-VOL.

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(Continued from the preceding page)

No.	Items	Specification
11	Cooperation with TrueCopy	SI : Supported The master volume of SI can be an M-VOL or R-VOL of TC. • TC volumes are shared with Universal Replicator volumes can't be SI pair volumes.
	Cooperation with TrueCopy (only for ShadowImage)	Supported • The M-VOL or R-VOL of TC can be a primary volume of SI. • The secondary volume of SI-MF can be an M-VOL of TC. • TC volumes are shared with Universal Replicator volumes can be SI pair volumes.
	Cooperation with HMBR (only for ShadowImage)	Supported • A primary volume of SI can be accessed from HOST like a usual volume. • A secondary volume of SI can not be accessed from HOST if the pair is not in SPLIT status. In the SPLIT status, a secondary volume of SI can access from HOST like a usual volume.
12	Cooperation with Volume Migration	Supported • The source, destination or RESERVE volume of Volume Migration can not be the primary, secondary or RESERVE volume of SI-MF/SI. • The primary, secondary or RESERVE volume of SI-MF/SI can be the source volume of Volume Migration. But if SI-MF/SI P-VOL or RootVOL already has 3 pairs, it can not be the source volume of Volume Migration. • When SI-MF/SI pair which is combined with Volume Migration is split, the migration of Volume Migration is canceled.
13	Cooperation with Universal Replicator (only for ShadowImage)	Supported • Universal Replicator volumes (primary / secondary) can be a primary volume of SI. • The secondary volume of SI can be Universal Replicator volumes (primary / secondary). • The journal volume of Universal Replicator can't be a primary or secondary volume of SI. • Universal Replicator volumes are shared with TC volumes can be SI pair volumes.

(To be continued)

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(Continued from the preceding page)

No.	Items	Specification
14	Cooperation with Universal Replicator for Mainframe (only for ShadowImage for Mainframe)	Supported • Universal Replicator for Mainframe volumes (primary / secondary) can be a primary volume of SI-MF. • The secondary volume of SI-MF can be Universal Replicator for Mainframe volumes (primary / secondary). • The journal volume of Universal Replicator for Mainframe can't be a primary or secondary volume of SI. • Universal Replicator for Mainframe volumes are shared with TC-MF volumes can be SI-MF pair volumes.
15	FlashCopy (R) V2 Option function	The FlashCopy (R) V2 Option function provides the same function as IBM FlashCopy. You can operate the FlashCopy (R) V2 Option function by using the PPRC TSO and DFSMSdss. The FlashCopy (R) V2 Option function forms a pair by virtually or physically copying S-VOL data to the T-VOL. (A pair formed by means of the FlashCopy (R) V2 Option function is especially called relationship.) Concerning FlashCopy (R) V2, locations of extents different from each other can be specified. FlashCopy (R) V2 forms one relationship for each unit of specified extent. When the relationship is established, a host can execute a reading/writing from/to T-VOL data that is a virtual or physical copy of S-VOL data. When establishing the relationship, the user can specify an extent for copying (to be referred to as extent). The relationship is canceled at the time when a copying of data in the extent is completed.
16	The Copy-on-Write Snapshot/Thin Image Optional function	The Copy-on-Write Snapshot/Thin Image Optional function uses the Virtual Volume (V-VOL) that has no actual volume capacity as the Secondary Volume (S-VOL). When the host access to a V-VOL, the access goes to either the Pool Volume (pool-VOL) or the Primary Volume (P-VOL) depending on whether the area on the P-VOL has been updated or not. The Pool Volume stores the before-image of data on P-VOL, which is copied to the Pool Volume before the host updates P-VOL. Each address on V-VOL is mapped to P-VOL or pool-VOL, and the mapping information (The Virtual Volume Mapping Information) is stored in the Shared Memory. The Copy-on-Write Snapshot/Thin Image Optional function supports OPEN-V only.

(To be continued)

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No.	Items	Specification
17	At-Time split Function performed from RAID manager (ShadowImage/ShadowImage for Mainframe)	This function applies to SI/SI-MF pairs that belong to a consistency group, and enables you to create Source volumes of all Target volumes in the same consistency group, at the time when the pairsplit command is executed using the Command Control Interface (CCI) software from the UNIX[®]/PC server host to the 9900V subsystem. Note: For further information on Command Control Interface, please refer to “Hitachi Command Control Interface User and Reference Guide”. An SI/SI-MF consistency group is a user-defined set of SI/SI-MF volume pairs used for the At-Time Split function. Users can defined a consistency group by using CCI on the UNIX[®]/PC server host. SI/SI-MF consistency groups also correspond to the groups registered in the CCI configuration definition file. SI/SI-MF consistency groups have the following restrictions: • You can configure up to 128 SI/SI-MF consistency groups in a subsystem. • A number (0 ~ 7F) is assigned to each consistency group. You can specify a consistency group number when you create SI pairs. If you do not specify a number, then the 9900V subsystem assigns a number automatically. • You can define up to 8,192 SI pairs in a consistency group. However, for LUSE volumes that contain n LDEVs, you should count as n pairs. Note: For further information on LUSE volumes, please refer to “Provisioning Guide for Open Systems”. • SI pair and SI-MF pair cannot share with same consistency group. • To configure SI/SI-MF consistency groups, you can only use the CCI software. However, to confirm the SI/SI-MF consistency group numbers, you can also use the Storage Navigator.

(To be continued)

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No.	Items	Specification									
18	At-Time Split Function performed from Business Continuity Manager or PPRC (ShadowImage for Mainframe)	To use this function, Business Continuity Manager or PPRC is required. This function performs one of the copy operations shown in the following table using Business Continuity Manager or PPRC for multiple SI-MF pairs that belong to the same consistency group. This function applies to SI-MF pairs that belong to a consistency group, and enables you to create Source Table: At-Time Split function performed from Business Continuity Manager or PPRC <table> <tr> <th>Copy</th><th>Business Continuity Manager</th><th>PPRC</th></tr> <tr> <td>Create the primary volume data at specified time in the secondary volume</td><td>Possible</td><td>Impossible</td></tr> <tr> <td>Create the primary volume data at the time when a Split operation is performed in the secondary volume</td><td>Possible</td><td>Possible</td></tr> </table> Possible : Operation can be performed Impossible : Operation cannot be performed - You can configure up to 128 consistency groups in a subsystem with SI-MF consistency groups. - A number (0~7F) is assigned to each consistency group - You can specify a consistency group number when pair is created. - To configure SI-MF consistency group numbers, you can also use PPRC or Business Continuity Manager or the Storage Navigator. - You can define up to 8,192 SI-MF pairs in a consistency group. - SI-MF pair and SI pair cannot share with same consistency group.	Copy	Business Continuity Manager	PPRC	Create the primary volume data at specified time in the secondary volume	Possible	Impossible	Create the primary volume data at the time when a Split operation is performed in the secondary volume	Possible	Possible
Copy	Business Continuity Manager	PPRC									
Create the primary volume data at specified time in the secondary volume	Possible	Impossible									
Create the primary volume data at the time when a Split operation is performed in the secondary volume	Possible	Possible									
19	The maximum number of pairs	The maximum number of pairs is as follows. The maximum number of pairs is the sum of the numbers of pairs of the SI-MF, SI and Volume Migration.									

(1) Calculating Maximum Number of Pairs

When you create ShadowImage pairs, resources called differential tables, pair tables will be required. The number of available differential tables, pair tables in one storage system depends on whether the additional shared memory is installed or not. There are several patterns of additional shared memory for differential tables, pair tables, and you can choose any pattern you like. Table 3.14.1.1-1 shows the pattern of additional shared memory.

Table 3.14.1.1-1 Additional Shared Memory for Differential Tables, Pair Tables

Additional Shared Memory for Business Copy	Number of Differential Tables	Number of Pair Tables	Number of System Volumes
Base (No additional shared memory)	26,176	8,192	16,384
Extension 1	104,768	16,384	65,536
Extension 2	209,600	16,384	65,536

Note:

- To install additional shared memory for differential tables, please call the Support Center.
- Even if you install additional shared memory for differential tables, pair tables, the maximum number of pairs is half of the total number of volumes in the storage system (see Table 3.14.1.1-1). For example, in case of “Base (No additional shared memory)” in Table 3.14.1.1-1, when P-VOLs and S-VOLs are in a one-to-one relationship, you can create up to 8,192 pairs. However, note that in case of “Extension 1” and “Extension 2”, the maximum number of pairs is 16,384 regardless of the total number of volumes in the storage system.

To calculate the maximum number of ShadowImage pairs, first you need to calculate how many differential tables, pair tables are required to create ShadowImage pairs, and then compare the result with the number of differential tables, pair tables in the whole storage system. Note that in addition to ShadowImage, the following program products will also use differential tables, pair tables.

The following program products use differential tables

- ShadowImage for z/OS
- FlashCopy (R) V2
- Volume Migration
- Copy-on-Write Snapshot

The following program products use pair tables

- ShadowImage for z/OS
- Volume Migration

If ShadowImage and these program products are used in the same storage system, the number that is deducted the number of differential tables, pair tables used by the pairs (migration plans in case of Volume Migration) of the program products shown in above from the number of differential tables, pair tables in the whole storage system will be the number of available differential tables, pair tables for ShadowImage pairs.

For information about how to calculate the number of differential tables, pair tables that are required for ShadowImage for z/OS, please refer to “Hitachi ShadowImage for Mainframe User Guide”, and as for FlashCopy (R) V2, please refer to “Hitachi Compatible FlashCopy (R) User Guide”. Also, please refer to “Volume Migration Guide” to calculate the number of differential tables, pair tables that are required for Volume Migration, refer to “Hitachi Copy-on-Write Snapshot User Guide” to calculate the number of differential tables that are required for Copy-on-Write Snapshot, and refer to “Hitachi Thin Image User Guide” to calculate the number of pair tables that are required for Thin Image.

Assuming that only ShadowImage uses differential tables, pair tables, this section describes how to calculate the number of differential tables, pair tables required for one ShadowImage pair, and the conditions you need to consider when calculating the number of ShadowImage pairs that can be created.

Note: You can use CCI’s inqraid command to query the number of the differential tables required when you create ShadowImage pairs. You can also query the number of the differential tables not used in the storage system by using this command (ShadowImage only). For details about inqraid command, please refer to “Hitachi Command Control Interface User and Reference Guide”.

(1-1) Calculation of the Number of Differential Tables, Pair Tables Required for One Pair

When you create a ShadowImage pair, the number of required differential tables, pair tables will change according to the emulation type of the volumes. To calculate the number of differential tables, pair tables required for a pair according to the emulation type, use the expression in Table 3.14.1.1-2.

Table 3.14.1.1-2 The Total Number of the Differential Tables Per Pair

Emulation Type	Expression
OPEN-3	Total number of the differential tables per pair = $((X) \div 48 + (Y) \times 15) \div (Z)$ (X): The capacity of the volume. (KB) (*1) (Y): The number of the control cylinders. (See Table 3.14.1.1-3) (Z): 20,448 (The number of the slots that can be managed by a differential table)
OPEN-8	
OPEN-9	Note that you should round up the number to the nearest whole number. For example, if the emulation type of a volume is OPEN-3, and when provided that the number of the cylinders of the divided volume is 2,403,360 KB ((X) in the expression above), the calculation of the total number of the differential tables is as follows. $(2,403,360 \div 48 + 8 \times 15) \div 20,448 = 2.4545...$ When you round up 2.4545 to the nearest whole number, it becomes 3. Therefore, the total number of the differential tables for one pair is 3 when emulation type is OPEN-3. In addition, 1 pair tables per 36 differential tables is used. The number of pair tables used for above-mentioned OPEN-3 becomes 1.
OPEN-E	
OPEN-L	
OPEN-V	Total number of the differential tables per pair = $((X) \div 256) \div (Z)$ (X): The capacity of the volume. (KB) (Z): 20,448 (The number of the slots that can be managed by a differential table) Note that you should round up the number to the nearest whole number. For example, if the emulation type of a volume is OPEN-V, and when provided that the number of the cylinders of the divided volume is 3,019,898,880 KB ((X) in the expression above), the calculation of the total number of the differential tables is as follows. $(3,019,898,880 \div 256) \div 20,448 = 576.9014...$ When you round up 576.9014 to the nearest whole number, it becomes 577. Therefore, the total number of the differential tables for one pair is 577 when emulation type is OPEN-V. In addition, 1 pair tables per 36 differential tables is used. The number of pair tables used for above- mentioned OPEN-V becomes 17. The emulation type of the case to use the two or more pair tables with the open system is only OPEN-V.

*1: If the volume is divided by VLL function, you need to apply the capacity of the volume after the division. You cannot perform VLL operations on a OPEN-L volume. Therefore, if the emulation type is OPEN-L, the value substitute for (X) is the default capacity of the volume.

The following table shows the number of the control cylinders according to the emulation types.

Table 3.14.1.1-3 The Number of the Control Cylinders According to the Emulation Types

Emulation Type	Number of the Control Cylinders
OPEN-3	8 (5,760KB)
OPEN-8	27 (19,440KB)
OPEN-9	
OPEN-E	19 (13,680KB)
OPEN-L	7 (5,040KB)
OPEN-V	0 (0KB)

(1-2) Conditions for the Number of ShadowImage Pairs that can be Created (In Case of No LUSE Volume Exists)

The number of ShadowImage pairs that can be created will change according to whether LUSE volumes are used or not. This section describes the how to calculate the number of ShadowImage pairs that can be created, when no LUSE volume is used (e.g. 1 LU consists of one volume).

When you do not use LUSE volume, you can use the following inequation to know whether you will be able to create the desired number of ShadowImage pairs or not.

You need to meet the inequation below:

$$\Sigma \{(\alpha) \times (\text{the number of ShadowImage pairs})\} \leq (\beta)$$

and

$$\Sigma \{(\gamma) \times (\text{the number of ShadowImage pairs})\} \leq (\delta)$$

- (α) : The required number of differential tables per pair.
 (α) changes according to the emulation type. For information about how to calculate (α) , see Table 3.14.1.1-2.
- (β) : The number of differential tables available in the storage system.
 If an additional shared memory for differential tables is not installed, (β) is 26,176. If an additional shared memory for differential tables is installed, see Table 3.14.1.1-1.
- (γ) : The required number of pair tables per pair.
 Value of (γ) changes according to the (α) . For information about how to calculate (γ) , see Table 3.14.1.1-2.
- (δ) : The number of pair tables available in the storage system.
 If an additional shared memory for pair tables is not installed, (δ) is 8,192. If an additional shared memory for pair tables is installed, see Table 3.14.1.1-1.

For example, if you are to create 10 pairs of OPEN-3 volumes and 20 pairs of OPEN-L volumes in a subsystem that is not installed with an additional shared memory for differential tables, pair tables, you can use the condition inequation as follows:

When the emulation type is OPEN-3, and if the capacity of the volume is 2,403,360 kB, the number of differential tables required for a pair will be 3. The number of pair tables required for a pair will be 1. When the emulation type is OPEN-V, and if the capacity of the volume is 3,019,898,880 kB, the number of differential tables required for a pair will be 577. The number of pair tables required for a pair will be 17.

If you apply these numbers to the above-mentioned inequation:

$$3 \times 10 + 577 \times 20 = 11,570 \leq 26,167$$

and

$$1 \times 10 + 17 \times 20 = 350 \leq 8,192$$

Since 11,570 is smaller than 26,167, you can see that 10 pairs of OPEN-3 volumes and 20 pairs of OPEN-L volumes can be created.

(1-3) Conditions for the Number of ShadowImage Pairs that can be Created (In Case of LUSE Volume Exists)

The number of ShadowImage pairs that can be created will change according to whether LUSE volumes are used or not. This section describes how to calculate the number of ShadowImage pairs that can be created, when LUSE volumes are used.

When you use LUSE volume, you can use the following inequation to know whether you will be able to create the desired number of ShadowImage pairs or not.

You need to meet the inequation below.

$$\Sigma [\Sigma \{ (\alpha) \times (\text{the number of the volumes that forms LUSE volumes}) \} \times (\text{the number of ShadowImage pairs})] \leq (\beta)$$

and

$$\Sigma [\Sigma \{ (\gamma) \times (\text{the number of the volumes that forms LUSE volumes}) \} \times (\text{the number of ShadowImage pairs})] \leq (\delta)$$

- (α) : The required number of differential tables for each volume that forms LUSE volume.

When you use LUSE volumes to create a ShadowImage pair, every volume that forms the LUSE volume will use the differential tables as a pair. For example, if you create a ShadowImage pair by using LUSE volumes which are created by combining two OPEN-V volumes, you need differential tables for two OPEN-V pairs.

(α) changes according to the emulation type. For information about how to calculate (α) , see Table 3.14.1.1-2.

- (β) : The number of differential tables available in the storage system.

If an additional shared memory for differential tables is not installed, (β) is 26,176. If an additional shared memory for differential tables is installed, see Table 3.14.1.1-1.

- (γ) : The required number of pair tables for each volume that forms LUSE volume.

Value of (γ) changes according to the (α) . For information about how to calculate (γ) , see Table 3.14.1.1-2.

- (δ) : The number of pair tables available in the storage system.

If an additional shared memory for pair tables is not installed, (δ) is 8,192. If an additional shared memory for pair tables is installed, see Table 3.14.1.1-1.

For example, if you are to create 10 pairs of LUSE volumes consisting respectively of three OPEN-3 volumes, you can use the condition inequation as follows:

When the emulation type is OPEN-3, and if the capacity of the volume is 2,403,360 kB, the number of differential tables required for a pair will be 3. The number of pair tables required for a pair will be 17.

If you apply this number to the above-mentioned inequation:

$$(3 \times 3) \times 10 = 90 \leq 26,176$$

and

$$(1 \times 3) \times 10 = 30 \leq 8,192$$

Therefore, you can see that 10 ShadowImage pairs which are formed by three OPEN-3 volumes can be created.

(2) Calculating Maximum Number of Pairs

When you create SIz pairs, resources called differential tables, pair tables will be required. The number of available differential tables, pair tables in one storage system depends on whether the additional shared memory is installed or not. There are several patterns of additional shared memory for differential tables, pair tables, and you can choose any pattern you like. Table 3.14.1.2-1 shows the pattern of additional shared memory.

Table 3.14.1.2-1 Additional Shared Memory for Differential Tables, Pair Tables

Additional Shared Memory for Business Copy	Number of Differential Tables	Number of Pair Tables	Number of System Volumes
Base (No additional shared memory)	26,176	8,192	16,384
Extension 1	104,768	16,384	65,536
Extension 2	209,600	16,384	65,536

Note:

- To install additional shared memory for differential tables, please call the Support Center.
- Even if you install additional shared memory for differential tables and pair tables, the maximum number of pairs is half of the total number of volumes in the storage system (see Table 3.14.1.2-1). For example, in case of “Base (No additional shared memory)” in Table 3.14.1.2-1, when S-VOLs and T-VOLs are in a one-to-one relationship, you can create up to 8,192 pairs. However, note that in case of “Extension 1” and “Extension 2”, the maximum number of pairs is 16,384 regardless of the total number of volumes in the storage system.

To calculate the maximum number of SIz pairs, first you need to calculate how many differential tables, pair tables are required to create SIz pairs, and then compare the result with the number of differential tables, pair tables in the whole storage system. Note that in addition to ShadowImage for z/OS, the following program products will also use differential tables, pair tables.

The following program products use differential tables

- ShadowImage
- FlashCopy (R) V2
- Volume Migration
- Copy-on-Write Snapshot

The following program products use pair tables

- ShadowImage
- Volume Migration

If ShadowImage for z/OS and these program products are used in the same storage system, the number that is deducted the number of differential tables, pair tables used by the pairs (migration plans in case of Volume Migration) of the program products shown in above from the number of differential tables, pair tables in the whole storage system will be the number of available differential tables, pair tables for SIz pairs.

For information about how to calculate the number of differential tables, pair tables that are required for ShadowImage, please refer to “Hitachi ShadowImage (R) User Guide”, and as for FlashCopy (R) V2, please refer to “Hitachi Compatible FlashCopy (R) User Guide”. Also, please refer to “Volume Migration Guide” to calculate the number of differential tables, pair tables that are required for Volume Migration, refer to “Hitachi Copy-on-Write Snapshot User Guide” to calculate the number of differential tables that are required for Copy-on-Write Snapshot, and refer to “Hitachi Thin Image User Guide” to calculate the number of pair tables that are required for Thin Image.

Assuming that only ShadowImage for z/OS uses differential tables, pair tables, this section describes how to calculate the number of differential tables, pair tables required for one SIz pair, and the conditions you need to consider when calculating the number of SIz pairs that can be created.

- The capacity of each volume used to create a pair (this is the capacity specified as the CVS or customized volume size)

Use the following expression to calculate the total number of the differential tables, pair tables per pair.

$\text{Total number of the differential tables per pair} = ((X) + (Y)) \times 15 \div (Z)$

(X): The number of the cylinders of the volume which is divided at arbitrary size.

(Y): The number of the control cylinders. (See Table 3.14.1.2-2)

(Z): 20,448 (The number of the slots that can be managed by a differential table)

Note that you should round up the number to the nearest whole number. For example, in case of a volume which emulation type is 3390-3, and when provided that the number of the cylinders of the divided volume is 3,390 ((X) in the expression above), the calculation of the total number of the differential table is as follows.

$$(3,339 + 6) \times 15 \div 20,448 = 2.4537...$$

When you round up 2.4537 to the nearest whole number, it becomes 3. Therefore, the total number of the differential table for one pair is 3 when emulation type is 3390-3.

In addition, 1 pair tables per 36 differential tables is used. The number of pair tables used for above-mentioned 3390-3 becomes 1. (When the number of cylinders for the volume is a value of default, the number of pair tables used 3390-M becomes 2.) The emulation type of the case to use the two or more pair tables with the Mainframe is only 3390-M/A.

The following table shows the number of the control cylinders according to the emulation types.

Table 3.14.1.2-2 The Number of the Control Cylinders According to the Emulation Types (1/2)

Emulation Type	Number of the Control Cylinders
3380-3	7
3380-3A	7
3380-3B	7
3380-3C	7
3390-3	6
3390-3A	6
3390-3B	6
3390-3C	6
3390-3R	6
3390-9	25
3390-9A	25
3390-9B	25
3390-9C	25
3390-L	23
3390-LA	23
3390-LB	23
3390-LC	23

Table 3.14.1.2-2 The Number of the Control Cylinders According to the Emulation Types (2/2)

Emulation Type	Number of the Control Cylinders
3390-M	53
3390-MA	53
3390-MB	53
3390-MC	53
3390-A	53 (*1)

*1: This value is different from an actual number of control cylinders in 3390-A.

This value is used to calculate the number of differential table for a pair of ShadowImage for Mainframe.

If you intend to create pairs with volumes of different emulation types, the maximum number of pairs you can create will depend on the following conditions.

Note: For details about the calculation of the total number of the differential tables, pair tables per a pair, see the expression described just before Table 3.14.1.2-2.

The maximum number of pairs that you can create is the largest number that meets the inequation below :

$$\Sigma (\alpha) \leq (\beta)$$

and

$$\Sigma (\gamma) \leq (\delta)$$

$\Sigma (\alpha)$ stands for the total number of differential tables per pair (see Table 3.14.1.2-2), and (β) stands for the number of differential tables available in the storage system.

$\Sigma (\gamma)$ stands for the total number of pair tables per pair (see Table 3.14.1.2-2), and (δ) stands for the number of pair tables available in the storage system.

(β) is 26,176 when an additional shared memory for differential tables is not installed. If an additional shared memory for differential tables is installed, see Table 3.14.1.2-1 for (β) .

(δ) is 26,176 when an additional shared memory for pair tables is not installed. If an additional shared memory for pair tables is installed, see Table 3.14.1.2-1 for (δ) .

For example, if you are to create 10 pairs of 3390-3 volumes and 20 pairs of 3390-L volumes in a storage system that is not installed with an additional shared memory for differential tables, pair tables, the following equation would be used to calculate $\Sigma (\alpha)$, $\Sigma (\gamma)$:

$$(3 \times 10) + (24 \times 20) = 510.$$

and

$$(1 \times 10) + (1 \times 20) = 30$$

Since 510 is smaller than 26,176, it meets the equation, $\Sigma (\alpha) \leq (\beta)$, thus ensuring you that 10 pairs of 3390-3 volumes and 20 pairs of 3390-L volumes can be created.

(3) Calculating the Maximum Number of FlashCopy (R) V2 Relationships

FlashCopy (R) V2 can establish up to 1,048,575 relationships. However, FlashCopy (R) V2 may not be able to establish up to 1,048,575 relationships depending on the number of resources required for the copy operation that vary according to the attributes (emulation type, capacity, the size of the data that is copied, the position of the extent) of the volumes and extents used for establishing the relationships.

You can use the FlashCopy (R) V2 Information dialog box (see “Hitachi Compatible FlashCopy (R) User Guide”) to check the number of remaining resources that are currently available. Check the FlashCopy (R) V2 Information dialog box when you create a FlashCopy (R) V2 relationship.

Note: The following software programs share the resources used for copy operation.

- ShadowImage for z/OS
- ShadowImage
- Copy-on-Write Snapshot
- Thin Image
- Volume Migration

The resources used by ShadowImage for z/OS, ShadowImage, Copy-on-Write Snapshot, Thin Image, and Volume Migration cannot be used for FlashCopy (R) V2. The resources that remain when you exclude the resources used by ShadowImage for z/OS, ShadowImage, Copy-on-Write Snapshot, Thin Image, and Volume Migration from the total resources are available resources for FlashCopy (R) V2. For details about the calculation of the resources used by each software program, refer to the following manuals.

- Hitachi ShadowImage for Mainframe User Guide
- Hitachi ShadowImage (R) User Guide
- Hitachi Copy-on-Write Snapshot User Guide
- Hitachi Thin Image User Guide
- Volume Migration Guide

■ Establishing relationships by volume copying

Use the following expression to calculate the total number of the resources to be used per relationship.

$\text{Total number of the differential tables per pair} = ((X) + (Y)) \times 15 \div (Z)$

(X): The number of the cylinders of the volume.

(Y): The number of the control cylinders. (See Table 3.14.1.3-1)

(Z): The number of the slots that can be managed by a differential table. (639×32)

Note that you should round up the number to the nearest whole number.

Following table shows the number of the control cylinders for each emulation type.

Table 3.14.1.3-1 The Number of the Control Cylinders for Each Emulation Type

Emulation Type	Number of the Control Cylinders
3380-3	7
3390-1	5
3390-2	6
3390-3	6
3390-3R	6
3390-9	25
3390-L	23
3390-M	53
3390-A	7 per 1113 cylinder

The number of resources to be used per a relationship are the total number of the resources of the copy source and copy target. For example, in case of a volume which emulation type is 3390-3, and when provided that the number of the cylinders of the divided volume is 3,390 ((X) in the expression above) the calculation of the total number of the differential table is as follows:

Copy source: $(3,339 + 6) \times 15 \div (639 \times 32) = \uparrow 2.45379 \uparrow = 3$

Copy target: $(3,339 + 6) \times 15 \div (639 \times 32) = \uparrow 2.45379 \uparrow = 3$

When you round up 2.45379 to the nearest whole number, it becomes 3. Therefore, the total number of the resources to be used for one relationship is 6 when emulation type is 3390-3.

When volumes that differ in the emulation type and capacity are, the number of relationships that can be established is determined according to the following condition.

Note: For details about the calculation of the total number of the resources to be used per a relationship, see the expression described above.

The maximum number of relationships that can be established is the largest number that meets the equation, $\Sigma(\alpha) \leq (\beta)$, where:

$\Sigma(\alpha)$ stands for the total number of resources used per a relationship, and

(β) stands for the total number of resources available in the subsystem.

(β) means the total number of resources available in the storage system.

$(\beta) = 26,176$ or $104,768$ or $209,600$.

■ Establishing relationships by dataset copying

To establish relationships between extents, the number of required resources is same as the number of resources used per relationship, provided that no extents in the same volume overlap. If the extents used for establishing the relationships overlap, the number of resources required to establish the relationships is the number of resources to be used multiplied by the number of extents that overlap.

The following figures illustrate the different cases of dataset copying, for example when the extents overlap or not. For information about the calculation example of the used resources, see Table 3.14.1.3-2.

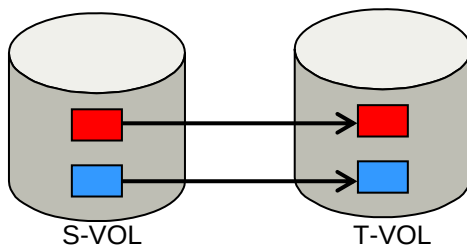


Fig. 3.14.1.3-1 Copying Data in Two Extents that do not Overlap (One T-VOL)

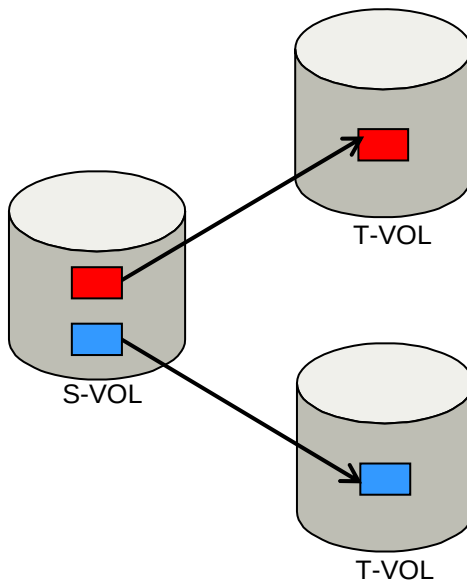


Fig. 3.14.1.3-2 Copying Data in Two Extents that do not Overlap (Two T-VOLs)

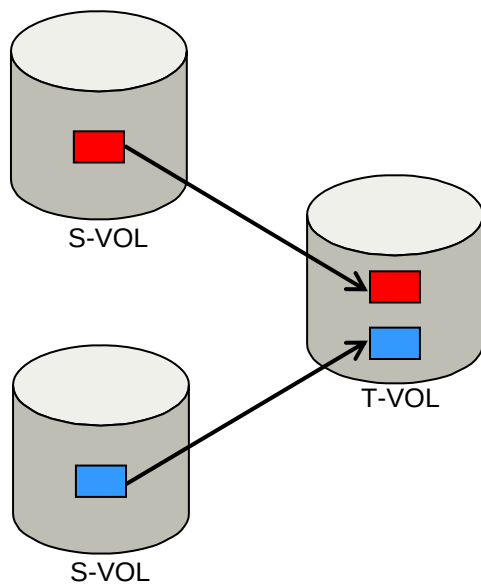


Fig. 3.14.1.3-3 Copying Data in Two Extents that do not Overlap (Two S-VOLs)

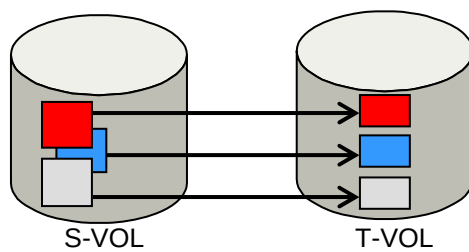


Fig. 3.14.1.3-4 Copying Data in Three Extents that Overlap (One T-VOL)

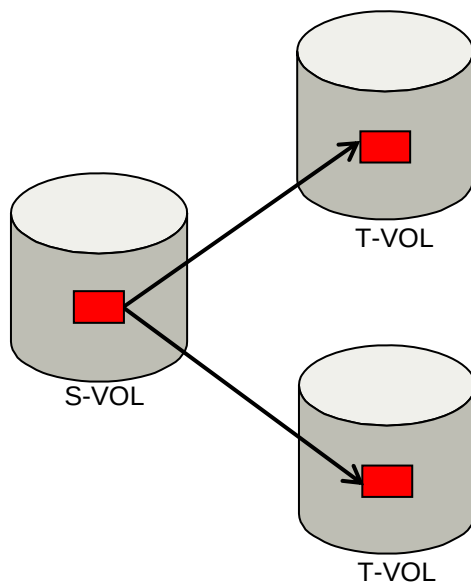


Fig. 3.14.1.3-5 Copying Data in Two Extents that Overlap (Two T-VOLs)

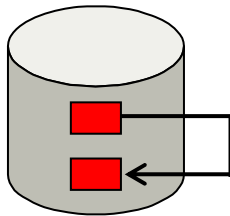


Fig. 3.14.1.3-6 Copying One Extent to Another in the Same Volume

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Table 3.14.1.3-2 provides the calculation examples of the required resources according to the patterns of copying.

Table 3.14.1.3-2 Referential Examples for Calculating the Number of Resources Required to Create the FlashCopy (R) V2 Relationships

Copy Patterns	Required number of resources														
	3380-3, 3390-1, 3390-2, 3390-3, 3390-3R			3390-9			3390-L			3390-M			3390-A (Max. size 223.2GB, Number of the cylinders 262,668)		
	S-VOL	T-VOL	Total	S-VOL	T-VOL	Total	S-VOL	T-VOL	Total	S-VOL	T-VOL	Total	S-VOL	T-VOL	Total
Copying Data in Two Extents that do not Overlap (One T-VOL) See Fig. 3.14.1.3-1	1	1	2	3	3	6	9	9	18	17	17	34	65	65	130
Copying Data in Two Extents that do not Overlap (Two T-VOLs) See Fig. 3.14.1.3-2	1	2 (1+1)	3	3	6 (3+3)	9	9	18 (9+9)	27	17	34 (17+17)	51	65	130 (65+65)	195
Copying Data in Two Extents that do not Overlap (Two S-VOLs) See Fig. 3.14.1.3-3	2 (1+1)	1	3	6 (3+3)	3	9	18 (9+9)	9	27	34 (17+17)	17	51	130 (65+65)	65	195
Copying Data in Three Extents that Overlap (One T-VOL) See Fig. 3.14.1.3-4	3 (1×3)	1	4	9 (3×3)	3	12	27 (9×3)	9	36	51 (17×3)	17	68	195 (65×3)	65	260
Copying Data in Two Extents that Overlap (Two T-VOLs) See Fig. 3.14.1.3-5	2 (1×2)	2 (1+1)	4	6 (2×3)	6 (3+3)	12	18 (9×2)	18 (9+9)	36	34 (17×2)	34 (17+17)	68	130 (65×2)	130 (65+65)	260
Copying One Extent to Another in the Same Volume See Fig. 3.14.1.3-6	2 (*1)	N/A	2	6 (*1)	N/A	6	18 (*1)	N/A	18	34 (*1)	N/A	34	130 (*1)	N/A	130

*1: Half is for the copy source extent, and another half is for the copy target extent.

Note:

- In the case of the emulation type 3380-3, 3390-3, or 3390-3R, maximum number of resources that can be used as S-VOL is 16. You cannot establish any relationship if 16 resources are already used in the S-VOL, and if the copy data range of relationships that are already established overlap with all the resources.
- In the case of the emulation type 3390-9, maximum number of resources that can be used as S-VOL is 48.
- In the case of the emulation type 3390-L, maximum number of resources that can be used as S-VOL is 144.
- In the case of the emulation type 3390-M, maximum number of resources that can be used as S-VOL is 272.
- In the case of the emulation type 3390-A (Max. size), maximum number of resources that can be used as S-VOL is 1,040.

The number of pairs that can be created is determined according to the following condition.

The maximum number of relations that can be established is the largest number that meets the equations, $\Sigma(\alpha) \leq (\beta)$ and $\Sigma(\gamma) \leq 1,048,575$, where:

$\Sigma(\alpha)$ stands for the total number of resources that need to be used,

(β) stands for the total number of resources available in the subsystem,

$(\beta) = 26,176$ when additional shared memory is not installed.

$(\beta) = 57,600$, or 104,768, or 146,688, or 209,600 when additional shared memory is installed.

And $\Sigma(\gamma)$ stands for the total number of relationships.

The following figure shows the example of when 7 relationships are created with 3390-3 volumes, and 3 relationships are created with 3390-L volumes (32,769 CYL).

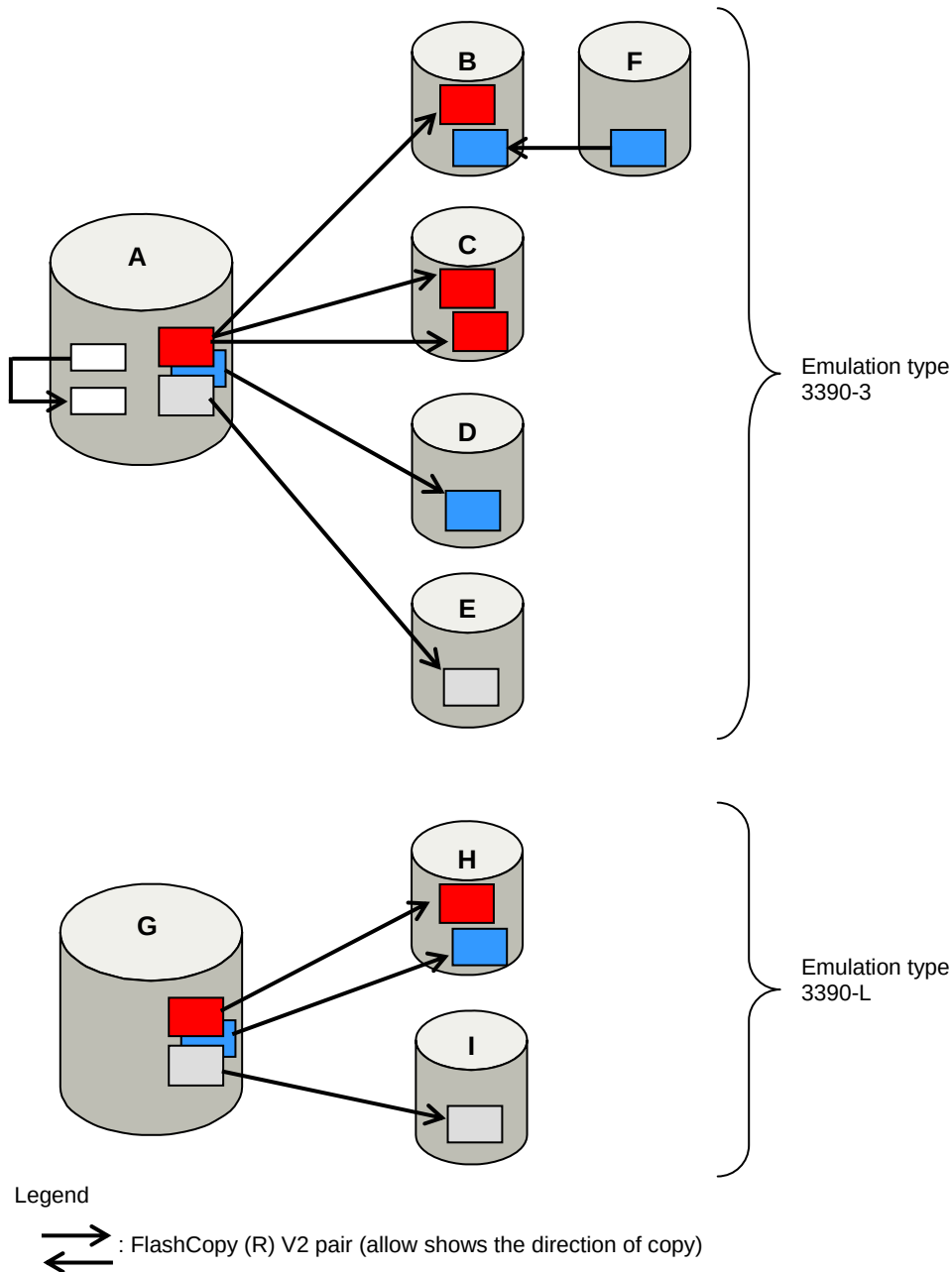


Fig. 3.14.1.3-7 Referential Example for Calculating the Number of Relationships

According to Fig. 3.14.1.3-7, the total number of resources used per pair is calculated as:

$$\text{Resources used for A - H} = (3 + 1) + 1 + 1 + 1 + 1 + 1 + (9 \times 3) + 9 + 9 = 54.$$

The conditions for the number of relationships you can create are:

$$\Sigma(\alpha) \leq (\beta) \text{ and } \Sigma(\gamma) \leq 1,048,575$$

In the case of the example shown in Fig. 3.14.1.3-7, $54 \leq 26,176$ when additional shared memory is not installed, $54 \leq 57,600$, or 104,768, or 146,688, or 209,600 when additional shared memory is installed. In addition, $10 \leq 104,768$. Since the example shown in Fig. 3.14.1.3-7 meets the conditions shown above, you can establish all the relationships in Fig. 3.14.1.3-7.

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In case of ShadowImage for Mainframe/ShadowImage volume is selected for Volume Migration volume

	P-VOL	S-VOL	RootVOL	NodeVOL	LeafVOL	ReserveVOL
Source VOL	Possible (*1)	Possible	Possible (*1)	Possible (*2)	Command Reject	Possible
Target VOL	Command Reject	Command Reject	Command Reject	Command Reject	Command Reject	Command Reject
ReserveVOL	Command Reject	Command Reject	Command Reject	Command Reject	Command Reject	Command Reject

*1: It is impossible if ShadowImage for Mainframe/ShadowImage P-VOL or RootVOL already has 3 pairs.

*2: It is impossible if ShadowImage for Mainframe/ShadowImage NodeVOL is already paired with 2 LeafVOLs.

If you want to execute migration of Volume Migration, you need to delete the pair and reset ReserveVOL of ShadowImage for Mainframe/ShadowImage.

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In case of Volume Migration volume is selected for ShadowImage for Mainframe/ShadowImage volume

	Source VOL	Target VOL	ReserveVOL
P-VOL	Command Reject	Command Reject	Command Reject
S-VOL	Command Reject	Command Reject	Command Reject
RootVOL	Command Reject	Command Reject	Command Reject
NodeVOL	Command Reject	Command Reject	Command Reject
LeafVOL	Command Reject	Command Reject	Command Reject
ReserveVOL	Command Reject	Command Reject	Command Reject

If you want to add pair of ShadowImage for Mainframe/ShadowImage, you need to cancel Volume Migration migration.

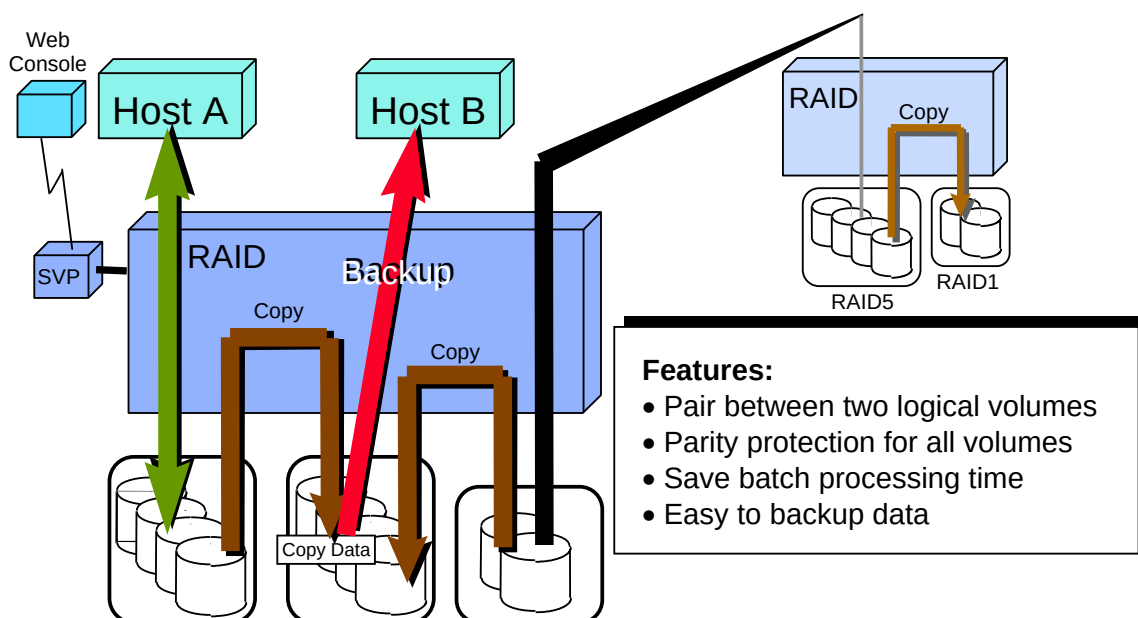
CAUTION

Copy process is done asynchronously with HOST I/O according to differential bit map. Differential bit map is recorded on shared memory. So if shared memory is lost by offline micro exchange or volatile PSON etc., DKC lost differential bit map.

In these cases DKC treat as whole volume area has differential data, so copy process will take longer time than usual. And if the pair is SPLIT-PEND status, the pair become SUSPEND status because lost of differential bit map.

Primary volumes and secondary volumes of SI-MF/SI pairs should be placed on many RAID groups separately. And SI-MF/SI pairs which are operated at the same time should be placed in other RAID groups. SI-MF/SI pairs which are concentrated at very few RAID groups may influence HOST I/O performance.

If DKC is busy, increase Cache, DKA and RAID groups. And secondary volumes of SI-MF/SI pairs should be placed in the increased RAID groups. SI-MF/SI pairs in very busy DKC may influence HOST I/O performance.



3.14.2 Construction of ShadowImage for Mainframe & ShadowImage

- ShadowImage for Mainframe & ShadowImage can be controlled from SVP, Web Console and HOST.
- DKA with LA exchange has to exist in the subsystem.

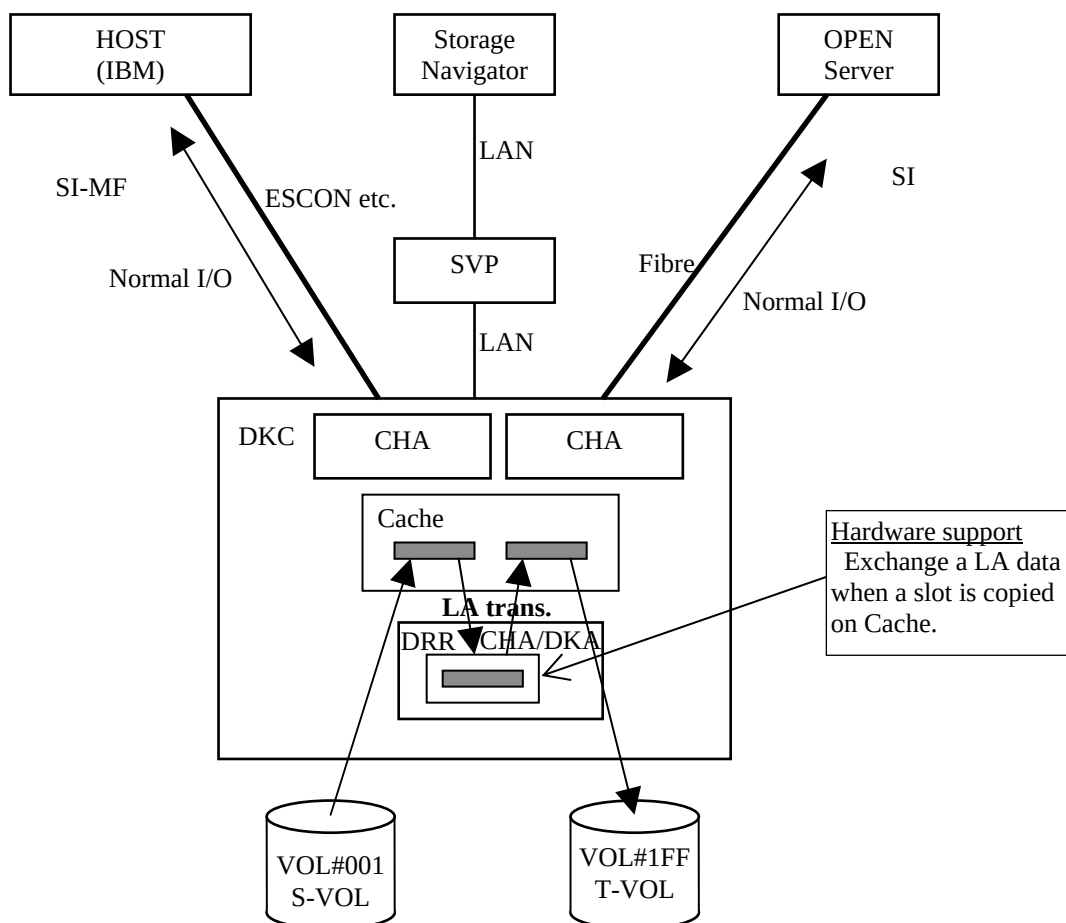
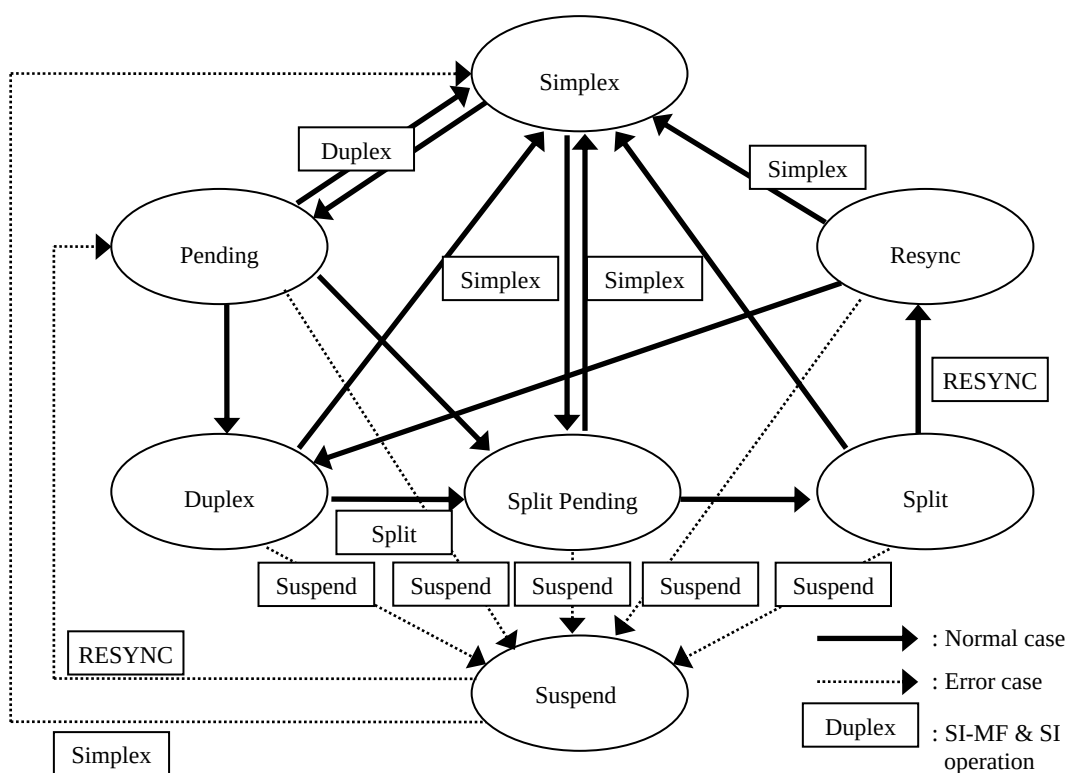


Fig. 3.14.2-1 Construction of ShadowImage for Mainframe & ShadowImage

3.14.3 Status transition

Table 3.14.3-1 Status of ShadowImage for Mainframe & ShadowImage

No.	Status	Definition
1	Simplex	There is no pair with the volume.
2	Pending	In the copy job status from the master volume to the destination volume for duplex status.
3	Duplex	The copy from master to destination is finished. The destination volume can not be accessed from HOST.
4	Split Pending	In the copy job status of the differential data from the master volume.
5	Split	The pair is split. The destination volume can be accessed from HOST. In this status, the position of write data from the HOST is recorded on a bitmap to reduce the copy time on RESYNC.
6	Resync	In the copy job status of the differential data from master to destination.
7	Suspend	There is an error with the pair. After a running copy job was stopped by the SVP operation, the pair status is "suspend".



3.14.4 Interface

(1) Outline

ShadowImage for Mainframe & ShadowImage support a command set to control ShadowImage for Mainframe & ShadowImage functions.

This command set is a common interface in a subsystem. So the commands from different HOSTs are translated to the ShadowImage for Mainframe & ShadowImage command at each command process.

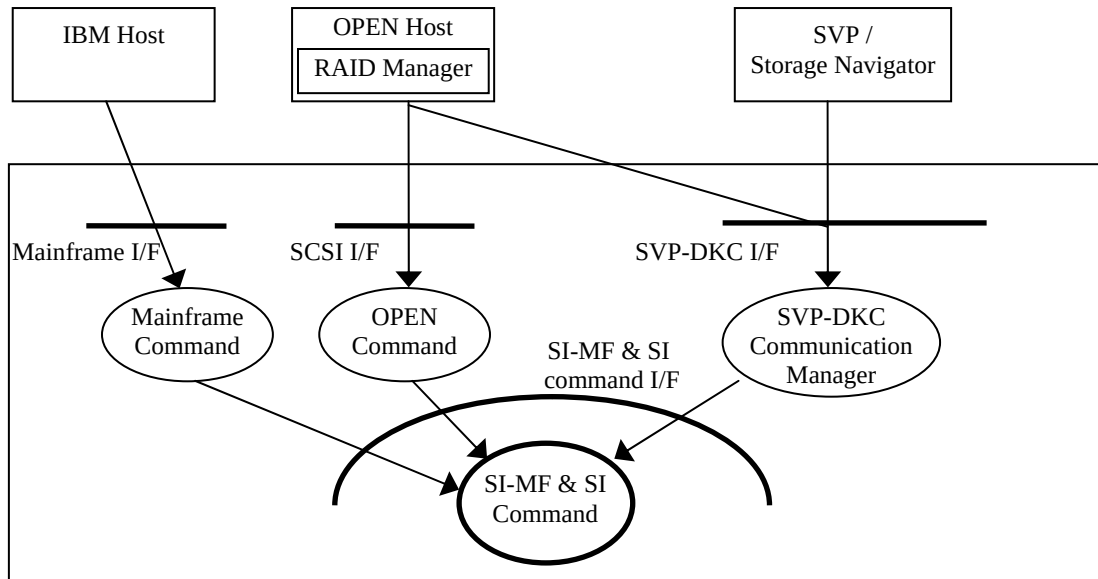


Fig. 3.14.4-1 Outline of ShadowImage for Mainframe & ShadowImage I/F

Notice: It is necessary to define Command Device before using RAID Manager with In-Band on OPEN HOST.

Do not define Command Device on a heavy-load path.

It is unnecessary to define Command Device before using RAID Manager with Out-of-Band on OPEN HOST.

(2) ShadowImage for Mainframe & ShadowImage operation

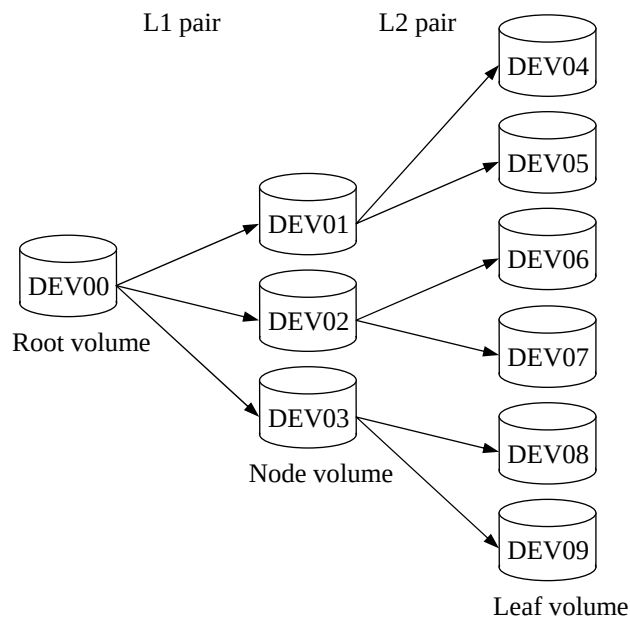
Table 3.14.4-1 ShadowImage for Mainframe & ShadowImage operation

No.	Command	Operation
1	Duplex	Creates a pair and start initial copy
2	Split	Splits the pair
3	RESYNC	Resumes the pair and start differential copy
4	Simplex	Deletes the pair
5	Suspend	Suspends the pair action
6	Status Check	Requires the status information
7	Reserve	Marks and Unmarks the volume for a candidate of destination volume

3.14.5 Cascade function

Cascade function makes a pair with an existed Target volume as a new Source volume. See the figure below.

This function is available for ShadowImage only.



No.	Content	Specification
1	Pair structure	A Target volume of L1 pair (=Node volume) can be a Source volume of L2 pair.
2	Number of copies	Root : Node = 1 : 3 Node : Leaf = 1 : 2 Root : (Node + Leaf) = 1 : 9
3	Split pair condition	L2 pair is able to execute split pair request only when the L1 pair is in the split status.
4	Delete pair condition	- No conditions. - When L1 pair is deleted, L2 pair becomes L1 pair.
5	Combination with TrueCopy	Possible. However, Node volume and Leaf volume are treated as a target volume.
6	Combination with Volume Migration	Possible. However, Leaf volume cannot be moved.

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- Name of volume type
 - Source volume of the first pair : Root Volume
 - Target volume of the first pair : Node Volume
 - Source volume of the 2nd pair : Node Volume
 - Target volume of the 2nd pair : Leaf Volume
- Name of pair
 - The first pair (A pair of root volume is source volume) : L1 pair
 - The second pair (A pair of node volume is source volume) : L2 pair
- Name of pair chain
 - A chain of L1 pair and L2 pair with a node volume: stream

3.14.6 Reverse-RESYNC

(1) Reverse-RESYNC Function/Quick Restore Function

The Reverse-RESYNC function is an extension of the RESYNC function of the ShadowImage. The Quick Restore function is a similar function with Reverse-RESYNC, but it speeds up the operation.

When a pair in the Split status is requested to perform the Reverse-RESYNC, the differential data between the target volume and the source volume is copied to the source volume from the target volume.

When a pair in the Split status is requested to perform the Quick Restore, a volume map in DKC is changed to swap contents of Source volume and Target volume without copying the Source volume data to the Target volume. The Source volume and the Target volume are resynchronized when update copy operations are performed for pairs in the Duplex status.

Note on RAID Level and DCR swap:

The Quick Restore operation changes locations of the data for primary volumes and secondary volumes and location of DCR of ShadowImage for Mainframe/ShadowImage pairs. Therefore, the operation may change RAID levels and HDD types of the volumes. For example, if the primary volume is RAID1 and the secondary volume is RAID5, Quick Restore operation changes the primary volume to RAID5 and the secondary to RAID1. RAID6 volume is also similar.

If you want to go back to the previous state, follow the actions below:

- step1 : Stop HOST I/O to the pair
- step2 : Split the pair
- step3 : Perform Quick Restore for the pair
- step4 : Restart HOST I/O to the pair

Due to the replacement of DCR setting locations, you must operate 1 or 2 shown below.

1. Set the same DCR location for Source volume and Target volume.
2. Reset the DCR settings of Source volume and Target volume before Quick Restore, and set DCR of Source volume and Target volume after the pair transits to the Duplex status by Quick Restore.

Unless you perform the operation above, I/O performance to the same data may be down for the change of the locations of cache-resident area after Quick Restore.

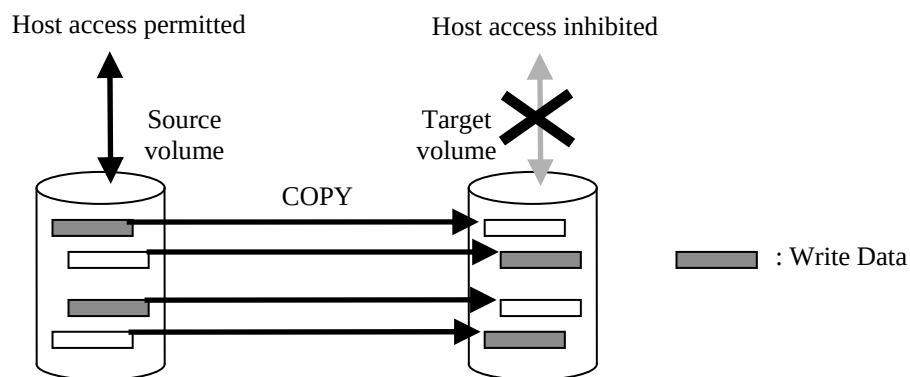


Fig. 3.14.6-1 Normal RESYNC Process

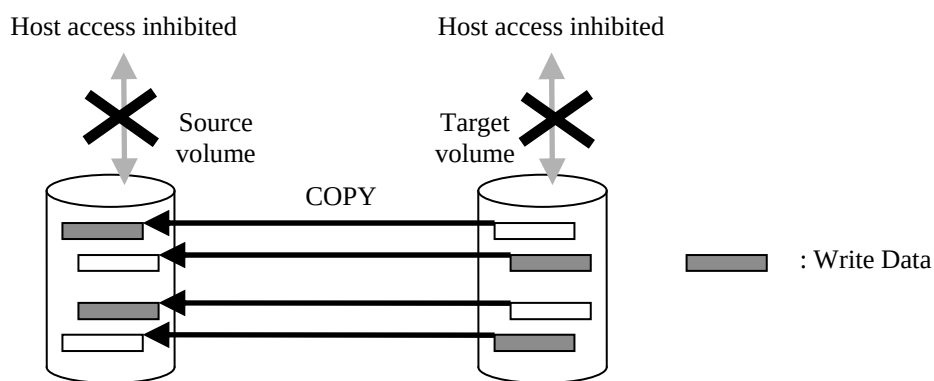


Fig. 3.14.6-2 Reverse RESYNC Process

THEORY03-14-340**(2) Specifications**

No.	Item	Description
1	RESYNC copy pattern	- The data of the target volume is copied to the source volume. - The copy pattern can be selected by specifying a unit of operation. Specified operation unit : SVP/RMC: In units of pair operation at a time RAID manager: In units of command
2	Copy range	In the case of the Reverse-Copy and Quick Restore in the Split status, a range for merging the writing into the source and target volumes
3	Copy format	Same format as that of a copy in the Duplex status
4	Applicable LDEV type	- SI-MF : 3390-3/3R/9/L/M/A, 3380-3, Emulation types and CVSs of them - SI : OPEN-3/8/9/E/L/V, emulation types and CVSs (except OPEN-L emulation type) and LUSE of them
5	Host access during copying	(1) In the case of the main frame volume - Source volume: Reading and writing disabled - Target volume: Reading and writing disabled (2) In the case of the open volume - Source volume: Writing disabled - Target volume: Reading and writing disabled Note: The reason why the source volume is not disabled to read is to make the volume recognizable by the host and it does not mean that the data is assured.
6	Specification method	SVP/ Storage Navigator: Add a specification for the RESYNC pattern onto the Pair Resync screen.
7	Conditions of command reception	- The pair concerned is in the Split status. - Another pair sharing the source volume is in the Suspend or Split status. → If this condition is not satisfied, the CMD RJT takes place. - When the Reverse-Resync or Quick Restore is being executed by another pair which is sharing the source volume, it is impossible to change the pair status of the pair concerned. (However, the pair deletion and pair suspension requests are excluded.) - The source volume of the pair concerned has no pair of the TC-MF/TC or in the Suspend status. (See Item No.14 in this table.)
8	Status display during copying	- SVP/Storage Navigator SI-MF : RESYNC -R SI : COPY(RS-R) The display of the attribute, source or target, is not changed. - RAID manager Pair status display: RCPY The display of the attribute, source or target, is not changed.

(To be continued)

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(Continued from the preceding page)

No.	Item	Description
9	Condition after normal end of the copy operation	- The pair concerned enters the Duplex status. - The conditions of the host access after the status transition are shown below. (1) Mainframe volume - Source volume: Reading and writing enabled - Target volume: Reading and writing disabled (2) Open volume - Source volume: Reading and writing enabled - Target volume: Writing disabled
10	Impacts on another pair	In another pair sharing the source volume, the part actually copied becomes the difference after executing this function. Example: Pair of the other target volumes in the 1:3 configuration
11	Operation when the copying terminates abnormally	(1) The pair concerned enters the Suspend status. (2) The source volume of the pair concerned is enabled to read and write. → Data is not assured. The target volume of the pair concerned is disabled to read nor write in the case of the Mainframe volume and disabled to write in the case of the open volume. (3) The status of a pair sharing the source volume is not changed.
12	Operation when a suspension request is received during copying	Same as above
13	Relation to the cascade function	The Reverse-RESYNC and Quick Restore cannot be executed for the L2 pair.

(To be continued)

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(Continued from the preceding page)

No.	Item	Description
14	Relation to the TrueCopy for Mainframe/TrueCopy	• In the case where “M-volume of the TC-MF/TC” = “Source volume of the ShadowImage” “Pair status of the TC-MF/TC” = “Suspend” → The Reserve-Resync and Quick Restore can be executed. “Pair status of the TC-MF/TC” ≠ “Suspend” → The Reserve-Resync and Quick Restore cannot be executed. (Command Reject) • In the case where “R-volume of the TC-MF/TC” = “Source volume of the ShadowImage” “Pair status of the TC-MF/TC” = “Suspend” → The Reserve-Resync and Quick Restore can be executed. “Pair status of the TC-MF/TC” ≠ “Suspend” → The Reserve-Resync and Quick Restore cannot be executed. (Command Reject) • In the case where “Target volume of the ShadowImage” = “M-VOL of the TC-MF/TC” “Pair status of the TC-MF/TC” = “Suspend” → The Reserve-Resync and Quick Restore can be executed. “Pair status of the TC-MF/TC” ≠ “Suspend” → The Reserve-Resync and Quick Restore cannot be executed. (Command Reject) • A pair of the TC-MF/TC cannot be created with the volume of the ShadowImage executing the Reserve-Resync or Quick Restore. (Command Reject) These specifications do not depend on using external Volumes.

(To be continued)

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(Continued from the preceding page)

No.	Item	Description
15	Relation to the Universal Replicator / Universal Replicator for Mainframe	• In the case where “Primary volume of the Universal Replicator / Universal Replicator for Mainframe” = “Source volume of the ShadowImage” “Pair status of the Universal Replicator / Universal Replicator for Mainframe” = “Suspend” → The Reserve-Resync and Quick Restore can be executed. “Pair status of the Universal Replicator / Universal Replicator for Mainframe” ≠ “Suspend” → The Reserve-Resync and Quick Restore cannot be executed. (Command Reject) • In the case where “Secondary volume of the Universal Replicator / Universal Replicator for Mainframe” = “Source volume of the ShadowImage” “Pair status of the Universal Replicator / Universal Replicator for Mainframe” = “Suspend” → The Reserve-Resync and Quick Restore can be executed. “Pair status of the Universal Replicator / Universal Replicator for Mainframe” ≠ “Suspend” → The Reserve-Resync and Quick Restore cannot be executed. (Command Reject) These specifications do not depend on using external Volumes.

(3) Action to be taken when the pair is suspended during the Reverse-RESYNC

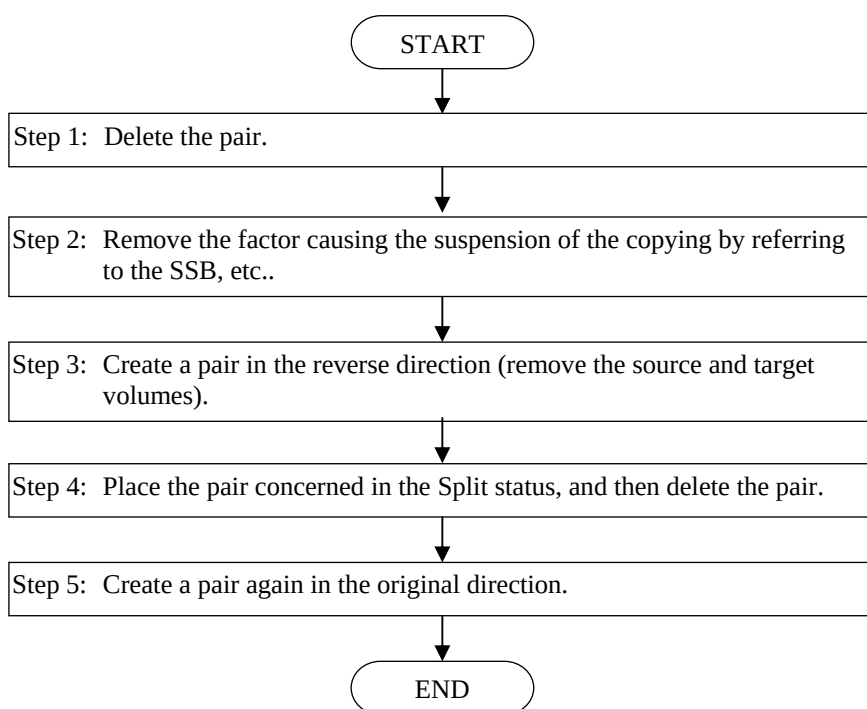
The recovery procedure to be used when the pair executing the Reverse-RESYNC is suspended owing to some problem or is explicitly transferred to the Suspend status by a command from the SVP/Web Console/RAID manager is explained below.

(a) Case 1: A case where the Suspend status can be recovered without recovering the LDEV concerned

This is equivalent to a case where the pair encounters an event that copying cannot be continued owing to a detection of pinned data or a staging time-out.

Or, it is equivalent to a case where the pair is explicitly transferred to the Suspend status by a command.

<<Recovery procedure>>



- (b) Case 2: A case where the Suspend status cannot be recovered unless the LDEV concerned is recovered

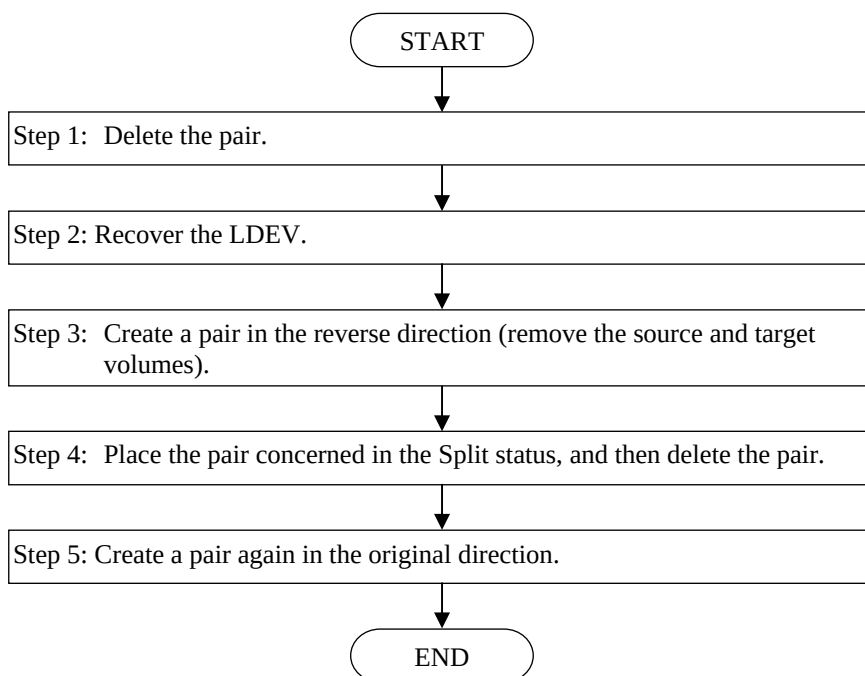
This is equivalent to a case that the LDEV is blocked.

To recover the blockade of the LDEV, an LDEV formatting or LDEV recovery is required. Both of them cannot be executed in the state that the ShadowImage pair is created. (A guard works against it.) Therefore, delete the pair once, recover the LDEV, and then create the pair once again.

However, in the pending state, caution must be taken because the data of the source volume is copied to the target volume if the pair is simply created again. Recover the blockade following the procedure below.

The following procedure is applicable just to a restoration of the source volume using the target volume. The following procedure does not include a procedure for directly restoring the source volume when the target volume is blocked.

- Case 2-1: A case where the source volume is blocked
<<Recovery procedure>>

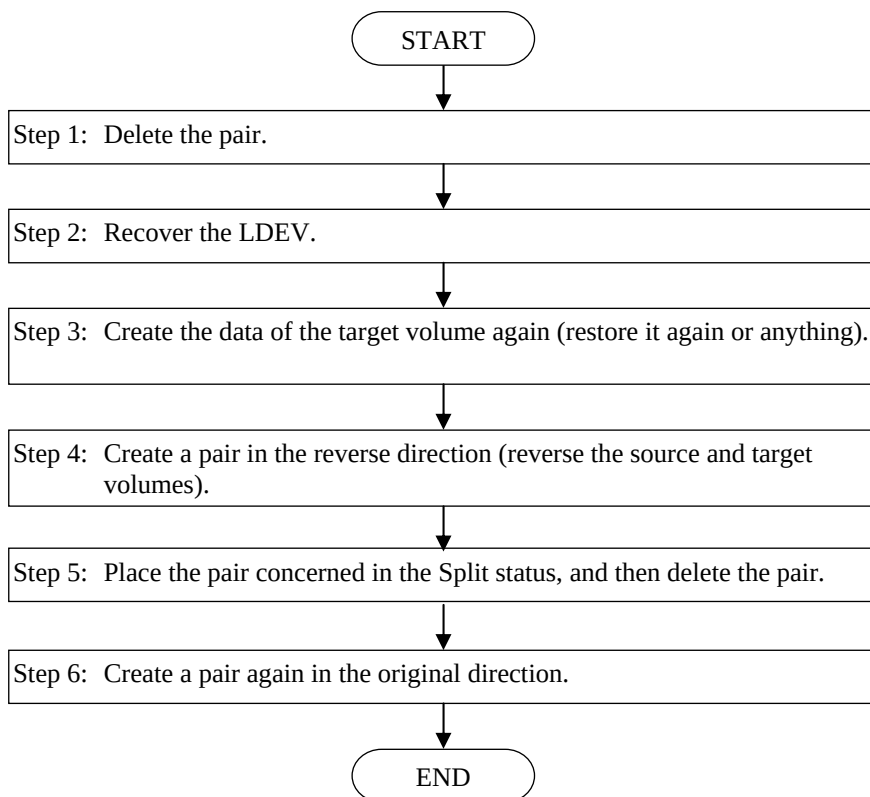


THEORY03-14-400

- Case 2-2: A case where the target volume is blocked

A recovery procedure for restoring data of the target volume is added because the copy source of the Reverse-RESYNC cannot be accessed.

<<Recovery procedure>>



3.14.7 FlashCopy (R) V2 Option function

When there is no shared memory at Location 2, be sure to add it before installing FlashCopy (R) V2. The addition of the shared memory is to be done by service personnel sent for by a user.

(1) FlashCopy (R) V2 Option functions

FlashCopy (R) V2 provides a function to copy data in high-speed.

FlashCopy (R) V2 forms a pair by copying data of a copy source (source volume) virtually or physically to a copy destination (target volume).

A pair formed by means of FlashCopy (R) V2 is called a “relationship.” Once a relationship of FlashCopy (R) V2 is established, a host can execute a reading/writing from/to target data that is a virtual or physical copy of source volume data.

When making a copy of each data set, a relationship of only the specified data set (an extent of the CCHH). This extent of data to be copied is called an “extent.” The minimum unit of the extent is a track.

(2) Use of FlashCopy (R) V2 Option together with the other function

A FlashCopy (R) V2 pair can be formed using an ShadowImage for Mainframe volume in the Simplex status. Besides the pair can be formed also using a P-VOL in the Split or Duplex status as a copy source.

Table 3.14.7-1 Possibility of Volume Sharing by FlashCopy (R) V2 and Other Copy Solutions

	Possibility of coexistence with FlashCopy (R) V2	
	FlashCopy (R) V2 S-VOL	FlashCopy (R) V2 T-VOL
ShadowImage S-VOL	Possible	Impossible
ShadowImage T-VOL	Impossible	Impossible
XRC PVOL	Possible	Impossible
XRC SVOL	Impossible	Impossible
TC-MF M-VOL	Possible	Possible
TC-MF R-VOL	Possible	Impossible
UR-MF PVOL	Possible	Possible
UR-MF SVOL	Impossible	Impossible
CC S-VOL	Possible	Impossible
CC T-VOL	Impossible	Impossible
Volume Migration	Impossible	Impossible

Note: Even if a volume can be shared by FlashCopy (R) V2 and another copy solution, there may be a case where restrictions are placed on the pair status. For details of the restriction, refer to the section, “Using with other program products together” in the “Hitachi Compatible FlashCopy (R) User Guide”.

3.14.8 Micro-program Exchange

(1) Off-line Micro-program Exchange

- ① The existence of relationship of FlashCopy (R) V2 option is checked on the Compatible FlashCopy (R) Information screen on Storage Navigator. Refer to “Hitachi Compatible FlashCopy (R) User Guide”, “Viewing resource information of Version 2 using Storage Navigator”.
 - ①-1: In the case of existing no relationship of FlashCopy (R) V2 option. go to ②.
 - ①-2: In the case of existing relationship.
Request to delete all relationship to user. However, notify user of information no longer being guaranteed T-VOL by deleting the relationship under copy.
- ② If the Copy-on-Write/Thin Image Option is installed, notify the users that data on S-VOL will be invalid.
- ③ Perform micro-program exchange operation.
- ④ If required, establish the relationship of FlashCopy (R) V2 option again.
- ⑤ If the Copy-on-Write/Thin Image Option is installed, restore the pool-VOL.

- Note 1: If step 1 above is not performed, all relationship of FlashCopy (R) V2 option is deleted forcibly .
If T-VOL is external volume, the subsystem might stand up with normal T-VOL, without blocked T-VOL.
In this case, the data of T-VOL isn't guaranteed, so you need operate either following one.
- Dataset of T-VOL is deleted
 - Initialization of volume is performed
- Note 2: Request user to delete all relationship of FlashCopy (R) V2 option beforehand at the time of performing off-line micro exchange.
- Note 3: When performing Offline Micro-Exchange, ask the user to stop using Copy-on-Write Snapshot/Thin Image, i.e.;
- Remove all Snapshot/Thin Image pairs
 - Disband all Pool Groups

THEORY03-14-450**3.14.9 Notes on powering off**

When performing a powering off, take notice of the following.

Item	Note	Reason
1	(ShadowImage) Take care that the time required for the copying becomes longer. Make a schedule taking the copying time into consideration.	If data in the shared memory has volatilized when the next powering on is performed, the following phenomena occur. - When the pair is in the Pending or Resync status, the data, from which a copying has been completed before the powering off, is also treated as data to be copied again. - Even if no I/O has been issued, the rate of data identity does not reach 100% when the pair status is changed to Duplex. - The data that has become the one to be copied again is copied to the secondary volume after the pair status is changed to Duplex. - When the pair is in the Duplex status, the data, from which a copying has been completed before the powering off, is also treated as data to be copied again. - The rate of data identity will be 0%. - The copying of the data, which has become the one to be copied again, is performed in the state in which the pair is in the Duplex status. - When the pair is in the Split status, the whole volume will be a differential between the two volumes. - The rate of data identity will be 0%. - Data of the whole volume is copied when a resynchronization is performed.
2	(ShadowImage) As to a pair in the Split transitional status (SP-Pend, V-Split), complete the copying of it and put it in the Split status.	If data in the shared memory has volatilized when the next powering on is performed, the following phenomenon occurs. When the pair is Split transitional status (SP-Pend, V-Split), it is changed to Suspend.
3	(FlashCopy (R) V2 Option function) Perform a powering off of the subsystem after the copying is completed.	If data in the shared memory has volatilized when the next powering on is performed, the following phenomena occur. - The relationship is dissolved. - The secondary volume is detached. If T-VOL is external volume, the subsystem might stand up with normal T-VOL, without blocked T-VOL. In this case, the data of T-VOL isn't guaranteed, so you need operate either following one. - Dataset of T-VOL is deleted - Initialization of volume is performed
4	(ShadowImage At-Time Split function) Perform PS OFF when by split operation by At-Time Split function, after change status of all pairs belonging to consistency group is completed. (ShadowImage for Mainframe At-Time Split function) Perform PS OFF when by pair operation of copy group specification, or split operation by split time registration, after change status of all pairs belonging to consistency group is completed.	Pair by which change status is not carried out even if it carries out PS ON may occur.

3.14.10 Copy-on-Write Snapshot/Thin Image option

Both Copy-on-Write Snapshot option and Thin Image option require the shared memory. For more details, please refer to the section of “6.2 Required CM Capacity” ([INST06-70](#)).

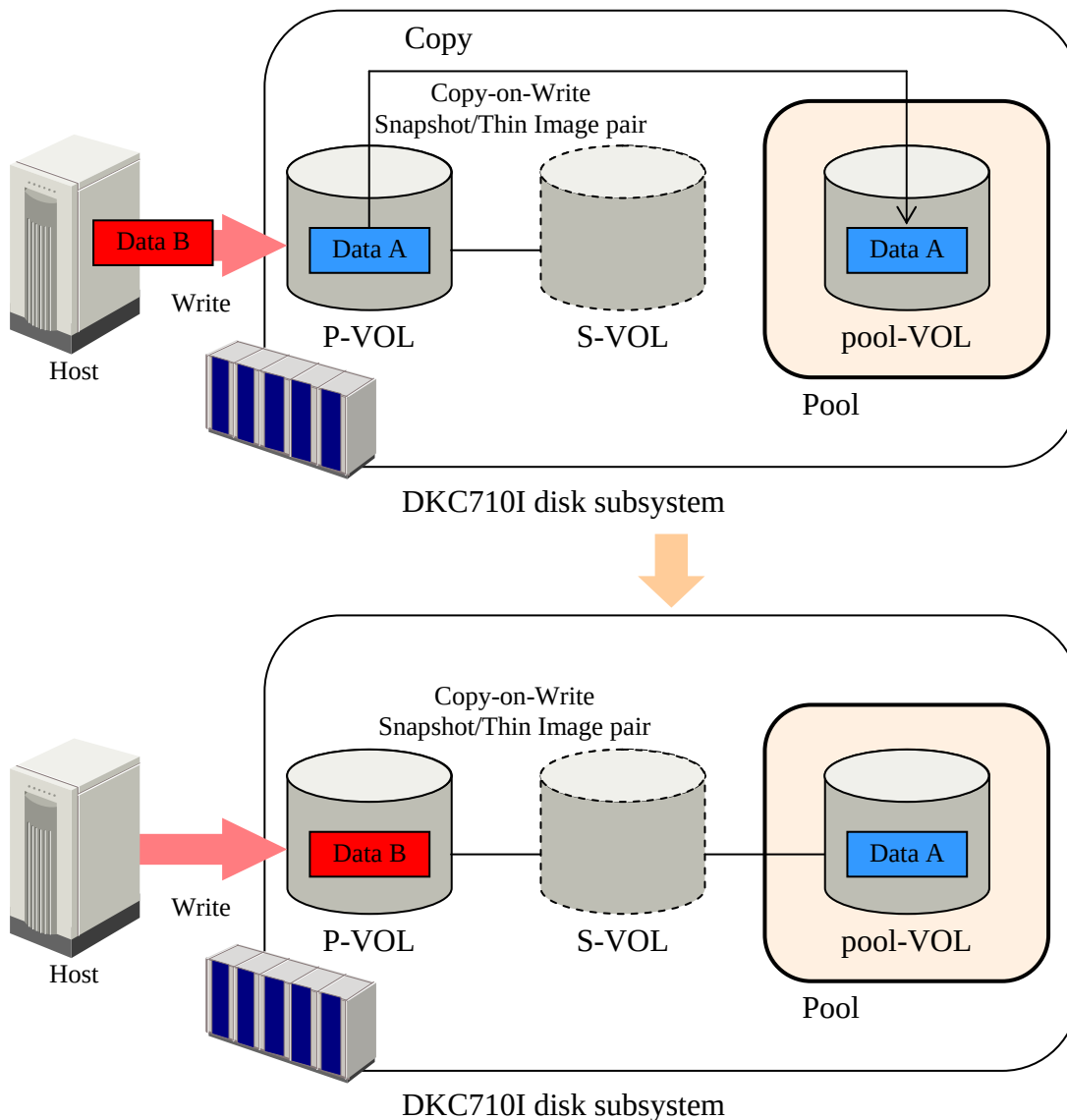
(1) Copy-on-Write Snapshot/Thin Image function

It is a product to copy and manage the data in the disk subsystem as well as the ShadowImage function. The Copy-on-Write Snapshot/Thin Image forms the pair of which the logical volume is made as the primary volume (hereafter, indicated as P-VOL), and the virtual volume (hereafter, indicated as V-VOL) is made as the secondary volume (hereafter, indicated as S-VOL).

Because the S-VOL of the Snapshot/Thin Image pair is the V-VOL with no reality, the S-VOL does not actually consume the capacity of the disk subsystem.

As for the Snapshot/Thin Image pair, only the part to be updated is copied to the pool-VOL among the data of the P-VOL. Therefore, the capacity used by the entire disk subsystem can be reduced.

It is possible to access the S-VOL of the Snapshot/Thin Image pair. In this case, the data of the P-VOL is referred to via the S-VOL. Therefore, the load concentrates on the parity group of the P-VOL. Also, if the P-VOL becomes a failure, it cannot access the S-VOL.



(2) Pool-VOL

A pool is an area to store the snapshot data acquired by the Copy-on-Write Snapshot/Thin Image.

The pool is configured with two or more pool-VOLs, and the snapshot data is actually stored in the pool-VOL.

As a result of writing the data in the volume of the Snapshot/Thin Image pair, when the amount of the pool in use exceeds the capacity of the pool, the Snapshot/Thin Image pair becomes PSUE (status of the failure occurrence), and cannot acquire the snapshot data.

(3) Shared memories of Copy-on-Write Snapshot

In the case of Copy-on-Write Snapshot, it is necessary to secure the capacity of 1Gbytes × 2 to 2Gbytes × 2 for the V-VOL management area (VFS SYSAREA) where the pool is managed.

3.15 TPF

3.15.1 An outline of TPF

TPF stands for Transaction Processing Facility.

TPF is one of operating systems (OS) for mainframes mainly used for airline customer reservation systems.

To correspond to TPF, DKC must support logical exclusive lock facility and extended cache facility.

The former is a function which is called MPLF (Multi-Path Lock Facility) and the latter is a function which is called RC (Record Cache).

DKC has implemented a special version of microprogram which supports the MPLF and RC functions of TPF feature (RPQ#8B0178), described in IBM public manuals:

- (a) IBM3990 Transaction Processing Facility support RPQs (GA32-0134-03)
- (b) IBM3990 Storage Control Reference for Model 6 (GA32-0274-03)

(1) An outline of MPLF

This facility provides a means, using a DKC, to control concurrent usage of resources in host systems via use of logical locks. A logical lock may be defined for the control of a shared resource, where the sharing of that resource must be controlled. Each shared resource has its own name called Lock Name. Every Lock Name controls multiple lock states (2 to 16).

The following figure shows the outline of I/O sequence which uses MPLF.

DKC recognizes up to 16 MPLF users. In this figure, user A and user B are shown. These users may belong to the same HOST or different HOSTs. Each user must indicate MPLP (Multi-Path Lock Partition) to use MPLF. MPLP is a means of logically subdividing the MPLs (Multi-Path Locks) for a user set. The maximum number of MPLP is four. Each MPLP has numbered from 1 to 4. The process to get permission to use MPLF is called CONNECT.

The connected user executes the SET LOCK STATE process using Lock Name. The MPL corresponding to specified Lock Name is assigned to the user. This assignment is canceled by the UNLOCK process. HOSTs can share the DASD without contradiction by using this MPLF.

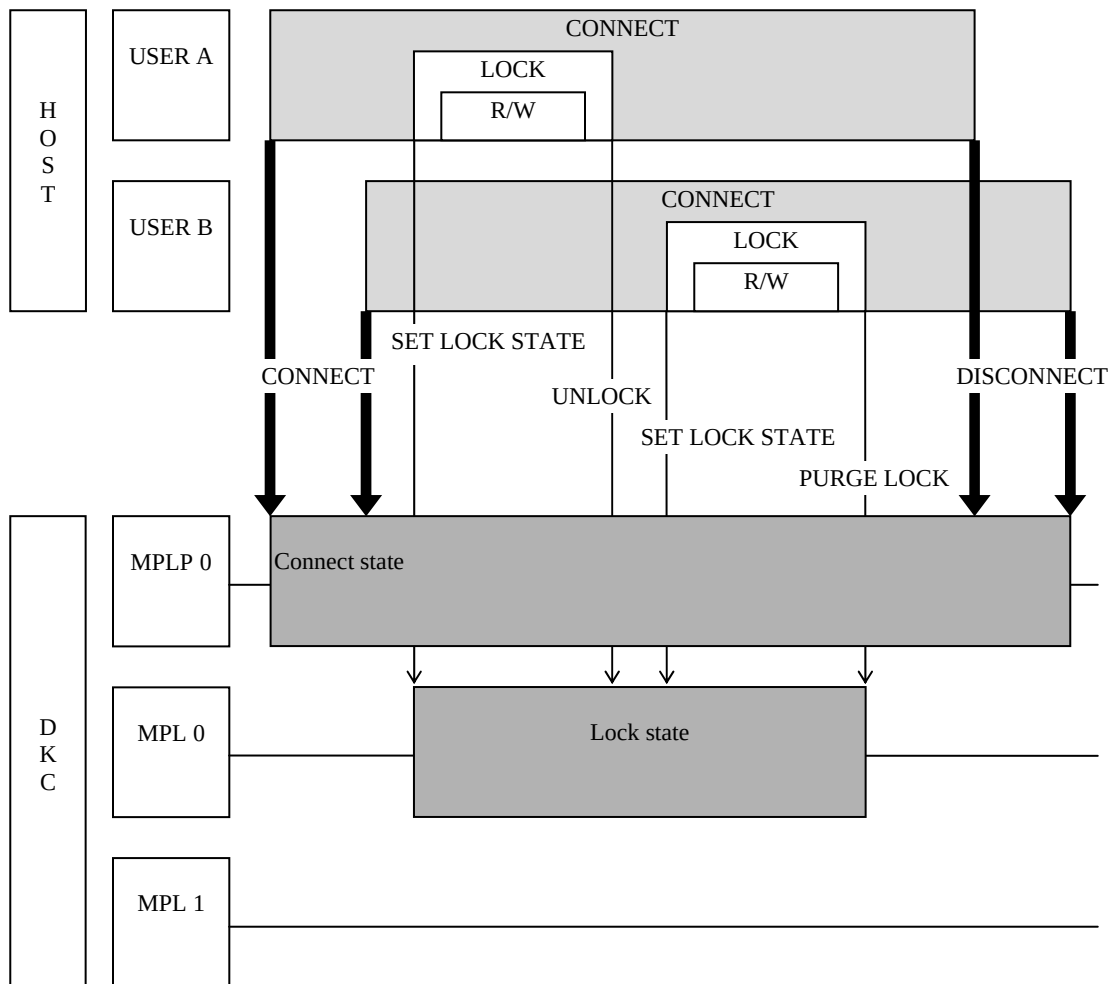


Fig. 3.15.1-1 An outline of MPLF

(2) An outline of RC

RC has the following two features:

- (a) Record Mode Chain
- (b) Record Caching

The following explains these features.

(a) Record Mode Chain

Record Mode Chain consists of the following 4 command chains:

- 1) Mainline Processing (Read)
- 2) Mainline Processing (Write)
- 3) Capture
- 4) Restore

To execute Record Mode Chain, a subsystem must be initialized for Record Caching, and Record Mode must be allowed for the addressed device. Under these conditions, Record Mode Chain works when Record Mode Chain is indicated in the Extended Global Attributes of Define Extent command. Otherwise, the chain is processed in a standard mode.

A Mainline Processing chain consists of a Define Extent command, a Locate Record command, and a single Read Data or Write Update Data command.

A Capture chain consists of a Define Extent command followed by a Seek command and multiple Read Count, Key, and Data commands.

A Restore chain consists of a Define Extent command, a Locate Record command, and multiple Write Update Data commands.

(b) Record Caching

Record Caching is a naming contract with Track Caching used in a standard model. At the completion of first initialization, all caches are allocated to Track Slot as a standard model. Record Cache will be allocated if Set Cache Allocation Parameters Order is issued.

THEORY03-15-40**3.15.2 TPF Support Requirement****(1) OS**

TPF Ver.4.1.

(2) Hardware

The following table shows subsystem hardware specification for TPF support.

Table 3.15.2-1 TPF Support Hardware Specification

Item	Description
Number of MODs	Max. 16,384/box
Number of LCUs/Box	Max. 64
Number of SSIDs/LCU	1
Cache/SM capacity	(Refer to INST06-70)
RAID level	6, 5 or 1
Emulation type	
(1) LCU	2107
(2) Device	3390-3/9/L/M
Number or Multi-Path Locks	16,384/LCU (assigned to only 16LCUs) 4,096/LCU (assigned to 64LCUs)
Option features:	
(1) CVS	Available
(2) DCR	Available
(3) TC-MF	Available *2
(4) UR	Available *2
(5) SI-MF	Available
(6) VM	Available *1
(7) Cross-OS File Exchange	(Not Available)
(8) HMBR	(Not Available)

*1: VM supports only a monitor function.

*2: It is available for only offline volume.

3.15.3 TPF trouble shooting method

Basically TPF environment and MVS (as a standard operation system) are same in troubleshooting.

A example order is below:

- (a) Collect system error information by Syslog...etc.
- (b) Collect DKC error information by SVP dump operation.
- (c) Send the above data to T.S.D.

3.15.4 The differences of DASD-TPF (MPLF) vs DASD-MVS

(1) Data-exclusive method by MPLF function

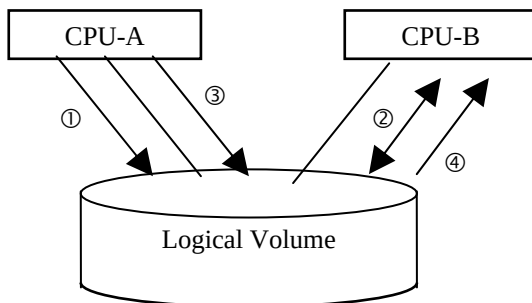
MVS environments

- (a) Logical volume (Device) is the unit of data-exclusive between several CPUs.
- (b) “Device” is owned by one CPU during CPU processing (accessing), and “Device-busy” status is reported to another CPU’s accesses.
- (c) “Device-end” status is used to notify the waiting CPUs.
- (d) when the device becomes free.

TPF environments

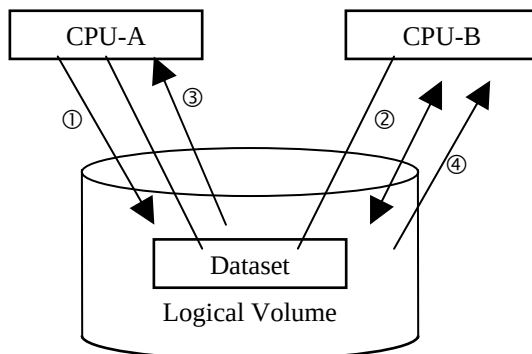
- (a) Logical “Lock” is used for this purpose, instead of logical volume (device) of MVS.
 - (b) Most Read/Write CCWs have a unique: Prefix-CCW (Set Lock) to own the target lock. And only when the request-lock is granted to, its CCW continues the following Read/Write processes.
 - DSB=“4C” is for granted / DSB=“0C” is for NOT-granted (wait).
 - (c) “Attention” status is used to notify the waiting CPUs when the lock becomes free.
 - (d) The relationship between Lock and Dataset is completely free.
- Usually TPF users (customers) have their own definitions.

MVS environments



- ① Reserve/Read&Write Access by CPU-A (Successful).
- ② CPU-B's trial is rejected by Device-busy (Failed).
- ③ Terminate its process and release the volume.
- ④ Free (Device-end) will be sent. CPU-B can use this volume.

TPF environments



- ① Set Lock/Read&Write process *1 by CPU-A (Successful).
- ② CPU-B's trial is rejected by Not-granted (failed).
- ③ Terminate with Unlock, by CPU-A.
- ④ Free (Attention) will be sent. *2. CPU-B can use this Dataset.

*1: Typical CCW chain:

- Set lock State (x27/order(x30));
- Read Subsystem Data (x3E);
- TIC (to be continued if granted)
- (ordinary CCW chain)

*2: This report's path/Address is usually different from above ②.

Fig. 3.15.4-1 Environments of DASD-TPF and DASD-MVS

(2) No path-group

MVS environments

- (a) Each CPU establishes the Path-group on every DASD Online-device, using all the connected paths.
- (b) Channel and DASD (Control Unit) rotate the I/O service path to meet each occasion within this group.
- (c) “Device-end” status can be reported through any-path of this group.

TPF environments

- (a) TPF OS/CPU does not establish this Path-Group, even if the configuration has multiple-paths for DASD.
- (b) But the Channel rotates the I/O request-path, within the connected paths. (Like old MVS way)
- (c) “Attention” report is restricted to one “Connect-Path” which has been defined during IPL (Vary-online) procedure.

(3) Connect Path/Device

- (a) TPF system issues “Connect order” to define :
 - Lock tables on each DASD control-unit.
 - Report path & Device for Attention interrupt.
- (b) This order is code (x33) of Perform Subsystem Function (x27) command.
- (c) This order is issued during the IPL process of each CPU.
- (d) CPU (channel) only has the capability to change this path and device definition.

Table 3.15.4-1 Order-list of Perform Subsystem Function (x27) command

Order	Meaning	Function
x10	Commit	RC
x11	Discard	
x18	Prepare for Read Subsystem Data	
x19	Destage Modified Tracks	
x1B	Set Special Intercept Condition	
x20	Set Cache Allocation Parameters	
x21	Suspend/Resume Function	
x22	Prepare to Read Lock Data	MPLF
x30	Set Lock State	
x31	Purge Lock	
x32	Unlock	
x33	Connect	
x34	Disconnect	

For details, please see the following IBM RPQ manual;

“IBM 3990 Transaction Processing Facility Support RPQs” (GA32-0134-03)

(4) Channel Re-drive function

MVS environments

- (a) In general, the Channel selects the most proper path (in the Path-group) for each I/O request.
- (b) In MVS environments, there is not this kind of function.

TPF environments

- (a) In TPF environments, to keep a fast I/O response and I/O request-order (fast-in, fast-out), this kind of special function has been introduced. (This is our conjecture.)
- (b) By the channel-monitor data, once I/O request is rejected with Control-unit busy by DASD, Sub-channel repeats a reconnect-trial to DASD (with some short interval) until (1) the sub-channel gets into DASD or (2) it reaches the trial-count threshold. (In this case, the I/O request is registered to some waiting Queue in the channel.)
- (c) And once the I/O request is accepted by DASD control-unit, next Control-unit judges this would be accepted or not using "Lock" status.

(5) Fixed Record-size

Dataset structure in DASD

In general, TPF software makes the following logical structure in DASDs.

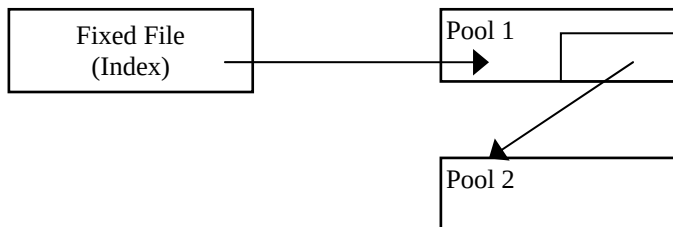


Fig. 3.15.4-2 Logical structure in DASDs

Table 3.15.4-2 Pool records Classification

Logical (usable) size	Physical size
381 Bytes	384 Bytes
1,055 Bytes	1,056 Bytes
4,095 Bytes	4,096 Bytes

Only three lengths exist for pool records.

Table 3.15.4-3 More detailed classification

381 Record	1,055 Record	4,095 Record
SLT (Small, Long Term)	LLT (Large, Long Term)	4LT (4KB, Long Term)
SST (Small, Short Term)	LST (Large, Short Term)	4ST (4KB, Short Term)
SDP (Small, Long Term, Duplicated)	LDP (Large, Long Term, Duplicated)	4DP (4KB, Long Term, Duplicated)

(6) Prime/Dupe MODs pairs

- (a) To improve Data-integrity of DASD, TPF system often makes the Data-duplications on different two DASD subsystems.
- (b) The following figure shows one example of these pairs.
Prime MOD(module)s and Dupe MODs are always located on each side of subsystem (spread to all subsystems).

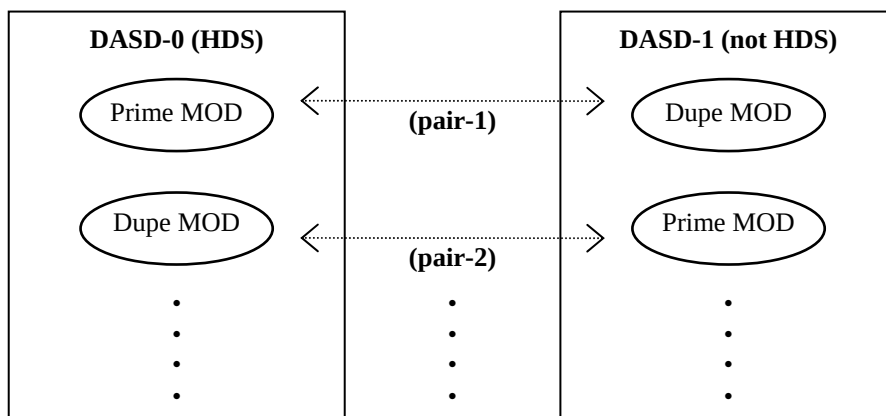


Fig. 3.15.4-3 Prime/Dupe MODs pairs

(7) Data Copy procedures

The Copy procedures are taken for the following purposes:

- (a) To make a pair (To copy data from Prime MOD to Dupe).
- (b) To recover the failed data (To copy the remaining data to the re-init MOD).

There are two ways to make a pair.

- (a) AFC (All File Copy)
- (b) AMOD copy
 - (a): In this copy process, the destination-drive of the copy keeps “Offline” status, and just after the completion of this copy, the source-drive becomes “Offline” and the destination-drive changes to “Online”. From the view-point of TPF software, there is only one MOD, independent of copy process.
 - (b): In this copy process, both source-drive and destination-drive stay “Online”. TPF software can distinguish both drives, even in the copy process.

3.15.5 Notices for TrueCopy for Mainframe-option setting

<SVP operation>

(1) RCU Option

We strongly recommend you to select “No” in the “PPRC support by host” column of the “RCU Option” window.

We strongly recommend you to select the “Not Report” in the “Service SIM of Remote Copy” column of the “RCU Option” window.

(2) Add Pair

We strongly recommend you to select the “Copy to R-VOL” in the “CFW Data” column of the “Add Pair” window.

(3) Suspend Pair

We strongly recommend you to select the “Disable” in the “SSB(F/M=FB)” column of the “Suspend Pair” window.

<Host (TPF-OS) consideration>

In MVS-OS world, DKC with TC-MF expects (requires) Customers to extend I/O Patrol Timer to prevent many MIHs from reporting.

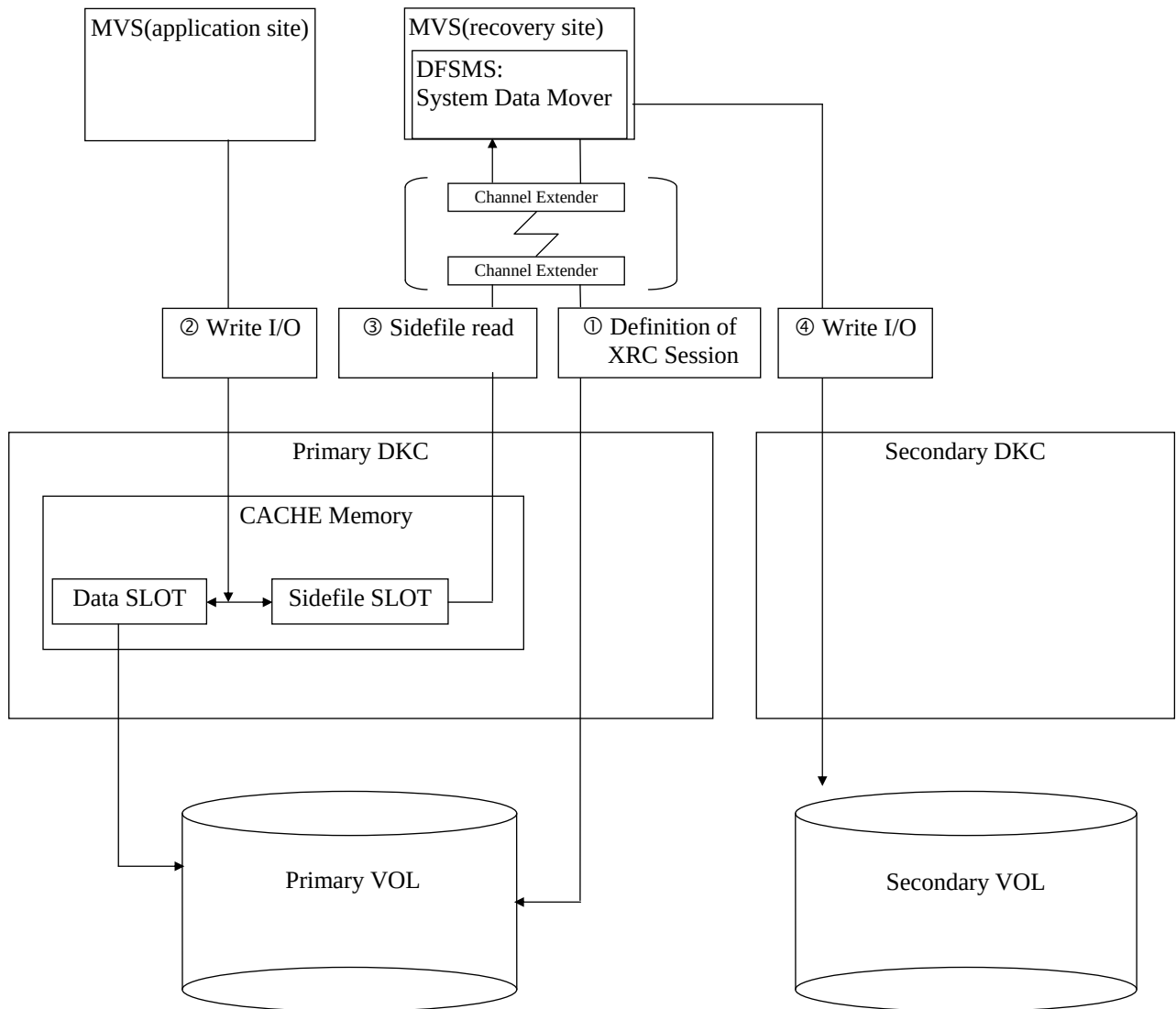
Also in TPF-OS world, same consideration is required, so please discuss with your Customer to find the opportunity to extend “Stalled Module Queue” timer over 5 seconds.

3.16 XRC

3.16.1 Outline of XRC

XRC is not supported in Ver.1.

XRC (eXtended Remote Copy) function provides for data replication at distance in order to recover for disaster.



- System Data Mover defines a XRC pair session. (①)
- When a write command is issued to the primary volume from application site, the primary DKC makes Sidefile data (replication) on cache memory. (②)
- System Data Mover reads Sidefile data non-synchronously at distance, and writes it to the secondary volume. (③, ④)

Fig.3.16.1-1 An outline of XRC

3.16.2 XRC Support Requirements

3.16.2.1 OS

(1) OS level

- (a) MVS/ESA 4.3.0 or upper.
- (b) DFSMS/MVS 1.1.0 or upper.

<Restriction of SMS 1.4 environment>

The Maximum number of XRC pair per CU image is up to 128 under SMS 1.4 environment. CCA (Channel Connection Address) can be specified to 128 logical devices per CU image such as '00' - '7F'. CCA addresses '80' - 'FF' for XRC may be rejected by System Data Mover.

(2) Conditions of XRC in use

- (a) The following conditions must be satisfied by OS before starting the XRC function,

- CACHE ON
- NVS ON

and must be the CACHE ON status on DKC.

When CACHE OFF/NVS OFF commands are issued by OS or Cache malfunctions (includes 'Ref code=FFEE: Area temporary blocking) occur, the XRC function is stopped.

(b) I/O Patrol Value

(I) Without CHL Extender

- Current patrol time(more than 30sec).

(II) With CHL Extender

- More than 70sec.

(c) Session ID

- Up to 64Session ID's can be utilized per CU for Concurrent Copy (CC) and XRC.
- Up to 64Session ID's can be utilized per CU for XRC.
- Up to 16Session ID's can be utilized per VOL for Concurrent Copy (CC) and XRC.
- Only 1Session ID can be utilized per VOL for XRC.

3.16.2.2 Hardware

(1) XRC Support Hardware Specification.

Table 3.16.2.2-1 XRC Support Hardware Specification

CU Type	2105/2107(*1)
DEV Type	3390-3/9/L/M(*3)/A(*4), 3380-3(*2)
DKC Model	Primary: RAID700 Recommended Secondary: RAID700/RAID600/RAID500/RAID450/RAID400/ RAID300/RAID200HA/DKC80/DKC90
RAID Level	RAID5/RAID1
Channel	FICON

*1: Do not intermix of DKC emulation type '2105/2107' and 3990-6/6E in the same DKC.

If you change DKC emulation type '2105/2107', the following operation.

- Delete All CC/XRC pairs
- Change DKC emulation type 2105/2107 of All CHE PK
- RESUME CC/XRC pairs

*2: 3380-3 is supported only when the DKC emulation type is '2105/2107'.

*3: If you want to use DKU emulation type 3390-M, PTF 'UA18053: Support XRC volume SIZE up to 65520 CYL' adaptation is necessary.

*4: 3390-A is supported only when the DKC emulation type is '2107'.

(2) CACHE SIZE

Cache capacity should be doubled from the current cache size.

(The amount of Sidefile data may occupy up to 60% of total cache capacity.)

THEORY03-16-40**3.16.2.3 Micro-program**

- (1) XRC supports from the 1st version of Main Frame Micro-program.
- (2) CNT extender version 4.9 or upper level code is recommended.

(3) Device Blocking Function and Load Balancing Control

DKC does not block Write I/Os for the logical device which is specified the DONOTBLOCK option not to affect performance impact for application programs.

<Requirements>

The following conditions need to activate the DONOT BLOCK option.

For Operating system

- The operating system should support the DONOT BLOCK option.

For RAID system

- Set XRC option DONOT BLOCK = Enable for the DONOT BLOCK option.

DKC performs current load balancing control, if DONOT BLOCK = Disable (default).

- Should be holding DONOT BLOCK = Disable (default), if the operating system does not support the function.

3.16.2.4 XRC recommendations

- (1) Recovery site CPU is the most ideal location for Data Mover.
- (2) Data Mover's path should be utilized only to read Sidefile.
- (3) Subsystem configurations
 - Cache capacity : Should be doubled from current cache size.
 - Confirmation for Number of channel paths for system data mover (SDM)
 - Confirmation for Work loads for the subsystem
- (4) Utility device for primary volume
 - Should be prepared for each XRC session.
 - A low activity device should be selected as a Utility Device
 - Utility Device should be specified at the 1st time before establishing pair volumes.
- (5) System Data Mover (SDM)
 - Confirmation for PTF levels
 - No record found problem. : APAR # OW30183, OW33680
 - Necessary tuning for SDM data set : Capacity, Geometry of the data set
- (6) DB2
 - Broken VSAM index file problem : APAR # II08859
- (7) Others
 - CPU MIPS : Enough for XRC environment
 - LINE CAPACITY : Enough for XRC environment with channel extender.
- (8) XRC PP option
 - If the ANTA5107E(RC=9014 REAS=604 OR REAS=608) console message is displayed during the XADDPAIR operation for XRC pairs the operation might be unsuccessful.
 - In this case, you may check the XRC PP Option Installed. If XRC PP Option not install Please install XRC PP option.
 - Hitachi – Extended Remote Copy PP Option effects only 2105/2107 dkctype.
 - You can use Hitachi – Extended Remote Copy for 3990 dkctype without this PP option.
- (9) XRC with FICON

Table 3.16.2.4-1 XRC and FICON configuration

		Record set transfer path (System Data Mover - DKC)	
		FICON	ESCON
Application site	ESCON	Not Supported	Not Supported
(System and DKC)	FICON	Supported	Not Supported

- (10) TOD setting or updating of Synchronization information
 In the case that the amount of Sidefiles reach to the threshold, XRC pair may be suspended due to operator's manual operation of "TOD setting" or updating of "Synchronization information".

3.16.3 Online Maintenance while Concurrent Copy (CC)/XRC in use

(1) Availability of Installation and DE-installation.

Component	Maintenance Type	During initial copy		Established		Suspend	
		Primary	Secondary	Primary	Secondary	Primary	Secondary
HDD canister	Installation	*	x	*	x	*	x
	De-installation	*	x	*	x	*	x
Cache PCB	Installation	*	x	*	x	*	x
	De-installation	*	x	*	x	*	x
CHA	Installation	x	x	x	x	x	x
	De-installation	x	x	x	x	x	x
DKA	Installation	x	x	x	x	x	x
	De-installation	x	x	x	x	x	x
MPA	Installation	x	x	x	x	x	x
	De-installation	x	x	x	x	x	x
ESW PCB	Installation	x	x	x	x	x	x
	De-installation	x	x	x	x	x	x

x: Maintenance is available.

*: Maintenance is available but it should take place when workload is low. The following are recommendations.

When a maintenance operation is needed while CC/XRC is being used, I/O's for CC/XRC pair volumes or CC/XRC itself should be stopped before the maintenance operation.

If the maintenance operation must be done while CC/XRC is being used, you must confirm that the usage of Sidefile monitor is less than 20% of total Cache capacity by monitoring each combination of MPPK and CLPR usage before you start the maintenance operation. Only when the usage of Sidefile monitor is less than 20% of total Cache capacity, you can proceed the maintenance operation.

Refer to "Monitoring" in the SVP SECTION about Sidefile monitor.

- Select the [Monitor] button in the SVP main panel to start the monitoring feature.
- From the menu in the 'Monitor' panel, select [Monitor]-[Open...].
- Select 'Cache' from [Object] and 'Cache Sidefile' from [Item] in the "Select Monitor Item" panel. After that, select [=>] button and then the [OK] button.

(2) Availability of the System tuning .

When the following System tuning operation is needed while CC/XRC is being used, CC/XRC should be stopped before the System tuning operation.

- It is impossible to change the DKC No, SSID, or DKC Emulation type by System tuning operation while CC/XRC is being used.

(3) Availability of the Replacement.

Component	Maintenance Type	During initial copy		Established		Suspend	
		Primary	Secondary	Primary	Secondary	Primary	Secondary
Logical Device	Blockade	**	**	**	**	**	**
	Recovery	**	**	**	**	**	**
	Format	**	**	**	**	**	**
	Verify	x	x	x	x	x	x
HDD canister	Replace	x	x	x	x	x	x
Cache PCB	Replace	*	x	*	x	*	x
CHA	Replace	x	x	x	x	x	x
DKA	Replace	x	x	x	x	x	x
MPA	Replace	x	x	x	x	x	x
ESW PCB	Replace	x	x	x	x	x	x

x: Maintenance is available

*: Maintenance is available but it should take place when workload is low. The following are recommendations.

When a maintenance operation is needed while CC/XRC is being used, I/O's for CC/XRC pair volumes or CC/XRC itself should be stopped before the maintenance operation.

If the maintenance operation must be done while CC/XRC is being used, you must confirm that the usage of Sidefile monitor is less than 20% of total Cache capacity by monitoring each combination of MPPK and CLPR usage before you start maintenance operation. Only when the usage of Sidefile monitor is less than 20% of total Cache capacity, you can proceed the maintenance operation.

Refer to "Monitoring" in the SVP SECTION about Sidefile monitor.

- Select the [Monitor] button in the SVP main panel to start the monitoring feature.
- From the menu in the 'Monitor' panel, select [Monitor]-[Open...].
- Select 'Cache' from [Object] and 'Cache Sidefile' from [Item] in the "Select Monitor Item" panel. After that, select [=>] button and then the [OK] button.

** : When a maintenance operation is needed while CC/XRC is being used, CC/XRC should be stopped before the maintenance operation.

3.17 Volume Migration

3.17.1 Volume Migration Overview

This document describes the function of Volume Migration that is one of program products.

RAID system can be constructed by several types of physical drives and three types of RAID levels (RAID1, RAID5 and RAID6).

This combination of the type of physical drive and the type of RAID level provides a system that cost and performance are optimized to user environment. However, it is difficult to get information about actual operation of physical drives in the RAID system unlike other disk subsystems.

- (1) Volume Migration provides solutions of the problem and supports decision of users to determine system construction as described below.
 - (a) Load balancing of system resources
Unbalance of utilization of system resources makes performance worse. Volume Migration supports decision of optimized allocation of logical volumes to physical drives.
 - (b) Migration of logical volumes optimized to access patterns to physical drives
For instance, RAID5/RAID6 are suitable to sequential access, and RAID1 of high performance drive is suitable to random access that is required small response time. Volume Migration shows types of access pattern to physical drives clearly, and supports migration of logical volumes to suit the access pattern.
- (2) Volume Migration consists of following subfunction to achieve above purposes. Users can refer to utilization of system resources monitored by monitor function, decide reallocation plan by using estimate function, and reallocate the logical volumes by volume moving (migration) function.
 - (a) Monitor function(*1) monitors and shows utilization of system resources.
 - (b) Estimate function estimates utilization of parity groups after migration of logical volumes.
 - (c) Volume moving (migration) function moves logical volumes to specified parity groups.
 - (d) Automating Migration function makes a migration plan from information that users preset, and moves the logical volumes by the migration plan automatically.

*1: The license of Performance Monitor is required.
For details, refer to “Performance Guide” of Program products.

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3.17.2 Hardware requirements

Addition of SM capacity setting may be needed if SM capacity setting in the DKC is not enough.
Please refer to INSTALLATION SECTION.

3.17.3 Software requirements

The Program Product, Performance Monitor is required.

3.17.4 Monitor function

The Performance Monitor Program is required to perform this function.

(1) How to start and stop.

Monitoring starts in DKC by direction from the Monitoring Option window.

Monitor function monitors ratios of utilization of system resources described below.

(a) Usage rates of channel processors

(b) Starnet utilization ratio

(c) Usage rates of DDRs

(d) Parity group utilization: Disk utilization of parity groups.

The used time of physical drives in a parity groups.

(e) Parity group utilization ratio of each logical volume: The used time of physical drives of synchronous and asynchronous access on each logical volume, averaged by the number of physical drives in the parity group.

Parity group utilization means the sum of utilization of each logical volume in the parity group.

Directions for an stop from the Monitoring Option window to finish the collection of the Monitoring information.

(2) How to collect

Monitoring information is acquired automatically until directions for an acquisition end are issued after directions for an acquisition start of the Monitoring information are issued on the Monitoring Option Window.

When acquired Monitoring information is collected in SVP, it learns to refer to it with a [Physical] tab.

It is done automatically collecting opportunity Monitoring information every 15 minutes.

The collected Monitoring information up to 3 months is stored in the hard disk of SVP.

When a monitor function is continued for more than 3 months, it is erased in order from the old information, and new Monitoring information is cumulated.

(3) How to view

The Monitoring information which accumulated in SVP can be referred to with a [Physical] tab.

The period of the Monitoring information which accumulated can be specified by the operation of the part Term.(It is optional in the unit for 15 minutes.)

Information about the Monitoring information of the period specified in the part Term is indicated in the Table part and the Graph part.

The utilization of the resource (average and maximum value) chosen in the Tree part is indicated in the Table part.

The utilization of the element chosen by the Table part is graphed and indicated by the Graph part.

3.17.5 Estimate function

The estimate function estimates changes of parity group utilization and parity group utilization of each logical volume after migration of the logical volume to specified parity group. The estimate function estimates the changes from the monitored information.

3.17.6 Volume moving (migration) function

Volume moving (migration) function moves data in logical volume (source volume) to physical location of another logical volume (destination volume). Users specify the volumes in Volume Migration utility window.

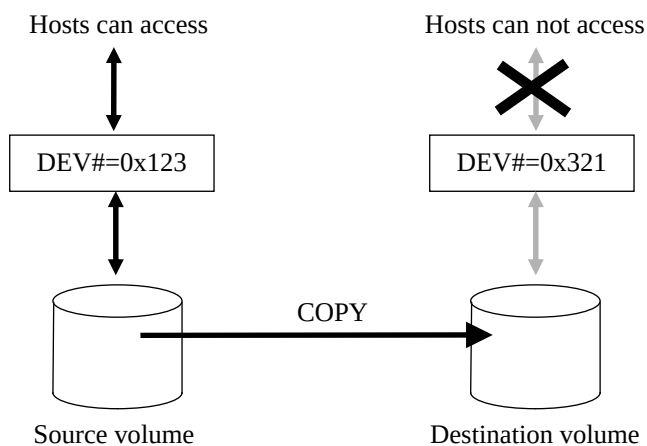


Fig. 3.17.6-1 Before moving

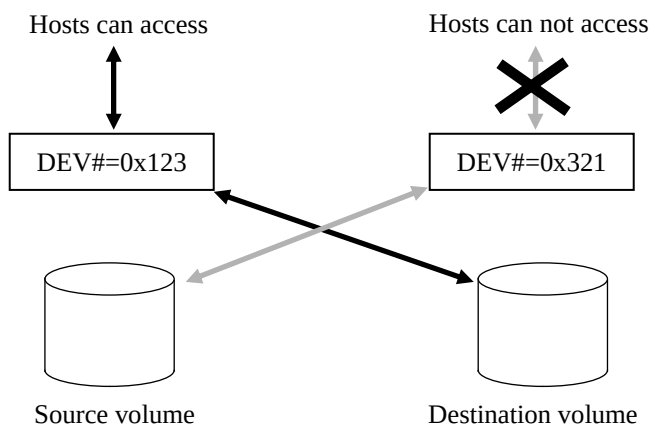


Fig. 3.17.6-2 After moving

(1) Volume moving function Overview

(a) Source volumes:

The following volumes cannot be used as source volumes:

- Volumes which are set as command devices (devices reserved for use by the host)
- Volumes which are used by XRC
- Volumes which are used by Concurrent Copy (CC)
- Volumes which have FlashAccess (also called DCR) data stored in cache
- Volumes which are in an abnormal or inaccessible condition (e.g., pinned track, fenced)
- Journal Volumes which are used by Universal Replicator
- Volumes which are reserved by a migration program other than Volume Migration
- Volumes on which CCI is performing volume migration operation
- Secondary volumes that form a Copy-on-Write Snapshot pair
- Volumes that form a Thin Image pair
- Virtual volumes and pool volumes
- Volume executing Quick Format

If the status of volumes that form TrueCopy for Mainframe pairs is suspended or duplex, the volumes can be used as source volumes. If you delete an TrueCopy for Mainframe pair from an MCU, the status of the M-VOL and the R-VOL changes to simplex so that the volumes can be used as source volumes. If you delete an TrueCopy for Mainframe pair from an RCU, the status of the M-VOL changes to suspended and the status of the R-VOL changes to simplex so that the volumes can be used as source volumes.

If the status of volumes that forms TrueCopy pairs is PSUS or PSUE or PAIR, the volumes can be used as source volumes. If not, the volumes cannot be used as source volumes. If you delete an TrueCopy pair from an MCU, the status of the P-VOL and the S-VOL changes to SMPL so that the volumes can be used as source volumes. If you delete an TrueCopy pair from an RCU, the status of the P-VOL changes to PSUS and the status of the S-VOL changes to SMPL, so that the volumes can be used as source volumes.

— Dynamic Provisioning / Dynamic Provisioning for Mainframe Volume

If the Dynamic Provisioning / Dynamic Provisioning for Mainframe Volume are used as source volumes, the Dynamic Provisioning / Dynamic Provisioning for Mainframe Volume that associates same pool volume as source volumes can't be specified as target volumes.

The Dynamic Provisioning / Dynamic Provisioning for Mainframe V-VOL whose capacity is being expanded cannot be used as the source volume for volume migration. After DP V-VOL expansion is completed, the V-VOL can be used as the source volume for migration. In this case, make sure that the capacity of the target volume must be the same as that of the expanded source volume.

— Volumes which configure the Universal Replicator for Mainframe pairs

If the status of the volumes is Pending duplex or Duplex, they cannot be source volumes. Also, if the volumes which configure the Universal Replicator for Mainframe pairs are used as source volumes, external volumes cannot be specified as target volumes.

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When Delta Resync is set in 3D Multi Target Configuration (See Fig. 3.17.6-3), P-VOL and S-VOL of a pair of Universal Replicator for Mainframe and for Delta Resync can be set as a source volume. However, the status of each pair in 3D Multi Target Configuration is required to be as the following table.

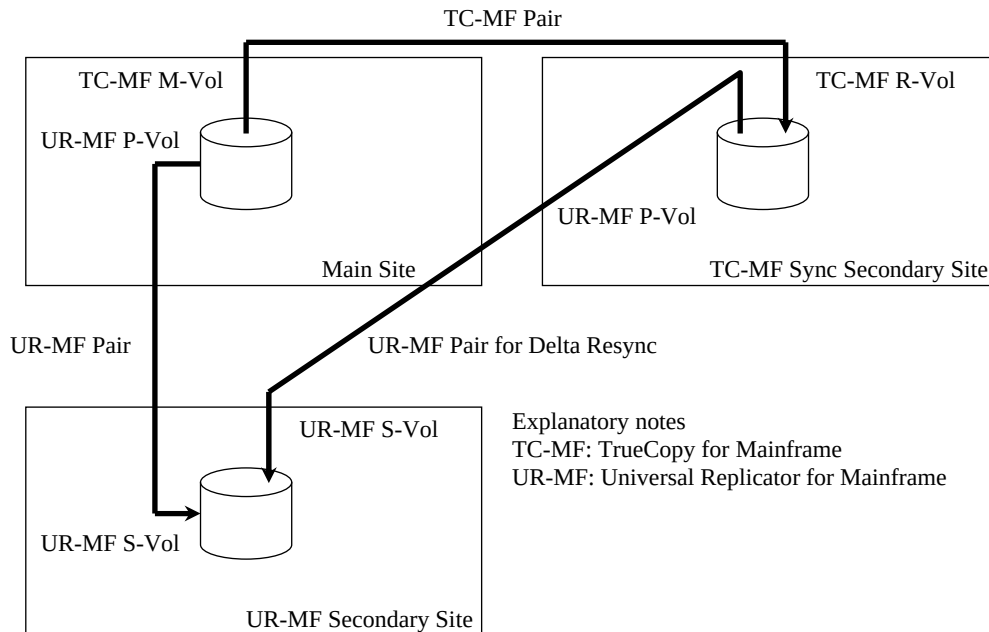


Fig. 3.17.6-3 3D Multi Target Configuration (Universal Replicator for Mainframe)

Table 3.17.6-1 The Status of Each Pair when P-VOL of UR-MF Pair for Delta Resync is Set as a Source Volume

Pair	Pair Status
TC-MF Pair	SUSPEND
UR-MF Pair	Random Pair Status
UR-MF Pair for Delta Resync	HOLD or HLDE

Table 3.17.6-2 The Status of Each Pair when S-VOL of UR-MF Pair for Delta Resync is Set as a Source Volume

Pair	Pair Status
TC-MF Pair	Random Pair Status
UR-MF Pair	SUSPEND
UR-MF Pair for Delta Resync	HOLD or HLDE

- Volumes which configure the Universal Replicator pairs

If the status of the volumes is COPY or PAIR, they cannot be source volumes.

Also, if the volumes which configure the Universal Replicator pairs are used as source volumes, external volumes cannot be specified as target volumes.

When Delta Resync is set in 3D Multi Target Configuration (See Fig. 3.17.6-4), P-VOL and S-VOL of a pair of Universal Replicator and for Delta Resync can be set as a source volume. However, the status of each pair in 3D Multi Target Configuration is required to be as the following table.

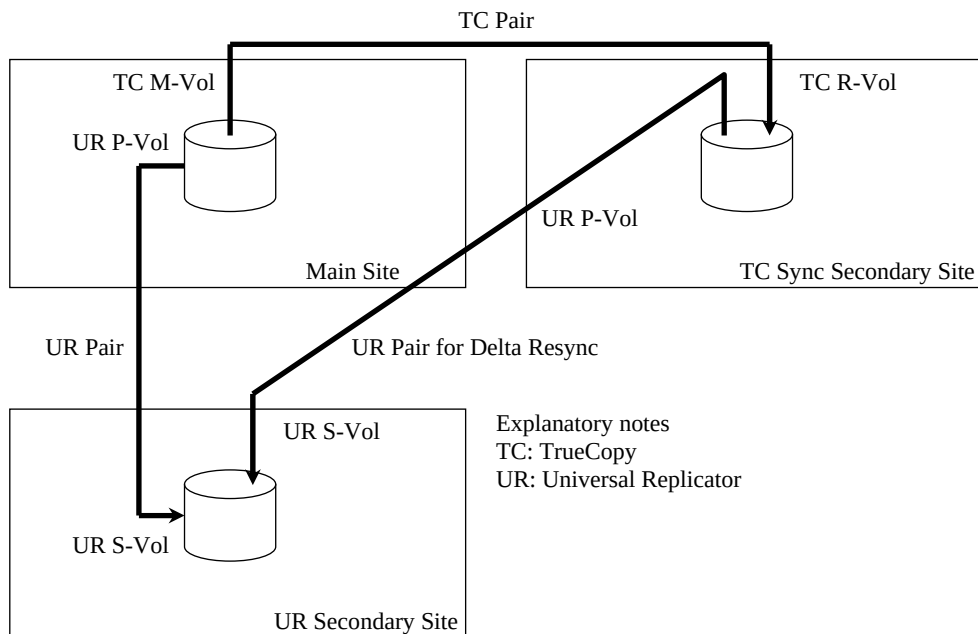


Fig. 3.17.6-4 3D Multi Target Configuration (Universal Replicator)

Table 3.17.6-3 The Status of Each Pair when P-VOL of UR Pair for Delta Resync is Set as a Source Volume

Pair	Pair Status
TC Pair	PSUS
UR Pair	Random Pair Status
UR Pair for Delta Resync	HOLD or HLDE

Table 3.17.6-4 The Status of Each Pair when S-VOL of UR Pair for Delta Resync is Set as a Source Volume

Pair	Pair Status
TC Pair	Random Pair Status
UR Pair	PSUS
UR Pair for Delta Resync	HOLD or HLDE

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- Volumes that form a Copy-on-Write Snapshot pair
 - The S-VOL of Copy-on-Write Snapshot pair can not be used as source volumes.
 - The P-VOL of Copy-on-Write Snapshot pair can be used as source volumes, only if the status of Copy-on-Write Snapshot pair is PAIR.

For volumes that form an ShadowImage for Mainframe pair or an ShadowImage pair, it depends on the status or configuration of the pair whether the volumes can be used as source volumes, as explained below:

- If the status of the pair is not SP-Pend/V-Split, the volumes can be used as source volumes. If the status of the pair is SP-Pend/V-Split, the volumes cannot be used as source volumes.
- The table below explains whether volumes that do not form a cascade pair can be used as source volumes:

Table 3.17.6-5 Whether volumes that do not form a cascade pair can be used as source volumes

If the pair is configured as follows	Can P-VOLs be used as source volumes?	Can S-VOLs be used as source volumes?
If the ratio of P-VOLs to S-VOLs is 1:1	Yes	Yes
If the ratio of P-VOLs to S-VOLs is 1:2	Yes	Yes
If the ratio of P-VOLs to S-VOLs is 1:3	No	Yes

- The table below explains whether volumes that form a cascade pair can be used as source volumes:

Table 3.17.6-6 Whether volumes that form a cascade pair can be used as source volumes

If the pair is configured as follows	Can P-VOLs be used as source volumes?	Can S-VOLs be used as source volumes?
If the pair is an L1 pair and the ratio of P-VOLs to S-VOLs is 1:1	Yes	Yes
If the pair is an L1 pair and the ratio of P-VOLs to S-VOLs is 1:2	Yes	Yes
If the pair is an L1 pair and the ratio of P-VOLs to S-VOLs is 1:3	No	Yes
If the pair is an L2 pair and the ratio of P-VOLs to S-VOLs is 1:1	Yes	No
If the pair is an L2 pair and the ratio of P-VOLs to S-VOLs is 1:2	No	No

Caution: If any of the following operations is performed on a source volume, the volume migration process stops:

- XRC operation
- CC operation
- TrueCopy for Mainframe/TrueCopy operation that changes the volume status to something other than suspended
- ShadowImage (ShadowImage for Mainframe/ShadowImage) operation that changes the volume status to SP-Pend/V-Split.
- Universal Replicator for Mainframe operation or Universal Replicator operation which seems to make the volumes the status of COPY

(b) Target volumes:

Target volumes must be reserved prior to migration. The Volume Migration Web Console software allows you to reserve volumes as Volume Migration target volumes.

Hosts cannot access Volume Migration-reserved volumes.

The following volumes cannot be reserved as target volumes:

- Logical Unit Size Expansion (LUSE) volumes
- Volumes which are set as command devices (devices reserved for use by the host)
- Volumes which are assigned to Hitachi ShadowImage (ShadowImage for Mainframe/ShadowImage) or Hitachi Remote Copy (TrueCopy for Mainframe/TrueCopy) pairs
- Volumes which are used by XRC
- Volumes which are used by Concurrent Copy (CC)
- Volumes which are reserved for ShadowImage operations
- Volumes which have FlashAccess (also called DCR) data stored in cache
- Volumes which are in an abnormal or inaccessible condition (e.g., pinned track, fenced)
- Onlined volume
- Volumes which are used by Universal Replicator (Primary Data Volume, Secondary Data Volume and Journal Volume)
- Volumes which are set as Read Only or Protect from Volume Retention Manager
- Volumes which are set as T-VOL/R-VOL Disabled from Volume Security
- Volumes which are set as Read Only, Protect or S-VOL Disable from Data Retention Utility
- Volumes which are reserved by a migration program other than Volume Migration
- Volumes on which CCI is performing volume migration operation
- Volumes that form a Copy-on-Write Snapshot/Thin Image pair
- Virtual volumes and pool volumes
- Volume executing Quick Format
- The Dynamic Provisioning/Dynamic Provisioning for Mainframe V-VOL whose capacity is being expanded

(c) Specifying Volumes:

Source volumes and Target volumes are specified by LDEV number.

An open volume is also specified by one LDEV number. If the volumes are set as LUSE, you can specify by one LDEV number. Volume Migration will migrate the LDEV which is one of a LUSE and its access is higher.

(d) Moving of multi volumes:

Moving of volumes can be performed by repeating instruction about each volume.

In using Volume Migration for manual volume migration, the number of migration plans that can be executed concurrently might be restricted. The number of migration plans that can be executed concurrently depends on the following conditions.

- How much shared memory is available for differential tables:
You may use 26,176 differential tables if no additional shared memory for differential tables is installed.
You may use 104,768, or 209,600 differential tables if additional shared memory for differential tables is installed.
- How much shared memory is available for pair tables:
You may use 8,192 pair tables if no additional shared memory for differential tables is installed.
You may use 16,384 pair tables if additional shared memory for differential tables is installed.
To install additional shared memory for differential tables, please call the Support Center.
- The emulation type and capacity of each volume to be migrated:
The number of differential tables, pair tables needed to migrate one volume differs depending on the emulation type and size of the volume. For the number of differential tables, pair tables needed for migrating a mainframe volume, see section (i). For the number of differential tables, pair tables needed for migrating an open-system volume, see section (ii).

You can estimate the maximum number of migration plans that can be executed concurrently by applying the above conditions into the following equation:

$$\Sigma (\alpha) \leq (\beta)$$

and

$$\Sigma (\gamma) \leq (\delta)$$

$\Sigma (\alpha)$ stands for the total number of differential tables needed for migrating all volumes (β) stands for the number of differential tables available in the DKC710I storage system.

$\Sigma (\gamma)$ stands for the total number of pair tables needed for migrating all volumes (δ) stands for the number of pair tables available in the DKC710I storage system.

For example, if you want to create 20 migration plans of OPEN-3 volumes (size of a volume is 2,403,360 kilobytes), the number of the required differential tables is 3, the number of the required pair tables is 1 that can be found by the calculation described in section (ii). When you apply this number to the equation, it will be as follows:

$$[(3 \times 20) = 60] \leq 26,176$$

and

$$[(1 \times 20) = 20] \leq 8,192$$

Since this equation is true, you can create all the migration plans that you wish to create.

In this section, we mentioned the calculation of the maximum number of migration plans when only Volume Migration is running. However, in fact, the total number of differential tables used by Copy-on-Write Snapshot, ShadowImage, ShadowImage for z/OS (R), FlashCopy (R) V2, and Volume Migration should be within the value of (β), and the total number of pair tables used by ShadowImage, ShadowImage for z/OS (R), Volume Migration, should be within the value of (δ). For details on how to calculate the number of differential tables, pair tables used by the programs other than Volume Migration, please refer to the following manuals:

- For ShadowImage, please refer to “Hitachi ShadowImage (R) User Guide”.
- For ShadowImage for z/OS (R), please refer to “Hitachi ShadowImage for Mainframe User Guide”.
- For FlashCopy (R) V2, please refer to “Hitachi Compatible FlashCopy (R) User Guide”.
- For Copy-on-Write Snapshot, please refer to “Hitachi Copy-on-Write Snapshot User Guide”.

(i) Calculating Differential Tables, Pair Tables Required for Mainframe Volume Migration

When you migrate mainframe volumes, use the following expression to calculate the total number of the required differential tables, pair tables per migration plan.

Total number of the differential tables per migration plan = $((X) + (Y)) \times 15 \div (Z)$

(X): The number of the cylinders of the volume to be migrated.*

(Y): The number of the control cylinders. (See Table 3.17.6-7)

(Z): The number of the slots that can be managed by a differential table. (20,448)

*: If the volume is divided by the VLL function, this value means the number of the cylinders of the divided volume.

Note that you should round up the number to the nearest whole number.

For example, in case of a volume which emulation type is 3390-3, and when provided that the number of the cylinders of the volume is 3,390 ((X) in the expression above), the calculation of the total number of the differential table is as follows.

$$(3,390 + 6) \times 15 \div (20,448) = 2.453785211$$

When you round up 2.453785211 to the nearest whole number, it becomes 3.

Therefore, the total number of the differential table for one migration plan is 3 when emulation type is 3390-3.

In addition, 1 pair tables per 36 differential tables is used. The number of pair tables used for above-mentioned 3390-3 becomes 1. (When the number of cylinders for the volume is a value of default, the number of pair tables used 3390-M becomes 2.) The emulation type of the case to use the two or more pair tables with the mainframe is only 3390-M/A.

The following table shows the number of the control cylinders according to the emulation types.

Table 3.17.6-7 The Number of the Control Cylinders According to the Emulation Types

Emulation Type	Number of the Control Cylinders
3380-3	7
3380-3A	7
3380-3B	7
3380-3C	7
3390-3	6
3390-3A	6
3390-3B	6
3390-3C	6
3390-3R	6
3390-9	25
3390-9A	25
3390-9B	25
3390-9C	25
3390-L	23
3390-LA	23
3390-LB	23
3390-M	53
3390-MA	53
3390-MB	53
3390-MC	53
3390-LC	23
3390-A	53 (*1)

*1: This value is different from an actual number of control cylinders in 3390-A.
This value is used to calculate the number of differential table for a pair of Volume Migration.

(ii) Calculating Differential Tables, Pair Tables Required for Open-System Volume Migration

When you migrate open-system volumes, use the expression in Table 3.17.6-8 to calculate the total number of the required differential tables, pair tables per migration plan.

Table 3.17.6-8 The Total Number of the Differential Tables Per Migration Plan

Emulation Type	Expression
OPEN-3	Total number of the differential tables per migration plan = $((X) \div 48 + (Y) \times 15) \div (Z)$ (X): The capacity of the volume to be migrated. (kilobyte) (*1) (Y): The number of the control cylinders. (See Table 3.17.6-9) (Z): The number of the slots that can be managed by a differential table. (20,448)
OPEN-8	
OPEN-9	
OPEN-E	Note that you should round up the number to the nearest whole number. For example, if the emulation type of a volume is OPEN-3, and when provided that the number of the cylinders of the volume is 2,403,360 kilobytes ((X) in the expression above), the calculation of the total number of the differential tables is as follows. $(2,403,360 \div 48 + 8 \times 15) \div 20,448 = 2.454518779$ When you round up 2.454518779 to the nearest whole number, it becomes 3. Therefore, the total number of the differential tables for one migration plan is 3 when emulation type is OPEN-3. In addition, 1 pair tables per 36 differential tables is used. The number of pair tables used for above-mentioned OPEN-3 becomes 1.
OPEN-L	
OPEN-V	Total number of the differential tables per migration plan = $((X) \div 256) \div (Z)$ (X): The capacity of the volume to be migrated. (kilobyte) (*1) (Z): The number of the slots that can be managed by a differential table. (20,448) Note that you should round up the number to the nearest whole number. For example, if the emulation type of a volume is OPEN-V, and when provided that the number of the cylinders of the volume is 3,019,898,880 kilobytes ((X) in the expression above), the calculation of the total number of the differential tables is as follows. $(3,019,898,880 \div 256) \div 20,448 = 576.9014085$ When you round up 576.9014085 to the nearest whole number, it becomes 577. Therefore, the total number of the differential tables for one migration plan is 577 when emulation type is OPEN V. In addition, 1 pair tables per 36 differential tables is used. The number of pair tables used for above- mentioned OPEN-V becomes 17. The emulation type of the case to use the two or more pair tables with the open system is only OPEN-V.

*1: If the volume is divided by the VLL function, this value means the capacity of the divided volume. Note that if the emulation type is OPEN-L, the VLL function is unavailable.

The following table shows the number of the control cylinders according to the emulation types.

Table 3.17.6-9 The Number of the Control Cylinders According to the Emulation Types

Emulation Type	Number of the Control Cylinders
OPEN-3	8 (5,760KB)
OPEN-8	27 (19,440KB)
OPEN-9	
OPEN-E	19 (13,680KB)
OPEN-L	7 (5,040KB)
OPEN-V	0 (0KB)

(e) Abort moving:

Users can direct to abort the instructed moving before completion.

With aborting, the data in the destination volume is not guaranteed.

Users can direct to abort by each LDEV.

(f) Notice when the DKC is maintenance:

Volume migration may be failed if you start the following action:

(i) Replace Cache/HDD

(ii) Install/deinstall Cache/HDD

(iii) Change of SM capacity setting

(2) Conditions for moving

Data moving is performed when all conditions about source volume and destination volume described below are satisfied.

(a) Both of the volumes have same emulation type.

(b) Both of the volumes have same size.

(c) There is no PIN data in the source volume.

(d) Both of the volumes are not blockade.

(e) Both of the volumes in same DKC.

(f) The volumes are not instructed to move already and not waiting to move.

(g) The volumes are not combination of CVS Volume and Normal Volume.

(3) Viewing History

Users can see the history of volume moving (migration).

3.17.7 Decision of volume moving (migration)

Volume Migration supports decision of users about disk system performance tuning by logical volume moving (migration). This section describes usage and points to notice about monitor function.

(1) Inspecting utilization of system resources

First of all, using monitoring function, a user investigates MP utilization, Startnet utilization, DRR utilization, RAID group utilization. a user investigates whether there exists overloaded resources, or imbalance of resource utilization. Then the user tunes resource utilization in the manner described in the following clause.

Note: Due to average system resource utilization, there will be such a case as a portion of system performance will be negatively effected although total performance of a system will be improved. For example, if there exists RAID groups A and B of utilization 20% and 90% respectively, and if the utilization will become 55% and 55% if a logical volume residing in parity group B moves parity group A. Then response time of I/Os to parity group A will be increased while response time of I/Os and throughput to parity group B will be improved.

(2) Tuning Starnet utilization

Since Starnet are common resources in RAID700, migration of logical volumes does not improve system performance. The user should consider migration the data to other DKC.

(3) Tuning MP utilization

Migration of logical volumes does not improve MP performance. Therefore if MPs are overloaded on an average, the user should consider installation of new MPs. And if the utilization of MPs are imbalance, the user should consider that channel paths connecting to a CHA, which includes overloaded MPs, is reconfigured into the connection to another CHA which includes MPs of lower utilization.

(4) Tuning DRR utilization

If utilization of DRRs is in high average, the user should consider installing new DKAs and HDDs or migration logical volumes of RAID5/6 to RAID1 or migration the data to other DKC. After installation of DKAs and HDDs, logical volumes which had high traffic of write access (especially of sequential write access) should be migrated to a parity group in newly installed HDDs. The estimate function cannot simulate the DRR utilization.

(5) Tuning RAID group utilization

If parity groups are in high utilization, the user should consider installing new HDDs. After installation of HDDs, logical volume which had high traffic of I/Os should be migrated to a parity group in newly installed HDDs by reference RAID group utilization on a logical volume.

If utilization of each parity group is imbalanced, the user should consider migration of logical volumes from the current parity group showing high utilization to the one showing lower utilization.

These methods should be applied with a view to large improvement. There would be least improvement in a case of slight difference of utilization of each parity group, or if DRRs or DKPs are already comparatively highly utilized.

If a number of the condition are right, the user should decide to do considering each examination items.

When errors exist in the system, utilization of system resource can increase or be unbalanced.

3.17.8 Automating Volume Migration function

(1) Automating Volume Migration function Overview

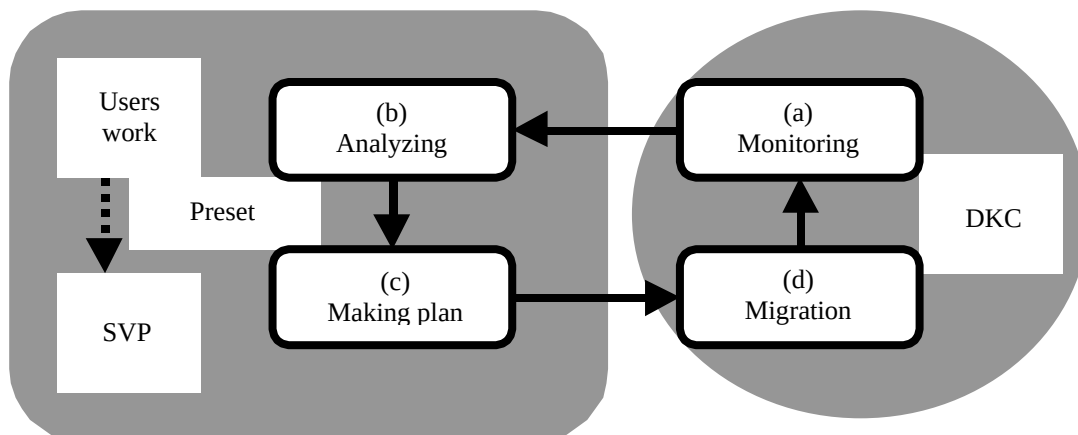
Automating Volume Migration function provides a typical tuning method of Volume Migration based on parameters given by users, and performs tuning plan automatically.

(2) Overview of tuning

Tuning by Volume Migration can be proceeded by performing the following steps repeatedly.

- (a) Monitoring information
- (b) Analyzing information
- (c) Making volume migration plan (decision of volume migration)
- (d) Moving volume (migration)
- (a') Monitoring information again to confirm condition and effect of the performed tuning.

Preset function reduces users' work by providing a typical tuning method of Volume Migration based on parameters given by users, and performs tuning plan automatically. When (b) Analyzing and (c) Making plan are done by users, it can perform fine tuning.



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(3) Process of tuning by Automating Volume Migration function

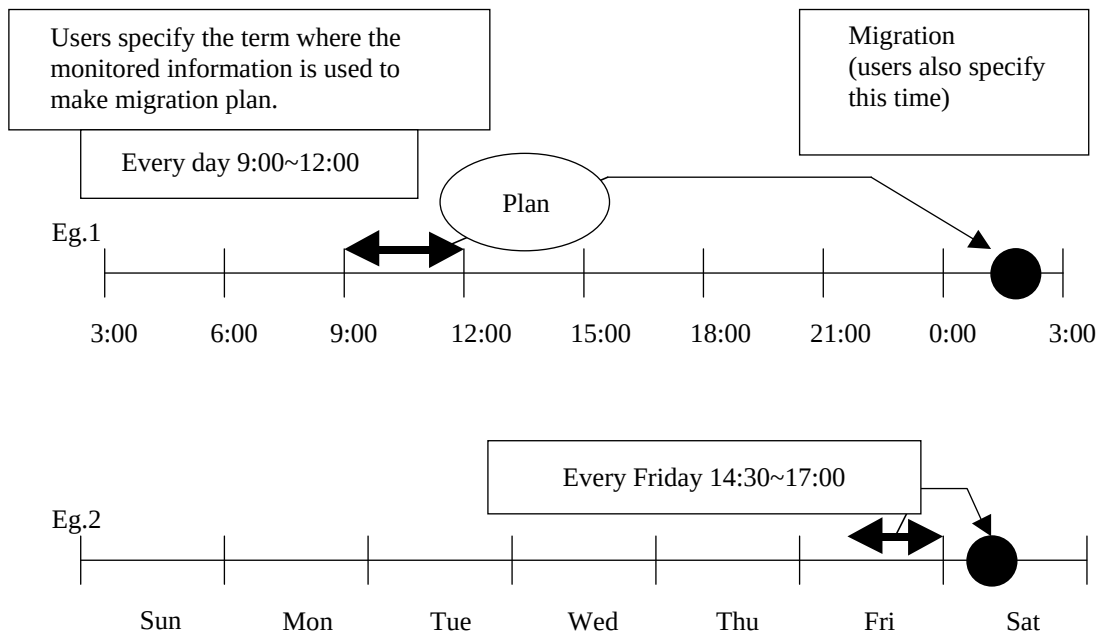
(a) Basic process flow of tuning by Automating Volume Migration function

Preset function performs the following two processes.

- Making Plan: Detecting volumes that have problems by monitored information (disk utilization) and making plan of volume Migration
- Migration: Moving volume according to the plan.

These two processes are repeated by the cycle described above, the length of the cycle depends on users. In the preset function, this cycle is supposed from one day to one week or several weeks at most.

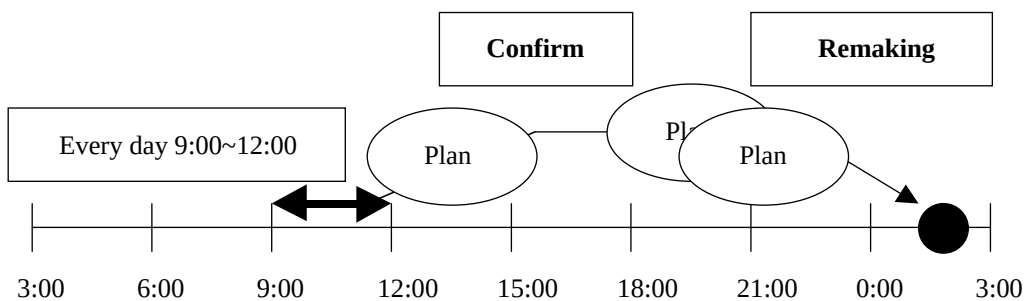
Users can specify the term where the monitored information is used to make the plan focusing on concerns of users. For example, users can specify the highest load term in a day or in a week as the referred term for making plan.



(b) Confirming and remaking of plan by users

During the period from the planning by preset function until migration, users can see the plan and delete it if needed.

During the same period as above, users can remake the plan manually with changing parameters.



(4) Making plan

(a) Tuning based on disk utilization ratio

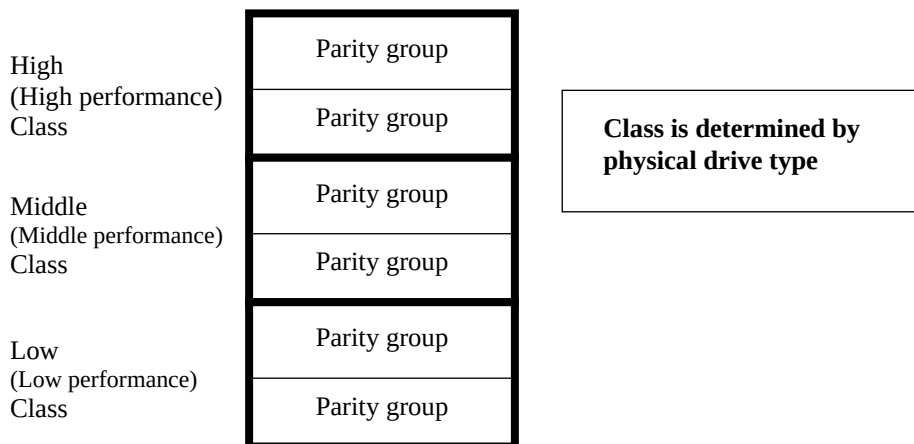
Volume Migration monitors utilization ratios of various system resources, but the preset function uses disk utilization ratio to make a migration plan to solve disk neck as a typical tuning method. Users could refer to other information if needed.

Users also specify parameters for tuning based on disk utilization ratio. Users should set these parameters for their system (preset function provides default value for these parameters roughly).

(b) Hierarchy of parity groups and management by class

Parity groups in DKC have hierarchy by drive type and RAID type. Volume Migration provides a function to optimize the usage of this hierarchy. Preset function manages this hierarchy as class (parity group set).

Parity groups are divided into classes. The classes are ordered from high level (high performance) to low level (low performance). This classification is decided by performance of physical drive type of each parity group.



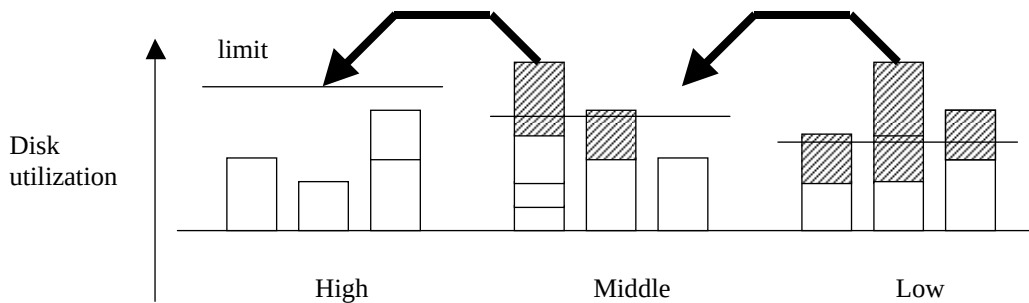
A method of migration plan which the preset function performs is described below. Preset function uses the monitored information in the term that is the data to be referred to make the plan.

(b-1) Management by maximum limit of disk utilization ratio

A maximum limit of disk utilization (parity group utilization) is specified to each parity group. Users should specify this limit for their systems. (Volume Migration uses the default value but it is desirable that user sets the desired value.)

For the parity groups that exceed this limit, preset function makes plan of moving volumes from this parity group to another parity group in higher class.

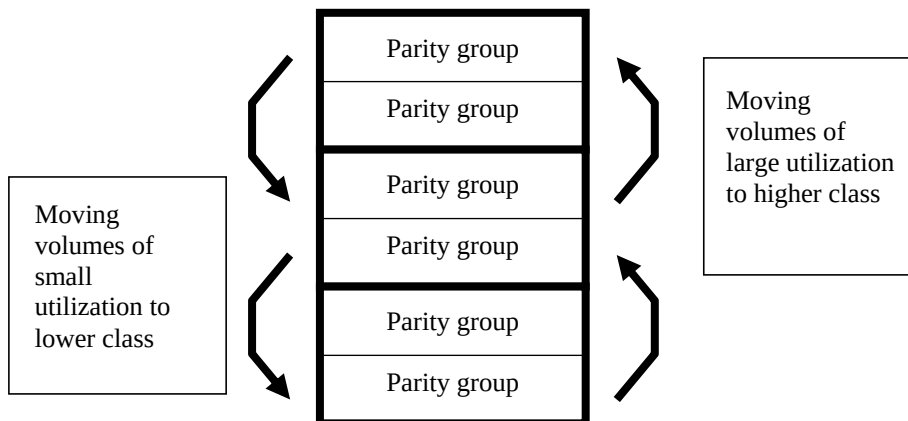
This avoids physical disk neck and provides load balancing of disk utilization.



(b-2) Selection of volumes to migration

In the migration plan described above, volumes of larger disk utilization are selected to be moved from the parity group that exceeds the limit to higher class. Moving larger utilization volumes to higher performance class is expected to make large tuning effect. And larger utilization means larger amount of access from host, and this also makes large tuning effect.

When the reserved (empty) volumes run short in the high class, volumes of smaller disk utilization are selected to be moved from higher class to lower class to make reserve volumes.



Preset function provides some criteria for you to select them, average of disk utilization, average of highest Nth value of disk utilization in the referred term, and a value considering sequential/random access pattern.

(b-3) Specifying maximum limit of disk utilization ratio by users

When the same maximum limit of disk utilization ratio described above is given to each class (parity group) classified by drive types, performance of each physical drive type makes performance of each class directly.

When the users specify the limit to each class with bias, users can make the difference of performance of classes larger or smaller.

Users can specify parity groups to fixed parity groups in which volumes users do not want to move automatically. Preset function does not make a migration plan about fixed parity groups and volumes in the fixed parity groups.

(b-4) Notice for making plan

Volume Migration can make these plans only on the following conditions:

- Volume Migration can estimate the disk utilization ratio against all migrated parity groups.
- The disk utilization rate of all migrated parity groups should not be over the maximum rate. If the rate of one parity group is over the maximum rate, Volume Migration could not make a plan.

(b-5) Notice for reference term

Volume Migration could not use old information before the last volume migration in order to reduce the influence of performance by volume migration.

Therefore, Volume Migration sometimes fails in making a plan by lack of information.

(5) Moving (migration) by preset function

Preset function performs moving (migration) process once a day at time specified by users. If there is a migration plan made by preset function at the time, volumes are moved by the plan.

Users can specify the limit of moving to avoid the overload by moving (data copy) process. If the disk utilization ratio of parity groups in which moving is started exceeds the moving process limit, the moving in the parity group will be aborted.

Users can specify the time limit of moving. If a plan does not complete in the time limit, the remaining plan will be executed in the following day. If the new plan will be made until the next migration time, those remaining plans will be deleted before making the plan.

3.18 Data Assurance at a Time When a Power Failure Occurs

Refer to “2.2.3 (8) Battery” ([THEORY02-180](#)) for the operation to be done when a power failure occurs.

3.19 PAV

3.19.1 Overview

3.19.1.1 Overview of PAV

PAV (Parallel Access Volume) enables a host computer to issue multiple I/O requests in parallel to each device in the disk subsystem. Usually, host computers are able to issue only a single I/O request to a single device. When a host computer issues one I/O request to a device, the host computer is unable to issue another I/O request to that device. However, PAV enables you to assign one or more aliases to a single device so that the host computer is able to issue multiple I/O requests. In this way, PAV provides the host computer with substantially faster access to data in the disk subsystem.

When you assign aliases to a device, you specify the addresses of unused LDEVs (logical devices or logical volumes) in the disk subsystem. The specified addresses are used as alias addresses.

Throughout this manual, the term base device refers to a device to which aliases will be assigned. Also, the term alias device refers to an alias.

PAV operates in either of the following ways: static PAV and dynamic PAV. These are described next:

■ Static PAV

When static PAV is used, the number of aliases for each base device remains unchanged even if the number of I/O requests to each device changes. As explained later, when dynamic PAV is used, the number of aliases for a base device is likely to increase as the number of I/O requests to the device increases; this means the number of aliases for other base devices may decrease. However, when static PAV is used, the number of aliases remains as specified by the Web Console user or SVP operation user.

Before you assign aliases to base devices, you should consider whether I/O requests will converge on some of the base devices. We recommend that you assign more aliases on base devices on which I/O requests are expectedly converge. Otherwise, PAV might not be able to provide much faster access to data in the disk subsystem.

The following figure gives an example of static PAV. In this figure, each of the three base devices (numbered 10, 11, and 12, respectively) has two aliases assigned. I/O requests converge on the base device #10, but the number of aliases for each base device remains unchanged.

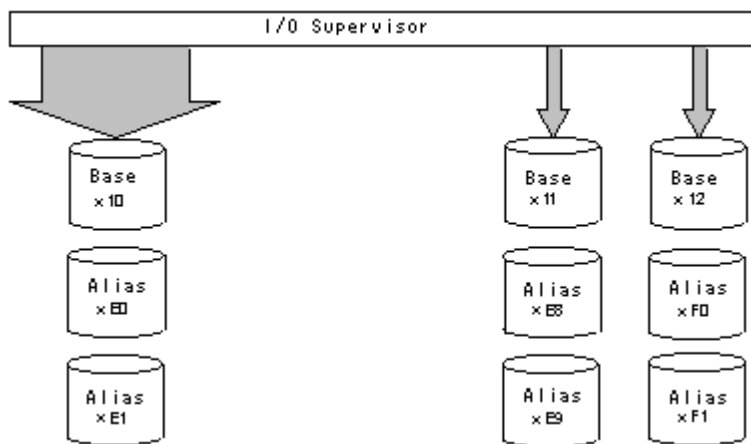


Fig. 3.19.1.1-1 Static PAV

■ Dynamic PAV

When dynamic PAV is used, the number of aliases for a base device may change as the number of I/O requests to the device changes. If I/O requests converge on some of the base devices, the number of aliases may increase for these base devices but may decrease for the other base devices. Dynamic PAV can balance workloads on base devices and optimize the speed for accessing data in the disk subsystem.

The following figure gives an example of dynamic PAV. In this example, each of the three base devices (#10, #11, and #12) was originally assigned two aliases. As I/O requests converge on #10, the number of aliases for #10 increases to four. For the base devices #11 and #12, the number of aliases decreases to one.

Dynamic PAV requires the Workload Manager (WLM), a special function provided by the operating system at the host computer. For details, see sections 3.19.2.1 and 3.19.2.2.

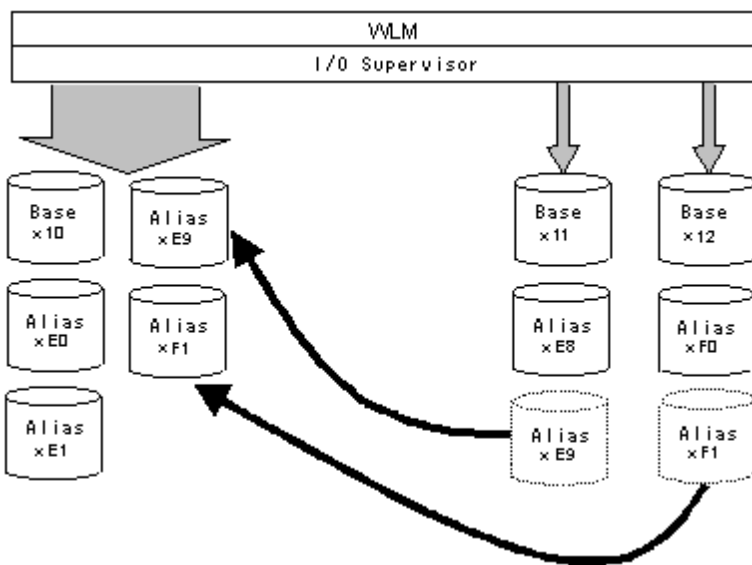


Fig. 3.19.1.1-2 Dynamic PAV

3.19.1.2 How to Obtain Optimum Results from PAV

To obtain good results from PAV, you should be aware of the following:

- The best results can be obtained if the number of aliases is “Number of available channel paths minus 1”. If the number of aliases is specified this way, I/O operations can use all the channel paths, and thus the best results can be obtained.
- PAV may not produce good results when many channel paths are used. If all the channel paths are used, no good results can be expected.
- PAV lets you assign unused devices for use as aliases. If you assign most of the unused devices for use as aliases, only a small amount of free devices are available. It is recommended that you think about adding more disks in the future when you determine the number of aliases to be assigned.

If we assume that there are 256 devices and we assign the same number of alias devices to each base devices, the number of base devices and alias devices is calculated as explained in Table 3.19.1.2-1. The recommended ratio of base devices to alias devices is 1:3.

If you can expect the types of jobs to be passed to base devices, or if you can expect how many accesses should be made to each base device, you should determine the number of aliases for each base device so that it meets the requirements for each base device.

Table 3.19.1.2-1 The ratio of base devices to aliases

Ratio (base devices : alias devices)	The number of base devices	The number of alias devices
1:3 (recommended)	64	192
1:1	128	128

- Good results cannot be expected on devices that are always shared and used by multiple host computers.
- If dynamic PAV can be used in all the systems, good results can be expected if you assign 8 to 16 aliases to each CU (control unit).

3.19.2 Preparing for PAV Operations

3.19.2.1 System Requirements

To be able to run, PAV requires the following operating systems to be installed on the host computer:

- For static PAV
 - OS/390 V1R3 (DFSMS/DSF 1.3) with Program Temporary Fix (PTF) or later
 - VM/ESA 2.4.0 or later
- For dynamic PAV
 - OS/390 V2R7 (DFSMS/DSF 1.5) with PTF or later
 - z/VM5.2 with PTF or later
- For Hyper PAV
 - z/OS 1.8 or later
 - z/OS 1.6 with PTF or later
 - z/VM5.3 or later

Note: When you use z/VM, it is a premise to use z/OS as a guest OS on z/VM.

Note: To perform operations with PAV, you must have administrator access privileges. Users who do not have administrator access privileges can only view PAV information.
The following restrictions apply when using PAV.

Table 3.19.2.1-1 Restrictions that apply when using PAV

No.	Item	Specifications
1	DKC emulation type	I-2105/2107
2	DKU emulation type	3390-3, 3390-3R, 3390-9, 3390-L, 3390-M, 3390-A, 3380-3
3	Number of aliases that can be assigned to a single base device	Up to 255
4	Alias device numbers that can be used	When you set aliases for base devices, you can use the device numbers of unused devices as the alias device numbers. When you set aliases for base devices, you must be aware that the alias devices and the base devices must belong to the same CU.
5	Device functions that can concurrently be used with PAV	• Customized Volume Size (CVS) • Dynamic Cache Residence (DCR) • Volume Security
6	Device functions that cannot concurrently be used with PAV	• Cross-OS File Exchange – Do not intermingle a device used by Cross-OS File Exchange in CU (Control Unit) including a device performed by PAV. – Do not change DKU emulation type of a device performed by PAV to a DKU emulation type to use by Cross-OS File Exchange.
7	Copy functions that can concurrently be used with PAV	• Concurrent Copy (CC)/XRC – Do not intermix DKC emulation type of 2105/2107 and 3990-6/6E in the MCU. • TrueCopy for Mainframe / ShadowImage for Mainframe / Volume Migration – You can be intermixed DKC emulation type of 2105/2107 and 3990-6/6E in the same DKC.

3.19.2.2 Preparations at the Host Computer

This section briefly describes arrangements that should be made at the host computer. For detailed information, see the documentation for MVS.

3.19.2.2.1 Generation Definition of Base Devices and Alias Addresses

The address mapping between base devices and the corresponding alias devices must be defined at generation.

The address mapping between base devices and alias devices at the host computer should match the corresponding address mapping at the DKC side. If it does not match, a serious failure might occur during data processing.

The following gives an example of mapping between base devices and aliases devices:

(A)	x 00-x1F:Base	(B)	x 00-x3F:Base	(C)	x 00-x7F:Alias	(D)	x 00-x3F:Alias
	x 20-xFF:Alias		x 40-x7F:Alias		x 80-xFF:Base		x 40-x7F:Base
			x 80-xBF:Base				x 80-xBF:Alias
			x C0-xFF:Alias				x C0-xFF:Base

Note: The recommended ratio of base devices to aliases is 1:3, if each base device is assumed to be assigned the same number of aliases.

3.19.2.2.2 Setting the WLM Operation Mode

If you want to use dynamic PAV, you must set the WLM (Workload Manager) operation mode to *goal mode*. WLM manages workloads on MVS and can use two operation modes, which include goal mode. In goal mode, WLM manages the system to fulfill the performance goal that was specified before the system began to operate.

You should be aware that static PAV is used instead of dynamic PAV if compatibility mode is used instead of goal mode.

For details on the WLM operation modes, see the documentation for MVS.

3.20 Hyper PAV

3.20.1 Overview of Hyper PAV

Hyper PAV was evolved from static PAV and dynamic PAV.

If you use Hyper PAV, alias devices that were assigned to a base device are shared with all base devices in the same CU. Thereby, alias devices do not need to be shifted by dynamic PAV.

Moreover, you can use more devices for a base device than when you use PAV because you can reduce devices that are assigned for an alias device.

You can specify the type of PAV (PAV or Hyper PAV) to use for each host computer. Therefore, an alias device may accept both I/O requests that are issued when you use the PAV and Hyper PAV.

Note: When you use z/VM, it is a premise to use z/OS as a guest OS on z/VM.

3.20.2 Hyper PAV function setting procedure

This appendix describes the procedures for installing and uninstalling Hyper PAV. The procedure depends on whether Hyper PAV is used from z/OS or from z/OS used as a guest OS on z/VM. The following subsections describe each procedure.

This appendix also describes the point to be checked when you change the setting to enable or disable Hyper PAV on the host computer and when you restart DKC710I while using Hyper PAV.

Note: When you use Hyper PAV on z/VM, DKC710I has to be defined as a support device of z/VM.

■ Conventions used in this section

This section uses the following symbols and typefaces to explain each command operation:

italics

Indicates a type of an input value. You can type the arbitrary value.

- (hyphen)

You use it when specify the range to enable the settings (for example, 8101-81FF).

3.20.2.1 Installing Hyper PAV

3.20.2.1.1 Using Hyper PAV from z/OS

To install Hyper PAV when you will to use Hyper PAV from z/OS:

1. Upgrade the host software to support Hyper PAV, that is, z/OS 1.8 or later, or z/OS 1.6 with PTF or later.
2. Install the PAV software.
3. Install the Compatible Hyper PAV software.
4. Assign aliases.
If your installation is a new DKC710I, and you have already assigned aliases to the base volumes for Hyper PAV, skip this step.
5. On the host computer, enable Hyper PAV.
6. Issue the DEVSERV QPAV command from the host to make sure that the displayed aliases are those assigned for Hyper PAV.

- The aliases for Hyper PAV cannot be displayed, though DEVSERV QPAV command has been issued.

Execute either of the following operations, and then issue the DEVSERV QPAV command and check the display again.

- If the host accesses only the corresponding DKC710I, disable Hyper PAV on the host computer, and then enable Hyper PAV again.
- If the host accesses other storage systems that use Hyper PAV, issue the following commands from the host to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2,OFFLINE
CF CHP(channel-pass1 - channel-pass2),OFFLINE
CF CHP(channel-pass1 - channel-pass2),ONLINE
V base-device-number1 - base-device-number2,ONLINE
```

- Cross-OS File Exchange is used on the host computer.

After performing the installation of Hyper PAV as mentioned above, issue the following commands.

```
V Cross-OS-File-Exchange-volume-number1 - Cross-OS-File-Exchange-volume-number2, OFFLINE
V Cross-OS-File-Exchange-volume-number1 - Cross-OS-File-Exchange-volume-number2, ONLINE
```


3.20.2.1.2 Using Hyper PAV from z/OS Used as a Guest OS on z/VM

To install Hyper PAV when you will use Hyper PAV from z/OS that is used as a guest OS on z/VM:

1. Upgrade the host software to support Hyper PAV.
z/VM: z/VM 5.3 or later
z/OS (guest OS): 1.8 or later, or z/OS 1.6 with PTF or later
2. Install the PAV software.
3. Install the Compatible Hyper PAV software.
4. Assign aliases.
If your installation is a new DKC710I, and you have already assigned aliases to the base volumes for Hyper PAV, skip this step.
5. On z/VM, enable Hyper PAV.
6. On z/OS which is used as a guest OS on z/VM, enable Hyper PAV.
7. Issue the QUERY PAV command from z/VM, and make sure that the displayed aliases are those assigned for Hyper PAV.
8. Issue the DEVSERV QPAV command from z/OS, and make sure that the displayed aliases are those assigned for Hyper PAV.

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- The aliases for Hyper PAV cannot be displayed after DEVSERV QPAV command issued from z/OS or QUERY PAV command issued from z/VM.

Execute either of the following operations, and then issue the command and check the display again.

- If the host accesses only the corresponding DKC710I, disable Hyper PAV on the host computer, and then enable Hyper PAV again.
 - If the host accesses other storage systems that use Hyper PAV, execute the following procedure.
- a) Issue the following command from z/OS which is used as a guest OS on z/VM to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2,OFFLINE
```

- b) Issue the following commands from z/VM to all base devices and alias devices used for Hyper PAV in the corresponding CU.

```
DET alias-device-number1 - alias-device-number2
DET base-device-number1 - base-device-number2
VARY OFFLINE alias-device-number1 - alias-device-number2
VARY OFFLINE base-device-number1 - base-device-number2
VARY OFFLINE CHPID channel-pass1
VARY OFFLINE CHPID channel-pass2
:
VARY ONLINE CHPID channel-pass1
VARY ONLINE CHPID channel-pass2
:
VARY ONLINE base-device-number1 - base-device-number2
VARY ONLINE alias-device-number1 - alias-device-number2
ATT base-device-number1 - base-device-number2*
ATT alias-device-number1 - alias-device-number2*
```

- c) Issue the following command from z/OS to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2,ONLINE
```

- d) Issue the following command from z/OS to all channel paths configured on the corresponding CU. The command has to be issued for each channel path.

```
V PATH(base-device-number1 - base-device-number2, channel-pass),ONLINE
```

THEORY03-20-50**3.20.2.2 Restarting the DKC710I While Using Hyper PAV****3.20.2.2.1 Using Hyper PAV from z/OS**

When you restart a DKC710I storage system while using Hyper PAV, issue the DEVSERV QPAV command from the host after restarting the DKC710I. Make sure that the aliases displayed as the ones assigned for Hyper PAV. If these aliases cannot be displayed as for Hyper PAV, issue the following commands to all base devices in the corresponding CU, and then check again.

```
V base-device-number1 - base-device-number2,OFFLINE
CF CHP(channel-pass1 - channel-pass2),OFFLINE
CF CHP(channel-pass1 - channel-pass2),ONLINE
V base-device-number1 - base-device-number2,ONLINE
```

3.20.2.2.2 Using Hyper PAV from z/OS which is Used as a Guest OS on z/VM

When you restart a DKC710I storage system while using Hyper PAV, issue the DEVSERV QPAV command from z/OS, and the QUERY PAV command from z/VM, after restarting the DKC710I. Make sure that the aliases displayed as the ones assigned for Hyper PAV. If these aliases cannot be displayed as for Hyper PAV, execute the following procedure and then check again.

1. Issue the following command from z/OS which is used as a guest OS on z/VM to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2,OFFLINE
```

2. Issue the following commands from z/VM to all base devices and alias devices used for Hyper PAV in the corresponding CU.

```
DET alias-device-number1 - alias-device-number2
DET base-device-number1 - base-device-number2
VARY OFFLINE alias-device-number1 - alias-device-number2
VARY OFFLINE base-device-number1 - base-device-number2
VARY OFFLINE CHPID channel-pass1
VARY OFFLINE CHPID channel-pass2
:
VARY ONLINE CHPID channel-pass1
VARY ONLINE CHPID channel-pass2
:
VARY ONLINE base-device-number1 - base-device-number2
VARY ONLINE alias-device-number1 - alias-device-number2
ATT base-device-number1 - base-device-number2*
ATT alias-device-number1 - alias-device-number2*
```

3. Issue the following command from z/OS to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2,ONLINE
```

4. Issue the following command from z/OS to all channel paths set on the corresponding CU. The command has to be issued to each channel path.

```
V PATH(base-device-number1 - base-device-number2, channel-pass),ONLINE
```

3.20.2.3 Changing the Hyper PAV Setting on z/OS While Using Hyper PAV

If you change the setting to enable or disable Hyper PAV on z/OS while using Hyper PAV, and if you use Cross-OS File Exchange on z/OS computer, issue the following commands to all Cross-OS File Exchange volumes after you enable or disable Hyper PAV on the host computer.

```
V Cross-OS-File-Exchange-volume-number1 - Cross-OS-File-Exchange-volume-number2, OFFLINE
V Cross-OS-File-Exchange-volume-number1 - Cross-OS-File-Exchange-volume-number2, ONLINE
```

3.20.2.4 Uninstalling Hyper PAV

3.20.2.4.1 Using Hyper PAV from z/OS

To uninstall Hyper PAV when you use Hyper PAV from z/OS:

1. On the host computer, disable Hyper PAV.
2. Uninstall the Compatible Hyper PAV software.
For information on uninstall of Storage Navigator software, please refer to “Hitachi Storage Navigator User Guide”.
3. Execute the **DEVSERV (DS)** command as shown below from the host to a device per CU:
DS QD,xxx,VALIDATE (XXX = device number)
4. Issue the DEVSERV QPAV command and make sure that the displayed aliases are those assigned for Hyper PAV.

- Hyper PAV and Cross-OS File Exchange are still used on the other storage systems which are accessed from the corresponding host:

Execute the following procedure to uninstall Hyper PAV only from the target DKC710I.

1. Issue the following commands to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2, OFFLINE
CF CHP(channel-pass1 - channel-pass2), OFFLINE
```

2. Uninstall the Compatible Hyper PAV software.
For information on uninstall of Storage Navigator software, please refer to “Hitachi Storage Navigator User Guide”.

3. Issue the following commands to all base devices in the corresponding CU.

```
CF CHP(channel-pass1 - channel-pass2), ONLINE
V base-device-number1 - base-device-number2, ONLINE
```

4. Issue the DEVSERV QPAV command and make sure that the displayed aliases are those assigned for Hyper PAV.

- The aliases for Hyper PAV cannot be displayed after DEVSERV QPAV command has been issued from the host.

Execute either of the following operations, and then issue the command and check the display again.

- If the host accesses only the corresponding DKC710I, enable Hyper PAV on the host computer, and then disable Hyper PAV again.
- If the host accesses other storage systems that use Hyper PAV, execute the following commands to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2,OFFLINE
CF CHP(channel-pass1 - channel-pass2),OFFLINE
CF CHP(channel-pass1 - channel-pass2),ONLINE
V base-device-number1 - base-device-number2,ONLINE
```

3.20.2.4.2 Using Hyper PAV from z/OS which is Guest OS on z/VM

To uninstall Hyper PAV when you use Hyper PAV from z/OS that is used as a guest OS on z/VM:

1. On the host computer, disable Hyper PAV.
2. Uninstall the Hyper PAV software.
For information on uninstall of Storage Navigator software, please refer to “Hitachi Storage Navigator User Guide”.
3. Execute the **DEVSERV (DS)** command as shown below from z/OS which is used as a guest OS on z/VM to an arbitrary device per CU:
DS QD,xxx,VALIDATE (XXX = device number)
4. Issue the QUERY PAV command from z/VM to make sure that the displayed aliases are those assigned for Hyper PAV.
5. Issue the DEVSERV QPAV command from z/OS to make sure that the displayed aliases are those assigned for Hyper PAV.

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- The aliases for Hyper PAV cannot be displayed after DEVSERV QPAV command issued from z/OS or QUERY PAV command issued from z/VM.

Execute either of the following operations, and then issue DEVSERV QPAV command or QUERY PAV command and check the display again.

- If the host accesses only the corresponding DKC710I, enable Hyper PAV on the host computer, and then disable Hyper PAV again.
- If the host accesses other storage systems that use Hyper PAV, execute the following procedure.

- a) Issue the following command from z/OS which is guest OS on z/VM to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2,OFFLINE
```

- b) Issue the following commands from z/VM to all base devices and alias devices used for Hyper PAV in the corresponding CU.

```
DET alias-device-number1 - alias-device-number2
DET base-device-number1 - base-device-number2
VARY OFFLINE alias-device-number1 - alias-device-number2
VARY OFFLINE base-device-number1 - base-device-number2
VARY OFFLINE CHPID channel-pass1
VARY OFFLINE CHPID channel-pass2
:
VARY ONLINE CHPID channel-pass1
VARY ONLINE CHPID channel-pass2
:
VARY ONLINE base-device-number1 - base-device-number2
VARY ONLINE alias-device-number1 - alias-device-number2
ATT base-device-number1 - base-device-number2*
ATT alias-device-number1 - alias-device-number2*
```

- c) Issue the following command from z/OS to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2,ONLINE
```

- d) Issue the following command from z/OS to all channel paths configured on the corresponding CU. The command has to be issued to each channel path.

```
V PATH(base-device-number1 - base-device-number2, channel-pass),ONLINE
```

3.21 FICON

3.21.1 Introduction

FICON is the new mainframe architecture, which is FC-SB-2/FC-SB-3/FC-SB-4 protocol based on Fiber channel physical layer protocol (FC-PH) and it is approved by ANSI.

The specification of FICON is below.

- Full duplex data transfer
- Multiple concurrent I/O operations on channel
- High bandwidth data transfer (100MB/s, 200MB/s, 400MB/s, 800MB/s)
- Fewer control unit interfaces
- Pipelined CCW execution
- High Performance FICON (HPF) function

THEORY03-21-20**3.21.2 FICON specification**

Table 3.21.2-1 shows the specification of FICON.

Table 3.21.2-1 FICON specification

Items		Contents	
Support DKC emulation type		I-2105-F20	I-2107
Range of CU address (*5)		0 to 3F	0 to FE
Number of logical volumes (*6)		1 to 16384	1 to 65280
Number of connectable channel port		16 to 80 (*1) 16 to 176 (*2)	
Maximum number of logical paths per CU		2048	
Maximum number of logical paths per port (*7)		65536	261120
Maximum number of logical paths per CHA		65536	261120
Maximum number of logical paths per subsystem		131072	522240
Support fiber channel	Bandwidth	1Gbps/2Gbps/4Gbps (*3) 2Gbps/4Gbps/8Gbps (*4)	
	Cable and connector	LC-Duplex	
	Mode	Single Mode Fiber/Multi Mode Fiber	

*1: In case of the one module component.

*2: In case of the two module components.

*3: In case of the 16MFL/16MFS PCB.

*4: In case of the 16MUL/16MUS PCB.

*5: When the number of CUs per FICON channel (CHPID) exceeds the limitation, there is a possibility that HOST OS IPL fails.

*6: Number of logical volumes connectable to the one FICON channel (CHPID) is 16384.

*7: The maximum number of connectable hosts per FICON port is 1024.

(1024 host paths × 64 CUs = 65536 logical paths for 2105-F20 emulation. 1024 host paths × 255 CUs = 261120 logical paths for 2107-900 emulation.)

3.21.3 Configuration

(1) Topology

The pattern of connection between FICON and channel are such as below.

- Point to point connection
- Switched point to point connection
- Non cascading connection
- Cascading connection

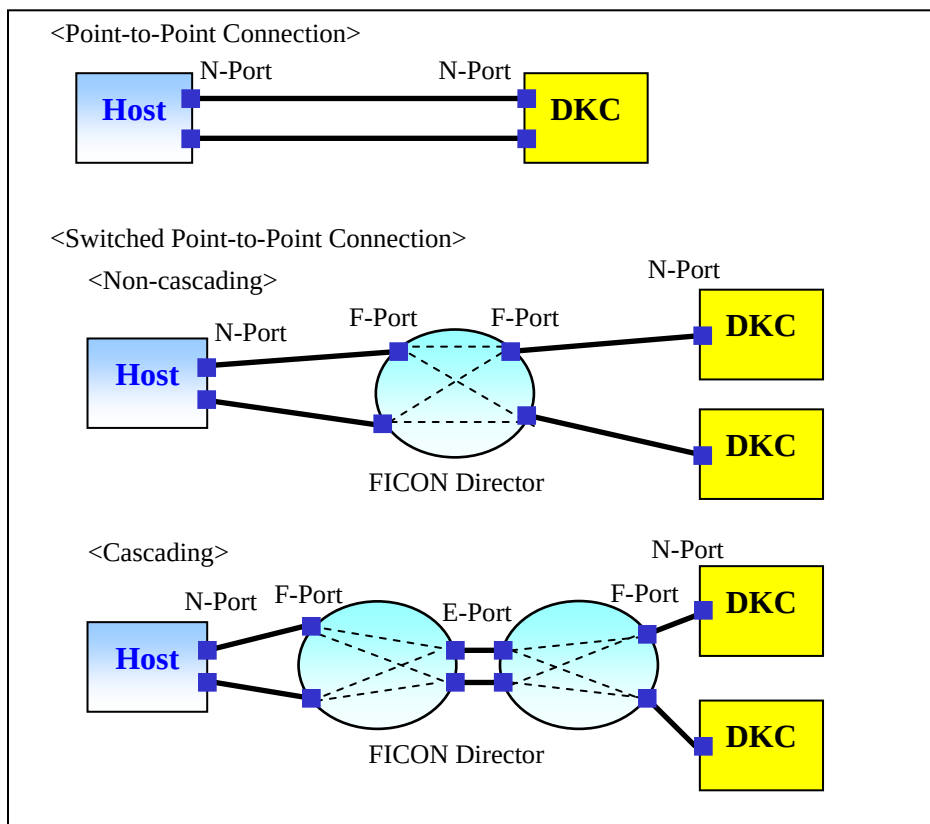


Fig. 3.21.3-1 FICON Topology

3.21.4 The operation procedure

(1) Notice about Speed Auto Negotiation

A stable physical environment (fully mated connectors, no cable flexing, no transient noise sources, etc.) is expected on Speed Auto Negotiation. Otherwise, Speed Auto Negotiation may settle to not fastest speed but an optimum speed.

To change into fastest speed, check whether it is the stable physical environment, and execute either of the following operations.

Confirm the Link speed from the 'Physical path status' window of DKC after executing each operation.

- DKC PS OFF/ON
- Dummy replace the package including the FICON ports.
- Remove and insert the FICON cable which is connected to the FICON port in DKC. (*1)
- Block and Unblock the associated outbound switch/director port. (*1) (*2)

*1: Execute this after deleting the logical paths from the host with the "CHPID OFFLINE" operation. If this operation is not executed, Incident log may be reported.

*2: Alternate method using switch/director configuration.

<Operating procedure from switch control window (Ex: in the EFCM)>

- (a) Block the associated outbound switch/director port to the CHA interface that is currently "Negotiated" to not fastest speed (Ex: 1Gb/s).
- (b) Change port speed setting from "Negotiate mode" to "Fastest speed fix mode (Ex: 2Gb/s mode)", then from "Fastest speed fix mode (Ex: 2Gb/s mode)" back to "Negotiate mode" in the switch/director port configuration window.
- (c) Unblock the switch/director port.
- (d) Observe the "Online" and "Fastest speed (Ex: 2Gb/s)" link establish without errors on the switch/director port status window.

(2) Configuring Alternate paths

In mainframe systems, the concept of alternate paths is available for the purpose of avoiding system down.

We recommend you to configure alternate paths based on the following priorities.

The supported mainframe fibre package is as follows.

- Mainframe fibre 16 port adapter

The internal structure and characteristics of each package are as shown in Table 3.21.4-1.

Table 3.21.4-1 Internal structures and characteristics of mainframe packages

Item	Mainframe fibre 16 port adapter
Internal structure	
Characteristics	• Can access all processor through ESW from 1Port (↔) • 1HTP controls 2Port • 4HTP/1MHUB/PCB

HTP : Processor used for controlling FIBARC/FICON protocols

BRG : HSN-PCI bridge

HSN : Unique protocol interface

Port 1A/3A/5A/7A/1B/3B/5B/7B: Port IDs in Cluster 1/BASIC slot

The mainframe fibre 16 port adapter can access all processors from 16 ports. Regardless of the locations of the used ports and the number of ports, it is always possible to perform processing by using all processors. HTP, however, is shared by two ports. If you use ports of different HTPs (For example, Port 1A and 1B in the figure), the throughput performance of one path is better than using ports of the same HTP (For example, Port 1A and 3A).

In addition to the package structure described above, power redundancy is provided using the cluster configurations.

Considering the structures and performance, we recommend you to set paths based on the following priorities when configuring alternate paths.

- Priority 1: Set paths to modules/clusters
- Priority 2: Set paths to packages
- Priority 3: Set paths to HTPs

(3) Notes on High Performance FICON (HPF)

To use the High Performance FICON (HPF), “Mainframe Fibre Channel Adapter” and “High Performance FICON (R) of the PP License” is required.

Do not install High Performance FICON (HPF) to a DKC which Mainframe Fibre Channel Adapter is not set up.

Do not remove all of the Mainframe Fibre Channel Adapters when High Performance FICON (HPF) is installed.

3.22 Universal Volume Manager (UVM)

3.22.1 Overview

Universal Volume Manager is a program product that realizes the virtualization of the storage subsystem. Universal Volume Manager enables you to operate multiple storage subsystems including DKC710I subsystem as if they are all in one storage subsystem. As Universal Volume Manager realizes the virtualization of the storage subsystem, the system administrator can manage the different kinds of multiple storage subsystems as one storage subsystem.

Once you connect the DKC710I subsystem and another kind of storage subsystem using Universal Volume Manager, the system administrator can also manage another storage subsystem using DKC710I Storage Navigator. For example, the system administrator can set the path from a host computer to the volume of DF600 subsystem using LUN Management of DKC710I.

In addition to the function of Universal Volume Manager, the ShadowImage function enables you to easily make a backup copy of data stored in the DKC710I subsystem to another storage subsystem. It is also easy to restore the backed up copy of data to DKC710I subsystem.

In this manual, the source DKC710I subsystem is called “local subsystem”, and the connected storage subsystem is called “external subsystem”. The volume managed in the local subsystem is called “internal volume”, and the volume in the external subsystem is called “external volume”.

Features of Universal Volume Manager are as follows:

By mapping an external volume as an internal volume using Universal Volume Manager, it becomes possible to operate the external volume using DKC710I Storage Navigator as if it is a volume in the DKC710I subsystem.

“Mapping” means assigning the CU:LDEV numbers of the internal volumes to the external volumes. By assigning the numbers of the internal volumes to the external volumes, the system administrator will be able to operate not only internal volumes of DKC710I subsystem but also external volumes using DKC710I Storage Navigator.

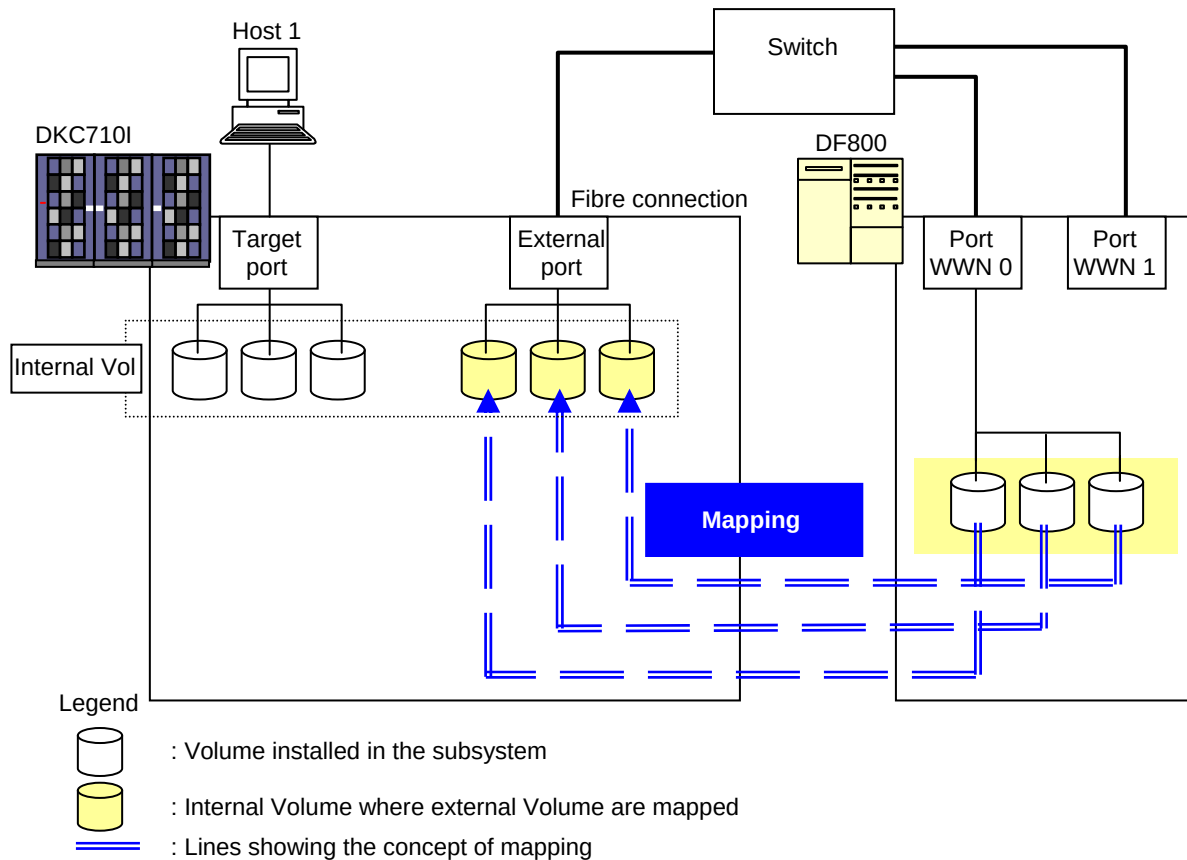


Figure 3.22.1-1

Figure 3.22.1-1 shows the idea of connection between a DKC710I subsystem and an external storage subsystem which are connected by the Universal Volume Manager function. In Figure 3.22.1-1, the external subsystem is connected to the external port of the DKC710I subsystem via a switch using the Fibre-channel interface. The external port is a kind of port attribute, which is used for Universal Volume Manager. In Figure 3.22.1-1, the external volumes are mapped as DKC710I volumes.

3.22.2 Procedure of using external volumes

- (1) Prepare in the external subsystem a volume to be used for UVM.
- (2) Change the port attribute to External.
- (3) Connect the external subsystem to the external port.
- (4) Search for the external subsystem from the UVM operation panel (Discovery).
- (5) Map an external volume.
 - (a) Register to an external volume group
 - (b) Select the cache mode
- (6) Format the volume (MF volume only)
- (7) Define the host path (Open volume only)
- (8) Other settings

3.22.2.1 Prepare in the external subsystem a volume to be used for UVM

Prepare a volume to be used for UVM in the external subsystem connected to the DKC710I.

Note: The volume in the external subsystem should be about 38 MB (77,760 Blocks) ~ 60 TB (128,849,018,880 Blocks). If the capacity of the external volume is 60 TB or larger, you can use up to 60 TB of the volume.

If one mapped external volume uses as one internal volume, the external volume size must be less than 128,849,011,200 blocks or smaller.

3.22.2.2 Change the port attribute to External

The port used for Universal Volume Manager needs to be set as the external port. When the external subsystem is connected to the external port of the local subsystem, you can view the information on the external subsystem from the DKC710I Storage Navigator computer. The external subsystem cannot be connected to the ports other than the external port.

In order to set the port attribute to external, you need to release the paths set to the port. The attribute of the port where the paths are set cannot be changed to external. Before starting the Universal Volume Manager operations, you need to know the ports whose attributes can be changed to external.

Note: The ports whose attributes are set for remote copy software (eg., RCU target, initiator) or the other features cannot be used as external ports for Universal Volume Manager. Change the port attribute to external if the port attribute is set to other than external.

3.22.2.3 Connect the external subsystem to the external port

Insert a Fibre cable into the external port from the external subsystem.

3.22.2.4 Search for the external subsystem from the UVM operation panel (Discovery)

Search for the external subsystem from the UVM operation panel (LU Operation tab) in the Storage Navigator.

You cannot use the external volume from the DKC710I by just discovering the external subsystem. You need to perform the Add LU operation (mapping) shown in the next section.

3.22.2.5 Map an external volume

When you connect the external subsystem to the external port, volumes in the external subsystem (external volumes) can be mapped as volumes in the local subsystem (internal volumes). Confirm which volumes in which external subsystem you need to map as internal volumes.

Only one external volume can be mapped as one internal volume. The maximum number of external volumes, which can be mapped, is 4096 per port.

When the external volume is more than 60 TB (128,849,018,880 Blocks), you can access the data stored in the field up to 60 TB. If one mapped external volume uses as one internal volume, the external volume size must be less than 128,849,011,200 blocks or smaller.

You cannot access the data that is stored in the field over 60 TB. The external volumes of about 38 MB (77,760 Blocks) or smaller cannot be mapped. When you want to set the OPEN-V emulation type, 47 MB (96,000 Blocks) or smaller external volume cannot be mapped.

(1) Register to an external volume group

When you map an external volume as an internal volume, you need to register the external volume to an external volume group.

The user can classify the external volumes, which is set by Universal Volume Manager, into the groups according to the use. The group is called external volume group (ExG). For instance, you can register multiple volumes in one external subsystem to one external volume group. Or, even though the data you want to manage in a lump is stored in volumes in the different external subsystems, you can register the volumes in one external volume group and manage them in block.

You need to assign numbers from 1 to 16384 to external LU groups. A maximum of 16384 external volume groups can be created. A maximum number of volumes, which can be registered in one external group, is 4096.

(2) Select the external volume attribute

When you map an external volume as an internal volume, you set the attributes of the external volume. The attributes of an external volume can be set using Add LU panel of Universal Volume Manager.

(a) I/O cache mode (Cache mode: Disable or Enable)

You can set if the operation uses the cache or not when the host I/O is demanded. If you select Enable, the host I/O once goes to the cache and then to the volume. If you select Disable, the host I/O comes directly to the volume not coming through the cache.

(3) Emulation type

You can set the emulation type of the mapped volume.

THEORY03-22-70**3.22.2.6 Format volume (MF volume only)**

If you set the MF emulation type (3380-x/3390-x) for the external volume which is mapped as an internal volume, you need to format the LDEV before using the volume.

Use the VLL feature to format the LDEV.

3.22.2.7 Define the host path (Open volume only)

If you set the Open emulation type (Open-x) for the external volume which is mapped as an internal volume, define a path between the host and the internal subsystem. Use the LUNM feature to define a path.

3.22.2.8 Other settings

(1) Define alternate path to the external volume

When you map an external volume as an internal volume, the path(s) will be set from the internal volume to the external volume. When two paths, which can be set, from the two different clusters to the external volume exist, the two paths are set at the time of the mapping. When two settable paths do not exist, one path is set at the time of the mapping.

You can set up to eight paths to the external volume including the automatically set paths.

Among the paths to the external volume, a path that is given the highest priority is called a primary path. Paths other than the primary path are also called alternative paths.

When the external volume is mapped as the internal volume using Universal Volume Manager, the host I/O operations to the external volume are enabled normally using the path set in the mapping operation. However, the path is automatically switched to the alternate path when the path set in mapping operation cannot be used due to, for instance, maintenance operation in the subsystem, or a failure in the channel processor. Because the path is switched to the alternate path, you can continue performing the I/O operation to the external volume that is mapped by Universal Volume Manager as usual even though an error occurred in the original path.

If the alternate path is not set, host I/O, is aborted when a maintenance operation is performed for the subsystem or a trouble such as a failure in the channel processor occurs.

It is recommended to set the alternate paths for safer operation.

To set the alternate path, use the path setting function of Universal Volume Manager.

Figure 3.22.2.8-1 illustrates an example of setting an alternate path. In Figure 3.22.2.8-1, external subsystem ports, “WWN A” and “WWN B”, are connected to “CL1-A” and “CL2-A” respectively which are set to the external ports in the DKC710I subsystem. You need to specify the port of a different cluster in the DKC710I subsystem for the alternate path as “CL1” port and “CL2” port are specified in Figure 3.22.2.8-1.

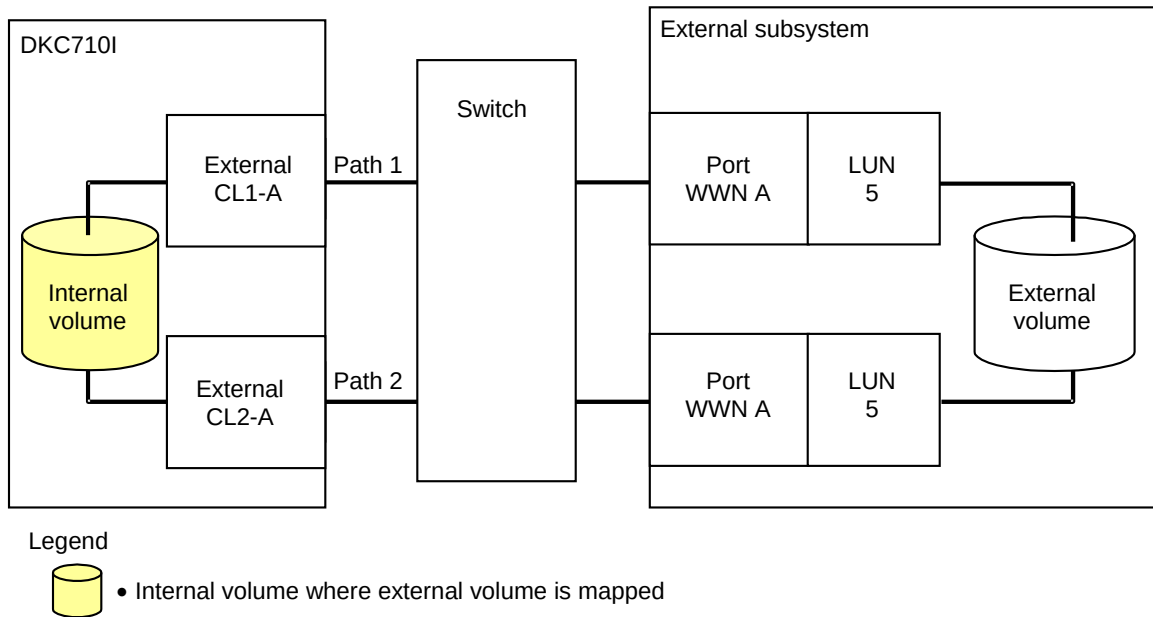


Figure 3.22.2.8-1

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Figure 3.22.2.8-2 also illustrates an example of setting an alternate path. In Figure 3.22.2.8-2, two ports are specified in the DKC710I subsystem, and connected to the ports in the external subsystem via the switch. In this case, two ports of different clusters are specified in the DKC710I subsystem. Therefore, the setting of the alternate path is enabled.

In Figure 3.22.2.8-3, two paths are also set between the internal volume and the external volume. However, one port is specified in the DKC710I subsystem, and two ports are specified in the external subsystems via the switch. Since two ports of different clusters need to be set in the DKC710I subsystem for alternate path settings in Universal Volume Manager, we do not recommend the setting shown in Figure 3.22.2.8-3.

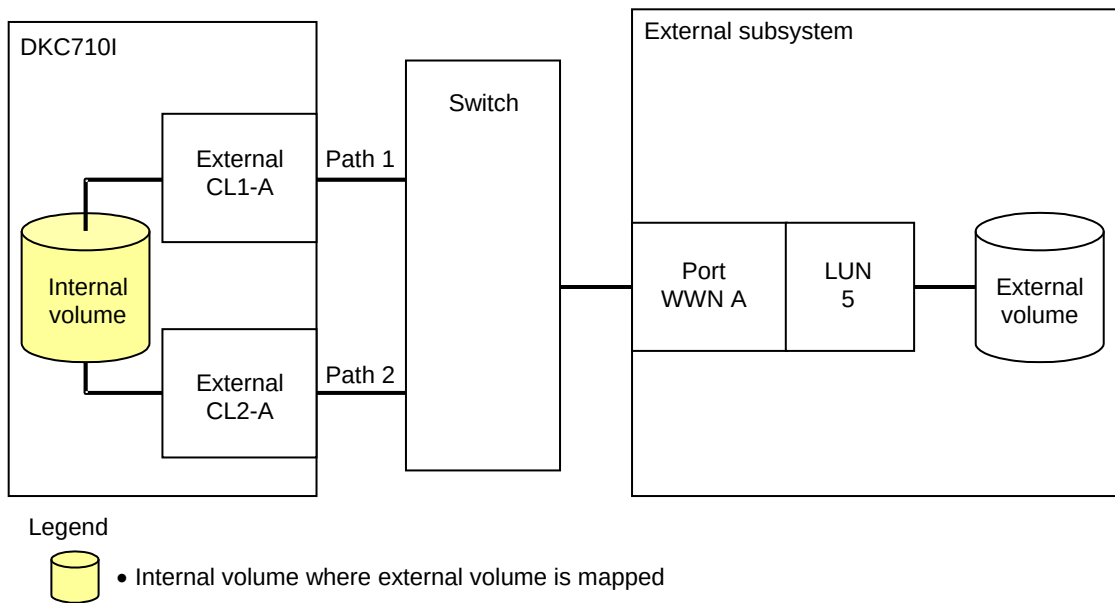


Figure 3.22.2.8-2

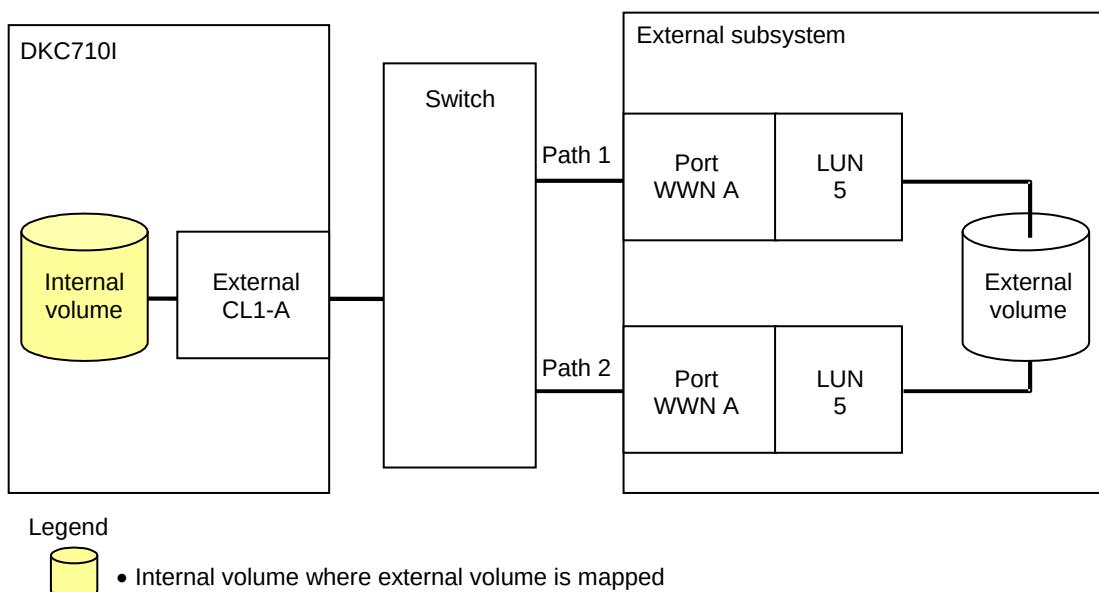


Figure 3.22.2.8-3

3.23 Universal Replicator

This Chapter explains Universal Replicator (hereafter referred to as UR).

3.23.1 URz Components

URz operations involve the DKC710I subsystems at the primary and secondary sites, the physical communications paths between these subsystems, and the DKC710I URz Web Console software. URz copies the original online data at the primary site to the offline backup volumes at the secondary site via the dedicated fibre-channel remote copy connections using a journal volume. You can operate the URz software with the user-friendly GUI environment using the DKC710I URz Web Console software. Note: Host failover software is required for effective disaster recovery with URz.

For management of URz journal groups that consist of journal volumes located in multiple subsystems, host I/O time stamping function (provided by MVS DFSMSdfp) is a requisite functional item. An error reporting communications (ERC) feature is essential for URz to be able to recover data lost in a disaster.

Figure 3.23-1 shows the URz components and their functions:

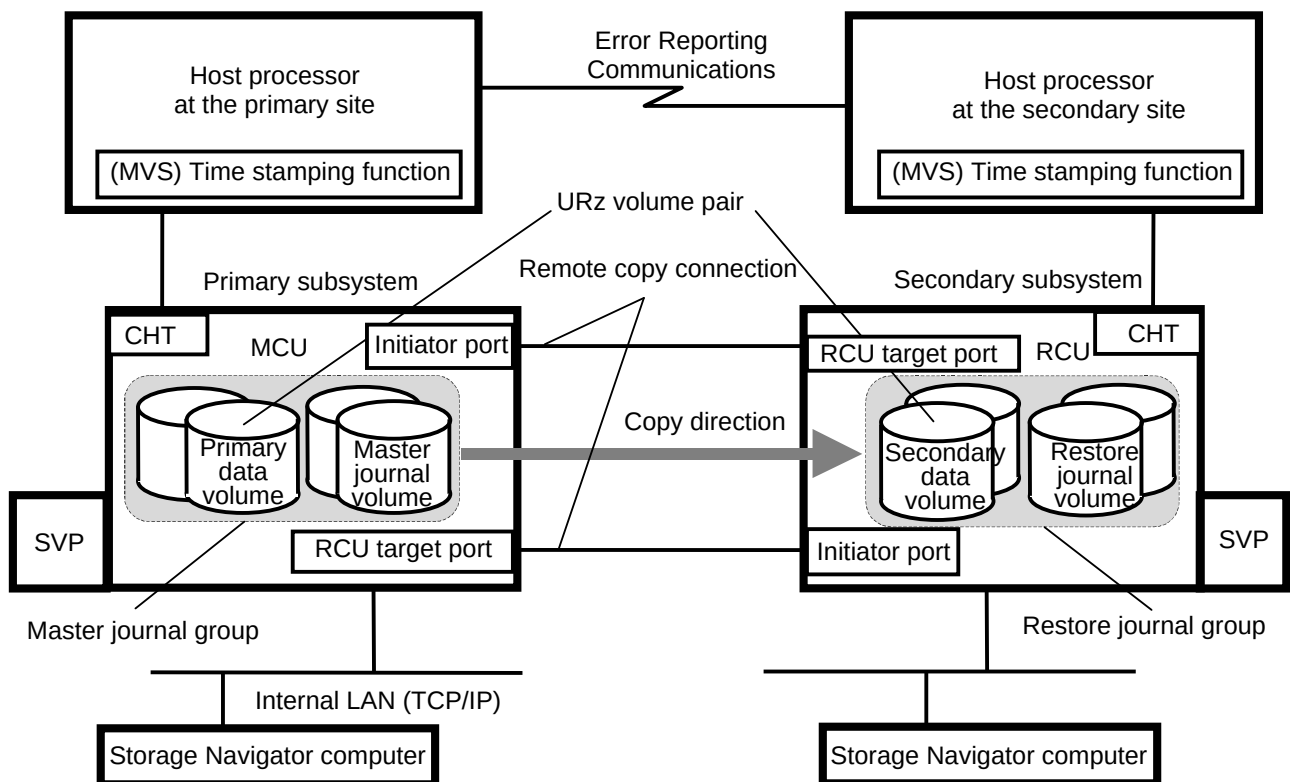


Figure 3.23-1 URz components

Table 3.23-2 shows the plural secondary subsystems connection configuration of URz. By connecting one primary subsystem with more than one secondary subsystem, you can create a volume pair that has a one-to-one relationship for each journal group.

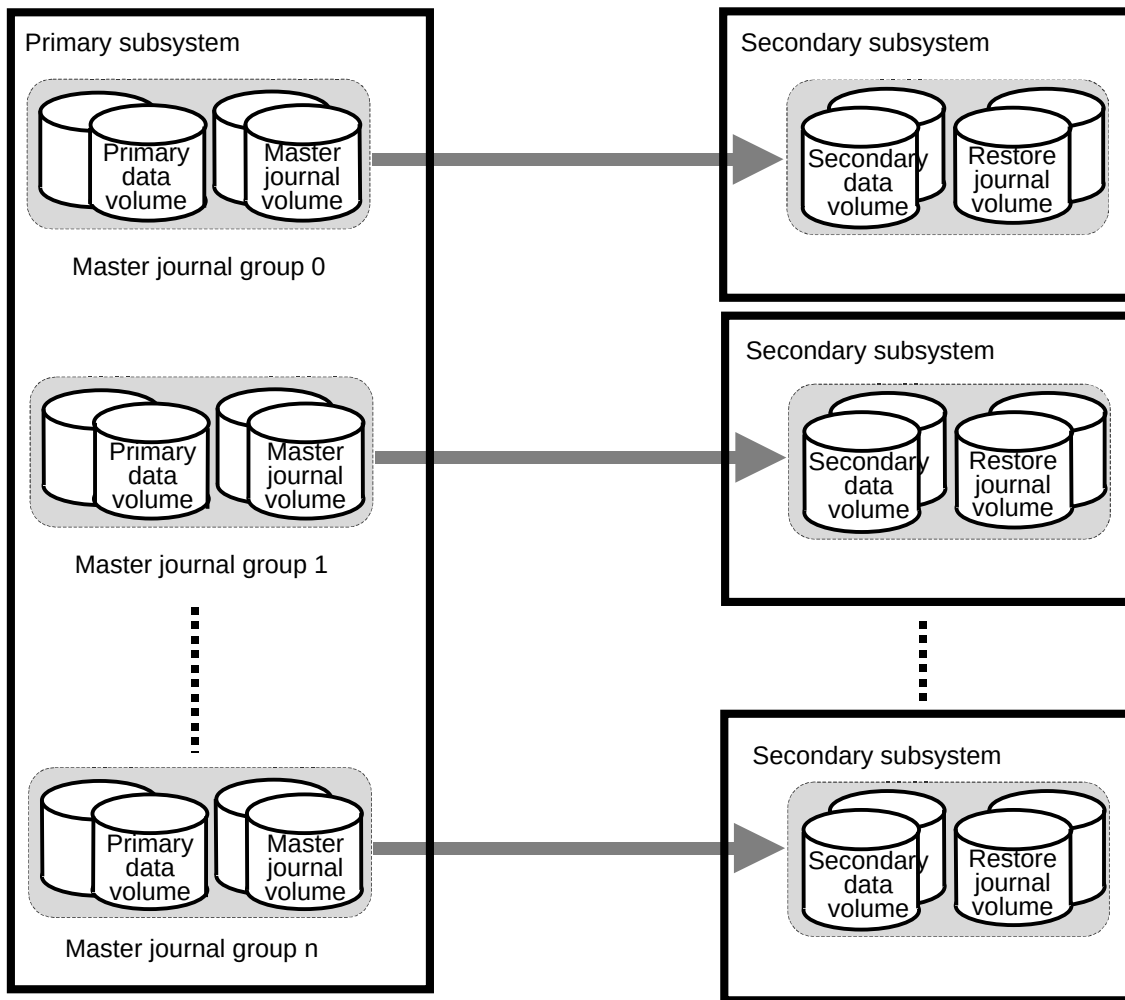


Figure 3.23-2 Connection Configuration of Plural Secondary Subsystems

This URz components describes:

- DKC710I RAID storage subsystem (see section 3.23.1.1)
- Main and remote control units (primary subsystems and secondary subsystems) (see section 3.23.1.2)
- Journal group (see section 3.23.1.3)
- Data volume pair (see section 3.23.1.4)
- Journal volume (see section 3.23.1.5)
- Remote copy connections (see section 3.23.1.6)
- Initiator ports and RCU target ports (see section 3.23.1.7)
- DKC710I URz Web Console software (see section 3.23.1.8)
- Host I/O time stamping function (see section 3.23.1.9)
- Error reporting communications (ERC) (see section 3.23.1.10)

3.23.1.1 DKC710I Storage Subsystems

URz operations involve the DKC710I subsystems at the primary and secondary sites. The primary subsystem consists of the main control unit (primary subsystem) and SVP. The secondary subsystem consists of the remote control unit (secondary subsystem) and SVP.

3.23.1.2 Main and Remote Control Units (Primary Subsystems and Secondary Subsystems)

The main control unit (primary subsystem) and remote control unit (secondary subsystem) control URz operations:

- The primary subsystem is the control unit in the primary subsystem which controls the primary data volume of the URz pairs and master journal volume. The Storage Navigator Web Console PC must be LAN-attached to the primary subsystem. The primary subsystem communicates with the secondary subsystem via the dedicated remote copy connections. The primary subsystem controls the host I/O operations to the URz primary data volume and the journal obtain operation of the master journal volume as well as the URz initial copy and update copy operations between the primary data volumes and the secondary data volumes.
- The secondary subsystem is the control unit in the secondary subsystem which controls the secondary data volume of the URz pairs and restore journal volume. The secondary subsystem controls copying of journals and restoring of journals to secondary data volumes. The secondary subsystem assists in managing the URz pair status and configuration (e.g., rejects write I/Os to the URz secondary data volumes). The secondary subsystem issues the read journal command to the primary subsystem and executes copying of journals. The secondary Storage Navigator PC should be connected to the secondary subsystems at the secondary site on a separate LAN. The secondary subsystems should also be attached to a host system to allow sense information to be reported in case of a problem with a secondary data volume or secondary subsystem and to provide disaster recovery capabilities.

3.23.1.3 Journal Group

Journal group consists of two or more data volumes and journal volumes. It is a feature that allows you to sort multiple data volumes and journal volumes into collective units to tailor URz to meet your unique business needs. The journal group in the primary subsystem is referred to as the master journal group. The journal group in the secondary subsystem is referred to as the restore journal group. The data volumes in the master journal group are also called the primary data volumes. The journal volumes in the master journal group are called the master journal volumes. The data volumes in the restore journal group are similarly called the secondary data volumes. The journal volumes in the restore journal group are called the restore journal volumes.

The data update sequence from the host is managed per the journal group. The data update sequence consistency between the master and restore journal groups to be paired is maintained and ensured. The master and restore journal groups are managed according to the journal group number. The journal numbers of master and restore journal groups that are paired can be different. One data volume and one journal volume can belong to only one journal group.

3.23.1.4 Data Volume Pair

URz performs remote copy operations for data volume pairs created by the user. Each URz pair consists of one primary data volume and one secondary data volume which can be located in different subsystems. The URz primary data volumes are the primary volumes (LDEVs) which contain the original data, and the URz secondary data volumes are the secondary volumes (LDEVs) which contain the backup or duplicate data. During normal URz operations, the primary data volume remains available to all hosts at all times for read and write I/O operations. During normal URz operations, the secondary subsystem rejects all host-requested write I/Os for the secondary data volume. The secondary data volume write enable option allows write access to a secondary data volume while the pair is split and uses the secondary data volume and primary data volume track maps to resynchronize the pair (see section 3.23.2.4).

3.23.1.5 Journal Volume

When URz is used, updates to primary data volumes can be stored in other volumes, which are called journal volumes. The updates (which is sometimes referred to as update data) that will be stored in journal volumes are called journal data.

Because journal data will be stored in journal volumes, you can perform and manage highly reliable remote copy operations without suspension of remote copy operations. For example:

- Even if a communication path between the primary subsystem and the secondary subsystem fails temporarily, remote copy operations can continue after the communication path is recovered.
- If data transfer from hosts to the primary subsystem is temporarily faster than data transfer between the primary subsystem and the secondary subsystem, remote copy operations between the primary subsystem and the secondary subsystem can continue. Because journal volumes can contain a lot more update data than the cache memory can contain, remote copy operations can continue if data transfer from hosts to the primary subsystem is faster for a relatively long period of time than data transfer between the primary subsystem and the secondary subsystem.

(1) The Number of Journal Volumes

One journal group can contain up to 64 journal volumes. Each of the journal volumes can have different volume sizes and different RAID configurations. Journal data will be stored sequentially and separately into each journal volume in the same journal group.

(2) Specifications of Journal Volumes

■ Types of logical units (LUs):

The following DKU emulation types are allowed for journal volumes:

Table 3.23.1.5-1 Emulation Types for Journal Volumes

Emulation Category	Supported Emulation Types
DKU (drive)	• OPEN-V • All mainframe volumes that can be used with DKC710I Note: Status of mainframe volumes cannot be referenced.

■ Volumes and their capacity:

You can use VLL volumes for journal volumes.

Journal volumes in the same journal group can be of different capacity. A master journal volume and the corresponding restore journal volume can be of different capacity.

A journal volume consists of two areas: one area is used for storing journal data, and the other area is used for storing metadata for remote copy.

■ RAID configuration:

Journal volumes support all RAID configurations that are supported by DKC710I. Journal volumes also support all physical volumes that are supported by DKC710I.

■ Support for option programs:

Cache Residency Manager volumes can be used for journal volumes.

Caution: Volumes containing a VMA (volume management area) cannot be used as journal volumes.

(3) Restrictions on Journal Volumes

■ Registering journal volumes:

Caution: You must register journal volumes in a journal group before you create a data volume pair for the first time in the journal group.

You can add journal volumes under any of the following conditions:

- When the journal group does not contain data volumes (i.e., before you create a data volume pair for the first time in the journal group, or after all data volume pairs are deleted)
- When all data volume pairs in the journal group are suspended.
- When processing for changing the status of a data volume pair (for example, deletion or suspension of a data volume pair) is not in progress

Note: If a path is defined from a host to a volume, you cannot register the volume as a journal volume.

You can use Storage Navigator computers to register journal volumes.

If you add a journal volume when a remote copy operation is in progress (i.e., when at least one data volume pair exists for data copying), the metadata area of the journal volume (see (4)) will be unused and only the journal data area will be used. To make the metadata area usable, you need to split (suspend) all the data volume pairs in the journal group and then restore (resynchronize) the pairs.

Adding journal volumes during a remote copy operation will not decrease the metadata usage rate if the metadata usage rate is high.

Adding journal volumes during a remote copy operation may not change the journal data usage rate until the journal volumes are used. To check the journal data usage rate, use the Usage Monitor panel.

■ Deleting journal volumes:

You can delete journal volumes under any of the following conditions:

- When the journal group does not contain data volumes (i.e., before you create a data volume pair for the first time in the journal group, or after all data volume pairs are deleted)
- When all data volume pairs in the journal group are suspended.

You can use Storage Navigator computers to delete journal volumes.

Caution: After you delete a journal volume that is a mainframe volume, you must format the volume (LDEV) by using Virtual LVI/LUN (VLL). Unless you format the volume, data in the volume will not be guaranteed.

■ Access from hosts to journal volumes:

If a path is defined from a host to a volume, you cannot register the volume as a journal volume.

You cannot define paths from hosts to journal volumes. This means that hosts cannot read from and write to journal volumes.

(4) Journal Volume Areas

The journal volume consists of the metadata area and the journal data area. The ratio of metadata area to journal data area is common in the journal volumes within the journal group.

In the metadata area, the metadata that manages the journal data is stored. For further information on the metadata area, see Table 3.23.3.1-1. The journal data that the metadata manages is stored in the journal data area.

3.23.1.6 Remote Copy Connections

The remote copy connections are the physical paths used by the primary subsystems to communicate with the secondary subsystems. Remote copy connections enable communication between the primary and secondary subsystems. The primary subsystems and secondary subsystems are connected via fibre-channel interface cables. You must establish paths from the primary to the secondary subsystem, and also from the secondary to the primary subsystem. Up to eight paths can be established in both of these directions.

When fibre-channel interface (optical multimode shortwave) connections are used, two switches are required for distances greater than 0.5 km (1,640 feet), and distances up to 1.5 km (4,920 feet, 0.93 miles) are supported. If the distance between the primary and secondary sites is greater than 1.5 km, the optical single mode longwave interface connections are required. When fibre-channel interface (single-mode longwave) connections are used, two switches are required for distances greater than 10 km (6.2 miles), and distances up to 30 km (18.6 miles) are supported.

3.23.1.7 Initiator Ports and RCU Target Ports

The initiator port and the RCU target port are required at both the primary subsystem and secondary subsystem. The initiator port at the primary subsystem is connected to the RCU target port at the secondary subsystem via the fibre channel interface. The initiator port at the secondary subsystem is connected to the RCU target port at the primary subsystem. The initiator port at the secondary subsystem issues a “read journal” command to the primary subsystem, and then the RCU target port at the primary subsystem sends journal data to the secondary subsystem in response to the “read journal” command.

Any fibre-channel interface port of the DKC710I can be configured as an initiator port. The initiator ports cannot communicate with the host processor channels. The host channel paths must be connected to the fibre-channel interface port other than the initiator port.

3.23.1.8 URz Web Console Software

DKC710I Storage Navigator Java applet program product includes URz for the DKC710I subsystem. The DKC710I Storage Navigator software communicates with the SVP of each DKC710I subsystem via defined TCP/IP connections.

The Storage Navigator PC at the primary site must be attached to the primary subsystem. You should also attach a Storage Navigator PC at the secondary site to all secondary subsystems. Having a Storage Navigator PC at the secondary site enables you to change the URz parameter of the secondary subsystem and access the URz secondary data volume (e.g. for the maintenance of media). If you need to perform URz operations in the reverse direction from the secondary site to the primary site (e.g., disaster recovery), the DKC710I URz software simplifies and expedites this process.

3.23.1.9 Host I/O Time-Stamping Function

If you plan to establish URz journal groups, the I/O time-stamping function must be installed on the host processor at the primary site. The I/O time-stamp, which is provided by MVS DFSMSdfp, is the same time-stamp that is used by IBM® XRC pairs. The I/O time-stamping function should also be installed on the host processor at the secondary site, so that time-stamps can be used when copying data in the reverse direction.

Note: If the system at the primary and/or secondary site consists of several CPU complexes, a SYSPLEX timer is required to provide a common time reference for the I/O time-stamping function.

3.23.1.10 Error Reporting Communications (ERC)

Error reporting communications (ERC), which transfers information between host processors at the primary and secondary sites, is a critical component of any disaster recovery effort. You can configure ERC using channel-to-channel communications, NetView technology, or other interconnect technologies, depending on your installation requirements and standards. Neither URz nor the URz Web Console software provides ERC between the primary and secondary sites.

When URz is used as a data migration tool, ERC is recommended but is not required. When URz is used as a disaster recovery tool, ERC is required to ensure effective disaster recovery operations. When a URz pair is suspended due to an error condition, the primary subsystem generates sense information which results in an IEA491E system console message. This information should be transferred to the primary site via the ERC for effective disaster detection and recovery.

3.23.2 Remote Copy Operations

Figure 3.23-3 illustrates the two types of URz remote copy operations: initial copy and update copy.

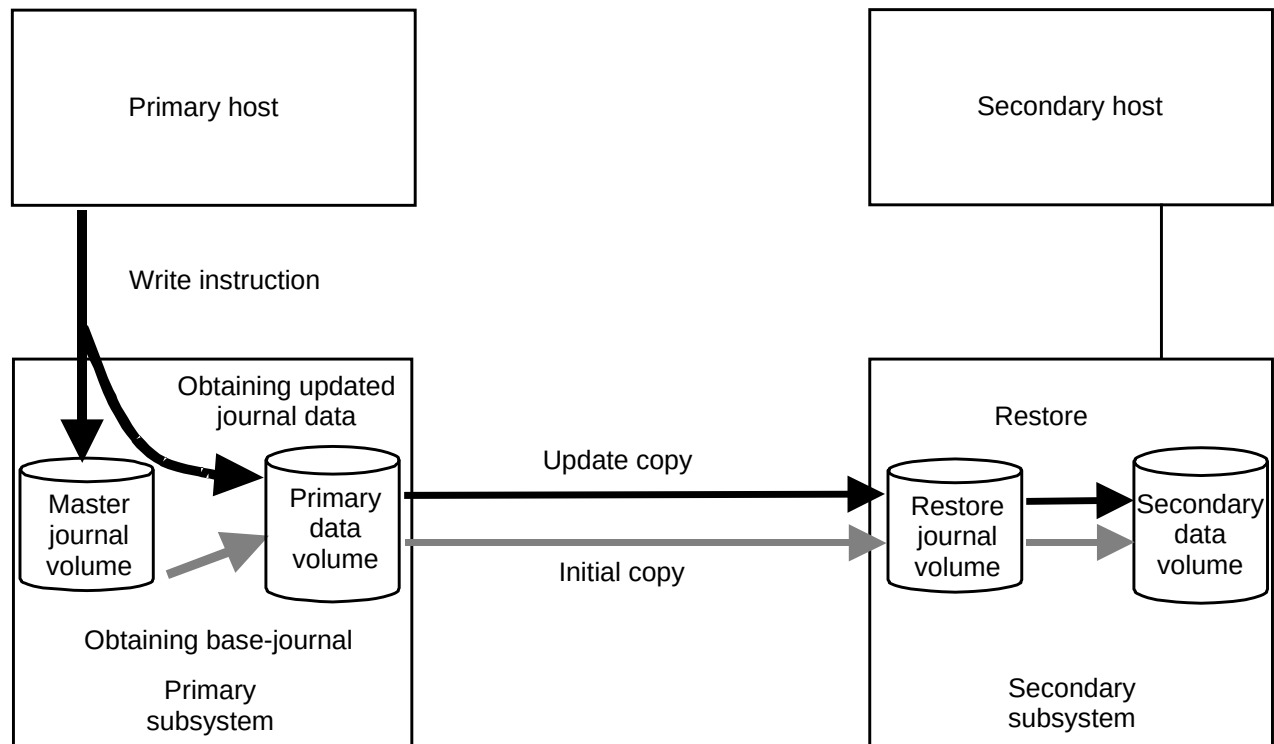


Figure 3.23-3 Remote copy operations

This section describes the following topics that are related to remote copy operations with URz:

- Initial copy operation (see section 3.23.2.1)
- Update copy operation (see section 3.23.2.2)
- Read and write I/O operations for URz volumes (see section 3.23.2.3)
- Secondary data volume write option (see section 3.23.2.4)
- Secondary data volume read option (see section 3.23.2.5)
- Difference management (see section 3.23.2.6)

3.23.2.1 Initial Copy Operation

Initial copy operations synchronize data in the primary data volume and data in the secondary data volume. Initial copy operations are performed independently from host I/Os. Initial copy operations are performed when you create a data volume pair or when you resynchronize a suspended pair. The initial copy operation copies the base-journal data that is obtained from the primary data volume at the primary subsystem to the secondary subsystem, and then restores the base-journal to the secondary data volume.

If the journal-obtain operation starts at the primary data volume, the primary subsystem obtains all data of the primary data volume as the base-journal data, in sequence. The base-journal contains a replica of the entire data volume or a replica of updates to the data volume. The base-journal will be copied from the primary subsystem to the secondary subsystem after the secondary subsystem issues a read-journal command. After a base-journal is copied to the secondary subsystem, the base-journal will be stored in a restore journal volume in a restore journal group where the secondary data volume belongs. After that, the data in the restore journal volume will be restored to the secondary data volume, so that the data in the secondary data volume synchronizes with the data in the primary data volume.

The base-journal data is stored in the entire data volume or the area for the difference. The area for the difference is used when the difference resynchronization operation is performed. The journal data for the entire data volume is created when the data volume pair is created. The difference journal data is obtained when the pair status of the data volume changes from the Suspending status to the Pair resync status. Merging the difference bitmaps that are recorded on both primary and secondary data volumes enables you to obtain the journal data for only difference. When a data volume pair is suspended, the status of data that is updated from the host to the primary and secondary data volumes is recorded to the difference bitmap.

The base-journal data of primary subsystem is stored to the secondary subsystem journal volume according to the read command from the secondary subsystem. After that, the base-journal data is restored from the journal volume to the secondary data volume. The initial copy operation will finish when all base-journals are restored.

Note: If you manipulate volumes (not journal groups) to create or resynchronize two or more data volume pairs within the same journal group, the base journal of one of the pairs will be stored in the restore journal volume, and then the base journal of another pair will be stored in the restore journal volume. Therefore, the operation for restoring the latter base journal will be delayed.

Note: You can specify None as the copy mode for initial copy operations. If the None mode is selected, initial copy operations will not be performed. The None mode must be used at your responsibility only when you are sure that data in the primary data volume is completely the same as data in the secondary data volumes.

3.23.2.2 Update Copy Operation

When a host performs a write I/O operation to a primary data volume of a data volume pair, an update copy operation will be performed. During an update copy operation, the update data that is written to the primary data volume is obtained as an update journal. The update journal will be copied to the secondary subsystem, and then restored to the secondary data volume.

The primary subsystem obtains update data that the host writes to the primary data volume as update journals. Update journals will be stored in journal volumes in the journal group that the primary data volume belongs to. When the secondary subsystem issues “read journal” commands, update journals will be copied from the primary subsystem to the secondary subsystem asynchronously with completion of write I/Os by the host. Update journals that are copied to the secondary subsystem will be stored in journal volumes in the journal group that the secondary data volume belongs to. The secondary subsystem will restore the update journals to the secondary data volumes in the order write I/Os are made, so that the secondary data volumes will be updated just like the primary data volumes are updated.

3.23.2.3 Read and Write I/O Operations During URz Volumes

When a primary subsystem receives a read I/O for a URz primary data volume, the primary subsystem performs the read from the primary data volume. If the read fails, the redundancy provided by RAID-1 or RAID-5 technology recovers the failure. The primary subsystem does not read the URz secondary data volume for recovery.

When a primary subsystem receives a write I/O for the primary data volume with PAIR status, the primary subsystem performs the update copy operation, as well as writing to the primary data volume.

The primary subsystem completes the primary data volume write operations independently of the update copy operations at the secondary data volume. The secondary subsystem updates the data in the secondary data volume according to the write sequence number of journal data. This will maintain the data consistency between the primary and secondary data volumes. If the primary data volume write operation fails, the primary subsystem reports a unit check and does not create the journal data for this operation. If the update copy operation fails, the secondary subsystem suspends either the affected pair or all URz pairs in the journal group, depending on the type of failure. When the suspended URz pair or journal group is resumed (Resume Pair), the primary subsystem and secondary subsystem negotiate the resynchronization of the pair(s).

During normal URz operations, the secondary subsystem does not allow URz secondary data volumes to be online (mounted), and therefore hosts cannot read from and write to secondary data volumes. The URz secondary data volume write enable option allows write access to a secondary data volume while the pair is split (see section 3.23.2.4). The secondary data volume write option can only be enabled when you split the pair from the primary subsystem.

3.23.2.4 Secondary Data Volume Write Option

For additional flexibility, URz provides a secondary data volume write option (S-Vol. Write) which enables write I/O to the secondary data volume of a split URz pair. The secondary data volume write option can be selected by the user during the Suspend Pair operation and applies only to the selected pair(s). The secondary data volume write option can be accessed only when you are connected to the primary subsystem. When you resync a split URz pair which has the secondary data volume write option enabled, the secondary subsystem sends the secondary data volume track bitmap to the primary subsystem, and the primary subsystem merges the primary data volume and secondary data volume bitmaps to determine which tracks are out-of sync. This ensures proper resynchronization of the pair.

3.23.2.5 Secondary Data Volume Read Option

For additional flexibility, URz offers a special secondary data volume read option. The Hitachi representative enables the secondary data volume read option on the secondary subsystem (mode 20). The secondary data volume read option allows you to read a URz secondary data volume only while the pair is suspended, that is, without having to delete the pair. The secondary subsystem will allow you to change only the VOLSER of the suspended secondary data volume, so that the secondary data volume can be online to the same host as the primary data volume while the pair is suspended. All other write I/Os will be rejected by the secondary subsystem. The primary subsystem copies the VOLSER of the primary data volume back onto the secondary data volume when the pair is resumed. When the secondary data volume read option is not enabled and/or the pair is not suspended, the secondary subsystem rejects all read and write I/Os to a URz secondary data volume.

3.23.2.6 Difference Management

The differential data (updated by write I/Os during split or suspension) between the primary data volume and the secondary data volume is stored in each track bitmap. When a split/suspended pair is resumed (Resume Pair), the primary subsystem merges the primary data volume and secondary data volume bitmaps, and the differential data is copied to the secondary data volume.

3.23.3 Journal Processing

The URz journal data contains the primary data volume updates and the metadata information (associated control information), which enables the secondary subsystem to maintain update consistency of the URz secondary data volumes. URz journal processing includes:

- Creating and storing journals at the primary subsystem (see section 3.23.3.1)
- Copying journals to the secondary subsystem (see section 3.23.3.2)
- Storing journals at the secondary subsystem (see section 3.23.3.3)
- Selecting and restoring journals at the secondary subsystem (see section 3.23.3.4)
- Types of journals (see section 3.23.3.5)

3.23.3.1 Creating and Storing Journals at the Primary Subsystem

When a primary subsystem performs an update (host-requested write I/O) on a URz primary data volume, the primary subsystem creates a journal data to be transferred to secondary subsystem. The journal data will be stored into the cache at first, and then into the journal volume.

Metadata information will be attached to journal data (see Table 3.23.3.1-1). When base-journal is obtained, only metadata information is created and stored in UR cache or the journal volume.

Table 3.23.3.1-1 Metadata Information

Type	Description
Journal type	Type of journal (e.g., base-journal or update journal)
LDEV No. (data)	The number of primary data volume that stores the original data
Original data storing position	The primary data volume slot number, and the start and end of sub-block number (data length)
LDEV No. (journal)	The volume number of master journal volume that stores the journal data
Journal data storing position	The slot number of master journal volume, and the start sub-block number
Journal sequence number	The sequence number that is assigned when the journal is obtained
Timestamp	The time when the journal data is obtained

The journal sequence number indicates the primary data volume write sequence that the primary subsystem has created for each journal group. The journal data is transferred to the secondary subsystem asynchronously with the host I/O. The secondary subsystem updates the secondary data volume in the same order as the primary data volume according to the sequence number information in the journal.

3.23.3.2 Copying Journals to the Secondary Subsystem

When a primary subsystem receives a read journal command from a secondary subsystem, the primary subsystem sends the journal data to the secondary subsystem. The secondary subsystem's initiator ports act as host processor channels and issue special I/O operations, called remote I/Os (RIOs), to the primary subsystem. The RIO transfers the journal data in FBA format using a single channel command. The primary subsystem can send several journal data using a single RIO, even if their sequence numbers are not contiguous. Therefore, the journal data are usually sent to the secondary subsystem in a different order than the journal data were created at the primary subsystem. The secondary subsystem ensures that the journal data are applied to the secondary data volume in the correct sequence. This method of remote I/O provides the most efficient use of primary subsystem-to-secondary subsystem link resources.

3.23.3.3 Storing Journal at the Secondary Subsystem

A secondary subsystem receives the journal data that is transferred from a primary subsystem according to the read journal command. The journal data will be stored into the cache at first, and then into the journal volume.

Note: The primary subsystem does not remove the target journal data from its master journal volume until it receives the sequence numbers of restored journal which is give to the read journal command from the secondary subsystem. This is true even if the primary subsystem and secondary subsystem are connected via a channel extender product.

3.23.3.4 Selecting and Restoring Journal at the Secondary Subsystem

The secondary subsystem selects journal data to be promoted to formal data (or “restored”) as follows:

1. The secondary subsystem gives the number as the management information to distinguish the journal data arrival to the sequence number that is assigned to the journal data from the primary subsystem. If the number is 1, the journal data arrived at the secondary subsystem. If the number is 0, the journal data has not arrived yet. The secondary subsystem determines whether the journal data should be settled or not according to this number. If the journal data has not arrived yet, the secondary subsystem waits for the journal data.
2. When the top of queue in the journal group indicates the journal data arrival, the secondary subsystem selects the journal data which has the lowest sequence number, and then settles this journal data.
3. The secondary subsystem repeats steps 1. and 2. to select and settle the journal data.

Figure 3.23-4 illustrates the journal data selection and settling at the secondary subsystem. This diagram shows that journal data S1 arrives at the secondary subsystem because the management information indicates 1. The secondary subsystem selects journal data S1 to be settled, because S1 is the lowest sequence number. When S1 is removed from the queue of sequence numbers, journal data S2 becomes the top entry, but it has not arrived yet. The management information of journal data S2 is 0. The secondary subsystem waits journal data S2. When journal data S2 arrives, the secondary subsystem selects S2 as the next journal data to be settled. The journal data selected by the secondary subsystem is marked as “host-dirty” and treated as formal data.

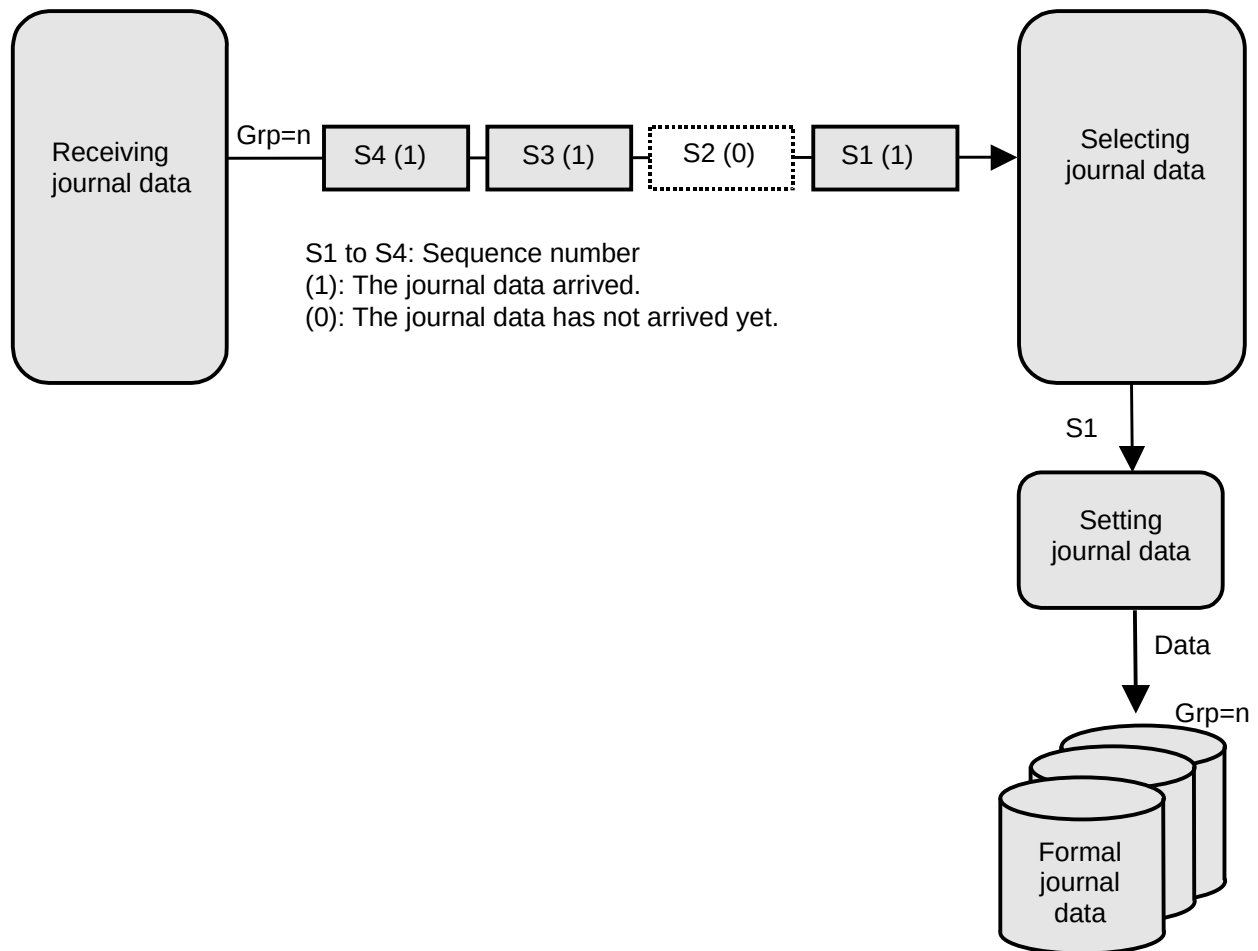


Figure 3.23-4 Selecting and Settling Journal at the Secondary Subsystem

The secondary subsystem settles and restores the journal data to the secondary data volume as follows:

- Journal data stored in the cache
The journal data is copied to the corresponding cached track and promoted to formal data.
- Journal data stored in the restore journal volume
The journal data is read from the restore journal volume to cache. The journal data that is read to cache is copied to the existing cache track and promoted to formal data. After that, the space for the restore journal volume is released.

3.23.3.5 Types of Journal

In addition to the journal data for updating, the primary subsystem sends control information to the secondary subsystem. This control information indicates when volume pair status changes and when a primary subsystem power-off sequence is initiated, and also maintain sequence numbers in periods of low host activities.

3.23.4 UR operation

3.23.4.1 Pair operation

The following figure illustrates an UR pair configuration. In the configuration, UR pairs belong to the journal group. Each journal group and UR pair have an attribute and status. Each attribute and status is described in the following subsections.

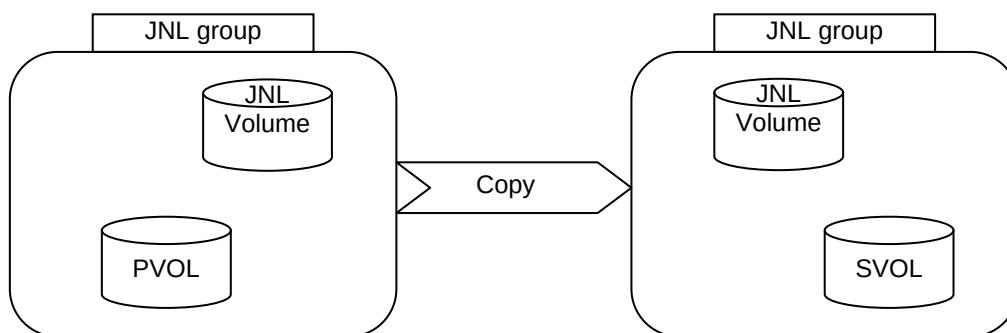


Figure 3.23-5 Relationship between pairs and journal groups

(1) Journal group

Prior to pair creation, the journal volume needs to be registered, and the journal group needs to be defined. You can delete journal groups that are not in use. To define journal groups, you need to register journal volumes. On the other hand, to delete journal groups, you need to delete all journal volumes.

Table 3.23.4.1-1 Journal group attributes

#	Journal group attribute	Meaning
1	Initial	No UR pair is set in the journal group to which journal volumes are registered.
2	Master	The journal group to which the logical volume storing the original data (PVOL) belongs. The attribute of the journal group in Master is called “M journal”.
3	Restore	The journal group to which the logical volume storing the duplicated data (SVOL) belongs. The attribute of the journal group in Restore is called “R journal”.

Table 3.23.4.1-2 Journal group status

#	Journal group status	Meaning
1	–	UR pairs are not set in the target group
2	Active	Base/update copy is in progress in the target group
3	Halting	Base/update copy is halted in the target group
4	Stopping	The target group is being suspended, or being deleted
5	Stop	The target group is suspended. (All UR pairs in the target group are suspended)

Table 3.23.4.1-3 Journal group operations

#	Operation	Specified attribute	Description
1	Register journal volume	MJNL/RJNL	✓ Register a logical volume, to which no path is defined, as a JNL volume. ✓ Can register the additional volume to the existing journal group only when the UR remote copy is stopped (Journal group status is STOP). ✓ When the journal group state is ACTIVE, the journal volume can be registered. (However, only the journal area increases, and after the journal group suspend and resync, the meta data area increases). ✓ Can register UR pair to the journal group to which the journal volume is registered.
2	Delete journal volume	MJNL/RJNL	✓ Delete the logical volume registered as a journal volume from the journal volume. ✓ Can delete it only when UR remote copy is stopped (Journal group status is STOP or the group attribute is Initial) if there are two or more journal volumes in the target journal group. ✓ Can delete it only when the target group does not have any UR pair (Group attribute is Initial) if the number of journal volumes in the target journal group is one ✓ No UR pair can be registered to such a journal group from which all journal volumes are deleted. ✓ When the journal volume of MF emulation type is deleted, a volume concerned blockades because LDEV format is necessary. When the same volume is re-used as a journal volume, format is not necessary for automatic blockage restoration.

(2) UR pairs

UR performs a remote copy operation for the logical volume pair set by the user. Based on pair operations, pair attributes and pair statuses are added to the logical volumes. You can perform the following remote copy operations for UR pairs. The figure below illustrates how the UR pair status changes due to each operation.

Table 3.23.4.1-4 Pair attributes

#	Pair attribute	Description
1	SMPL	Target volume is not assigned to an UR pair.
2	PVOL	Primary volume. Data volume to which the original data is stored.
3	SVOL	Secondary volume. Data volume to which backup or duplicated data is stored.

Table 3.23.4.1-5 Pair status

#	Pair status	Description
1	SMPL	Target volume is not assigned to an UR pair.
2	COPY	Base copy is in progress and data of the PVOL and SVOL of the UR pair do not match completely. When their data match, the status changes to PAIR.
3	PAIR	Base copy is completed, and data of the PVOL and SVOL match completely.
4	PSUS/SSUS	Copy operation is suspended in the UR pair.
5	PSUE	An error is detected in the DKC, and the copy in the UR pair is stopped (Suspended).
6	PFUL	The journal usage in the journal volume exceeded the threshold. The copy operation is continued.
7	PFUS	The capacity of the stored journal exceeded the journal volume capacity, and the copy operation is suspended in DKC.
8	SSWS	Data can be written to the SVOL in which Takeover is in progress.
9	Suspending	The status of the UR pair is being changed to Suspend.
10	Deleting	The UR pair is deleted, and the status is being changed to SMPL.

Table 3.23.4.1-6 Pair operations

#	Operation	Specified attribute	Description
1	Pair create	MJNL	Register the logical volume to which a path is defined as an UR pair. There are two types of copy instruction, "All copy" and "NO copy". "All copy" performs a base copy, and "NO copy" does not perform a base copy.
2	Pair suspend	MJNL/RJNL	Change the status of the UR pair, which is performing the base/update copy, to the suspend status.
3	Pair delete	MJNL/RJNL	Delete the already registered UR pair.
4	Pair resync	MJNL/RJNL	Change the pair status of the UR, in which the copy operation is suspended, to the pair resume status. (RJNL can be specified only when swapping is specified)
5	Takeover	RJNL	Swap MJNL and RJNL (reverse the source and the target) and resync the pair.

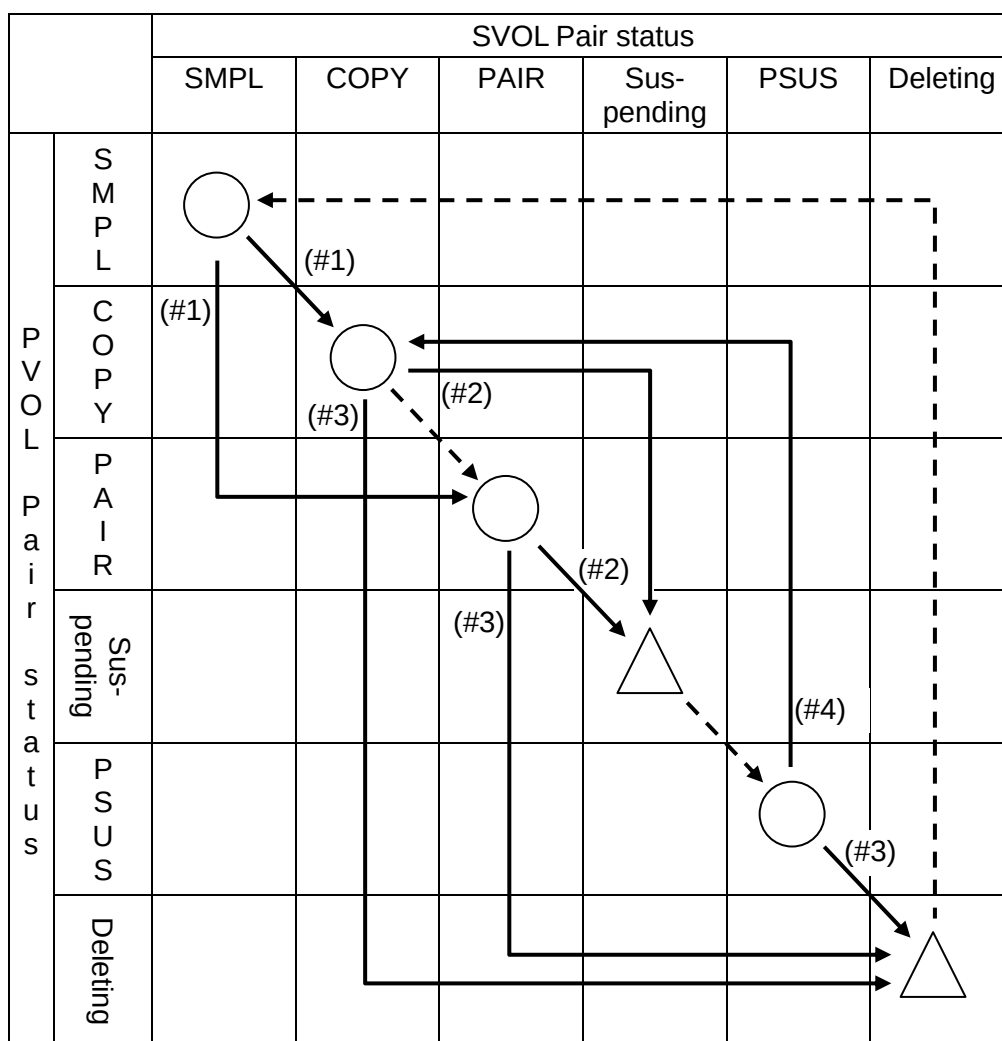


Figure 3.23-6 Pair attributes

(3) Pair create

Logical volume to which a path is defined is registered to the target journal group as an UR pair (data volume). The specification of a data volume and UR pair in a journal group is as follows.

Table 3.23.4.1-7 Pair create

#	Item	Mainframe	Open platform
1	Pair create timing	✓ Can register the pair only when the specified journal group exists, and no Suspending/Deleting pair is included in that journal group.	✓ Can register the pair only when the specified journal group exists, and no Suspending/Deleting pair is included in that journal group.

● Pair create option

When creating a pair, you can set a pair create option. The following table shows the options and applications that can be specified.

Table 3.23.4.1-8 Pair create options

#	Option	Feature overview	OP	MF	RM	BC
1	Copy type	You can choose to or not to perform a base copy. The following copy types are available. ✓ All copy: Perform base copy when creating a pair. ✓ No copy: Not perform base copy when creating a pair.	○	○	○	○
2	Priority	Specify which pair you want to perform a base copy first when creating multiple pairs at a time. ✓ Setting: 1-255	○	○	—	—
3	Error level	Set error levels. You can choose either of the following levels. ✓ Group: Even if an error which affects only the specified volume occurs, all pairs in the journal group will suspend due to the error. ✓ Volume: When an error which affects only the specified volume occurs, only that pair suspends due to the error. However, when an error which affects the entire journal group occurs, all pairs in the journal group are suspended.	○	○	—	○
4	SVOL ONLINE Check	Check whether SVOL is ONLINE or not, and if it is ONLINE, you cannot create a pair. You can choose either of the following. ✓ No Check: Create a pair without checking whether SVOL is ONLINE ✓ SVOL ONLINE: Check if SVOL is ONLINE.	—	—	—	○
5	CFW data	Choose whether MCU copies the CFW data to SVOL. You can choose either of the following. ✓ Copy to SVOL: MCU copies the CFW data to SVOL. ✓ PVOL only: MCU does not copy the CFW data to SVOL.	—	○	—	—

Legend) OP: Instruction from Storage Navigator (OPEN), MF: Instruction from Storage Navigator (MF)
RM: Instruction from RAID Manager, BC: Instruction from BC Manager

(4) Pair suspend

The copy operation of an UR pair is stopped, and the pair status is changed to PSUS. When all UR pairs in a journal group are suspended, the status of the journal group is changed to STOP. The specifications of the suspend operation are as follows.

- ✓ This operation is performed when the target volume is in the COPY/PAIR status and all volumes in the journal group are in the status other than Suspending/Deleting status.
- ✓ The pair suspend operation can be performed from PVOL/SVOL. The processing of the suspend operation is the same for both PVOL/SVOL instructions.
- ✓ When you perform the pair suspend operation, you can specify the Pend Update and the suspend range. The table below shows the relationships of Pend Update and the suspend range.

Table 3.23.4.1-9 Pair suspend

#	Pend Update	Feature overview	Volume	Group
1	Flush	✓ When the suspend operation is received, the pending data in MCU/RCU is reflected. ✓ When the operation is performed while the host I/O is being processed, the contents of the PVOL and SVOP are not the same. (In the operation after the host I/O is stopped, the contents of the PVOL and SVOL are the same)	○	○
2	Purge	✓ When the suspend operation is received, the difference of the pending data in MCU/RCU is recorded to the differential bitmaps. (Since the data is not reflected, the contents of the PVOL and SVOL are not the same) ✓ The status can be changed to Suspend in a short time.	—	○

● Pair suspend option

When you perform a pair suspend operation, you can specify a pair suspend option. The following table shows the options and applications you can specify.

Table 3.23.4.1-10 Pair suspend option

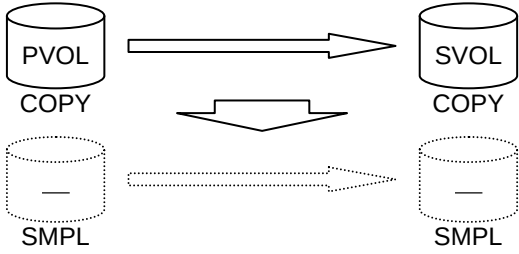
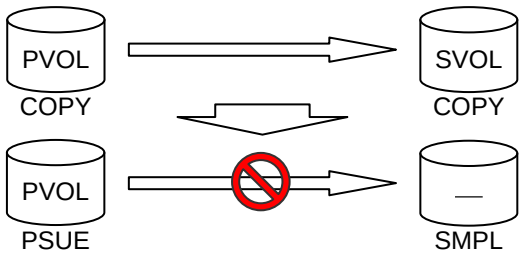
#	Option	Feature overview	OP	MF	RM	BC
1	Pend Update	You can choose a Pend Update type when performing a pair suspend. (Note that only Flush is available for RAID Manager) ✓ Flush: The Pend data is processed in the Flush mode. ✓ Purge: The Pend data is processed in the Purge mode.	○	○	–	○
2	Range	You can specify the suspend range. (However, when the Purge mode is selected in Pend Update, only “Group” can be selected) ✓ Volume: Only the specified UR pairs are suspended. ✓ Group: All pairs in the specified journal group are suspended.	○	○	○	○
3	SVOL write	You can choose to perform Write/Read to the SVOL when performing a pair suspend. ✓ Disable: Cannot Read/Write data to the suspended SVOL. ✓ Enable: Can Read/Write data to the suspended SVOL.	○	○	○	○

(5) Pair delete

The UR pair is deleted, and the pair volumes are restored to non-UR logical volumes. When all UR pairs in the target journal group are deleted, the attribute of the journal group is changed to Initial. The following table shows the specifications of the pair delete operation.

- ✓ This operation is performed when the target volume is in the normal status (COPY/PAIR/PSUS(PSUE)) and all volumes in the journal group are in the status other than Suspending/Deleting.
- ✓ If you perform the pair delete operation for an UR pair after stopping the host I/O, the data in the PVOL and that in the SVOL are the same. (When this operation is performed while the host I/O is in progress, the data are not the same.)
- ✓ The pair delete operation can be performed from PVOL/SVOL. Note that the feature depends on the specified volume attribute. The following table shows the specified volume attributes and the features.

Table 3.23.4.1-11 Pair delete

#	Specified volume	Feature overview
1	PVOL specified	✓ The statuses of both PVOL and SVOL are changed to SMPL, and the UR pair will be deleted. 
2	SVOL specified	✓ Only the status of SVOL changes to SMPL, and the PVOL status is not changed. If the PVOL is in the COPY/PAIR status, the pair will be suspended due to a failure (PSUE). When the operation is performed to the suspended pair, the PVOL status is not changed.  ✓ The UR pair of only the PVOL after the pair delete operation cannot be resynchronized. Therefore, you need to delete the pair using the PVOL-specified pair delete operation.

● Pair delete option

When you perform a pair delete operation, you can specify a pair delete option. The following table shows the options and applications you can specify.

Table 3.23.4.1-12 Pair delete option

#	Option	Feature overview	OP	MF	RM	BC
1	Range	You can specify the following pair delete range. ✓ Volume: Only the specified UR pairs are deleted. ✓ Group: All pairs in the specified journal group are deleted.	○	○	○	○
2	Specified volume attribute	You can specify the attribute of the volume to which the pair delete is performed. PVOL specified: Normal pair delete operation is performed. SVOL specified: Pair is deleted only in SVOL.	○	○	○	—
3	ForceDelete	You can specify ForceDelete which deletes pairs regardless of the pair status. The overview of the ForceDelete feature is as follows. ✓ ForceDelete deletes only the pairs in the specified volume without recognizing the status of the paired volume. Therefore, the operations in the target (paired) volume is not guaranteed. ✓ Only “Group” range is available. (Note that only “Volume” range is available for SMPL volumes) ✓ After the ForceDelete operation, the data in PVOL and that in SVOL are not the same.	○	○	—	—

(6) Pair resync (Pair resume)

The copy operation of the suspended UR pair is resumed. When a copy operation of one pair is resumed in the journal group in which the copy operation is stopped (STOP), the journal group status will be changed to Active. The specifications of pair resync operation are as follows.

- ✓ This operation is performed when the target UR pair is in the PSUS/PSUE status and the journal group to which the target UR belongs does not contain UR pair in the Suspending/Deleting status. However, this operation cannot be performed to the PVOL which is paired with the SVOL in the SSWS status.
- ✓ The operations can be specified in PVOL. However, the Swap instruction can be specified in SVOL optionally.

● Pair resync option

When you perform a pair resync operation, you can specify a pair resync option. In addition, when the range of the operation is “volume”, you can change the pair create option for the target volume. The following table shows the options and applications you can specify.

Table 3.23.4.1-13 Pair resync option

#	Option	Feature overview	OP	MF	RM	BC
1	Range	You can specify the following pair resync range. ✓ Volume: Only the specified UR pairs are resynchronized. ✓ Group: All pairs in the specified journal group are resynchronized.	○	○	○	○
2	Priority	To resynchronize multiple pairs at a time, set the priority of the base copy operation. ✓ Range: 1-255	○	○	—	—
3	Error level	Set the error level in the case of a failure. (Enabled only when the range “volume”) ✓ Group: Even if a failure affects only the specified volume, all pairs in the journal group will be suspended due to the failure. ✓ Volume: When a failure affects only the specified volume, only the pair will be suspended due to the failure. However, when a failure affects the entire journal group, all pairs in the journal group will be suspended due to the failure.	○	○	—	○
4	Swap	This option is specified in the SVOL, the volumes are swapped (SVOL→PVOL/PVOL→SVOL). The differential data is resynchronized from the swapped PVOL to SVOL. See “3.23.4.1 (7) Takeover” for the swapping feature.	—	—	○	○

(7) Takeover (Reverse Resync)

Takeover swaps PVOL and SVOL (switch the source and the target) and resynchronizes the pair. The specifications of the Takeover operation are as follows.

- ✓ Only RAID Manager can perform this operation.
- ✓ This operation is performed to SVOL. It can be performed even if the PVOL (i.e. DKC in the MCU) is lost due to disaster etc.
- ✓ This operation is performed when the pair status of the SVOL is PAIR or PSUS/SSWS and when the target RCU does not contain UR pairs in the Suspending/Deleting or COPY status. The following table shows when the Takeover command is issued.

Table 3.23.4.1-14 Takeover

#	Pair status	Feature overview
1	PAIR	(1) When a Takeover command is issued to the RCU, the Flush suspend is performed for the specified group. When it is issued, the SVOL status changes to SSWS, and it becomes a volume that can be read/written. (2) After the pair is suspended, a pair resync swap is performed to swap the PVOL and the SVOL, and an initial copy operation is performed.
2	PSUS/PSUE	(1) When a Takeover command is issued to RCU, the Flush suspend is not performed for the specified group. Only the SVOL status is changed to SSWS. (2) After the suspend operation completes, a pair resync swap is performed to swap the PVOL and the SVOL, and an initial copy is performed.

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(8) JNL group status and display of pair status by RAID Manager

We summarize the relationship between display of JNL group status and display of pair status regarding RAID Manager(RM) compared with JAVA display as the following.

① Operation suspend

#	JAVA Pair status	RM Pair status	RM (M-JNL) JNLGroup status	RM (R-JNL) JNLGroup status	Remarks
1	SMPL	SMPL	—	—	—
2	COPY/PAIR	COPY/PAIR	PJNN	SJNN	—
3	Suspending				—
4	PSUS	PSUS/SSUS	PJSN	SJSN	—

② JNL utilization threshold over (JNL utilization is over 80% (but...not failure))

#	JAVA Pair status	RM Pair status	RM (M-JNL) JNLGroup status	RM (R-JNL) JNLGroup status	Remarks
1	SMPL	SMPL	—	—	—
2	COPY/PAIR	PFUL	PJNF	SJNF	—
3	Suspending	—	—	—	Pair status will not change to “Suspend”.
4	PSUS	PSUS/SSUS	—	—	Same as above

③ Failure suspend (except for JNL puncture)

#	JAVA Pair status	RM Pair status	RM (M-JNL) JNLGroup status	RM (R-JNL) JNLGroup status	Remarks
1	SMPL	SMPL	—	—	—
2	COPY/PAIR	COPY/PAIR	PJNN	SJNN	—
3	Suspending	PSUE	PJSE	SJSE	—
4	PSUE	PSUE			—

④ JNL puncture suspend

#	JAVA Pair status	RM Pair status	RM (M-JNL) JNLGroup status	RM (R-JNL) JNLGroup status	Remarks
1	SMPL	SMPL	—	—	—
2	COPY/PAIR	COPY/PAIR	PJNN	SJNN	—
3	Suspending	PFUS	PJSF	SJSF	—
4	PSUS	PFUS			—

3.23.4.2 USAGE/HISTORY

(1) USAGE

This feature enables you to view the UR information (Frequency of I/O for UR pair, transfer rate of journals between MCU/RCU, usage of journals in MCU/RCU etc.) using SVP and Web Console. The specifications are as follows.

Table 3.23.4.2-1 USAGE specification

#	Item	Specification etc.
1	Sampling interval	1-15 min. (1 min.)
2	Samplings	1440
3	Unit of sampling/display	• For each LU • For each JNL group • For each system
4	Sampling item	See Table 3.23.4.2-2
5	Others	You can save the monitor data in the text format using the Export Tool of Performance Monitor.

Table 3.23.4.2-2 Sampled items

#		Category	Statistics	Description
1	M C U	Host I/O	Write Record Count	The number of Write I/Os per second
2			Write Transfer Rate	The amount of data that are written per second (KB/sec.)
3		Initial copy	Initial copy HIT rate	Initial copy hit rate (%)
4			Average Transfer Rate	The average transfer rate for initial copy operations (KB/sec.)
5	M C U	Async copy	M-JNL Asynchronous RIO count	Number of async RIOs per second in MCU
6			M-JNL Total Number of Journal	The number of journals at MCU
7			M-JNL Average Transfer Rate	The average transfer rate for journals at MCU (KB/sec.)
8			M-JNL Average RIO Response	The remote I/O process time at MCU (milliseconds)
9	R C U	Async copy	R-JNL Asynchronous RIO count	The number of asynchronous remote I/Os per second at the RCU
10			R-JNL Total Number of Journal	The number of journals at the RCU
11			R-JNL Average Transfer Rate	The average transfer rate for journals at RCU (KB/sec.)
12			R-JNL Average RIO Response	The remote I/O process time at RCU (milliseconds)
13	M C U	Journal group	Data Used Rate	Data usage rate for journals at MCU (%)
14			Meta Data Used Rate	Metadata usage rate for journals at MCU (%)
15	R C U	Journal group	Data Used Rate	Data usage rate for journals at RCU (%)
16			Meta Data Used Rate	Metadata usage rate for journals at RCU (%)

(2) HISTORY

This feature enables you to view the history of operations for data volume pairs (Operations performed in the past) using SVP and Web Console. The specifications are as follows.

Table 3.23.4.2-3 HISTORY specifications

#	Item	Spec etc.
1	Displayed info	Date and time of the operation, contents of the operation (See #3, Journal group number, Mirror ID, Data volume, Target volume)
2	Samplings	524288, or for one week
3	Operation	• Pair create • Pair delete • Pair recovery • Pair split etc.
4	Others	The snapshot function enables you to save operation history to a text file.

3.23.4.3 Option

The following table shows UR settings. For pair settings, see 3.23.4.1. The following system option and journal group options are supported.

Table 3.23.4.3-1 List of options

#	Affected	Setting	Description	Supported version
1	System	Max number of initial copy VOLs	✓ Number of volumes to which initial copy operations are performed at a time. The setting value is 1-128. ✓ Default is 64.	
2	Journal group	Inflow Control	✓ Indicates whether to restrict inflow of update I/Os to the PVOL (whether to delay a response to the hosts). ✓ If you select “Yes”, the inflow control is performed according to the condition of #3.	
3		Data Overflow Watch	✓ Indicates the time (in seconds) for monitoring whether metadata and journal data are of journal volume are full. ✓ When either of the areas becomes full, the target group will be suspended due to a failure after this specified time. ✓ The setting value is 0-600 sec.	
4		Use of Cache	✓ If you select “USE”, journal data will be stored into the cache and don’t destage journal volumes in the restore journal group as long as the cache memory is not filled. The JNL restore performance improves.	

(To be continued)

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(Continued from preceding page)

#	Affected	Setting	Description	Supported version
5	Mirror	Copy pace	✓ Initial copy pace (speed). ✓ The setting value is “Low”, “Medium” or “High”.	
6		Speed of Line	✓ JNL copy performance pace (speed). ✓ The setting value is “256Mbps”, “100Mbps” or “50Mbps”.	
7		Unit of Path Watch time	✓ Unit of Path Watch time (#8) ✓ The setting value is “minute”, “hour” or “day”.	
8		Path Watch time	✓ Time for monitoring a path from the time it is blocked until it is suspended due to a failure. ✓ The setting value is 1 min - 30 days. ✓ You can specify whether to forward the Path Watch time value of the master journal group to the restore journal group. If the Path Watch time value is forwarded from the master journal group to the restore journal group, the two journal groups will have the same Path Watch time value.	
9		Forward Path Watch time	✓ If you select “Yes”, the Path Watch time (#8) value of the master journal group will be forwarded to the restore journal group.	
10		Delta resync Failure	✓ Specify the processing that takes place when delta resync operation cannot be performed. ✓ If “Copy of all” is specified, the whole data in primary data volume is copied to secondary data volume when delta resync operation cannot be performed.	

Table 3.23.4.3-2 Link failure monitoring mode

Mode	Feature digest	Feature overview
448	Mode for suspending the pair immediately after UR path is disconnected	Turn this mode ON when you want to suspend the pair due to a failure immediately after a communication failure is detected between UR M-R. This mode runs only when Mode 449 is OFF. ON: In MCU, the pair is suspended due to a failure immediately after the RDJNL from RCU is stopped. In RCU, the pair is suspended due to a failure immediately after the RDJNL fails. OFF: In MCU, the pair is suspended due to a failure when the RDJNL from RCU is stopped for a certain period of time. In RCU, the pair is suspended due to a failure when the RDJNL fails for a certain period of time.
449	Mode for prohibiting UR path watch	Turn this mode ON when you want to prevent communication failures between UR M-R from being detected. On is default since ver.50-05-00-00. ON: In MCU, the RDJNL stop check from RCU is prevented. In RCU, the RDJNL failure monitoring is prevented. OFF: Communication failures between M-R are detected.

3.23.5 Maintenance features and procedure

3.23.5.1 Maintenance

The following table shows limitations/impact on the maintenance operations regarding the UR operations. Other limitations/impact refer to “2.8 Availability of Installation and De-installation” of INSTALLATION SECTION ([INST02-200](#)).

Table 3.23.5.1-1 Limitations/restrictions on maintenance

#	Item	Limitation/impact	Note
1	CM replacement/ change of SM capacity setting in MCU	Pair in the initial copy status will suspend due to a failure.	
2	Microprogram exchange in RCU	The pair may be suspended in MCU due to a failure. (Cause: Link failure, journal full)	Alternate paths are set between MCU and RCU. If microprogram is not replaced using these alternate paths at a time, the pair will not be suspended due to a link failure.
3	CHT replacement in MCU/RCU	The pair may be suspended in MCU/RCU due to a failure. (Cause: Link failure, journal full)	Alternate paths are set between MCU and RCU. If microprogram is not replaced using these alternate paths at a time, the pair will not be suspended due to a link failure.

3.23.5.2 PS OFF/ON Process

Before you power off/on (PS OFF/ON) the DKC, we recommend that you suspend all pairs (all JNL groups) by specifying Flush in advance as shown below. When you stop the host I/O and suspend (Flush) the pairs in advance, the contents of PVOL and SVOL match. Consequently, the operation can be continued using the SVOL data in R-DKC even if you fail to power on the M-DKC for some reason. The recommended procedure is as follows.

- (1) Stop the host I/O.
- (2) Issue the suspend (Flush) request for M-JNL, and change the statuses of both M-JNL and R-JNL to suspend.
- (3) Power off the M-DKC.
- (4) Power off the R-DKC.
- (5) Power on the R-DKC.
- (6) Power on the M-DKC.
- (7) Resynchronize the pair upon the pair resync request.
- (8) Resume the host I/O.

If you do not perform the procedure above, operations are performed as follows. The numbers in the table below show the target of PS OFF/ON, and the order of PS OFF/ON. “-” shows that it is not the target of PS OFF/ON.

Table 3.23.5.2-1 PS OFF/ON

	Part and Order of PS OFF/ON				Operation
	M-DKC		R-DKC		
	OFF	ON	OFF	ON	
Case 1	1	2	–	–	[PS OFF/ON only M-DKC] No problem.
Case 2	–	–	1	2	[PS OFF/ON only R-DKC] Pair may be suspended due to a failure in MCU. As a result, R-JNL detects the failure suspension when PS ON is performed, and the pair may be also suspended. Such a failure suspension is caused because the M-JNL is full or the read journal is stopped.
Case 3	1	3	2	4	[PS OFF/ON both M-DKC and R-DKC] PS ON the M-DKC first. If it takes time until R-DKC PS ON (4) after M-DKC PS ON (3), the same phenomenon as Case 2 will occur.
Case 4	1	4	2	3	[PS OFF/ON both M-DKC and R-DKC] The procedure is the recommended one, except that host I/O stop and pair suspension are excluded. When PS ON is performed, the pair status before PS OFF is maintained.
Case 5	2	3	1	4	[PS OFF/ON both M-DKC and R-DKC] PS OFF R-DKC first. If it takes time until M-DKC PS OFF (2) after R-DKC PS OFF (1), the same phenomenon as Case 2 will occur. If it takes time until R-DKC PS ON(4) after M-DKC PS ON (3), the same phenomenon as Case 2 will occur.
Case 6	2	4	1	3	[PS OFF/ON both M-DKC and R-DKC] If it takes time until M-DKC PS OFF (2) after R-DKC PS OFF (1), the same phenomenon as Case 2 will occur.

3.23.5.3 Power failure

When a power failure occurs, UR pairs will be in the following status.

Table 3.23.5.3-1 Power failures

#	Item	Pair in PS ON	Recovery
1	SM/CM non-volatile	Suspended due to a failure	Resynchronize to the target group
2	SM/CM volatile	Journal group information and pair information will be lost.	Register journal group and pair

3.23.6 Cautions on software

3.23.6.1 Error recovery

The following subsections describes failure detection, error report, and recovery in UR. When a failure occurs in UR, Group or Volume (according to the error level setting) will be suspended.

(1) Error report

The following table shows the error report in the case of a failure.

Table 3.23.6.1-1 Error report

Item	Type	SSB(F/M)	SIM
Path	Link failure	–	0x2180-XX
Pair	Failure suspend	F/M=0xFB Not reported to host	Serious SIM Not reported to host

(2) Failure detection and recovery

Failure detection and recovery in MCU are described in the following table.

Table 3.23.6.1-2 Failure detection and recovery

Part	Description	Error	Recovery
Path failure	Link failure of MCU->RCU	SIM=0x2180	Recover the link
	Link failure of MCU<-RCU	When Read JNL is stopped for a certain period of time, the target Volume/Group is suspended, and F/M=0xFB, SIM is generated. (see Table 3.23.4.3-1 and Table 3.23.4.3-2.)	Recover the link Resync after the failure recovered
Data volume failure	PDEV failure	Target Volume/Group is suspended F/M=0xFB, SIM Update I/O is managed as differential data	Resync after the failure recovered
Journal failure	PDEV failure	Target Group is suspended F/M=0xFB, SIM Update I/O is managed as differential data	Resync after the failure recovered
Journal full	Metadata area or journal data area of JNL volume is not sufficient for a certain period of time	Target Group is suspended F/M=0xFB, SIM Update I/O is managed as differential data	Resync after the failure recovered

(3) Failure detection in RCU

Failure detection and recovery in RCU are described in the following table.

Table 3.23.6.1-3 Failure detection in RCU

Part	Description	Error	Recovery
Path failure	Link failure of MCU<-RCU	SIM=0x2180When Read JNL is stopped for a certain period of time, the target Volume/Group is suspended, and F/M=0xFB, SIM is generated. (see Table 3.23.4.3-1 and Table 3.23.4.3-2.)	Recover the link Resync after the failure recovered
Data volume failure	PDEV failure	Target Volume/Group is suspended F/M=0xFB, SIM	Resync after the failure recovered
Journal failure	PDEV failure	Target Group is suspended F/M=0xFB, SIM	Resync after the failure recovered

3.23.7 Disaster Recovery Operations

3.23.7.1 Preparation for Disaster Recovery

The type of disaster and the status of the URz volume pairs will determine the best approach for disaster recovery. Unfortunately, some disasters are not so “orderly” and involve intermittent or gradual failures occurring over a longer period of time. The user should anticipate and plan for all types of failures and disasters.

The major steps in preparing for disaster recovery are:

1. Identify the journal groups and data volumes that contain important files and data (e.g. DB2 log files, master catalogs, key user catalogs, and system control datasets) for disaster recovery.
2. Install the Storage Navigator PC and URz hardware and software, and establish Universal Replicator operations for the journal groups and data volumes identified in step (1).
3. Establish file and database recovery procedures. These procedures should already be established for recovering data volumes that become inaccessible due to some failure.
4. Install and configure error reporting communications (ERC) between the primary and secondary sites.

3.23.7.2 Sense information is transferred between sites

When the primary subsystem (or secondary subsystem for URz) suspends a URz pair due to an error condition, the primary subsystem or secondary subsystem sends sense information with unit check status to the appropriate host(s). This sense information is used during disaster recovery. You must transfer the sense information to the secondary site via the error reporting communications (ERC).

3.23.7.3 File and Database Recovery Procedures

When the primary or secondary subsystem suspends a URz pair due to a disaster, the secondary data volume may contain in-process data. A data set could be open, or transactions may not have completed. Therefore, you need to establish file recovery procedures. These procedures should be the same as those used for recovering data volume that becomes inaccessible due to control unit failure.

URz does not provide any procedure for detecting and retrieving lost updates. To detect and recreate lost updates, you must check other current information (e.g., database log file) that was active at the primary site when the disaster occurred. Note that the journal log file entries of most DBMS have the same system TOD clock information that is used for the I/O time-stamps (when timer type = system). The URz group consistency time can be extremely useful when performing this detection and retrieval. Since this detection/retrieval process can take a while, your disaster recovery scenario should be designed so that detection/retrieval of lost updates is performed after the application has been started at the secondary site.

You should prepare for file and database recovery by using:

- Files for file recovery (e.g., database log files which have been verified as current).
- The sense information with system time stamp which will be transferred via ERC.

3.23.7.4 Switching Operations to the Secondary Site

If a disaster or failure occurs at the primary site, the first disaster recovery activity is to use Business Continuity Manager to switch your operations to the remote backup site.

The basic procedures for switching operations to the remote backup site are:

1. Check whether the restore journal group includes a secondary data volume whose pair status is Pending duplex or Suspend (equivalent to SUSPOP in Business Continuity Manager).
If such a pair exists, consistency in the secondary data volume is dubious, and recovery with guaranteed consistency is impossible. In this case, if you want to use the secondary data volume, you must delete the pair.
2. If such a pair does not exist, use Business Continuity Manager to execute the YKSUSPND REVERSE option on the restore journal group (YKSUSPND is a command for splitting a pair).
If an error occurs, consistency in the secondary data volume is dubious, and recovery with guaranteed consistency is impossible. In this case, if you want to use the secondary data volume, you must delete the pair.
3. If no error occurs in step 2, wait until the splitting finishes. When the splitting finishes, the secondary data volume becomes usable with maintained consistency.
4. When the splitting finishes, use Business Continuity Manager to execute the YKRESYNC REVERSE option on the restore journal group (YKRESYNC is a command for restoring a pair). This option attempts to restore the pair and reverse the primary/secondary relationship.
5. Check whether there is a pair whose pair status of the restore journal group is Suspend (equivalent to SWAPPING in Business Continuity Manager).
If such a pair does not exist, the pair is successfully restored and the copy direction is reversed, and then copying of data from the secondary site to the primary site will start.

If the YKSUSPND command finishes successfully and the splitting ends successfully, you can resume business tasks (i.e., you can start business applications) by using secondary data volumes in the secondary site. Also, if the primary subsystem, the secondary subsystem, and remote copy connections are free from failure and fully operational, the restoring of the pair will finish successfully, and then copying of data from the secondary site to the primary site will start.

3.23.7.5 Transferring Operations Back to the Primary Site

Once the disaster recovery procedure is finished and your business applications are running at the secondary site, the next activity is to restore the primary site and make arrangements for copying data from the secondary site back to the primary site. The following procedure explains how to use Business Continuity Manager to copy data from the secondary site to the primary site:

1. Restore the primary subsystem and remote copy connections, and make sure that all URz components are fully operational.
2. At the primary site, locate primary data volumes whose pair status is Pending duplex or Duplex, and then locate corresponding secondary data volumes whose pair status is Suspend, which is equivalent to SWAPPING in Business Continuity Manager terminology. If such volume pairs are found, issue a request for splitting the pairs to the primary data volumes.
3. At the primary site, locate primary data volumes whose pair status is not Simplex, and then locate corresponding secondary data volumes whose pair status is Simplex. If such volume pairs are found, issue a request for deleting the pairs to the primary data volumes.
4. At the primary site, locate data volume pairs whose pair status is Simplex, and then use Business Continuity Manager to execute YKRECOVER on the secondary data volume (YKRECOVER is a command for deleting a pair).
5. Execute the YKRESYNC REVERSE option on secondary data volumes whose pair status is Suspend, which is equivalent to SWAPPING in Business Continuity Manager terminology (YKRESYNC is the Business Continuity Manager command for resynchronizing pair). This reverses primary data volumes and secondary data volumes to resynchronize pairs.
6. Create pairs, specifying secondary data volumes whose pair status is Simplex as primary data volumes. This creates pairs in which primary data volumes and secondary data volumes are reversed.
7. Verify that pair status of all secondary data volumes (which were originally primary data volumes) changes from Pending Duplex to Duplex. If the pair status is changed to Duplex, initial copy operations are finished and consistency is maintained.

The above procedure enables copying of data from the secondary site to the primary site. Data in the secondary site will be reflected on the primary site.

3.23.7.6 Resuming Normal Operations at the Primary Site

Once the URz volume pairs have been established in the reverse direction, you are ready to resume normal operations at the primary site. The following procedure explains how to resume normal operations at the primary site by using Business Continuity Manager. Remember that the URz terminology is now reversed: the original primary data volumes are now secondary data volumes, and the original secondary data volumes are now primary data volumes.

1. At the primary and secondary sites, make sure that all URz components are fully operational and are free from failures.
2. Make sure that pair status of primary and secondary data volumes in all URz pairs is “Duplex”. This indicates that the URz initial copy operations are complete and consistency is maintained.
3. Stop the applications at the secondary site.
4. Issue a request for splitting pairs to master journal groups (which were originally restore journal groups); please use the Business Continuity Manager to execute the YKSUSPND FLUSH SVOL PERMIT option on the master journal group (which was originally the restore journal group); YKSUSPND is a command for splitting pairs. If an error occurs when splitting pairs, please remove the error cause and go back to step 1 after resuming your business task at the secondary site.
5. If no error occurs in step 4, wait until suspension finishes. After suspension finishes, check whether there is a secondary data volume (which is originally a primary data volume) whose pair status is other than Suspend (equivalent to SUSPOP with Business Continuity Manager). If such a pair exists, please remove the error cause and go back to step 1 after resuming your business task at the secondary site.
6. If there is no secondary data volume (which is originally a primary data volume) whose pair status is other than Suspend (equivalent to SUSPOP with Business Continuity Manager), data in primary data volumes are the same as data in secondary data volumes, and the secondary data volume (which are originally primary data volumes) are usable. Please resume applications at the primary site.
7. Execute the YKSUSPND FORWARD command on the restore journal group (which were originally master journal group); YKSUSPND is a Business Continuity Manager command and REVERSE is an option. Wait until suspension completes.
8. After suspension completes, execute the Business Continuity Manager YKRESYNC FORWARD command on the restore journal group (which were originally master journal group). This reverses primary data volumes and secondary data volumes to resynchronize pairs and restores copy direction to its original direction.

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3.25 Cautions when Stopping the Subsystem

Pay attention to the following instructions concerning the operation when the subsystem stops immediately after turning on the PDU breaker and completing the power off of the subsystem.

3.25.1 Precautions in a Power Off Mode

<Precautions>

Before you turn off the distribution panel breaker or the PDU breaker, make sure to turn off the power of the SVP. (Refer to SVP SECTION “1.8 Power Off” ([SVP01-160](#)))

Do not remove the battery connectors from the cache PCB when the subsystem has electricity and the BS-ON LED is lit (breakers ON and AC input has electricity). If you remove the battery connectors, the abnormality of the batteries is detected as the batteries are being charged and have electricity during the BS-ON LED is lit.

If you power on the subsystem when the abnormality of the batteries is detected in both the clusters, the subsystem is prohibited from starting for a certain period of time (maximum 90 minutes) and the battery charging SIM = FE00XX and the battery warning SIM = FFFA0X are generated as cache data backup cannot be performed in the case of power outage.

If the battery warning SIM = FFFA0X is generated by removing the battery connectors, follow “41. Procedure When SIM = FE00XX is Generated” ([TRBL41-10](#)) and perform recovery operation of the battery warning as the battery cannot be recovered by connecting. Unless recovery operation of the battery warning is performed, the data in cache memory cannot be guaranteed in the case of power outage.

Even if the PDU breaker is immediately after turning on, or the equipment is in the state of the power off after the process of the power off is completed, the equipment is in a standby mode. In this standby mode, the AC input is supplied to the power supply in the subsystem, and this supplies the power supply to the FANs, the cache memory modules and some PCBs (MP packages, SSWs, or the like).

Please execute the following process when the standby electricity must be controlled, because the standby electricity (*1) exists in the equipment under this condition.

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- (1) When the equipment is powered on
Turn on the breaker of each PDU just before the power on processing.
- (2) When the equipment is powered off
After the power off processing is completed, turn each PDU breaker off.
When turning each PDU breaker off, make sure the power off processing is completed in advance. When the breaker is turned off during the power off processing, the battery power is burned and the power on time may take little longer at the next power on processing depending on to the battery charge, because the equipment shifts to the emergency SSD transfer processing of the data with the battery. Moreover, in advance of the turning each PDU breaker off, make sure the AC cables of the other equipment are not connected to the PDU that is turned off.
The management information stored in the memory is transferred to the nonvolatile memory (SSD) in the cache memory adapter during the power off process, therefore, leaving the breaker of the PDUs on is needless for the data retention.

*1: The maximum standby electricity is 0.79kVA per DKC, and 1.34kVA per DKU. (Refer to Table 2.17.1-1.)

Table 2.17.1-1 Maximum Standby Electricity per DKC/DKU Frame

Frame	DKC (CBX/CBXA/CBXG/CBXB/ CBXH) [kVA]	DKU (UBX/SBX) [kVA]	Subtotal [kVA]
RACK-00 Frame	0.79	1.34×2	3.47
RACK-10 Frame	0.79	1.34×2	3.47
RACK-01 Frame	—	1.34×3	4.02
RACK-02 Frame	—	1.34×3	4.02
RACK-11 Frame	—	1.34×3	4.02
RACK-12 Frame	—	1.34×3	4.02
Total [kVA]			23.02

3.25.2 Operations when a distribution panel breaker is turned off

<Precautions>

Before you turn off the distribution panel breaker or the PDU breaker, make sure to turn off the power of the SVP. (Refer to SVP SECTION "1.8 Power Off" ([SVP01-160](#)))

Do not remove the battery connectors from the cache PCB even after the subsystem is powered off and the breakers on the PDPs or the PDUs are turned off.

If you leave the breakers of the devices off for more than one month, charge the batteries before powering on the subsystem at the time of the next startup of the subsystem.

Procedure for charging the batteries:

Turn on the breakers on the PDPs and the PDUs, which makes the BS-ON LED lit, and then charge the batteries until the BATTERY CHARGE LED (See LOCATION SECTION ([LOC03-30~40](#)).) goes from blinking (charge in progress) to solid (charge completed).

(Charging time is up to 30 minutes in the case that the breakers are kept off for more than one month.)

When the distribution panel breaker or the PDU breaker is turned off, execute the operation after making sure that the power supply of the subsystem was normally turned off, by confirming the PS was normally turned off according to the Power OFF Event Log (Refer to 3.14.2 Power OFF Procedure in INSTALLATION SECTION.) of SVP.

When the Power OFF Event Log confirmation is impossible, suspend the operation and request customers to restart the subsystem to confirm that the PS is normally turned off.

<Precautions>

Request the thoroughness in the following operations to the customer if the distribution panel breaker or the PDU is impossible to keep the on-state after the power of the subsystem is turned off.

1. Point to be checked before turning the breaker off

Request the customer to make sure that the power off processing of the subsystem is completed (READY lamp, MESSAGE lamp and ALARM lamp are turned off) before turning off the breaker.

2. Operation when breaker is turned off for two weeks or more

A built-in battery spontaneously becomes a state of discharge when the distribution panel breaker or PDU breaker is turned off after the subsystem is powered off.

Therefore, when the breaker is turned off for two weeks or more, charging the built-in battery to full will take a maximum of three hours. Accordingly, request the customer to charge the battery prior to the restarting of the subsystem.

3.26 System Disk

The system disk is a volume for storing information used by the disk subsystem. The overview of the system disk is shown below.

3.26.1 Setting the System Disk

The Virtual LVI/LUN software is required for setting the system disk. Set the system disk using the Install CV operation or Make Volume operation of this software.

The use and required capacity (number of cylinders in case of 3390 track format and 3380 track format) of the system disk are shown in the table below.

Use	In case of OPEN-V	In case of 3390	In case of 3380
Buffer area of Audit log	130 Mbytes	154 cylinders	185 cylinders

When using the system disk for the above use, prepare the system disk with the above-mentioned required capacity remained in one volume. For example, if you set one volume of the system disk of 200 Mbytes, it is usable for storing for buffer area of the Audit log. However, even if you set two volumes of 100 Mbytes, you cannot use them for storing buffer area of the Audit log.

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The cautions about setting the system disk are as shown below.

- Do not store the usual data in the system disk.
- In case of the mixed configuration of the internal and external volumes, define the system disk as the internal volume.
- In case of the multiple platform configuration or track format mixed configuration, define the setting volume of the system disk in priority order such as OPEN-V, 3390 track format and 3380 track format.
- If you create system disks in a mainframe volume, specify the LDKC:CU:LDEV number that is not configured in the host I/O generation.
- Do not perform the BIND setting of DCR to the system disk.
- When two or more system disks are defined, it is used for order with a young LDEC:CU:LDEV number.
- When two or more system disks are defined, other system disks are not used by the automatic operation at the failure of the system disk.
- When Mode676 is turned on for the Buffer area of Audit log, the use of the system disk becomes effective.

3.26.2 Protecting the System Disk

The system disk is protected from the de-installation/blockade operation, host I/O and maintenance operation as shown below.

The de-installation of the system disk is performed using the Volume To Space operation. However, the de-installation/blockade operation may be denied as shown in the table below depending on the use status of the system disk.

Case to be denied	Actions to be taken
System disk is being used for Audit log.	Execute it again after release the MODE676.
Blocked system disk	Execute it again after changing to the normal status (If you cannot change it, you can execute it by entering the password.).

The system disk is protected from open I/O by denying the SCSI path definition for the system disk. The system disk is protected from the mainframe I/O by returning CC3 at the time of issuing the mainframe command for the system disk.

The following maintenance operation for the system disk cannot be performed.

- Creating pair of TrueCopy/UR/XRC/ShadowImage/Copy-on-Write Snapshot/Thin Image
- Instructing VOL migration of Volume Migration and setting reserve VOL
- Setting access right of Volume Security
- Setting the attribution other than Read/Write possible of Data Retention Utility and Volume Retention Manager
- Setting the journal volume of UR
- Instructing LDEV connection by LUSE
- Setting PAV
- Volume Initialize of CVS
- Setting the SCSI path definition
- Setting the command device/remote command device
- Setting Write Through suppression setting VOL/pool-VOL

3.26.3 Failure recovery of the System Disk

The failure recovery procedure of the system disk is shown in the table below.

Use	Failure recovery procedure
Buffer area of Audit log	① Release the MODE676. ② De-install the system disk using the Volume To Space operation. ③ When the hardware has a problem, perform the maintenance action based on the action code instruction. ④ Reset the system disk, which is once de-installed on the process ②, with the Install CV or the Make Volume operation. ⑤ Set the MODE676.

3.27 Encryption License Key

3.27.1 Overview of encryption

In DKC710I subsystem, you are able to encrypt data stored in volumes in the disk subsystem by using Encryption License Key.

By encrypting data, you can prevent data from being leaked when you replace the disk subsystem or hard disks in the subsystem or when these are stolen.

3.27.2 Specifications of encryption

Table 3.27.2-1 shows the specifications of encryption with Encryption License Key.

Table 3.27.2-1 Specifications of encryption with Encryption License Key

Item		Specifications
Hardware spec	Encryption algorithm	AES 256bit
Volume to encrypt	Volume type	Open volumes, mainframe volumes, multiplatform volumes
	Emulation type	All emulation types
Encryption key management	Unit of creating encryption key	RAID group
	Number of encryption keys	32
	Unit of setting encryption	RAID group
Converting non-encrypted data/encrypted data	Encryption of existing data	Convert non-encrypted data/encrypted data for RAID group in which encryption is set by using the existing function (Volume Migration, ShadowImage etc.).

3.27.3 Notes on using Encryption License Key

Please note the following when using Encryption License Key.

Table 3.27.3-1 Notes on Encryption License Key

#	Item	Content
1	Volumes to encrypt	Only internal volumes in the disk subsystem can be encrypted with Encryption License Key. External volumes cannot be encrypted.
2	LDEV format	You cannot perform high-speed format (drive format) for disks under RAID group in which encryption is set. Time required for LDEV format performed for the RAID group in which encryption is set depends on the number of RAID groups.
3	Encryption/ non-encryption status of volumes	When encrypting user data, set encryption for all volumes in which the data is stored in order to prevent the data from being leaked. Example 1: In the case a copy function is used, and when encryption is set for P-VOL, set it also for S-VOL. When encryption is set for P-VOL, and non-encryption is set for S-VOL (or vice versa), you cannot prevent data on the non-encrypted volume from being leaked. Example 2: To encrypt data stored in LUSE volumes or pool, create the volume by using only encrypted LDEVs. If you create the volume by using both encrypted LDEVs and non-encrypted LDEVs, you cannot prevent the data from being leaked.
4	Convert non-encrypted data/ encrypted data	The specifications of converting non-encrypted data/encrypted data comply with the specifications of the copy function (Volume Migration, ShadowImage etc.) used for conversion.
5		In the case of Volume Migration, you cannot perform such an auto migration that would switch encryption/non-encryption status.
6		To convert non-encrypted LUSE volumes into encrypted ones with auto migration of Volume Migration, you need to convert each LDEV that constitutes LUSE. Therefore while LUSE volume migration is performed, LUSE contains both encrypted volumes and non-encrypted volumes. To prevent data from being leaked, complete conversion of all volumes that constitute LUSE when converting encrypted data into encrypted data.
7	Switch encryption setting	When you switch the encryption setting of RAID group, you need to perform LDEV format again. To switch the encryption setting, back up data as necessary.

3.27.4 Creation of encryption key

An encryption key is used for data encryption and decryption. 32 encryption key can be created in a disk subsystem.

Only customer security administrators are able to create encryption keys.

In the following cases, however, creation of encryption key is inhibited to avoid data corruption.

- Due to a failure in the disk subsystem, the disk subsystem does not have any encryption key but it has a RAID group in which encryption is set.

In this case, restore the backed up encryption key.

3.27.5 Backup of encryption key

There are two types of encryption key backup; backup within the subsystem and backup outside the subsystem. In the case of backup within the subsystem, the encryption key is backed up in the flash memory in the disk subsystem. In the case of backup outside the subsystem, it is backed up in the machine in which Storage Navigator is running (Storage Navigator PC).

- Backup within the subsystem

Encryption key created on SM is backed up in the flash memory in the disk subsystem.

Encryption key is automatically backed up within the subsystem at the time it is created.

- Backup outside the subsystem

Encryption key created on SM is backed up in the Storage Navigator PC. Backup outside the subsystem is performed when requested by the user from Storage Navigator.

3.27.6 Restoration of encryption key

There are two types of encryption key restoration; restoration from backup within the subsystem and restoration from backup outside the subsystem.

- Restoration from backup within the subsystem

When the encryption key on SM cannot be used, the encryption key backed up within the subsystem is restored.

Restoration from backup within the subsystem is automatically performed in the subsystem.

- Restoration from backup outside the subsystem

When encryption keys including the encryption key backed up within the subsystem cannot be used in the disk subsystem, the encryption key backed up outside the subsystem is restored.

Restoration from backup outside the subsystem is performed when requested by the security administrator from Storage Navigator.

3.27.7 Setting and releasing encryption

You can set and release encryption by specifying a RAID group. Set and release encryption in the Parity Group list window in Web Console. To set encryption in a RAID group, you need to assign an encryption key to the target RAID group.

- Notes:
- Encryption can be set and released only when all volumes that belong to the RAID group are blocked, or when there is no volume in the RAID group.
When the RAID group contains at least one volume that is not blocked, you cannot set and release encryption.
 - When you switch the encryption setting, you need to perform LDEV format again.
Therefore set encryption before formatting the entire RAID group when installing RAID groups etc.

3.27.8 Encryption format

To format a RAID group in which encryption is set, format the entire disk area by writing encrypted 0 data in the entire disk area. This is called Encryption format.

When encryption is set for a RAID group, encryption format is performed before user data is written. When encryption is released, normal format is performed before user data is written.

Note: Encryption format can be performed only when all volumes in the RAID group can be formatted. When at least one volume cannot be formatted, encryption format cannot be performed.

3.27.9 Converting non-encrypted data/encrypted data

To encrypt existing data, create a RAID group in which encryption is set in advance and use a copy Program Product, such as Volume Migration, and ShadowImage, to convert data. Data conversion is performed per LDEV.

The specifications of converting non-encrypted data/encrypted data comply with the specifications of the copy function (Volume Migration, ShadowImage etc.) used for conversion.

3.27.10 Deleting encryption keys

Only customer security administrators are able to delete encryption keys. Note that if the encryption key to be deleted is assigned to a RAID group, it cannot be deleted.

3.27.11 Reference of encryption setting

You can check the encryption setting (Encryption: Enable/Disable) per RAID group.

3.28 CVS and DCR Option function

3.28.1 Customized Volume Size (CVS) Option

3.28.1.1 Outline

As regards the main frame host, the multiplicity of an I/O request is restricted to one per volume because UCBs are mutually exclusive.

Therefore, when two or more files to which I/Os are applied frequently exist in the same volume, a contention for the logical volume occurs. If this occurs, the files mentioned above are stored separately in different logical volumes and an action is taken to avoid contention for access. (Or means to prevent I/Os from generation is required.)

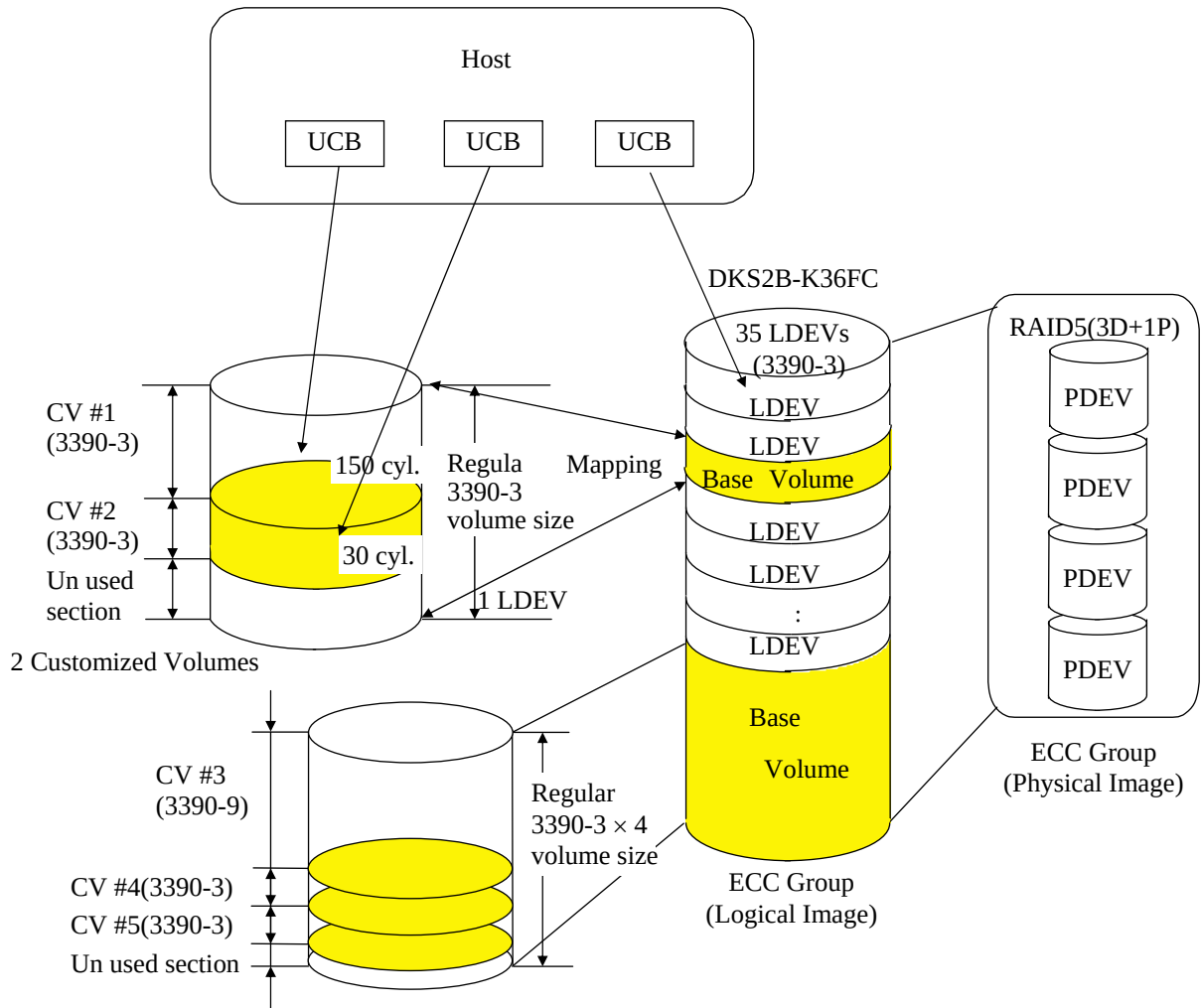
However, the work for adjusting the file arrangement giving consideration to the accessing characteristic of the file will be a burden on users of the DKC and it is not welcomed by them.

To solve this problem, the Customized Volume Size (CVS) option is provided. (Hereinafter, it is abbreviated to CVS.)

The CVS provides a function for freely defining the logical volume size. By doing this, even in a storage system with the same capacity, the number of volumes can be increased easily. As a result, a file with a high I/O frequency can be easily allocated to an independent volume. That is to say, the trouble to consider a combination of stored files in a volume can be saved.

3.28.1.2 Features

- The contention for UCB in the mainframe host can be avoided, and the waiting time (IOSQ time) from the IO starting command of the OS to the IO issuance by the UCB can be reduced.
- The capacity of the ECC group can be fully used.
- By combining with the Dynamic Cache Residence (DCR) option, high performance equivalent to that of a semiconductor storage device can be realized.



THEORY03-28-30**3.28.1.3 Specifications**

The CVS option consists of a function to provide variable capacity volumes and a function to provide free arrangement of volumes on the ECC group.

(a) Function to provide variable capacity volumes

This function can create the capacity volume as required by the users.

(b) Emulation type intermix on the ECC group

As regard the DKC710I, the logical volume type in the ECC group is restricted to the same type only. However, the CVS option enables the different emulation types of volumes to coexist in one ECC group.

Table 3.28.1.3-1 CVS Specifications

Parameter	Mainframe system	Open system	
Track format	3380,3390	OPEN-3, OPEN-8, OPEN-9, OPEN-E	OPEN-V
Emulation type Note: The emulation types followed by an asterisk (*) can only be used with Fujitsu Mainframe systems. Do not use these emulation types if you are not using Fujitsu Mainframe systems.	3380-3, 3380-3A, 3380-3B, 3380-3C 3390-3, 3390-3A, 3390-3B, 3390-3C, 3390-3R, 3390-9, 3390-9A, 3390-9B, 3390-9C, 3390-L, 3390-LA, 3390-LB, 3390-LC, 3390-M, 3390-MA, 3390-MB, 3390-MC, 3390-A	OPEN-3, OPEN-8, OPEN-9, OPEN-E	OPEN-V
Ability to intermix emulation type	Depends on the track geometry	Depends on the track geometry	Depends on the track geometry
Maximum number of volumes (normal and CVS) per VDEV	2,048 for RAID5 (7D+1P), RAID6 (6D+2P) or RAID6 (14D+2P) 1,024 for other RAID levels	2,048 for RAID5 (7D+1P), RAID6 (6D+2P) or RAID6 (14D+2P) 1,024 for other RAID levels	2,048 for RAID5 (7D+1P), RAID6 (6D+2P) or RAID6 (14D+2P) 1,024 for other RAID levels
Maximum number of volumes (normal and CVS) per storage system	65,280	65,280	65,280
Minimum size for one CVS Volume	User cylinder (+ Control cylinders) (See Table 3.28.1.3-2 about control cylinders)	36,000 KB (+ Control cylinders)	48,000KB (+ 50 cylinders)
Maximum size for one CVS Volume	User cylinder (+ Control cylinders) (See Table 3.28.1.3-2 about control cylinders)	See Table 3.28.1.3-3	See Table 3.28.1.3-3
Size increment	1 user cylinder	1 MB	1 MB (1 user cylinder)
Disk location for CVS Volume	Anywhere	Anywhere	Anywhere

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- Note:
- When you specify more than 65520 cylinders as 3390-A, the cylinder number is revised to the multiple of 1113 cylinders. (for example: When you specify 65521 cylinders, it becomes 65667 cylinders ($=1,113 \text{ cylinder} \times 59$)).
 - When you specify 3390-V, the size is revised to about 38MB (44.8 cylinders) multiples. Lower than few marks cut it off and display the number of the cylinders. (For example: When you specify 10000 cylinders, it becomes 10035 cylinders ($=44.8 \text{ cylinder} \times 224=10,035.2 \text{ cylinder}$)).
 - Capacity of more than 8GB is necessary to register 3390-V with a pool of Dynamic Provisioning for Mainframe/Thin Provisioning for Mainframe. When you make 3390-V, you should specify capacity of more than 9633 cylinders.

Note1:

(1) Mainframe volume

Number of physical cylinder allocated on ECC group is calculated by following formula.

Physical mapping onto ECC group(track) =

User logical cylinders(A) × 15 + Additional control cylinder(B) × 15 + Adjustment(C)

∴ 1 cylinder = 15 tracks

where, (A) is specified value through SVP/Web Console, (B) is defined from below chart depending on emulation type.

The value of (C) depends on (A) + (B) and (C) has the value such as ranging from 0 to 47, 0 to 55.

i) RAID5 (3D + 1P)

$$((C) = \uparrow \frac{((A) + (B)) \times 15}{24} \uparrow \times 24 - ((A) + (B)) \times 15$$

ii) RAID5 (7D + 1P)

$$((C) = \uparrow \frac{((A) + (B)) \times 15}{56} \uparrow \times 56 - ((A) + (B)) \times 15$$

iii) RAID1

$$((C) = \uparrow \frac{((A) + (B)) \times 15}{16} \uparrow \times 16 - ((A) + (B)) \times 15$$

iv) RAID6 (6D + 2P)

$$((C) = \uparrow \frac{((A) + (B)) \times 15}{48} \uparrow \times 48 - ((A) + (B)) \times 15$$

∴ $\uparrow \uparrow$ means round up to the next integer.

e.g. $\uparrow 3.96 \uparrow = 4$

(2) Open volume

You can set the data by Mbytes or Logical Blocks. You can also set by Cylinders in case of OPEN-V. And the Program will assign the actual value as the following expression. The maximum OPEN-V capacity depends on that of VDEV size.

Except for OPEN-V

$X = (\text{your setting size}) \times 1024 \div 720$ (if there is remainder, add 1 to X.)

$Y = (X \times 96 \times 15 \times 512) \div 1024 \div 1024$

OPEN-V

$X = (\text{your setting size}) \times 16 \div 15$ (if there is remainder, add 1 to X.)

$Y = (X \times 128 \times 15 \times 512) \div 1024 \div 1024$

Note: X is a value of converting capacity into number of cylinders. Y is a value of converting value into number of mega bytes.

In case of open volume, physical mapping onto ECC group(track) is also calculated by the expression of (1).

In case of set by Logical Blocks, the value is assigned as actual size directly.

Table 3.28.1.3-2 CV capacity by Emulation types (for Mainframe System)

Emulation type	Minimum CV capacity (Cyl)	Maximum CV capacity (Cyl)	Number of control cylinder (Cyl)
3380-3	1	3,339	7
3380-3A	1	3,339	7
3380-3B	1	3,339	7
3380-3C	1	3,339	7
3390-3	1	3,339	6
3390-3A	1	3,339	6
3390-3B	1	3,339	6
3390-3C	1	3,339	6
3390-3R	1	3,339	6
3390-9	1	10,017	25
3390-9A	1	10,017	25
3390-9B	1	10,017	25
3390-9C	1	10,017	25
3390-L	1	32,760	23
3390-LA	1	32,760	23
3390-LB	1	32,760	23
3390-LC	1	32,760	23
3390-M	1	65,520	53
3390-MA	1	65,520	53
3390-MB	1	65,520	53
3390-MC	1	65,520	53
3390-A	1	262,668	7 per 1113 cylinder
3390-V	1	837,760 (Internal volume) 1,117,760 (External volume)	0

THEORY03-28-70**Table 3.28.1.3-3 CV capacity by Emulation types (for Open System)**

Emulation type	Minimum CV capacity (Cyl)	Maximum CV capacity (Cyl)	Number of control cylinder (Cyl)
OPEN-V	48,000KB	Internal volume: 3,221,159,680KB (2.99TB) External volume: 4,294,967,296KB (4TB)	0KB (0Cyl)
OPEN-3	36,000KB (50Cyl)	2,403,360KB	5,760KB (8Cyl)
OPEN-8	36,000KB (50Cyl)	7,175,520KB	19,440KB (27Cyl)
OPEN-9	36,000KB (50Cyl)	7,211,520KB	19,440KB (27Cyl)
OPEN-E	36,000KB (50Cyl)	14,226,480KB	13,680KB (19Cyl)

Note: CVS functions are not applicable to OPEN-L volumes.

NOTICE:

When you set Cross-OS File Exchange volumes to customized volumes and reset them to the normal volume again, these volumes could not be set as Cross-OS File Exchange volumes. Please refer to the following table.

Emulation Types for Cross-OS File Exchange volumes	Emulation types after changing from Customized volume to normal volume
3390-3A	3390-3
3390-3B	
3390-3C	

If you want to reset these volumes as Cross-OS File Exchange, please call technical support division to set them to Cross-OS File Exchange volumes by SVP.

3.28.1.4 Maintenance functions

Features of the maintenance functions of the CVS option is that they allow execution of not only the conventional maintenance operations instructed by the SVP but also the maintenance operations instructed from the Storage Navigator. (See Item No. 2 to 5 in Table 3.28.1.4-1.)

Unlike the conventional LDEV addition or reduction, the operation for the ECC group is made unnecessary, so that the volumes can be operated from the Storage Navigator.

Table 3.28.1.4-1 Maintenance Function List

Item No.	Maintenance function	CE	User	Remarks
1	Concurrent addition or deletion of CVs at the time of addition or deinstallation of ECC group	✓	—	Same as the conventional addition or deinstallation of LDEVs
2	Addition of CVs only	✓	✓	Addition of CVs in the free area
3	Conversion of normal volumes to CV	✓	✓	
4	Conversion of CV to normal volumes	✓	✓	
5	Deletion of CVs only	✓	✓	Only the optional CVs are deleted and incorporated into the free area.No deinstallation of ECC group is involved.

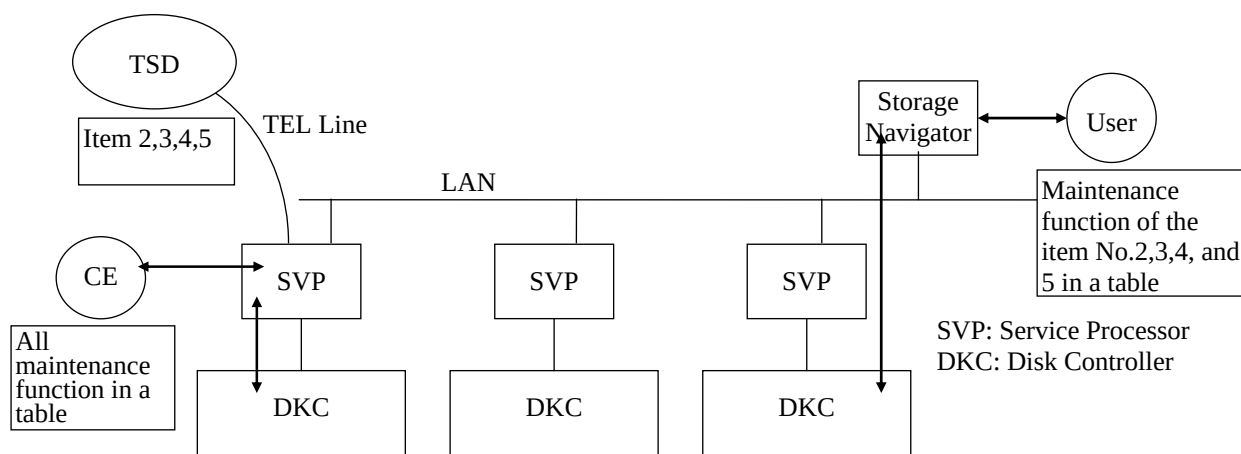


Fig. 3.28.1.4-1 Maintenance Execution Route when CVS Is Used

3.28.2 Dynamic Cache Residence (DCR) Option

3.28.2.1 Outline

Because cache capacity is usually smaller than the total HDD capacity in RAID subsystem, cache cannot keep all data at the same time which is stored whole HDDs in the subsystem.

Cache management controls cache extent so as to allocate more capacity to more frequently accessed data to embed this gap by LRU algorithm.

By this control, data with a low access frequency is hard to remain in the cache, de-staged into HDDs, therefore the more frequent accesses to physical HDDs occur, decrease the access performance and unpredictable response time appears.

The DCR option provides a function for making data being resident on the cache and realize high access performance.

DCR is a function to make the specified data resident in the specific Cache area in DKC. This will enable the host to always execute Cache hit of the specified data and access it at high speed.

3.28.2.2 Features

- Feature of the DCR consist of two modes, one is called “PRIOrity mode(hereinafter,it is abbreviated to PRIO)” and the other “BIND mode(hereinafter,it is abbreviate to BIND)”. PRIO is a basic mode(100% Read Hit) of this feature, which fits typical user needs and BIND is supplementary for special customer(100% Read/Write Hit. Replace SSD) needs.
- To use the DCR, addition of the cache memory is required for the service as a “DCR cache”.
- DCR supports PreStaging function. The PreStaging is a function which read data on Logical Volume onto cache by receiving Storage Navigator or SVP instructions.

3.28.2.2.1 PRIO

[Processing]

- When a read command to the data which is assigned as DCR extent is issued and first meet “miss” in cache, the data is staged into cache by usual staging mechanism.
The data remains in the DCR cache permanently for future access to guarantee read-hit performance even after data is transferred to the host, regardless usually cache LRU management. If a write command is issued to the data remaining in the cache in the way above, the data is updated with an out-of-DCR cache segment provided for write data duplication, and the data is de-staged into the HDD. Then the cache segment for write data duplication is returned to the out-of-DCR cache segment group.
In this case, new data is left in the cache extent together with old data.

[Performance impact]

- Theoretically, because above de-staging into HDD is processed by usual asynchronous de-staging mechanism, succeeding host access has a possibility to meet the same cache slot collision by locking both the host access and asynchronous de-staging process.
However in that case, by minimizing the collision time implemented in micro-code, performance impact will be negligible for usual customer jobs.
- In the case the subsystem cache becomes overloaded, a performance degradation occurs because the non-DCR cache segment must be used for the data assurance during a period between write data reception and de-staging operation completion.

Note:

When the operation of deleting the resident cache-data is performed during host I/O execution, the host I/O execution conflict with the procedure in which the data is transferred to disk drives (de-staging) may happen. It may cause the response performance degradation.

To avoid the response performance degradation, please limit the total capacity of data released by one operation.

- If the Host timeout period is more than 11 seconds, the amount of acceptable releasing cache is limited to 3Gbyte or less.
OPEN system: The amount of acceptable releasing cache is limited to 3Gbyte or less.
Mainframe system: The number of acceptable releasing cylinders is limited to 3000 or less.
- If the Host timeout period is less than 10 seconds, it is limited to 1Gbyte or less.
OPEN system: The amount of acceptable releasing cache is limited to 1Gbyte or less.
Mainframe system: The number of acceptable releasing cylinders is limited to 1000 or less.

Note:

If the setting or the release of the DCR extent is performed to a lot of LDEVs when there is I/O from Host, the response performance degradation of HOST I/O may occur.

To avoid the response performance degradation, limit the number of LDEVs to be set or released by one operation to 1.

[Maximum DCR capacity]

- Addition of the “DCR cache” is required for the DCR, and a number of disk tracks equivalent to the capacity of the added “DCR cache” is the maximum number definable for the DCR.

Besides, STR recommends to keep the standard cache capacity for the non-DCR portion as a minimum out-of-DCR cache, to avoid considerable performance degradation for original data because of the newly installed DCR (Standard Cache capacity is decided by the subsystem capacity).

To keep this rule, when the customer want to install DCR feature for the subsystem, he needs to install additional cache capacity as a DCR area is taken out of pre-defined standard cache capacity.

Table 3.28.2.2.1-1 indicates the additional cache capacity as a DCR area out of pre-defined standard cache capacity.

The additional cache capacity requires out-of-DCR cache capacity.

Table 3.28.2.2.1-1 is the relationship between number of using extents and additional cache capacity.

Table 3.28.2.2.1-1 Necessary addition of cache memory

	Number of Priority Mode extents			
	1 ~ 4096	4097 ~ 8192	8193 ~ 12288	12289 ~ 16384
Additional Standard cache memory capacity	2048MB × 2	4096MB × 2	6144MB × 2	8192MB × 2

Caution

A required cache capacity in PRIO mode:

standard cache capacity + DCR cache capacity + the above cache capacity

A required cache capacity in BIND mode:

standard cache capacity + DCR cache capacity

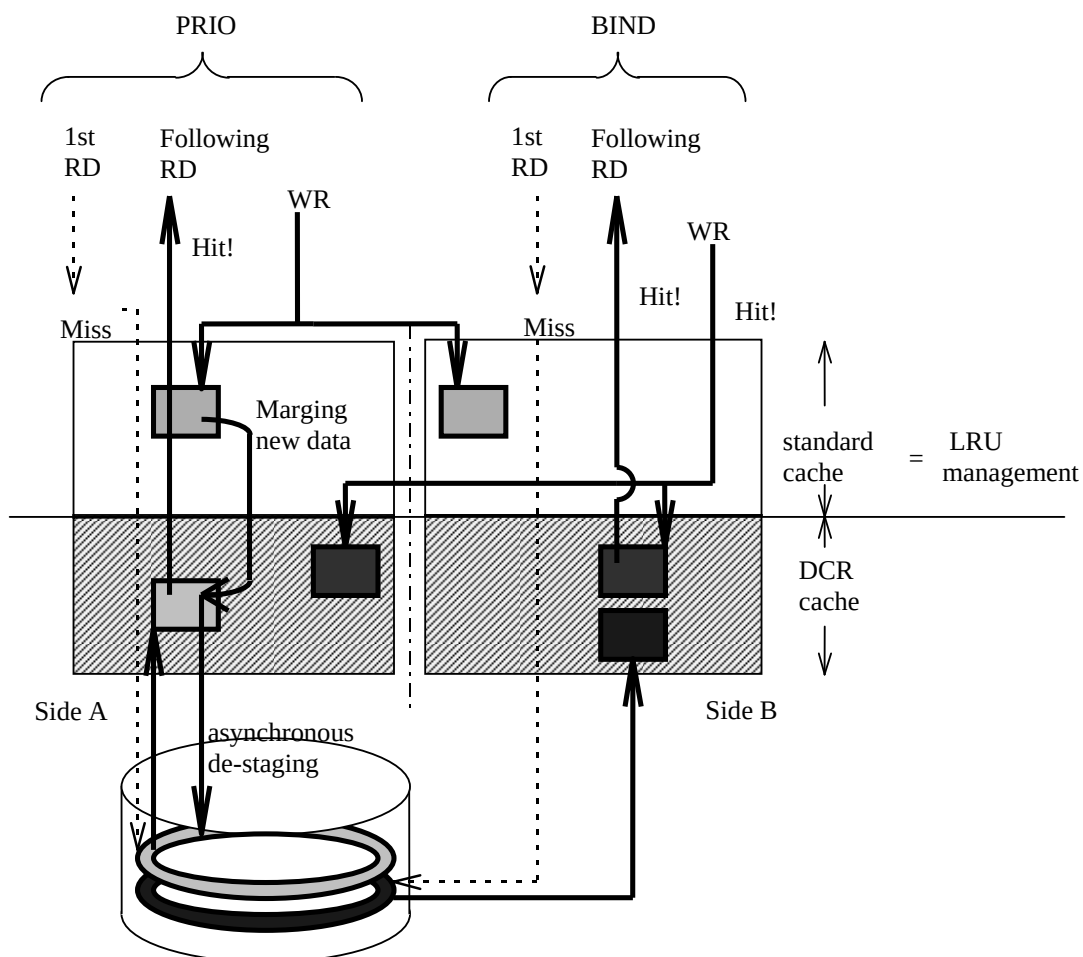


Fig. 3.28.2.2.1-1 Processing for DCR Extent

3.28.2.2.2 BIND

[Processing]

- As described above, there is a possibility that a responding performance degradation occurs in the PRIO mode because of a collide slot lock between the host access and asynchronous de-staging process or a waiting for the cache segment to be empty caused by an overload of the subsystem cache.

This is a negligibly small impact on the performance in the typical user environment, however, in some environments, if any, in which the performance is very critical and the maximum response time must be assured, the above factors to degrade the response may be the issues.

[Performance impact]

- In BIND, the difference for PRIO, not only read data but also being all write data for the assigned DCR extent are resident in cache, no de-stage process occurred by any write command. Thus, by protecting any asynchronous de-stage process for the DCR data, read operation become a perfectly hit process.
- However, as a compensation for the perfect hit performance, the cache, which is three times larger than that in the PRIO mode for RAID5/RAID6 and two times larger for RAID1, is used.

Note:

When the operation of deleting the resident cache-data is performed during host I/O execution, the host I/O execution conflict with the procedure in which the data is transferred to disk drives (de-staging) may happen. It may cause the response performance degradation.

To avoid the response performance degradation, please limit the total capacity of data released by one operation.

- If the Host timeout period is more than 11 seconds, the amount of acceptable releasing cache is limited to 3Gbyte or less.
 - OPEN system: The amount of acceptable releasing cache is limited to 3Gbyte or less.
 - Mainframe system: The number of acceptable releasing cylinders is limited to 3000 or less.
- If the Host timeout period is less than 10 seconds, it is limited to 1Gbyte or less.
 - OPEN system: The amount of acceptable releasing cache is limited to 1Gbyte or less.
 - Mainframe system: The number of acceptable releasing cylinders is limited to 1000 or less.

Note:

If the setting or the release of the DCR extent is performed to a lot of LDEVs when there is I/O from Host, the response performance degradation of HOST I/O may occur.

To avoid the response performance degradation, limit the number of LDEVs to be set or released by one operation to 1.

[Maximum DCR capacity]

- User data can be set 1/3 of cache capacity for BIND in case of RAID5/RAID6, or 1/2 of that in case of RAID1.

3.28.2.2.3 Assignment of DCR extent and guard logic

- BIND/PRIO modes can be assigned for each DCR extent individually.
For example, the user want to assign 1GB cache for PRIO and 256MB cache for BIND, DKC allocate the extents in additional cache area by 1GB for PRIO and 256MB times 3 equals 0.75GB for BIND. Total 1.75GB cache should be additionally installed. The user can assign repeatedly many DCR extents with choosing each mode for each extent. Say, 1GB for PRIO + 512MB for PRIO + 256MB for BIND + 128MB for BIND comes to 2.6GB total DCR area necessary. The real capacity of cache needs adjusting to the cache unit to be added.
- SVP micro-code accepts many extents allocated for DCR. A minimum of 4GB must remain unallocated to DCR.
In other words, DKC checks that the remaining cache capacity after DCR allocation is over 4GB, if the addition of DCR breaks the remaining 4GB boundary, the SVP rejects the allocation of DCR extents with an error message.
- From that point, the user theoretically can assign all cache capacity except 4GB for DCR regardless of their configurations, STR strongly recommend the user should keep standard cache capacity out of DCR dependant on the configuration according to the manuals. Guard boundary by SVP is only 4GB for all configurations.
- For the outline and the setting operation procedure of the DCR cache, see page [THEORY03-28-220](#).

3.28.2.2.4 DCR PreStaging

- The processor reports SIMs when the PreStaging abnormal end.
(following Table)

Error		REF CODE			SIM	Level	Host report	Remarks
		22	23	13	28			
DCR status	PreStaging abnormal end	48	21	xx	FE	Service	No	xx: abnormal end reason code

x'E1', x'10' : No DCR PP
 x'E2', x'20' : Subsystem busy
 x'E4', x'40' : Staging time over
 x'E5', x'50' : Cache or SM blockade
 x'E6', x'60' : LDEV warning
 x'E7', x'70' : Staging failure
 x'E8', x'80' : P/S OFF
 x'E9', x'90' : PreStaging canceled
 x'EA', x'a0' : Cache over loaded
 x'EB', x'b0' : Some MP's blockade

- In the case the subsystem cache becomes overloaded, a resulting performance degradation occurs during a PreStaging execution. We strongly recommend issuing a PreStaging request to stage data onto cache at the timing of normal load, or SIM REF CODE = 4821a0 may be reported resulting in failure.
- DKC rejects PreStaging requests during PreStaging execution. Please retry PreStaging requests after PreStaging termination.

If you specify the DCR setting on the volume during the quick formatting, do not use the prestaging function. If you want to use the prestaging function after the quick formatting processing completes, first you need to release the setting and then specify the DCR setting again, with the prestaging setting enabled this time. For information about the quick formatting, see the "Provisioning for Open Systems User Guide" or "Provisioning Mainframe Systems User Guide".

3.28.2.3 Specifications

Table 3.28.2.3-1 Specifications of the Function

Item No.	Item	Description
1	Maximum number of areas to be made resident	For the PRIO and BIND modes together: 4096 areas/logical volume 16384 areas/subsystem
2	Unit of area specified to be resident	Mainframe : 1 track, Open : 96 logical blocks*2 (512 logical blocks in case of OPEN-V)
3	Minimum/Maximum size of extent	1 track/logical volume size
4	Online change of resident area	Allowable (from the SVP and Web Console)
5	Addition of cache capacity	Mandatory (Program Product: Charged with cache)
6	Maximum usable cache capacity*1 as DCR	Capacity of the cache memory added as the DCR cache. The “standard cache capacity” must be ensured by the rule.

*1: Convert as follows:

For the 3390 emulation: 1 track = 66KB

For the OPEN-3/8/9/E/L emulation: 1 track (96 logical block) = 66KB

For the OPEN-V emulation: 1 track (512 logical block) = 264KB

*2: In the case of open volume, the DCR program recognizes logical blocks in 96 block increments (512 block increments for OPEN-V).

- If DCR function is used for OPEN-3, OPEN-8, OPEN-9, OPEN-E, OPEN-L or OPEN-V, whole volume should be specified for DCR.
It is because file of open system does not correspond to RAID track structure.

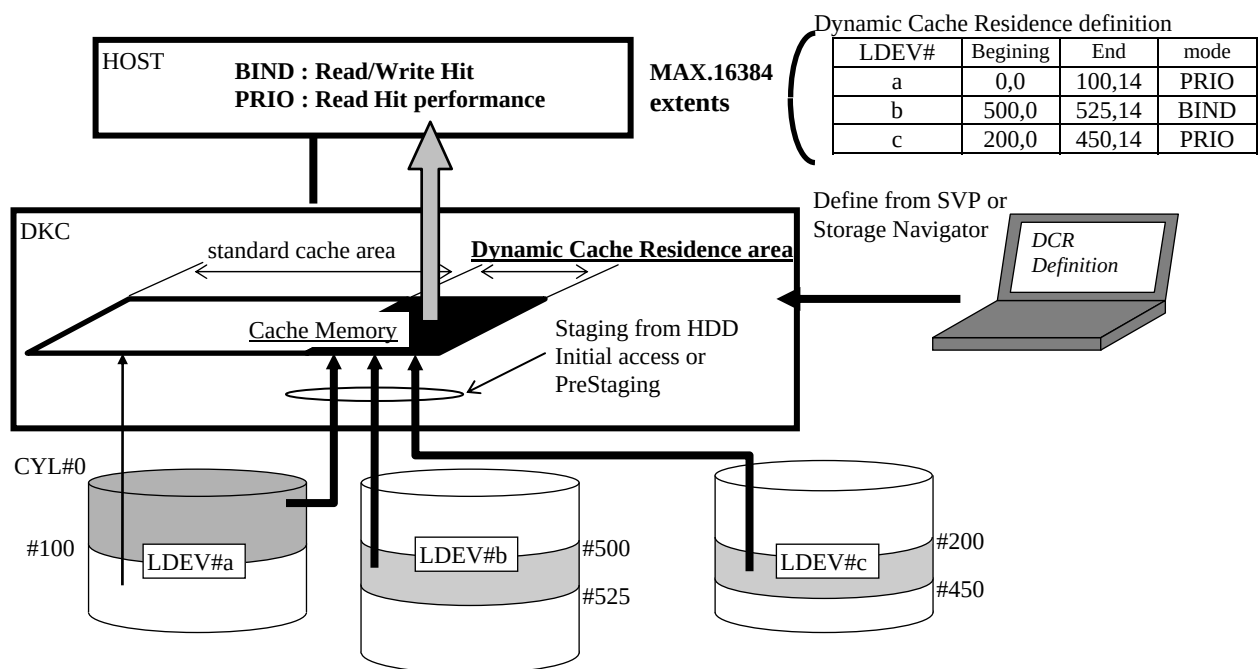


Fig. 3.28.2.3-1 Conceptual Diagram of DCR

3.28.2.4 Maintenance functions

The characteristic of the maintenance function of the DCR option is that the maintenance operation is possible from not only the SVP instruction but also Storage Navigator. (Refer to Table 3.28.2.4-1.)

Table 3.28.2.4-1 Maintenance Function List

Item No.	Maintenance operation	TSD	CE	User	Description
1	Addition of the DCR area	—	✓	✓	- Adds the DCR area. - Unit of the area to be specified by the SVP is a track.
2	Deletion of the DCR area	—	✓	✓	Deletes the continuous DCR area.
3	Change of the DCR area	—	✓	✓	Changes the DCR area size.
4	Status display of the DCR area	—	✓	✓	Displays the specifications of the DCR area.
5	Addition and de-installation of the DCR cache	—	✓	—	Because insertion and pulling off of the cache module into/from the DKC is required
6	Indication of DCR PreStaging	—	✓	✓	Indicates the DCR PreStaging.

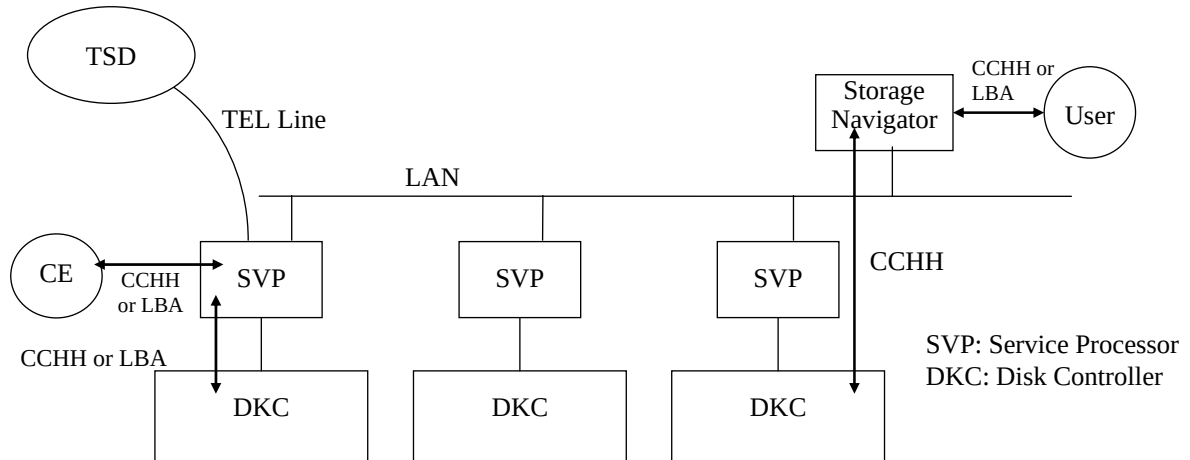


Fig. 3.28.2.4-1 Maintenance Execution Route when DCR Is Used

3.28.2.5 Notes on maintenance when DCR is used

When performing the following maintenance, it is attended with a temporary regression of the cache memory or shared memory. Since this regression disables retention of the cache capacity required for the DCR, the DCR function is automatically suppressed for a while until the maintenance is completed.

A service person is required to obtain an approval of a user before starting the maintenance because there is a high possibility that the DCR function suppression may result in a degradation of responding performance.

- (1) Cache replacement
- (2) Addition and de-installation of the cache (including addition and de-installation of the DCR cache)
- (3) Addition of the ECC Gr. and LDEV requiring addition of the SM because of the addition of the CU
- (4) Addition and de-installation of the SM
- (5) Cluster maintenance

We recommend that CE or Customer should execute the following action after DKC power supply restoration or equipment restoration, when the DKC power supply is down by power failure or mistake during “DCR area” release.

(Because it is a high possibility that the action may result in a degradation of responding performance, CE should execute the following action on a customer’s authority.)

Action : (1) CE or Customer should release all DCR areas in a DCR area released Volume.
(2) CE or Customer should set up again all DCR areas with the exception of the released DCR area in the DCR area released Volume.

Reason : When DKC power is off during “DCR area” release, it is possible that DKC left a release DCR data on Cache.

DKC does not faulty operation by leaving “released DCR data” use a excessive cache memory.

We recommend that CE or Customer should execute the above-mentioned action after DKC restoration, because DKC perfectly execute the “DCR area” release process.

3.28.2.6 Effects of DKC failures on DCR

The DCR function is automatically suppressed when any of the following failures occurs. The suppression continues until the regressed operation owing to the maintenance is canceled in the cases of Items (1) to (3) or continues until an automatic recovery of the shared memory by the microprogram is terminated normally in the case of Item (4).

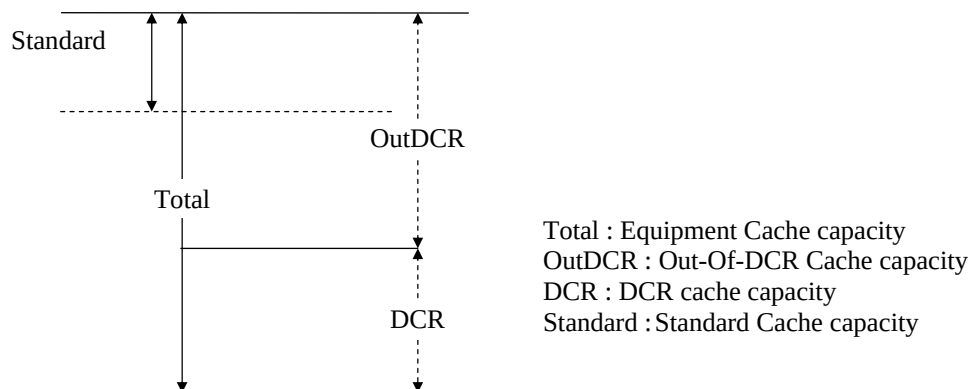
- (1) Cache failure
- (2) Shared memory failure
- (3) One-side cluster down
- (4) One-side shared memory blockade (SIMRC = FFEE)

3.28.2.7 Automatic cancellation of DCR

The DCR setting of a volume to be de-installed by the functions of Deletion of CVs (LDEV), Conversion of CV to normal volume, and Conversion of normal volume to CV is automatically canceled as a part of the de-installation processing by the SVP microprogram.

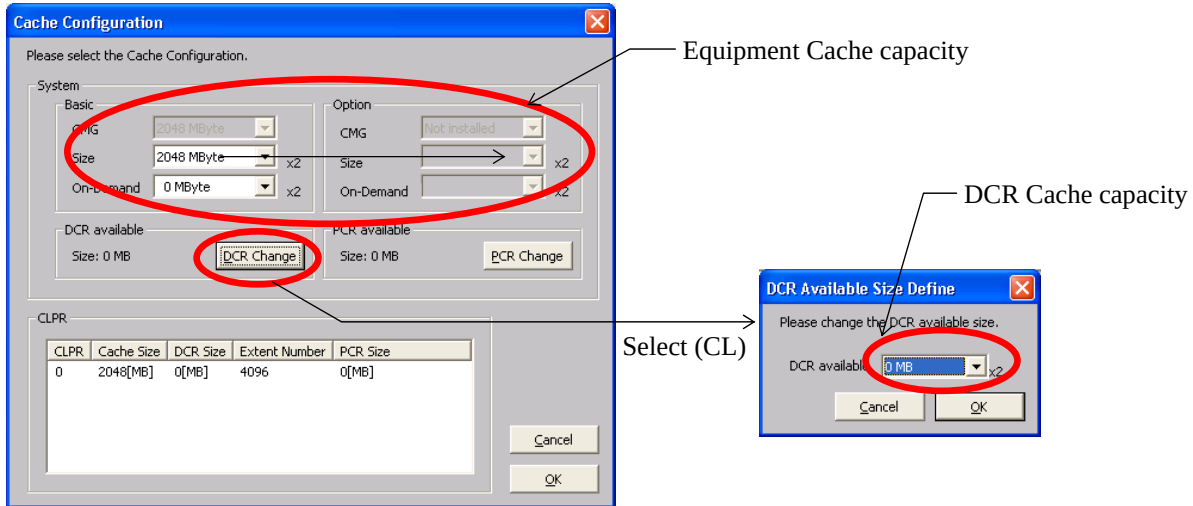
THEORY03-28-220**3.28.2.8 Explanation of DCR cache and procedure for setting operation****3.28.2.8.1 Explanation**

- A cache module must be defined and installed for the DCR before using the DCR.
- The DCR extent can be set only for the defined “DCR cache capacity.”
- The “out-of-DCR cache capacity” must be retained more than “standard cache capacity” which is defined in accordance with the disk capacity in order to assure the performance in the non-DCR area.
- Therefore, DCR extent definition more than “DCR cache capacity” is rejected according to the SVP guarding logic. Also, the “DCR cache capacity” definition lower than the minimum “standard cache capacity” ($2\text{GB} \times 2$) is also rejected.



3.28.2.8.2 Setting operation procedure

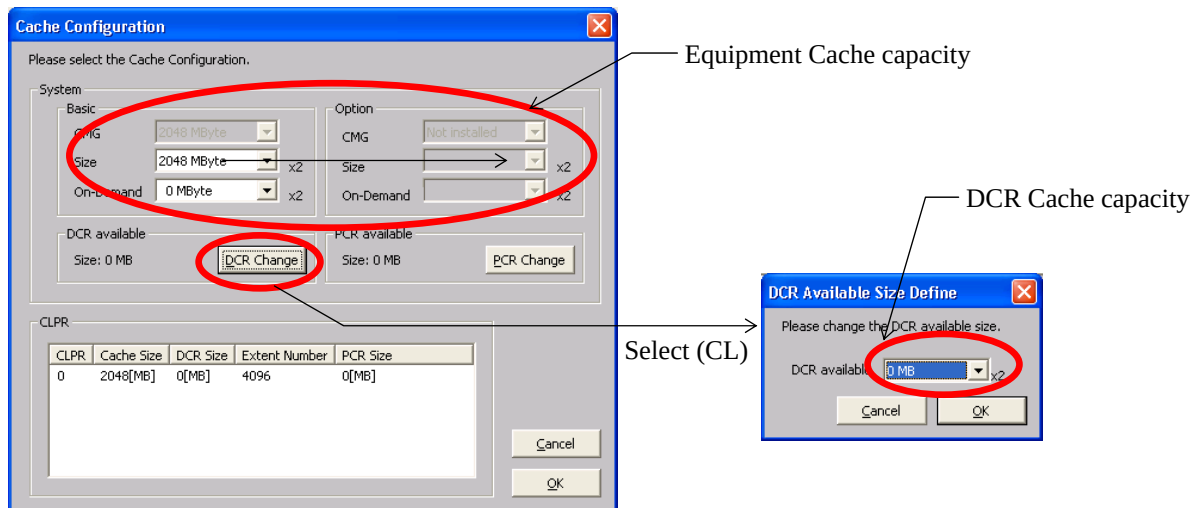
- (1) Setting DCR cache capacity in Define Config & Install sequence
Set the DCR cache capacity in the equipment cache capacity.



Note: Set the DCR cache capacity so that it is less than the “equipment cache capacity minus standard cache capacity.”

(2) Adding operation of DCR cache capacity in cache addition sequence

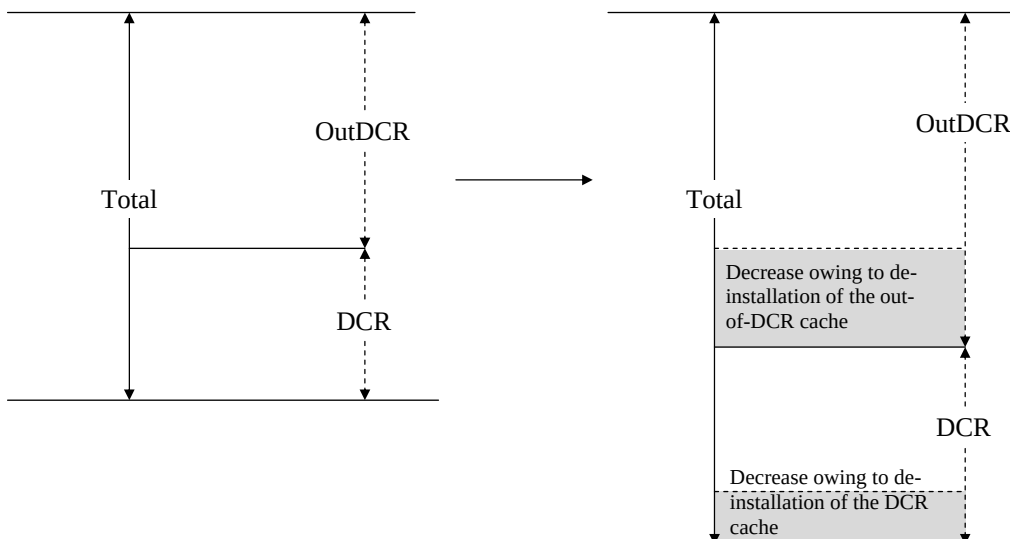
When adding the cache, set the DCR cache capacity in the equipment cache capacity after the addition.



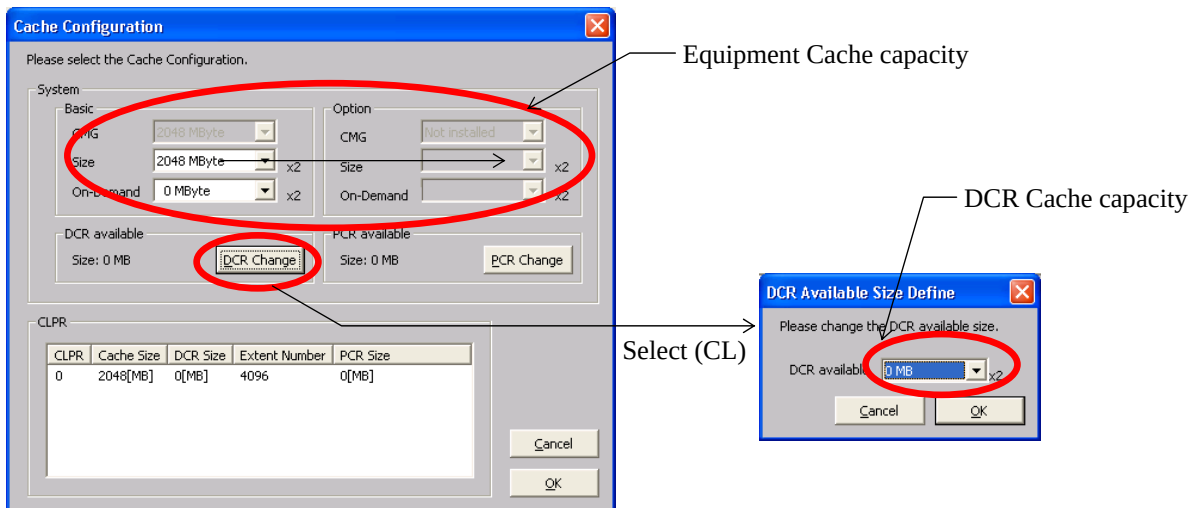
For example, to change a status with the cache of 2.0 GB $\times$ 2 installed and 256 MB $\times$ 2 of it set to the DCR cache to a status with the cache of 4.0 GB $\times$ 2 installed and 512 MB $\times$ 2 of it set to the DCR cache by adding the cache of 2.0 GB $\times$ 2,

- ① set the equipment cache capacity to 4.0 GB $\times$ 2 in the “Cache Configuration” dialog box, and
- ② press the “Change...” button to open the “DCR Available Size” dialog box and set the DCR cache capacity to 512 MB $\times$ 2.

The DCR cache capacity can be set up to the cache capacity to be added. In the above example, the DCR cache capacity can be set up to 768 MB $\times$ 2 by adding 512 MB $\times$ 2.



When de-installing the cache, set a capacity to be left as the DCR cache in the equipment cache capacity.



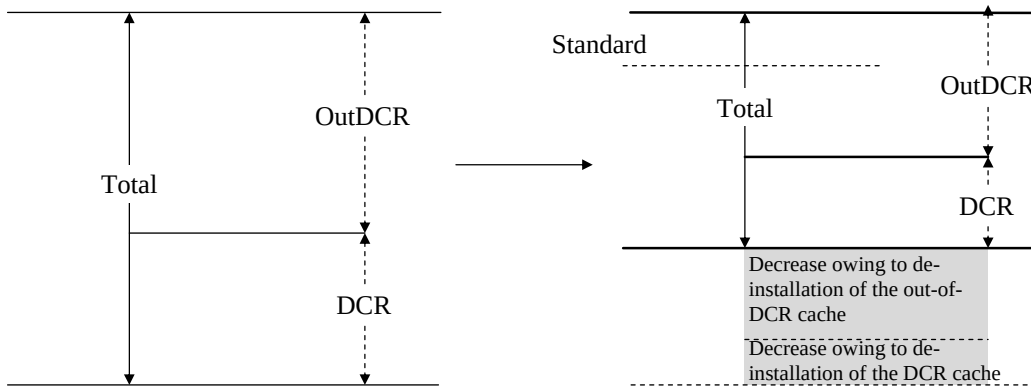
For example, to change a status with the cache of 4.0 GB $\times$ 2 installed and 512 MB $\times$ 2 of it set to the DCR cache to a status with the cache of 2.0 GB $\times$ 2 installed and 256 MB $\times$ 2 of it set to the DCR cache by de-installing the cache of 2.0 GB $\times$ 2,

- ① set the equipment cache capacity to 2.0 GB $\times$ 2 in the “Cache Configuration” dialog box, and
- ② Press the “Change...” button to open the “DCR Available Size” dialog box and set the DCR cache capacity to 256 MB $\times$ 2.

The maximum decreasable capacity of the DCR cache is equal to the capacity of the installed cache to be de-installed. The maximum decreasable capacity of the DCR cache capacity in the above example is 2.0 GB $\times$ 2. As a result, the DCR cache capacity after the de-installation becomes 0 MB $\times$ 2.

Notes :

- In the case in which the de-installation of the DCR cache causes the capacity used by the DCR actually defined as the DCR extent to be above the DCR cache capacity, the cache de-installing process is suspended by the SVP guarding logic. Before executing the DCR cache de-installation, cancel the DCR setting to decrease the actual capacity used by the DCR.
- It is required to avoid de-installation of the out-of-DCR cache which causes its capacity to be below the standard cache capacity.



- The “cache capacity used by the DCR” actually used as the DCR extent is displayed on the DCR Configuration screen in [SVP] - [Install] - [Refer Configuration] for confirmation.

DCR Configuration

Please select parity group to set DCR.

Grp.	LDEV	Size
1-1	0:00, 0:01, ...	16 Cyls 0 Heads
1-2	0:10, 0:11, ...	-----
1-3	0:20, 0:21, ...	-----
1-4	3:00, 3:01, ...	-----
2-1	0:30, 0:31, ...	1001 Cyls 0 Heads
2-2	3:14, 3:15, ...	-----
2-3	1:00, 1:01, ...	-----
2-4	2:00, 2:01, ...	-----
3-1	0:bc, 0:bd	-----
3-2	0:be, 0:bf	-----
3-3	0:c0, 0:c1	-----
3-4	0:c2, 0:c3	-----
3-5	0:c4, 0:c5	-----
3-6	0:c6, 0:c7	-----
3-7	1:24, 1:25, ...	-----
3-8	2:24, 2:25	-----
3-9	3:44, 3:45	-----
3-10	3:47, 3:48	-----

total 506.25 Mbyte x 2 use for DCR

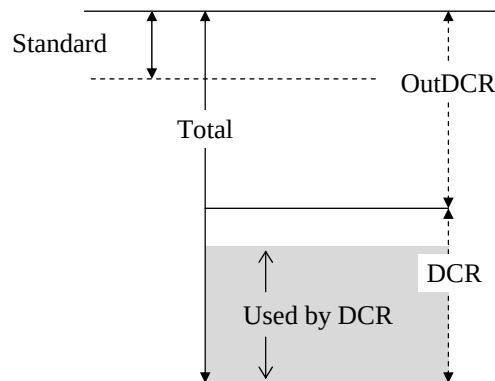
Selected Group:

10 Cyls 0 Heads (18.75 MByte) use for BIND.

6 Cyls 0 Heads (2.81 MByte) use for PRIO.

Buttons: Detail..., Cancel, Before <<, >> Next

Cache capacity used by the DCR



3.28.2.8.3 Notes at the time of operation

From a cash manager utility, while carrying out DCR setup / release, please do not perform DCR operation (a display is included) of SVP/Web Console simultaneously.

When the Volume is in quick formatting, please do not set and release DCR from Cache Manager Utility until the operation is completed. For information about the quick formatting, see “Provisioning Guide for Open Systems” “Provisioning Guide for Mainframe Systems”.

3.29 Caution of flash drive and flash module drive chassis installation

For caution of flash drive and flash module drive chassis installation, refer to [INST01-220](#).

3.30 Data guarantee

DKC710I makes unique reliability improvements and performs unique preventive maintenance.

3.30.1 Improve data reliability by Write & Verify (Write & Verify method) (Unique to SATA)

This function performs a reread check of write data to prevent improper write to disk drives.

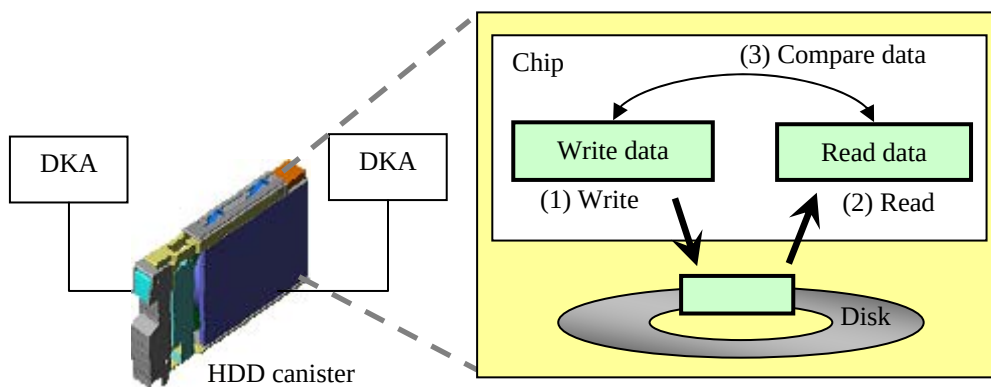


Figure 3.30.1-1 Write & Verify method

THEORY03-30-20**3.30.2 Data check using LA (Logical Address) (LA check) (Common to SAS drives and SATA)**

When data is transferred, the LA value of the target BLK (LA expectation value) and the LA value of the actual transferred data (Read LA value) are compared to guarantee data. This data guarantee is called “LA check”. With the LA check, it is possible to check whether data is read from the correct BLK location.

Table 3.30.2-1 LA check method

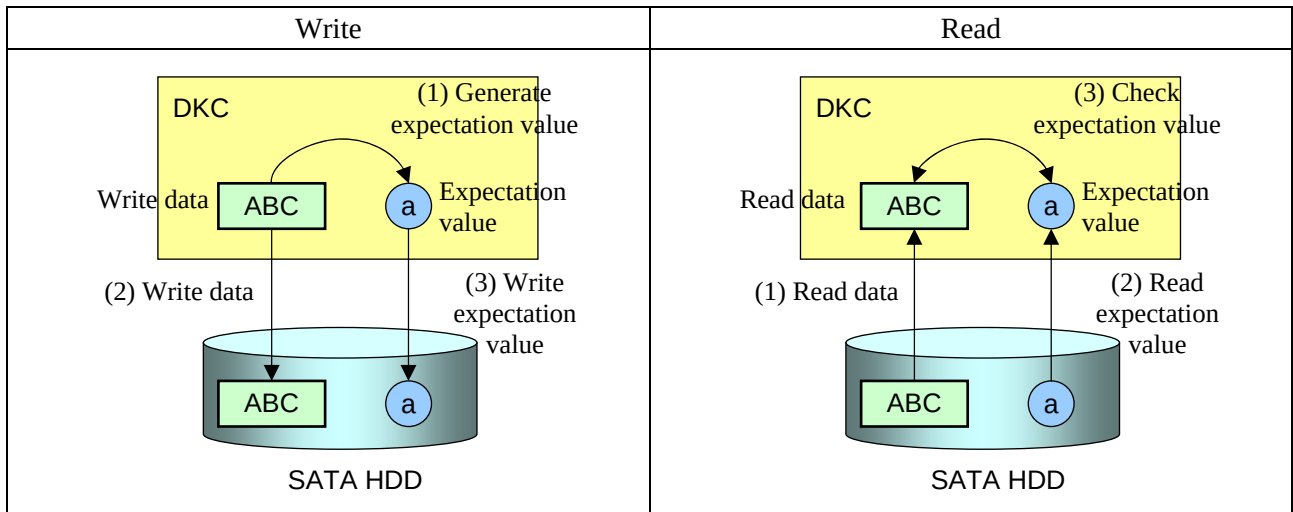
Write	Read
The diagram illustrates the write process. A Host sends data blocks D0, D1, D2, and D3. The Cache memory (CHA) stores this data in its Data field (512B) and calculates Logical Address (LA) values 0, 1, 2, and 3 in its LA field (8B). The Data Key Array (DKA) also stores these LA values. Finally, the Data Key Array (DKA) stores the data and LA values on the Hard Disk Drive (HDD).	The diagram illustrates the read process. The Data Key Array (DKA) calculates an LA expectation value (0, 1, 2, 3) based on the logical address. Data is then read from the HDD. The LA expectation value and the LA value of the read data are compared. If they are inconsistent, an error is detected. Finally, the Cache memory (CHA) transfers the data to the Host, removing the LA field.
(1) Receive Write request from Host. (2) CHA stores data on cache and adds the LA value and, at the same time, adds an LA value, which is a check code, to each BLK. (LA value is calculated based on the logical address of each BLK) (3) DKA stores data on HDD.	(1) DKA calculates the LA expectation value based on the logical address of the BLK to read. (2) Perform read from HDD. (3) Check whether the LA expectation value and the LA value of the read data are consistent. (When the LBA to read is wrong, the LA values would be inconsistent, and the error can be detected. In such a case, a correction read is performed to restore data.) (4) CHA transfers data to Host by removing the LA field.

3.30.3 Data check by expectation value check (SATA-Enhance method) (Unique to SATA)

(1) SATA-Enhance method

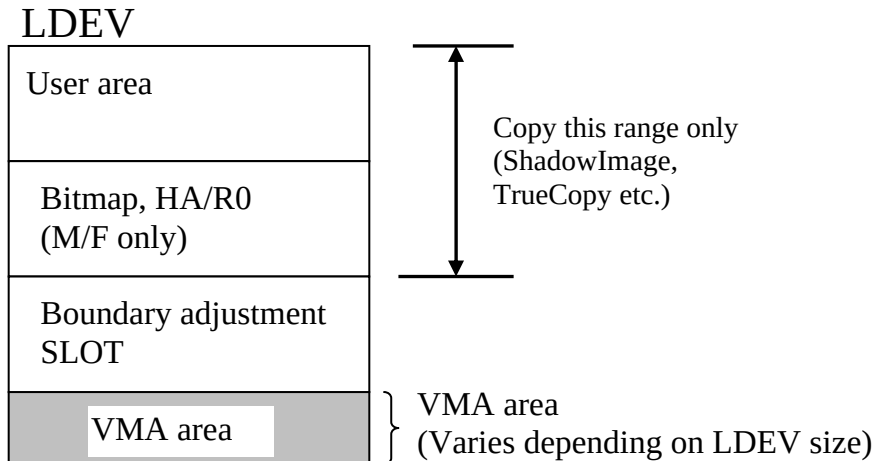
- When writing the write data from HOST to HDD, expectation value is generated and stored in an area where the write data is not stored.
- When a read request is issued from HOST, data and expectation value are read from HDD to check whether data is consistent with the expectation value.
- An area called VMA (Volume Management area) is added at the end of LDEV to store the expectation value. (For details, see Appendix.)
- This method is displayed as “SATA-E” in Web Console etc.

Table 3.30.3-1 SATA-Enhance method



(2) VMA area

In order to store the expectation value of write described in the previous page, a VMA area (Volume Management Area) is reserved at the end of LDEV in the case of the SATA Enhance method.



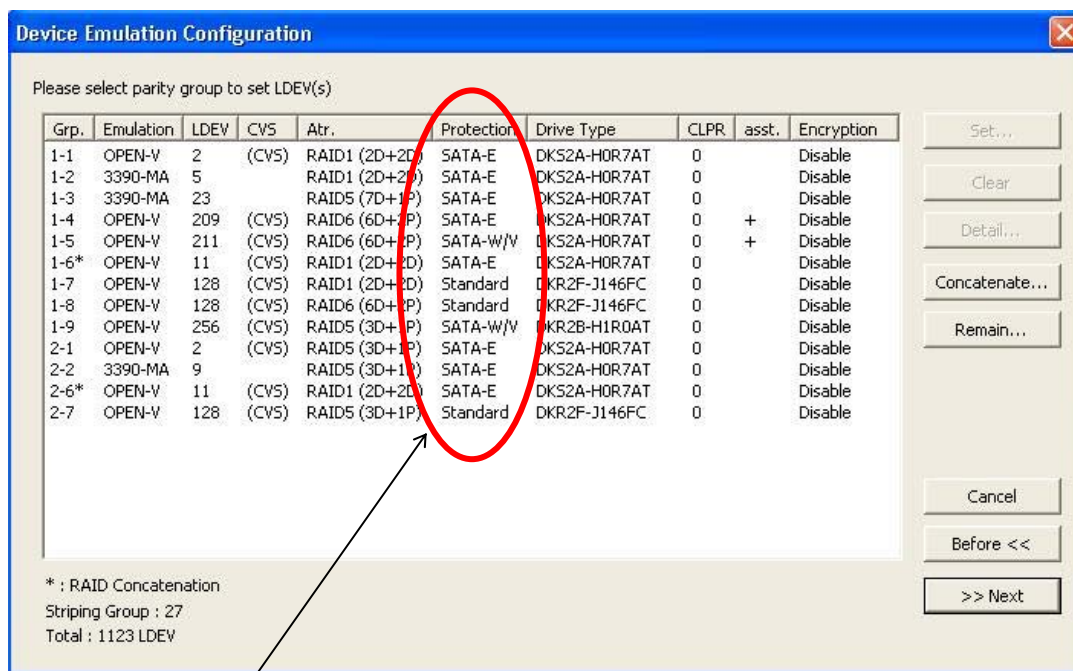
- When LDEV is defined in a RAID group, a VMA area is added after the user storage area.
- The number of LDEVs and LDEV capacity that can be specified are smaller than before because of the VMA area.
- Because the already installed RAID groups do not have the VMA area, you need to uninstall and install a RAID group to apply this method.
- For how to calculate the LDEV capacity that can be defined in the RAID group in the case of CVS, see “Provisioning Guide for Open Systems” “Provisioning Guide for Mainframe Systems”.

(3) Notes

- When installing or uninstalling CV, you cannot change the setting of this function (enable or disable).
- A parity group in which this function is enabled and a parity group in which it is disabled cannot be concatenated.
- Do not create LUSE by using a parity group in which this function is enabled and a parity group in which it is disabled.
- In a Quick Shadow or Dynamic Provisioning pool, do not mix a parity group in which this function is enabled and a parity group in which it is disabled.
- With the conventional method, when the subsystem is powered off with SM volatilization, (though data cannot be guaranteed 100%) data can be read by recovering LDEV forcibly. With the SATA-Enhance method, when the user data is not written and the expectation value is not written to the VMA area, the expectation values would be inconsistent, and data cannot be read. Therefore in the case of power off with SM volatilization, it is necessary to restore data from the backup.
- When the expectation value cannot be read from the VMA area due to two-point drive failure etc., the data cannot be read either. In this case, it is also necessary to restore data from the backup.

(4) Window display

The following information is displayed in the SVP/Web Console window to indicate that the parity group configuration is different from before.



SATA-W/V: SATA Write & Verify method
SATA-E: SATA Enhance method
Standard: SAS HDD, SSD, FMD, External Storage

THEORY03-31-10**3.31 PDEV Erase****3.31.1 PDEV Erase****3.31.1.1 Overview**

When the specified system option (*1) is set, the DKC deletes the data of PDEV automatically in the case according Table 3.31.1.1-2.

*1: Please contact to T.S.D.

Table 3.31.1.1-1 Overview

No.	Item	Content
1	SVP Operation	Select system option from “Install”.
2	Status	DKC only reports on SIM of starting the function. The progress status is not displayed.
3	Result	DKC reports on SIM of normality or abnormal end.
4	Recovery procedure at failure	Re-Erase of PDEV that terminates abnormally is impossible. Please exchange it for new service parts.
5	P/S off or B/K off	The Erase processing fails. It doesn't restart after P/S on.
6	How to stop the “PDEV Erase”	Please execute Replace from the Maintenance screen of the SVP operation, and exchange PDEV that Erase wants to stop for new service parts.

Table 3.31.1.1-2 PDEV Erase execution case

No.	Execution case
1	PDEV is blocked according to Drive Copy completion.

THEORY03-31-20**3.31.1.2 Rough estimate of Erase time**

The Erase time is decided by capacity and the rotational speed of PDEV.

Time is indicated as follows. (Time is a standard and it might take the TOV.)

Table 3.31.1.2-1 PDEV Erase completion expectation time

No.	Kind of PDEV		146GB	200GB	300GB	400GB	500GB	600GB	800GB	900GB
1	SAS (7.2Krpm)		—	—	—	—	2H	—	—	—
2	SAS (10Krpm)		—	—	1H	—	—	2H	—	2H
3	SAS (15Krpm)		1H	—	1H	—	—	—	—	—
4	SATA		—	—	—	—	—	—	—	—
5	Flash Drive	SLC	—	3M	—	6M	—	—	—	—
6		MLC	—	25M	—	45M	—	—	50M	—
7	Flash Module Drive		—	—	—	—	—	—	—	—

No.	Kind of PDEV		1TB	1.2TB	1.6TB	2TB	3TB	3.2TB	4TB
1	SAS (7.2Krpm)		4H	—	—	6H	7H	—	8H
2	SAS (10Krpm)		—	3H	—	—	—	—	—
3	SAS (15Krpm)		—	—	—	—	—	—	—
4	SATA		—	—	—	6H	—	—	—
5	Flash Drive	SLC	—	—	—	—	—	—	—
6		MLC	—	—	—	—	—	—	—
7	Flash Module Drive		—	—	15M	—	—	30M	—

Table 3.31.1.2-2 PDEV Erase TOV

No.	Kind of PDEV		146GB	200GB	300GB	400GB	500GB	600GB	800GB	900GB
1	SAS (7.2Krpm)		—	—	—	—	7H	—	—	—
2	SAS (10Krpm)		—	—	4H	—	—	7H	—	9H
3	SAS (15Krpm)		2H	—	4H	—	—	—	—	—
4	SATA		—	—	—	—	—	—	—	—
5	Flash Drive	SLC	—	2H	—	3H	—	—	—	—
6		MLC	—	2H	—	3H	—	—	130M	—
7	Flash Module Drive		—	—	—	—	—	—	—	—

No.	Kind of PDEV		1TB	1.2TB	1.6TB	2TB	3TB	3.2TB	4TB
1	SAS (7.2Krpm)		14H	—	—	18H	29H	—	32H
2	SAS (10Krpm)		—	10H	—	—	—	—	—
3	SAS (15Krpm)		—	—	—	—	—	—	—
4	SATA		—	—	—	18H	—	—	—
5	Flash Drive	SLC	—	—	—	—	—	—	—
6		MLC	—	—	—	—	—	—	—
7	Flash Module Drive		—	—	1H	—	—	2H	—

THEORY03-31-30**3.31.1.3 Influence in combination with other maintenance operation**

The influence on the maintenance operation during executing PDEV Erase becomes as follows.

Table 3.31.1.3-1 PDEV Replace

No.	Object part	Influence	Countermeasure
1	Replace from SVP as for PDEV that does PDEV Erase	PDEV Erase terminates abnormally.	Self replacement of PDEV will be failed. Please replace it to new one.
2	Replace from SVP as for PDEV that does not PDEV Erase	Nothing	—
3	User Replace	Please do not execute the user replacement during PDEV Erase.	Please execute it after completing PDEV Erase.

Table 3.31.1.3-2 DKA Replace

No.	Object part	Influence	Countermeasure
1	DKA connected with PDEV that is executed PDEV Erase	[SVP4198W] may be displayed. The DKA replacement might fail by [ONL2412E] when the password is entered. (*2)	<SIM4c2xxx/4c3xxx about this PDEV is not reported> Please replace PDEV (to which Erase is done) to new service parts. (*1) The DKA replacement might fail by [ONL2412E] when the password is entered. (*2)
2	DKA other than the above	Nothing	Nothing

Table 3.31.1.3-3 MPB Replace/MPB Removal

No.	Object part	Influence	Countermeasure
1	MPB that is executed PDEV Erase	[SVP4198W] may be displayed. The MPB replacement might fail by [ONL2412E] when the password is entered. (*2)	<SIM4c2xxx/4c3xxx about this PDEV is not reported> Please replace PDEV (to which Erase is done) to new service parts. (*1) The MPB replacement might fail by [ONL2412E] when the password is entered. (*2)
2	MPB other than the above	Nothing	Nothing

Table 3.31.1.3-4 SSW Replace

No.	Object part	Influence	Countermeasure
1	SSW connected with DKA connected with HDD that does PDEV Erase	[SVP4198W] may be displayed. The SSW replacement might fail by [ONL2788E] [ONL3395E] when the password is entered. (*2)	<SIM4c2xxx/4c3xxx about this PDEV is not reported> Please replace PDEV (to which Erase is done) to new service parts. (*1) The SSW replacement might fail by [ONL2788E][ONL3395E] when the password is entered. (*2)
2	SSW other than the above	Nothing	Nothing

Table 3.31.1.3-5 PDEV installation/Removal

No.	Object part	Influence	Countermeasure
1	ANY	Installation/De-installation might fail by [SVP739W].	Please wait for the Erase completion or replace PDEV (to which Erase is done) to new service parts. (*1)

Table 3.31.1.3-6 Exchanging microcode

No.	Object part	Influence	Countermeasure
1	DKC MAIN	[SVP0732W] may be displayed. Microcode exchanging might fail by [SMT2433E], when the password is entered. (*2)	Please wait for the Erase completion or replace PDEV (to which Erase is done) to new service parts. (*1)
2	DKU	[SVP0732W] may be displayed. Microcode exchanging might fail by [SMT2433E], when the password is entered. (*2)	Please wait for the Erase completion or replace PDEV (to which Erase is done) to new service parts. (*1)

Table 3.31.1.3-7 LDEV Format

No.	Object part	Influence	Countermeasure
1	ANY	There is a possibility that PATH-Inline fails. There is a possibility that the cable connection cannot be checked when the password is entered.	Please wait for the Erase completion or replace PDEV (to which Erase is done) to new service parts. (*1)

Table 3.31.1.3-8 PATH-Inline

No.	Object part	Influence	Countermeasure
1	DKA connected with PDEV that is executed PDEV Erase	There is a possibility of detecting the trouble by PATH-Inline.	Please wait for the Erase completion or replace PDEV (to which Erase is done) to new service parts. (*1)

Table 3.31.1.3-9 PS/OFF

No.	Object part	Influence	Countermeasure
1	ANY	PDEV Erase terminates abnormally.	<SIM4c2xxx/4c3xxx about this PDEV is not reported> Please wait for the Erase completion or replace PDEV (to which Erase is done) to new service parts. (*1)

*1: When PDEV that stops PDEV Erase is installed into DKC again, it might fail by Spin-up failure.

*2: It is not likely to be able to maintain it when failing because of concerned MSG until HDD Erase is completed or terminates abnormally.

THEORY03-31-60**3.31.1.4 Notes of various failures**

Notes of the failure during PDEV Erase become as follows.

No.	Failure	Object part	Notice	Countermeasure
1	B/K OFF/ Black Out	DKU BOX	There is a possibility that PDEV Erase fails due to the failure.	Please replace PDEV of the Erase object to new service parts after P/S on.
2		DKC BOX	Because watch JOB of Erase disappears, it is not possible to report on normality/abnormal termination SIM of Erase.	Please replace PDEV of the Erase object to new service parts after P/S on.
3	MP failure	DKP	[E/C 9470 is reported at the MP failure] JOB of the Erase watch is reported on E/C:9470 when Abort is done due to the MP failure, and ends processing. In this case, it is not possible to report on normality/abnormal termination SIM of Erase.	Please replace PDEV of the Erase object to new service parts after the recovery of MP failure.
4			[E/C 9470 is not reported at the MP failure] It becomes impossible to communicate with the controller who is doing Erase due to the MP failure. In this case, it becomes TOV of watch JOB with E/C:9450, and reports abnormal SIM.	Please replace PDEV to new service parts after judging the Erase success or failure after it waits while TOV of PDEV Erase after the recovery of MP.

3.32 Open platform

3.32.1 GENERAL

3.32.1.1 Product Outline and Features

The open platform optional feature can assign a partial or full of disk volume area of the DKC disk subsystem for the Mainframe and Open system hosts by installing Fibre channel adapter (CHF) packages to the disk controller (hereinafter called DKC). This function enables a use of high reliable and high performance disk subsystem realized by the DKC for an open platform or Fibre system environment. This also provides the customers with a flexible and optimized system construction capability for their system expansion and migration. In Open system environment, Fibre Channel (FC) and Fibre Channel over Ethernet (FCoE) can be used as a channel interface.

3.32.1.1.1 Fibre attachment option (FC/FCoE)

Some of the major features of this Fibre attachment option are listed below.

(1) Fibre interface connectivity

Fibre channel interface can be mounted as one controller. This enables multiplatform system users to share the high reliable and high performance resource realized by the DKC disk subsystem.

The SCSI interface is complied with ANSI SCSI-3, a standard interface for various peripheral devices for open systems. Thus, the DKC can be easily connected to various open-market Fibre host systems (e.g. Workstation servers and PC servers).

DKC710I can be connected to open system via Fibre interface by installing Fibre Adapter (DKC-F710I-8FC/16FC/8UFC/16UFC/8FOE).

Fibre connectivity is provided as channel option of DKC710I.

Fibre Adapter can be installed in any CHA location of DKC710I and can be co-exist with any other channel adapters.

(2) Fast and concurrent data transmission

Data can be read and written at a maximum speed of 8 Gbps with use of Fibre interface (in case of FCoE, the maximum speed is 10 Gbps).

All of the Fibre ports can transfer data concurrently too.

(3) All Fibre configuration (only for FC)

All Fibre configuration is also allowed either with one CHF pair or two, three or full of 12 CHF pairs configuration.

These will provide more flexible use of the subsystem for open system environment. (As FCoE does not support Initiator port, all of 12 sets configuration is not supported.)

(4) Cross-OS File Exchange support (only for FC)

By installing Cross-OS File Exchange mto optional feature, data in the mainframe volumes can be read from open systems and written into the open system volumes. Another way, by installing Cross-OS File Exchange otm optional feature, data can be transferred from open system to mainframe.

This enables faster data transmission of data base files between mainframe and open systems than currently used means such as network transfer.

The Cross-OS File Exchange mto/otm feature is available through Fibre adapters.

(5) HMBR (Hitachi Multiplatform Backup/Restore) support (only for FC)

By using HMBR optional feature, data in the open system can be managed by the backup systems and utilities provided in the mainframe systems. This enables a use of rich and high reliable and high performance backup systems of mainframe world to the open system environment.

The HMBR feature is available through Fibre adapters.

(6) Customer assets guarantee (Upgrading paths)

The Fibre attachment options allow on-site upgrading of already installed channel-type DKC systems owned by customers.

(7) High performance

The DKC has two independent areas of nonvolatile cache memory and this mechanism also applies to the Fibre attachment option. Thus, compared with a conventional disk array controller used for open systems and not having a cache, this disk subsystem has the following outstanding characteristics:

- ① Cache data management by LRU control
- ② Adoption of DFW (DASD Fast Write)
- ③ Write data duplexing
- ④ Nonvolatile cache

(8) High availability

The DKC is fault-tolerant against even single point of failure in its components and can successively read and write data without stopping the system. This concept is also taken over to the Fibre attachment option, which ensures fault-tolerance against even single point of failure in its components, except the CHF. Fault-tolerance against CHF and Fibre cable failures depends on the multi-path configuration support of the host system too.

(9) High data reliability

The Fibre attachment option automatically creates a guarantee code of a unique eight byte data, adds it to host data, and writes it onto the disk as data. The data guarantee code is checked automatically on the internal data bus of the DKC to prevent data errors due to array-specific data distribution or integration control. Thus, the reliability of the data improves.

(10) TrueCopy Support (only for FC)

TrueCopy is a function to realize the duplication of open system data by connecting the two DKC710I subsystems or inside parts of a single DKC710I using the Fibre.

This function enables the construction of a backup system against disasters by means of the duplication of data including those of the host system or the two volumes containing identical data to be used for different purposes. (As FCoE does not support the initiator port, TrueCopy configuration using FCoE cannot be created.)

(11) HAM (High Availability Manager) (only for FC)

HAM is a function that provides a storage system that can instantly continue the user operation in an unplanned termination of the DKC due to external causes such as power failure in a place where the storage device is placed. HAM is formed in combination with the alternate path software (HDLN) that supports this function, and prevents the storage device termination due to any cause beyond control that affects the user operation, and increases the availability of the entire information system including the operation application. (HAM configuration using FCoE cannot be created.)

THEORY03-32-40**3.32.1.2 Basic Specifications**

The basic specifications of the Fibre attachment are shown in Table 3.32.1.2-1.

Table 3.32.1.2-1 Basic specifications

Item		Specification	
		FC	FCoE
Host Channel	Max. # of Channels	192 (*1)	88
	Max. # of concurrent paths	256 (*1)	256
Data transfer		DKC-F710I-8FC/16FC: 1, 2, 4 Gbps DKC-F710I-8UFC/16UFC: 2, 4, 8 Gbps	DKC-F710I-8FOE: 10 Gbps
RAID level		RAID6/RAID5/RAID1	RAID6/RAID5/RAID1
RAID configuration		RAID6	RAID6
		RAID5	RAID5
		RAID1	RAID1
HDD		2R0H2M	2R0H2M
		146KCM	146KCM
		300JCM	300JCM
		500HCM	500HCM
		600JCM	600JCM
		1R0HCM	1R0HCM
		FLASH DRIVE	
400S1M	400S1M		
Cache capacity	minimum	4 G bytes	4 G byte
	maximum	128 G bytes (*2)	128 G byte (*2)
	additional unit	4 G bytes	4 G byte

*1: All PCB are the 16FC/16UFC.

*2: 1 G bytes DRAM.

3.32.1.3 Terminology

- (1) Arbitrated Loop
A configuration that allows multiple ports to be connected serially.
- (2) CHA
CHannel Adapter. A hardware package to connect with a channel interface.
- (3) CHF
CHannel adapter for Fibre. A hardware package to connect with Fibre interface.
- (4) Command descriptor block (CDB)
A command block in SCSI interface used to send requests from the initiator to a target.
- (5) DKA
DisK Adapter. A hardware package which controls disk drives within a DKC.
- (6) DKC
DisK Controller. A disk controller unit consisting of CHA, CHF, DKA, Cache and other components except DKU.
- (7) DKU
DisK Unit. Disk drives units.
- (8) Fabric
The entity which interconnects various N-Ports attached to it and is capable of routing frames.
- (9) FAL
File Access Library: A program package and provided as a program product for Cross-OS File Exchange.
- (10) FCU
File Conversion Utility: A program package and provided together with FAL for Cross-OS File Exchange.
- (11) HMBR
Hitachi Multiplatform Backup/Restore.
- (12) HA configuration
High Availability configuration

(13) Initiator

The OPEN device (usually, a host computer) that requests another OPEN device to operate.

(14) Logical unit (LU)

The logical unit of division of the subsystem data area accessible from SCSI interface.

(15) Logical unit number (LUN)

Identifier for a logical unit. LUN0-2048 can be assigned.

(16) Logical volume or logical device (LDEV)

The disk pack image, formed on an array disk, that is compatible with that of a 3390-3 in terms of cylinder and track quantities and the track capacity.

(17) Point-to-Point

A configuration that allows two ports to be connected serially.

(18) Open device

Collectively refers to the host computer, peripheral control units, and intelligent peripherals that are connected to Fibre channel.

(19) Target

An Open device (usually, the DKC) that operates at the request of the initiator.

(20) VENDOR UNIQUE or VU

A manufacturer- or device-unique definable bit, byte, field, or code value.

(21) Initiator Port

A port-type used for MCU port of TrueCopy function.

(22) RCU Target Port

A port-type used for RCU port of TrueCopy function.
This port allows LOGIN of host computers and MCUs.

(23) Target port

A port-type which is different from “Initiator Port” and “RCU Target Port”.
This port is a normal target port which is used without configuration of TrueCopy.
This “Target port” allows LOGIN of host computers. It does not allow LOGIN of MCUs.

(24) External Port

Port attribute set when using it as initiator of Universal Volume Manager function.

(25) FCoE (Fibre Channel over Ethernet)

FCoE is a protocol to transmit FC traffic on the “lossless Ethernet”. For I/O integration, this protocol enables to transfer different type of traffic (LAN, SAN) by using one physical infrastructure.

(26) Lossless Ethernet

Unlike usual Ethernet, Lossless Ethernet is a LAN expanded so as to eliminate packet loss (except physical failure), and complies with PFC, ETS, and DCBX. It is also known as DCB, CEE, or DCE.

(27) CNA (Converged Network Adapter)

CNA is an interface board on server side for FCoE. One CNA is capable of providing both NIC and FC HBA functions. It sends and receives Ethernet frame that is encapsulated FC to and from lossless Ethernet.

(28) FCoE frame

FCoE is an encapsulated header, payload, and CRC in FC frame in Ethernet frame. As FC frame is 2140 bytes at the maximum, jumbo frame is employed.

(29) FCF (Fibre Channel Forwarder)

FCF is an FCoE switch, which enables to switch from FC to lossless Ethernet and vice versa, and execute or release encapsulation of FC frame. Also there is FCoE controller, which executes FIP and is responsible to allocate MAC address to FC link.

(30) ENode (FCoE Node)

ENode is an FC node, such as host or storage, which has one or multiple lossless Ethernet MAC address.

(31) FIP (FCoE Initialization Protocol)

FIP is a protocol for initialization of FCoE. It is used mainly in phases such as Discovery of Enode/FCF or FLOGI/FLOGI_ACC.

(32) FCF MAC address

FCF MAC address is a static MAC address assigned by FCoE controller of FCF.

(33) ENode MAC address

ENode MAC address is a static MAC address assigned by FCoE controller of ENode.

(34) FPMA (Fabric Provided MAC Address)

FPMA is a dynamic MAC address assigned by FCF. It is assigned when FCF issues FLOGI LS_ACC/NPIV FDISC LS_ACC. Among 48bit, upper 24 bits and bottom 24 bits are in FC-MAP and N_Port_ID formats respectively.

(35) VLAN

VLAN is a function undertakes arbitrary network role for per port inside the switch. This enables multiple LANs to be connected to a physical link. Under the condition that different SWs of each vendor coexist, mutually connected VLAN can be established. (IEEE802.1Q)

3.32.1.4 Notice about maintenance operations

There are some notices about Fibre maintenance operations.

- (1) Before LUN path configuration is changed, Fibre I/O on the related Fibre port must be stopped.
- (2) Before Fibre channel adapter or LDEV is de-installed, the related LUN path must be de-installed.
- (3) Before Fibre channel adapter is replaced, the related Fibre I/O must be stopped.
- (4) When Fibre-Topology information is changed, pull out a Fibre cable between the port and SWITCH and put it back again. Before a change of Fibre-Topology information, pull out Fibre cable and put it back after completing the change.

THEORY03-32-80**3.32.2 Interface Specification****3.32.2.1 Fibre Physical Interface Specification**

The physical interface specification supported for Fibre Channel (FC) is shown in Table 3.32.2.1-1 to 3.32.2.1-3.

Fibre Channel over Ethernet (FCoE) physical interface specification is shown in Table 3.32.2.1-4 to 3.32.2.1-6.

Table 3.32.2.1-1 Fibre Physical specification

No.	Item		Specification	Remark
1	Host interface	Physical interface	Fibre Channel	FC-PH,FC-AL
		Logical interface	SCSI-3	FCP,FC-PLDA
			Fibre	FC-AL
2	Data Transfer Rate	Optic Fibre cable	1, 2, 4 Gbps/ 2, 4, 8 Gbps	8FC,16FC/ 8UFC,16UFC
3	Cable Length	Optic single mode Fibre	10km	Longwave laser (*)
		Optic multi mode Fibre	150 m/300 m/500 m	Shortwave laser
4	Connector Type		LC: 8FC/16FC/8UFC/16UFC	—
5	Topology		NL-Port (FC-AL) F-Port FL-Port	—
6	Service class		3	—
7	Protocol		FCP	—
8	Transfer code		8B/10B translate	—
9	Number of hosts		255/Path	—
10	Number of host groups		255/Path	—
11	Maximum number of LUs		2048/Path	—
12	PORT/PCB	16FC/16UFC	8 Port	—
		8FC/8UFC	4 Port	—

SP Mode : Standard Performance Mode

HP Mode : High Performance Mode

THEORY03-32-90**Table 3.32.2.1-2 Port name of Module #0**

Cluster	PCB Name	PCB Location	Port Name	Cluster	PCB Name	PCB Location	Port Name
CLS1	CHA11A (BASIC)	1EU	1A	CLS2	CHA11B (BASIC)	2QU	2A
			3A				4A
			5A				6A
			7A				8A
			1B (*1)				2B (*1)
			3B (*1)				4B (*1)
			5B (*1)				6B (*1)
			7B (*1)				8B (*1)
	CHA12A (ADD1)	1EL	1C		CHA12B (ADD1)	2QL	2C
			3C				4C
			5C				6C
			7C				8C
			1D (*1)				2D (*1)
			3D (*1)				4D (*1)
			5D (*1)				6D (*1)
			7D (*1)				8D (*1)
	CHA21A (ADD2)	1FU	1E		CHA21B (ADD2)	2RU	2E
			3E				4E
			5E				6E
			7E				8E
			1F (*1)				2F (*1)
			3F (*1)				4F (*1)
			5F (*1)				6F (*1)
			7F (*1)				8F (*1)
	CHA22A (ADD3)	1FL	1G		CHA22B (ADD3)	2RL	2G
			3G				4G
			5G				6G
			7G				8G
			1H (*1)				2H (*1)
			3H (*1)				4H (*1)
			5H (*1)				6H (*1)
			7H (*1)				8H (*1)
	CHA10A (DKA BASIC)	1AU	9A		CHA10B (DKA BASIC)	2MU	AA
			BA				CA
			DA				EA
			FA				GA
			9B (*1)				AB (*1)
			BB (*1)				CB (*1)
			DB (*1)				EB (*1)
			FB (*1)				GB (*1)
	CHA20A (DKA ADD1)	1AL	9C		CHA20B (DKA ADD1)	2ML	AC
			BC				CC
			DC				EC
			FC				GC
			9D (*1)				AD (*1)
			BD (*1)				CD (*1)
			DD (*1)				ED (*1)
			FD (*1)				GD (*1)

*1: The port location doesn't exist on 8FC/8UFC.

THEORY03-32-100**Table 3.32.2.1-3 Port name of Module #1**

Cluster	PCB Name	PCB Location	Port Name	Cluster	PCB Name	PCB Location	Port Name
CLS1	CHA11A (ADD4)	1GU	1J	CLS 2	CHA11B (ADD4)	2TU	2J
			3J				4J
			5J				6J
			7J				8J
			1K (*1)				2K (*1)
			3K (*1)				4K (*1)
			5K (*1)				6K (*1)
			7K (*1)				8K (*1)
	CHA12A (ADD5)	1GL	1L		CHA12B (ADD5)	2TL	2L
			3L				4L
			5L				6L
			7L				8L
			1M (*1)				2M (*1)
			3M (*1)				4M (*1)
			5M (*1)				6M (*1)
			7M (*1)				8M (*1)
	CHA21A (ADD6)	1HU	1N		CHA21B (ADD6)	2UU	2N
			3N				4N
			5N				6N
			7N				8N
			1P (*1)				2P (*1)
			3P (*1)				4P (*1)
			5P (*1)				6P (*1)
			7P (*1)				8P (*1)
	CHA22A (ADD7)	1HL	1Q		CHA22B (ADD7)	2UL	2Q
			3Q				4Q
			5Q				6Q
			7Q				8Q
			1R (*1)				2R (*1)
			3R (*1)				4R (*1)
			5R (*1)				6R (*1)
			7R (*1)				8R (*1)
	CHA10A (DKA ADD2)	1LU	9J		CHA10B (DKA ADD2)	2XU	AJ
			BJ				CJ
			DJ				EJ
			FJ				GJ
			9K (*1)				AK (*1)
			BK (*1)				CK (*1)
			DK (*1)				EK (*1)
			FK (*1)				GK (*1)
	CHA20A (DKA ADD3)	1LL	9L		CHA20B (DKA ADD3)	2XL	AL
			BL				CL
			DL				EL
			FL				GL
			9M (*1)				AM (*1)
			BM (*1)				CM (*1)
			DM (*1)				EM (*1)
			FM (*1)				GM (*1)

*1: The port location doesn't exist on 8FC/8UFC.

Table 3.32.2.1-4 Fibre Channel over Ethernet physical specification

No.	Item		Specification	Remark
1	Host interface	Physical interface	Fibre Channel over Ethernet	FC-PH
		Logical interface	SCSI-3	FCP
			FCoE	FC-BB-5
2	Data transfer rate	Optical Fibre cable	10 Gbps	8FOE
3	Cable length	Optical single mode Fibre	Not supported	Longwave laser
		Optical multi mode Fibre	300 m	Shortwave laser
4	Connector type		LC	—
5	Topology		F_Port	—
6	Service class		3	—
7	Protocol		FCP	—
8	Transfer code		64B/66B translate	—
9	Number of hosts		88/Path	—
10	Number of host groups		255/Path	—
11	Maximum number of LUs		2048/Path	—
12	Number of PORTs/PCBs		4 Ports	—

Table 3.32.2.1-5 Port name of Module #0

Cluster	PCB Name	PCB Location	Port Name	Cluster	PCB Name	PCB Location	Port Name
CLS1	CHA11A (BASIC)	1EU	1A	CLS2	CHA11B (BASIC)	2QU	2A
			3A				4A
			1B (*1)				2B (*1)
			3B (*1)				4B (*1)
	CHA12A (ADD1)	1EL	1C		CHA12B (ADD1)	2QL	2C
			3C				4C
			1D (*1)				2D (*1)
			3D (*1)				4D (*1)
	CHA21A (ADD2)	1FU	1E		CHA21B (ADD2)	2RU	2E
			3E				4E
			1F (*1)				2F (*1)
			3F (*1)				4F (*1)
	CHA22A (ADD3)	1FL	1G		CHA22B (ADD3)	2RL	2G
			3G				4G
			1H (*1)				2H (*1)
			3H (*1)				4H (*1)
	CHA10A (DKA BASIC)	1AU	9A		CHA10B (DKA BASIC)	2MU	AA
			BA				CA
			9B (*1)				AB (*1)
			BB (*1)				CB (*1)
	CHA20A (DKA ADD1)	1AL	9C		CHA20B (DKA ADD1)	2ML	AC
			BC				CC
			9D (*1)				AD (*1)
			BD (*1)				CD (*1)

*1: The port location doesn't exist on 8FC/8UFC.

Table 3.32.2.1-6 Port name of Module #1

Cluster	PCB Name	PCB Location	Port Name	Cluster	PCB Name	PCB Location	Port Name
CLS1	CHA11A (ADD4)	1GU	1J	CLS 2	CHA11B (ADD4)	2TU	2J
			3J				4J
			1K (*1)				2K (*1)
			3K (*1)				4K (*1)
	CHA12A (ADD5)	1GL	1L		CHA12B (ADD5)	2TL	2L
			3L				4L
			1M (*1)				2M (*1)
			3M (*1)				4M (*1)
	CHA21A (ADD6)	1HU	1N		CHA21B (ADD6)	2UU	2N
			3N				4N
			1P (*1)				2P (*1)
			3P (*1)				4P (*1)
	CHA22A (ADD7)	1HL	1Q		CHA22B (ADD7)	2UL	2Q
			3Q				4Q
			1R (*1)				2R (*1)
			3R (*1)				4R (*1)
	CHA10A (DKA ADD2)	1LU	9J		CHA10B (DKA ADD2)	2XU	AJ
			BJ				CJ
			9K (*1)				AK (*1)
			BK (*1)				CK (*1)
	CHA20A (DKA ADD3)	1LL	9L		CHA20B (DKA ADD3)	2XL	AL
			BL				CL
			9M (*1)				AM (*1)
			BM (*1)				CM (*1)

*1: The port location doesn't exist on 8FC/8UFC.

3.32.3 CONFIGURATION

3.32.3.1 System Configurations

3.32.3.1.1 Multiplatform Configuration

The DKC can be connected to a Fibre cable (FC/FCoE) as one of the devices and can exchange data with host via the Fibre cable. The conventional Channel open host systems can also be connected simultaneously with the Fibre cable. The possible system configurations with the Fibre attachment are shown below.

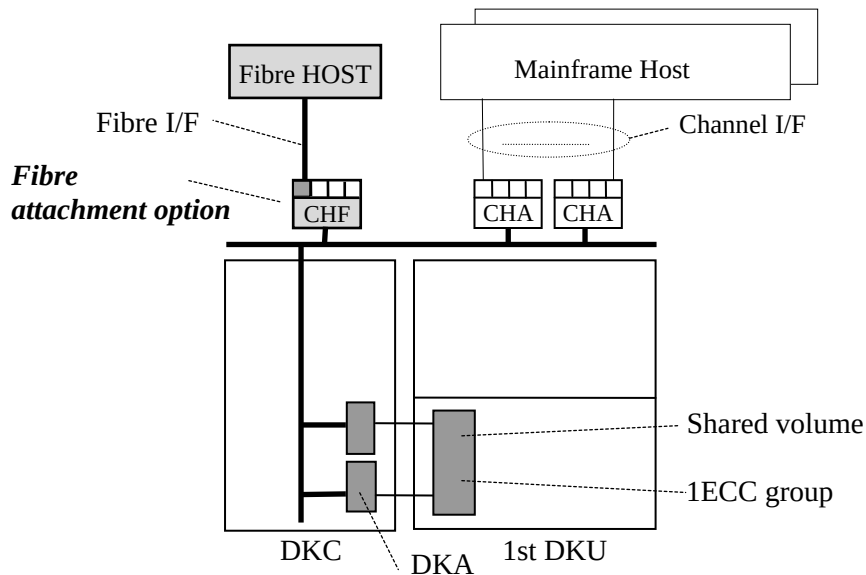


Fig. 3.32.3.1.1-1 multiplatform configuration example

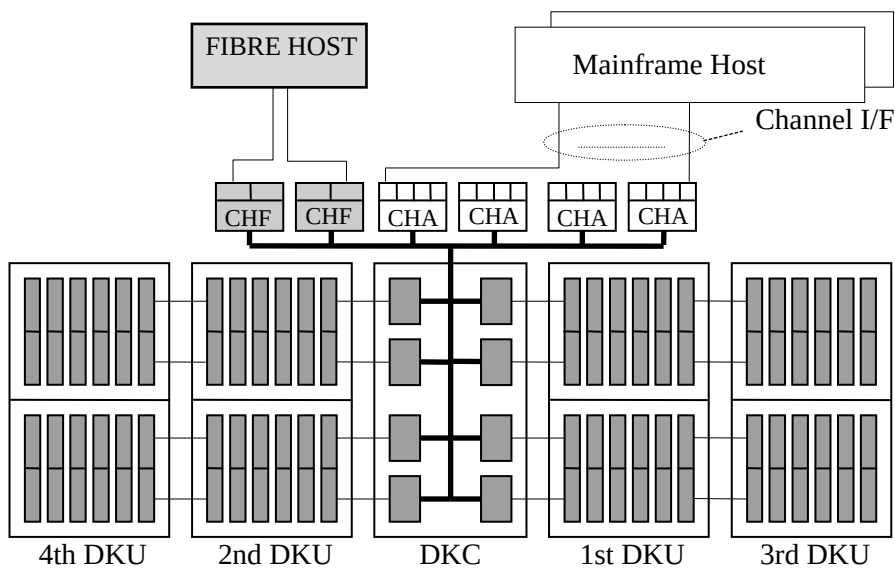


Fig. 3.32.3.1.1-2 multiplatform configuration example

3.32.3.1.2 All Fibre Configuration

The DKC can also have the All Fibre interface configuration installed only by CHF adapters. The possible system configurations for the All Fibre configuration are shown below. (only for FC. In case of FCoE, this configuration is not supported.)

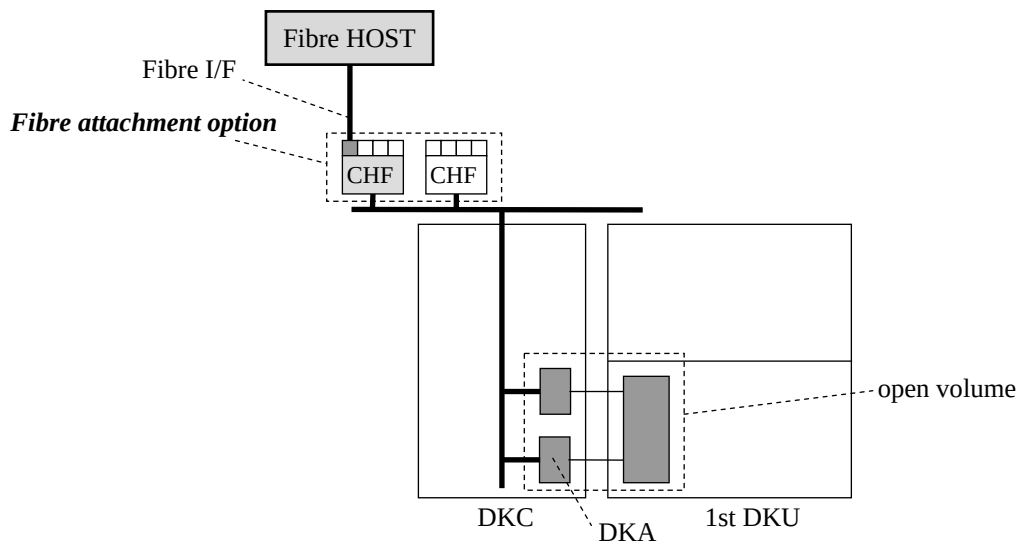


Fig. 3.32.3.1.2-1 Minimum system configuration for All Fibre

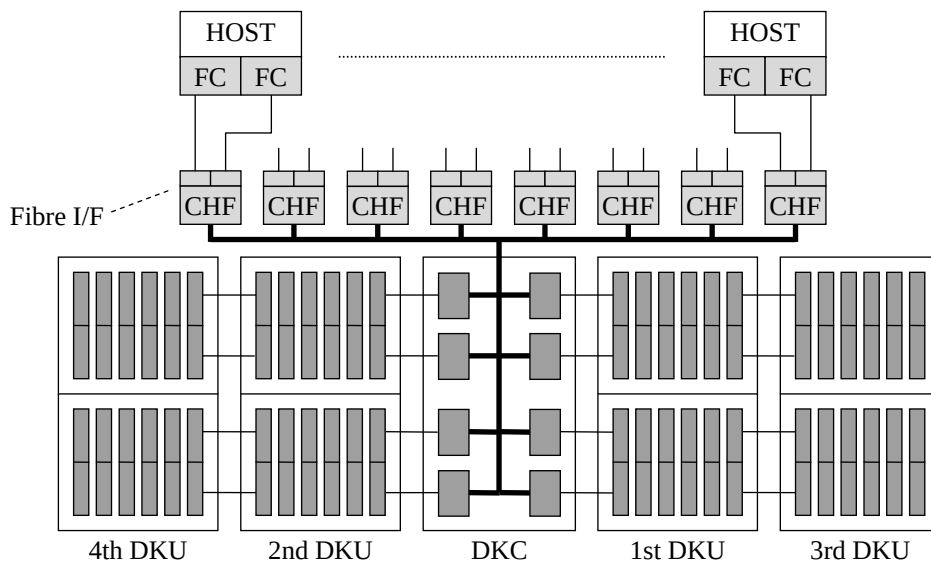


Fig. 3.32.3.1.2-2 Maximum system configuration example for All Fibre

THEORY03-32-140**3.32.3.2 Channel Configuration****3.32.3.2.1 Fibre Channel Configuration**

The Fibre channel adapter (CHF) PCBs must be used in sets of two. Up to 24 PCBs of the CHA and/or CHF can be installed in the DKC in total.

In the All Fibre configuration, it is possible to assign the CHF PCB to every one of the 24 PCBs. Each CHF PCB has 4 (8UFC/16UFC/8FOE) or 8 (8FS/16FS) Fibre channel ports.

Examples of channel configurations are shown in Table 3.32.3.2.1-1.

Table 3.32.3.2.1-1 Example of available channel configuration

No.	Basic	Addition 1	Addition 2	Addition 22	Addition 23	Remark
1	CHA	CHF	—	—	—	Minimum multiplatform
2	CHF	—	—	—	—	Minimum All Fibre
3	CHF	CHF	CHF	CHF	CHF	Maximum All Fibre

CHF: Fibre adapter, CHA: FICON, —: empty

Table 3.32.3.2.1-2 Channel Configuration

No.	Premise	Additional 3	Additional 2	Additional 1	Basic	Remark
1	3	CHF	—	—	—	CHA+DKA SLOT
2	3	CHF	CHF	CHF	CHF	CHA+DKA SLOT

3.32.3.3 Fibre Addressing

Each Fibre device can set a unique Port-ID number within the range from 1 to EF.

An addressing from the Fibre host to the Fibre volume in the DKC can be uniquely defined with a nexus between them. The nexus through the Initiator (host) ID, the Target (CHF port) ID, and LUN (Logical Unit Number) defines the addressing and access path. The maximum number of LUNs that can be assigned to one port is 2048.

The addressing configuration is shown in the Fig. 3.32.3.3.3-1. (FCoE does not support AL_PA topology)

3.32.3.3.1 Number of Hosts

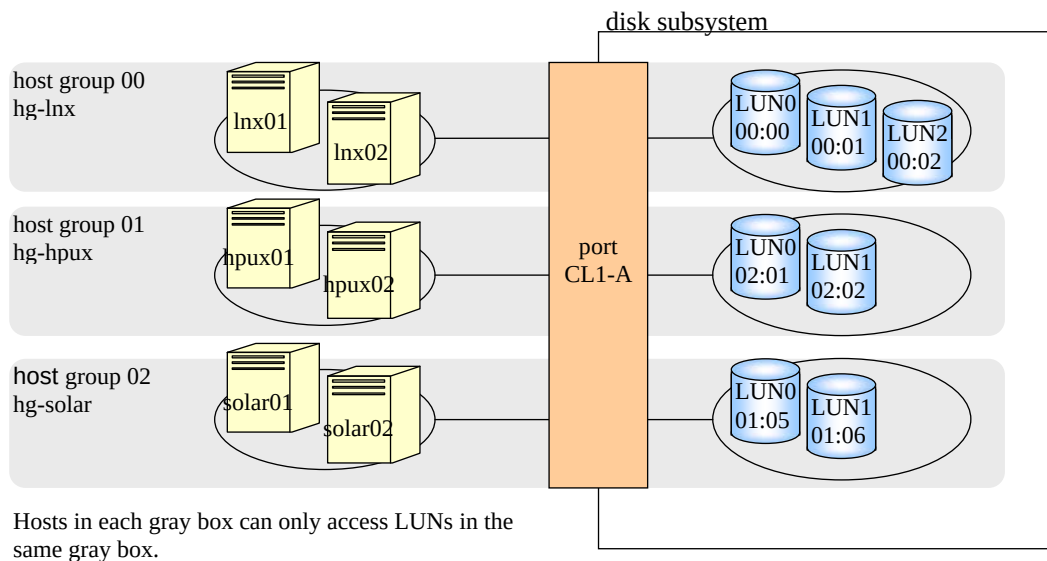
For Fibre channel, the number of connectable hosts is limited to 256 per Fibre port. (FC/FCoE)

For MCU port of TrueCopy function, this limitation is as follows:

The number of MCU connections is limited to 16 per RCU Target port. (only for FC)

THEORY03-32-160**3.32.3.3.2 Number of Host Groups**

You can define a host group admitted access for the some LU by LUN Security as a Host Group. For example, the two hosts in the hg-lnx group can only access the three LUs (00:00, 00:01, and 00:02). The two hosts in the hg-hpux group can only access the two LUs (02:01 and 02:02). The two hosts in the hg-solar group can only access the two LUs (01:05 and 01:06).



3.32.3.3.3 LUN (Logical Unit Number)

LUNs can be assigned from 0 to 2047 to each Fibre Port.

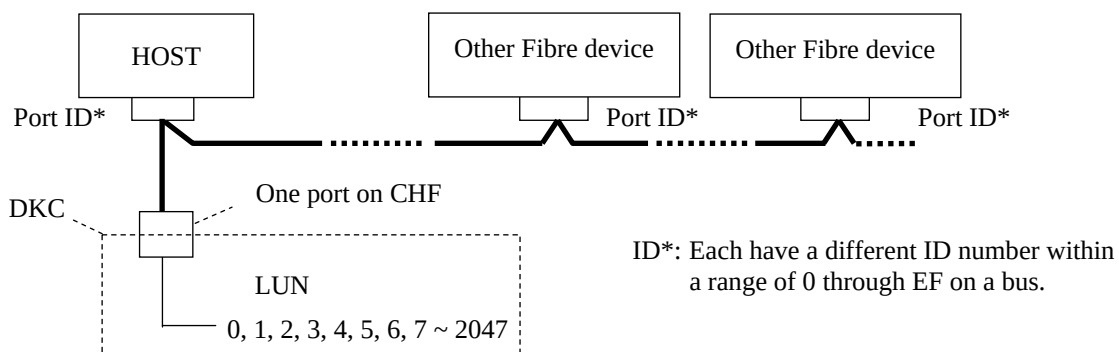


Fig. 3.32.3.3.3-1 Fibre addressing configuration from Host

3.32.3.3.4 PORT INFORMATION

A PORT address and the Topology can be set as PORT INFORMATION. The value of PORT address is EF and can be changed by user. Topology information is selected from “Fabric”, “FC-AL” or “Point to point”. (FCoE supports only “Fabric” and “Point to Point” topology.)

THEORY03-32-180**3.32.3.4 Logical Unit****3.32.3.4.1 Logical Unit Specification**

The specifications of Logical Units supported and accessible from Open system hosts are defined in the Table 3.32.3.4.1-1.

Table 3.32.3.4.1-1 LU specification (1/4)

No	Item		Specification			
1	Volume name		OPEN-3	OPEN-8	OPEN-9	OPEN-E
2	Volume attribute		- OPEN volume - HMBR volume	- OPEN volume - HMBR volume	- OPEN volume - HMBR volume	- SCSI volume
3	Access right	Fibre host	Read/Write	Read/Write	Read/Write	Read/Write
		M/F host	Read/Write (need HMBR option)	Read/Write (need HMBR option)	Read/Write (need HMBR option)	—
4	Logical Unit (LU) size	G byte (10^9)	2.4 GB	7.3 GB	7.3 GB	14.5 GB
		G byte ($1,024^3$)	2.29 GB	6.84 GB	6.87 GB	13.56 GB
5	Block size		512 Bytes	512 Bytes	512 Bytes	512 Bytes
6	# of blocks		4,806,720	14,351,040	14,423,040	28,452,960
7	LDEV emulation name		OPEN-3	OPEN-8	OPEN-9	OPEN-E
8	LDEV size : LU size		1 : 1	1 : 1	1 : 1	1 : 1

Table 3.32.3.4.1-1 LU specification (2/4)

No	Item		Specification				
1	Volume name		OPEN-L	OPEN-V (*1)	3390-3A	3390-3B	3390-3C
2	Volume attribute		- SCSI volume	- SCSI volume	- M/F volume - Cross-OS File Exchange volume	- M/F volume - Cross-OS File Exchange volume	- M/F volume - Cross-OS File Exchange volume
3	Access right	Fibre host	Read/Write	Read/Write	Read/Write (need Cross-OS File Exchange otm/mtio option)	Read only (need Cross-OS File Exchange mtio option)	Read/Write (need Cross-OS File Exchange otm/mtio option)
		M/F host	—	—	Read/Write	Read/Write	Read only
4	Logical Unit (LU) size	G byte (10^9)	36.4 GB	(*1)	—	—	—
		G byte ($1,024^3$)	33.94 GB	(*1)	—	—	—
5	Block size		512 Bytes	512 Bytes	512 Bytes	512 Bytes	512 Bytes
6	# of blocks		71,192,160	(*1)	5,825,520	5,822,040	5,825,520
7	LDEV emulation name		OPEN-L	OPEN-V	3390-3A	3390-3B	3390-3C
8	LDEV size : LU size		1 : 1	1 : 1	1 : 1	1 : 1	1 : 1

*1: OPEN-V is CVS basis. The default capacity of OPEN-V is nearly equals to the size of the parity group. So it depends on RAID level and DKU (HDD).
The capacity is limited by 2.812TB (1024^4), 3.019TB (10^{12}) or 6039,797,248 blocks logically.

*2: “0” is added to the emulation type of the V-VOLs (e.g. OPEN-0V).
When you create a Copy-on-Write Snapshot/Thin Image pair, specify the volume whose emulation type is displayed with “0” like OPEN-0V as the S-VOL.

Table 3.32.3.4.1-1 LU specification (3/4)

No	Item		Specification			
1	Volume name		OPEN-3×n (n=2 to 36)	OPEN-8×n (n=2 to 36)	OPEN-9×n (n=2 to 36)	OPEN-E×n (n=2 to 36)
2	Volume attribute		- LU size expansion	- LU size expansion	- LU size expansion	- LU size expansion
3	Access right	Fibre host	Read/Write	Read/Write	Read/Write	Read/Write
		M/F host	Read/Write (need HMBR option)	Read/Write (need HMBR option)	Read/Write (need HMBR option)	—
4	Logical Unit (LU) size	G byte (10 ⁹)	OPEN-3×n	OPEN-8×n	OPEN-9×n	OPEN-E×n
		G byte (1,024 ³)				
5	Block size		512 Bytes	512 Bytes	512 Bytes	512 Bytes
6	# of blocks		4,806,720×n	14,351,040×n	14,423,040×n	28,452,960×n
7	LDEV emulation name		—	—	—	—
8	LDEV size : LU size		1 : n	1 : n	1 : n	1 : n

Table 3.32.3.4.1-1 LU specification (4/4)

No	Item		Specification	
1	Volume name		OPEN-L×n (n=2 to 36)	OPEN-V×n (Note2) (n=2 to 36)
2	Volume attribute		- LU size expansion	- LU size expansion
3	Access right	Fibre host	Read/Write	Read/Write
		M/F host	—	—
4	Logical Unit (LU) size	G byte (10 ⁹)	OPEN-L×n	OPEN-V×n
		G byte (1,024 ³)		
5	Block size		512 Bytes	512 Bytes
6	# of blocks		71,192,160×n	(*3)
7	LDEV emulation name		—	—
8	LDEV size : LU size		1 : n	1 : n

*3: The maximum size of OPEN-V×n is up to 60TB (1024⁴) or 128,849,011,200 blocks.

3.32.3.4.2 Logical Unit Mapping of Fibre

Each volume name, such as OPEN-3, OPEN-8, OPEN-9, 3390-3A, 3390-3B, 3390-3C, is also used as an emulation type name to be specified for each ECC group. When the emulation type is defined on an ECC group, Logical volumes (LDEVs) are automatically allocated to the ECC group from the specified LDEV#. After creating LDEVs, each LUN of Fibre port will be mapped on any location of LDEV within DKC. This setting is performed by SVP operation or Web Console operation (option).

This flexible LU and LDEV mapping scheme enables the same logical volume to be set to multiple paths so that the host system can configure a shared volume configuration such as a High Availability (HA) configuration. In the shared volume environment, however, some lock mechanism need to be provided by the host systems. (The configuration where a volume is shared with FC and FCoE is not supported.)

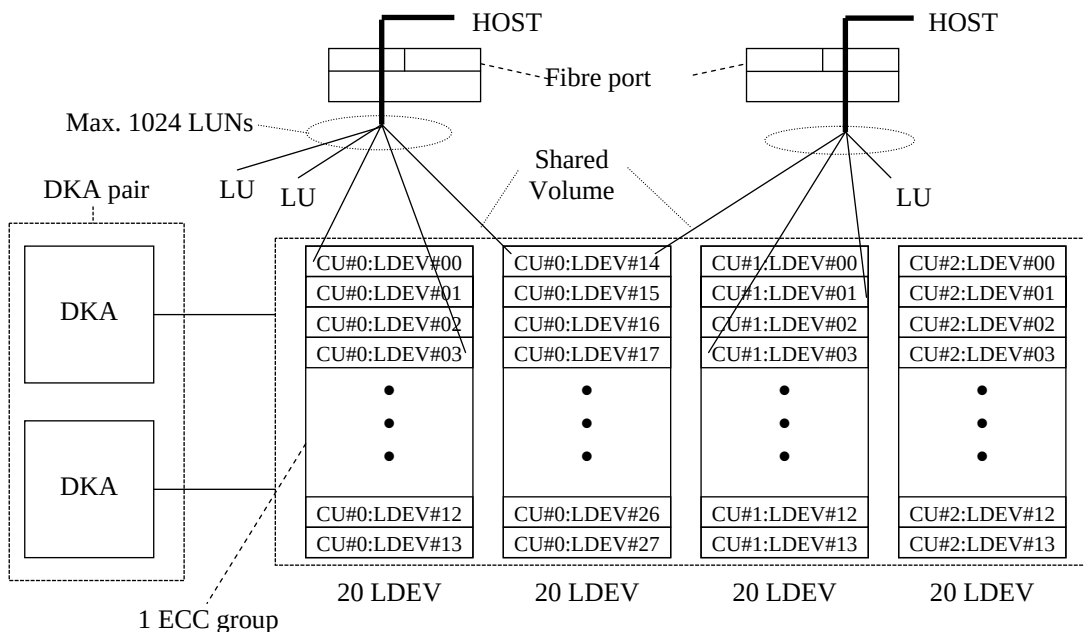


Fig. 3.32.3.4.2-1 LDEV and LU mapping for Fibre volume

3.32.3.4.3 Logical Unit Size Expansion (LUSE) Function

(1) Outline

This is a function to show the host the continuous LDEV of a volume exclusive for open system as a virtually large LU.

In the former configuration, one LU is one LDEV, but this expanding function can enlarge the LU size up to 265.8 G byte using OPEN-9×36 for example by showing the host two or more continuous LDEVs as a single LU.

Many LUs have been needed to cover the entire capacity of a disk subsystem before, but this function enables a small number of LUs to cover it from the viewpoint of host interface.

The MCU port (Initiator port) of TrueCopy function does not support LU size expansion.

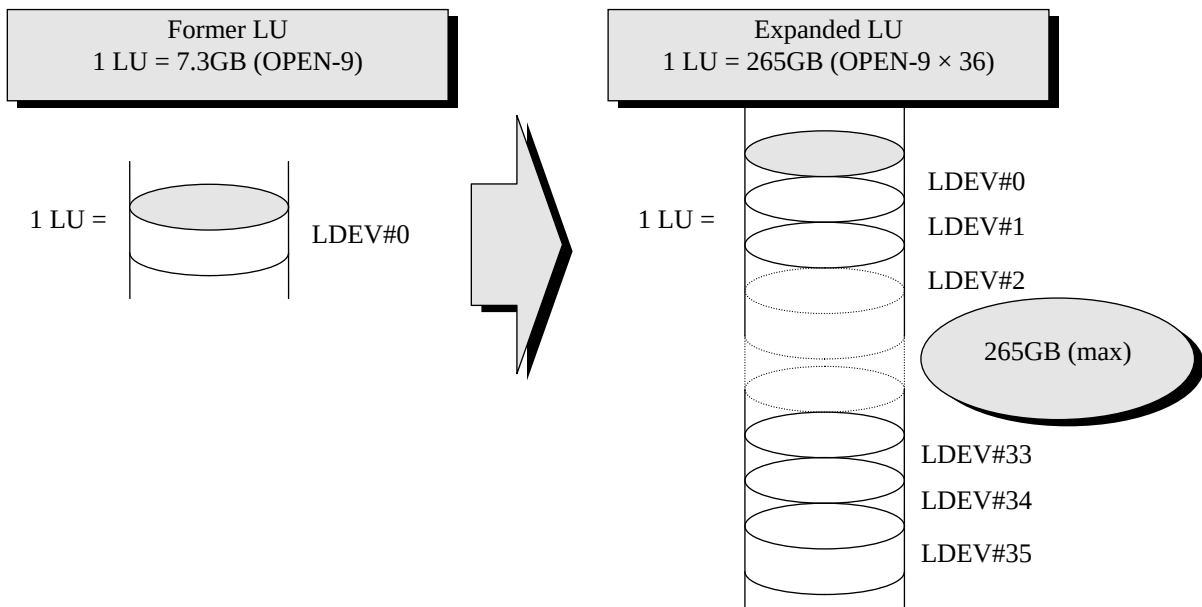


Fig. 3.32.3.4.3-1 Example of LU Size Expansion Function

(2) Specifications

Table 3.32.3.4.3-1 shows specifications for the LUSE. (1 KB = 1024 Byte)

Table 3.32.3.4.3-1 LUSE Specification(1/2)

Base volume	OPEN-3	OPEN-8	OPEN-9	OPEN-E	OPEN-L	OPEN-V (Note1)
LDEV Capacity	2.3 G byte	6.8 G byte	6.9 G byte	13.5 G byte	33.9 G byte	46.0 M byte ~ 2.8 T byte
Number of connectable LDEVs/LU	2 to 36					
LU Capacity	(2.3 G byte + 35 M byte) to 82.5 G byte	(6.8 G byte + 35 M byte) to 246.4 G byte	(6.9 G byte + 35 M byte) to 247.6 G byte	(13.5 G byte + 35 M byte) to 488.4 G byte	67.9 G byte to 1222.1 G byte	92.0 M byte to 60 T byte
Product name for responding to INQUIRY	OPEN-3×n	OPEN-8×n	OPEN-9×n	OPEN-E×n	OPEN-L×n	OPEN-V×n

Table 3.32.3.4.3-1 LUSE Specification(2/2)

Base volume	OPEN-3-CVS	OPEN-8-CVS	OPEN-9-CVS	OPEN-E-CVS
LDEV Capacity	35 M byte to 2.3 G byte	35 M byte to 6.8 G byte	35 M byte to 6.9 G byte	35 M byte to 13.5 G byte
Number of connectable LDEVs/LU	2 to 36			
LU Capacity	70 M byte to 82.5 G byte	70 M byte to 246.4 G byte	70 M byte to 247.6 G byte	70 M byte to 488.4 G byte
Product name for responding to INQUIRY	OPEN-3×n-CVS	OPEN-8×n-CVS	OPEN-9×n-CVS	OPEN-E×n-CVS

n: Number of connected LDEVs

Note1: OPEN-V is the volume of CVS basis.

Note2: LDEVs can be connected with different CU number and capacity though OPEN-L does not have CVS Volume type.

Note3: “0” is added to the emulation type of the V-VOLs (e.g. OPEN-0V).

When you create a Copy-on-Write Snapshot/Thin Image pair, specify the volume whose emulation type is displayed with “0” like OPEN-0V as the S-VOL.

(3) Effects and restrictions of LUSE function

(a) Effects

- Restrictions of usable capacity owing to the number of the usable hosts is released.
 - Restriction of the host capacity
 - Restriction of capacity owing to restriction of the number of LUs of the HA software
- The disk connection function on the host side such as VxVM becomes unnecessary.
- Effect of LU size extending with CV.
 - LU of optional size can be configured.
 - The load of PDEV can be dispersed by the LUSE configuration of CV dispersed in ECC.
 - Performance can be improved by increasing the multiplex frequency of LDEV.

(b) Restrictions

- Some OSs are slow in disk accesses handling large data and may not be usable depending on environment. (Example: AIX is slow in accesses handling data larger than 2GB.)
- The capacity should be determined as necessary in a system designed to achieve a high-speed operation by making the LUs perform multiple operation.

(4) Notes on use

When the LU is expanded, the following restrictions are added to a case where no expansion is made, such as a change in capacity seen from the open host owing to the specification of the expansion.

- (a) The LU size cannot be changed while the LU is being used by the host. If you want to change the LU size, the host must be rebooted once. If the LU size once set is to be changed, shut down the host, change the LU size, then start up the host again.
- (b) If an LU to being used or expanded is reconfigured in a new configuration or as a expanded LU, data which had been used will be lost.
Perform physical replacement work of the disk including data backup, separation of the former LU, LU connection after the configuration change, and restoration of backup data.
- (c) When an LDEV in the LU is blocked, an LU blocking error does not occur unless an access is made to the blocked LDEV. When the access to the blocked LDEV is made, a blocking error occurs in the expanded LU.
- (d) The LUSE volume can be used by the HMBR, however, all the volumes need to be backed up and restored.
- (e) The maintenance procedure when an error such as an LDEV blocking occurs is the same as before. Check the LDEV status from the SVP and perform the maintenance considering the relation between the LDEV and the LU.

3.32.3.4.4 LUN Security

(1) Outline

This function connects various kinds of servers into a segregated, secure environment via the switch in the Fibre channel port, and thus enables the storage and the server to be used in the SAN environment.

The MCU (initiator) port of TrueCopy does not support this function.

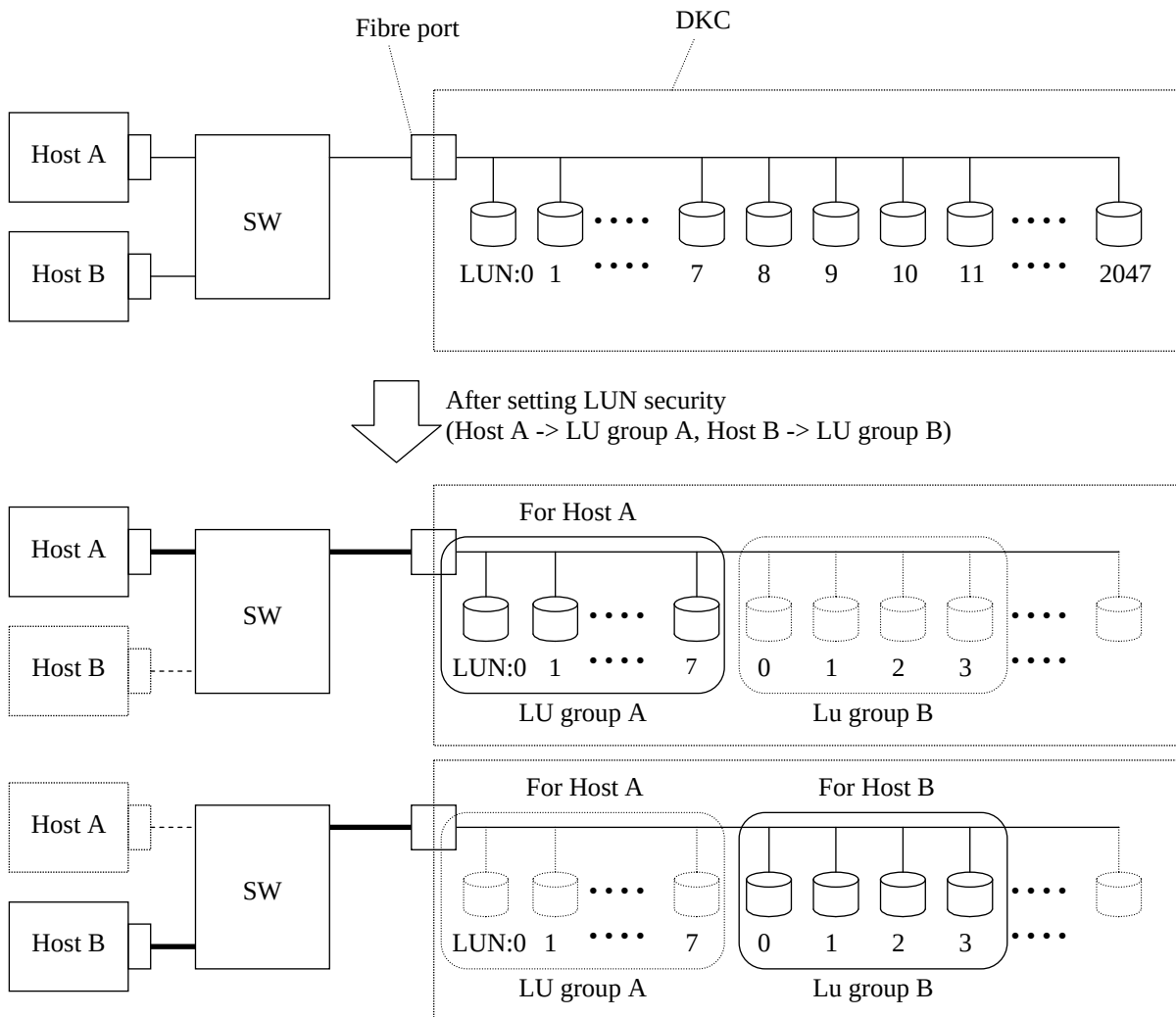


Fig. 3.32.3.4.4-1 LUN Security

THEORY03-32-250**3.32.3.5 Volume Specification****3.32.3.5.1 Volume Specification**

Model Number of Disk drive and supported RAID Level are shown in Table 3.32.3.5.1-1.

The emulation types of disk controller and disk units of DKC710I are shown in Table 3.32.3.5.1-2 and after.

Table 3.32.3.5.1-1 List of DKC710I Model number (1/2)

Model Number	Disk drive model	RAID Level
DKC-F710I-146KCM	DKS5B-K146SS DKS5C-K146SS	RAID1 (2D+2D) RAID5 (3D+1P, 7D+1P) RAID6 (6D+2P, 14D+2P)
DKC-F710I-200SAM	SDT5A-S200SS SDT5C-S200SS	
DKC-F710I-200SCM	SDT5A-S200SS SDT5C-S200SS SLR5A-S200SS SLR5B-S200SS	
DKC-F710I-200MCM	SFB5A-M200SS SLR5B-M200SS SLR5C-M200SS	
DKC-F710I-300JCM	DKR5C-J300SS DKR5D-J300SS DKS5B-J300SS DKS5D-J300SS DKS5E-J300SS	
DKC-F710I-300KCM	DKR5C-K300SS	
DKC-F710I-400SCM	SLR5A-S400SS SLR5B-S400SS	
DKC-F710I-400S1M	SDT2A-S400SS SDT2C-S400SS	
DKC-F710I-400S3M	SDT2A-S400SS SDT2C-S400SS	
DKC-F710I-400MCM	SFB5A-M400SS SLR5B-M400SS SLR5C-M400SS	
DKC-F710I-500HCM	DKS5A-H500SS DKS5B-H500SS	
DKC-F710I-600JCM	DKR5C-J600SS DKR5D-J600SS DKS5C-J600SS DKS5D-J600SS DKS5E-J600SS	
DKC-F710I-800MCM	SFB5A-M800SS SLR5C-M800SS	
DKC-F710I-900JCM	DKR5D-J900SS DKS5D-J900SS DKS5E-J900SS	

Table 3.32.3.5.1-1 List of DKC710I Model number (2/2)

Model Number	Disk drive model	RAID Level
DKC-F710I-1R0HCM	DKS5B-H1R0SS	RAID1 (2D+2D) RAID5 (3D+1P, 7D+1P) RAID6 (6D+2P, 14D+2P)
DKC-F710I-1R2JCM	DKR5E-J1R2SS DKS5F-J1R2SS	
DKC-F710I-1R6FM	NFH1A-P1R6SS NFH1C-P1R6SS	
DKC-F710I-2R0H2M	DKR2C-H2R0AT DKR2D-H2R0AT DKR2E-H2R0AT	
DKC-F710I-2R0H3M	DKS2C-H2R0SS DKS2D-H2R0SD DKS2D-H2R0SS DKS2E-H2R0SS DKS2P-H2R0SS DKW2E-H2R0SS	
DKC-F710I-3R0H3M	DKS2D-H3R0SS DKS2E-H3R0SS DKW2E-H3R0SS	
DKC-F710I-3R2FM	NFH1B-P3R2SS NFH1C-P3R2SS	
DKC-F710I-4R0H3M	DKS2E-H4R0SS DKW2E-H4R0SS	

Note: As for RAID1, the concatenation of two parity groups is possible (8HDDs).

In this case the number of volumes required is doubled.

Two concatenation and four concatenation (16HDDs and 32HDDs) of the RAID Groups are possible for RAID5 (7D+1P).

In this case, the number of volumes becomes twice or four times.

When OPEN-V is set in the parity group of the above-mentioned connection configuration, the maximum volume size becomes the parity cycle size of the source (2D+2D) or (7D+1P). It does not become twice or four times.

Note: The subsystem capacity is different from one of SVP, because of $1\text{GB}=1000^3\text{byte}$ calculation.

THEORY03-32-260**Table 3.32.3.5.1-2 List of DKC710I Model Emulation Types for RAID5 (3D+1P) (1/6)**

Emulation Type	Item	Emulation contents						
	DKC DKU	OPEN-3	OPEN-8	OPEN-9	OPEN-E	OPEN-L	OPEN-V	OPEN-K
Storage capacity (GB/volume)		2,461	7,347	7,384	14,567	36,450	(*1)	1,874
Number of volumes /parity groups	DKC-F710I-146KCM	174	58	58	29	11	1	229
	DKC-F710I-300JCM/KCM	350	117	116	59	23	1	459
	DKC-F710I-600JCM	700	234	233	118	47	1	919
	DKC-F710I-900JCM	1,000	352	350	177	71	1	1,000
	DKC-F710I-1R2JCM	—	—	—	—	—	2	—
	DKC-F710I-200SAM/SCM/MCM	239	80	79	40	16	1	313
	DKC-F710I-400SCM/S1M/S3M/MCM	478	160	159	81	32	1	627
	DKC-F710I-800MCM	957	820	319	162	64	1	1,000
	DKC-F710I-500HCM	598	200	199	101	40	1	784
	DKC-F710I-1R0HCM	—	—	—	—	—	1	—
	DKC-F710I-2R0H2M	—	—	—	—	—	2	—
	DKC-F710I-2R0H3M	—	—	—	—	—	2	—
	DKC-F710I-3R0H3M	—	—	—	—	—	3	—
	DKC-F710I-4R0H3M	—	—	—	—	—	4	—
	DKC-F710I-1R6FM	—	—	—	—	—	2	—
	DKC-F710I-3R2FM	—	—	—	—	—	4	—
Maximum number of parity groups	DKC-F710I-146KCM	375	511	511	511	511	511	285
	DKC-F710I-300JCM/KCM	186	511	511	511	511	511	142
	DKC-F710I-600JCM	93	278	280	511	511	511	71
	DKC-F710I-900JCM	65	185	186	368	511	511	65
	DKC-F710I-1R2JCM	—	—	—	—	—	511	—
	DKC-F710I-200SAM/SCM/MCM	64	64	64	64	64	64	64
	DKC-F710I-400SCM/S1M/S3M/MCM	64	64	64	64	64	64	64
	DKC-F710I-800MCM	64	64	64	64	64	64	64
	DKC-F710I-500HCM	109	326	328	511	511	511	83
	DKC-F710I-1R0HCM	—	—	—	—	—	511	—
	DKC-F710I-2R0H2M	—	—	—	—	—	319	—
	DKC-F710I-2R0H3M	—	—	—	—	—	319	—
	DKC-F710I-3R0H3M	—	—	—	—	—	319	—
	DKC-F710I-4R0H3M	—	—	—	—	—	319	—
	DKC-F710I-1R6FM	—	—	—	—	—	47	—
	DKC-F710I-3R2FM	—	—	—	—	—	47	—
Maximum number of volumes	DKC-F710I-146KCM	65,250	29,638	29,638	14,819	5,621	511	65,265
	DKC-F710I-300JCM/KCM	65,100	59,787	59,276	30,149	11,753	511	65,178
	DKC-F710I-600JCM	65,100	65,052	65,240	60,298	24,017	511	65,249
	DKC-F710I-900JCM	65,000	65,120	65,100	65,136	36,281	511	65,000
	DKC-F710I-1R2JCM	—	—	—	—	—	1,022	—
	DKC-F710I-200SAM/SCM/MCM	15,296	5,120	5,056	2,560	1,024	64	20,032
	DKC-F710I-400SCM/S1M/S3M/MCM	30,592	10,240	10,176	5,184	2,048	64	40,128
	DKC-F710I-800MCM	61,248	20,480	20,416	10,368	4,096	64	64,000
	DKC-F710I-500HCM	65,182	65,200	65,272	51,611	20,440	511	65,072
	DKC-F710I-1R0HCM	—	—	—	—	—	511	—
	DKC-F710I-2R0H2M	—	—	—	—	—	638	—
	DKC-F710I-2R0H3M	—	—	—	—	—	638	—
	DKC-F710I-3R0H3M	—	—	—	—	—	957	—
	DKC-F710I-4R0H3M	—	—	—	—	—	1,276	—
	DKC-F710I-1R6FM	—	—	—	—	—	94	—
	DKC-F710I-3R2FM	—	—	—	—	—	188	—

THEORY03-32-261**Table 3.32.3.5.1-2 List of DKC710I Model Emulation Types for RAID5 (3D+1P) (2/6)**

Emulation Type	Item		Emulation contents						
	DKC DKU		OPEN-3	OPEN-8	OPEN-9	OPEN-E	OPEN-L	OPEN-V	OPEN-K
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	Min	428	426	428	422	401	431	429
		Max	160,580	217,750	218,847	215,868	204,885	220,343	122,307
	DKC-F710I-300JCM/KCM	Min	861	860	857	859	838	865	860
		Max	160,211	439,255	437,694	439,180	428,397	441,760	122,144
	DKC-F710I-600JCM	Min	1,723	1,719	1,720	1,719	1,713	1,729	1,722
		Max	160,211	477,937	481,732	878,361	875,420	883,570	122,277
	DKC-F710I-900JCM	Min	2,461	2,586	2,584	2,578	2,588	2,953	1,874
		Max	159,965	478,437	480,698	948,836	1,322,442	1,325,483	121,810
	DKC-F710I-1R2JCM	Min	—	—	—	—	—	3,458	—
		Max	—	—	—	—	—	1,767,191	—
	DKC-F710I-200SAM/SCM/MCM	Min	588	588	583	583	583	591	587
		Max	37,643	37,617	37,334	37,292	37,325	37,805	37,540
	DKC-F710I-400SCM/S1M/S3M/MCM	Min	1,176	1,176	1,174	1,180	1,166	1,182	1,175
		Max	75,287	75,233	75,140	75,515	74,650	75,616	75,200
	DKC-F710I-800MCM	Min	2,355	2,351	2,355	2,360	2,333	2,363	1,874
		Max	150,731	150,467	150,752	151,031	149,299	151,232	119,936
	DKC-F710I-500HCM	Min	1,472	1,469	1,469	1,471	1,458	1,477	1,469
		Max	160,413	479,024	481,968	751,817	745,038	754,696	121,945
	DKC-F710I-1R0HCM	Min	—	—	—	—	—	2,954	—
		Max	—	—	—	—	—	1,509,698	—
	DKC-F710I-2R0H2M	Min	—	—	—	—	—	5,908	—
		Max	—	—	—	—	—	1,884,652 (1,884,846) (*2)	—
	DKC-F710I-2R0H3M	Min	—	—	—	—	—	5,874	—
		Max	—	—	—	—	—	1,873,870	—
	DKC-F710I-3R0H3M	Min	—	—	—	—	—	8,811	—
		Max	—	—	—	—	—	2,810,805	—
	DKC-F710I-4R0H3M	Min	—	—	—	—	—	11,748	—
		Max	—	—	—	—	—	3,747,740	—
	DKC-F710I-1R6FM	Min	—	—	—	—	—	5,278	—
		Max	—	—	—	—	—	248,047	—
	DKC-F710I-3R2FM	Min	—	—	—	—	—	10,555	—
		Max	—	—	—	—	—	496,099	—

THEORY03-32-270**Table 3.32.3.5.1-2 List of DKC710I Model Emulation Types for RAID5 (3D+1P) (3/6)**

Emulation Type	Item	Emulation contents			
		I-2105 / 2107			
		3390-9	3390-3/3R	3390-L	3390-M
Storage capacity (GB/volume)		8,510 (*3)	2,838 (*3)	27.8 (*3)	55,689 (*3)
Number of volumes /parity groups	DKC-F710I-146KCM	48	144	14	7
	DKC-F710I-300JCM/KCM	96	290	29	14
	DKC-F710I-600JCM	193	580	59	29
	DKC-F710I-900JCM	289	870	88	44
	DKC-F710I-1R2JCM	—	—	—	59
	DKC-F710I-200SAM/SCM/MCM	66	198	20	10
	DKC-F710I-400SCM/S1M/S3M/MCM	132	396	40	20
	DKC-F710I-800MCM	264	792	80	40
	DKC-F710I-500HCM	165	495	50	25
	DKC-F710I-1R0HCM	—	—	—	50
	DKC-F710I-2R0H2M	—	—	—	100
	DKC-F710I-2R0H3M	—	—	—	100
	DKC-F710I-3R0H3M	—	—	—	150
	DKC-F710I-4R0H3M	—	—	—	201
	DKC-F710I-1R6FM	—	—	—	90
	DKC-F710I-3R2FM	—	—	—	180
Maximum number of parity groups	DKC-F710I-146KCM	511	453	511	511
	DKC-F710I-300JCM/KCM	511	225	511	511
	DKC-F710I-600JCM	338	112	511	511
	DKC-F710I-900JCM	225	75	511	511
	DKC-F710I-1R2JCM	—	—	—	511
	DKC-F710I-200SAM/SCM/MCM	64	64	64	64
	DKC-F710I-400SCM/S1M/S3M/MCM	64	64	64	64
	DKC-F710I-800MCM	64	64	64	64
	DKC-F710I-500HCM	395	131	511	511
	DKC-F710I-1R0HCM	—	—	—	511
	DKC-F710I-2R0H2M	—	—	—	319
	DKC-F710I-2R0H3M	—	—	—	319
	DKC-F710I-3R0H3M	—	—	—	319
	DKC-F710I-4R0H3M	—	—	—	319
	DKC-F710I-1R6FM	—	—	—	47
	DKC-F710I-3R2FM	—	—	—	47
Maximum number of volumes	DKC-F710I-146KCM	24,528	65,232	7,154	3,577
	DKC-F710I-300JCM/KCM	49,056	65,250	14,819	7,154
	DKC-F710I-600JCM	65,234	64,960	30,149	14,819
	DKC-F710I-900JCM	65,025	65,250	44,968	22,484
	DKC-F710I-1R2JCM	—	—	—	30,149
	DKC-F710I-200SAM/SCM/MCM	4,224	12,672	1,280	640
	DKC-F710I-400SCM/S1M/S3M/MCM	8,448	25,344	2,560	1,280
	DKC-F710I-800MCM	16,896	50,688	5,120	2,560
	DKC-F710I-500HCM	65,175	64,845	25,550	12,775
	DKC-F710I-1R0HCM	—	—	—	25,550
	DKC-F710I-2R0H2M	—	—	—	31,900
	DKC-F710I-2R0H3M	—	—	—	31,900
	DKC-F710I-3R0H3M	—	—	—	47,850
	DKC-F710I-4R0H3M	—	—	—	64,119
	DKC-F710I-1R6FM	—	—	—	4,230
	DKC-F710I-3R2FM	—	—	—	8,460

Table 3.32.3.5.1-2 List of DKC710I Model Emulation Types for RAID5 (3D+1P) (4/6)

Emulation Type	Item		Emulation contents			
	DKC		I-2105 / 2107			
	DKU		3390-9	3390-3/3R	3390-L	3390-M
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	Min	428	409	389	390
		Max	208,733	185,128	198,881	199,200
	DKC-F710I-300JCM/KCM	Min	817	823	806	780
		Max	417,467	185,180	411,968	398,399
	DKC-F710I-600JCM	Min	1,642	1,646	1,640	1,615
		Max	555,141	184,356	838,142	825,255
	DKC-F710I-900JCM	Min	2,459	2,469	2,446	2,450
		Max	555,363	185,180	1,250,110	1,252,111
	DKC-F710I-1R2JCM	Min	—	—	—	3,286
		Max	—	—	—	1,678,968
	DKC-F710I-200SAM/SCM/MCM	Min	562	562	556	557
		Max	35,946	35,963	35,584	35,641
	DKC-F710I-400SCM/S1M/S3M/MCM	Min	1,123	1,124	1,112	1,114
		Max	71,892	71,926	71,168	71,282
	DKC-F710I-800MCM	Min	2,247	2,248	2,224	2,228
		Max	143,785	143,853	142,336	142,564
	DKC-F710I-500HCM	Min	1,472	1,405	1,390	1,392
		Max	581,622	184,030	710,290	711,427
	DKC-F710I-1R0HCM	Min	—	—	—	2,784
		Max	—	—	—	1,422,854
	DKC-F710I-2R0H2M	Min	—	—	—	5,569
		Max	—	—	—	1,776,479
	DKC-F710I-2R0H3M	Min	—	—	—	5,569
		Max	—	—	—	1,776,479
	DKC-F710I-3R0H3M	Min	—	—	—	8,353
		Max	—	—	—	2,664,719
	DKC-F710I-4R0H3M	Min	—	—	—	11,193
		Max	—	—	—	3,570,723
	DKC-F710I-1R6FM	Min	—	—	—	5,012
		Max	—	—	—	235,564
	DKC-F710I-3R2FM	Min	—	—	—	10,024
		Max	—	—	—	471,129

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Table 3.32.3.5.1-2 List of DKC710I Model Emulation Types for RAID5 (3D+1P) (5/6)

Emulation Type	Item	Emulation contents					
	DKC DKU	3390-A	3390-A (3 type)	I-2107 3390-A (9 type)	3390-A (L type)	3390-A (M type)	— 3390-V
Storage capacity (GB/volume)		223.257 (*3)	2.838 (*3)	8.514 (*3)	27.844 (*3)	55.689 (*3)	712.062 (*3)
Number of volumes /parity groups	DKC-F710I-146KCM	1	144	48	14	7	1
	DKC-F710I-300JCM/KCM	3	288	96	28	14	1
	DKC-F710I-600JCM	7	493	192	57	29	2
	DKC-F710I-900JCM	11	866	288	86	44	3
	DKC-F710I-1R2JCM	14	—	—	—	58	4
	DKC-F710I-200SAM/SCM/MCM	2	197	65	19	10	1
	DKC-F710I-400SCM/S1M/S3M/MCM	5	394	131	39	20	1
	DKC-F710I-800MCM	10	789	263	78	40	3
	DKC-F710I-500HCM	6	493	164	49	25	1
	DKC-F710I-1R0HCM	12	—	—	—	50	3
	DKC-F710I-2R0H2M	25	—	—	—	100	7
	DKC-F710I-2R0H3M	24	—	—	—	99	7
	DKC-F710I-3R0H3M	37	—	—	—	149	11
	DKC-F710I-4R0H3M	49	—	—	—	199	15
	DKC-F710I-1R6FM	22	—	—	—	89	7
Maximum number of parity groups	DKC-F710I-3R2FM	44	—	—	—	179	14
	DKC-F710I-146KCM	511	453	511	511	511	511
	DKC-F710I-300JCM/KCM	511	226	511	511	511	511
	DKC-F710I-600JCM	511	132	340	511	511	511
	DKC-F710I-900JCM	511	75	226	511	511	511
	DKC-F710I-1R2JCM	511	—	—	—	511	511
	DKC-F710I-200SAM/SCM/MCM	64	64	64	64	64	64
	DKC-F710I-400SCM/S1M/S3M/MCM	64	64	64	64	64	64
	DKC-F710I-800MCM	64	64	64	64	64	64
	DKC-F710I-500HCM	511	132	398	511	511	511
	DKC-F710I-1R0HCM	511	—	—	—	511	511
	DKC-F710I-2R0H2M	319	—	—	—	319	319
	DKC-F710I-2R0H3M	319	—	—	—	319	319
	DKC-F710I-3R0H3M	319	—	—	—	319	319
	DKC-F710I-4R0H3M	319	—	—	—	319	319
Maximum number of volumes	DKC-F710I-1R6FM	47	—	—	—	47	47
	DKC-F710I-3R2FM	47	—	—	—	47	47
	DKC-F710I-146KCM	511	65,232	24,528	7,154	3,577	511
	DKC-F710I-300JCM/KCM	1,533	65,088	49,056	14,308	7,154	511
	DKC-F710I-600JCM	3,577	65,076	65,280	29,127	14,819	1,022
	DKC-F710I-900JCM	5,621	64,950	65,088	43,946	22,484	1,533
	DKC-F710I-1R2JCM	7,154	—	—	—	29,638	2,044
	DKC-F710I-200SAM/SCM/MCM	128	12,608	4,160	1,216	640	64
	DKC-F710I-400SCM/S1M/S3M/MCM	320	25,216	8,384	2,496	1,280	64
	DKC-F710I-800MCM	640	50,496	16,832	4,992	2,560	192
	DKC-F710I-500HCM	3,066	65,076	65,272	25,039	12,775	511
	DKC-F710I-1R0HCM	6,132	—	—	—	25,550	1,533
	DKC-F710I-2R0H2M	7,975	—	—	—	31,900	2,233
	DKC-F710I-2R0H3M	7,656	—	—	—	31,581	2,233
	DKC-F710I-3R0H3M	11,803	—	—	—	47,531	3,509
	DKC-F710I-4R0H3M	15,631	—	—	—	63,481	4,785
	DKC-F710I-1R6FM	1,034	—	—	—	4,183	329
	DKC-F710I-3R2FM	2,068	—	—	—	8,413	658

Table 3.32.3.5.1-2 List of DKC710I Model Emulation Types for RAID5 (3D+1P) (6/6)

Emulation Type	Item		Emulation contents					
	DKC		I-2107					—
	DKU		3390-A	3390-A (3 type)	3390-A (9 type)	3390-A (L type)	3390-A (M type)	3390-V
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	Min	223	409	409	390	390	712
		Max	114,084	185,128	208,831	199,196	199,200	363,864
	DKC-F710I-300JCM/KCM	Min	670	817	817	780	780	712
		Max	342,253	184,720	417,663	398,392	398,399	363,864
	DKC-F710I-600JCM	Min	1,563	1,399	1,635	1,587	1,615	1,424
		Max	798,590	184,686	555,794	811,012	825,255	727,727
	DKC-F710I-900JCM	Min	2,456	2,458	2,452	2,395	2,450	2,136
		Max	1,254,928	184,328	554,159	1,223,632	1,252,111	1,091,591
	DKC-F710I-1R2JCM	Min	3,126	—	—	—	3,230	2,848
		Max	1,597,181	—	—	—	1,650,511	1,455,455
	DKC-F710I-200SAM/SCM/MCM	Min	447	559	553	529	557	712
		Max	28,577	35,782	35,418	33,858	35,641	45,572
	DKC-F710I-400SCM/S1M/S3M/MCM	Min	1,116	1,118	1,115	1,086	1,114	712
		Max	71,442	71,563	71,381	69,449	71,282	45,572
	DKC-F710I-800MCM	Min	2,233	2,239	2,239	2,172	2,228	2,136
		Max	142,884	143,308	143,308	138,997	142,564	136,716
	DKC-F710I-500HCM	Min	1,340	1,399	1,396	1,364	1,392	712
		Max	684,506	184,686	555,726	697,186	711,427	363,864
	DKC-F710I-1R0HCM	Min	2,679	—	—	—	2,784	2,136
		Max	1,369,012	—	—	—	1,422,854	1,091,591
	DKC-F710I-2R0H2M	Min	5,581	—	—	—	5,569	4,984
		Max	1,780,475	—	—	—	1,776,479	1,590,034
	DKC-F710I-2R0H3M	Min	5,358	—	—	—	5,513	4,984
		Max	1,709,256	—	—	—	1,758,714	1,590,034
	DKC-F710I-3R0H3M	Min	8,261	—	—	—	8,298	7,833
		Max	2,635,102	—	—	—	2,646,954	2,498,626
	DKC-F710I-4R0H3M	Min	10,940	—	—	—	11,082	10,681
		Max	3,489,730	—	—	—	3,535,193	3,407,217
	DKC-F710I-1R6FM	Min	4,912	—	—	—	4,956	4,984
		Max	230,848	—	—	—	232,947	234,268
	DKC-F710I-3R2FM	Min	9,823	—	—	—	9,968	9,969
		Max	461,695	—	—	—	468,512	468,537

- *1: The value of OPEN-V is the default one in the installation of parity group. In case of OPEN-V, storage capacity differs depending on RAID level and DKU (HDD) type because OPEN-V is CVS basis. The default volume size is nearly equal to that of a parity group.
- *2: The value in parentheses is capacity of the parity group with SATA W&V (Write & Verify) improved.
- *3: The value is the capacity for Main Frame Host.

THEORY03-32-300**Table 3.32.3.5.1-3 List of DKC710I Model Emulation Types for RAID5 (7D+1P) (1/6)**

Emulation Type	Item	Emulation contents						
	DKC DKU	OPEN-3	OPEN-8	OPEN-9	— OPEN-E	OPEN-L	OPEN-V	OPEN-K
Storage capacity (GB/volume)		2,461	7,347	7,384	14,567	36,450	(*1)	1,874
Number of volumes /parity groups	DKC-F710I-146KCM	407	136	135	69	27	1	534
	DKC-F710I-300JCM/KCM	817	273	272	138	55	1	1,071
	DKC-F710I-600JCM	1,634	547	544	276	110	2	2,000
	DKC-F710I-900JCM	2,000	821	817	415	166	2	2,000
	DKC-F710I-1R2JCM	—	—	—	—	—	3	—
	DKC-F710I-200SAM/SCM/MCM	558	187	186	94	37	1	732
	DKC-F710I-400SCM/S1M/S3M/MCM	1,116	374	372	189	75	1	1,464
	DKC-F710I-800MCM	2,000	748	744	378	151	2	2,000
	DKC-F710I-500HCM	1,395	467	465	236	94	2	1,830
	DKC-F710I-1R0HCM	—	—	—	—	—	3	—
	DKC-F710I-2R0H2M	—	—	—	—	—	5	—
	DKC-F710I-2R0H3M	—	—	—	—	—	5	—
	DKC-F710I-3R0H3M	—	—	—	—	—	7	—
	DKC-F710I-4R0H3M	—	—	—	—	—	9	—
	DKC-F710I-1R6FM	—	—	—	—	—	4	—
	DKC-F710I-3R2FM	—	—	—	—	—	8	—
Maximum number of parity groups	DKC-F710I-146KCM	160	255	255	255	255	255	122
	DKC-F710I-300JCM/KCM	79	239	240	255	255	255	60
	DKC-F710I-600JCM	39	119	120	236	255	255	32
	DKC-F710I-900JCM	32	79	79	157	255	255	32
	DKC-F710I-1R2JCM	—	—	—	—	—	255	—
	DKC-F710I-200SAM/SCM/MCM	32	32	32	32	32	32	32
	DKC-F710I-400SCM/S1M/S3M/MCM	32	32	32	32	32	32	32
	DKC-F710I-800MCM	32	32	32	32	32	32	32
	DKC-F710I-500HCM	46	139	140	255	255	255	35
	DKC-F710I-1R0HCM	—	—	—	—	—	255	—
	DKC-F710I-2R0H2M	—	—	—	—	—	159	—
	DKC-F710I-2R0H3M	—	—	—	—	—	159	—
	DKC-F710I-3R0H3M	—	—	—	—	—	159	—
	DKC-F710I-4R0H3M	—	—	—	—	—	159	—
	DKC-F710I-1R6FM	—	—	—	—	—	23	—
	DKC-F710I-3R2FM	—	—	—	—	—	23	—
Maximum number of volumes	DKC-F710I-146KCM	65,120	34,680	34,425	17,595	6,885	255	65,148
	DKC-F710I-300JCM/KCM	64,543	65,247	65,280	35,190	14,025	255	64,260
	DKC-F710I-600JCM	63,726	65,093	65,280	65,136	28,050	510	64,000
	DKC-F710I-900JCM	64,000	64,859	64,543	65,155	42,330	510	64,000
	DKC-F710I-1R2JCM	—	—	—	—	—	765	—
	DKC-F710I-200SAM/SCM/MCM	17,856	5,984	5,952	3,008	1,184	32	23,424
	DKC-F710I-400SCM/S1M/S3M/MCM	35,712	11,968	11,904	6,048	2,400	32	46,848
	DKC-F710I-800MCM	64,000	23,936	23,808	12,096	4,832	64	64,000
	DKC-F710I-500HCM	64,170	64,913	65,100	60,180	23,970	510	64,050
	DKC-F710I-1R0HCM	—	—	—	—	—	765	—
	DKC-F710I-2R0H2M	—	—	—	—	—	795	—
	DKC-F710I-2R0H3M	—	—	—	—	—	795	—
	DKC-F710I-3R0H3M	—	—	—	—	—	1,113	—
	DKC-F710I-4R0H3M	—	—	—	—	—	1,431	—
	DKC-F710I-1R6FM	—	—	—	—	—	92	—
	DKC-F710I-3R2FM	—	—	—	—	—	184	—

THEORY03-32-301**Table 3.32.3.5.1-3 List of DKC710I Model Emulation Types for RAID5 (7D+1P) (2/6)**

Emulation Type	Item		Emulation contents						
	DKC DKU		OPEN-3	OPEN-8	OPEN-9	OPEN-E	OPEN-L	OPEN-V	OPEN-K
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	Min	1,002	999	997	1,005	984	1,006	1,001
		Max	160,260	254,794	254,194	256,306	250,958	256,607	122,087
	DKC-F710I-300JCM/KCM	Min	2,011	2,006	2,008	2,010	2,005	2,017	2,007
		Max	158,840	479,370	482,028	512,613	511,211	514,412	120,423
	DKC-F710I-600JCM	Min	4,021	4,019	4,017	4,020	4,010	4,035	3,748
		Max	156,830	478,238	482,028	948,836	1,022,423	1,028,849	119,936
	DKC-F710I-900JCM	Min	4,922	6,032	6,033	6,045	6,051	6,053	3,748
		Max	157,504	476,519	476,586	949,113	1,542,929	1,543,388	119,936
	DKC-F710I-1R2JCM	Min	—	—	—	—	—	8,070	—
		Max	—	—	—	—	—	2,057,723	—
	DKC-F710I-200SAM/SCM/MCM	Min	1,373	1,374	1,373	1,369	1,349	1,378	1,372
		Max	43,944	43,964	43,950	43,818	43,157	44,109	43,897
	DKC-F710I-400SCM/S1M/S3M/MCM	Min	2,746	2,748	2,747	2,753	2,734	2,757	2,744
		Max	87,887	87,929	87,899	88,101	87,480	88,221	87,793
	DKC-F710I-800MCM	Min	4,922	5,496	5,494	5,506	5,504	5,514	3,748
		Max	157,504	175,858	175,798	176,202	176,126	176,442	119,936
	DKC-F710I-500HCM	Min	3,433	3,431	3,434	3,438	3,426	3,446	3,429
		Max	157,922	476,916	480,698	876,642	873,707	878,756	120,030
	DKC-F710I-1R0HCM	Min	—	—	—	—	—	6,892	—
		Max	—	—	—	—	—	1,757,537	—
	DKC-F710I-2R0H2M	Min	—	—	—	—	—	13,786	—
		Max	—	—	—	—	—	2,191,974 (2,192,103) (*2)	—
	DKC-F710I-2R0H3M	Min	—	—	—	—	—	13,707	—
		Max	—	—	—	—	—	2,179,334	—
	DKC-F710I-3R0H3M	Min	—	—	—	—	—	20,560	—
		Max	—	—	—	—	—	3,268,992	—
	DKC-F710I-4R0H3M	Min	—	—	—	—	—	27,413	—
		Max	—	—	—	—	—	4,358,667	—
	DKC-F710I-1R6FM	Min	—	—	—	—	—	12,315	—
		Max	—	—	—	—	—	283,234	—
	DKC-F710I-3R2FM	Min	—	—	—	—	—	24,629	—
		Max	—	—	—	—	—	566,467	—

THEORY03-32-310**Table 3.32.3.5.1-3 List of DKC710I Model Emulation Types for RAID5 (7D+1P) (3/6)**

Emulation Type	Item	Emulation contents			
	DKC	I-2105 / 2107			
	DKU	3390-9	3390-3/3R	3390-L	3390-M
Storage capacity (GB/volume)		8,510 (*3)	2,838 (*3)	27.8 (*3)	55,689 (*3)
Number of volumes /parity groups	DKC-F710I-146KCM	112	337	34	17
	DKC-F710I-300JCM/KCM	225	676	69	34
	DKC-F710I-600JCM	450	1,353	138	69
	DKC-F710I-900JCM	676	2,000	207	103
	DKC-F710I-1R2JCM	—	—	—	138
	DKC-F710I-200SAM/SCM/MCM	154	462	47	23
	DKC-F710I-400SCM/S1M/S3M/MCM	308	925	94	47
	DKC-F710I-800MCM	616	1,850	188	94
	DKC-F710I-500HCM	385	1,156	117	58
	DKC-F710I-1R0HCM	—	—	—	117
	DKC-F710I-2R0H2M	—	—	—	235
	DKC-F710I-2R0H3M	—	—	—	234
	DKC-F710I-3R0H3M	—	—	—	351
	DKC-F710I-4R0H3M	—	—	—	469
	DKC-F710I-1R6FM	—	—	—	210
	DKC-F710I-3R2FM	—	—	—	421
Maximum number of parity groups	DKC-F710I-146KCM	255	193	255	255
	DKC-F710I-300JCM/KCM	255	96	255	255
	DKC-F710I-600JCM	145	48	255	255
	DKC-F710I-900JCM	96	32	255	255
	DKC-F710I-1R2JCM	—	—	—	255
	DKC-F710I-200SAM/SCM/MCM	32	32	32	32
	DKC-F710I-400SCM/S1M/S3M/MCM	32	32	32	32
	DKC-F710I-800MCM	32	32	32	32
	DKC-F710I-500HCM	169	56	255	255
	DKC-F710I-1R0HCM	—	—	—	255
	DKC-F710I-2R0H2M	—	—	—	159
	DKC-F710I-2R0H3M	—	—	—	159
	DKC-F710I-3R0H3M	—	—	—	159
	DKC-F710I-4R0H3M	—	—	—	139
	DKC-F710I-1R6FM	—	—	—	23
	DKC-F710I-3R2FM	—	—	—	23
Maximum number of volumes	DKC-F710I-146KCM	28,560	65,041	8,670	4,335
	DKC-F710I-300JCM/KCM	57,375	64,896	17,595	8,670
	DKC-F710I-600JCM	65,250	64,944	35,190	17,595
	DKC-F710I-900JCM	64,896	64,000	52,785	26,256
	DKC-F710I-1R2JCM	—	—	—	35,190
	DKC-F710I-200SAM/SCM/MCM	4,928	14,784	1,504	736
	DKC-F710I-400SCM/S1M/S3M/MCM	9,856	29,600	3,008	1,504
	DKC-F710I-800MCM	19,712	59,200	6,016	3,008
	DKC-F710I-500HCM	65,065	64,736	29,835	14,790
	DKC-F710I-1R0HCM	—	—	—	29,835
	DKC-F710I-2R0H2M	—	—	—	37,365
	DKC-F710I-2R0H3M	—	—	—	37,206
	DKC-F710I-3R0H3M	—	—	—	55,809
	DKC-F710I-4R0H3M	—	—	—	65,191
	DKC-F710I-1R6FM	—	—	—	4,830
	DKC-F710I-3R2FM	—	—	—	9,683

Table 3.32.3.5.1-3 List of DKC710I Model Emulation Types for RAID5 (7D+1P) (4/6)

Emulation Type	Item		Emulation contents			
	DKC		I-2105 / 2107			
	DKU		3390-9	3390-3/3R	3390-L	3390-M
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	Min	953	956	945	947
		Max	243,064	184,586	241,026	241,412
	DKC-F710I-300JCM/KCM	Min	1,914	1,918	1,918	1,893
		Max	488,261	184,175	489,141	482,824
	DKC-F710I-600JCM	Min	3,830	3,840	3,836	3,843
		Max	555,278	184,311	987,282	488,003
	DKC-F710I-900JCM	Min	5,753	5,676	5,755	5,736
		Max	552,265	181,632	1,467,423	1,462,672
	DKC-F710I-1R2JCM	Min	—	—	—	7,685
		Max	—	—	—	1,959,696
	DKC-F710I-200SAM/SCM/MCM	Min	1,311	1,311	1,307	1,281
		Max	41,937	41,957	41,811	40,987
	DKC-F710I-400SCM/S1M/S3M/MCM	Min	2,621	2,625	2,613	2,617
		Max	83,875	84,005	83,622	83,756
	DKC-F710I-800MCM	Min	5,242	5,250	5,226	5,235
		Max	167,749	168,010	167,245	167,513
	DKC-F710I-500HCM	Min	3,276	3,281	3,253	3,230
		Max	553,703	183,721	829,413	823,640
	DKC-F710I-1R0HCM	Min	—	—	—	6,516
		Max	—	—	—	1,661,481
	DKC-F710I-2R0H2M	Min	—	—	—	13,087
		Max	—	—	—	2,080,819
	DKC-F710I-2R0H3M	Min	—	—	—	13,031
		Max	—	—	—	2,071,965
	DKC-F710I-3R0H3M	Min	—	—	—	19,547
		Max	—	—	—	3,107,947
	DKC-F710I-4R0H3M	Min	—	—	—	26,118
		Max	—	—	—	3,630,422
	DKC-F710I-1R6FM	Min	—	—	—	11,695
		Max	—	—	—	268,978
	DKC-F710I-3R2FM	Min	—	—	—	23,445
		Max	—	—	—	539,237

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Table 3.32.3.5.1-3 List of DKC710I Model Emulation Types for RAID5 (7D+1P) (5/6)

Emulation Type	Item	Emulation contents					
	DKC DKU	3390-A	3390-A (3 type)	I-2107 3390-A (9 type)	3390-A (L type)	3390-A (M type)	— 3390-V
Storage capacity (GB/volume)		223.257 (*3)	2.838 (*3)	8.514 (*3)	27.844 (*3)	55.689 (*3)	712.062 (*3)
Number of volumes /parity groups	DKC-F710I-146KCM	4	336	112	33	17	1
	DKC-F710I-300JCM/KCM	8	673	224	67	34	2
	DKC-F710I-600JCM	17	1,347	449	134	68	5
	DKC-F710I-900JCM	25	2,000	673	202	102	8
	DKC-F710I-1R2JCM	34	—	—	—	137	10
	DKC-F710I-200SAM/SCM/MCM	5	460	153	46	23	1
	DKC-F710I-400SCM/S1M/S3M/MCM	11	921	307	92	46	3
	DKC-F710I-800MCM	23	1,842	614	184	93	7
	DKC-F710I-500HCM	14	1,151	383	115	58	4
	DKC-F710I-1R0HCM	29	—	—	—	117	9
	DKC-F710I-2R0H2M	58	—	—	—	233	18
	DKC-F710I-2R0H3M	58	—	—	—	232	18
	DKC-F710I-3R0H3M	87	—	—	—	349	27
	DKC-F710I-4R0H3M	116	—	—	—	465	36
	DKC-F710I-1R6FM	52	—	—	—	209	16
Maximum number of parity groups	DKC-F710I-3R2FM	104	—	—	—	418	32
	DKC-F710I-146KCM	255	194	255	255	255	255
	DKC-F710I-300JCM/KCM	255	96	255	255	255	255
	DKC-F710I-600JCM	255	48	145	255	255	255
	DKC-F710I-900JCM	255	32	96	255	255	255
	DKC-F710I-1R2JCM	255	—	—	—	255	255
	DKC-F710I-200SAM/SCM/MCM	32	32	32	32	32	32
	DKC-F710I-400SCM/S1M/S3M/MCM	32	32	32	32	32	32
	DKC-F710I-800MCM	32	32	32	32	32	32
	DKC-F710I-500HCM	255	56	170	255	255	255
	DKC-F710I-1R0HCM	255	—	—	—	255	255
	DKC-F710I-2R0H2M	159	—	—	—	159	159
	DKC-F710I-2R0H3M	159	—	—	—	159	159
	DKC-F710I-3R0H3M	159	—	—	—	159	159
	DKC-F710I-4R0H3M	159	—	—	—	140	159
Maximum number of volumes	DKC-F710I-1R6FM	23	—	—	—	23	23
	DKC-F710I-3R2FM	23	—	—	—	23	23
	DKC-F710I-146KCM	1,020	65,184	28,560	8,415	4,335	255
	DKC-F710I-300JCM/KCM	2,040	64,608	57,120	17,085	8,670	510
	DKC-F710I-600JCM	4,335	64,656	65,105	34,170	17,340	1,275
	DKC-F710I-900JCM	6,375	64,000	64,608	51,510	26,010	2,040
	DKC-F710I-1R2JCM	8,670	—	—	—	34,935	2,550
	DKC-F710I-200SAM/SCM/MCM	160	14,720	4,896	1,472	736	32
	DKC-F710I-400SCM/S1M/S3M/MCM	352	29,472	9,824	2,944	1,472	96
	DKC-F710I-800MCM	736	58,944	19,648	5,888	2,976	224
	DKC-F710I-500HCM	3,570	64,456	65,110	29,325	14,790	1,020
	DKC-F710I-1R0HCM	7,395	—	—	—	29,835	2,295
	DKC-F710I-2R0H2M	9,222	—	—	—	37,047	2,862
	DKC-F710I-2R0H3M	9,222	—	—	—	36,888	2,862
	DKC-F710I-3R0H3M	13,833	—	—	—	55,491	4,293
	DKC-F710I-4R0H3M	18,444	—	—	—	65,100	5,724
	DKC-F710I-1R6FM	1,196	—	—	—	4,807	368
	DKC-F710I-3R2FM	2,392	—	—	—	9,614	736

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Table 3.32.3.5.1-3 List of DKC710I Model Emulation Types for RAID5 (7D+1P) (6/6)

Emulation Type	Item		Emulation contents					
	DKC		I-2107					—
	DKU		3390-A	3390-A (3 type)	3390-A (9 type)	3390-A (L type)	3390-A (M type)	3390-V
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	Min	893	954	954	919	947	712
		Max	227,722	184,992	243,160	234,307	241,412	181,576
	DKC-F710I-300JCM/KCM	Min	1,786	1,910	1,907	1,866	1,893	1,424
		Max	455,444	183,992	486,320	475,715	482,824	363,152
	DKC-F710I-600JCM	Min	3,795	3,823	3,823	3,731	3,787	3,560
		Max	967,819	183,494	554,304	951,429	965,647	907,879
	DKC-F710I-900JCM	Min	5,581	5,676	5,730	5,624	5,680	5,696
		Max	1,423,263	181,632	550,073	1,434,244	1,448,471	1,452,606
	DKC-F710I-1R2JCM	Min	7,591	—	—	—	7,629	7,121
		Max	1,935,638	—	—	—	1,945,495	1,815,758
	DKC-F710I-200SAM/SCM/MCM	Min	1,116	1,305	1,303	1,281	1,281	712
		Max	35,721	41,775	41,685	40,986	40,987	22,786
	DKC-F710I-400SCM/S1M/S3M/MCM	Min	2,456	2,614	2,614	2,562	2,562	2,136
		Max	78,586	83,642	83,642	81,973	81,974	68,358
	DKC-F710I-800MCM	Min	5,135	5,228	5,228	5,123	5,179	4,984
		Max	164,317	167,283	167,283	163,945	165,730	159,502
	DKC-F710I-500HCM	Min	3,126	3,267	3,261	3,202	3,230	2,848
		Max	797,027	182,926	554,347	816,525	823,640	726,303
	DKC-F710I-1R0HCM	Min	6,474	—	—	—	6,516	6,409
		Max	1,650,986	—	—	—	1,661,481	1,634,182
	DKC-F710I-2R0H2M	Min	12,949	—	—	—	12,976	12,817
		Max	2,058,876	—	—	—	2,063,110	2,037,921
	DKC-F710I-2R0H3M	Min	12,949	—	—	—	12,920	12,817
		Max	2,058,876	—	—	—	2,054,256	2,037,921
	DKC-F710I-3R0H3M	Min	19,423	—	—	—	19,435	19,226
		Max	3,088,314	—	—	—	3,090,238	3,056,882
	DKC-F710I-4R0H3M	Min	25,898	—	—	—	25,895	25,634
		Max	4,117,752	—	—	—	3,625,354	4,075,843
	DKC-F710I-1R6FM	Min	11,609	—	—	—	11,639	11,393
		Max	267,015	—	—	—	267,697	262,039
	DKC-F710I-3R2FM	Min	23,219	—	—	—	23,278	22,786
		Max	534,031	—	—	—	535,394	524,078

- *1: The value of OPEN-V is the default one in the installation of parity group. In case of OPEN-V, storage capacity differs depending on RAID level and DKU (HDD) type because OPEN-V is CVS basis. The default volume size is nearly equal to that of a parity group.
- *2: The value in parentheses is capacity of the parity group with SATA W&V (Write & Verify) improved.
- *3: The value is the capacity for Main Frame Host.

THEORY03-32-330**Table 3.32.3.5.1-4 List of DKC710I Model Emulation Types for RAID1 (2D+2D) (1/6)**

Emulation Type	Item	Emulation contents						
	DKC DKU	OPEN-3	OPEN-8	OPEN-9	— OPEN-E	OPEN-L	OPEN-V	OPEN-K
Storage capacity (GB/volume)		2,461	7,347	7,384	14,567	36,450	(*1)	1,874
Number of volumes /parity groups	DKC-F710I-146KCM	116	39	38	19	7	1	152
	DKC-F710I-300JCM/KCM	233	78	77	39	15	1	306
	DKC-F710I-600JCM	467	156	155	79	31	1	612
	DKC-F710I-1R2JCM	—	—	—	—	—	1	—
	DKC-F710I-900JCM	700	234	233	118	47	1	918
	DKC-F710I-200SAM/SCM/MCM	159	53	53	27	10	1	209
	DKC-F710I-400SCM/S1M/S3M/MCM	319	106	106	54	21	1	418
	DKC-F710I-800MCM	638	213	212	108	43	1	837
	DKC-F710I-500HCM	399	133	132	67	27	1	523
	DKC-F710I-1R0HCM	—	—	—	—	—	1	—
	DKC-F710I-2R0H2M	—	—	—	—	—	2	—
	DKC-F710I-2R0H3M	—	—	—	—	—	2	—
	DKC-F710I-3R0H3M	—	—	—	—	—	2	—
	DKC-F710I-4R0H3M	—	—	—	—	—	3	—
	DKC-F710I-1R6FM	—	—	—	—	—	2	—
	DKC-F710I-3R2FM	—	—	—	—	—	3	—
Maximum number of parity groups	DKC-F710I-146KCM	511	511	511	511	511	511	429
	DKC-F710I-300JCM/KCM	280	511	511	511	511	511	213
	DKC-F710I-600JCM	139	418	421	511	511	511	106
	DKC-F710I-900JCM	93	278	280	511	511	511	71
	DKC-F710I-1R2JCM	—	—	—	—	—	511	—
	DKC-F710I-200SAM/SCM/MCM	64	64	64	64	64	64	64
	DKC-F710I-400SCM/S1M/S3M/MCM	64	64	64	64	64	64	64
	DKC-F710I-800MCM	64	64	64	64	64	64	64
	DKC-F710I-500HCM	163	490	494	511	511	511	124
	DKC-F710I-1R0HCM	—	—	—	—	—	511	—
	DKC-F710I-2R0H2M	—	—	—	—	—	319	—
	DKC-F710I-2R0H3M	—	—	—	—	—	319	—
	DKC-F710I-3R0H3M	—	—	—	—	—	319	—
	DKC-F710I-4R0H3M	—	—	—	—	—	319	—
	DKC-F710I-1R6FM	—	—	—	—	—	47	—
	DKC-F710I-3R2FM	—	—	—	—	—	47	—
Maximum number of volumes	DKC-F710I-146KCM	59,276	19,929	19,418	9,709	3,577	511	65,208
	DKC-F710I-300JCM/KCM	65,240	39,858	39,347	19,929	7,665	511	65,178
	DKC-F710I-600JCM	64,913	65,208	65,255	40,369	15,841	511	64,872
	DKC-F710I-900JCM	65,100	65,052	65,240	60,298	24,017	511	65,178
	DKC-F710I-1R2JCM	—	—	—	—	—	511	—
	DKC-F710I-200SAM/SCM/MCM	10,176	3,392	3,392	1,728	640	64	13,376
	DKC-F710I-400SCM/S1M/S3M/MCM	20,416	6,784	6,784	3,456	1,344	64	26,752
	DKC-F710I-800MCM	40,832	13,632	13,568	6,912	2,752	64	53,568
	DKC-F710I-500HCM	65,037	65,170	65,208	34,237	13,797	511	64,852
	DKC-F710I-1R0HCM	—	—	—	—	—	511	—
	DKC-F710I-2R0H2M	—	—	—	—	—	638	—
	DKC-F710I-2R0H3M	—	—	—	—	—	638	—
	DKC-F710I-3R0H3M	—	—	—	—	—	638	—
	DKC-F710I-4R0H3M	—	—	—	—	—	957	—
	DKC-F710I-1R6FM	—	—	—	—	—	94	—
	DKC-F710I-3R2FM	—	—	—	—	—	141	—

THEORY03-32-331**Table 3.32.3.5.1-4 List of DKC710I Model Emulation Types for RAID1 (2D+2D) (2/6)**

Emulation Type	Item		Emulation contents						
	DKC DKU		OPEN-3	OPEN-8	OPEN-9	OPEN-E	OPEN-L	OPEN-V	OPEN-K
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	Min	285	287	281	277	255	288	285
		Max	145,878	146,418	143,383	141,431	130,382	146,913	122,200
	DKC-F710I-300JCM/KCM	Min	573	573	569	568	547	576	573
		Max	160,556	292,837	290,538	290,306	279,389	294,489	122,144
	DKC-F710I-600JCM	Min	1,149	1,146	1,145	1,151	1,130	1,153	1,147
		Max	159,751	479,083	481,843	588,055	577,404	589,030	121,570
	DKC-F710I-900JCM	Min	1,723	1,719	1,720	1,719	1,713	1,729	1,720
		Max	160,211	477,937	481,732	878,361	875,420	883,621	122,144
	DKC-F710I-1R2JCM	Min	—	—	—	—	—	2,306	—
		Max	—	—	—	—	—	1,178,111	—
	DKC-F710I-200SAM/SCM/MCM	Min	391	389	391	393	365	394	392
		Max	25,043	24,921	25,047	25,172	23,328	25,203	25,067
	DKC-F710I-400SCM/S1M/S3M/MCM	Min	785	779	783	787	765	788	783
		Max	50,244	49,842	50,093	50,344	48,989	50,406	50,133
	DKC-F710I-800MCM	Min	1,570	1,565	1,565	1,573	1,567	1,575	1,569
		Max	100,488	100,154	100,186	100,687	100,310	100,819	100,386
	DKC-F710I-500HCM	Min	982	977	975	976	984	985	980
		Max	160,056	478,804	481,496	498,730	502,901	503,131	121,533
	DKC-F710I-1R0HCM	Min	—	—	—	—	—	1,969	—
		Max	—	—	—	—	—	1,006,261	—
	DKC-F710I-2R0H2M	Min	—	—	—	—	—	3,938	—
		Max	—	—	—	—	—	1,256,222 (1,256,538) (*2)	—
	DKC-F710I-2R0H3M	Min	—	—	—	—	—	3,916	—
		Max	—	—	—	—	—	1,249,236	—
	DKC-F710I-3R0H3M	Min	—	—	—	—	—	5,874	—
		Max	—	—	—	—	—	1,873,870	—
	DKC-F710I-4R0H3M	Min	—	—	—	—	—	7,832	—
		Max	—	—	—	—	—	2,498,472	—
	DKC-F710I-1R6FM	Min	—	—	—	—	—	3,518	—
		Max	—	—	—	—	—	165,365	—
	DKC-F710I-3R2FM	Min	—	—	—	—	—	7,037	—
		Max	—	—	—	—	—	330,730	—

THEORY03-32-340**Table 3.32.3.5.1-4 List of DKC710I Model Emulation Types for RAID1 (2D+2D) (3/6)**

Emulation Type	Item	Emulation contents			
	DKC	I-2105 / 2107			
	DKU	3390-9	3390-3/3R	3390-L	3390-M
Storage capacity (GB/volume)		8,510 (*3)	2,838 (*3)	27.8 (*3)	55,689 (*3)
Number of volumes /parity groups	DKC-F710I-146KCM	32	96	9	4
	DKC-F710I-300JCM/KCM	64	193	19	9
	DKC-F710I-600JCM	128	386	39	19
	DKC-F710I-900JCM	193	580	59	29
	DKC-F710I-1R2JCM	—	—	—	39
	DKC-F710I-200SAM/SCM/MCM	44	132	13	6
	DKC-F710I-400SCM/S1M/S3M/MCM	88	264	26	13
	DKC-F710I-800MCM	176	528	53	26
	DKC-F710I-500HCM	110	330	33	16
	DKC-F710I-1R0HCM	—	—	—	33
	DKC-F710I-2R0H2M	—	—	—	67
	DKC-F710I-2R0H3M	—	—	—	67
	DKC-F710I-3R0H3M	—	—	—	100
	DKC-F710I-4R0H3M	—	—	—	134
	DKC-F710I-1R6FM	—	—	—	60
	DKC-F710I-3R2FM	—	—	—	120
Maximum number of parity groups	DKC-F710I-146KCM	511	511	511	511
	DKC-F710I-300JCM/KCM	511	338	511	511
	DKC-F710I-600JCM	510	169	511	511
	DKC-F710I-900JCM	338	112	511	511
	DKC-F710I-1R2JCM	—	—	—	511
	DKC-F710I-200SAM/SCM/MCM	64	64	64	64
	DKC-F710I-400SCM/S1M/S3M/MCM	64	64	64	64
	DKC-F710I-800MCM	64	64	64	64
	DKC-F710I-500HCM	511	197	511	511
	DKC-F710I-1R0HCM	—	—	—	511
	DKC-F710I-2R0H2M	—	—	—	319
	DKC-F710I-2R0H3M	—	—	—	319
	DKC-F710I-3R0H3M	—	—	—	319
	DKC-F710I-4R0H3M	—	—	—	319
	DKC-F710I-1R6FM	—	—	—	47
	DKC-F710I-3R2FM	—	—	—	47
Maximum number of volumes	DKC-F710I-146KCM	16,352	49,056	4,599	2,044
	DKC-F710I-300JCM/KCM	32,704	65,234	9,709	4,599
	DKC-F710I-600JCM	65,280	65,234	19,929	9,709
	DKC-F710I-900JCM	65,234	64,960	30,149	14,819
	DKC-F710I-1R2JCM	—	—	—	19,929
	DKC-F710I-200SAM/SCM/MCM	2,816	8,448	832	384
	DKC-F710I-400SCM/S1M/S3M/MCM	5,632	16,896	1,664	832
	DKC-F710I-800MCM	11,264	33,792	3,392	1,664
	DKC-F710I-500HCM	56,210	65,010	16,863	8,176
	DKC-F710I-1R0HCM	—	—	—	16,863
	DKC-F710I-2R0H2M	—	—	—	21,373
	DKC-F710I-2R0H3M	—	—	—	21,373
	DKC-F710I-3R0H3M	—	—	—	31,900
	DKC-F710I-4R0H3M	—	—	—	42,746
	DKC-F710I-1R6FM	—	—	—	2,820
	DKC-F710I-3R2FM	—	—	—	5,640

Table 3.32.3.5.1-4 List of DKC710I Model Emulation Types for RAID1 (2D+2D) (4/6)

Emulation Type	Item		Emulation contents			
	DKC		I-2105 / 2107			
	DKU		3390-9	3390-3/3R	3390-L	3390-M
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	Min	272	272	250	223
		Max	139,156	139,221	127,852	113,828
	DKC-F710I-300JCM/KCM	Min	545	548	528	501
		Max	278,311	185,134	169,910	256,114
	DKC-F710I-600JCM	Min	1,089	1,095	1,084	1,058
		Max	555,533	185,134	554,026	134,378
	DKC-F710I-900JCM	Min	1,642	1,646	1,640	1,615
		Max	555,141	184,356	838,142	825,255
	DKC-F710I-1R2JCM	Min	—	—	—	2,172
		Max	—	—	—	1,109,826
	DKC-F710I-200SAM/SCM/MCM	Min	374	375	361	334
		Max	23,964	23,975	23,130	21,385
	DKC-F710I-400SCM/S1M/S3M/MCM	Min	749	749	723	724
		Max	47,928	47,951	46,259	46,333
	DKC-F710I-800MCM	Min	1,498	1,498	1,473	1,448
		Max	95,857	95,902	94,298	92,666
	DKC-F710I-500HCM	Min	936	937	917	891
		Max	478,347	184,498	468,791	455,313
	DKC-F710I-1R0HCM	Min	—	—	—	1,838
		Max	—	—	—	939,084
	DKC-F710I-2R0H2M	Min	—	—	—	3,731
		Max	—	—	—	1,190,241
	DKC-F710I-2R0H3M	Min	—	—	—	3,731
		Max	—	—	—	1,190,241
	DKC-F710I-3R0H3M	Min	—	—	—	5,569
		Max	—	—	—	1,776,479
	DKC-F710I-4R0H3M	Min	—	—	—	7,462
		Max	—	—	—	2,380,482
	DKC-F710I-1R6FM	Min	—	—	—	3,341
		Max	—	—	—	157,043
	DKC-F710I-3R2FM	Min	—	—	—	6,683
		Max	—	—	—	314,086

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Table 3.32.3.5.1-4 List of DKC710I Model Emulation Types for RAID1 (2D+2D) (5/6)

Item		Emulation contents					
Emulation Type	DKC	I-2107					—
	DKU	3390-A	3390-A (3 type)	3390-A (9 type)	3390-A (L type)	3390-A (M type)	3390-V
Storage capacity (GB/volume)		223.257 (*3)	2.838 (*3)	8.514 (*3)	27.844 (*3)	55.689 (*3)	712.062 (*3)
Number of volumes /parity groups	DKC-F710I-146KCM	1	96	32	9	4	1
	DKC-F710I-300JCM/KCM	2	192	64	19	9	1
	DKC-F710I-600JCM	4	385	128	38	19	1
	DKC-F710I-900JCM	7	577	192	57	29	2
	DKC-F710I-1R2JCM	9	—	—	—	39	3
	DKC-F710I-200SAM/SCM/MCM	1	131	43	13	6	1
	DKC-F710I-400SCM/S1M/S3M/MCM	3	263	87	26	13	1
	DKC-F710I-800MCM	6	526	176	52	26	2
	DKC-F710I-500HCM	4	328	109	32	16	1
	DKC-F710I-1R0HCM	8	—	—	—	33	2
	DKC-F710I-2R0H2M	16	—	—	—	66	5
	DKC-F710I-2R0H3M	16	—	—	—	66	5
	DKC-F710I-3R0H3M	24	—	—	—	99	7
	DKC-F710I-4R0H3M	33	—	—	—	133	10
	DKC-F710I-1R6FM	14	—	—	—	59	4
DKC-F710I-3R2FM	29	—	—	—	119	9	
Maximum number of parity groups	DKC-F710I-146KCM	511	511	511	511	511	511
	DKC-F710I-300JCM/KCM	511	340	511	511	511	511
	DKC-F710I-600JCM	511	169	510	511	511	511
	DKC-F710I-900JCM	511	113	340	511	511	511
	DKC-F710I-1R2JCM	511	—	—	—	511	511
	DKC-F710I-200SAM/SCM/MCM	64	64	64	64	64	64
	DKC-F710I-400SCM/S1M/S3M/MCM	64	64	64	64	64	64
	DKC-F710I-800MCM	64	64	64	64	64	64
	DKC-F710I-500HCM	511	199	511	511	511	511
	DKC-F710I-1R0HCM	511	—	—	—	511	511
	DKC-F710I-2R0H2M	319	—	—	—	319	319
	DKC-F710I-2R0H3M	319	—	—	—	319	319
	DKC-F710I-3R0H3M	319	—	—	—	319	319
	DKC-F710I-4R0H3M	319	—	—	—	319	319
	DKC-F710I-1R6FM	47	—	—	—	47	47
DKC-F710I-3R2FM	47	—	—	—	47	47	
Maximum number of volumes	DKC-F710I-146KCM	511	49,056	16,352	4,599	2,044	511
	DKC-F710I-300JCM/KCM	1,022	65,280	32,704	9,709	4,599	511
	DKC-F710I-600JCM	2,044	65,065	65,280	19,418	9,709	511
	DKC-F710I-900JCM	3,577	65,201	65,280	29,127	14,819	1,022
	DKC-F710I-1R2JCM	4,599	—	—	—	19,929	1,533
	DKC-F710I-200SAM/SCM/MCM	64	8,384	2,752	832	384	64
	DKC-F710I-400SCM/S1M/S3M/MCM	192	16,832	5,568	1,664	832	64
	DKC-F710I-800MCM	384	33,664	11,200	3,328	1,664	128
	DKC-F710I-500HCM	2,044	65,272	55,699	16,352	8,176	511
	DKC-F710I-1R0HCM	4,088	—	—	—	16,863	1,022
	DKC-F710I-2R0H2M	5,104	—	—	—	21,054	1,595
	DKC-F710I-2R0H3M	5,104	—	—	—	21,054	1,595
	DKC-F710I-3R0H3M	7,656	—	—	—	31,581	2,233
	DKC-F710I-4R0H3M	10,527	—	—	—	42,427	3,190
	DKC-F710I-1R6FM	658	—	—	—	2,773	188
DKC-F710I-3R2FM	1,363	—	—	—	5,593	423	

Table 3.32.3.5.1-4 List of DKC710I Model Emulation Types for RAID1 (2D+2D) (6/6)

Emulation Type	Item		Emulation contents					
	DKC DKU		I-2107					—
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	Min	223	272	272	251	223	712
		Max	114,084	139,221	139,221	128,055	113,828	363,864
	DKC-F710I-300JCM/KCM	Min	447	545	545	529	501	712
		Max	228,169	185,265	278,442	270,337	256,114	363,864
	DKC-F710I-600JCM	Min	893	1,093	1,090	1,058	1,058	712
		Max	456,337	184,654	555,794	540,675	540,685	363,864
	DKC-F710I-900JCM	Min	1,563	1,638	1,635	1,587	1,615	1,424
		Max	798,590	185,040	555,794	811,012	825,255	727,727
	DKC-F710I-1R2JCM	Min	2,009	—	—	—	2,172	2,136
		Max	1,026,759	—	—	—	1,109,826	1,091,591
	DKC-F710I-200SAM/SCM/MCM	Min	223	372	366	362	334	712
		Max	14,288	23,794	23,431	23,166	21,385	45,572
	DKC-F710I-400SCM/S1M/S3M/MCM	Min	670	746	741	724	724	712
		Max	42,865	47,769	47,406	46,332	46,333	45,572
	DKC-F710I-800MCM	Min	1,340	1,493	1,490	1,448	1,448	1,424
		Max	85,731	95,538	95,357	92,665	92,666	91,144
	DKC-F710I-500HCM	Min	893	931	928	891	891	712
		Max	456,337	185,242	474,221	455,305	455,313	363,864
	DKC-F710I-1R0HCM	Min	1,786	—	—	—	1,835	1,424
		Max	912,675	—	—	—	937,583	727,727
	DKC-F710I-2R0H2M	Min	3,572	—	—	—	3,675	3,560
		Max	1,139,504	—	—	—	1,172,476	1,135,739
	DKC-F710I-2R0H3M	Min	3,572	—	—	—	3,675	3,560
		Max	1,139,504	—	—	—	1,172,476	1,135,739
	DKC-F710I-3R0H3M	Min	5,358	—	—	—	5,513	4,984
		Max	1,709,256	—	—	—	1,758,714	1,590,034
	DKC-F710I-4R0H3M	Min	7,367	—	—	—	7,407	7,121
		Max	2,350,226	—	—	—	2,362,717	2,271,478
	DKC-F710I-1R6FM	Min	3,126	—	—	—	3,286	2,848
		Max	146,903	—	—	—	154,426	133,868
	DKC-F710I-3R2FM	Min	6,474	—	—	—	6,627	6,409
		Max	304,299	—	—	—	311,469	301,202

- *1: The value of OPEN-V is the default one in the installation of parity group. In case of OPEN-V, storage capacity differs depending on RAID level and DKU (HDD) type because OPEN-V is CVS basis. The default volume size is nearly equal to that of a parity group.
- *2: The value in parentheses is capacity of the parity group with SATA W&V (Write & Verify) improved.
- *3: The value is the capacity for Main Frame Host.

THEORY03-32-360**Table 3.32.3.5.1-5 List of DKC710I Model Emulation Types for RAID6 (6D+2P) (1/6)**

Emulation Type	Item	Emulation contents						
	DKC DKU	OPEN-3	OPEN-8	OPEN-9	— OPEN-E	OPEN-L	OPEN-V	OPEN-K
Storage capacity (GB/volume)		2,461	7,347	7,384	14,567	36,450	(*1)	1,874
Number of volumes /parity groups	DKC-F710I-146KCM	349	117	116	59	23	1	458
	DKC-F710I-300JCM/KCM	700	234	233	118	47	1	918
	DKC-F710I-600JCM	1,401	469	466	237	94	2	1,836
	DKC-F710I-900JCM	2,000	704	700	355	142	2	2,000
	DKC-F710I-1R2JCM	—	—	—	—	—	3	—
	DKC-F710I-200SAM/SCM/MCM	478	160	159	81	32	1	627
	DKC-F710I-400SCM/S1M/S3M/MCM	957	320	319	162	64	1	1,255
	DKC-F710I-800MCM	1,915	641	638	324	129	2	2,000
	DKC-F710I-500HCM	1,196	400	398	202	81	1	1,568
	DKC-F710I-1R0HCM	—	—	—	—	—	2	—
	DKC-F710I-2R0H2M	—	—	—	—	—	4	—
	DKC-F710I-2R0H3M	—	—	—	—	—	4	—
	DKC-F710I-3R0H3M	—	—	—	—	—	6	—
	DKC-F710I-4R0H3M	—	—	—	—	—	8	—
	DKC-F710I-1R6FM	—	—	—	—	—	4	—
	DKC-F710I-3R2FM	—	—	—	—	—	7	—
Maximum number of parity groups	DKC-F710I-146KCM	187	255	255	255	255	255	142
	DKC-F710I-300JCM/KCM	93	255	255	255	255	255	71
	DKC-F710I-600JCM	46	139	140	255	255	255	35
	DKC-F710I-900JCM	32	92	93	183	255	255	32
	DKC-F710I-1R2JCM	—	—	—	—	—	255	—
	DKC-F710I-200SAM/SCM/MCM	32	32	32	32	32	32	32
	DKC-F710I-400SCM/S1M/S3M/MCM	32	32	32	32	32	32	32
	DKC-F710I-800MCM	32	32	32	32	32	32	32
	DKC-F710I-500HCM	54	163	164	255	255	255	41
	DKC-F710I-1R0HCM	—	—	—	—	—	255	—
	DKC-F710I-2R0H2M	—	—	—	—	—	159	—
	DKC-F710I-2R0H3M	—	—	—	—	—	159	—
	DKC-F710I-3R0H3M	—	—	—	—	—	159	—
	DKC-F710I-4R0H3M	—	—	—	—	—	159	—
	DKC-F710I-1R6FM	—	—	—	—	—	23	—
	DKC-F710I-3R2FM	—	—	—	—	—	23	—
Maximum number of volumes	DKC-F710I-146KCM	65,263	29,835	29,580	15,045	5,865	255	65,036
	DKC-F710I-300JCM/KCM	65,100	59,670	59,415	30,090	11,985	255	65,178
	DKC-F710I-600JCM	64,446	65,191	65,240	60,435	23,970	510	64,260
	DKC-F710I-900JCM	64,000	64,768	65,100	64,965	36,210	510	64,000
	DKC-F710I-1R2JCM	—	—	—	—	—	765	—
	DKC-F710I-200SAM/SCM/MCM	15,296	5,120	5,088	2,592	1,024	32	20,064
	DKC-F710I-400SCM/S1M/S3M/MCM	30,624	10,240	10,208	5,184	2,048	32	40,160
	DKC-F710I-800MCM	61,280	20,512	20,416	10,368	4,128	64	64,000
	DKC-F710I-500HCM	64,584	65,200	65,272	51,510	20,655	255	64,288
	DKC-F710I-1R0HCM	—	—	—	—	—	510	—
	DKC-F710I-2R0H2M	—	—	—	—	—	636	—
	DKC-F710I-2R0H3M	—	—	—	—	—	636	—
	DKC-F710I-3R0H3M	—	—	—	—	—	954	—
	DKC-F710I-4R0H3M	—	—	—	—	—	1,272	—
	DKC-F710I-1R6FM	—	—	—	—	—	92	—
	DKC-F710I-3R2FM	—	—	—	—	—	161	—

THEORY03-32-361**Table 3.32.3.5.1-5 List of DKC710I Model Emulation Types for RAID6 (6D+2P) (2/6)**

Emulation Type	Item		Emulation contents						
	DKC DKU		OPEN-3	OPEN-8	OPEN-9	OPEN-E	OPEN-L	OPEN-V	OPEN-K
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	Min	859	860	857	859	838	863	858
		Max	160,612	219,198	218,419	219,161	213,779	219,938	121,877
	DKC-F710I-300JCM/KCM	Min	1,723	1,719	1,720	1,719	1,713	1,729	1,720
		Max	160,211	438,395	438,720	438,321	436,853	440,921	122,144
	DKC-F710I-600JCM	Min	3,448	3,446	3,441	3,452	3,426	3,458	3,441
		Max	158,602	478,958	481,732	880,357	873,707	881,867	120,423
	DKC-F710I-900JCM	Min	4,922	5,172	5,169	5,171	5,176	5,188	3,748
		Max	157,504	475,850	480,698	946,345	1,319,855	1,322,889	119,936
	DKC-F710I-1R2JCM	Min	—	—	—	—	—	6,917	—
		Max	—	—	—	—	—	1,763,759	—
	DKC-F710I-200SAM/SCM/MCM	Min	1,176	1,176	1,174	1,180	1,166	1,182	1,175
		Max	37,643	37,617	37,570	37,758	37,325	37,808	37,600
	DKC-F710I-400SCM/S1M/S3M/MCM	Min	2,355	2,351	2,355	2,360	2,333	2,363	2,352
		Max	75,366	75,233	75,376	75,515	74,650	75,616	75,260
	DKC-F710I-800MCM	Min	4,713	4,709	4,711	4,720	4,702	4,726	3,748
		Max	150,810	150,702	150,752	151,031	150,466	151,235	119,936
	DKC-F710I-500HCM	Min	2,943	2,939	2,939	2,943	2,952	2,954	2,938
		Max	158,941	479,024	481,968	750,346	752,875	753,219	120,476
	DKC-F710I-1R0HCM	Min	—	—	—	—	—	5,908	—
		Max	—	—	—	—	—	1,506,438	—
	DKC-F710I-2R0H2M	Min	—	—	—	—	—	11,817	—
		Max	—	—	—	—	—	1,878,903 (1,878,933) (*2)	—
	DKC-F710I-2R0H3M	Min	—	—	—	—	—	11,748	—
		Max	—	—	—	—	—	1,867,996	—
	DKC-F710I-3R0H3M	Min	—	—	—	—	—	17,623	—
		Max	—	—	—	—	—	2,801,993	—
	DKC-F710I-4R0H3M	Min	—	—	—	—	—	23,497	—
		Max	—	—	—	—	—	1,735,991	—
	DKC-F710I-1R6FM	Min	—	—	—	—	—	10,555	—
		Max	—	—	—	—	—	242,772	—
	DKC-F710I-3R2FM	Min	—	—	—	—	—	21,111	—
		Max	—	—	—	—	—	485,544	—

THEORY03-32-370**Table 3.32.3.5.1-5 List of DKC710I Model Emulation Types for RAID6 (6D+2P) (3/6)**

Emulation Type	Item	Emulation contents			
	DKC	I-2105 / 2107			
	DKU	3390-9	3390-3/3R	3390-L	3390-M
Storage capacity (GB/volume)		8,510 (*3)	2,838 (*3)	27.8 (*3)	55,689 (*3)
Number of volumes /parity groups	DKC-F710I-146KCM	96	289	29	14
	DKC-F710I-300JCM/KCM	193	579	59	29
	DKC-F710I-600JCM	386	1,159	118	59
	DKC-F710I-900JCM	579	1,739	177	88
	DKC-F710I-1R2JCM	—	—	—	118
	DKC-F710I-200SAM/SCM/MCM	132	396	40	20
	DKC-F710I-400SCM/S1M/S3M/MCM	264	792	80	40
	DKC-F710I-800MCM	528	1,584	161	80
	DKC-F710I-500HCM	330	990	101	50
	DKC-F710I-1R0HCM	—	—	—	101
	DKC-F710I-2R0H2M	—	—	—	201
	DKC-F710I-2R0H3M	—	—	—	201
	DKC-F710I-3R0H3M	—	—	—	301
	DKC-F710I-4R0H3M	—	—	—	402
	DKC-F710I-1R6FM	—	—	—	180
	DKC-F710I-3R2FM	—	—	—	361
Maximum number of parity groups	DKC-F710I-146KCM	255	225	255	255
	DKC-F710I-300JCM/KCM	255	112	255	255
	DKC-F710I-600JCM	169	56	255	255
	DKC-F710I-900JCM	112	37	255	255
	DKC-F710I-1R2JCM	—	—	—	255
	DKC-F710I-200SAM/SCM/MCM	32	32	32	32
	DKC-F710I-400SCM/S1M/S3M/MCM	32	32	32	32
	DKC-F710I-800MCM	32	32	32	32
	DKC-F710I-500HCM	197	65	255	255
	DKC-F710I-1R0HCM	—	—	—	255
	DKC-F710I-2R0H2M	—	—	—	159
	DKC-F710I-2R0H3M	—	—	—	159
	DKC-F710I-3R0H3M	—	—	—	159
	DKC-F710I-4R0H3M	—	—	—	159
Maximum number of volumes	DKC-F710I-1R6FM	—	—	—	23
	DKC-F710I-3R2FM	—	—	—	23
	DKC-F710I-146KCM	24,480	65,025	7,395	3,570
	DKC-F710I-300JCM/KCM	49,215	64,848	15,045	7,395
	DKC-F710I-600JCM	65,234	64,904	30,090	15,045
	DKC-F710I-900JCM	64,848	64,343	45,135	22,440
	DKC-F710I-1R2JCM	—	—	—	30,090
	DKC-F710I-200SAM/SCM/MCM	4,224	12,672	1,280	640
	DKC-F710I-400SCM/S1M/S3M/MCM	8,448	25,344	2,560	1,280
	DKC-F710I-800MCM	16,896	50,688	5,152	2,560
	DKC-F710I-500HCM	65,010	64,350	25,755	12,750
	DKC-F710I-1R0HCM	—	—	—	25,755
	DKC-F710I-2R0H2M	—	—	—	31,959
	DKC-F710I-2R0H3M	—	—	—	31,959
	DKC-F710I-3R0H3M	—	—	—	47,859
	DKC-F710I-4R0H3M	—	—	—	63,918
	DKC-F710I-1R6FM	—	—	—	4,140
	DKC-F710I-3R2FM	—	—	—	8,303

THEORY03-32-371**Table 3.32.3.5.1-5 List of DKC710I Model Emulation Types for RAID6 (6D+2P) (4/6)**

Emulation Type	Item		Emulation contents			
	DKC		I-2105 / 2107			
	DKU		3390-9	3390-3/3R	3390-L	3390-M
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	Min	817	820	806	780
		Max	208,325	184,541	205,581	198,810
	DKC-F710I-300JCM/KCM	Min	1,642	1,643	1,640	1,615
		Max	418,820	184,039	418,251	411,820
	DKC-F710I-600JCM	Min	3,285	3,289	3,280	3,286
		Max	555,141	184,198	836,502	417,278
	DKC-F710I-900JCM	Min	4,927	4,935	4,921	4,901
		Max	551,856	182,605	1,254,753	1,249,661
	DKC-F710I-1R2JCM	Min	—	—	—	6,571
		Max	—	—	—	1,675,682
	DKC-F710I-200SAM/SCM/MCM	Min	1,123	1,124	1,112	1,114
		Max	35,946	35,963	35,584	35,641
	DKC-F710I-400SCM/S1M/S3M/MCM	Min	2,247	2,248	2,224	2,228
		Max	71,892	71,926	71,168	71,282
	DKC-F710I-800MCM	Min	4,493	4,495	4,476	4,455
		Max	143,785	143,853	143,226	142,564
	DKC-F710I-500HCM	Min	2,808	2,810	2,808	2,784
		Max	553,235	182,625	715,989	710,035
	DKC-F710I-1R0HCM	Min	—	—	—	5,625
		Max	—	—	—	1,434,270
	DKC-F710I-2R0H2M	Min	—	—	—	11,193
		Max	—	—	—	1,779,765
	DKC-F710I-2R0H3M	Min	—	—	—	11,193
		Max	—	—	—	1,779,765
	DKC-F710I-3R0H3M	Min	—	—	—	16,762
		Max	—	—	—	2,665,220
	DKC-F710I-4R0H3M	Min	—	—	—	22,387
		Max	—	—	—	3,559,530
	DKC-F710I-1R6FM	Min	—	—	—	10,024
		Max	—	—	—	230,552
	DKC-F710I-3R2FM	Min	—	—	—	20,104
		Max	—	—	—	462,386

THEORY03-32-380**Table 3.32.3.5.1-5 List of DKC710I Model Emulation Types for RAID6 (6D+2P) (5/6)**

Emulation Type	Item	Emulation contents					
	DKC	I-2107					—
	DKU	3390-A	3390-A (3 type)	3390-A (9 type)	3390-A (L type)	3390-A (M type)	3390-V
Storage capacity (GB/volume)		223.257 (*3)	2.838 (*3)	8.514 (*3)	27.844 (*3)	55.689 (*3)	712.062 (*3)
Number of volumes /parity groups	DKC-F710I-146KCM	3	288	96	28	14	1
	DKC-F710I-300JCM/KCM	7	577	192	57	29	2
	DKC-F710I-600JCM	14	1,155	385	115	58	4
	DKC-F710I-900JCM	22	1,733	577	173	88	6
	DKC-F710I-1R2JCM	29	—	—	—	117	9
	DKC-F710I-200SAM/SCM/MCM	5	394	131	39	20	1
	DKC-F710I-400SCM/S1M/S3M/MCM	10	789	263	78	40	3
	DKC-F710I-800MCM	20	1,578	526	157	80	6
	DKC-F710I-500HCM	12	986	328	98	50	3
	DKC-F710I-1R0HCM	25	—	—	—	101	7
	DKC-F710I-2R0H2M	50	—	—	—	200	15
	DKC-F710I-2R0H3M	49	—	—	—	199	15
	DKC-F710I-3R0H3M	74	—	—	—	299	23
	DKC-F710I-4R0H3M	99	—	—	—	399	31
	DKC-F710I-1R6FM	44	—	—	—	179	14
Maximum number of parity groups	DKC-F710I-3R2FM	89	—	—	—	358	28
	DKC-F710I-146KCM	255	226	255	255	255	255
	DKC-F710I-300JCM/KCM	255	113	255	255	255	255
	DKC-F710I-600JCM	255	56	169	255	255	255
	DKC-F710I-900JCM	255	37	113	255	255	255
	DKC-F710I-1R2JCM	255	—	—	—	255	255
	DKC-F710I-200SAM/SCM/MCM	32	32	32	32	32	32
	DKC-F710I-400SCM/S1M/S3M/MCM	32	32	32	32	32	32
	DKC-F710I-800MCM	32	32	32	32	32	32
	DKC-F710I-500HCM	255	66	199	255	255	255
	DKC-F710I-1R0HCM	255	—	—	—	255	255
	DKC-F710I-2R0H2M	159	—	—	—	159	159
	DKC-F710I-2R0H3M	159	—	—	—	159	159
	DKC-F710I-3R0H3M	159	—	—	—	159	159
	DKC-F710I-4R0H3M	159	—	—	—	159	159
Maximum number of volumes	DKC-F710I-1R6FM	23	—	—	—	23	23
	DKC-F710I-3R2FM	23	—	—	—	23	23
	DKC-F710I-146KCM	765	65,088	24,480	7,140	3,570	255
	DKC-F710I-300JCM/KCM	1,785	65,201	48,960	14,535	7,395	510
	DKC-F710I-600JCM	3,570	64,680	65,065	29,325	14,790	1,020
	DKC-F710I-900JCM	5,610	64,121	65,201	44,115	22,440	1,530
	DKC-F710I-1R2JCM	7,395	—	—	—	29,835	2,295
	DKC-F710I-200SAM/SCM/MCM	160	12,608	4,192	1,248	640	32
	DKC-F710I-400SCM/S1M/S3M/MCM	320	25,248	8,416	2,496	1,280	96
	DKC-F710I-800MCM	640	50,496	16,832	5,024	2,560	192
	DKC-F710I-500HCM	3,060	65,076	65,272	24,990	12,750	765
	DKC-F710I-1R0HCM	6,375	—	—	—	25,755	1,785
	DKC-F710I-2R0H2M	7,950	—	—	—	31,800	2,385
	DKC-F710I-2R0H3M	7,791	—	—	—	31,641	2,385
	DKC-F710I-3R0H3M	11,766	—	—	—	47,541	3,657
	DKC-F710I-4R0H3M	15,741	—	—	—	63,441	4,929
	DKC-F710I-1R6FM	1,012	—	—	—	4,117	322
	DKC-F710I-3R2FM	2,047	—	—	—	8,234	644

Table 3.32.3.5.1-5 List of DKC710I Model Emulation Types for RAID6 (6D+2P) (6/6)

Emulation Type	Item		Emulation contents					
	DKC		I-2107					—
	DKU		3390-A	3390-A (3 type)	3390-A (9 type)	3390-A (L type)	3390-A (M type)	3390-V
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	Min	670	817	817	780	780	712
		Max	170,792	184,720	208,423	198,806	198,810	181,576
	DKC-F710I-300JCM/KCM	Min	1,563	1,638	1,635	1,587	1,615	1,424
		Max	398,514	185,040	416,845	404,713	411,820	353,152
	DKC-F710I-600JCM	Min	3,126	3,278	3,278	3,202	3,230	2,848
		Max	797,027	183,562	553,963	816,525	823,640	726,303
	DKC-F710I-900JCM	Min	4,912	4,918	4,913	4,817	4,901	4,272
		Max	1,252,472	181,975	555,121	1,228,338	1,249,661	1,089,455
	DKC-F710I-1R2JCM	Min	6,474	—	—	—	6,516	6,409
		Max	1,650,986	—	—	—	1,661,481	1,634,182
	DKC-F710I-200SAM/SCM/MCM	Min	1,116	1,118	1,115	1,086	1,114	712
		Max	35,721	35,782	35,691	34,749	35,641	22,786
	DKC-F710I-400SCM/S1M/S3M/MCM	Min	2,233	2,239	2,239	2,172	2,228	2,136
		Max	71,442	71,654	71,654	69,499	71,282	68,358
	DKC-F710I-800MCM	Min	4,465	4,478	4,478	4,372	4,455	4,272
		Max	142,884	143,308	143,308	139,888	142,564	136,716
	DKC-F710I-500HCM	Min	2,679	2,798	2,792	2,728	2,784	2,136
		Max	683,166	184,686	555,725	695,821	710,035	544,727
	DKC-F710I-1R0HCM	Min	5,581	—	—	—	5,624	4,984
		Max	1,423,263	—	—	—	1,434,270	1,271,031
	DKC-F710I-2R0H2M	Min	11,163	—	—	—	11,138	10,681
		Max	1,774,893	—	—	—	1,770,910	1,698,268
	DKC-F710I-2R0H3M	Min	10,940	—	—	—	11,082	10,681
		Max	1,739,395	—	—	—	1,762,056	1,698,268
	DKC-F710I-3R0H3M	Min	16,521	—	—	—	16,651	16,377
		Max	2,626,842	—	—	—	2,647,511	2,604,011
	DKC-F710I-4R0H3M	Min	22,102	—	—	—	22,220	22,074
		Max	3,514,288	—	—	—	3,532,966	3,509,754
	DKC-F710I-1R6FM	Min	9,823	—	—	—	9,968	9,969
		Max	225,936	—	—	—	229,272	229,284
	DKC-F710I-3R2FM	Min	19,870	—	—	—	19,937	19,938
		Max	457,007	—	—	—	458,543	458,568

- *1: The value of OPEN-V is the default one in the installation of parity group. In case of OPEN-V, storage capacity differs depending on RAID level and DKU (HDD) type because OPEN-V is CVS basis. The default volume size is nearly equal to that of a parity group.
- *2: The value in parentheses is capacity of the parity group with SATA W&V (Write & Verify) improved.
- *3: The value is the capacity for Main Frame Host.

THEORY03-32-382**Table 3.32.3.5.1-6 List of DKC710I Model Emulation Types for RAID6 (14D+2P) (1/6)**

Emulation Type	Item	Emulation contents						
	DKC DKU	OPEN-3	OPEN-8	OPEN-9	OPEN-E	OPEN-L	OPEN-V	OPEN-K
Storage capacity (GB/volume)		2.461	7.347	7.384	14.567	36.450	(*1)	1.874
Number of volumes /parity groups	DKC-F710I-146KCM	—	—	—	—	—	1	—
	DKC-F710I-300JCM/KCM	—	—	—	—	—	2	—
	DKC-F710I-600JCM	—	—	—	—	—	3	—
	DKC-F710I-900JCM	—	—	—	—	—	4	—
	DKC-F710I-1R2JCM	—	—	—	—	—	5	—
	DKC-F710I-200SAM/SCM/MCM	—	—	—	—	—	1	—
	DKC-F710I-400SCM/S1M/S3M/MCM	—	—	—	—	—	2	—
	DKC-F710I-800MCM	—	—	—	—	—	4	—
	DKC-F710I-500HCM	—	—	—	—	—	3	—
	DKC-F710I-1R0HCM	—	—	—	—	—	5	—
	DKC-F710I-2R0H2M	—	—	—	—	—	9	—
	DKC-F710I-2R0H3M	—	—	—	—	—	9	—
	DKC-F710I-3R0H3M	—	—	—	—	—	13	—
	DKC-F710I-4R0H3M	—	—	—	—	—	17	—
Maximum number of parity groups	DKC-F710I-1R6FM	—	—	—	—	—	8	—
	DKC-F710I-3R2FM	—	—	—	—	—	15	—
	DKC-F710I-146KCM	—	—	—	—	—	127	—
	DKC-F710I-300JCM/KCM	—	—	—	—	—	127	—
	DKC-F710I-600JCM	—	—	—	—	—	127	—
	DKC-F710I-900JCM	—	—	—	—	—	127	—
	DKC-F710I-1R2JCM	—	—	—	—	—	127	—
	DKC-F710I-200SAM/SCM/MCM	—	—	—	—	—	16	—
	DKC-F710I-400SCM/S1M/S3M/MCM	—	—	—	—	—	16	—
	DKC-F710I-800MCM	—	—	—	—	—	16	—
	DKC-F710I-500HCM	—	—	—	—	—	127	—
	DKC-F710I-1R0HCM	—	—	—	—	—	127	—
	DKC-F710I-2R0H2M	—	—	—	—	—	79	—
	DKC-F710I-2R0H3M	—	—	—	—	—	79	—
	DKC-F710I-3R0H3M	—	—	—	—	—	79	—
Maximum number of volumes	DKC-F710I-4R0H3M	—	—	—	—	—	79	—
	DKC-F710I-1R6FM	—	—	—	—	—	11	—
	DKC-F710I-3R2FM	—	—	—	—	—	11	—
	DKC-F710I-146KCM	—	—	—	—	—	127	—
	DKC-F710I-300JCM/KCM	—	—	—	—	—	254	—
	DKC-F710I-600JCM	—	—	—	—	—	381	—
	DKC-F710I-900JCM	—	—	—	—	—	508	—
	DKC-F710I-1R2JCM	—	—	—	—	—	635	—
	DKC-F710I-200SAM/SCM/MCM	—	—	—	—	—	16	—
	DKC-F710I-400SCM/S1M/S3M/MCM	—	—	—	—	—	32	—
	DKC-F710I-800MCM	—	—	—	—	—	64	—
	DKC-F710I-500HCM	—	—	—	—	—	381	—
	DKC-F710I-1R0HCM	—	—	—	—	—	635	—
	DKC-F710I-2R0H2M	—	—	—	—	—	711	—
	DKC-F710I-2R0H3M	—	—	—	—	—	711	—
	DKC-F710I-3R0H3M	—	—	—	—	—	1,027	—
	DKC-F710I-4R0H3M	—	—	—	—	—	1,343	—
	DKC-F710I-1R6FM	—	—	—	—	—	88	—
	DKC-F710I-3R2FM	—	—	—	—	—	165	—

THEORY03-32-382A**Table 3.32.3.5.1-6 List of DKC710I Model Emulation Types for RAID6 (14D+2P) (2/6)**

Emulation Type	Item		Emulation contents						
	DKC DKU		OPEN-3	OPEN-8	OPEN-9	OPEN-E	OPEN-L	OPEN-V	OPEN-K
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	Min	—	—	—	—	—	2,013	—
		Max	—	—	—	—	—	255,613	—
	DKC-F710I-300JCM/KCM	Min	—	—	—	—	—	4,035	—
		Max	—	—	—	—	—	512,407	—
	DKC-F710I-600JCM	Min	—	—	—	—	—	8,070	—
		Max	—	—	—	—	—	1,024,827	—
	DKC-F710I-900JCM	Min	—	—	—	—	—	12,105	—
		Max	—	—	—	—	—	1,537,335	—
	DKC-F710I-1R2JCM	Min	—	—	—	—	—	16,139	—
		Max	—	—	—	—	—	2,049,653	—
	DKC-F710I-200SAM/SCM/MCM	Min	—	—	—	—	—	2,757	—
		Max	—	—	—	—	—	44,110	—
	DKC-F710I-400SCM/S1M/S3M/MCM	Min	—	—	—	—	—	5,514	—
		Max	—	—	—	—	—	88,221	—
	DKC-F710I-800MCM	Min	—	—	—	—	—	11,028	—
		Max	—	—	—	—	—	176,442	—
	DKC-F710I-500HCM	Min	—	—	—	—	—	6,892	—
		Max	—	—	—	—	—	875,322	—
	DKC-F710I-1R0HCM	Min	—	—	—	—	—	13,785	—
		Max	—	—	—	—	—	1,750,644	—
	DKC-F710I-2R0H2M	Min	—	—	—	—	—	27,573	—
		Max	—	—	—	—	—	2,178,267	—
	DKC-F710I-2R0H3M	Min	—	—	—	—	—	27,413	—
		Max	—	—	—	—	—	2,165,627	—
	DKC-F710I-3R0H3M	Min	—	—	—	—	—	41,120	—
		Max	—	—	—	—	—	3,248,441	—
	DKC-F710I-4R0H3M	Min	—	—	—	—	—	54,826	—
		Max	—	—	—	—	—	4,331,254	—
	DKC-F710I-1R6FM	Min	—	—	—	—	—	24,629	—
		Max	—	—	—	—	—	270,919	—
	DKC-F710I-3R2FM	Min	—	—	—	—	—	49,258	—
		Max	—	—	—	—	—	541,839	—

THEORY03-32-383**Table 3.32.3.5.1-6 List of DKC710I Model Emulation Types for RAID6 (14D+2P) (3/6)**

Emulation Type	Item	Emulation contents			
	DKC	I-2105 / 2107			
	DKU	3390-9	3390-3/3R	3390-L	3390-M
Storage capacity (GB/volume)		8,510 (*2)	2,838 (*2)	27.8 (*2)	55,689 (*2)
Number of volumes /parity groups	DKC-F710I-146KCM	—	—	—	34
	DKC-F710I-300JCM/KCM	—	—	—	69
	DKC-F710I-600JCM	—	—	—	138
	DKC-F710I-900JCM	—	—	—	207
	DKC-F710I-1R2JCM	—	—	—	276
	DKC-F710I-200SAM/SCM/MCM	—	—	—	47
	DKC-F710I-400SCM/S1M/S3M/MCM	—	—	—	94
	DKC-F710I-800MCM	—	—	—	188
	DKC-F710I-500HCM	—	—	—	117
	DKC-F710I-1R0HCM	—	—	—	235
	DKC-F710I-2R0H2M	—	—	—	471 (470) (*3)
	DKC-F710I-2R0H3M	—	—	—	469
	DKC-F710I-3R0H3M	—	—	—	703
	DKC-F710I-4R0H3M	—	—	—	938
	DKC-F710I-1R6FM	—	—	—	421
	DKC-F710I-3R2FM	—	—	—	843
Maximum number of parity groups	DKC-F710I-146KCM	—	—	—	127
	DKC-F710I-300JCM/KCM	—	—	—	127
	DKC-F710I-600JCM	—	—	—	127
	DKC-F710I-900JCM	—	—	—	127
	DKC-F710I-1R2JCM	—	—	—	127
	DKC-F710I-200SAM/SCM/MCM	—	—	—	16
	DKC-F710I-400SCM/S1M/S3M/MCM	—	—	—	16
	DKC-F710I-800MCM	—	—	—	16
	DKC-F710I-500HCM	—	—	—	127
	DKC-F710I-1R0HCM	—	—	—	127
	DKC-F710I-2R0H2M	—	—	—	79
	DKC-F710I-2R0H3M	—	—	—	79
	DKC-F710I-3R0H3M	—	—	—	79
	DKC-F710I-4R0H3M	—	—	—	69
	DKC-F710I-1R6FM	—	—	—	11
	DKC-F710I-3R2FM	—	—	—	11
Maximum number of volumes	DKC-F710I-146KCM	—	—	—	4,318
	DKC-F710I-300JCM/KCM	—	—	—	8,763
	DKC-F710I-600JCM	—	—	—	17,526
	DKC-F710I-900JCM	—	—	—	26,289
	DKC-F710I-1R2JCM	—	—	—	35,052
	DKC-F710I-200SAM/SCM/MCM	—	—	—	752
	DKC-F710I-400SCM/S1M/S3M/MCM	—	—	—	1,504
	DKC-F710I-800MCM	—	—	—	3,008
	DKC-F710I-500HCM	—	—	—	14,859
	DKC-F710I-1R0HCM	—	—	—	29,845
	DKC-F710I-2R0H2M	—	—	—	37,209 (37,130) (*3)
	DKC-F710I-2R0H3M	—	—	—	37,051
	DKC-F710I-3R0H3M	—	—	—	55,537
	DKC-F710I-4R0H3M	—	—	—	64,722
	DKC-F710I-1R6FM	—	—	—	4,631
	DKC-F710I-3R2FM	—	—	—	9,273

THEORY03-32-383A**Table 3.32.3.5.1-6 List of DKC710I Model Emulation Types for RAID6 (14D+2P) (4/6)**

Emulation Type	Item		Emulation contents			
	DKC		I-2105 / 2107			
	DKU		3390-9	3390-3/3R	3390-L	3390-M
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	Min	—	—	—	1,893
		Max	—	—	—	240,465
	DKC-F710I-300JCM/KCM	Min	—	—	—	3,843
		Max	—	—	—	488,003
	DKC-F710I-600JCM	Min	—	—	—	7,685
		Max	—	—	—	976,005
	DKC-F710I-900JCM	Min	—	—	—	11,528
		Max	—	—	—	1,464,008
	DKC-F710I-1R2JCM	Min	—	—	—	15,370
		Max	—	—	—	1,952,011
	DKC-F710I-200SAM/SCM/MCM	Min	—	—	—	2,617
		Max	—	—	—	41,878
	DKC-F710I-400SCM/S1M/S3M/MCM	Min	—	—	—	5,235
		Max	—	—	—	83,756
	DKC-F710I-800MCM	Min	—	—	—	10,470
		Max	—	—	—	167,513
	DKC-F710I-500HCM	Min	—	—	—	6,516
		Max	—	—	—	827,483
	DKC-F710I-1R0HCM	Min	—	—	—	13,087
		Max	—	—	—	1,662,038
	DKC-F710I-2R0H2M	Min	—	—	—	26,230 (26,174) (*3)
		Max	—	—	—	2,072,132 (2,067,733) (*3)
	DKC-F710I-2R0H3M	Min	—	—	—	26,118
		Max	—	—	—	2,063,333
	DKC-F710I-3R0H3M	Min	—	—	—	39,149
		Max	—	—	—	3,092,800
	DKC-F710I-4R0H3M	Min	—	—	—	52,236
		Max	—	—	—	3,604,303
	DKC-F710I-1R6FM	Min	—	—	—	23,445
		Max	—	—	—	257,896
	DKC-F710I-3R2FM	Min	—	—	—	46,945
		Max	—	—	—	516,404

THEORY03-32-384**Table 3.32.3.5.1-6 List of DKC710I Model Emulation Types for RAID6 (14D+2P) (5/6)**

Emulation Type	Item	Emulation contents					
	DKC	I-2107					—
	DKU	3390-A	3390-A (3 type)	3390-A (9 type)	3390-A (L type)	3390-A (M type)	3390-V
Storage capacity (GB/volume)		223.257 (*2)	2.838 (*2)	8.514 (*2)	27.844 (*2)	55.689 (*2)	712.062 (*2)
Number of volumes /parity groups	DKC-F710I-146KCM	8	—	—	—	34	2
	DKC-F710I-300JCM/KCM	17	—	—	—	64	5
	DKC-F710I-600JCM	34	—	—	—	137	10
	DKC-F710I-900JCM	51	—	—	—	205	16
	DKC-F710I-1R2JCM	68	—	—	—	274	21
	DKC-F710I-200SAM/SCM/MCM	11	—	—	—	46	3
	DKC-F710I-400SCM/S1M/S3M/MCM	23	—	—	—	93	7
	DKC-F710I-800MCM	46	—	—	—	187	14
	DKC-F710I-500HCM	29	—	—	—	117	9
	DKC-F710I-1R0HCM	58	—	—	—	234	18
	DKC-F710I-2R0H2M	116	—	—	—	466	36
	DKC-F710I-2R0H3M	116	—	—	—	465	36
	DKC-F710I-3R0H3M	174	—	—	—	698	55
	DKC-F710I-4R0H3M	232	—	—	—	931	73
	DKC-F710I-1R6FM	104	—	—	—	418	32
Maximum number of parity groups	DKC-F710I-3R2FM	209	—	—	—	836	65
	DKC-F710I-146KCM	127	—	—	—	127	127
	DKC-F710I-300JCM/KCM	127	—	—	—	127	127
	DKC-F710I-600JCM	127	—	—	—	127	127
	DKC-F710I-900JCM	127	—	—	—	127	127
	DKC-F710I-1R2JCM	127	—	—	—	127	127
	DKC-F710I-200SAM/SCM/MCM	16	—	—	—	16	16
	DKC-F710I-400SCM/S1M/S3M/MCM	16	—	—	—	16	16
	DKC-F710I-800MCM	16	—	—	—	16	16
	DKC-F710I-500HCM	127	—	—	—	127	127
	DKC-F710I-1R0HCM	127	—	—	—	127	127
	DKC-F710I-2R0H2M	79	—	—	—	79	79
	DKC-F710I-2R0H3M	79	—	—	—	79	79
	DKC-F710I-3R0H3M	79	—	—	—	79	79
	DKC-F710I-4R0H3M	79	—	—	—	79	79
Maximum number of volumes	DKC-F710I-1R6FM	11	—	—	—	11	11
	DKC-F710I-3R2FM	11	—	—	—	11	11
	DKC-F710I-146KCM	1,016	—	—	—	4,318	254
	DKC-F710I-300JCM/KCM	2,159	—	—	—	8,128	635
	DKC-F710I-600JCM	4,318	—	—	—	17,399	1,270
	DKC-F710I-900JCM	6,477	—	—	—	26,035	2,032
	DKC-F710I-1R2JCM	8,636	—	—	—	34,798	2,667
	DKC-F710I-200SAM/SCM/MCM	176	—	—	—	736	48
	DKC-F710I-400SCM/S1M/S3M/MCM	368	—	—	—	1,488	112
	DKC-F710I-800MCM	736	—	—	—	2,992	224
	DKC-F710I-500HCM	3,683	—	—	—	14,859	1,143
	DKC-F710I-1R0HCM	7,366	—	—	—	29,718	2,286
	DKC-F710I-2R0H2M	9,164	—	—	—	36,814	2,844
	DKC-F710I-2R0H3M	9,164	—	—	—	36,735	2,844
	DKC-F710I-3R0H3M	13,746	—	—	—	55,142	4,345
	DKC-F710I-4R0H3M	18,328	—	—	—	65,170	5,767
	DKC-F710I-1R6FM	1,144	—	—	—	4,598	352
	DKC-F710I-3R2FM	2,299	—	—	—	9,196	715

Table 3.32.3.5.1-6 List of DKC710I Model Emulation Types for RAID6 (14D+2P) (6/6)

Item			Emulation contents					
Emulation Type	DKC		I-2107					—
	DKU		3390-A	3390-A (3 type)	3390-A (9 type)	3390-A (L type)	3390-A (M type)	3390-V
Subsystem capacity (user area) (GB)	DKC-F710I-146KCM	Min	1,786	—	—	—	1,893	1,424
		Max	226,829	—	—	—	240,465	180,864
	DKC-F710I-300JCM/KCM	Min	3,795	—	—	—	3,564	3,560
		Max	482,012	—	—	—	452,640	452,159
	DKC-F710I-600JCM	Min	7,591	—	—	—	7,629	7,121
		Max	964,024	—	—	—	968,933	904,319
	DKC-F710I-900JCM	Min	11,386	—	—	—	11,416	11,393
		Max	1,446,036	—	—	—	1,449,863	1,446,910
	DKC-F710I-1R2JCM	Min	15,181	—	—	—	15,259	14,953
		Max	1,928,047	—	—	—	1,937,866	1,899,069
	DKC-F710I-200SAM/SCM/MCM	Min	2,456	—	—	—	2,562	2,136
		Max	39,293	—	—	—	40,987	34,179
	DKC-F710I-400SCM/S1M/S3M/MCM	Min	5,135	—	—	—	5,179	4,984
		Max	82,159	—	—	—	82,865	79,751
	DKC-F710I-800MCM	Min	10,270	—	—	—	10,414	9,969
		Max	164,317	—	—	—	166,621	159,502
	DKC-F710I-500HCM	Min	6,474	—	—	—	6,516	6,409
		Max	822,256	—	—	—	827,483	813,887
	DKC-F710I-1R0HCM	Min	12,949	—	—	—	13,031	12,817
		Max	1,644,511	—	—	—	1,654,966	1,627,774
	DKC-F710I-2R0H2M	Min	25,898	—	—	—	25,951	25,634
		Max	2,045,927	—	—	—	2,050,135	2,025,104
	DKC-F710I-2R0H3M	Min	25,898	—	—	—	25,895	25,634
		Max	2,045,927	—	—	—	2,045,735	2,025,104
	DKC-F710I-3R0H3M	Min	38,847	—	—	—	38,871	39,163
		Max	3,068,891	—	—	—	3,070,803	3,093,909
	DKC-F710I-4R0H3M	Min	51,796	—	—	—	51,846	51,981
		Max	4,091,854	—	—	—	3,629,252	4,106,462
	DKC-F710I-1R6FM	Min	23,219	—	—	—	23,278	22,786
		Max	255,406	—	—	—	256,058	250,646
	DKC-F710I-3R2FM	Min	46,660	—	—	—	46,556	46,284
		Max	513,267	—	—	—	512,116	509,124

- *1: The value of OPEN-V is the default one in the installation of parity group. In case of OPEN-V, storage capacity differs depending on RAID level and DKU (HDD) type because OPEN-V is CVS basis. The default volume size is nearly equal to that of a parity group.
- *2: The value is the capacity for Main Frame Host.
- *3: The number in parentheses is the value in SATA-Enhance method.

THEORY03-32-390**Table 3.32.3.5.1-7 The relation between OPEN-V capacity, RAID level and DKU type (1/2)**

DKU type		Capacity			Number of LDEV
		MB	CYL	Logical BlockSR	
RAID5 (3D+1P)	DKC-F710I-146KCM	411313.5	438734	842370048	1
	DKC-F710I-300JCM/KCM	824536.5	879505.6	1688650752	1
	DKC-F710I-600JCM	1649074.5	1759012.8	3377304576	1
	DKC-F710I-900JCM	2473764.0	2638681.6	5066268672	1
	DKC-F710I-1R2JCM	3298149.0	3518025.6	6754609152	2
	DKC-F710I-200SAM/SCM/MCM	563400.0	600960.0	1153843200	1
	DKC-F710I-400SCM/S1M/S3M/MCM	1126801.5	1201921.6	2307689472	1
	DKC-F710I-800MCM	2253604.5	2403844.8	4615382016	1
	DKC-F710I-500HCM	1408503.0	1502403.2	2884614144	1
	DKC-F710I-1R0HCM	2817006.0	3004806.4	5769228288	1
	DKC-F710I-2R0H2M	5635128.0	6010803.2	11540742144	2
	DKC-F710I-2R0H3M	5602086.0	5975558.4	11473072128	2
	DKC-F710I-3R0H3M	8403129.0	8963337.6	17209608192	3
	DKC-F710I-4R0H3M	11204172.0	11951116.8	22946144256	4
	DKC-F710I-1R6FM	5033157.0	5368700.8	10307905536	2
	DKC-F710I-3R2FM	10066320.0	10737408.0	20615823360	4
RAID5 (7D+1P)	DKC-F710I-146KCM	959731.5	1023713.6	1965530112	1
	DKC-F710I-300JCM/KCM	1923918.5	2052179.7	3940185088	1
	DKC-F710I-600JCM	3847837.0	4104359.4	7880370176	2
	DKC-F710I-900JCM	5772116.0	6156923.7	11821293568	2
	DKC-F710I-1R2JCM	7695681.0	8208726.4	15760754688	3
	DKC-F710I-200SAM/SCM/MCM	1314600.0	1402240.0	2692300800	1
	DKC-F710I-400SCM/S1M/S3M/MCM	2629203.5	2804483.7	5384608768	1
	DKC-F710I-800MCM	5258407.0	5608967.4	10769217536	2
	DKC-F710I-500HCM	3286507.0	3505607.4	6730766336	2
	DKC-F710I-1R0HCM	6573010.5	7011211.2	13461525504	3
	DKC-F710I-2R0H2M	13148520.0	14025088.0	26928168960	5
	DKC-F710I-2R0H3M	13071537.5	13942973.3	26770508800	5
	DKC-F710I-3R0H3M	19607301.0	20914454.4	40155752448	7
	DKC-F710I-4R0H3M	26143078.0	27885950.4	53541024768	9
	DKC-F710I-1R6FM	11744026.0	12526961.0	24051765248	4
	DKC-F710I-3R2FM	23488080.0	25053952.0	48103587840	8
RAID1 (2D+2D)	DKC-F710I-146KCM	274209.0	292489.6	561580032	1
	DKC-F710I-300JCM/KCM	549691.0	586337.0	1125767168	1
	DKC-F710I-600JCM	1099383.0	1172675.2	2251536384	1
	DKC-F710I-900JCM	1649176.0	1759121.0	3377512448	1
	DKC-F710I-1R2JCM	2198766.0	2345350.4	4503072768	1
	DKC-F710I-200SAM/SCM/MCM	375600.0	400640.0	769228800	1
	DKC-F710I-400SCM/S1M/S3M/MCM	751201.0	801281.0	1538459648	1
	DKC-F710I-800MCM	1502403.0	1602563.2	3076921344	1
	DKC-F710I-500HCM	939002.0	1001602.1	1923076096	1
	DKC-F710I-1R0HCM	1878004.0	2003204.2	3846152192	1
	DKC-F710I-2R0H2M	3756756.0	4007206.4	7693836288	2
	DKC-F710I-2R0H3M	3734724.0	3983705.6	7648714752	2
	DKC-F710I-3R0H3M	5602088.0	5975560.5	11473076224	2
	DKC-F710I-4R0H3M	7469451.0	7967414.4	15297435648	3
	DKC-F710I-1R6FM	3355438.0	3579133.8	6871937024	2
	DKC-F710I-3R2FM	6710883.0	7158275.2	13743888384	3

THEORY03-32-391**Table 3.32.3.5.1-7 The relation between OPEN-V capacity, RAID level and DKU type (2/2)**

DKU type		Capacity			Number of LDEV
		MB	CYL	Logical BlockSR	
RAID6 (6D+2P)	DKC-F710I-146KCM	822627.0	877468.8	1684740096	1
	DKC-F710I-300JCM/KCM	1649073.0	1759011.2	3377301504	1
	DKC-F710I-600JCM	3298146.0	3518022.4	6754603008	2
	DKC-F710I-900JCM	4947528.0	5277363.2	10132537344	2
	DKC-F710I-1R2JCM	6596298.0	7036051.2	13509218304	3
	DKC-F710I-200SAM/SCM/MCM	1126800.0	1201920.0	2307686400	1
	DKC-F710I-400SCM/S1M/S3M/MCM	2253603.0	2403843.2	4615378944	1
	DKC-F710I-800MCM	4507206.0	4807686.4	9230757888	2
	DKC-F710I-500HCM	2817006.0	3004806.4	5769228288	1
	DKC-F710I-1R0HCM	5634012.0	6009612.8	11538456576	2
	DKC-F710I-2R0H2M	11270208.0	12021555.2	23081385984	4
	DKC-F710I-2R0H3M	11204172.0	11951116.8	22946144256	4
	DKC-F710I-3R0H3M	16806258.0	17926675.2	34419216384	6
	DKC-F710I-4R0H3M	22408344.0	23902233.6	45892288512	8
	DKC-F710I-1R6FM	10066308.0	10737395.2	20615798784	4
	DKC-F710I-3R2FM	20132637.0	21474812.8	41231640576	7
RAID6 (14D+2P)	DKC-F710I-146KCM	1919463.0	2047427.2	3931060244	1
	DKC-F710I-300JCM/KCM	3847840.5	4104363.2	7880377344	2
	DKC-F710I-600JCM	7695681.0	8208726.4	15760754688	3
	DKC-F710I-900JCM	11544232.0	12313847.4	23642587136	4
	DKC-F710I-1R2JCM	15391355.0	16417445.3	31521495040	5
	DKC-F710I-200SAM/SCM/MCM	2629203.5	2804483.7	5384608768	1
	DKC-F710I-400SCM/S1M/S3M/MCM	5258410.5	5608971.2	10769224704	2
	DKC-F710I-800MCM	10516800.0	11217920.0	21538406400	4
	DKC-F710I-500HCM	6573014.0	7011214.9	13461532672	3
	DKC-F710I-1R0HCM	13146031.5	14022433.6	26923072512	5
	DKC-F710I-2R0H2M	26297309.5	28050463.4	53856889856	9
	DKC-F710I-2R0H3M	26143078.5	27885950.4	53541024768	9
	DKC-F710I-3R0H3M	39214616.0	41828923.7	80311533568	13
	DKC-F710I-4R0H3M	52286101.0	55771841.0	107081934848	17
	DKC-F710I-1R6FM	23488024.0	25053892.2	48103473152	8
	DKC-F710I-3R2FM	46976160.0	50107904.0	96207175680	15

Note: In case of OPEN-V, the relationship between Capacity[MB] and Cylinder number is as follows.

$$A[\text{MB}] = B[\text{Cyl}] * 15 * 128 * 512 / 1000 / 1000 \text{ (1MB = } 1000^2 \text{ byte)}$$

or

$$A[\text{MB}] = B[\text{Cyl}] * 15 * 128 * 512 / 1024 / 1024 \text{ (1MB = } 1024^2 \text{ byte)}$$

where A is the capacity by MB, B is that by Cylinder number.

The relationship between Capacity[MB] and Logical BlockSR is as follows.

$$A[\text{MB}] = C * 512 / 1000 / 1000 \text{ (1MB = } 1000^2 \text{ byte)}$$

or

$$A[\text{MB}] = C * 512 / 1024 / 1024 \text{ (1MB = } 1024^2 \text{ byte)}$$

where C is the capacity by Logical BlockSR.

3.32.3.5.2 Intermix Specification

Refer to 3.7.2 Emulation Device Type (2) of [THEORY03-07-100](#) about Intermix Specification.

3.32.3.5.3 Cross-OS File Exchange volume intermix within ECC group

3.32.3.5.3.1 Cross-OS File Exchange volume intermix within ECC group

- (1) Four emulation types of volume can coexist within one ECC group about each groups below.
 - ① 3390-3A, -3B, -3C, -3 (or 3390-3A, -3B, -3C, -3R)
 - ② 3390-9A, -9B, -9C, -9
 - ③ 3390-LA, -LB, -LC, -L
- (2) The type can be changed for each one volume within an ECC group.
- (3) The type can be changed by the emulation type change function of the SVP.
- (4) The emulation type change function allows any change of types among 3A, 3B, 3C, 3, and 3R.
- (5) At “define configuration and install” or installation of disk drives, device definition and LDEV-FMT are performed in units of ECC group with any type of 3A, 3B, 3C, 3, and 3R. Afterwards the type is changed for each one volume if necessary.
When the type change is completed, all volumes are initialized (a VTOC is created for volumes) from the mainframe system.
- (6) After the type change, the previous data is not assured.
After the type change, all volumes must be initialized (a VTOC must be created) from the mainframe system.
However, data is assured as before for the type change between 3390-3 and 3390-3R, and if you want to assure the data, all volumes must not be initialized (a VTOC must not be created). Any data is not assured for a type change other than that between 3390-3 and 3390-3R.

3.32.3.5.3.2 Intermix with 3390-3R

- (1) The 3390-3/-3A/-3B/-3C types can coexist within a subsystem.
Intermixing is allowed both within and beyond a 32-LDEV address boundary.
- (2) The 3390-3R/-3A/-3B/-3C types can coexist within a subsystem.
 - An intermixture of the 3390-3R and any of 3390-3A/-3B/-3C is allowed in units of 32-LDEV address boundary (with the same type within each boundary). It is not allowed within a 32-LDEV address boundary because of the restriction on the mainframe system.
 - An intermixture of the 3390-3A/-3B/-3C is allowed within and out of units of 32-LDEV address boundary.
- (3) The 3390-3 and 3390-3R cannot coexist within a subsystem.
 - When changing the type from 3390-3 to 3390-R and vice versa by the emulation type change function, the type must be changed not partially but totally, since the 3390-3 and 3390-3R cannot coexist within a subsystem.
The SVP rejects partial change.
 - The intermixture can be changed from that of the 3390-3/-3A/-3B/-3C to that of the 3390-3R/-3A/-3B/-3C (with an intermixture part of the 3390-3A/-3B/-3C remaining unchanged) and vice versa by the emulation type change function between 3390-3 and 3390-3R.

3.32.3.6 Volume Configuration

3.32.3.6.1 Volume Configuration

(1) Minimum Volume Configuration

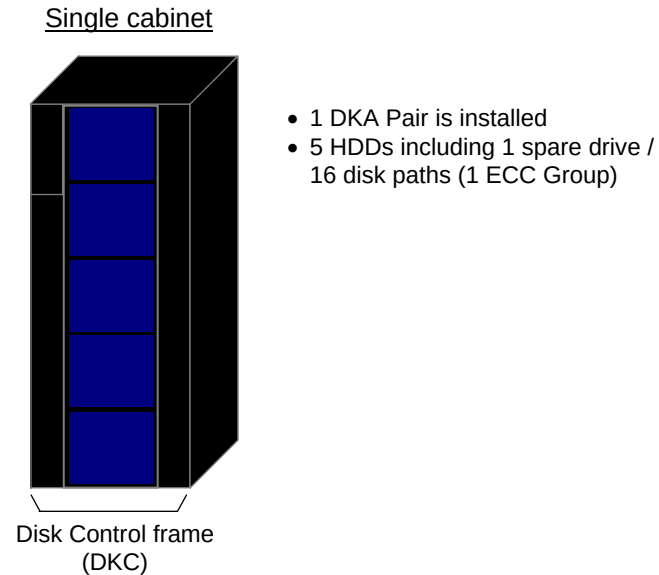


Fig. 3.32.3.6.1-1 Minimum volume configuration

(2) Maximum Volume Configuration

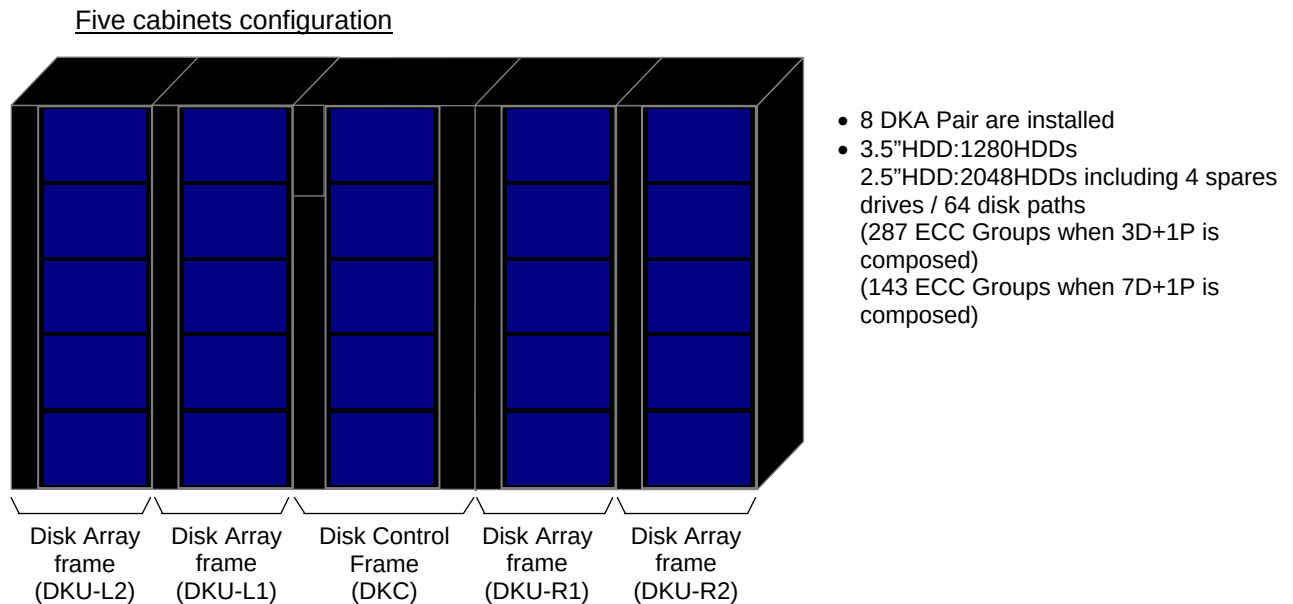


Fig. 3.32.3.6.1-2 Maximum volume configuration

3.32.3.6.2 Intermix Volume Configuration

PDEV intermix of same parity group : ECC group
 PDEV intermix of different parity group : DKA pair
 RAID intermix : DKA pair
 LDEV intermix : ECC group
 MF/OPEN volume intermix : ECC group

(1) Typical LDEV intermix configuration

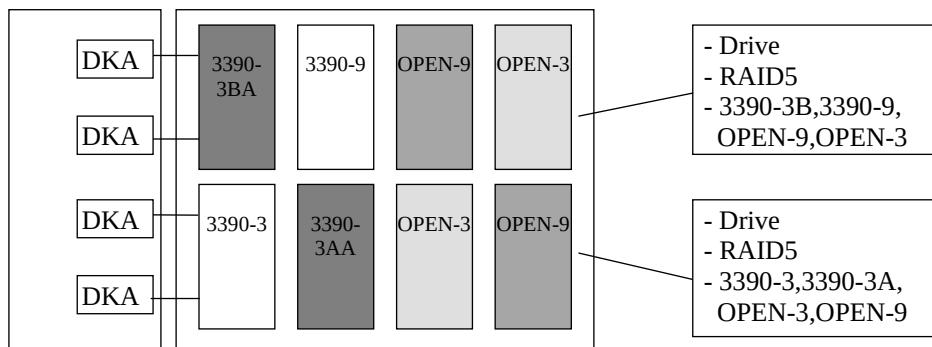


Fig. 3.32.3.6.2-1 Typical LDEV intermix configuration example

(2) Typical RAID intermix configuration

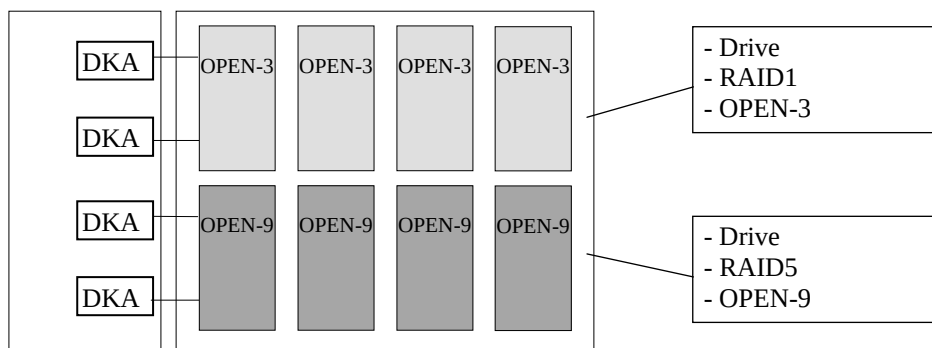


Fig. 3.32.3.6.2-2 Typical RAID intermix configuration example

(3) Typical PDEV intermix configuration

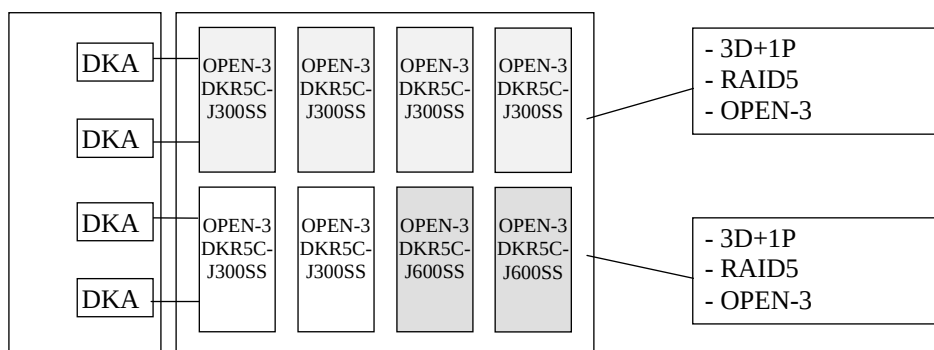


Fig. 3.32.3.6.2-3 Typical PDEV intermix configuration example

3.32.3.6.3 Cross-OS File Exchange Volume Configuration

(1) Typical volume configuration for Cross-OS File Exchange

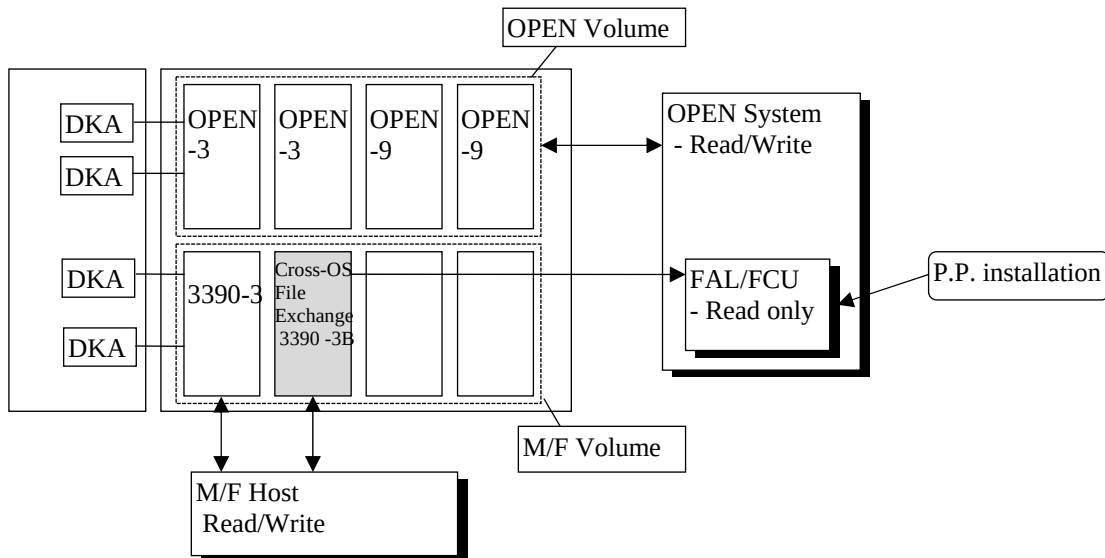


Fig. 3.32.3.6.3-1 Typical volume configuration for Cross-OS File Exchange

(2) Valid volume configuration

The configuration shown in Fig. 3.32.3.6.3-2 is valid.

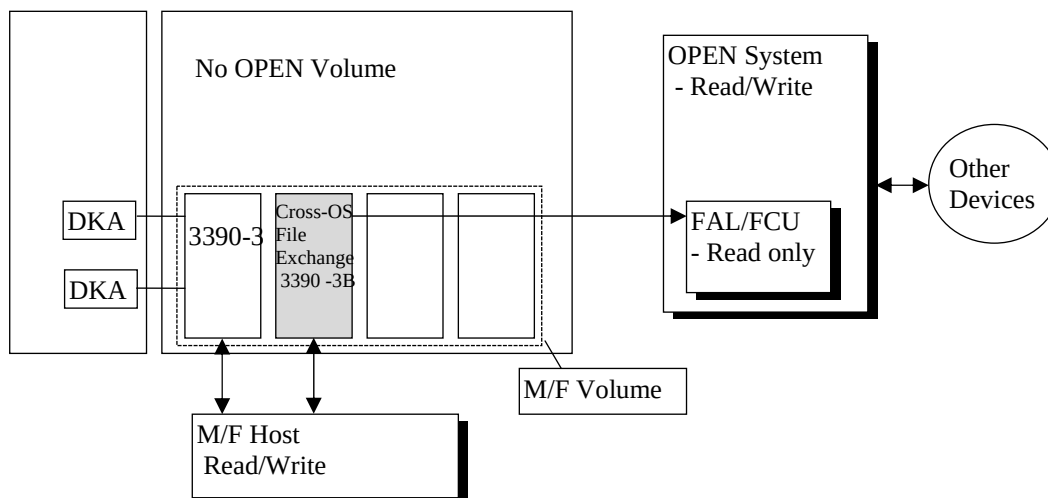


Fig. 3.32.3.6.3-2 Valid volume configuration for Cross-OS File Exchange

3.32.3.6.4 HMBR Volume Configuration

(1) Typical volume configuration example for HMBR

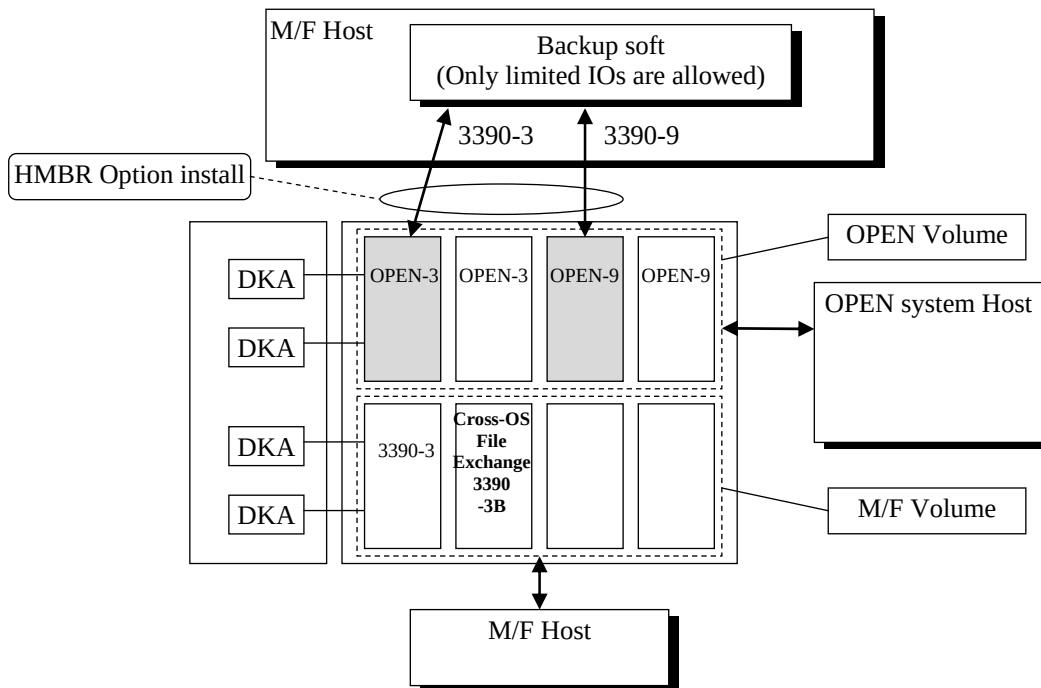


Fig. 3.32.3.6.4-1 Typical volume configuration for HMBR

(2) Valid volume configuration example for HMBR

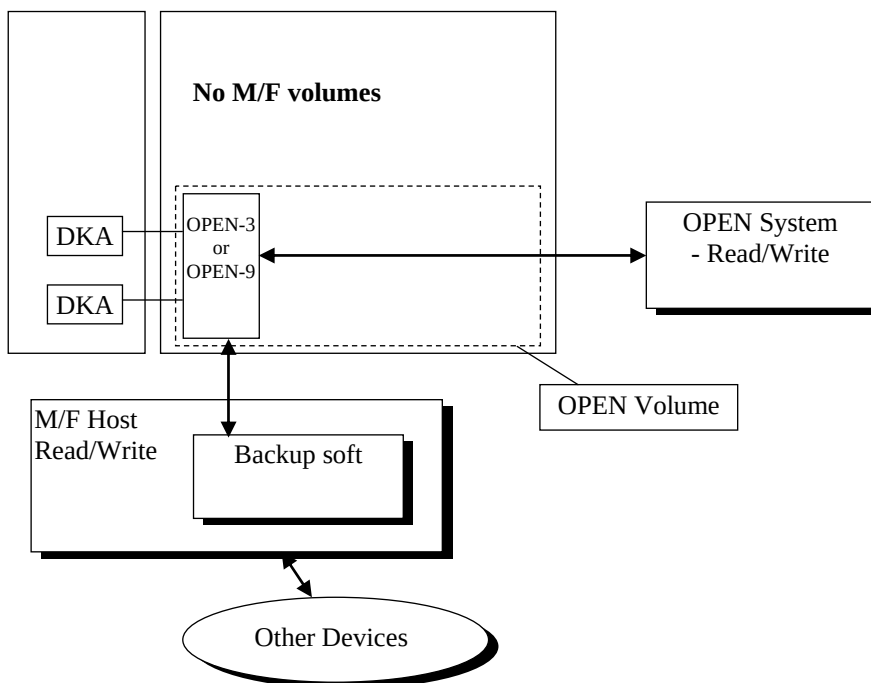


Fig. 3.32.3.6.4-1 Valid volume configuration for HMBR

3.32.3.7 Open Volume Setting

3.32.3.7.1 Setting of open volume space

The procedure of open volume setting is performed either by using the SVP or Storage Navigator function (optional feature).

3.32.3.7.2 LUN setting

- LUN setting:

- Select the CHF, Fibre port and the LUN, and select the CU# and LDEV# to be assigned to the LUN.
- Repeat the above procedure as needed.

The MCU port (Initiator port) of TrueCopy function does not support this setting.

Note 1: It is possible to refer to the contents which is already set on the SVP display.

Note 2: The above setting can be done during on-line.

Note 3: Duplicated access paths' setting from the different hosts to the same LDEV is allowed. This will provide a means to share the same volume among host computers. It is, however, the host responsibility to manage an exclusive control on the shared volume.

Refer to the INSTALLATION SECTION for more detailed procedures.

3.32.3.8 Host mode setting

It is necessary to set Host Mode by using SVP if you want to change a host system.
The meanings of each mode are follows.

*****HDS RAID Controller Models*****

MODE 00 : Standard mode (Linux)
 MODE 01 : VMWare host mode
 MODE 03 : HP-UX host mode
 MODE 05 : OpenVMS host mode
 MODE 07 : Tru64 host mode
 MODE 09 : Solaris host mode
 MODE 0A : NetWare host mode
 MODE 0C : Windows2000/2003
 MODE 0F : AIX host mode
 MODE 21 : VMWare host mode (Online LUSE)
 MODE 2C : Windows2000/2003 host mode (Online LUSE)
 MODE 4C : UVM connection host mode *1
 others : Reserved

*****HP RAID Controller Models*****

MODE 00 : Standard mode (Linux)
 MODE 01 : VMWare host mode
 MODE 05 : OpenVMS host mode
 MODE 07 : Tru64 host mode
 MODE 08 : HP-UX host mode
 MODE 09 : Solaris host mode
 MODE 0A : NetWare host mode
 MODE 0C : Windows2000/2003, NonStop OS
 MODE 0F : AIX host mode
 MODE 21 : VMWare host mode (Online LUSE)
 MODE 2C : Windows2000/2003 host mode (Online LUSE), NonStop OS (Online LUSE)
 MODE 4C : UVM connection host mode *1
 others : Reserved

Please set the HOST MODE OPTION if required.

Please see “LUN Management” ([INST05-1040 to INST05-1610](#)). Also see the operational manual for more detailed information about the alternate link and HA software.

*1: If setting this mode to ON when DKC710I is being used as an External Storage, the data of the MF-VOL (Multi-platform VOL emulation only) in the DKC710I can be succeeded.

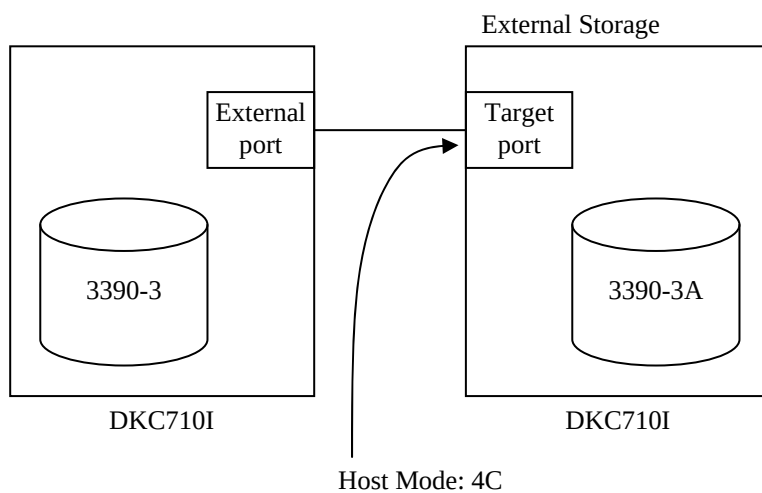


Fig. 3.32.3.8-1 Typical system configuration in MODE 4C

3.32.4 Control Function

3.32.4.1 Cache Usage

The DKC has two independent areas of non-volatile cache memory for the mainframe volumes. This mechanism also commonly applies to the OPEN volumes without any distinction. Thus, the high reliability and high performance realized by the following features can be commonly applied to the OPEN volumes.

① Cache data management by LRU control

Data that has been read out is stored into the cache and managed under LRU control. For upright transaction processing, therefore, a high cache hit ratio can be expected and a data-writing time is reduced for improved system throughput.

② Adoption of DFW (DASD Fast Write)

At the same time that the normal write command writes data into the cache, it reports the end of the write operations to a host. Data writing to disk is asynchronous with host access. The host, therefore, can execute the next process without waiting for the end of data writing to disk.

③ Write data duplexing

The same write data is stored into the two areas of a cache provided in the DKC. Thus, loss of DFW data can be avoided even one failure occurs in the cache.

④ Nonvolatile cache

The cache in the DKC is non-volatile by battery backup. Once data has been written into the cache, its non-volatility will maintain the data, even if a power interruption occurs. Under a standard system configuration having a fully charged battery pack, data is guaranteed for at least 48 hours

3.32.4.2 SCSI Command Multi-processing

3.32.4.2.1 Command Tag Queuing

The Command Tag Queuing function defined in the SCSI specification is supported. This function allows each Fibre port on CHF to accept multiple SCSI commands even for the same LUN. The DKC can process those queued commands in parallel because a LUN is composed of multiple physical disk drives.

The MCU port (Initiator port) of TrueCopy function can not support this function because it does not support a connection with a host computer.

3.32.4.2.2 Concurrent data transfer

Four Fibre ports on a CHF can perform the host I/Os and data transfer with maximum 8 Gbps (in case of FCoE, the maximum speed is 10 Gbps) transfer concurrently.

This is also applied among different CHFs.

The MCU port (Initiator port) of TrueCopy function can not support this function because it does not support a connection with a host computer.

THEORY03-32-520**3.32.5 SCSI Commands****3.32.5.1 Fibre**

The DASD commands defined under the SCSI-3 standards and those supported by the DKC are listed in Table 3.32.5.1-1.

Table 3.32.5.1-1 SCSI-3 DASD commands and DKC-supported commands

Group	Op Code	Name of Command	Type	O:Supported	Remarks
0 (00 _H -1F _H)	00 _H	Test Unit Ready	CTL/SNS	○	
	01 _H	Rezero Unit	CTL/SNS	Nop	
	03 _H	Request Sense	CTL/SNS	○	
	04 _H	Format Unit	DIAG	Nop	
	07 _H	Reassign Blocks	DIAG	○	For RAID5, Nop
	08 _H	Read (6)	RD/WR	○	
	0A _H	Write (6)	RD/WR	○	
	0B _H	Seek (6)	CTL/SNS	Nop	
	12 _H	Inquiry	CTL/SNS	○	
	15 _H	Mode Select (6)	CTL/SNS	○	
	16 _H	Reserve	CTL/SNS	○	
	17 _H	Release	CTL/SNS	○	
	18 _H	Copy	—	—	
	1A _H	Mode Sense (6)	CTL/SNS	○	
	1B _H	Start/Stop Unit	CTL/SNS	Nop	
	1C _H	Receive Diagnostic Results	DIAG	—	
	1D _H	Send Diagnostic	DIAG	Nop	Supported only for self-test.
	1E _H	Prevent Allow Medium Removal	—	—	
	1F _H	Reserved code	—	—	
	Other	Vendor-unique	—	—	
1 (20 _H -3F _H)	25 _H	Read Capacity (10)	CTL/SNS	○	
	28 _H	Read (10)	RD/WR	○	
	2A _H	Write (10)	RD/WR	○	
	2B _H	Seek (10)	CTL/SNS	Nop	
	2E _H	Write And Verify (10)	RD/WR	○	Supported only Write for DKC710I.
	2F _H	Verify (10)	RD/WR	Nop	
	30 _H	Search Data High	—	—	
	31 _H	Search Data Equal	—	—	
	32 _H	Search Data Low	—	—	
	33 _H	Set Limits (10)	—	—	
	34 _H	Pre-Fetch (10)	—	—	
	35 _H	Synchronize Cache (10)	CTL/SNS	Nop	
	36 _H	Lock-Unlock Cache (10)	—	—	
	37 _H	Read Defect Data (10)	DIAG	○	No defect always reported.
	38 _H	Reserved code	—	—	
	39 _H	Compare	—	—	

THEORY03-32-530**Table 3.32.5.1-1 SCSI-2 DASD commands and DKC-supported commands (Continued)**

Group	Op Code	Name of Command	Type	O:Supported	Remarks
1 (20 _H -3F _H)	3A _H	Copy And Verify	—	—	
	3B _H	Write Buffer	DIAG	○	
	3C _H	Read Buffer	DIAG	○	
	3D _H	Reserved code	—	—	
	3E _H	Read Long	—	—	
	3F _H	Write Long	—	—	
	Other	Vendor-unique	—	—	
2 (40 _H -5F _H)	40 _H	Change Definition	—	—	
	41 _H	Write Same	—	—	
	4C _H	Log Select	—	—	
	4D _H	Log Sense	—	—	
	50 _H	XD Write (10)	—	—	
	51 _H	XP Write (10)	—	—	
	52 _H	XD Read (10)	—	—	
	53 _H	XD Write Read (10)	—	—	
	55 _H	Mode Select (10)	CTL/SNS	○	
	56 _H	Reserve (10)	CTL/SNS	○	
	57 _H	Release (10)	CTL/SNS	○	
	5A _H	Mode Sense (10)	CTL/SNS	○	
	5E _H	Persistent Reserve IN	CTL/SNS	○	
	5F _H	Persistent Reserve OUT	CTL/SNS	○	
	Other	Reserved code	—	—	
3 (60 _H -7F _H)	7F _H /0001	Rebuild (32)	—	—	
	7F _H /0002	Regenerate (32)	—	—	
	7F _H /0003	XD Read (32)	—	—	
	7F _H /0004	XD Write (32)	—	—	
	7F _H /0005	XD Write Extend (32)	—	—	
	7F _H /0006	XD Write (32)	—	—	
	7F _H /0007	XD Write Read (32)	—	—	
	7F _H /0008	XD Write Extend (64)	—	—	
	Other	Reserved code	—	—	
4 (80 _H -9F _H)	80 _H	XD Write Extend (16)	—	—	
	81 _H	Rebuild (16)	—	—	
	82 _H	Regenerate (16)	—	—	
	83 _H	Extended Copy	CTL/SNS	○	
	84 _H	Receive Copy Result	CTL/SNS	○	
	85 _H	Access Control IN	—	—	
	86 _H	Access Control OUT	—	—	
	88 _H	Read (16)	RD/WR	○	
	8A _H	Write (16)	RD/WR	○	
	8C _H	Read Attributes	—	—	
	8D _H	Write Attributes	—	—	

THEORY03-32-540**Table 3.32.5.1-1 SCSI-2 DASD commands and DKC-supported commands (Continued)**

Group	Op Code	Name of Command	Type	○:Supported	Remarks
4 (80 _H -9F _H)	8E _H	Write And Verify (16)	RD/WR	○	
	8F _H	Verify (16)	RD/WR	Nop	
	90 _H	Pre-Fetch (16)	—	—	
	91 _H	Synchronized Cache (16)	CTL/SNS	Nop	
	92 _H	Lock-Unlock Cache (16)	—	—	
	93 _H	Write Same (16)	—	—	
	9E/10 _H	Read Capacity (16)	CTL/SNS	○	
	Other	Vendor-unique	—	—	
5 (A0 _H -BF _H)	A0 _H	Report LUN	CTL/SNS	○	
	A3 _H /xx _H	Maintenance IN	CTL/SNS	—	
	A3 _H /05 _H	Report Device Identifier	CTL/SNS	○	
	A3 _H /0A _H	Report Target Port Groups	CTL/SNS	—	
	A3 _H /0B _H	Report Aliases	CTL/SNS	—	
	A3 _H /0C _H	Report Supported Operation Codes	CTL/SNS	—	
	A3 _H /0D _H	Report Supported Task Management Functions	CTL/SNS	—	
	A3 _H /0E _H	Report Priority	CTL/SNS	—	
	A3 _H /0F _H	Report Timestamp	CTL/SNS	—	
	A4 _H /XX _H	Maintenance OUT	CTL/SNS	—	
	A4 _H /06 _H	Set Device Identifier	CTL/SNS	—	
	A4 _H /0A _H	Set Target Port Groups	CTL/SNS	○	
	A4 _H /0B _H	Change Aliases	CTL/SNS	—	
	A4 _H /0E _H	Set Priority	CTL/SNS	—	
	A4 _H /0F _H	Set Timestamp	CTL/SNS	—	
	A7 _H	Move Medium Attached	—	—	
	A8 _H	Read (12)	RD/WR	○	
	AA _H	Write (12)	RD/WR	○	
	AE _H	Write And Verify (12)	RD/WR	○	However, only the Write operation.
	AF _H	Verify (12)	RD/WR	Nop	
	B3 _H	Set Limits (12)	—	—	
	B4 _H	Read Element Status Attached	—	—	
	B7 _H	Read Defect Data (12)	CTL/SNS	○	However, it always reports on Defect nothing.
	BA _H	Redundancy Group IN	—	—	
	BB _H	Redundancy Group OUT	—	—	
	BC _H	Spare IN	—	—	
	BD _H	Spare OUT	—	—	
	BE _H	Volume Set IN	—	—	
	BF _H	Volume Set OUT	—	—	
	Other	Reserved code	—	—	

THEORY03-32-550**Table 3.32.5.1-1 SCSI-2 DASD commands and DKC-supported commands (Continued)**

Group	Op Code	Name of Command	Type	O:Supported	Remarks
6 (C0 _H -DF _H)	C0 _H ~D0 _H	Vendor-unique	—	—	
7 (E0 _H -FF _H)	E8 _H	Read With Skip Mask (IBM-unique)	CTL/SNS	—	
	EA _H	Write With Skip Mask (IBM-unique)	CTL/SNS	—	
	Other	Vendor-unique	—	—	

3.32.6 Cross-OS File Exchange

3.32.6.1 Overview

The Cross-OS File Exchange optional feature provides a function to enable the SAM files of the mainframe to be accessed by the open system host by executing the File Access Library (FAL) program or File Conversion Utility (FCU) program installed in the open system host. Accessible frame files are limited to the SAM files only.

The FCU program has code conversion function between EBCDIC and ASCII.

The FAL has disclosed API and users can incorporate the FAL program directly into a user program.

This optional feature is supplied as a program product (P.P.) that consists of the following programs:

- (1) File Access Library program (FAL)
 - C language functions and a Header file for incorporation into a user program
- (2) File Conversion Utility program (FCU)
 - An execution-format utility program that contains the access library

The program product is supplied separately for each platform of the open system. Table 3.32.6.1-1 lists platforms supported for using the Cross-OS File Exchange.

Table 3.32.6.1-1 Platforms supported

#	Platform supported	OS	Window System
1	SUN	Solaris	Motif 1.2
2	HP	HP-UX, Tru64	Motif 1.2
3	IBM	AIX	Motif 1.2
4	(Not specified)	Windows2000 Windows2003 Windows2008	MFC
5	(Not specified)	Linux	MFC

3.32.6.2 Installation

(1) Installation of P.P.

For the method of installing the P.P. (containing FAL and FCU) and its detailed specifications, refer to the manual attached to the P.P.

(2) Cross-OS File Exchange volume setting

Volumes whose emulation type is 3390-3A, 3390-3B, 3390-3C, 3390-9A, 3390-9B, 3390-9C, 3390-LA, 3390-LB, 3390-LC, 3390-MA, 3390-MB, 3390-MC, 3380-3A, 3380-3B and 3380-3C can be used for the Cross-OS File Exchange operations. In addition to being accessible as 3390-3/9/L/M type volumes from the mainframe host in the same manner as before, the 3390-3B/9B/LB/MB type volumes permit read-only access from the open system host.

The 3390-3A/9A/LA/MA type volumes can be accessible as 3390-3/9/L/M from the mainframe host and permit a read/write access from the open system host. The 3390-3C/9C/LC/MC can be read only accessible as 3390-3/9/L/M from mainframe host and permit a read/write access from the open system host. The 3390-3C/9C/LC/MC permit creating and updating of VTOC.

The 3380-3B type volumes permit read-only access from the open system host. The 3380-3A type volumes can be accessible as 3380-3 from the mainframe host and permit a read/write access from the open system host. The 3380-3C can be read only accessible as 3380-3 from mainframe host and permit a read/write access from the open system host. The 3380-3C permit creating and updating of VTOC.

Table 3.32.6.2-1 Cross-OS File Exchange volume specifications

#	Volume attribute	Emulation Type	Access right		Remarks
			Mainframe	Open system	
1	Mainframe volume	3390-3A/9A/LA/MA	R/W	R/W	Cross-OS File Exchange volume
2		3390-3B/9B/LB/MB	R/W	R	Cross-OS File Exchange volume
3		3390-3C/9C/LC/MC	R	R/W	Cross-OS File Exchange volume
4		3380-3A	R/W	R/W	Cross-OS File Exchange volume
5		3380-3B	R/W	R	Cross-OS File Exchange volume
6		3380-3C	R	R/W	Cross-OS File Exchange volume
7	Open volume	OPEN-3	(Backup/Restore)	R/W	Cross-OS File Exchange volume
8		OPEN-E		R/W	Cross-OS File Exchange volume
9		OPEN-9	(Backup/Restore)	R/W	Cross-OS File Exchange volume

(To be continued)

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(Continued from the preceding page)

#	Volume attribute	Emulation Type	Access right		Remarks
			Mainframe	Open system	
10		OPEN-L		R/W	Cross-OS File Exchange volume
11		OPEN-8	(Backup/Restore)	R/W	Cross-OS File Exchange volume
12		OPEN-V		R/W	Cross-OS File Exchange volume

The 3390-3A, 3390-3B, 3390-3C, 3390-9A, 3390-9B, 3390-9C, 3390-LA, 3390-LB, 3390-LC, 3390-MA, 3390-MB, 3390-MC, 3380-3A, 3380-3B and 3380-3C type Cross-OS File Exchange volumes can be set during initial installation or LDEV addition. To use volumes used by the mainframe and/or OPEN as the Cross-OS File Exchange volumes, they must be set as the Cross-OS File Exchange volumes by removing the corresponding ECC group once and then adding them again.

This procedure is the same as the ordinary one for setting emulation type of another drive.

The drive emulation type can be changed between 3390-3 and 3390-3A and 3390-3B and 3390-3C by change emulation operation. The drive emulation type can be changed between 3390-9 and 3390-9A and 3390-9B and 3390-9C by change emulation operation. The drive emulation type can be changed between 3390-L and 3390-LA and 3390-LB and 3390-LC by change emulation operation. The drive emulation type can be changed between 3390-M and 3390-MA and 3390-MB and 3390-MC by change emulation operation. The drive emulation type can be changed between 3380-3 and 3380-3A and 3380-3B and 3380-3C by change emulation operation.

(3) Setting from the open system host

- To access the Cross-OS File Exchange volumes from the open system host, it is necessary to define the connection to the open system host and to set an OPEN path. The method of defining the OPEN path for the open system host is the same as that of the ordinary OPEN path definition with the SVP.
- Refer to the manual attached to the P.P. for the method of setting the open system host to enable it to access the Cross-OS File Exchange volumes. This setting operation requires labeling of the Cross-OS File Exchange volumes, for example.

3.32.6.3 Notes on Use

A like the ordinary mainframe volumes, the 3390-3B, 3390-3A, 3390-9B, 3390-9A, 3390-LB, 3390-LA, 3390-MB, 3390-MA, 3380-3B and 3380-3A type Cross-OS File Exchange volumes can be accessed from the mainframe. The 3390-3C, 3390-9C, 3390-LC, 3390-MC and 3380-3C type Cross-OS File Exchange volumes can be read only accessed any area except VTOC area from the mainframe.

If the OPEN path are not defined for 3390-3A/B, 3390-9A/B, 3390-LA/B, 3390-MA/B or 3380-3A/B, the volume can not be accessed from the open system host.

Sun/Solaris can not use 3390-MA, 3390-MB and 3390-MC.

3.32.7 HMBR (Hitachi Multiplatform Backup/Restore)

3.32.7.1 Overview

The Hitachi Multiplatform Backup/Restore (HMBR) optional feature allows an open system volume on the DKC disk subsystem to be read from the mainframe host by a volume unit as backup data. It also allows the backup data to be restoreFd from the mainframe host to the open system volume.

Any special additional software packages are not required to perform these functions on both mainframe host and open system host. The DKC disk subsystem can convert the different data block format between open system (fixed block length data) and mainframe system (CKD format data).

The HMBR has the following features:

- (1) Enabling the existing backup/restore programs such as “DFHSM and DFDSS” or “DFSMSHsm and DFSMSdss” in the mainframe to collect and restore the backup of open system data under the DKC Multiplatform disk subsystem in a unit of Logical Unit volume.
- (2) Performing the backup and restore operation with high data transfer rate of FICON 100/200/400/800 MB/s between mainframe host and the DKC disk subsystem.
- (3) Providing the open systems with powerful backup functions being used on mainframe systems, such as backup file generation management, primary/secondary duplication management, and automatic backup control.
- (4) Offering various backup media to the system, such as disk drives, magnetic tapes, or magnetic tape libraries.

3.32.7.2 System Configuration

A system configuration example and functional overview are shown in the Fig. 3.32.7.2-1.

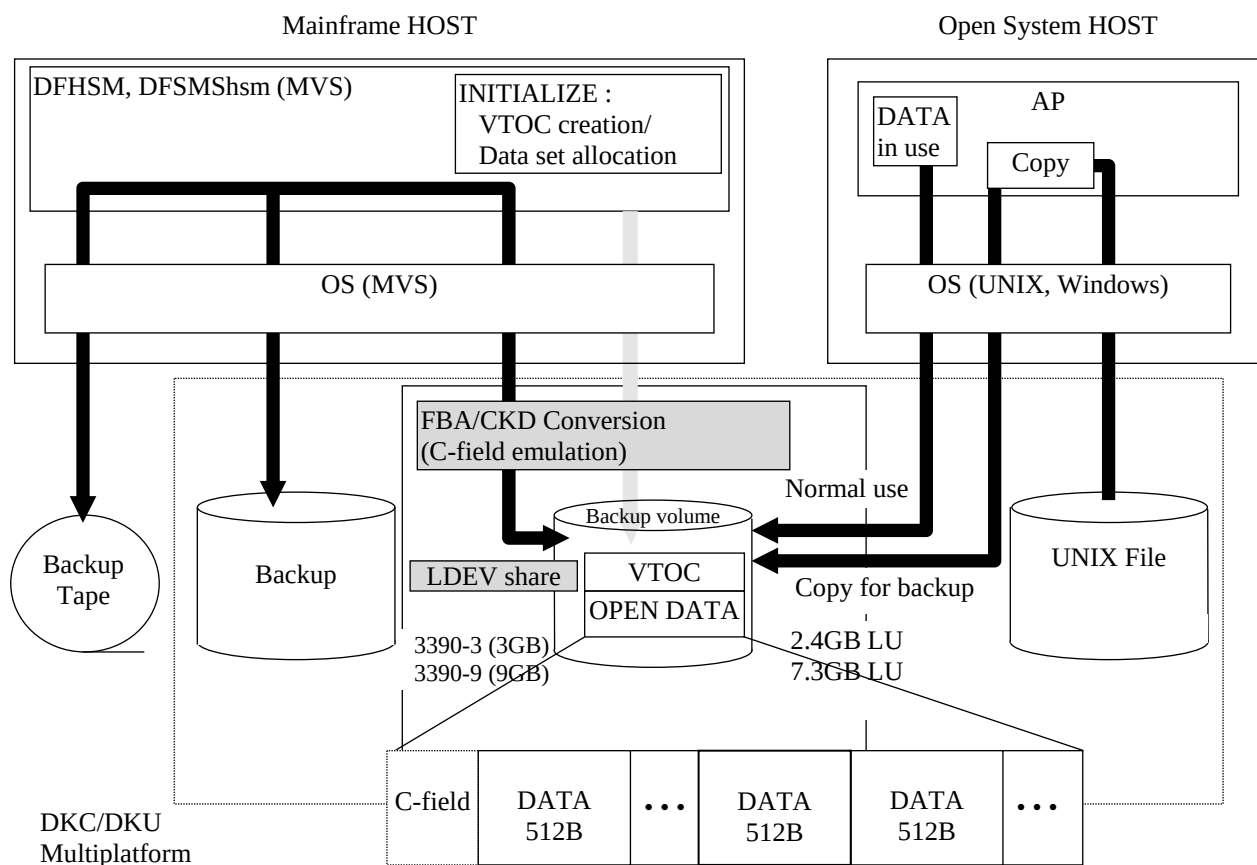


Fig. 3.32.7.2-1 System configuration example

THEORY03-32-620**3.32.7.3 Basic Specification**

The basic specification of HMBR is shown in the Table 3.32.7.3-1.

Table 3.32.7.3-1 Basic specification of HMBR

No	Item		Specification		Remarks
1	Attached system	Mainframe	MVS/ESA		
2		Open system	SUN (Solaris 2.6) or later HP (HP-UX 10.x) or later IBM (AIX 4.2) or later Windows2000/2003/2008		
3	Backup software	Mainframe	DFHSM, DFDSS DFSMSHsm, DFSMSdss		
4	Device type	Mainframe	3390-3	3390-9	
5		Open system	OPEN-3 (LUN=2.4GB)	OPEN-8/9 (LUN=7.3GB)	
6	Maximum number of volumes for backup/restore		- As many Logical Units as specified for OPEN-3/9 for Open system.		
7	Setup for backup volume		- By installing SOM109 option (on SVP), all Logical Units defined as OPEN-3/8/9 can be accessed from MVS		
8	Preparation before taking backup	VSN, VTOC creation	- ICKDSF (INIT)		
9		Dataset allocation	- IEFBR14		
10	Backup method		- Volume full tracks dump by using DFDSS and DFSMSdss.		
11	VTOC format		- Standard VTOC. Note: Do not use SMS for backup volumes since Index VTOC is used in SMS.		
12	VTOC allocation		- Cylinder 0, Head 1 to 14 (fixed location)		
13	Data set allocated	# of data sets	- One/VOL	- Three/VOL	
14		Extent	- Cylinder 1, Head 0 to User cylinder MAX.		
15	Restrictions for mainframe side utility programs		- Other utility programs than listed above are not allowed. - For Write type commands, other than those used by the above listed utility programs are rejected. (Only FORMAT WR with 16KB data length is allowed for write type command.) Read or Control type commands can be used. - Verify option is not allowed.		

3.32.7.4 Backup Volume Specification

(1) Setup for Backup Volume

Step-1: Set system option mode 109 by SVP.

Step-2: By setting the system option mode 109, all the Logical Units (OPEN-3, OPEN-8, and OPEN-9 type), already installed or newly installed, will be ready to be used for backup/restore from the mainframe host.

Note-1 Immediately after the system option mode 109 is de-installed, an access from the mainframe to OPEN-3, OPEN-8 or OPEN-9 will be rejected.

Note-2 The Logical Unit data already stored, which has been used before the installation of system option mode 109, can be used continuously for its original use and/or for backup/restore purpose.

(2) Access to Backup Volume

The specification applied to accessing the backup volume is shown in the Table 3.32.7.4-1.

Table 3.32.7.4-1 Specification of accessing the backup volume

No	Items	Specification
1	Volume type	- OPEN-3 (2.4GB), OPEN-8 (7.3GB), OPEN-9 (7.3GB)
2	Access from Open system	- No restriction.
3	Access from mainframe host	- Possible to Read/Write as 3390-3 for OPEN-3 and as 3390-9 for OPEN-8/9. - For Write type commands, only the following command is allowed: - Format Write with data length of 16 KB. - Other write type commands are rejected.

3.32.7.5 Precautions

(1) Preparations

<System generation>

The volume for HMBR is recognized as the 3390-3 or 3390-9 from the MVS system. Specify UNIT = 3390 using the IODEVICE macro when incorporating the volume into the MVS system.

This volume can be backed up or restored using only DFDSS from the MVS system. Access from other programs is rejected.

<Volume initialization>

Use the system utility to initialize the volume from the mainframe system.

You must create VTOC in Cylinder 0. This initialization works VSN be written in an area other than the area in the volume where the open system data is written, which does not damage the open system data.

<Dataset allocation>

After volume initialization, allocate a single dataset (for OPEN-3; three datasets for OPEN-9) to the volume from the mainframe system. The extent of the dataset is from cylinder 1, head 0 to the user cylinder end.

When executing backup or restoration of the open system data by using HMBR, the backup/restoration utility in the mainframe specifies VSN/DSN of the above volume and dataset for execution. Thus you can facilitate backup or restoration by assigning to VSN and DSN names related to the device file names in the open system of the volume (LU).

(2) Unmounting the volume

When obtaining backup by using HMBR, terminate the open system processing in advance and unmount the volume in order to assure consistency of the backup data. For backup of the volume connected to the AIX system, the varyoffvg command must be executed. If the backup utility in the mainframe is activated without doing this, the backup job may be halted awaiting operator intervention or the job may contain inconsistent, incomplete backup data.

(3) Volume exclusion

Though the volume as target for HMBR is an open volume and stores data in the open system, it also has VSN and can be accessed from the mainframe. Normally it is recommended to keep the volume off-line from the mainframe to prevent a data write from the mainframe that will damage the open system data. During backup or restoration, establish locks to prevent access to the HMBR-target volume (LU) from the open system.

(4) Backup unit

Unit of backup by HMBR is LU. Note that restoring backup data for recovery from damaged files will recover the state when backup was obtained, including other files (files which have not been damaged) within the same LU.

(6) Backup of the volume managed by LVM

Unit of data which can be backed up/restored by HMBR is the physical volume (LU) only. However, because the logical volume may be mapped over more than one physical volume, the consistency of the logical volume data is not assured by LU-based backup. When using HMBR in a system managed by such LVM, you must back up all physical volumes (LUs) comprising volume groups in the same occasion. This requires operational expertise as the following describes:

① **Study of physical/logical mapping (OPEN system)**

Use the commands of the OPEN system to check correspondence between the logical volume group and physical volume group (LU) for the backup target volume.

② **Creating the job control statement (JCL) (mainframe)**

From all physical volumes (LUs) comprising the backup-target volume group obtained in step ①, list the mainframe VSNs and DSNs corresponding to the device file names. When executing backup using the batch job format, create the JCL for executing the backup utility specifying VSNs and DSNs listed above.

③ **Unmounting the target logical volume**

Unmount all logical volumes in the backup-target volume group.

④ **Executing the mainframe backup utility**

Execute the mainframe backup utility to obtain backup of VSNs/DSNs corresponding to all physical volumes (LUs) comprising the backup-target volume group.

⑤ **Precautions**

In the above volume-group-based backup, all logical volumes in the volume group are backed up in the same occasion. Note that restoration is made on a per volume group basis and the entire volume group returns to the state when backup was obtained. When logical-volume-based backup or restoration is required, a volume group must contain only one logical volume.

When modification to the configuration of the logical volume or volume group is made (such as addition, deletion or splitting of logical volumes in a volume group, or addition of a new physical volume in a volume group), volume-group-based backup must be executed using the new configuration. If this is skipped and backup data obtained via HMBR is restored, only data entity is restored to the old LV/LG configuration. This may disrupt the consistency with the LVM management information stored separately from the data entity, causing damage to data.

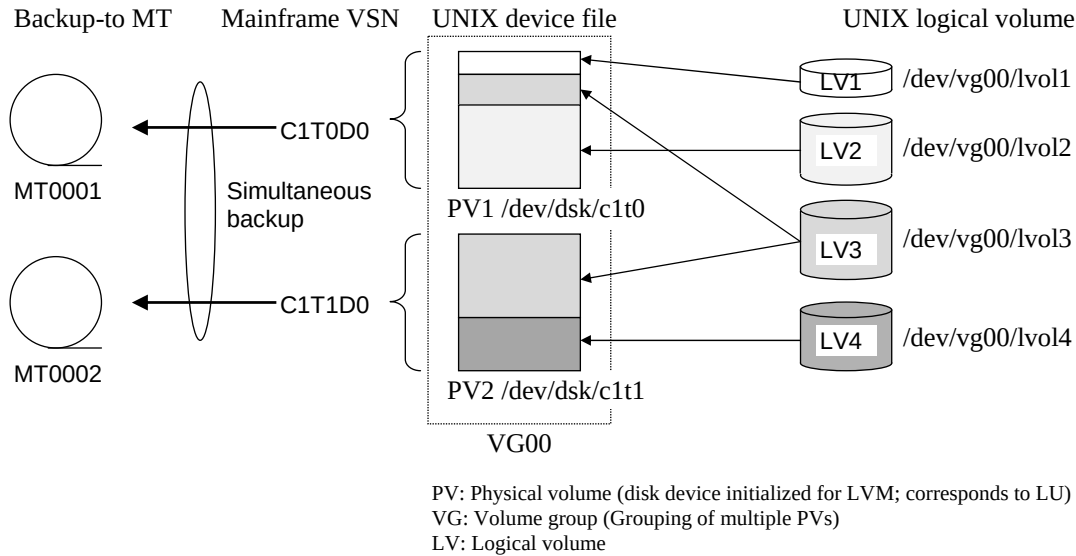


Fig. 3.32.7.5-1 Backup of Volumes managed by LVM

(7) Backup of database

To backup a database, first terminate its operation to place it off-line before making a backup. You must backup of all LUs where data files are stored at the same occasion. Follow the required backup method for each database management system to determine whether or not backup is required and the backup method for other files comprising the database (such as control file and log file). Follow the restoration procedure or approach for each database management system to determine when a log file must be used to restore the database to the state just before fault, or the synchronicity of the control file and data file must be restored.

(8) Backup of open volume

When obtaining backup by using HMBR, do not use verify option of mainframe utility.

(9) A method of the backup and restore operations for Windows system data is shown in the following.

<Backup>

- Delete a drive letter in the Logical Units by Disk Administrator.
- Re-allocate a drive letter to the Logical Units by Disk Administrator.
- Backup Windows system data by mainframe host.

<Restore>

- Delete a drive letter to the Logical Units by Disk Administrator.
- Restore it from mainframe host to the Logical Units.

Re-allocate drive letter to the Logical Units by Disk Administrator.

3.32.8 HA Software Linkage Configuration in a Cluster Server Environment

When this subsystem is linked to High-Availability software (HA software) which implements dual-system operation for improved total system fault-tolerance and availability, the open system side can also achieve higher reliability on the system scale.

3.32.8.1 Example of System Configurations

(1) Hot-standby system configuration

The HA software minimizes system down time in the event of hardware or software failures and allows processing to be restarted or continued. The basic system takes a hot-standby (asymmetric) configuration, in which, as shown in the figure below, two hosts (an active host and a standby host) are connected via a monitoring communication line. In the hot-standby configuration, a complete dual system can be built by connecting the Fibre cables of the active and standby hosts to different CHF Fibre ports.

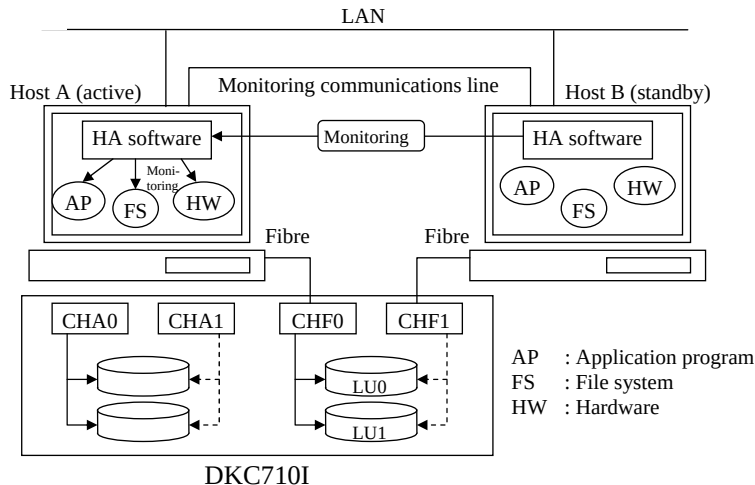


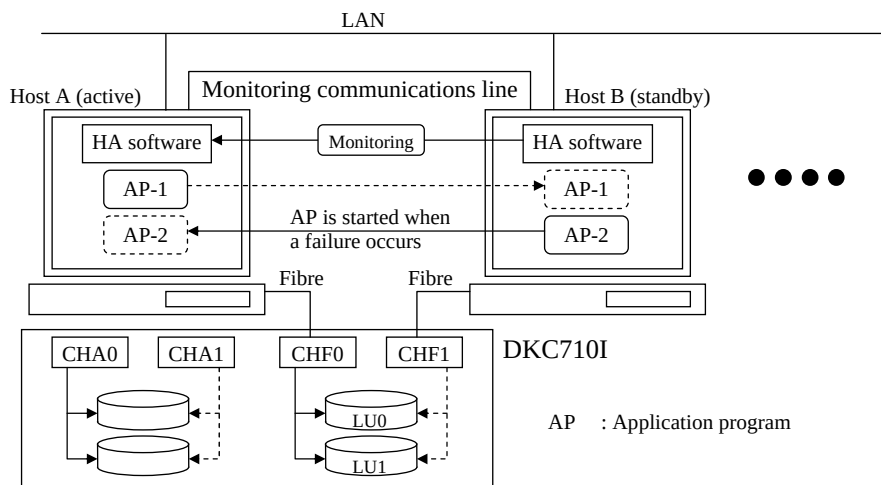
Fig. 3.32.8.1-1 Hot-standby configuration

- The HA software under the hot-standby configuration operates in the following sequence:
 - a. The HA software within the active host monitors the operational status of own system by using a monitoring agent and sends the results to the standby host through the monitoring communication line (this process is referred to as “heart beat transmission”). The HA software within the standby host monitors the operational status of the active host based on the received information.
 - b. If an error message is received from the active host or no message is received, the HA software of the standby host judges that a failure has occurred in the active host. As a result, it transfers management of the IP addresses, disks, and other common resources, to the standby host (this process is referred to as “fail-over”).
 - c. The HA software starts the application program concerned within the standby host to take over the processing on behalf of the active host.

- Use of the HA software allows a processing request from a client to be taken over. In the case of some specific application programs, however, it appears to the client as if the host that was processing the task has been rebooted due to the host switching. To ensure continued processing, therefore, a login to the application program within the host or sending of the processing request may need to be executed once again.

(2) Mutual standby system configuration

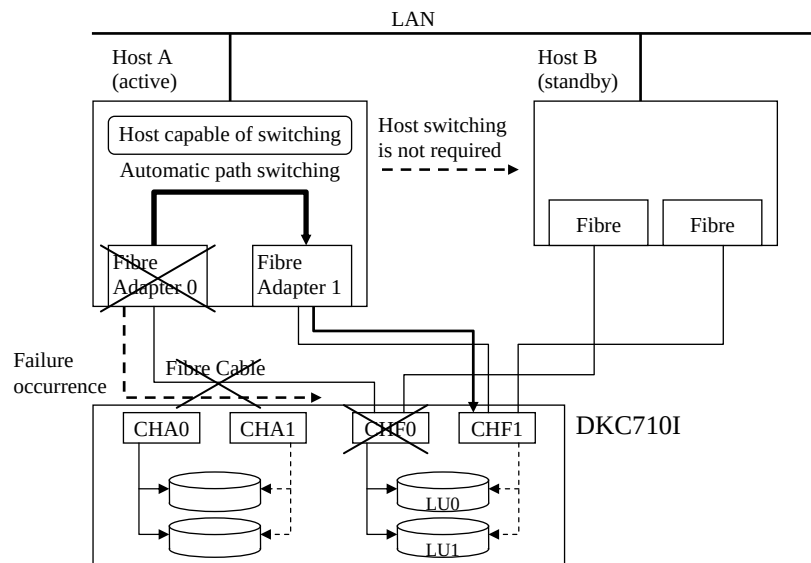
In addition to the hot-standby configuration described above, a mutual standby (symmetric) configuration can be used to allow two or more hosts to monitor each other. Since this subsystem has eight Fibre ports, it can, in particular, be applied to a large-scale cluster environment in which more than two hosts exist.



- In the mutual standby configuration, since both hosts operate as the active hosts, no resources exist that become unnecessary during normal processing. On the other hand, however, during a backup operation the disadvantages are caused that performance deteriorated and that the software configuration becomes complex.
- This subsystem is scheduled to support SUN Microsystems SUN CLUSTER, Symantec Cluster server, Hewlett-Packard MC/ServiceGuard, and IBM HACMP and so on.

3.32.8.2 Configuration Using Host Path Switching Function

When the host is interlocked with the HA software and has a path switching capability, if a failure occurs in the Fibre adapter, Fibre cable, or DKC (Fibre ports and the CHF) that is being used, automatic path switching will take place as shown below.



The path switching function enables processing to be continued without host switching in the event of a failure in the Fibre adapter, Fibre cable, array controller, or other components.

3.32.9 TrueCopy

3.32.9.1 Overview

The Hitachi Open Remote Copy function can remotely duplicate data (volumes) under the control of the subsystem by directly connecting the two DKC710s. A backup system against disasters can be constructed by installing one of the two DKC710s at the main site and the other at the recovery site and configuring the HA cluster on the server side by means of the HA (High Availability) software.

This function also enables the two volumes containing identical data to be used for different purposes by duplicating data (volumes) within the same DKC710I or between the two DKC710s and separating the volumes in a primary-and-secondary relation at any time.

An online database can be backed up or batch programs can be executed while the database is being accessed. There are TrueCopy and Universal Replicator (UR) for TrueCopy.

The TrueCopy makes various settings and it controls operations by means of the RAID manager/TrueCopy, which runs on the open system. The RAID manager/TrueCopy provides various commands for user applications to control the TrueCopy functions. Creation of a user shell script using these commands enables the TrueCopy control being interlocked with server's fail-over executed by the HA software.

There is Fibre channel interface of connection form between CUs. (FCoE cannot be used for connection between CUs.)

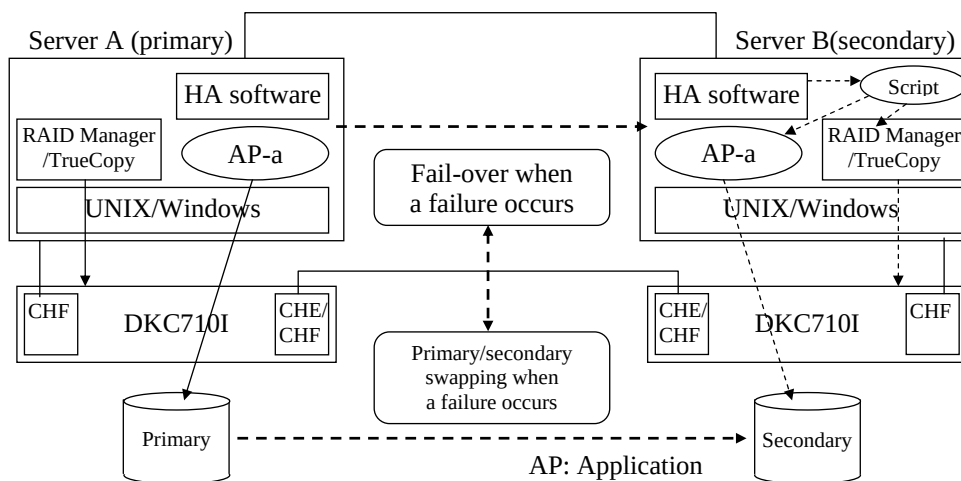


Fig. 3.32.9.1-1 Outline of TrueCopy Function and Example of Application to HA Configuration (Hot Standby Configuration)

3.32.9.2 Basic Specifications

Basic TrueCopy specifications are shown below.

Table 3.32.9.2-1 Basic Specifications of TrueCopy

No.	Item	Description	Remarks
1	Host interface on open system side	Fibre Channel	Conforming to base platform function. Connection configuration using FCoE is not supported.
2	Supporting OS platform	Conforming to base platform function.	
3	Connection between the CUs	Fibre Channel	Connection configuration using FCoE is not supported.
4	Means for setting the paired LU	RAID Manager/TrueCopy	
		Storage Navigator	
		Web Console	
5	Number of LUs capable of the duplicated writing	Maximum 32768 pairs	Depending on emulation type
6	LU size capable of the duplicated writing (The paired VOL must be the same DEV type.)	All basic emulation types (include OPEN-V*)	Maximum 4TB
		LUSE	
		CVS	
7	Duplicated writing mode	Synchronized (Sync)	
8	Combination of the CUs	One-to-one correspondence N-to-one correspondence one-to-N correspondence	
9	Fence level	Data, Status, Never	Supports a function equivalent to the TC-MF.
10	Multiple DKC support	Yes	For CU#0 through CU#FE, TrueCopy pairs can be created.
11	Control of the TC-MF and the TC in DKC mixture (HMBR function)	Can be mixed	

*: Since OPEN-V is based on CVS, the capacity changes with RAID-level or DKU (HDD) type.
Please refer to “3.32.3.4.1 Logical Unit Specification” for details.

(1) Means for setting the paired LU:

The following three means are provided:

- RAID Manager/TrueCopy
- SVP
- Storage Navigator

Not only the pairing but also a series of pair state changes are possible by using these three means. However, the user can use two means only: the command instruction from the RAID Manager/TrueCopy and the instruction from the Web Console.

(2) LU size capable of the duplicated writing:

All emulation types' volumes are replicable.

(Condition: The primary volume and the secondary volume must have the same emulation type.)

If two LUSE volumes are paired with TrueCopy, a LUSE P-VOL must be paired with S-VOL of the same size and the same structure. For example, if a LUSE P-VOL is connected with the volumes of 1GB, 2GB, and 3GB in this order, you must specify the LUSE volume which has exactly the same size and the same connection order as the S-VOL.

(3) Fence level:

The TrueCopy, alike the TrueCopy for Mainframe, supports three types of fence level: Data, Status, and Never.

- (4) Control of the TrueCopy for Mainframe pairs and the TrueCopy pairs mixture:
Control of the mixture of the TrueCopy for Mainframe pairs and the TrueCopy pairs is possible within the one DKC.
- S-VOL (secondary VOL) access:
 - ① An RD access to the secondary VOL is permitted to accept the RD command issued to the disk label when the secondary server is started.
 - ② In order to support the DataPlex function, write access to the secondary VOL is permitted on condition that the pair is being suspended.
Using the RAID Manager/TrueCopy or SVP, you can indicate the permission of write operation to S-VOL. After this indication, if the server performs any write operation to S-VOL, in Pair Resync (Resume) operation all tracks on P-VOL will be copied to S-VOL. If using SVP, the permission of write operation to S-VOL is executed by setting “S-VOL write Enable” on Suspend Pair display in the indication of S-VOL Suspend on MCU. Also, you can confirm using RAID manager/TrueCopy or SVP whether “S-VOL write Enable” on S-VOL is permitted or not.

- HMBR function for the TrueCopy paired VOL

- ① Overview

Open Remote Copy function makes possible to make a backup and restoration of TrueCopy pair volumes using a mainframe machine. (HMBR function for the TrueCopy paired VOL)

After suspending TrueCopy pairs by a TrueCopy command of RAID Manager/TT, you can make a backup from a mainframe machine. In this case the backup data is got from S-Vols. Therefore to make a backup, you don't have to stop processes from open systems to P-Vols.

Before restoring backup data, you must delete TrueCopy pairs and make them simplex volumes by a TrueCopy command of RAID Manager/TT. After restoring data, create TrueCopy pairs using the same volumes as P-Vols or S-Vols before deleting pairs. Thus you can create the same duplicated status as before.

- ② Preparation for Backup

Before making a backup of TrueCopy pair volumes using HMBR function, you need to set VSN, and to create VTOC from a mainframe machine as written in "7.5 Precautions". These operations must be done before TrueCopy pairs are created.

- ③ VSN, VTOC in TrueCopy pairs

By the initial copy of a TrueCopy pair, VSN and VTOC in the P-Vol are not copied to S-Vol. As a result, both P-Vol and S-Vol have different VSN and VTOC.

- ④ Write operation from a mainframe machine to TrueCopy pair volumes.

Once a TrueCopy pair is created, all write operations from a mainframe machine to the TrueCopy pair volume are rejected, except rewriting of VNS to S-Vol. Therefore a mainframe machine cannot erase original data written by an open system.

- ⑤ Others

While an initial copy for TrueCopy pairs is executed, the link between S-Vol and a mainframe machine should be off-line. If the link is on-line, the initial copy is aborted. While there exists any I/O from a mainframe machine to an open volume, don't start initial copy from the volume to another. When you start the copy operation, a mainframe I/O is aborted.

When you start initial copy, you need to stop a mainframe I/O to a open volume which is to be a P-Vol of a TrueCopy pair.

(5) Restriction for Connecting with Former Model of Storage System

When you connect the storage systems with the following combinations, the range you can specify for each model is restricted.

- DKC710I and DKC610I

When you connect DKC710I and DKC610I, you may specify as shown in Table 3.32.9.2-2.

Table 3.32.9.2-2 Range You Can Specify when You Connect DKC710I and DKC610I

Restriction Item	DKC710I ^{*1}	DKC610I ^{*1,*2} (50-07-85-xx/xx)
Port number	From 1A to GR	From 1A to GR
LUN	From 0000 to 03FF	From 0000 to 03FF
LDKC ^{*2} :CU:LDEV	From 00:00:00 to 00:3F:FF	From 00:00 to 3F:FF

*1: It does not affect to the value whether the model connects as MCU or RCU.

*2: LDKC number is applied only for DKC610I.

◆ Restrictions:

(1) Command device:

- ① The TrueCopy provides users with a command to enable a state change and status display of the TrueCopy pair from the server.
- ② Assign a special LUN called a command device so that the DKC710I can receive this pair state change and pair status display commands.
- ③ Users cannot use the command device. A command device with a capacity of 2.4GB within the subsystem cannot be used (when the OPEN3 is assigned as a command device). If you install the micro version supporting CVS function for Open volume, you can specify CVS volume as command device. In this case, the minimum capacity of command device is 35MB.
- ④ Use Web Console to specify the command device.

(2) Flashing updated data in the server:

When the TrueCopy is used as a DataPlex function, split the primary/secondary paired VOL. A Sync command or the like must be issued before splitting it and a file system buffer must be flashed when acquiring a backup from the secondary VOL. Thus, the latest backup can be acquired.

(3) P-VOL (primary VOL) access:

Pair suspend operation (pairsplit-P option) from RAID Manager/TrueCopy can be executed to TrueCopy pair volumes.

3.32.9.3 Basic UR Specifications

Basic UR specifications are shown below.

Table 3.32.9.3-1 Basic Specifications of UR

No.	Item	Description	Remarks
1	Host interface on open system side	Fibre Channel	Conforming to base platform function. Connection configuration using FCoE is not supported.
2	Supporting OS platform	Conforming to base platform function.	
3	Connection between the CUs	Fibre Channel	Connection configuration using FCoE is not supported.
4	Means for setting the Journal volume	Storage Navigator	
		Web Console	
5	Number of setting Journal volumes in a Journal Group	64 volumes	
6	LU type for setting the Journal volume	OPEN-V*	
		CVS	
7	Means for setting the paired LU	RAID Manager/UR	
		Storage Navigator	
		Web Console	
8	Number of LUs capable of the duplicated writing	Maximum 65280 pairs (*1)	
9	LU size capable of the duplicated writing (The paired VOL must be the same DEV type.)	OPEN-V (*2)	
		LUSE	
		CVS	
10	Duplicated writing mode	Asynchronized (Async)	
11	Combination of the CUs	One-to-one correspondence	
12	Multiple DKC support	Yes	For CU#0 through CU#FE, UR pairs can be created.

*1: The number of maximum pairs is different depending on the volume size of each pair.
Please refer to “Hitachi Universal Replicator User Guide” for the number of maximum pairs.

*2: Since OPEN-V is based on CVS, the capacity changes with RAID-level or DKU (HDD) type.
Please refer to “3.32.3.4.1 Logical Unit Specification” for details.

(1) Means for setting the paired LU:

The following three means are provided:

- RAID Manager/UR
- Web Console
- Storage Navigator

Not only the pairing but also a series of pair state changes are possible by using these three means. However, the user can use two means only: the command instruction from the RAID Manager/UR and the instruction from the Web Console.

(2) LU size capable of the duplicated writing:

The replicable volume is only OPEN-V.

(Condition: The primary volume and the secondary volume must have the same emulation type.)

If two LUSE volumes are paired with UR, a LUSE P-VOL must be paired with S-VOL of the same size and the same structure. For example, if a LUSE P-VOL is connected with the volumes of 1GB, 2GB, and 3GB in this order, you must specify the LUSE volume which has exactly the same size and the same connection order as the S-VOL.

(3) Copy Mode:

UR: The copy operation and the host I/O can be performed asynchronously, but it must to ensure the update sequence consistency of Write progress across multiple primary volumes (The data written late cannot be copied earlier.). In addition, when a failure occurs, the function (for multiple pairs) having multiple pairs blocked while keeping the update sequence consistency is available. In this way, the group composed of pairs, which are the control objects, is called Consistency Group.

(4) Means for setting the Journal Volume:

The following two means are provided.

- Web Console
- Storage Navigator

Not only the setting Journal volume but also Journal Group options are possible to be changed by using these two means. However, the user can use only instruction from the Web Console.

(5) Connections DKC610I/DKC510I Subsystem

Usable configurations depending on combinations of models of MCU and RCU to be connected are shown in the following table.

Descriptions following the (1), (2), and (3) in the table express extents of the usable ports, DEV#'s, and LUNs respectively.

Also, descriptions on the left and right of a slash (/) express the extents of the usable models of the MCU and RCU respectively.

• When MCU is DKC710I, RCU is DKC610I /DKC510I

	DKC610I / DKC510I
(1) Port#	1A ~ GR / 1A ~ GR
(2) DEV#	00:00:00 ~00:3F:FF / 00:00 ~ 3F:FF
(3) LUN#	0000 ~ 07FF / 0000 ~ 03FF

• When RCU is DKC710I, MCU is DKC610I /DKC510I

	DKC610I / DKC510I
(1) Port#	1A ~ GR / 1A ~ GR
(2) DEV#	00:00 ~ 3F:FF / 00:00:00 ~00:3F:FF
(3) LUN#	0000 ~ 03FF / 0000 ~ 07FF

◆ Restrictions:

(1) Command device:

- ① The UR provides users with a command to enable a state change and status display of the UR pair from the server.
- ② Assign a special LUN called a command device so that the DKC710I can receive this pair state change and pair status display commands.
- ③ Users cannot use the command device. A command device with a capacity of 2.4GB within the subsystem cannot be used. If you install the micro version supporting CVS function for Open volume, you can specify CVS volume as command device. In this case, the minimum capacity of command device is 35MB.
- ④ Use Web Console to specify the command device.

(2) Flashing updated data in the server:

When the UR is used as a DataPlex function, split the primary/secondary paired VOL. A Sync command or the like must be issued before splitting it and a file system buffer must be flashed when acquiring a backup from the secondary VOL. Thus, the latest backup can be acquired.

(3) S-VOL (secondary VOL) access:

- ① An RD access to the secondary VOL is permitted to accept the RD command issued to the disk label when the secondary server is started.
- ② In order to support the DataPlex function, write access to the secondary VOL is permitted on condition that the pair is being suspended.
Using the RAID Manager/UR or SVP, you can indicate the permission of write operation to S-VOL. After this indication, if the server performs any write operation to S-VOL, in Pair Resync (Resume) operation all tracks on P-VOL will be copied to S-VOL. If using SVP, the permission of write operation to S-VOL is executed by setting “S-VOL write Enable” on Suspend Pair display in the indication of S-VOL Suspend on MCU.
Also, you can confirm using RAID Manager/UR or SVP whether “S-VOL write Enable” on S-VOL is permitted or not.

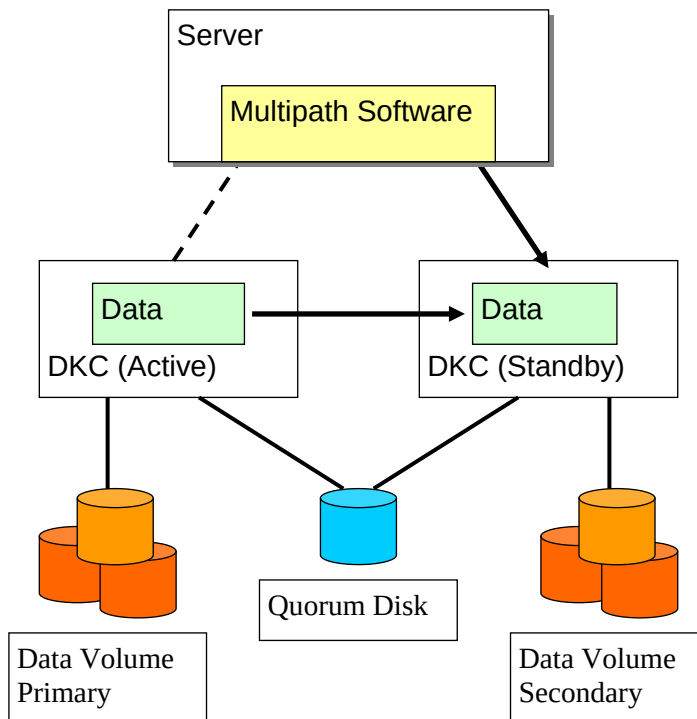
3.32.9.4 HAM (High Availability Manager) Overview

The High Availability Manager function can duplicate data (volumes) under the control of the subsystem by directly connecting the two DKC710s as much as The Hitachi Open remote Copy.

When the trouble occurs in active DKC710, it is necessary to run your applications to the HARC function. However, the HAM can operate failover by the automatic operation.

There is Fibre channel interface of connection form between CUs. (FCoE cannot be used for connection between CUs.)

Outline of High Availability Manager



THEORY03-32-802**3.32.9.5 Basic HAM Specifications**

Basic HAM specifications are shown below.

No.	Item	Description	Remarks
1	Host interface on open system side		Conforming to the HOCR
2	Supporting OS platform	Windows2000 (x86/IPF)	
3		Windows2003 (x86/x64/IPF)	
4		Windows2008 (x86/x64/IPF)	
5	Supporting Multipath Software	HDL	
6	Connection between the CUs	Fibre Channel	Conforming to the HOCR
7	Number of LUs capable of the HAM Volume	Maximum 32768 pairs	Conforming to the HOCR
8	LU type for setting the HAM volume	All	
9		CVS Volume	
10	Means for setting the paired LU	Storage Navigator	
11		Web Console	
		RaidManager *1	
12	Fence level	Never	
13	Number of LUs capable of the Quorum disk	Maximum 128	
14	LU type for setting the Quorum Disk	Only Extent Volume	
15	Means for setting the Quorum disk	Storage Navigator	
16		Web Console	

*1: When you use RaidManager, the HAM volumes is seen as the TrueCopy volumes.

◆ Means for setting the paired LU:

The following three means are provided:

- RAIDManager/UR
- Web Console
- Storage Navigator

When you use RaidManager, the HAM volumes is seen as the TrueCopy volumes. Operation is available in RaidManager, Suspend, SwapSuspend, Resync, ReverseResync Only.

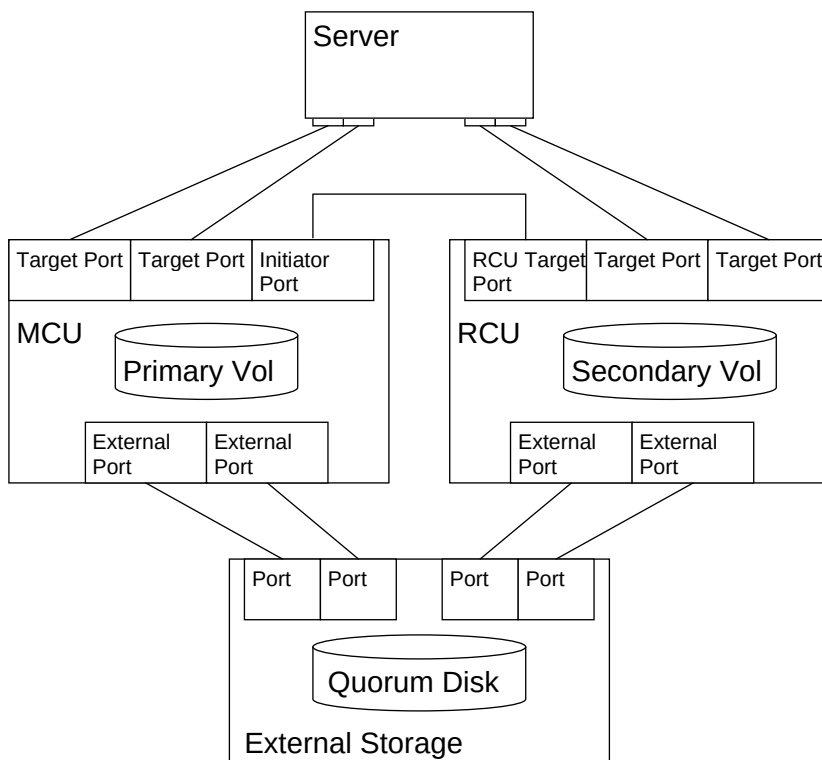
Not only the pairing but also a series of pair state changes are possible by using Web Console or Storage Navigator.

However, the user can use two means only: the command instruction from the RAIDManager/UR and the instruction from the remote console.

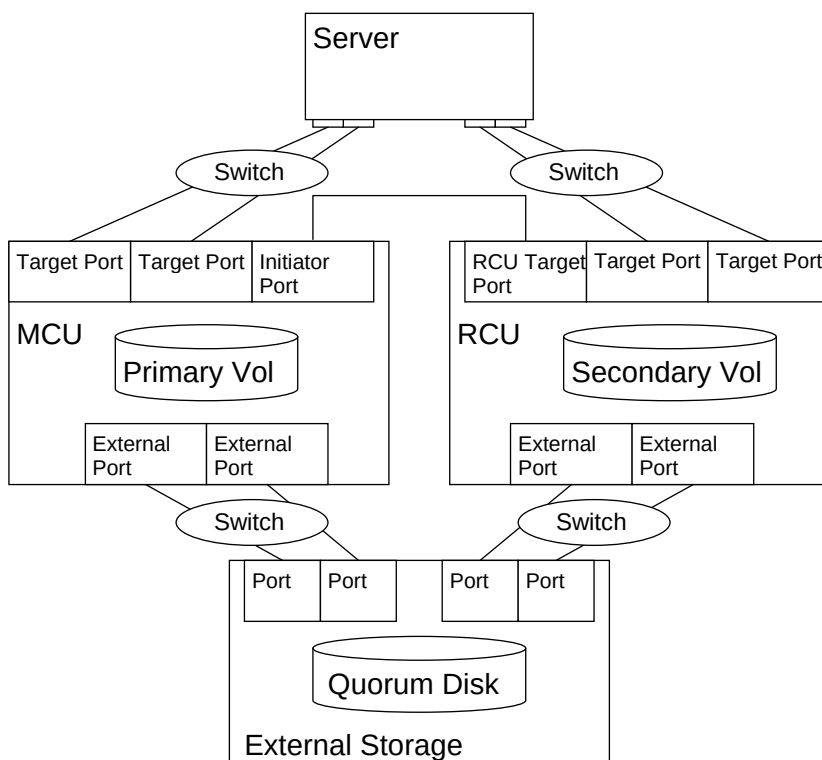
◆ Connected block diagram

Connected composition example is shown in the following.

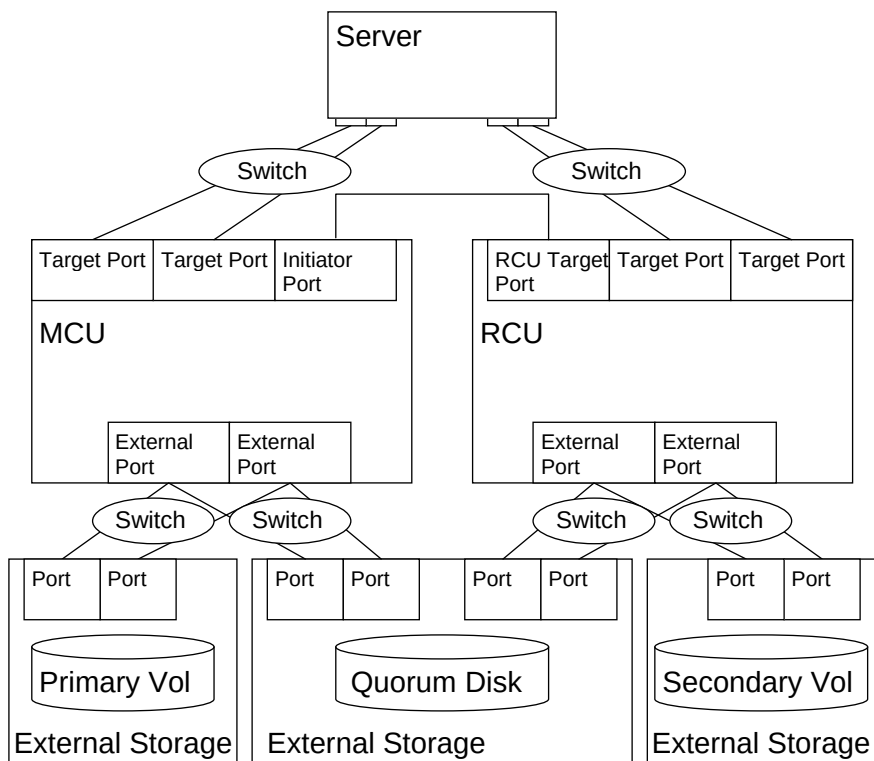
(a) Direct



(b) Between switch



(c) When you use the external storage for primary vol or secondary vol.



3.32.10 LUN installation

3.32.10.1 Overview

LUN installation feature makes it enable to add LUNs to DKC710I Fibre ports while I/Os are still running.

Some host operations are required before the added volumes are recognized and become usable from the host operating systems.

MCU port (Initiator port)/External of TrueCopy function does not support LUN installation.

3.32.10.2 Specifications

(1) General

- (a) LUN installation feature supports Fibre interface.
- (b) LUN installation is supported.
- (c) LUN installation can be executed by SVP or by Web Console.
- (d) Some operating systems require reboot operation to recognize the newly added volumes.
- (e) When new LDEVs should be installed for LUN installation, install the LDEVs by SVP first. Then add LUNs by LUN installation from SVP or Web Console.
- (f) MCU (Initiator port)/External port of TrueCopy function does not support LUN installation.

(2) Platform support

Host Platforms supported for LUN installation are shown in Table 3.32.10.2-1.

Table 3.32.10.2-1 Platform support level

Support level	FIBRE
(A) LUN installation and LUN recognition.	Solaris, HP-UX, AIX, Windows2000, Windows2003
(B) LUN installation only. Reboot is required before new LUNs are recognized.	Linux
(C) LUN installation is not supported. Host must be shutdown before installing LUNs and then must be rebooted.	—

3.32.10.3 Operations

(1) Operations

Step 1: Execute LUN installation from SVP or from JAVA = “Web Console”.

Step 2: Check whether or not the initiator platform of the Fibre port supports LUN recognition with Table 3.32.10.3-1.

Support (A) -> Execute LUN recognition procedures in Table 3.32.10.3-1

Not support (B) -> Reboot host and execute normal install procedure.

(2) Host operations

Host operations for LUN recognition are shown in Table 3.32.10.3-1.

Table 3.32.10.3-1 LUN recognition procedures outline for each platform

Platform	LUN recognition procedures
HP-UX	(1) ioscan (check device added after IPL) (2) insf (create device files)
Solaris	(1) /usr/sbin/drvconfig (2) /usr/sbin/devlinks (3) /usr/sbin/disks (4) /usr/ucb/ucblinks
AIX	(1) Devices-Install/Configure Devices Added After IPL By SMIT
Windows2000 Windows2003	Automatically detected

3.32.11 LUN de-installation

3.32.11.1 Overview

LUN de-installation feature makes it enable to delete LUNs to DKC710I Fibre ports while I/Os are still running.

MCU (Initiator port)/External port of TrueCopy function does not support Online LUN de-installation.

3.32.11.2 Specifications

(1) General

- (a) LUN de-installation feature supports Fibre interface.
- (b) LUN de-installation can be used only for the ports on which LUNs are already existing.
- (c) LUN de-installation can be executed by SVP or by “Web Console”.
- (d) When LUNs should be de-installed for LUN de-installation, stop Host I/O of concerned LUNs.
- (e) If necessary , execute backup of concerned LUNs.
- (f) De-install concerned LUNs from HOST.
- (g) In case of AIX, release the reserve of concerned LUNs.
- (h) In case of HP-UX do not delete LUN=0 under existing target ID.
- (i) MCU (Initiator port)/External port of TrueCopy function does not support Online LUN de-installation.

Note: If LUN de-installation is done without stopping Host I/O, or releasing the reserve, it would fail. Then stop HOST I/O or release the reserve of concerned LUNs and try again. If LUN de-installation would fail after stopping Host I/O or releasing the reserve, there is a possibility that the health check command from HOST is issued. At that time, wait about three minutes and try again.

(2) Platform support

Host platforms supported for LUN de-installation are shown in Table 3.32.11.2-1.

Table 3.32.11.2-1 Support platform

Platform	OS	Fibre
HP	HP-UX	○
SUN	Solaris	○
RS/6000	AIX	○
PC	Windows2003 Windows2008	○

(example) ○: support, ×: not support

3.32.11.3 Operations

(1) Operations

Step 1: Confirm whether or not the initiator platform of the FIBRE port supports LUN de-installation with Table 3.32.11.2-1.

Support :Go to Step 2.

Not support :Go to Step 3.

Step 2: If HOST MODE of the port is not 00 or 04 or 07 use, go to Step 4.

Step 3: Stop Host I/O of concerned LUNs.

Step 4: If necessary, execute backup of concerned LUNs.

Step 5: De-install concerned LUNs form HOST.

Step 6: In case AIX, release the reserve of concerned LUNs.

If not, go to Step 7.

Step:7 Execute LUN de-installation from SVP or from Remote “Web Console”.

(2) Host operations

Host operations for LUN de-installation procedures are shown in Table 3.32.11.3-1.

Table 3.32.11.3-1 LUN de-installation procedures outline for each platform

Platform	LUN de-installation procedures
HP-UX	mount point:/01, volume group name:vg01 (1) umount /01 (umount) (2) vgchange -a n vg01 (deactive volume groups) (3) vgexport /dev/vg01 (export volume groups)
Solaris	mount point:/01 (1) umount /01 (unmout)
AIX	mount point:/01, volume group name:vg01, device file name:hdisk1 (1) umount /01 (umount) (2) rmfs -r" /01 (delete file systems) (3) varyoffvg vg01 (vary off) (4) exportvg vg01 (export volume groups) (5) rmdev -I 'hdisk1' '-d' (delete devime files)

3.32.12 Prioritized Port Control (PPC)

3.32.12.1 Overview

The Prioritized Port Control (PPC) feature allows you to use the DKC for both production and development. The assumed system configuration for using the Prioritized Port Control option consists of a single DKC that is connected to multiple production servers and development servers. Using the Prioritized Port Control function under this system configuration allows you to optimize the performance of the development servers without adversely affecting the performance of the production servers.

MCU port (Initiator port) of Fibre Remote Copy function does not support Prioritized Port Control (PPC).

The Prioritized Port Control option has two different control targets: fibre port and open-systems host's World Wide Name (WWN). The fibre ports used on production servers are called prioritized ports, and the fibre ports used on development servers are called non-prioritized ports. Similarly, the WWNs used on production servers are called prioritized WWNs, and the WWNs used on development servers are called non-prioritized WWNs.

Note: The Prioritized Port Control option cannot be used simultaneously for both the ports and WWNs for the same DKC. Up to 176 ports or 2048 WWNs can be controlled for each DKC.

The Prioritized Port Control option monitors I/O rate and transfer rate of the fibre ports or WWNs. The monitored data (I/O rate and transfer rate) is called the performance data, and it can be displayed in graphs. You can use the performance data to estimate the threshold and upper limit for the ports or WWNs, and optimize the total performance of the DKC.

■ Prioritized Ports and WWNs

The fibre ports or WWNs used on production servers are called prioritized ports or prioritized WWNs, respectively. Prioritized ports or WWNs can have threshold control set, but are not subject to upper limit control. Threshold control allows the maximum workload of the development server to be set according to the workload of the production server, rather than at an absolute level. To do this, the user specifies whether the current workload of the production server is high or low, so that the value of the threshold control is indexed accordingly.

■ Non-Prioritized Ports and WWNs

The fibre ports or WWNs used on development servers are called non-prioritized ports or prioritized WWNs, respectively. Non-prioritized ports or WWNs are subject to upper limit control, but not threshold control. Upper limit control makes it possible to set the I/O of the non-prioritized port or WWN within a range that does not affect the performance of the prioritized port or WWN.

3.32.12.2 Overview of Monitoring

■ Monitoring Function

Monitoring allows you to collect performance data, so that you can set optimum upper limit and threshold controls. When monitoring the ports, you can collect data on the maximum, minimum and average performance, and select either per port, all prioritized ports, or all non-prioritized ports. When monitoring the WWNs, you can collect data on the average performance only, and select either per WWN, all prioritized WWNs, or all non-prioritized WWNs.

The performance data can be displayed in graph format either in the real time mode or offline mode. The real time mode displays the performance data of the currently active ports or WWNs. The data is refreshed in every time that you specified between 1 and 15 minutes by minutes, and you can view the varying data in real time. The offline mode displays the stored performance data. Statistics are collected at a user-specified interval between 1 and 15 minutes, and stored between 1 and 15 days.

■ Monitoring and Graph Display Mode

When you activate the Prioritized Port Control option, the Select Mode panel where you can select either Port Real Time Mode, Port Offline Mode, WWN Real Time Mode, or WWN Offline Mode opens. When you select one of the modes, monitoring starts automatically and continues unless you stop monitoring. However, data can be stored for up to 15 days. To stop the monitoring function, exit the Prioritized Port Control option, and when a message asking if you want to stop monitoring is displayed, select the Yes button.

- The Port/WWN Real Time Mode is recommended if you want to monitor the port or WWN performance for a specific period of time (within 24 hours) of a day to check the performance in real time.
- The Port/WWN Offline Mode is recommended if you want to collect certain amount of the port or WWN performance data (maximum of one week), and check the performance in non-real time.

To determine a preliminary upper limit and threshold, run the development server by using the performance data collected from the production server that was run beforehand and check the changes of performance of a prioritized port. If the performance of the prioritized port does not change, set a value by increasing an upper limit of the non-prioritized port. After that, recollect and analyze the performance data. Repeat these steps to determine the optimized upper limit and threshold. (See Fig. 3.32.12.3-1.)

3.32.12.3 Procedure (Flow) of Prioritized Port Control

To perform the prioritized port control, determine the upper limit to the non-prioritized port by checking that the performance monitoring function does not affect production. Fig. 3.32.12.3-1 shows the procedures for prioritized port control.

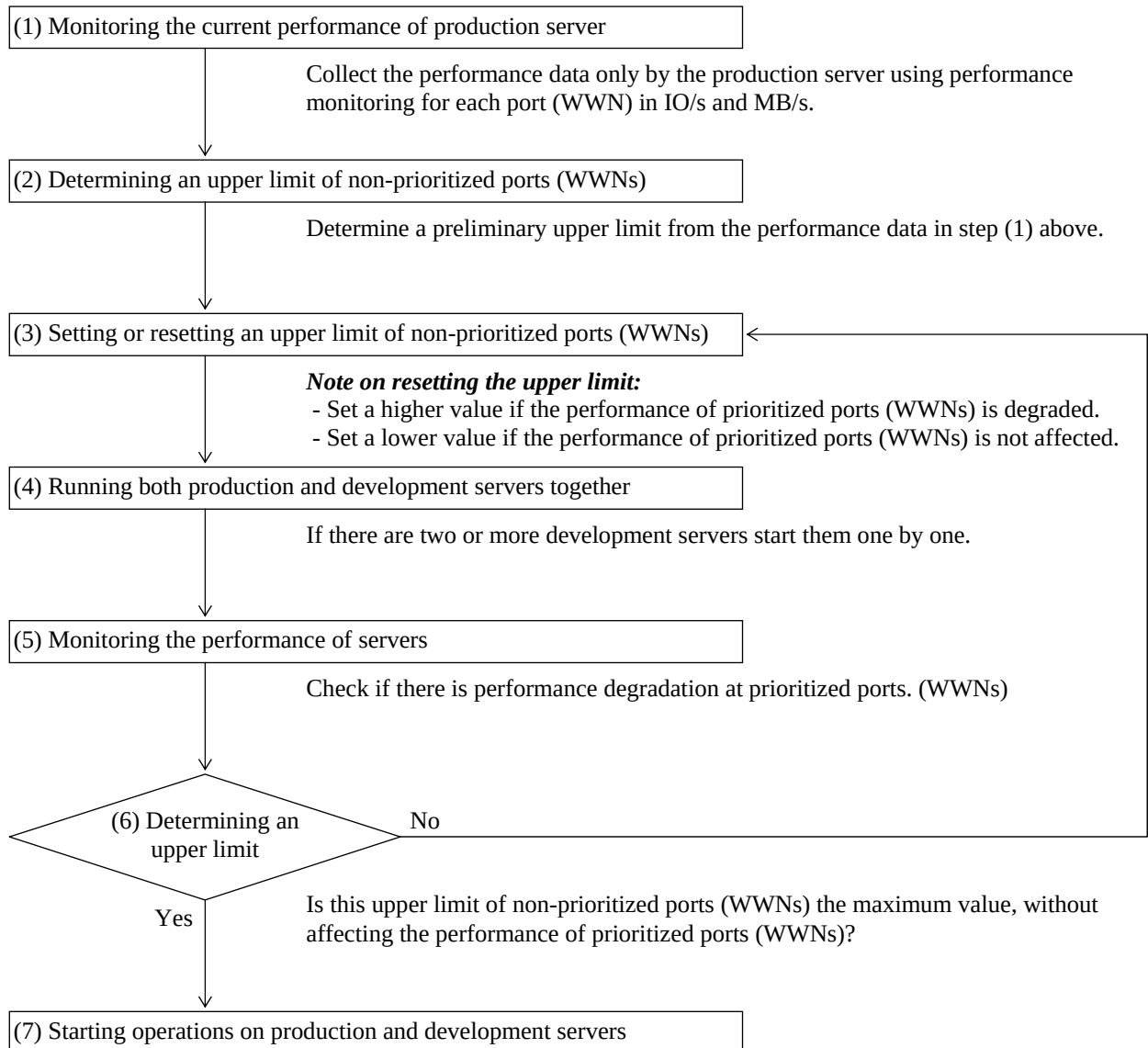


Fig. 3.32.12.3-1 Flow of Prioritized Ports Control

3.33 Mainframe Fibre Data Migration

This section describes the maintenance and the recovery operation (in case of failure) on the execution of Mainframe Fibre Data Migration (Hereinafter referred to as Mainframe Fibre DM) functions.

3.33.1 Mainframe Fibre DM Function Overview

Mainframe Fibre DM is a function that uses when the data in the subsystem migrates to VSP through the Mainframe Fibre I/F.

Please refer to the Mainframe Fibre Data Migration Operation Manual for further information of the necessary configurations to execute this function or of the operational procedures.

THEORY03-33-20**3.33.1.1 Mainframe Fibre DM Configuration**

The following figure shows the configuration while migrating the data by the Mainframe Fibre DM.

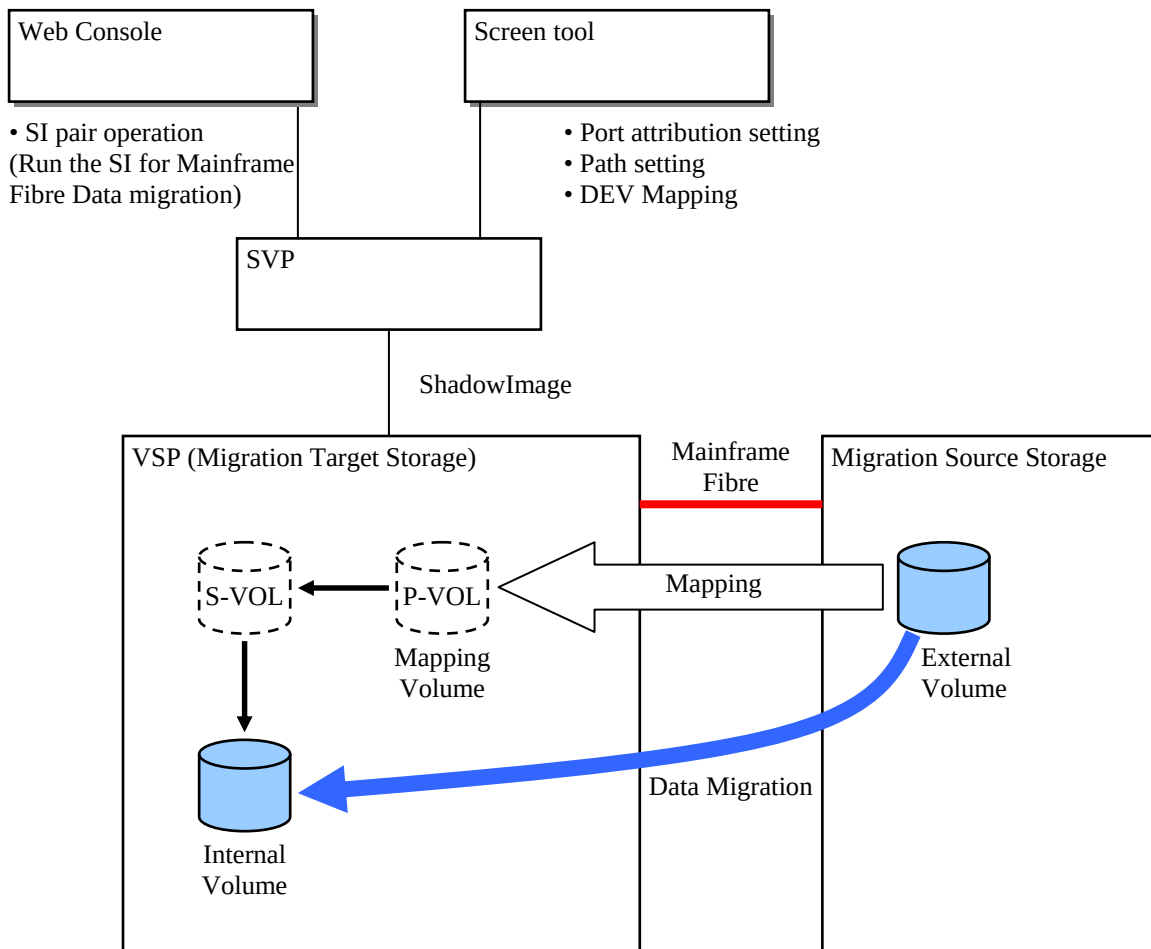


Fig. 3.33.1.1-1 Mainframe Fibre DM Configuration

The data migration by the Mainframe Fibre DM uses the screen tool of the Mainframe Fibre DM, and the ShadowImage (hereinafter referred to as SI) as shown on the above.

- (1) It maps the data migration source volume inside the VSP as a virtual volume. This mapping process runs the tool for Mainframe Fibre DM, whose program starts from the SVP.
- (2) It runs the Web Console from the SVP, and creates a pair: the above described mapping volume as a P-VOL of SI, and the migration target volume as a S-VOL of SI, with the SI for Mainframe Fibre DM.
- (3) SI for Mainframe Fibre DM tries to copy the data from the P-VOL of SI, but the actual data is in the Data migration source volume of the external storage. Therefore the data is read and copied to the S-VOL of SI in the VSP, which is the destination.

This process realizes the data migration.

THEORY03-33-30**3.33.1.2 The Outline of Mainframe Fibre DM Operation**

The following shows the data migration process by the Mainframe Fibre DM.

*1: Operation by the local data migration operator

*2: Operation by the maintenance staff

1. Migration planning preparation (preparation) (*1)
2. Constructing of the Work Environment (2-1) Upgrade the version of the Micro-program of the Mainframe Fibre DM supported version (*2) (2-2) Necessary hardware installation (*2) (2-3) Installation of the Program Product that it related to Mainframe Fibre DM (*1) (2-4) Mainframe Fibre DM Tool Start-up (*1) (2-5) Port attribution setting by the Mainframe Fibre DM tool (*1) (2-6) Connection of the Mainframe Fibre physical cable (*2) (2-7) Physical path setting by the Mainframe Fibre DM tool (*1) (2-8) Offline the Host path of the migration source storage (*2) (2-9) CU path setting by the Mainframe Fibre DM tool (*1) (2-10) Virtual Volume mapping of the migration source volume by the Mainframe Fibre DM tool (*1)
3. Data Migration Operation (3-1) Data copy to the migration target volume by the SI for Mainframe (*1)
4. Confirmation operation of the Data migration completion (*1)
5. Cleanup after the operation completed (5-1) Delete the SI for Mainframe Pair (*1) (5-2) Unmapping the volume executed by the Mainframe Fibre DM tool (*1) (5-3) Delete the CU path executed by the Mainframe Fibre DM tool (*1) (5-4) Delete the physical path executed by the Mainframe Fibre DM tool (*1) (5-5) Remove the physical cable between the migration source storage and the migration target storage (*2) (5-6) Port attribution change from the Mainframe Fibre DM tool (FNP to HTP) (*1) (5-7) Uninstall the Program Product of the Mainframe Fibre DM (*1) (5-8) Uninstall the Program Product of the SI (Term & Unlimited) (*1) (5-9) Remote the hardware that is installed for the Mainframe Fibre DM operation (*2) (5-10) Confirm the state of device (*2) (5-11) SIM complete

Note

- (*1) When a failure occurred by such an incorrect operation of the local data migration operator, the maintenance operation such as the insert and remove of the cable may be requested for the maintenance staff.
- About the timing of the online process from the host to the migration target volume, it should be executed by the instruction of the local data migration operator, based on the data migration plan.

3.33.2 Maintenance

This section describes the maintenance operation during the data migrating by the Mainframe Fibre DM.

Maintenance should not be done basically while operating the Mainframe Fibre DM unless the maintenance is required due to the failure occurrence.

3.33.2.1 PCB Maintenance

3.33.2.1.1 PCB Replacement

When replacing the PCB of the FNP attribution, if the physical path of the Mainframe Fibre DM is created on the PCB, a warning message is displayed to confirm whether it is the last path or not.

In this case, please ask to the local Mainframe Fibre DM data migration operator.

If the replacement is done in the state of existing the path, the incident is reported to the migration source storage. Therefore, you need to report to the customer that situation in advance.

After replacing the PCB, connect the cable to the same port before replacing. If the cable is not connected to those exact positions, the path will not be recovered.

3.33.2.1.2 Removing PCB

In the case of removing the Mainframe Fibre PCB (Mainframe Fibre initiator) which is set the FNP attribution, it cannot be removed if the Mainframe Fibre DM physical path is existed on the subject PCB.

In this case, please ask to the local Mainframe Fibre DM data migration operator.

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3.33.2.2 Micro-program Exchange

3.33.2.2.1 Online Micro-program Exchange

The Online Micro-program Exchange is enabled even if the Mainframe Fibre DM is in use.

3.33.2.3 PS OFF/ON

Do not execute PS OFF/ON of the VSP or the external storage of the data destination during the use of Mainframe Fibre DM.

If the PS OFF/ON is required, contact the local data migration operator and request them to finish the data migration operation by the Mainframe Fibre DM, and then execute it.

3.34 Notes on maintenance during LDEV Format/drive copy operations

This section describes whether maintenance operations can be performed when Dynamic Sparing, Correction Copy, Copy Back, Correction Access, or LDEV Format is running or when data copying to a spare disk is complete.

If Correction Copy runs due to a drive failure or Dynamic Sparing runs due to preventive maintenance on large-capacity disk drives or flash drives, it may take long to copy data. In the case of low-speed LDEV Format performed due to volume installation, it may take time depending on the I/O frequency because host I/Os are prioritized. In such a case, it is recommended to perform operations, such as replacement, installation, and removal, after Dynamic Sparing, LDEV Format etc. is completed, based on the basic maintenance policy, but the following maintenance operations are available.

THEORY03-34-20

Maintenance operation		Storage system status					
		Dynamic Sparing	Correction Copy	Copy Back	Correction Access	Copied to spare disk	LDEV Format
Replacement	CACHE	Impossible	Impossible	Impossible	Possible (*1)	Possible	Impossible
	MPB	Impossible	Impossible	Impossible	Possible (*1)	Possible	Impossible
	CHA	Impossible	Impossible	Impossible	Possible (*1)	Possible	Impossible
	Power supply	Possible	Possible	Possible	Possible	Possible	Possible
	SVP	Possible	Possible	Possible	Possible	Possible	Possible
	SSW	Impossible	Impossible	Impossible	Possible (*1)	Possible	Impossible
	ESW	Impossible	Impossible	Impossible	Possible (*1)	Possible	Impossible
	DKA	Impossible	Impossible	Impossible	Possible (*1)	Possible	Impossible
	PDEV	Possible (*1)	Possible (*1)	Possible (*1)	Possible (*1)	Possible	Possible (*4) (*6)
Installation/ Removal	CACHE/SM	Impossible	Impossible	Impossible	Possible (*1)	Possible (*6)	Impossible
	MPB	Impossible	Impossible	Impossible	Possible (*1)	Possible (*6)	Impossible
	CHA	Impossible	Impossible	Impossible	Possible (*1)	Possible (*6)	Impossible
	Power supply	Possible	Possible	Possible	Possible	Possible	Possible
	SVP	Possible	Possible	Possible	Possible	Possible	Possible
	DKA	Impossible	Impossible	Impossible	Possible (*1)	Possible (*6)	Impossible
	PDEV	Impossible	Impossible	Impossible	Possible (*1)	Possible (*2) (*6)	Impossible
Micro-program exchange	Online	Possible (*3) (*6)	Possible (*3) (*6)	Possible (*3) (*6)	Possible (*1)	Possible (*1) (*7)	Impossible
	Offline	Impossible	Impossible	Impossible	Impossible	Possible	Impossible
	SVP only	Possible	Possible	Possible	Possible	Possible	Possible
LDEV maintenance	Blockade	Impossible	Impossible	Impossible	Possible	Possible	Impossible
	Restore	Impossible	Impossible	Impossible	Possible	Possible	Impossible
	Format	Possible (*5) (*6)	Possible (*5) (*6)	Possible (*5) (*6)	Possible	Possible	Impossible
	Verify	Impossible	Impossible	Impossible	Possible (*1)	Possible	Impossible

*1: It is prevented with a message, but you can perform it by entering the password.

*2: It is impossible to remove a RAID group in which data is migrated to a spare disk and the spare disk.

*3: Micro-program exchange can be performed if DKU/SCHIP micro-program exchange is not included.

*4: It is impossible when high-speed LDEV Format is running. When low-speed LDEV Format is running, it is possible to replace PDEV in a RAID group in which LDEV Format is not running.

*5: It is possible to perform LDEV Format for LDEV defined in a RAID group in which Dynamic Sparing, Correction Copy, or Copy Back is not running.

*6: It is available when the microcode version is 70-04-xx-xx/xx or later.

*7: Micro-program exchange can be performed if DKU, SCHIP, Expander or Expander[FMU] micro-program exchange is not included.

4. Power-on Sequences

4.1 IMPL Sequence

The IMPL sequence, which is executed when power is turned on, is comprised of the following four modules:

(1) BIOS

The BIOS starts other MP cores after a ROM boot. Subsequently, the BIOS expands the OS loader from the flash memory into the local memory and OS loader is executed.

(2) OS loader

The OS loader performs the minimum necessary amount of initializations, tests the hardware resources, then loads the Real Time OS modules into the local memory and the Real Time OS is executed.

(3) Real Time OS modules

Real Time OS is a root task that initializes the tables in the local memory that are used for intertask communications. Real Time OS also initializes network environment, and create the DKC task.

(4) DKC task

When the DKC task is created, it executes initialization routines. Initialization routines initialize the most part of the environment that the DKC task uses. When the environment is established so that the DKC task can start scanning, the DKC task notifies the SVP of a power event log. Subsequently, the DKC task turns on the power for the physical drives and, when the logical drives become ready, The DKC task notifies the host processor of an NRTR.

The control flow of IMPL processing is shown in Fig. 4.1-1.

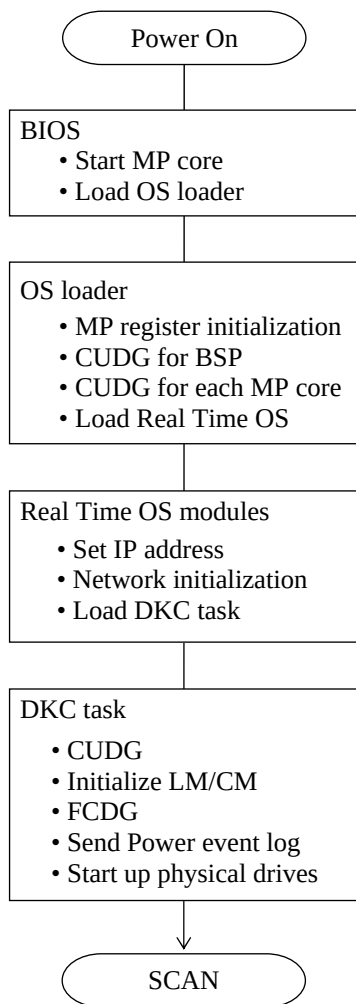
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Fig. 4.1-1 IMPL Sequence

4.2 Drive Power-on Sequence

An overcurrent condition may occur if two or more drives which connected with same HDD-PWR started at the same time. To preclude the overcurrent condition, HDDs connected with same HDD-PWR is started one by one at approximately 5 second intervals in cases of 3.5 inch HDD BOX, and at approximately 3 second intervals in cases of 3.5 inch HDD BOX.

When the logical devices become ready as the result of the startup of the physical drives, the host processor is notified to that effect.

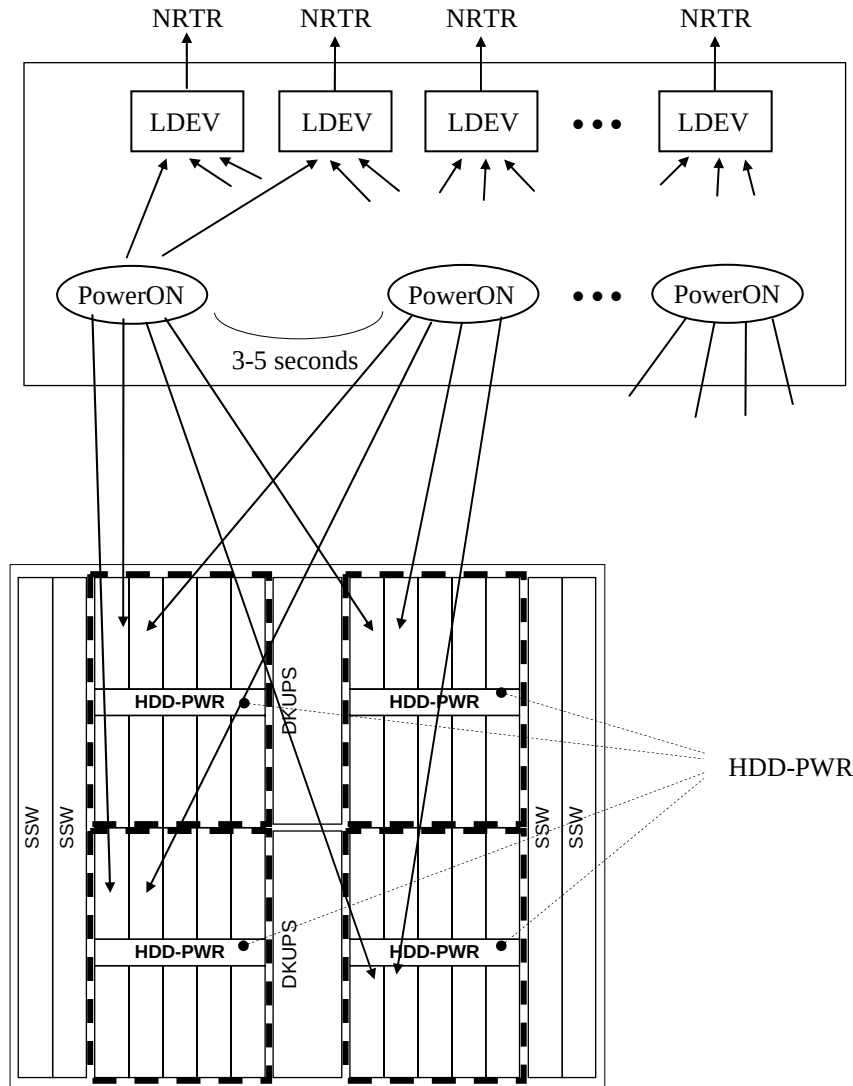


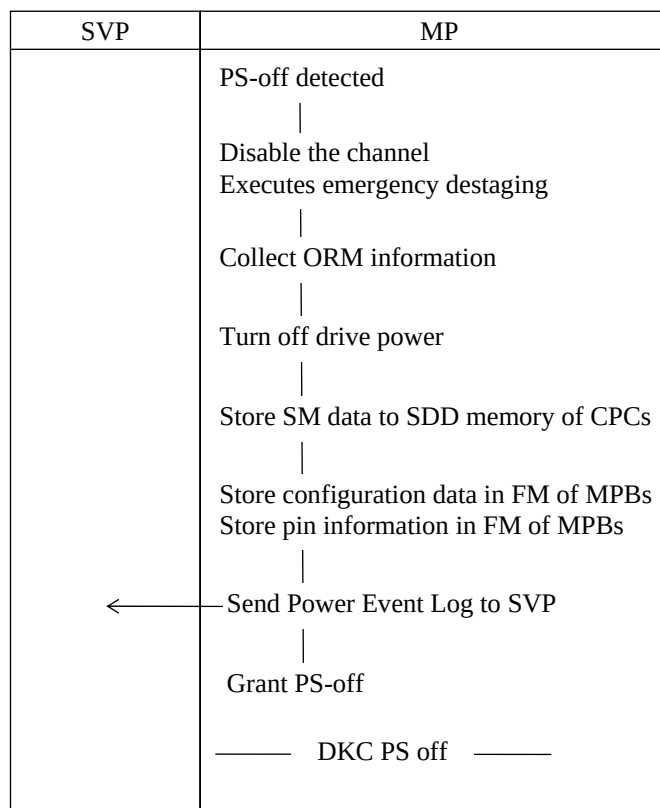
Fig. 4.2-1 Drive Power-on Sequence

4.3 Planned Stop

When a power-off is specified by a maintenance personnel, this subsystem checks for termination of tasks that are blocked or running on all logical devices. When all the tasks are terminated, this subsystem disables the CHL and executes emergency destaging. If a track for which destaging fails (pinned track) occurs, this subsystem stores the pin information in shared memory.

Subsequently, this subsystem saves the configuration data and the pin information(which is used as hand-over information) in flash memory of MPBs, save all SM data (which is used as none-volatile power on) in SSD memory of CPCs. Then, sends Power Event Log to the SVP, notifies the hardware of the grant to turn off the power.

The hardware turns off main power when power-off grants for all processors are presented.



THEORY05-10**5. Appendixes****5.1 Physical-Logical Device Matrixes (2.5 INCH BOX)****RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(1/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-000	HDD000-00	00/00	01-01	01-01	01-01
	HDD000-01	00/01	01-02	01-02	
	HDD000-02	00/02	01-03	01-03	01-03
	HDD000-03	00/03	01-04	01-04	
	HDD000-04	00/04	01-05	01-05	01-05
	HDD000-05	00/05	01-06	01-06	
	HDD000-06	00/06	01-07	01-07	01-07
	HDD000-07	00/07	01-08	01-08	
	HDD000-08	00/08	01-09	01-09	01-09
	HDD000-09	00/09	01-10	01-10	
	HDD000-0A	00/0A	01-11	01-11	01-11
	HDD000-0B	00/0B	01-12	01-12	
	HDD000-0C	00/0C	01-13	01-13	01-13
	HDD000-0D	00/0D	01-14	01-14	
	HDD000-0E	00/0E	01-15	01-15	01-15
	HDD000-0F	00/0F	01-16/Spare	01-16/Spare	01-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(2/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-001	HDD001-00	01/00	01-01	01-01	01-01
	HDD001-01	01/01	01-02	01-02	
	HDD001-02	01/02	01-03	01-03	01-03
	HDD001-03	01/03	01-04	01-04	
	HDD001-04	01/04	01-05	01-05	01-05
	HDD001-05	01/05	01-06	01-06	
	HDD001-06	01/06	01-07	01-07	01-07
	HDD001-07	01/07	01-08	01-08	
	HDD001-08	01/08	01-09	01-09	01-09
	HDD001-09	01/09	01-10	01-10	
	HDD001-0A	01/0A	01-11	01-11	01-11
	HDD001-0B	01/0B	01-12	01-12	
	HDD001-0C	01/0C	01-13	01-13	01-13
	HDD001-0D	01/0D	01-14	01-14	
	HDD001-0E	01/0E	01-15	01-15	01-15
	HDD001-0F	01/0F	01-16/Spare	01-16/Spare	01-15/Spare

THEORY05-20**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(3/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-002	HDD002-00	02/00	01-01	01-01	01-01
	HDD002-01	02/01	01-02	01-02	
	HDD002-02	02/02	01-03	01-03	01-03
	HDD002-03	02/03	01-04	01-04	
	HDD002-04	02/04	01-05	01-05	01-05
	HDD002-05	02/05	01-06	01-06	
	HDD002-06	02/06	01-07	01-07	01-07
	HDD002-07	02/07	01-08	01-08	
	HDD002-08	02/08	01-09	01-09	01-09
	HDD002-09	02/09	01-10	01-10	
	HDD002-0A	02/0A	01-11	01-11	01-11
	HDD002-0B	02/0B	01-12	01-12	
	HDD002-0C	02/0C	01-13	01-13	01-13
	HDD002-0D	02/0D	01-14	01-14	
	HDD002-0E	02/0E	01-15	01-15	01-15
	HDD002-0F	02/0F	01-16/Spare	01-16/Spare	01-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(4/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-003	HDD003-00	03/00	01-01	01-01	01-01
	HDD003-01	03/01	01-02	01-02	
	HDD003-02	03/02	01-03	01-03	01-03
	HDD003-03	03/03	01-04	01-04	
	HDD003-04	03/04	01-05	01-05	01-05
	HDD003-05	03/05	01-06	01-06	
	HDD003-06	03/06	01-07	01-07	01-07
	HDD003-07	03/07	01-08	01-08	
	HDD003-08	03/08	01-09	01-09	01-09
	HDD003-09	03/09	01-10	01-10	
	HDD003-0A	03/0A	01-11	01-11	01-11
	HDD003-0B	03/0B	01-12	01-12	
	HDD003-0C	03/0C	01-13	01-13	01-13
	HDD003-0D	03/0D	01-14	01-14	
	HDD003-0E	03/0E	01-15	01-15	01-15
	HDD003-0F	03/0F	01-16/Spare	01-16/Spare	01-15/Spare

THEORY05-30**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(5/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-004	HDD004-00	04/00	02-01	01-01	01-01
	HDD004-01	04/01	02-02	01-02	
	HDD004-02	04/02	02-03	01-03	01-03
	HDD004-03	04/03	02-04	01-04	
	HDD004-04	04/04	02-05	01-05	01-05
	HDD004-05	04/05	02-06	01-06	
	HDD004-06	04/06	02-07	01-07	01-07
	HDD004-07	04/07	02-08	01-08	
	HDD004-08	04/08	02-09	01-09	01-09
	HDD004-09	04/09	02-10	01-10	
	HDD004-0A	04/0A	02-11	01-11	01-11
	HDD004-0B	04/0B	02-12	01-12	
	HDD004-0C	04/0C	02-13	01-13	01-13
	HDD004-0D	04/0D	02-14	01-14	
	HDD004-0E	04/0E	02-15	01-15	01-15
	HDD004-0F	04/0F	02-16/Spare	01-16/Spare	01-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(6/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-005	HDD005-00	05/00	02-01	01-01	01-01
	HDD005-01	05/01	02-02	01-02	
	HDD005-02	05/02	02-03	01-03	01-03
	HDD005-03	05/03	02-04	01-04	
	HDD005-04	05/04	02-05	01-05	01-05
	HDD005-05	05/05	02-06	01-06	
	HDD005-06	05/06	02-07	01-07	01-07
	HDD005-07	05/07	02-08	01-08	
	HDD005-08	05/08	02-09	01-09	01-09
	HDD005-09	05/09	02-10	01-10	
	HDD005-0A	05/0A	02-11	01-11	01-11
	HDD005-0B	05/0B	02-12	01-12	
	HDD005-0C	05/0C	02-13	01-13	01-13
	HDD005-0D	05/0D	02-14	01-14	
	HDD005-0E	05/0E	02-15	01-15	01-15
	HDD005-0F	05/0F	02-16/Spare	01-16/Spare	01-15/Spare

THEORY05-40**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(7/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-006	HDD006-00	06/00	02-01	01-01	01-01
	HDD006-01	06/01	02-02	01-02	
	HDD006-02	06/02	02-03	01-03	01-03
	HDD006-03	06/03	02-04	01-04	
	HDD006-04	06/04	02-05	01-05	01-05
	HDD006-05	06/05	02-06	01-06	
	HDD006-06	06/06	02-07	01-07	01-07
	HDD006-07	06/07	02-08	01-08	
	HDD006-08	06/08	02-09	01-09	01-09
	HDD006-09	06/09	02-10	01-10	
	HDD006-0A	06/0A	02-11	01-11	01-11
	HDD006-0B	06/0B	02-12	01-12	
	HDD006-0C	06/0C	02-13	01-13	01-13
	HDD006-0D	06/0D	02-14	01-14	
	HDD006-0E	06/0E	02-15	01-15	01-15
	HDD006-0F	06/0F	02-16/Spare	01-16/Spare	01-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(8/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-007	HDD007-00	07/00	02-01	01-01	01-01
	HDD007-01	07/01	02-02	01-02	
	HDD007-02	07/02	02-03	01-03	01-03
	HDD007-03	07/03	02-04	01-04	
	HDD007-04	07/04	02-05	01-05	01-05
	HDD007-05	07/05	02-06	01-06	
	HDD007-06	07/06	02-07	01-07	01-07
	HDD007-07	07/07	02-08	01-08	
	HDD007-08	07/08	02-09	01-09	01-09
	HDD007-09	07/09	02-10	01-10	
	HDD007-0A	07/0A	02-11	01-11	01-11
	HDD007-0B	07/0B	02-12	01-12	
	HDD007-0C	07/0C	02-13	01-13	01-13
	HDD007-0D	07/0D	02-14	01-14	
	HDD007-0E	07/0E	02-15	01-15	01-15
	HDD007-0F	07/0F	02-16/Spare	01-16/Spare	01-15/Spare

THEORY05-50**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(9/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-100	HDD100-00	08/00	03-01	03-01	03-01
	HDD100-01	08/01	03-02	03-02	
	HDD100-02	08/02	03-03	03-03	03-03
	HDD100-03	08/03	03-04	03-04	
	HDD100-04	08/04	03-05	03-05	03-05
	HDD100-05	08/05	03-06	03-06	
	HDD100-06	08/06	03-07	03-07	03-07
	HDD100-07	08/07	03-08	03-08	
	HDD100-08	08/08	03-09	03-09	03-09
	HDD100-09	08/09	03-10	03-10	
	HDD100-0A	08/0A	03-11	03-11	03-11
	HDD100-0B	08/0B	03-12	03-12	
	HDD100-0C	08/0C	03-13	03-13	03-13
	HDD100-0D	08/0D	03-14	03-14	
	HDD100-0E	08/0E	03-15	03-15	03-15
	HDD100-0F	08/0F	03-16/Spare	03-16/Spare	03-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(10/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-101	HDD101-00	09/00	03-01	03-01	03-01
	HDD101-01	09/01	03-02	03-02	
	HDD101-02	09/02	03-03	03-03	03-03
	HDD101-03	09/03	03-04	03-04	
	HDD101-04	09/04	03-05	03-05	03-05
	HDD101-05	09/05	03-06	03-06	
	HDD101-06	09/06	03-07	03-07	03-07
	HDD101-07	09/07	03-08	03-08	
	HDD101-08	09/08	03-09	03-09	03-09
	HDD101-09	09/09	03-10	03-10	
	HDD101-0A	09/0A	03-11	03-11	03-11
	HDD101-0B	09/0B	03-12	03-12	
	HDD101-0C	09/0C	03-13	03-13	03-13
	HDD101-0D	09/0D	03-14	03-14	
	HDD101-0E	09/0E	03-15	03-15	03-15
	HDD101-0F	09/0F	03-16/Spare	03-16/Spare	03-15/Spare

THEORY05-60**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(11/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-102	HDD102-00	0A/00	03-01	03-01	03-01
	HDD102-01	0A/01	03-02	03-02	
	HDD102-02	0A/02	03-03	03-03	03-03
	HDD102-03	0A/03	03-04	03-04	
	HDD102-04	0A/04	03-05	03-05	03-05
	HDD102-05	0A/05	03-06	03-06	
	HDD102-06	0A/06	03-07	03-07	03-07
	HDD102-07	0A/07	03-08	03-08	
	HDD102-08	0A/08	03-09	03-09	03-09
	HDD102-09	0A/09	03-10	03-10	
	HDD102-0A	0A/0A	03-11	03-11	03-11
	HDD102-0B	0A/0B	03-12	03-12	
	HDD102-0C	0A/0C	03-13	03-13	03-13
	HDD102-0D	0A/0D	03-14	03-14	
	HDD102-0E	0A/0E	03-15	03-15	03-15
	HDD102-0F	0A/0F	03-16/Spare	03-16/Spare	03-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(12/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-103	HDD103-00	0B/00	03-01	03-01	03-01
	HDD103-01	0B/01	03-02	03-02	
	HDD103-02	0B/02	03-03	03-03	03-03
	HDD103-03	0B/03	03-04	03-04	
	HDD103-04	0B/04	03-05	03-05	03-05
	HDD103-05	0B/05	03-06	03-06	
	HDD103-06	0B/06	03-07	03-07	03-07
	HDD103-07	0B/07	03-08	03-08	
	HDD103-08	0B/08	03-09	03-09	03-09
	HDD103-09	0B/09	03-10	03-10	
	HDD103-0A	0B/0A	03-11	03-11	03-11
	HDD103-0B	0B/0B	03-12	03-12	
	HDD103-0C	0B/0C	03-13	03-13	03-13
	HDD103-0D	0B/0D	03-14	03-14	
	HDD103-0E	0B/0E	03-15	03-15	03-15
	HDD103-0F	0B/0F	03-16/Spare	03-16/Spare	03-15/Spare

THEORY05-70**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(13/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-104	HDD104-00	0C/00	04-01	03-01	03-01
	HDD104-01	0C/01	04-02	03-02	
	HDD104-02	0C/02	04-03	03-03	03-03
	HDD104-03	0C/03	04-04	03-04	
	HDD104-04	0C/04	04-05	03-05	03-05
	HDD104-05	0C/05	04-06	03-06	
	HDD104-06	0C/06	04-07	03-07	03-07
	HDD104-07	0C/07	04-08	03-08	
	HDD104-08	0C/08	04-09	03-09	03-09
	HDD104-09	0C/09	04-10	03-10	
	HDD104-0A	0C/0A	04-11	03-11	03-11
	HDD104-0B	0C/0B	04-12	03-12	
	HDD104-0C	0C/0C	04-13	03-13	03-13
	HDD104-0D	0C/0D	04-14	03-14	
	HDD104-0E	0C/0E	04-15	03-15	03-15
	HDD104-0F	0C/0F	04-16/Spare	03-16/Spare	03-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(14/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-105	HDD105-00	0D/00	04-01	03-01	03-01
	HDD105-01	0D/01	04-02	03-02	
	HDD105-02	0D/02	04-03	03-03	03-03
	HDD105-03	0D/03	04-04	03-04	
	HDD105-04	0D/04	04-05	03-05	03-05
	HDD105-05	0D/05	04-06	03-06	
	HDD105-06	0D/06	04-07	03-07	03-07
	HDD105-07	0D/07	04-08	03-08	
	HDD105-08	0D/08	04-09	03-09	03-09
	HDD105-09	0D/09	04-10	03-10	
	HDD105-0A	0D/0A	04-11	03-11	03-11
	HDD105-0B	0D/0B	04-12	03-12	
	HDD105-0C	0D/0C	04-13	03-13	03-13
	HDD105-0D	0D/0D	04-14	03-14	
	HDD105-0E	0D/0E	04-15	03-15	03-15
	HDD105-0F	0D/0F	04-16/Spare	03-16/Spare	03-15/Spare

THEORY05-80**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(15/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-106	HDD106-00	0E/00	04-01	03-01	03-01
	HDD106-01	0E/01	04-02	03-02	
	HDD106-02	0E/02	04-03	03-03	
	HDD106-03	0E/03	04-04	03-04	03-03
	HDD106-04	0E/04	04-05	03-05	
	HDD106-05	0E/05	04-06	03-06	
	HDD106-06	0E/06	04-07	03-07	03-05
	HDD106-07	0E/07	04-08	03-08	
	HDD106-08	0E/08	04-09	03-09	
	HDD106-09	0E/09	04-10	03-10	03-07
	HDD106-0A	0E/0A	04-11	03-11	
	HDD106-0B	0E/0B	04-12	03-12	
	HDD106-0C	0E/0C	04-13	03-13	03-09
	HDD106-0D	0E/0D	04-14	03-14	
	HDD106-0E	0E/0E	04-15	03-15	
	HDD106-0F	0E/0F	04-16/Spare	03-16/Spare	03-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(16/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-107	HDD107-00	0F/00	04-01	03-01	03-01
	HDD107-01	0F/01	04-02	03-02	
	HDD107-02	0F/02	04-03	03-03	
	HDD107-03	0F/03	04-04	03-04	03-03
	HDD107-04	0F/04	04-05	03-05	
	HDD107-05	0F/05	04-06	03-06	
	HDD107-06	0F/06	04-07	03-07	03-05
	HDD107-07	0F/07	04-08	03-08	
	HDD107-08	0F/08	04-09	03-09	
	HDD107-09	0F/09	04-10	03-10	03-07
	HDD107-0A	0F/0A	04-11	03-11	
	HDD107-0B	0F/0B	04-12	03-12	
	HDD107-0C	0F/0C	04-13	03-13	03-09
	HDD107-0D	0F/0D	04-14	03-14	
	HDD107-0E	0F/0E	04-15	03-15	
	HDD107-0F	0F/0F	04-16/Spare	03-16/Spare	03-15/Spare

THEORY05-90**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(17/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-010	HDD010-00	00/10	05-01	05-01	05-01
	HDD010-01	00/11	05-02	05-02	
	HDD010-02	00/12	05-03	05-03	05-03
	HDD010-03	00/13	05-04	05-04	
	HDD010-04	00/14	05-05	05-05	05-05
	HDD010-05	00/15	05-06	05-06	
	HDD010-06	00/16	05-07	05-07	05-07
	HDD010-07	00/17	05-08	05-08	
	HDD010-08	00/18	05-09	05-09	05-09
	HDD010-09	00/19	05-10	05-10	
	HDD010-0A	00/1A	05-11	05-11	05-11
	HDD010-0B	00/1B	05-12	05-12	
	HDD010-0C	00/1C	05-13	05-13	05-13
	HDD010-0D	00/1D	05-14	05-14	
	HDD010-0E	00/1E	05-15	05-15	05-15
	HDD010-0F	00/1F	05-16/Spare	05-16/Spare	05-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(18/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-011	HDD011-00	01/10	05-01	05-01	05-01
	HDD011-01	01/11	05-02	05-02	
	HDD011-02	01/12	05-03	05-03	05-03
	HDD011-03	01/13	05-04	05-04	
	HDD011-04	01/14	05-05	05-05	05-05
	HDD011-05	01/15	05-06	05-06	
	HDD011-06	01/16	05-07	05-07	05-07
	HDD011-07	01/17	05-08	05-08	
	HDD011-08	01/18	05-09	05-09	05-09
	HDD011-09	01/19	05-10	05-10	
	HDD011-0A	01/1A	05-11	05-11	05-11
	HDD011-0B	01/1B	05-12	05-12	
	HDD011-0C	01/1C	05-13	05-13	05-13
	HDD011-0D	01/1D	05-14	05-14	
	HDD011-0E	01/1E	05-15	05-15	05-15
	HDD011-0F	01/1F	05-16/Spare	05-16/Spare	05-15/Spare

THEORY05-100**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(19/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-012	HDD012-00	02/10	05-01	05-01	05-01
	HDD012-01	02/11	05-02	05-02	
	HDD012-02	02/12	05-03	05-03	05-03
	HDD012-03	02/13	05-04	05-04	
	HDD012-04	02/14	05-05	05-05	05-05
	HDD012-05	02/15	05-06	05-06	
	HDD012-06	02/16	05-07	05-07	05-07
	HDD012-07	02/17	05-08	05-08	
	HDD012-08	02/18	05-09	05-09	05-09
	HDD012-09	02/19	05-10	05-10	
	HDD012-0A	02/1A	05-11	05-11	05-11
	HDD012-0B	02/1B	05-12	05-12	
	HDD012-0C	02/1C	05-13	05-13	05-13
	HDD012-0D	02/1D	05-14	05-14	
	HDD012-0E	02/1E	05-15	05-15	05-15
	HDD012-0F	02/1F	05-16/Spare	05-16/Spare	05-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(20/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-013	HDD013-00	03/10	05-01	05-01	05-01
	HDD013-01	03/11	05-02	05-02	
	HDD013-02	03/12	05-03	05-03	05-03
	HDD013-03	03/13	05-04	05-04	
	HDD013-04	03/14	05-05	05-05	05-05
	HDD013-05	03/15	05-06	05-06	
	HDD013-06	03/16	05-07	05-07	05-07
	HDD013-07	03/17	05-08	05-08	
	HDD013-08	03/18	05-09	05-09	05-09
	HDD013-09	03/19	05-10	05-10	
	HDD013-0A	03/1A	05-11	05-11	05-11
	HDD013-0B	03/1B	05-12	05-12	
	HDD013-0C	03/1C	05-13	05-13	05-13
	HDD013-0D	03/1D	05-14	05-14	
	HDD013-0E	03/1E	05-15	05-15	05-15
	HDD013-0F	03/1F	05-16/Spare	05-16/Spare	05-15/Spare

THEORY05-110**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(21/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-014	HDD014-00	04/10	06-01	05-01	05-01
	HDD014-01	04/11	06-02	05-02	
	HDD014-02	04/12	06-03	05-03	05-03
	HDD014-03	04/13	06-04	05-04	
	HDD014-04	04/14	06-05	05-05	05-05
	HDD014-05	04/15	06-06	05-06	
	HDD014-06	04/16	06-07	05-07	05-07
	HDD014-07	04/17	06-08	05-08	
	HDD014-08	04/18	06-09	05-09	05-09
	HDD014-09	04/19	06-10	05-10	
	HDD014-0A	04/1A	06-11	05-11	05-11
	HDD014-0B	04/1B	06-12	05-12	
	HDD014-0C	04/1C	06-13	05-13	05-13
	HDD014-0D	04/1D	06-14	05-14	
	HDD014-0E	04/1E	06-15	05-15	05-15
	HDD014-0F	04/1F	06-16/Spare	05-16/Spare	05-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(22/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-015	HDD015-00	05/10	06-01	05-01	05-01
	HDD015-01	05/11	06-02	05-02	
	HDD015-02	05/12	06-03	05-03	05-03
	HDD015-03	05/13	06-04	05-04	
	HDD015-04	05/14	06-05	05-05	05-05
	HDD015-05	05/15	06-06	05-06	
	HDD015-06	05/16	06-07	05-07	05-07
	HDD015-07	05/17	06-08	05-08	
	HDD015-08	05/18	06-09	05-09	05-09
	HDD015-09	05/19	06-10	05-10	
	HDD015-0A	05/1A	06-11	05-11	05-11
	HDD015-0B	05/1B	06-12	05-12	
	HDD015-0C	05/1C	06-13	05-13	05-13
	HDD015-0D	05/1D	06-14	05-14	
	HDD015-0E	05/1E	06-15	05-15	05-15
	HDD015-0F	05/1F	06-16/Spare	05-16/Spare	05-15/Spare

THEORY05-120**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(23/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-016	HDD016-00	06/10	06-01	05-01	05-01
	HDD016-01	06/11	06-02	05-02	
	HDD016-02	06/12	06-03	05-03	05-03
	HDD016-03	06/13	06-04	05-04	
	HDD016-04	06/14	06-05	05-05	05-05
	HDD016-05	06/15	06-06	05-06	
	HDD016-06	06/16	06-07	05-07	05-07
	HDD016-07	06/17	06-08	05-08	
	HDD016-08	06/18	06-09	05-09	05-09
	HDD016-09	06/19	06-10	05-10	
	HDD016-0A	06/1A	06-11	05-11	05-11
	HDD016-0B	06/1B	06-12	05-12	
	HDD016-0C	06/1C	06-13	05-13	05-13
	HDD016-0D	06/1D	06-14	05-14	
	HDD016-0E	06/1E	06-15	05-15	05-15
	HDD016-0F	06/1F	06-16/Spare	05-16/Spare	05-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(24/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-017	HDD017-00	07/10	06-01	05-01	05-01
	HDD017-01	07/11	06-02	05-02	
	HDD017-02	07/12	06-03	05-03	05-03
	HDD017-03	07/13	06-04	05-04	
	HDD017-04	07/14	06-05	05-05	05-05
	HDD017-05	07/15	06-06	05-06	
	HDD017-06	07/16	06-07	05-07	05-07
	HDD017-07	07/17	06-08	05-08	
	HDD017-08	07/18	06-09	05-09	05-09
	HDD017-09	07/19	06-10	05-10	
	HDD017-0A	07/1A	06-11	05-11	05-11
	HDD017-0B	07/1B	06-12	05-12	
	HDD017-0C	07/1C	06-13	05-13	05-13
	HDD017-0D	07/1D	06-14	05-14	
	HDD017-0E	07/1E	06-15	05-15	05-15
	HDD017-0F	07/1F	06-16/Spare	05-16/Spare	05-15/Spare

THEORY05-130**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(25/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-110	HDD110-00	08/10	07-01	07-01	07-01
	HDD110-01	08/11	07-02	07-02	
	HDD110-02	08/12	07-03	07-03	07-03
	HDD110-03	08/13	07-04	07-04	
	HDD110-04	08/14	07-05	07-05	07-05
	HDD110-05	08/15	07-06	07-06	
	HDD110-06	08/16	07-07	07-07	07-07
	HDD110-07	08/17	07-08	07-08	
	HDD110-08	08/18	07-09	07-09	07-09
	HDD110-09	08/19	07-10	07-10	
	HDD110-0A	08/1A	07-11	07-11	07-11
	HDD110-0B	08/1B	07-12	07-12	
	HDD110-0C	08/1C	07-13	07-13	07-13
	HDD110-0D	08/1D	07-14	07-14	
	HDD110-0E	08/1E	07-15	07-15	07-15
	HDD110-0F	08/1F	07-16/Spare	07-16/Spare	07-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(26/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-111	HDD111-00	09/10	07-01	07-01	07-01
	HDD111-01	09/11	07-02	07-02	
	HDD111-02	09/12	07-03	07-03	07-03
	HDD111-03	09/13	07-04	07-04	
	HDD111-04	09/14	07-05	07-05	07-05
	HDD111-05	09/15	07-06	07-06	
	HDD111-06	09/16	07-07	07-07	07-07
	HDD111-07	09/17	07-08	07-08	
	HDD111-08	09/18	07-09	07-09	07-09
	HDD111-09	09/19	07-10	07-10	
	HDD111-0A	09/1A	07-11	07-11	07-11
	HDD111-0B	09/1B	07-12	07-12	
	HDD111-0C	09/1C	07-13	07-13	07-13
	HDD111-0D	09/1D	07-14	07-14	
	HDD111-0E	09/1E	07-15	07-15	07-15
	HDD111-0F	09/1F	07-16/Spare	07-16/Spare	07-15/Spare

THEORY05-140**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(27/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-112	HDD112-00	0A/10	07-01	07-01	07-01
	HDD112-01	0A/11	07-02	07-02	
	HDD112-02	0A/12	07-03	07-03	07-03
	HDD112-03	0A/13	07-04	07-04	
	HDD112-04	0A/14	07-05	07-05	07-05
	HDD112-05	0A/15	07-06	07-06	
	HDD112-06	0A/16	07-07	07-07	07-07
	HDD112-07	0A/17	07-08	07-08	
	HDD112-08	0A/18	07-09	07-09	07-09
	HDD112-09	0A/19	07-10	07-10	
	HDD112-0A	0A/1A	07-11	07-11	07-11
	HDD112-0B	0A/1B	07-12	07-12	
	HDD112-0C	0A/1C	07-13	07-13	07-13
	HDD112-0D	0A/1D	07-14	07-14	
	HDD112-0E	0A/1E	07-15	07-15	07-15
	HDD112-0F	0A/1F	07-16/Spare	07-16/Spare	07-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(28/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-113	HDD113-00	0B/10	07-01	07-01	07-01
	HDD113-01	0B/11	07-02	07-02	
	HDD113-02	0B/12	07-03	07-03	07-03
	HDD113-03	0B/13	07-04	07-04	
	HDD113-04	0B/14	07-05	07-05	07-05
	HDD113-05	0B/15	07-06	07-06	
	HDD113-06	0B/16	07-07	07-07	07-07
	HDD113-07	0B/17	07-08	07-08	
	HDD113-08	0B/18	07-09	07-09	07-09
	HDD113-09	0B/19	07-10	07-10	
	HDD113-0A	0B/1A	07-11	07-11	07-11
	HDD113-0B	0B/1B	07-12	07-12	
	HDD113-0C	0B/1C	07-13	07-13	07-13
	HDD113-0D	0B/1D	07-14	07-14	
	HDD113-0E	0B/1E	07-15	07-15	07-15
	HDD113-0F	0B/1F	07-16/Spare	07-16/Spare	07-15/Spare

THEORY05-150**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(29/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-114	HDD114-00	0C/10	08-01	07-01	07-01
	HDD114-01	0C/11	08-02	07-02	
	HDD114-02	0C/12	08-03	07-03	07-03
	HDD114-03	0C/13	08-04	07-04	
	HDD114-04	0C/14	08-05	07-05	07-05
	HDD114-05	0C/15	08-06	07-06	
	HDD114-06	0C/16	08-07	07-07	07-07
	HDD114-07	0C/17	08-08	07-08	
	HDD114-08	0C/18	08-09	07-09	07-09
	HDD114-09	0C/19	08-10	07-10	
	HDD114-0A	0C/1A	08-11	07-11	07-11
	HDD114-0B	0C/1B	08-12	07-12	
	HDD114-0C	0C/1C	08-13	07-13	07-13
	HDD114-0D	0C/1D	08-14	07-14	
	HDD114-0E	0C/1E	08-15	07-15	07-15
	HDD114-0F	0C/1F	08-16/Spare	07-16/Spare	07-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(30/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-115	HDD115-00	0D/10	08-01	07-01	07-01
	HDD115-01	0D/11	08-02	07-02	
	HDD115-02	0D/12	08-03	07-03	07-03
	HDD115-03	0D/13	08-04	07-04	
	HDD115-04	0D/14	08-05	07-05	07-05
	HDD115-05	0D/15	08-06	07-06	
	HDD115-06	0D/16	08-07	07-07	07-07
	HDD115-07	0D/17	08-08	07-08	
	HDD115-08	0D/18	08-09	07-09	07-09
	HDD115-09	0D/19	08-10	07-10	
	HDD115-0A	0D/1A	08-11	07-11	07-11
	HDD115-0B	0D/1B	08-12	07-12	
	HDD115-0C	0D/1C	08-13	07-13	07-13
	HDD115-0D	0D/1D	08-14	07-14	
	HDD115-0E	0D/1E	08-15	07-15	07-15
	HDD115-0F	0D/1F	08-16/Spare	07-16/Spare	07-15/Spare

THEORY05-160**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(31/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-116	HDD116-00	0E/10	08-01	07-01	07-01
	HDD116-01	0E/11	08-02	07-02	
	HDD116-02	0E/12	08-03	07-03	07-03
	HDD116-03	0E/13	08-04	07-04	
	HDD116-04	0E/14	08-05	07-05	07-05
	HDD116-05	0E/15	08-06	07-06	
	HDD116-06	0E/16	08-07	07-07	07-07
	HDD116-07	0E/17	08-08	07-08	
	HDD116-08	0E/18	08-09	07-09	07-09
	HDD116-09	0E/19	08-10	07-10	
	HDD116-0A	0E/1A	08-11	07-11	07-11
	HDD116-0B	0E/1B	08-12	07-12	
	HDD116-0C	0E/1C	08-13	07-13	07-13
	HDD116-0D	0E/1D	08-14	07-14	
	HDD116-0E	0E/1E	08-15	07-15	07-15
	HDD116-0F	0E/1F	08-16/Spare	07-16/Spare	07-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(32/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-117	HDD117-00	0F/10	08-01	07-01	07-01
	HDD117-01	0F/11	08-02	07-02	
	HDD117-02	0F/12	08-03	07-03	07-03
	HDD117-03	0F/13	08-04	07-04	
	HDD117-04	0F/14	08-05	07-05	07-05
	HDD117-05	0F/15	08-06	07-06	
	HDD117-06	0F/16	08-07	07-07	07-07
	HDD117-07	0F/17	08-08	07-08	
	HDD117-08	0F/18	08-09	07-09	07-09
	HDD117-09	0F/19	08-10	07-10	
	HDD117-0A	0F/1A	08-11	07-11	07-11
	HDD117-0B	0F/1B	08-12	07-12	
	HDD117-0C	0F/1C	08-13	07-13	07-13
	HDD117-0D	0F/1D	08-14	07-14	
	HDD117-0E	0F/1E	08-15	07-15	07-15
	HDD117-0F	0F/1F	08-16/Spare	07-16/Spare	07-15/Spare

THEORY05-170**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(33/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-020	HDD020-00	00/20	09-01	09-01	09-01
	HDD020-01	00/21	09-02	09-02	
	HDD020-02	00/22	09-03	09-03	09-03
	HDD020-03	00/23	09-04	09-04	
	HDD020-04	00/24	09-05	09-05	09-05
	HDD020-05	00/25	09-06	09-06	
	HDD020-06	00/26	09-07	09-07	09-07
	HDD020-07	00/27	09-08	09-08	
	HDD020-08	00/28	09-09	09-09	09-09
	HDD020-09	00/29	09-10	09-10	
	HDD020-0A	00/2A	09-11	09-11	09-11
	HDD020-0B	00/2B	09-12	09-12	
	HDD020-0C	00/2C	09-13	09-13	09-13
	HDD020-0D	00/2D	09-14	09-14	
	HDD020-0E	00/2E	09-15	09-15	09-15
	HDD020-0F	00/2F	09-16/Spare	09-16/Spare	09-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(34/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-021	HDD021-00	01/20	09-01	09-01	09-01
	HDD021-01	01/21	09-02	09-02	
	HDD021-02	01/22	09-03	09-03	09-03
	HDD021-03	01/23	09-04	09-04	
	HDD021-04	01/24	09-05	09-05	09-05
	HDD021-05	01/25	09-06	09-06	
	HDD021-06	01/26	09-07	09-07	09-07
	HDD021-07	01/27	09-08	09-08	
	HDD021-08	01/28	09-09	09-09	09-09
	HDD021-09	01/29	09-10	09-10	
	HDD021-0A	01/2A	09-11	09-11	09-11
	HDD021-0B	01/2B	09-12	09-12	
	HDD021-0C	01/2C	09-13	09-13	09-13
	HDD021-0D	01/2D	09-14	09-14	
	HDD021-0E	01/2E	09-15	09-15	09-15
	HDD021-0F	01/2F	09-16/Spare	09-16/Spare	09-15/Spare

THEORY05-180**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(35/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-022	HDD022-00	02/20	09-01	09-01	09-01
	HDD022-01	02/21	09-02	09-02	
	HDD022-02	02/22	09-03	09-03	09-03
	HDD022-03	02/23	09-04	09-04	
	HDD022-04	02/24	09-05	09-05	09-05
	HDD022-05	02/25	09-06	09-06	
	HDD022-06	02/26	09-07	09-07	09-07
	HDD022-07	02/27	09-08	09-08	
	HDD022-08	02/28	09-09	09-09	09-09
	HDD022-09	02/29	09-10	09-10	
	HDD022-0A	02/2A	09-11	09-11	09-11
	HDD022-0B	02/2B	09-12	09-12	
	HDD022-0C	02/2C	09-13	09-13	09-13
	HDD022-0D	02/2D	09-14	09-14	
	HDD022-0E	02/2E	09-15	09-15	09-15
	HDD022-0F	02/2F	09-16/Spare	09-16/Spare	09-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(36/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-023	HDD023-00	03/20	09-01	09-01	09-01
	HDD023-01	03/21	09-02	09-02	
	HDD023-02	03/22	09-03	09-03	09-03
	HDD023-03	03/23	09-04	09-04	
	HDD023-04	03/24	09-05	09-05	09-05
	HDD023-05	03/25	09-06	09-06	
	HDD023-06	03/26	09-07	09-07	09-07
	HDD023-07	03/27	09-08	09-08	
	HDD023-08	03/28	09-09	09-09	09-09
	HDD023-09	03/29	09-10	09-10	
	HDD023-0A	03/2A	09-11	09-11	09-11
	HDD023-0B	03/2B	09-12	09-12	
	HDD023-0C	03/2C	09-13	09-13	09-13
	HDD023-0D	03/2D	09-14	09-14	
	HDD023-0E	03/2E	09-15	09-15	09-15
	HDD023-0F	03/2F	09-16/Spare	09-16/Spare	09-15/Spare

THEORY05-190**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(37/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-024	HDD024-00	04/20	10-01	09-01	09-01
	HDD024-01	04/21	10-02	09-02	
	HDD024-02	04/22	10-03	09-03	09-03
	HDD024-03	04/23	10-04	09-04	
	HDD024-04	04/24	10-05	09-05	09-05
	HDD024-05	04/25	10-06	09-06	
	HDD024-06	04/26	10-07	09-07	09-07
	HDD024-07	04/27	10-08	09-08	
	HDD024-08	04/28	10-09	09-09	09-09
	HDD024-09	04/29	10-10	09-10	
	HDD024-0A	04/2A	10-11	09-11	09-11
	HDD024-0B	04/2B	10-12	09-12	
	HDD024-0C	04/2C	10-13	09-13	09-13
	HDD024-0D	04/2D	10-14	09-14	
	HDD024-0E	04/2E	10-15	09-15	09-15
	HDD024-0F	04/2F	10-16/Spare	09-16/Spare	09-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(38/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-025	HDD025-00	05/20	10-01	09-01	09-01
	HDD025-01	05/21	10-02	09-02	
	HDD025-02	05/22	10-03	09-03	09-03
	HDD025-03	05/23	10-04	09-04	
	HDD025-04	05/24	10-05	09-05	09-05
	HDD025-05	05/25	10-06	09-06	
	HDD025-06	05/26	10-07	09-07	09-07
	HDD025-07	05/27	10-08	09-08	
	HDD025-08	05/28	10-09	09-09	09-09
	HDD025-09	05/29	10-10	09-10	
	HDD025-0A	05/2A	10-11	09-11	09-11
	HDD025-0B	05/2B	10-12	09-12	
	HDD025-0C	05/2C	10-13	09-13	09-13
	HDD025-0D	05/2D	10-14	09-14	
	HDD025-0E	05/2E	10-15	09-15	09-15
	HDD025-0F	05/2F	10-16/Spare	09-16/Spare	09-15/Spare

THEORY05-200**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(39/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-026	HDD026-00	06/20	10-01	09-01	09-01
	HDD026-01	06/21	10-02	09-02	
	HDD026-02	06/22	10-03	09-03	09-03
	HDD026-03	06/23	10-04	09-04	
	HDD026-04	06/24	10-05	09-05	09-05
	HDD026-05	06/25	10-06	09-06	
	HDD026-06	06/26	10-07	09-07	09-07
	HDD026-07	06/27	10-08	09-08	
	HDD026-08	06/28	10-09	09-09	09-09
	HDD026-09	06/29	10-10	09-10	
	HDD026-0A	06/2A	10-11	09-11	09-11
	HDD026-0B	06/2B	10-12	09-12	
	HDD026-0C	06/2C	10-13	09-13	09-13
	HDD026-0D	06/2D	10-14	09-14	
	HDD026-0E	06/2E	10-15	09-15	09-15
	HDD026-0F	06/2F	10-16/Spare	09-16/Spare	09-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(40/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-027	HDD027-00	07/20	10-01	09-01	09-01
	HDD027-01	07/21	10-02	09-02	
	HDD027-02	07/22	10-03	09-03	09-03
	HDD027-03	07/23	10-04	09-04	
	HDD027-04	07/24	10-05	09-05	09-05
	HDD027-05	07/25	10-06	09-06	
	HDD027-06	07/26	10-07	09-07	09-07
	HDD027-07	07/27	10-08	09-08	
	HDD027-08	07/28	10-09	09-09	09-09
	HDD027-09	07/29	10-10	09-10	
	HDD027-0A	07/2A	10-11	09-11	09-11
	HDD027-0B	07/2B	10-12	09-12	
	HDD027-0C	07/2C	10-13	09-13	09-13
	HDD027-0D	07/2D	10-14	09-14	
	HDD027-0E	07/2E	10-15	09-15	09-15
	HDD027-0F	07/2F	10-16/Spare	09-16/Spare	09-15/Spare

THEORY05-210**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(41/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-120	HDD120-00	08/20	11-01	11-01	11-01
	HDD120-01	08/21	11-02	11-02	
	HDD120-02	08/22	11-03	11-03	11-03
	HDD120-03	08/23	11-04	11-04	
	HDD120-04	08/24	11-05	11-05	11-05
	HDD120-05	08/25	11-06	11-06	
	HDD120-06	08/26	11-07	11-07	11-07
	HDD120-07	08/27	11-08	11-08	
	HDD120-08	08/28	11-09	11-09	11-09
	HDD120-09	08/29	11-10	11-10	
	HDD120-0A	08/2A	11-11	11-11	11-11
	HDD120-0B	08/2B	11-12	11-12	
	HDD120-0C	08/2C	11-13	11-13	11-13
	HDD120-0D	08/2D	11-14	11-14	
	HDD120-0E	08/2E	11-15	11-15	11-15
	HDD120-0F	08/2F	11-16/Spare	11-16/Spare	11-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(42/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-121	HDD121-00	09/20	11-01	11-01	11-01
	HDD121-01	09/21	11-02	11-02	
	HDD121-02	09/22	11-03	11-03	11-03
	HDD121-03	09/23	11-04	11-04	
	HDD121-04	09/24	11-05	11-05	11-05
	HDD121-05	09/25	11-06	11-06	
	HDD121-06	09/26	11-07	11-07	11-07
	HDD121-07	09/27	11-08	11-08	
	HDD121-08	09/28	11-09	11-09	11-09
	HDD121-09	09/29	11-10	11-10	
	HDD121-0A	09/2A	11-11	11-11	11-11
	HDD121-0B	09/2B	11-12	11-12	
	HDD121-0C	09/2C	11-13	11-13	11-13
	HDD121-0D	09/2D	11-14	11-14	
	HDD121-0E	09/2E	11-15	11-15	11-15
	HDD121-0F	09/2F	11-16/Spare	11-16/Spare	11-15/Spare

THEORY05-220**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(43/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-122	HDD122-00	0A/20	11-01	11-01	11-01
	HDD122-01	0A/21	11-02	11-02	
	HDD122-02	0A/22	11-03	11-03	11-03
	HDD122-03	0A/23	11-04	11-04	
	HDD122-04	0A/24	11-05	11-05	11-05
	HDD122-05	0A/25	11-06	11-06	
	HDD122-06	0A/26	11-07	11-07	11-07
	HDD122-07	0A/27	11-08	11-08	
	HDD122-08	0A/28	11-09	11-09	11-09
	HDD122-09	0A/29	11-10	11-10	
	HDD122-0A	0A/2A	11-11	11-11	11-11
	HDD122-0B	0A/2B	11-12	11-12	
	HDD122-0C	0A/2C	11-13	11-13	11-13
	HDD122-0D	0A/2D	11-14	11-14	
	HDD122-0E	0A/2E	11-15	11-15	11-15
	HDD122-0F	0A/2F	11-16/Spare	11-16/Spare	11-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(44/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-123	HDD123-00	0B/20	11-01	11-01	11-01
	HDD123-01	0B/21	11-02	11-02	
	HDD123-02	0B/22	11-03	11-03	11-03
	HDD123-03	0B/23	11-04	11-04	
	HDD123-04	0B/24	11-05	11-05	11-05
	HDD123-05	0B/25	11-06	11-06	
	HDD123-06	0B/26	11-07	11-07	11-07
	HDD123-07	0B/27	11-08	11-08	
	HDD123-08	0B/28	11-09	11-09	11-09
	HDD123-09	0B/29	11-10	11-10	
	HDD123-0A	0B/2A	11-11	11-11	11-11
	HDD123-0B	0B/2B	11-12	11-12	
	HDD123-0C	0B/2C	11-13	11-13	11-13
	HDD123-0D	0B/2D	11-14	11-14	
	HDD123-0E	0B/2E	11-15	11-15	11-15
	HDD123-0F	0B/2F	11-16/Spare	11-16/Spare	11-15/Spare

THEORY05-230**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(45/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-124	HDD124-00	0C/20	12-01	11-01	11-01
	HDD124-01	0C/21	12-02	11-02	
	HDD124-02	0C/22	12-03	11-03	11-03
	HDD124-03	0C/23	12-04	11-04	
	HDD124-04	0C/24	12-05	11-05	11-05
	HDD124-05	0C/25	12-06	11-06	
	HDD124-06	0C/26	12-07	11-07	11-07
	HDD124-07	0C/27	12-08	11-08	
	HDD124-08	0C/28	12-09	11-09	11-09
	HDD124-09	0C/29	12-10	11-10	
	HDD124-0A	0C/2A	12-11	11-11	11-11
	HDD124-0B	0C/2B	12-12	11-12	
	HDD124-0C	0C/2C	12-13	11-13	11-13
	HDD124-0D	0C/2D	12-14	11-14	
	HDD124-0E	0C/2E	12-15	11-15	11-15
	HDD124-0F	0C/2F	12-16/Spare	11-16/Spare	11-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(46/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-125	HDD125-00	0D/20	12-01	11-01	11-01
	HDD125-01	0D/21	12-02	11-02	
	HDD125-02	0D/22	12-03	11-03	11-03
	HDD125-03	0D/23	12-04	11-04	
	HDD125-04	0D/24	12-05	11-05	11-05
	HDD125-05	0D/25	12-06	11-06	
	HDD125-06	0D/26	12-07	11-07	11-07
	HDD125-07	0D/27	12-08	11-08	
	HDD125-08	0D/28	12-09	11-09	11-09
	HDD125-09	0D/29	12-10	11-10	
	HDD125-0A	0D/2A	12-11	11-11	11-11
	HDD125-0B	0D/2B	12-12	11-12	
	HDD125-0C	0D/2C	12-13	11-13	11-13
	HDD125-0D	0D/2D	12-14	11-14	
	HDD125-0E	0D/2E	12-15	11-15	11-15
	HDD125-0F	0D/2F	12-16/Spare	11-16/Spare	11-15/Spare

THEORY05-240**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(47/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-126	HDD126-00	0E/20	12-01	11-01	11-01
	HDD126-01	0E/21	12-02	11-02	
	HDD126-02	0E/22	12-03	11-03	11-03
	HDD126-03	0E/23	12-04	11-04	
	HDD126-04	0E/24	12-05	11-05	11-05
	HDD126-05	0E/25	12-06	11-06	
	HDD126-06	0E/26	12-07	11-07	11-07
	HDD126-07	0E/27	12-08	11-08	
	HDD126-08	0E/28	12-09	11-09	11-09
	HDD126-09	0E/29	12-10	11-10	
	HDD126-0A	0E/2A	12-11	11-11	11-11
	HDD126-0B	0E/2B	12-12	11-12	
	HDD126-0C	0E/2C	12-13	11-13	11-13
	HDD126-0D	0E/2D	12-14	11-14	
	HDD126-0E	0E/2E	12-15	11-15	11-15
	HDD126-0F	0E/2F	12-16/Spare	11-16/Spare	11-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(48/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-127	HDD127-00	0F/20	12-01	11-01	11-01
	HDD127-01	0F/21	12-02	11-02	
	HDD127-02	0F/22	12-03	11-03	11-03
	HDD127-03	0F/23	12-04	11-04	
	HDD127-04	0F/24	12-05	11-05	11-05
	HDD127-05	0F/25	12-06	11-06	
	HDD127-06	0F/26	12-07	11-07	11-07
	HDD127-07	0F/27	12-08	11-08	
	HDD127-08	0F/28	12-09	11-09	11-09
	HDD127-09	0F/29	12-10	11-10	
	HDD127-0A	0F/2A	12-11	11-11	11-11
	HDD127-0B	0F/2B	12-12	11-12	
	HDD127-0C	0F/2C	12-13	11-13	11-13
	HDD127-0D	0F/2D	12-14	11-14	
	HDD127-0E	0F/2E	12-15	11-15	11-15
	HDD127-0F	0F/2F	12-16/Spare	11-16/Spare	11-15/Spare

THEORY05-250**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(49/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-030	HDD030-00	00/30	13-01	13-01	13-01
	HDD030-01	00/31	13-02	13-02	
	HDD030-02	00/32	13-03	13-03	13-03
	HDD030-03	00/33	13-04	13-04	
	HDD030-04	00/34	13-05	13-05	13-05
	HDD030-05	00/35	13-06	13-06	
	HDD030-06	00/36	13-07	13-07	13-07
	HDD030-07	00/37	13-08	13-08	
	HDD030-08	00/38	13-09	13-09	13-09
	HDD030-09	00/39	13-10	13-10	
	HDD030-0A	00/3A	13-11	13-11	13-11
	HDD030-0B	00/3B	13-12	13-12	
	HDD030-0C	00/3C	13-13	13-13	13-13
	HDD030-0D	00/3D	13-14	13-14	
	HDD030-0E	00/3E	13-15	13-15	13-15
	HDD030-0F	00/3F	13-16/Spare	13-16/Spare	13-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(50/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-031	HDD031-00	01/30	13-01	13-01	13-01
	HDD031-01	01/31	13-02	13-02	
	HDD031-02	01/32	13-03	13-03	13-03
	HDD031-03	01/33	13-04	13-04	
	HDD031-04	01/34	13-05	13-05	13-05
	HDD031-05	01/35	13-06	13-06	
	HDD031-06	01/36	13-07	13-07	13-07
	HDD031-07	01/37	13-08	13-08	
	HDD031-08	01/38	13-09	13-09	13-09
	HDD031-09	01/39	13-10	13-10	
	HDD031-0A	01/3A	13-11	13-11	13-11
	HDD031-0B	01/3B	13-12	13-12	
	HDD031-0C	01/3C	13-13	13-13	13-13
	HDD031-0D	01/3D	13-14	13-14	
	HDD031-0E	01/3E	13-15	13-15	13-15
	HDD031-0F	01/3F	13-16/Spare	13-16/Spare	13-15/Spare

THEORY05-260**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(51/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-032	HDD032-00	02/30	13-01	13-01	13-01
	HDD032-01	02/31	13-02	13-02	
	HDD032-02	02/32	13-03	13-03	13-03
	HDD032-03	02/33	13-04	13-04	
	HDD032-04	02/34	13-05	13-05	13-05
	HDD032-05	02/35	13-06	13-06	
	HDD032-06	02/36	13-07	13-07	13-07
	HDD032-07	02/37	13-08	13-08	
	HDD032-08	02/38	13-09	13-09	13-09
	HDD032-09	02/39	13-10	13-10	
	HDD032-0A	02/3A	13-11	13-11	13-11
	HDD032-0B	02/3B	13-12	13-12	
	HDD032-0C	02/3C	13-13	13-13	13-13
	HDD032-0D	02/3D	13-14	13-14	
	HDD032-0E	02/3E	13-15	13-15	13-15
	HDD032-0F	02/3F	13-16/Spare	13-16/Spare	13-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(52/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-033	HDD033-00	03/30	13-01	13-01	13-01
	HDD033-01	03/31	13-02	13-02	
	HDD033-02	03/32	13-03	13-03	13-03
	HDD033-03	03/33	13-04	13-04	
	HDD033-04	03/34	13-05	13-05	13-05
	HDD033-05	03/35	13-06	13-06	
	HDD033-06	03/36	13-07	13-07	13-07
	HDD033-07	03/37	13-08	13-08	
	HDD033-08	03/38	13-09	13-09	13-09
	HDD033-09	03/39	13-10	13-10	
	HDD033-0A	03/3A	13-11	13-11	13-11
	HDD033-0B	03/3B	13-12	13-12	
	HDD033-0C	03/3C	13-13	13-13	13-13
	HDD033-0D	03/3D	13-14	13-14	
	HDD033-0E	03/3E	13-15	13-15	13-15
	HDD033-0F	03/3F	13-16/Spare	13-16/Spare	13-15/Spare

THEORY05-270**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(53/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-034	HDD034-00	04/30	14-01	13-01	13-01
	HDD034-01	04/31	14-02	13-02	
	HDD034-02	04/32	14-03	13-03	13-03
	HDD034-03	04/33	14-04	13-04	
	HDD034-04	04/34	14-05	13-05	13-05
	HDD034-05	04/35	14-06	13-06	
	HDD034-06	04/36	14-07	13-07	13-07
	HDD034-07	04/37	14-08	13-08	
	HDD034-08	04/38	14-09	13-09	13-09
	HDD034-09	04/39	14-10	13-10	
	HDD034-0A	04/3A	14-11	13-11	13-11
	HDD034-0B	04/3B	14-12	13-12	
	HDD034-0C	04/3C	14-13	13-13	13-13
	HDD034-0D	04/3D	14-14	13-14	
	HDD034-0E	04/3E	14-15	13-15	13-15
	HDD034-0F	04/3F	14-16/Spare	13-16/Spare	13-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(54/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-035	HDD035-00	05/30	14-01	13-01	13-01
	HDD035-01	05/31	14-02	13-02	
	HDD035-02	05/32	14-03	13-03	13-03
	HDD035-03	05/33	14-04	13-04	
	HDD035-04	05/34	14-05	13-05	13-05
	HDD035-05	05/35	14-06	13-06	
	HDD035-06	05/36	14-07	13-07	13-07
	HDD035-07	05/37	14-08	13-08	
	HDD035-08	05/38	14-09	13-09	13-09
	HDD035-09	05/39	14-10	13-10	
	HDD035-0A	05/3A	14-11	13-11	13-11
	HDD035-0B	05/3B	14-12	13-12	
	HDD035-0C	05/3C	14-13	13-13	13-13
	HDD035-0D	05/3D	14-14	13-14	
	HDD035-0E	05/3E	14-15	13-15	13-15
	HDD035-0F	05/3F	14-16/Spare	13-16/Spare	13-15/Spare

THEORY05-280**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(55/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-036	HDD036-00	06/30	14-01	13-01	13-01
	HDD036-01	06/31	14-02	13-02	
	HDD036-02	06/32	14-03	13-03	13-03
	HDD036-03	06/33	14-04	13-04	
	HDD036-04	06/34	14-05	13-05	13-05
	HDD036-05	06/35	14-06	13-06	
	HDD036-06	06/36	14-07	13-07	13-07
	HDD036-07	06/37	14-08	13-08	
	HDD036-08	06/38	14-09	13-09	13-09
	HDD036-09	06/39	14-10	13-10	
	HDD036-0A	06/3A	14-11	13-11	13-11
	HDD036-0B	06/3B	14-12	13-12	
	HDD036-0C	06/3C	14-13	13-13	13-13
	HDD036-0D	06/3D	14-14	13-14	
	HDD036-0E	06/3E	14-15	13-15	13-15
	HDD036-0F	06/3F	14-16/Spare	13-16/Spare	13-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(56/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-037	HDD037-00	07/30	14-01	13-01	13-01
	HDD037-01	07/31	14-02	13-02	
	HDD037-02	07/32	14-03	13-03	13-03
	HDD037-03	07/33	14-04	13-04	
	HDD037-04	07/34	14-05	13-05	13-05
	HDD037-05	07/35	14-06	13-06	
	HDD037-06	07/36	14-07	13-07	13-07
	HDD037-07	07/37	14-08	13-08	
	HDD037-08	07/38	14-09	13-09	13-09
	HDD037-09	07/39	14-10	13-10	
	HDD037-0A	07/3A	14-11	13-11	13-11
	HDD037-0B	07/3B	14-12	13-12	
	HDD037-0C	07/3C	14-13	13-13	13-13
	HDD037-0D	07/3D	14-14	13-14	
	HDD037-0E	07/3E	14-15	13-15	13-15
	HDD037-0F	07/3F	14-16/Spare	13-16/Spare	13-15/Spare

THEORY05-290**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(57/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-130	HDD130-00	08/30	15-01	15-01	15-01
	HDD130-01	08/31	15-02	15-02	
	HDD130-02	08/32	15-03	15-03	15-03
	HDD130-03	08/33	15-04	15-04	
	HDD130-04	08/34	15-05	15-05	15-05
	HDD130-05	08/35	15-06	15-06	
	HDD130-06	08/36	15-07	15-07	15-07
	HDD130-07	08/37	15-08	15-08	
	HDD130-08	08/38	15-09	15-09	15-09
	HDD130-09	08/39	15-10	15-10	
	HDD130-0A	08/3A	15-11	15-11	15-11
	HDD130-0B	08/3B	15-12	15-12	
	HDD130-0C	08/3C	15-13	15-13	15-13
	HDD130-0D	08/3D	15-14	15-14	
	HDD130-0E	08/3E	15-15	15-15	15-15
	HDD130-0F	08/3F	15-16/Spare	15-16/Spare	15-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(58/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-131	HDD131-00	09/30	15-01	15-01	15-01
	HDD131-01	09/31	15-02	15-02	
	HDD131-02	09/32	15-03	15-03	15-03
	HDD131-03	09/33	15-04	15-04	
	HDD131-04	09/34	15-05	15-05	15-05
	HDD131-05	09/35	15-06	15-06	
	HDD131-06	09/36	15-07	15-07	15-07
	HDD131-07	09/37	15-08	15-08	
	HDD131-08	09/38	15-09	15-09	15-09
	HDD131-09	09/39	15-10	15-10	
	HDD131-0A	09/3A	15-11	15-11	15-11
	HDD131-0B	09/3B	15-12	15-12	
	HDD131-0C	09/3C	15-13	15-13	15-13
	HDD131-0D	09/3D	15-14	15-14	
	HDD131-0E	09/3E	15-15	15-15	15-15
	HDD131-0F	09/3F	15-16/Spare	15-16/Spare	15-15/Spare

THEORY05-300**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(59/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-132	HDD132-00	0A/30	15-01	15-01	15-01
	HDD132-01	0A/31	15-02	15-02	
	HDD132-02	0A/32	15-03	15-03	15-03
	HDD132-03	0A/33	15-04	15-04	
	HDD132-04	0A/34	15-05	15-05	15-05
	HDD132-05	0A/35	15-06	15-06	
	HDD132-06	0A/36	15-07	15-07	15-07
	HDD132-07	0A/37	15-08	15-08	
	HDD132-08	0A/38	15-09	15-09	15-09
	HDD132-09	0A/39	15-10	15-10	
	HDD132-0A	0A/3A	15-11	15-11	15-11
	HDD132-0B	0A/3B	15-12	15-12	
	HDD132-0C	0A/3C	15-13	15-13	15-13
	HDD132-0D	0A/3D	15-14	15-14	
	HDD132-0E	0A/3E	15-15	15-15	15-15
	HDD132-0F	0A/3F	15-16/Spare	15-16/Spare	15-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(60/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-133	HDD133-00	0B/30	15-01	15-01	15-01
	HDD133-01	0B/31	15-02	15-02	
	HDD133-02	0B/32	15-03	15-03	15-03
	HDD133-03	0B/33	15-04	15-04	
	HDD133-04	0B/34	15-05	15-05	15-05
	HDD133-05	0B/35	15-06	15-06	
	HDD133-06	0B/36	15-07	15-07	15-07
	HDD133-07	0B/37	15-08	15-08	
	HDD133-08	0B/38	15-09	15-09	15-09
	HDD133-09	0B/39	15-10	15-10	
	HDD133-0A	0B/3A	15-11	15-11	15-11
	HDD133-0B	0B/3B	15-12	15-12	
	HDD133-0C	0B/3C	15-13	15-13	15-13
	HDD133-0D	0B/3D	15-14	15-14	
	HDD133-0E	0B/3E	15-15	15-15	15-15
	HDD133-0F	0B/3F	15-16/Spare	15-16/Spare	15-15/Spare

THEORY05-310**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(61/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-134	HDD134-00	0C/30	16-01	15-01	15-01
	HDD134-01	0C/31	16-02	15-02	
	HDD134-02	0C/32	16-03	15-03	15-03
	HDD134-03	0C/33	16-04	15-04	
	HDD134-04	0C/34	16-05	15-05	15-05
	HDD134-05	0C/35	16-06	15-06	
	HDD134-06	0C/36	16-07	15-07	15-07
	HDD134-07	0C/37	16-08	15-08	
	HDD134-08	0C/38	16-09	15-09	15-09
	HDD134-09	0C/39	16-10	15-10	
	HDD134-0A	0C/3A	16-11	15-11	15-11
	HDD134-0B	0C/3B	16-12	15-12	
	HDD134-0C	0C/3C	16-13	15-13	15-13
	HDD134-0D	0C/3D	16-14	15-14	
	HDD134-0E	0C/3E	16-15	15-15	15-15
	HDD134-0F	0C/3F	16-16/Spare	15-16/Spare	15-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(62/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-135	HDD135-00	0D/30	16-01	15-01	15-01
	HDD135-01	0D/31	16-02	15-02	
	HDD135-02	0D/32	16-03	15-03	15-03
	HDD135-03	0D/33	16-04	15-04	
	HDD135-04	0D/34	16-05	15-05	15-05
	HDD135-05	0D/35	16-06	15-06	
	HDD135-06	0D/36	16-07	15-07	15-07
	HDD135-07	0D/37	16-08	15-08	
	HDD135-08	0D/38	16-09	15-09	15-09
	HDD135-09	0D/39	16-10	15-10	
	HDD135-0A	0D/3A	16-11	15-11	15-11
	HDD135-0B	0D/3B	16-12	15-12	
	HDD135-0C	0D/3C	16-13	15-13	15-13
	HDD135-0D	0D/3D	16-14	15-14	
	HDD135-0E	0D/3E	16-15	15-15	15-15
	HDD135-0F	0D/3F	16-16/Spare	15-16/Spare	15-15/Spare

THEORY05-320**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(63/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-136	HDD136-00	0E/30	16-01	15-01	15-01
	HDD136-01	0E/31	16-02	15-02	
	HDD136-02	0E/32	16-03	15-03	15-03
	HDD136-03	0E/33	16-04	15-04	
	HDD136-04	0E/34	16-05	15-05	15-05
	HDD136-05	0E/35	16-06	15-06	
	HDD136-06	0E/36	16-07	15-07	15-07
	HDD136-07	0E/37	16-08	15-08	
	HDD136-08	0E/38	16-09	15-09	15-09
	HDD136-09	0E/39	16-10	15-10	
	HDD136-0A	0E/3A	16-11	15-11	15-11
	HDD136-0B	0E/3B	16-12	15-12	
	HDD136-0C	0E/3C	16-13	15-13	15-13
	HDD136-0D	0E/3D	16-14	15-14	
	HDD136-0E	0E/3E	16-15	15-15	15-15
	HDD136-0F	0E/3F	16-16/Spare	15-16/Spare	15-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(64/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-137	HDD137-00	0F/30	16-01	15-01	15-01
	HDD137-01	0F/31	16-02	15-02	
	HDD137-02	0F/32	16-03	15-03	15-03
	HDD137-03	0F/33	16-04	15-04	
	HDD137-04	0F/34	16-05	15-05	15-05
	HDD137-05	0F/35	16-06	15-06	
	HDD137-06	0F/36	16-07	15-07	15-07
	HDD137-07	0F/37	16-08	15-08	
	HDD137-08	0F/38	16-09	15-09	15-09
	HDD137-09	0F/39	16-10	15-10	
	HDD137-0A	0F/3A	16-11	15-11	15-11
	HDD137-0B	0F/3B	16-12	15-12	
	HDD137-0C	0F/3C	16-13	15-13	15-13
	HDD137-0D	0F/3D	16-14	15-14	
	HDD137-0E	0F/3E	16-15	15-15	15-15
	HDD137-0F	0F/3F	16-16/Spare	15-16/Spare	15-15/Spare

THEORY05-330**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(65/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-040	HDD040-00	00/40	17-01	17-01	17-01
	HDD040-01	00/41	17-02	17-02	
	HDD040-02	00/42	17-03	17-03	17-03
	HDD040-03	00/43	17-04	17-04	
	HDD040-04	00/44	17-05	17-05	17-05
	HDD040-05	00/45	17-06	17-06	
	HDD040-06	00/46	17-07	17-07	17-07
	HDD040-07	00/47	17-08	17-08	
	HDD040-08	00/48	17-09	17-09	17-09
	HDD040-09	00/49	17-10	17-10	
	HDD040-0A	00/4A	17-11	17-11	17-11
	HDD040-0B	00/4B	17-12	17-12	
	HDD040-0C	00/4C	17-13	17-13	17-13
	HDD040-0D	00/4D	17-14	17-14	
	HDD040-0E	00/4E	17-15	17-15	17-15
	HDD040-0F	00/4F	17-16/Spare	17-16/Spare	17-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(66/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-041	HDD041-00	01/40	17-01	17-01	17-01
	HDD041-01	01/41	17-02	17-02	
	HDD041-02	01/42	17-03	17-03	17-03
	HDD041-03	01/43	17-04	17-04	
	HDD041-04	01/44	17-05	17-05	17-05
	HDD041-05	01/45	17-06	17-06	
	HDD041-06	01/46	17-07	17-07	17-07
	HDD041-07	01/47	17-08	17-08	
	HDD041-08	01/48	17-09	17-09	17-09
	HDD041-09	01/49	17-10	17-10	
	HDD041-0A	01/4A	17-11	17-11	17-11
	HDD041-0B	01/4B	17-12	17-12	
	HDD041-0C	01/4C	17-13	17-13	17-13
	HDD041-0D	01/4D	17-14	17-14	
	HDD041-0E	01/4E	17-15	17-15	17-15
	HDD041-0F	01/4F	17-16/Spare	17-16/Spare	17-15/Spare

THEORY05-340**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(67/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-042	HDD042-00	02/40	17-01	17-01	17-01
	HDD042-01	02/41	17-02	17-02	
	HDD042-02	02/42	17-03	17-03	17-03
	HDD042-03	02/43	17-04	17-04	
	HDD042-04	02/44	17-05	17-05	17-05
	HDD042-05	02/45	17-06	17-06	
	HDD042-06	02/46	17-07	17-07	17-07
	HDD042-07	02/47	17-08	17-08	
	HDD042-08	02/48	17-09	17-09	17-09
	HDD042-09	02/49	17-10	17-10	
	HDD042-0A	02/4A	17-11	17-11	17-11
	HDD042-0B	02/4B	17-12	17-12	
	HDD042-0C	02/4C	17-13	17-13	17-13
	HDD042-0D	02/4D	17-14	17-14	
	HDD042-0E	02/4E	17-15	17-15	17-15
	HDD042-0F	02/4F	17-16/Spare	17-16/Spare	17-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(68/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-043	HDD043-00	03/40	17-01	17-01	17-01
	HDD043-01	03/41	17-02	17-02	
	HDD043-02	03/42	17-03	17-03	17-03
	HDD043-03	03/43	17-04	17-04	
	HDD043-04	03/44	17-05	17-05	17-05
	HDD043-05	03/45	17-06	17-06	
	HDD043-06	03/46	17-07	17-07	17-07
	HDD043-07	03/47	17-08	17-08	
	HDD043-08	03/48	17-09	17-09	17-09
	HDD043-09	03/49	17-10	17-10	
	HDD043-0A	03/4A	17-11	17-11	17-11
	HDD043-0B	03/4B	17-12	17-12	
	HDD043-0C	03/4C	17-13	17-13	17-13
	HDD043-0D	03/4D	17-14	17-14	
	HDD043-0E	03/4E	17-15	17-15	17-15
	HDD043-0F	03/4F	17-16/Spare	17-16/Spare	17-15/Spare

THEORY05-350**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(69/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-044	HDD044-00	04/40	18-01	17-01	17-01
	HDD044-01	04/41	18-02	17-02	
	HDD044-02	04/42	18-03	17-03	17-03
	HDD044-03	04/43	18-04	17-04	
	HDD044-04	04/44	18-05	17-05	17-05
	HDD044-05	04/45	18-06	17-06	
	HDD044-06	04/46	18-07	17-07	17-07
	HDD044-07	04/47	18-08	17-08	
	HDD044-08	04/48	18-09	17-09	17-09
	HDD044-09	04/49	18-10	17-10	
	HDD044-0A	04/4A	18-11	17-11	17-11
	HDD044-0B	04/4B	18-12	17-12	
	HDD044-0C	04/4C	18-13	17-13	17-13
	HDD044-0D	04/4D	18-14	17-14	
	HDD044-0E	04/4E	18-15	17-15	17-15
	HDD044-0F	04/4F	18-16/Spare	17-16/Spare	17-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(70/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-045	HDD045-00	05/40	18-01	17-01	17-01
	HDD045-01	05/41	18-02	17-02	
	HDD045-02	05/42	18-03	17-03	17-03
	HDD045-03	05/43	18-04	17-04	
	HDD045-04	05/44	18-05	17-05	17-05
	HDD045-05	05/45	18-06	17-06	
	HDD045-06	05/46	18-07	17-07	17-07
	HDD045-07	05/47	18-08	17-08	
	HDD045-08	05/48	18-09	17-09	17-09
	HDD045-09	05/49	18-10	17-10	
	HDD045-0A	05/4A	18-11	17-11	17-11
	HDD045-0B	05/4B	18-12	17-12	
	HDD045-0C	05/4C	18-13	17-13	17-13
	HDD045-0D	05/4D	18-14	17-14	
	HDD045-0E	05/4E	18-15	17-15	17-15
	HDD045-0F	05/4F	18-16/Spare	17-16/Spare	17-15/Spare

THEORY05-360**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(71/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-046	HDD046-00	06/40	18-01	17-01	17-01
	HDD046-01	06/41	18-02	17-02	
	HDD046-02	06/42	18-03	17-03	17-03
	HDD046-03	06/43	18-04	17-04	
	HDD046-04	06/44	18-05	17-05	17-05
	HDD046-05	06/45	18-06	17-06	
	HDD046-06	06/46	18-07	17-07	17-07
	HDD046-07	06/47	18-08	17-08	
	HDD046-08	06/48	18-09	17-09	17-09
	HDD046-09	06/49	18-10	17-10	
	HDD046-0A	06/4A	18-11	17-11	17-11
	HDD046-0B	06/4B	18-12	17-12	
	HDD046-0C	06/4C	18-13	17-13	17-13
	HDD046-0D	06/4D	18-14	17-14	
	HDD046-0E	06/4E	18-15	17-15	17-15
	HDD046-0F	06/4F	18-16/Spare	17-16/Spare	17-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(72/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-047	HDD047-00	07/40	18-01	17-01	17-01
	HDD047-01	07/41	18-02	17-02	
	HDD047-02	07/42	18-03	17-03	17-03
	HDD047-03	07/43	18-04	17-04	
	HDD047-04	07/44	18-05	17-05	17-05
	HDD047-05	07/45	18-06	17-06	
	HDD047-06	07/46	18-07	17-07	17-07
	HDD047-07	07/47	18-08	17-08	
	HDD047-08	07/48	18-09	17-09	17-09
	HDD047-09	07/49	18-10	17-10	
	HDD047-0A	07/4A	18-11	17-11	17-11
	HDD047-0B	07/4B	18-12	17-12	
	HDD047-0C	07/4C	18-13	17-13	17-13
	HDD047-0D	07/4D	18-14	17-14	
	HDD047-0E	07/4E	18-15	17-15	17-15
	HDD047-0F	07/4F	18-16/Spare	17-16/Spare	17-15/Spare

THEORY05-370**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(73/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-140	HDD140-00	08/40	19-01	19-01	19-01
	HDD140-01	08/41	19-02	19-02	
	HDD140-02	08/42	19-03	19-03	19-03
	HDD140-03	08/43	19-04	19-04	
	HDD140-04	08/44	19-05	19-05	19-05
	HDD140-05	08/45	19-06	19-06	
	HDD140-06	08/46	19-07	19-07	19-07
	HDD140-07	08/47	19-08	19-08	
	HDD140-08	08/48	19-09	19-09	19-09
	HDD140-09	08/49	19-10	19-10	
	HDD140-0A	08/4A	19-11	19-11	19-11
	HDD140-0B	08/4B	19-12	19-12	
	HDD140-0C	08/4C	19-13	19-13	19-13
	HDD140-0D	08/4D	19-14	19-14	
	HDD140-0E	08/4E	19-15	19-15	19-15
	HDD140-0F	08/4F	19-16/Spare	19-16/Spare	19-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(74/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-141	HDD141-00	09/40	19-01	19-01	19-01
	HDD141-01	09/41	19-02	19-02	
	HDD141-02	09/42	19-03	19-03	19-03
	HDD141-03	09/43	19-04	19-04	
	HDD141-04	09/44	19-05	19-05	19-05
	HDD141-05	09/45	19-06	19-06	
	HDD141-06	09/46	19-07	19-07	19-07
	HDD141-07	09/47	19-08	19-08	
	HDD141-08	09/48	19-09	19-09	19-09
	HDD141-09	09/49	19-10	19-10	
	HDD141-0A	09/4A	19-11	19-11	19-11
	HDD141-0B	09/4B	19-12	19-12	
	HDD141-0C	09/4C	19-13	19-13	19-13
	HDD141-0D	09/4D	19-14	19-14	
	HDD141-0E	09/4E	19-15	19-15	19-15
	HDD141-0F	09/4F	19-16/Spare	19-16/Spare	19-15/Spare

THEORY05-380**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(75/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-142	HDD142-00	0A/40	19-01	19-01	19-01
	HDD142-01	0A/41	19-02	19-02	
	HDD142-02	0A/42	19-03	19-03	19-03
	HDD142-03	0A/43	19-04	19-04	
	HDD142-04	0A/44	19-05	19-05	19-05
	HDD142-05	0A/45	19-06	19-06	
	HDD142-06	0A/46	19-07	19-07	19-07
	HDD142-07	0A/47	19-08	19-08	
	HDD142-08	0A/48	19-09	19-09	19-09
	HDD142-09	0A/49	19-10	19-10	
	HDD142-0A	0A/4A	19-11	19-11	19-11
	HDD142-0B	0A/4B	19-12	19-12	
	HDD142-0C	0A/4C	19-13	19-13	19-13
	HDD142-0D	0A/4D	19-14	19-14	
	HDD142-0E	0A/4E	19-15	19-15	19-15
	HDD142-0F	0A/4F	19-16/Spare	19-16/Spare	19-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(76/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-143	HDD143-00	0B/40	19-01	19-01	19-01
	HDD143-01	0B/41	19-02	19-02	
	HDD143-02	0B/42	19-03	19-03	19-03
	HDD143-03	0B/43	19-04	19-04	
	HDD143-04	0B/44	19-05	19-05	19-05
	HDD143-05	0B/45	19-06	19-06	
	HDD143-06	0B/46	19-07	19-07	19-07
	HDD143-07	0B/47	19-08	19-08	
	HDD143-08	0B/48	19-09	19-09	19-09
	HDD143-09	0B/49	19-10	19-10	
	HDD143-0A	0B/4A	19-11	19-11	19-11
	HDD143-0B	0B/4B	19-12	19-12	
	HDD143-0C	0B/4C	19-13	19-13	19-13
	HDD143-0D	0B/4D	19-14	19-14	
	HDD143-0E	0B/4E	19-15	19-15	19-15
	HDD143-0F	0B/4F	19-16/Spare	19-16/Spare	19-15/Spare

THEORY05-390**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(77/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-144	HDD144-00	0C/40	20-01	19-01	19-01
	HDD144-01	0C/41	20-02	19-02	
	HDD144-02	0C/42	20-03	19-03	19-03
	HDD144-03	0C/43	20-04	19-04	
	HDD144-04	0C/44	20-05	19-05	19-05
	HDD144-05	0C/45	20-06	19-06	
	HDD144-06	0C/46	20-07	19-07	19-07
	HDD144-07	0C/47	20-08	19-08	
	HDD144-08	0C/48	20-09	19-09	19-09
	HDD144-09	0C/49	20-10	19-10	
	HDD144-0A	0C/4A	20-11	19-11	19-11
	HDD144-0B	0C/4B	20-12	19-12	
	HDD144-0C	0C/4C	20-13	19-13	19-13
	HDD144-0D	0C/4D	20-14	19-14	
	HDD144-0E	0C/4E	20-15	19-15	19-15
	HDD144-0F	0C/4F	20-16/Spare	19-16/Spare	19-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(78/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-145	HDD145-00	0D/40	20-01	19-01	19-01
	HDD145-01	0D/41	20-02	19-02	
	HDD145-02	0D/42	20-03	19-03	19-03
	HDD145-03	0D/43	20-04	19-04	
	HDD145-04	0D/44	20-05	19-05	19-05
	HDD145-05	0D/45	20-06	19-06	
	HDD145-06	0D/46	20-07	19-07	19-07
	HDD145-07	0D/47	20-08	19-08	
	HDD145-08	0D/48	20-09	19-09	19-09
	HDD145-09	0D/49	20-10	19-10	
	HDD145-0A	0D/4A	20-11	19-11	19-11
	HDD145-0B	0D/4B	20-12	19-12	
	HDD145-0C	0D/4C	20-13	19-13	19-13
	HDD145-0D	0D/4D	20-14	19-14	
	HDD145-0E	0D/4E	20-15	19-15	19-15
	HDD145-0F	0D/4F	20-16/Spare	19-16/Spare	19-15/Spare

THEORY05-400**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(79/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-146	HDD146-00	0E/40	20-01	19-01	19-01
	HDD146-01	0E/41	20-02	19-02	
	HDD146-02	0E/42	20-03	19-03	19-03
	HDD146-03	0E/43	20-04	19-04	
	HDD146-04	0E/44	20-05	19-05	19-05
	HDD146-05	0E/45	20-06	19-06	
	HDD146-06	0E/46	20-07	19-07	19-07
	HDD146-07	0E/47	20-08	19-08	
	HDD146-08	0E/48	20-09	19-09	19-09
	HDD146-09	0E/49	20-10	19-10	
	HDD146-0A	0E/4A	20-11	19-11	19-11
	HDD146-0B	0E/4B	20-12	19-12	
	HDD146-0C	0E/4C	20-13	19-13	19-13
	HDD146-0D	0E/4D	20-14	19-14	
	HDD146-0E	0E/4E	20-15	19-15	19-15
	HDD146-0F	0E/4F	20-16/Spare	19-16/Spare	19-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(80/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-147	HDD147-00	0F/40	20-01	19-01	19-01
	HDD147-01	0F/41	20-02	19-02	
	HDD147-02	0F/42	20-03	19-03	19-03
	HDD147-03	0F/43	20-04	19-04	
	HDD147-04	0F/44	20-05	19-05	19-05
	HDD147-05	0F/45	20-06	19-06	
	HDD147-06	0F/46	20-07	19-07	19-07
	HDD147-07	0F/47	20-08	19-08	
	HDD147-08	0F/48	20-09	19-09	19-09
	HDD147-09	0F/49	20-10	19-10	
	HDD147-0A	0F/4A	20-11	19-11	19-11
	HDD147-0B	0F/4B	20-12	19-12	
	HDD147-0C	0F/4C	20-13	19-13	19-13
	HDD147-0D	0F/4D	20-14	19-14	
	HDD147-0E	0F/4E	20-15	19-15	19-15
	HDD147-0F	0F/4F	20-16/Spare	19-16/Spare	19-15/Spare

THEORY05-410**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(81/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-050	HDD050-00	00/50	21-01	21-01	21-01
	HDD050-01	00/51	21-02	21-02	
	HDD050-02	00/52	21-03	21-03	21-03
	HDD050-03	00/53	21-04	21-04	
	HDD050-04	00/54	21-05	21-05	21-05
	HDD050-05	00/55	21-06	21-06	
	HDD050-06	00/56	21-07	21-07	21-07
	HDD050-07	00/57	21-08	21-08	
	HDD050-08	00/58	21-09	21-09	21-09
	HDD050-09	00/59	21-10	21-10	
	HDD050-0A	00/5A	21-11	21-11	21-11
	HDD050-0B	00/5B	21-12	21-12	
	HDD050-0C	00/5C	21-13	21-13	21-13
	HDD050-0D	00/5D	21-14	21-14	
	HDD050-0E	00/5E	21-15	21-15	21-15
	HDD050-0F	00/5F	21-16/Spare	21-16/Spare	21-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(82/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-051	HDD051-00	01/50	21-01	21-01	21-01
	HDD051-01	01/51	21-02	21-02	
	HDD051-02	01/52	21-03	21-03	21-03
	HDD051-03	01/53	21-04	21-04	
	HDD051-04	01/54	21-05	21-05	21-05
	HDD051-05	01/55	21-06	21-06	
	HDD051-06	01/56	21-07	21-07	21-07
	HDD051-07	01/57	21-08	21-08	
	HDD051-08	01/58	21-09	21-09	21-09
	HDD051-09	01/59	21-10	21-10	
	HDD051-0A	01/5A	21-11	21-11	21-11
	HDD051-0B	01/5B	21-12	21-12	
	HDD051-0C	01/5C	21-13	21-13	21-13
	HDD051-0D	01/5D	21-14	21-14	
	HDD051-0E	01/5E	21-15	21-15	21-15
	HDD051-0F	01/5F	21-16/Spare	21-16/Spare	21-15/Spare

THEORY05-420**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(83/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-052	HDD052-00	02/50	21-01	21-01	21-01
	HDD052-01	02/51	21-02	21-02	
	HDD052-02	02/52	21-03	21-03	21-03
	HDD052-03	02/53	21-04	21-04	
	HDD052-04	02/54	21-05	21-05	21-05
	HDD052-05	02/55	21-06	21-06	
	HDD052-06	02/56	21-07	21-07	21-07
	HDD052-07	02/57	21-08	21-08	
	HDD052-08	02/58	21-09	21-09	21-09
	HDD052-09	02/59	21-10	21-10	
	HDD052-0A	02/5A	21-11	21-11	21-11
	HDD052-0B	02/5B	21-12	21-12	
	HDD052-0C	02/5C	21-13	21-13	21-13
	HDD052-0D	02/5D	21-14	21-14	
	HDD052-0E	02/5E	21-15	21-15	21-15
	HDD052-0F	02/5F	21-16/Spare	21-16/Spare	21-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(84/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-053	HDD053-00	03/50	21-01	21-01	21-01
	HDD053-01	03/51	21-02	21-02	
	HDD053-02	03/52	21-03	21-03	21-03
	HDD053-03	03/53	21-04	21-04	
	HDD053-04	03/54	21-05	21-05	21-05
	HDD053-05	03/55	21-06	21-06	
	HDD053-06	03/56	21-07	21-07	21-07
	HDD053-07	03/57	21-08	21-08	
	HDD053-08	03/58	21-09	21-09	21-09
	HDD053-09	03/59	21-10	21-10	
	HDD053-0A	03/5A	21-11	21-11	21-11
	HDD053-0B	03/5B	21-12	21-12	
	HDD053-0C	03/5C	21-13	21-13	21-13
	HDD053-0D	03/5D	21-14	21-14	
	HDD053-0E	03/5E	21-15	21-15	21-15
	HDD053-0F	03/5F	21-16/Spare	21-16/Spare	21-15/Spare

THEORY05-430**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(85/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-054	HDD054-00	04/50	22-01	21-01	21-01
	HDD054-01	04/51	22-02	21-02	
	HDD054-02	04/52	22-03	21-03	21-03
	HDD054-03	04/53	22-04	21-04	
	HDD054-04	04/54	22-05	21-05	21-05
	HDD054-05	04/55	22-06	21-06	
	HDD054-06	04/56	22-07	21-07	21-07
	HDD054-07	04/57	22-08	21-08	
	HDD054-08	04/58	22-09	21-09	21-09
	HDD054-09	04/59	22-10	21-10	
	HDD054-0A	04/5A	22-11	21-11	21-11
	HDD054-0B	04/5B	22-12	21-12	
	HDD054-0C	04/5C	22-13	21-13	21-13
	HDD054-0D	04/5D	22-14	21-14	
	HDD054-0E	04/5E	22-15	21-15	21-15
	HDD054-0F	04/5F	22-16/Spare	21-16/Spare	21-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(86/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-055	HDD055-00	05/50	22-01	21-01	21-01
	HDD055-01	05/51	22-02	21-02	
	HDD055-02	05/52	22-03	21-03	21-03
	HDD055-03	05/53	22-04	21-04	
	HDD055-04	05/54	22-05	21-05	21-05
	HDD055-05	05/55	22-06	21-06	
	HDD055-06	05/56	22-07	21-07	21-07
	HDD055-07	05/57	22-08	21-08	
	HDD055-08	05/58	22-09	21-09	21-09
	HDD055-09	05/59	22-10	21-10	
	HDD055-0A	05/5A	22-11	21-11	21-11
	HDD055-0B	05/5B	22-12	21-12	
	HDD055-0C	05/5C	22-13	21-13	21-13
	HDD055-0D	05/5D	22-14	21-14	
	HDD055-0E	05/5E	22-15	21-15	21-15
	HDD055-0F	05/5F	22-16/Spare	21-16/Spare	21-15/Spare

THEORY05-440**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(87/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-056	HDD056-00	06/50	22-01	21-01	21-01
	HDD056-01	06/51	22-02	21-02	
	HDD056-02	06/52	22-03	21-03	21-03
	HDD056-03	06/53	22-04	21-04	
	HDD056-04	06/54	22-05	21-05	21-05
	HDD056-05	06/55	22-06	21-06	
	HDD056-06	06/56	22-07	21-07	21-07
	HDD056-07	06/57	22-08	21-08	
	HDD056-08	06/58	22-09	21-09	21-09
	HDD056-09	06/59	22-10	21-10	
	HDD056-0A	06/5A	22-11	21-11	21-11
	HDD056-0B	06/5B	22-12	21-12	
	HDD056-0C	06/5C	22-13	21-13	21-13
	HDD056-0D	06/5D	22-14	21-14	
	HDD056-0E	06/5E	22-15	21-15	21-15
	HDD056-0F	06/5F	22-16/Spare	21-16/Spare	21-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(88/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-057	HDD057-00	07/50	22-01	21-01	21-01
	HDD057-01	07/51	22-02	21-02	
	HDD057-02	07/52	22-03	21-03	21-03
	HDD057-03	07/53	22-04	21-04	
	HDD057-04	07/54	22-05	21-05	21-05
	HDD057-05	07/55	22-06	21-06	
	HDD057-06	07/56	22-07	21-07	21-07
	HDD057-07	07/57	22-08	21-08	
	HDD057-08	07/58	22-09	21-09	21-09
	HDD057-09	07/59	22-10	21-10	
	HDD057-0A	07/5A	22-11	21-11	21-11
	HDD057-0B	07/5B	22-12	21-12	
	HDD057-0C	07/5C	22-13	21-13	21-13
	HDD057-0D	07/5D	22-14	21-14	
	HDD057-0E	07/5E	22-15	21-15	21-15
	HDD057-0F	07/5F	22-16/Spare	21-16/Spare	21-15/Spare

THEORY05-450**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(89/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-150	HDD150-00	08/50	23-01	23-01	23-01
	HDD150-01	08/51	23-02	23-02	
	HDD150-02	08/52	23-03	23-03	23-03
	HDD150-03	08/53	23-04	23-04	
	HDD150-04	08/54	23-05	23-05	23-05
	HDD150-05	08/55	23-06	23-06	
	HDD150-06	08/56	23-07	23-07	23-07
	HDD150-07	08/57	23-08	23-08	
	HDD150-08	08/58	23-09	23-09	23-09
	HDD150-09	08/59	23-10	23-10	
	HDD150-0A	08/5A	23-11	23-11	23-11
	HDD150-0B	08/5B	23-12	23-12	
	HDD150-0C	08/5C	23-13	23-13	23-13
	HDD150-0D	08/5D	23-14	23-14	
	HDD150-0E	08/5E	23-15	23-15	23-15
	HDD150-0F	08/5F	23-16/Spare	23-16/Spare	23-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(90/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-151	HDD151-00	09/50	23-01	23-01	23-01
	HDD151-01	09/51	23-02	23-02	
	HDD151-02	09/52	23-03	23-03	23-03
	HDD151-03	09/53	23-04	23-04	
	HDD151-04	09/54	23-05	23-05	23-05
	HDD151-05	09/55	23-06	23-06	
	HDD151-06	09/56	23-07	23-07	23-07
	HDD151-07	09/57	23-08	23-08	
	HDD151-08	09/58	23-09	23-09	23-09
	HDD151-09	09/59	23-10	23-10	
	HDD151-0A	09/5A	23-11	23-11	23-11
	HDD151-0B	09/5B	23-12	23-12	
	HDD151-0C	09/5C	23-13	23-13	23-13
	HDD151-0D	09/5D	23-14	23-14	
	HDD151-0E	09/5E	23-15	23-15	23-15
	HDD151-0F	09/5F	23-16/Spare	23-16/Spare	23-15/Spare

THEORY05-460**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(91/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-152	HDD152-00	0A/50	23-01	23-01	23-01
	HDD152-01	0A/51	23-02	23-02	
	HDD152-02	0A/52	23-03	23-03	23-03
	HDD152-03	0A/53	23-04	23-04	
	HDD152-04	0A/54	23-05	23-05	23-05
	HDD152-05	0A/55	23-06	23-06	
	HDD152-06	0A/56	23-07	23-07	23-07
	HDD152-07	0A/57	23-08	23-08	
	HDD152-08	0A/58	23-09	23-09	23-09
	HDD152-09	0A/59	23-10	23-10	
	HDD152-0A	0A/5A	23-11	23-11	23-11
	HDD152-0B	0A/5B	23-12	23-12	
	HDD152-0C	0A/5C	23-13	23-13	23-13
	HDD152-0D	0A/5D	23-14	23-14	
	HDD152-0E	0A/5E	23-15	23-15	23-15
	HDD152-0F	0A/5F	23-16/Spare	23-16/Spare	23-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(92/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-153	HDD153-00	0B/50	23-01	23-01	23-01
	HDD153-01	0B/51	23-02	23-02	
	HDD153-02	0B/52	23-03	23-03	23-03
	HDD153-03	0B/53	23-04	23-04	
	HDD153-04	0B/54	23-05	23-05	23-05
	HDD153-05	0B/55	23-06	23-06	
	HDD153-06	0B/56	23-07	23-07	23-07
	HDD153-07	0B/57	23-08	23-08	
	HDD153-08	0B/58	23-09	23-09	23-09
	HDD153-09	0B/59	23-10	23-10	
	HDD153-0A	0B/5A	23-11	23-11	23-11
	HDD153-0B	0B/5B	23-12	23-12	
	HDD153-0C	0B/5C	23-13	23-13	23-13
	HDD153-0D	0B/5D	23-14	23-14	
	HDD153-0E	0B/5E	23-15	23-15	23-15
	HDD153-0F	0B/5F	23-16/Spare	23-16/Spare	23-15/Spare

THEORY05-470**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(93/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-154	HDD154-00	0C/50	24-01	23-01	23-01
	HDD154-01	0C/51	24-02	23-02	
	HDD154-02	0C/52	24-03	23-03	23-03
	HDD154-03	0C/53	24-04	23-04	
	HDD154-04	0C/54	24-05	23-05	23-05
	HDD154-05	0C/55	24-06	23-06	
	HDD154-06	0C/56	24-07	23-07	23-07
	HDD154-07	0C/57	24-08	23-08	
	HDD154-08	0C/58	24-09	23-09	23-09
	HDD154-09	0C/59	24-10	23-10	
	HDD154-0A	0C/5A	24-11	23-11	23-11
	HDD154-0B	0C/5B	24-12	23-12	
	HDD154-0C	0C/5C	24-13	23-13	23-13
	HDD154-0D	0C/5D	24-14	23-14	
	HDD154-0E	0C/5E	24-15	23-15	23-15
	HDD154-0F	0C/5F	24-16/Spare	23-16/Spare	23-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(94/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-155	HDD155-00	0D/50	24-01	23-01	23-01
	HDD155-01	0D/51	24-02	23-02	
	HDD155-02	0D/52	24-03	23-03	23-03
	HDD155-03	0D/53	24-04	23-04	
	HDD155-04	0D/54	24-05	23-05	23-05
	HDD155-05	0D/55	24-06	23-06	
	HDD155-06	0D/56	24-07	23-07	23-07
	HDD155-07	0D/57	24-08	23-08	
	HDD155-08	0D/58	24-09	23-09	23-09
	HDD155-09	0D/59	24-10	23-10	
	HDD155-0A	0D/5A	24-11	23-11	23-11
	HDD155-0B	0D/5B	24-12	23-12	
	HDD155-0C	0D/5C	24-13	23-13	23-13
	HDD155-0D	0D/5D	24-14	23-14	
	HDD155-0E	0D/5E	24-15	23-15	23-15
	HDD155-0F	0D/5F	24-16/Spare	23-16/Spare	23-15/Spare

THEORY05-480**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(95/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-156	HDD156-00	0E/50	24-01	23-01	23-01
	HDD156-01	0E/51	24-02	23-02	
	HDD156-02	0E/52	24-03	23-03	23-03
	HDD156-03	0E/53	24-04	23-04	
	HDD156-04	0E/54	24-05	23-05	23-05
	HDD156-05	0E/55	24-06	23-06	
	HDD156-06	0E/56	24-07	23-07	23-07
	HDD156-07	0E/57	24-08	23-08	
	HDD156-08	0E/58	24-09	23-09	23-09
	HDD156-09	0E/59	24-10	23-10	
	HDD156-0A	0E/5A	24-11	23-11	23-11
	HDD156-0B	0E/5B	24-12	23-12	
	HDD156-0C	0E/5C	24-13	23-13	23-13
	HDD156-0D	0E/5D	24-14	23-14	
	HDD156-0E	0E/5E	24-15	23-15	23-15
	HDD156-0F	0E/5F	24-16/Spare	23-16/Spare	23-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(96/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-157	HDD157-00	0F/50	24-01	23-01	23-01
	HDD157-01	0F/51	24-02	23-02	
	HDD157-02	0F/52	24-03	23-03	23-03
	HDD157-03	0F/53	24-04	23-04	
	HDD157-04	0F/54	24-05	23-05	23-05
	HDD157-05	0F/55	24-06	23-06	
	HDD157-06	0F/56	24-07	23-07	23-07
	HDD157-07	0F/57	24-08	23-08	
	HDD157-08	0F/58	24-09	23-09	23-09
	HDD157-09	0F/59	24-10	23-10	
	HDD157-0A	0F/5A	24-11	23-11	23-11
	HDD157-0B	0F/5B	24-12	23-12	
	HDD157-0C	0F/5C	24-13	23-13	23-13
	HDD157-0D	0F/5D	24-14	23-14	
	HDD157-0E	0F/5E	24-15	23-15	23-15
	HDD157-0F	0F/5F	24-16/Spare	23-16/Spare	23-15/Spare

THEORY05-490**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(97/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-060	HDD060-00	00/60	25-01	25-01	25-01
	HDD060-01	00/61	25-02	25-02	
	HDD060-02	00/62	25-03	25-03	25-03
	HDD060-03	00/63	25-04	25-04	
	HDD060-04	00/64	25-05	25-05	25-05
	HDD060-05	00/65	25-06	25-06	
	HDD060-06	00/66	25-07	25-07	25-07
	HDD060-07	00/67	25-08	25-08	
	HDD060-08	00/68	25-09	25-09	25-09
	HDD060-09	00/69	25-10	25-10	
	HDD060-0A	00/6A	25-11	25-11	25-11
	HDD060-0B	00/6B	25-12	25-12	
	HDD060-0C	00/6C	25-13	25-13	25-13
	HDD060-0D	00/6D	25-14	25-14	
	HDD060-0E	00/6E	25-15	25-15	25-15
	HDD060-0F	00/6F	25-16/Spare	25-16/Spare	25-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(98/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-061	HDD061-00	01/60	25-01	25-01	25-01
	HDD061-01	01/61	25-02	25-02	
	HDD061-02	01/62	25-03	25-03	25-03
	HDD061-03	01/63	25-04	25-04	
	HDD061-04	01/64	25-05	25-05	25-05
	HDD061-05	01/65	25-06	25-06	
	HDD061-06	01/66	25-07	25-07	25-07
	HDD061-07	01/67	25-08	25-08	
	HDD061-08	01/68	25-09	25-09	25-09
	HDD061-09	01/69	25-10	25-10	
	HDD061-0A	01/6A	25-11	25-11	25-11
	HDD061-0B	01/6B	25-12	25-12	
	HDD061-0C	01/6C	25-13	25-13	25-13
	HDD061-0D	01/6D	25-14	25-14	
	HDD061-0E	01/6E	25-15	25-15	25-15
	HDD061-0F	01/6F	25-16/Spare	25-16/Spare	25-15/Spare

THEORY05-500**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(99/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-062	HDD062-00	02/60	25-01	25-01	25-01
	HDD062-01	02/61	25-02	25-02	
	HDD062-02	02/62	25-03	25-03	25-03
	HDD062-03	02/63	25-04	25-04	
	HDD062-04	02/64	25-05	25-05	25-05
	HDD062-05	02/65	25-06	25-06	
	HDD062-06	02/66	25-07	25-07	25-07
	HDD062-07	02/67	25-08	25-08	
	HDD062-08	02/68	25-09	25-09	25-09
	HDD062-09	02/69	25-10	25-10	
	HDD062-0A	02/6A	25-11	25-11	25-11
	HDD062-0B	02/6B	25-12	25-12	
	HDD062-0C	02/6C	25-13	25-13	25-13
	HDD062-0D	02/6D	25-14	25-14	
	HDD062-0E	02/6E	25-15	25-15	25-15
	HDD062-0F	02/6F	25-16/Spare	25-16/Spare	25-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(100/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-063	HDD063-00	03/60	25-01	25-01	25-01
	HDD063-01	03/61	25-02	25-02	
	HDD063-02	03/62	25-03	25-03	25-03
	HDD063-03	03/63	25-04	25-04	
	HDD063-04	03/64	25-05	25-05	25-05
	HDD063-05	03/65	25-06	25-06	
	HDD063-06	03/66	25-07	25-07	25-07
	HDD063-07	03/67	25-08	25-08	
	HDD063-08	03/68	25-09	25-09	25-09
	HDD063-09	03/69	25-10	25-10	
	HDD063-0A	03/6A	25-11	25-11	25-11
	HDD063-0B	03/6B	25-12	25-12	
	HDD063-0C	03/6C	25-13	25-13	25-13
	HDD063-0D	03/6D	25-14	25-14	
	HDD063-0E	03/6E	25-15	25-15	25-15
	HDD063-0F	03/6F	25-16/Spare	25-16/Spare	25-15/Spare

THEORY05-510**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(101/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-064	HDD064-00	04/60	26-01	25-01	25-01
	HDD064-01	04/61	26-02	25-02	
	HDD064-02	04/62	26-03	25-03	25-03
	HDD064-03	04/63	26-04	25-04	
	HDD064-04	04/64	26-05	25-05	25-05
	HDD064-05	04/65	26-06	25-06	
	HDD064-06	04/66	26-07	25-07	25-07
	HDD064-07	04/67	26-08	25-08	
	HDD064-08	04/68	26-09	25-09	25-09
	HDD064-09	04/69	26-10	25-10	
	HDD064-0A	04/6A	26-11	25-11	25-11
	HDD064-0B	04/6B	26-12	25-12	
	HDD064-0C	04/6C	26-13	25-13	25-13
	HDD064-0D	04/6D	26-14	25-14	
	HDD064-0E	04/6E	26-15	25-15	25-15
	HDD064-0F	04/6F	26-16/Spare	25-16/Spare	25-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(102/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-065	HDD065-00	05/60	26-01	25-01	25-01
	HDD065-01	05/61	26-02	25-02	
	HDD065-02	05/62	26-03	25-03	25-03
	HDD065-03	05/63	26-04	25-04	
	HDD065-04	05/64	26-05	25-05	25-05
	HDD065-05	05/65	26-06	25-06	
	HDD065-06	05/66	26-07	25-07	25-07
	HDD065-07	05/67	26-08	25-08	
	HDD065-08	05/68	26-09	25-09	25-09
	HDD065-09	05/69	26-10	25-10	
	HDD065-0A	05/6A	26-11	25-11	25-11
	HDD065-0B	05/6B	26-12	25-12	
	HDD065-0C	05/6C	26-13	25-13	25-13
	HDD065-0D	05/6D	26-14	25-14	
	HDD065-0E	05/6E	26-15	25-15	25-15
	HDD065-0F	05/6F	26-16/Spare	25-16/Spare	25-15/Spare

THEORY05-520**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(103/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-066	HDD066-00	06/60	26-01	25-01	25-01
	HDD066-01	06/61	26-02	25-02	
	HDD066-02	06/62	26-03	25-03	25-03
	HDD066-03	06/63	26-04	25-04	
	HDD066-04	06/64	26-05	25-05	25-05
	HDD066-05	06/65	26-06	25-06	
	HDD066-06	06/66	26-07	25-07	25-07
	HDD066-07	06/67	26-08	25-08	
	HDD066-08	06/68	26-09	25-09	25-09
	HDD066-09	06/69	26-10	25-10	
	HDD066-0A	06/6A	26-11	25-11	25-11
	HDD066-0B	06/6B	26-12	25-12	
	HDD066-0C	06/6C	26-13	25-13	25-13
	HDD066-0D	06/6D	26-14	25-14	
	HDD066-0E	06/6E	26-15	25-15	25-15
	HDD066-0F	06/6F	26-16/Spare	25-16/Spare	25-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(104/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-067	HDD067-00	07/60	26-01	25-01	25-01
	HDD067-01	07/61	26-02	25-02	
	HDD067-02	07/62	26-03	25-03	25-03
	HDD067-03	07/63	26-04	25-04	
	HDD067-04	07/64	26-05	25-05	25-05
	HDD067-05	07/65	26-06	25-06	
	HDD067-06	07/66	26-07	25-07	25-07
	HDD067-07	07/67	26-08	25-08	
	HDD067-08	07/68	26-09	25-09	25-09
	HDD067-09	07/69	26-10	25-10	
	HDD067-0A	07/6A	26-11	25-11	25-11
	HDD067-0B	07/6B	26-12	25-12	
	HDD067-0C	07/6C	26-13	25-13	25-13
	HDD067-0D	07/6D	26-14	25-14	
	HDD067-0E	07/6E	26-15	25-15	25-15
	HDD067-0F	07/6F	26-16/Spare	25-16/Spare	25-15/Spare

THEORY05-530**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(105/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-160	HDD160-00	08/60	27-01	27-01	27-01
	HDD160-01	08/61	27-02	27-02	
	HDD160-02	08/62	27-03	27-03	27-03
	HDD160-03	08/63	27-04	27-04	
	HDD160-04	08/64	27-05	27-05	27-05
	HDD160-05	08/65	27-06	27-06	
	HDD160-06	08/66	27-07	27-07	27-07
	HDD160-07	08/67	27-08	27-08	
	HDD160-08	08/68	27-09	27-09	27-09
	HDD160-09	08/69	27-10	27-10	
	HDD160-0A	08/6A	27-11	27-11	27-11
	HDD160-0B	08/6B	27-12	27-12	
	HDD160-0C	08/6C	27-13	27-13	27-13
	HDD160-0D	08/6D	27-14	27-14	
	HDD160-0E	08/6E	27-15	27-15	27-15
	HDD160-0F	08/6F	27-16/Spare	27-16/Spare	27-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(106/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-161	HDD161-00	09/60	27-01	27-01	27-01
	HDD161-01	09/61	27-02	27-02	
	HDD161-02	09/62	27-03	27-03	27-03
	HDD161-03	09/63	27-04	27-04	
	HDD161-04	09/64	27-05	27-05	27-05
	HDD161-05	09/65	27-06	27-06	
	HDD161-06	09/66	27-07	27-07	27-07
	HDD161-07	09/67	27-08	27-08	
	HDD161-08	09/68	27-09	27-09	27-09
	HDD161-09	09/69	27-10	27-10	
	HDD161-0A	09/6A	27-11	27-11	27-11
	HDD161-0B	09/6B	27-12	27-12	
	HDD161-0C	09/6C	27-13	27-13	27-13
	HDD161-0D	09/6D	27-14	27-14	
	HDD161-0E	09/6E	27-15	27-15	27-15
	HDD161-0F	09/6F	27-16/Spare	27-16/Spare	27-15/Spare

THEORY05-540**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(107/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-162	HDD162-00	0A/60	27-01	27-01	27-01
	HDD162-01	0A/61	27-02	27-02	
	HDD162-02	0A/62	27-03	27-03	27-03
	HDD162-03	0A/63	27-04	27-04	
	HDD162-04	0A/64	27-05	27-05	27-05
	HDD162-05	0A/65	27-06	27-06	
	HDD162-06	0A/66	27-07	27-07	27-07
	HDD162-07	0A/67	27-08	27-08	
	HDD162-08	0A/68	27-09	27-09	27-09
	HDD162-09	0A/69	27-10	27-10	
	HDD162-0A	0A/6A	27-11	27-11	27-11
	HDD162-0B	0A/6B	27-12	27-12	
	HDD162-0C	0A/6C	27-13	27-13	27-13
	HDD162-0D	0A/6D	27-14	27-14	
	HDD162-0E	0A/6E	27-15	27-15	27-15
	HDD162-0F	0A/6F	27-16/Spare	27-16/Spare	27-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(108/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-163	HDD163-00	0B/60	27-01	27-01	27-01
	HDD163-01	0B/61	27-02	27-02	
	HDD163-02	0B/62	27-03	27-03	27-03
	HDD163-03	0B/63	27-04	27-04	
	HDD163-04	0B/64	27-05	27-05	27-05
	HDD163-05	0B/65	27-06	27-06	
	HDD163-06	0B/66	27-07	27-07	27-07
	HDD163-07	0B/67	27-08	27-08	
	HDD163-08	0B/68	27-09	27-09	27-09
	HDD163-09	0B/69	27-10	27-10	
	HDD163-0A	0B/6A	27-11	27-11	27-11
	HDD163-0B	0B/6B	27-12	27-12	
	HDD163-0C	0B/6C	27-13	27-13	27-13
	HDD163-0D	0B/6D	27-14	27-14	
	HDD163-0E	0B/6E	27-15	27-15	27-15
	HDD163-0F	0B/6F	27-16/Spare	27-16/Spare	27-15/Spare

THEORY05-550**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(109/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-164	HDD164-00	0C/60	28-01	27-01	27-01
	HDD164-01	0C/61	28-02	27-02	
	HDD164-02	0C/62	28-03	27-03	27-03
	HDD164-03	0C/63	28-04	27-04	
	HDD164-04	0C/64	28-05	27-05	27-05
	HDD164-05	0C/65	28-06	27-06	
	HDD164-06	0C/66	28-07	27-07	27-07
	HDD164-07	0C/67	28-08	27-08	
	HDD164-08	0C/68	28-09	27-09	27-09
	HDD164-09	0C/69	28-10	27-10	
	HDD164-0A	0C/6A	28-11	27-11	27-11
	HDD164-0B	0C/6B	28-12	27-12	
	HDD164-0C	0C/6C	28-13	27-13	27-13
	HDD164-0D	0C/6D	28-14	27-14	
	HDD164-0E	0C/6E	28-15	27-15	27-15
	HDD164-0F	0C/6F	28-16/Spare	27-16/Spare	27-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(110/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-165	HDD165-00	0D/60	28-01	27-01	27-01
	HDD165-01	0D/61	28-02	27-02	
	HDD165-02	0D/62	28-03	27-03	27-03
	HDD165-03	0D/63	28-04	27-04	
	HDD165-04	0D/64	28-05	27-05	27-05
	HDD165-05	0D/65	28-06	27-06	
	HDD165-06	0D/66	28-07	27-07	27-07
	HDD165-07	0D/67	28-08	27-08	
	HDD165-08	0D/68	28-09	27-09	27-09
	HDD165-09	0D/69	28-10	27-10	
	HDD165-0A	0D/6A	28-11	27-11	27-11
	HDD165-0B	0D/6B	28-12	27-12	
	HDD165-0C	0D/6C	28-13	27-13	27-13
	HDD165-0D	0D/6D	28-14	27-14	
	HDD165-0E	0D/6E	28-15	27-15	27-15
	HDD165-0F	0D/6F	28-16/Spare	27-16/Spare	27-15/Spare

THEORY05-560**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(111/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-166	HDD166-00	0E/60	28-01	27-01	27-01
	HDD166-01	0E/61	28-02	27-02	
	HDD166-02	0E/62	28-03	27-03	27-03
	HDD166-03	0E/63	28-04	27-04	
	HDD166-04	0E/64	28-05	27-05	27-05
	HDD166-05	0E/65	28-06	27-06	
	HDD166-06	0E/66	28-07	27-07	27-07
	HDD166-07	0E/67	28-08	27-08	
	HDD166-08	0E/68	28-09	27-09	27-09
	HDD166-09	0E/69	28-10	27-10	
	HDD166-0A	0E/6A	28-11	27-11	27-11
	HDD166-0B	0E/6B	28-12	27-12	
	HDD166-0C	0E/6C	28-13	27-13	27-13
	HDD166-0D	0E/6D	28-14	27-14	
	HDD166-0E	0E/6E	28-15	27-15	27-15
	HDD166-0F	0E/6F	28-16/Spare	27-16/Spare	27-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(112/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-167	HDD167-00	0F/60	28-01	27-01	27-01
	HDD167-01	0F/61	28-02	27-02	
	HDD167-02	0F/62	28-03	27-03	27-03
	HDD167-03	0F/63	28-04	27-04	
	HDD167-04	0F/64	28-05	27-05	27-05
	HDD167-05	0F/65	28-06	27-06	
	HDD167-06	0F/66	28-07	27-07	27-07
	HDD167-07	0F/67	28-08	27-08	
	HDD167-08	0F/68	28-09	27-09	27-09
	HDD167-09	0F/69	28-10	27-10	
	HDD167-0A	0F/6A	28-11	27-11	27-11
	HDD167-0B	0F/6B	28-12	27-12	
	HDD167-0C	0F/6C	28-13	27-13	27-13
	HDD167-0D	0F/6D	28-14	27-14	
	HDD167-0E	0F/6E	28-15	27-15	27-15
	HDD167-0F	0F/6F	28-16/Spare	27-16/Spare	27-15/Spare

THEORY05-570**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(113/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-070	HDD070-00	00/70	29-01	29-01	29-01
	HDD070-01	00/71	29-02	29-02	
	HDD070-02	00/72	29-03	29-03	29-03
	HDD070-03	00/73	29-04	29-04	
	HDD070-04	00/74	29-05	29-05	29-05
	HDD070-05	00/75	29-06	29-06	
	HDD070-06	00/76	29-07	29-07	29-07
	HDD070-07	00/77	29-08	29-08	
	HDD070-08	00/78	29-09	29-09	29-09
	HDD070-09	00/79	29-10	29-10	
	HDD070-0A	00/7A	29-11	29-11	29-11
	HDD070-0B	00/7B	29-12	29-12	
	HDD070-0C	00/7C	29-13	29-13	29-13
	HDD070-0D	00/7D	29-14	29-14	
	HDD070-0E	00/7E	29-15	29-15	29-15
	HDD070-0F	00/7F	29-16/Spare	29-16/Spare	29-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(114/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-071	HDD071-00	01/70	29-01	29-01	29-01
	HDD071-01	01/71	29-02	29-02	
	HDD071-02	01/72	29-03	29-03	29-03
	HDD071-03	01/73	29-04	29-04	
	HDD071-04	01/74	29-05	29-05	29-05
	HDD071-05	01/75	29-06	29-06	
	HDD071-06	01/76	29-07	29-07	29-07
	HDD071-07	01/77	29-08	29-08	
	HDD071-08	01/78	29-09	29-09	29-09
	HDD071-09	01/79	29-10	29-10	
	HDD071-0A	01/7A	29-11	29-11	29-11
	HDD071-0B	01/7B	29-12	29-12	
	HDD071-0C	01/7C	29-13	29-13	29-13
	HDD071-0D	01/7D	29-14	29-14	
	HDD071-0E	01/7E	29-15	29-15	29-15
	HDD071-0F	01/7F	29-16/Spare	29-16/Spare	29-15/Spare

THEORY05-580**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(115/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-072	HDD072-00	02/70	29-01	29-01	29-01
	HDD072-01	02/71	29-02	29-02	
	HDD072-02	02/72	29-03	29-03	29-03
	HDD072-03	02/73	29-04	29-04	
	HDD072-04	02/74	29-05	29-05	29-05
	HDD072-05	02/75	29-06	29-06	
	HDD072-06	02/76	29-07	29-07	29-07
	HDD072-07	02/77	29-08	29-08	
	HDD072-08	02/78	29-09	29-09	29-09
	HDD072-09	02/79	29-10	29-10	
	HDD072-0A	02/7A	29-11	29-11	29-11
	HDD072-0B	02/7B	29-12	29-12	
	HDD072-0C	02/7C	29-13	29-13	29-13
	HDD072-0D	02/7D	29-14	29-14	
	HDD072-0E	02/7E	29-15	29-15	29-15
	HDD072-0F	02/7F	29-16/Spare	29-16/Spare	29-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(116/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-073	HDD073-00	03/70	29-01	29-01	29-01
	HDD073-01	03/71	29-02	29-02	
	HDD073-02	03/72	29-03	29-03	29-03
	HDD073-03	03/73	29-04	29-04	
	HDD073-04	03/74	29-05	29-05	29-05
	HDD073-05	03/75	29-06	29-06	
	HDD073-06	03/76	29-07	29-07	29-07
	HDD073-07	03/77	29-08	29-08	
	HDD073-08	03/78	29-09	29-09	29-09
	HDD073-09	03/79	29-10	29-10	
	HDD073-0A	03/7A	29-11	29-11	29-11
	HDD073-0B	03/7B	29-12	29-12	
	HDD073-0C	03/7C	29-13	29-13	29-13
	HDD073-0D	03/7D	29-14	29-14	
	HDD073-0E	03/7E	29-15	29-15	29-15
	HDD073-0F	03/7F	29-16/Spare	29-16/Spare	29-15/Spare

THEORY05-590**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(117/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-074	HDD074-00	04/70	30-01	29-01	29-01
	HDD074-01	04/71	30-02	29-02	
	HDD074-02	04/72	30-03	29-03	29-03
	HDD074-03	04/73	30-04	29-04	
	HDD074-04	04/74	30-05	29-05	29-05
	HDD074-05	04/75	30-06	29-06	
	HDD074-06	04/76	30-07	29-07	29-07
	HDD074-07	04/77	30-08	29-08	
	HDD074-08	04/78	30-09	29-09	29-09
	HDD074-09	04/79	30-10	29-10	
	HDD074-0A	04/7A	30-11	29-11	29-11
	HDD074-0B	04/7B	30-12	29-12	
	HDD074-0C	04/7C	30-13	29-13	29-13
	HDD074-0D	04/7D	30-14	29-14	
	HDD074-0E	04/7E	30-15	29-15	29-15
	HDD074-0F	04/7F	30-16/Spare	29-16/Spare	29-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(118/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-075	HDD075-00	05/70	30-01	29-01	29-01
	HDD075-01	05/71	30-02	29-02	
	HDD075-02	05/72	30-03	29-03	29-03
	HDD075-03	05/73	30-04	29-04	
	HDD075-04	05/74	30-05	29-05	29-05
	HDD075-05	05/75	30-06	29-06	
	HDD075-06	05/76	30-07	29-07	29-07
	HDD075-07	05/77	30-08	29-08	
	HDD075-08	05/78	30-09	29-09	29-09
	HDD075-09	05/79	30-10	29-10	
	HDD075-0A	05/7A	30-11	29-11	29-11
	HDD075-0B	05/7B	30-12	29-12	
	HDD075-0C	05/7C	30-13	29-13	29-13
	HDD075-0D	05/7D	30-14	29-14	
	HDD075-0E	05/7E	30-15	29-15	29-15
	HDD075-0F	05/7F	30-16/Spare	29-16/Spare	29-15/Spare

THEORY05-600**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(119/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-076	HDD076-00	06/70	30-01	29-01	29-01
	HDD076-01	06/71	30-02	29-02	
	HDD076-02	06/72	30-03	29-03	29-03
	HDD076-03	06/73	30-04	29-04	
	HDD076-04	06/74	30-05	29-05	29-05
	HDD076-05	06/75	30-06	29-06	
	HDD076-06	06/76	30-07	29-07	29-07
	HDD076-07	06/77	30-08	29-08	
	HDD076-08	06/78	30-09	29-09	29-09
	HDD076-09	06/79	30-10	29-10	
	HDD076-0A	06/7A	30-11	29-11	29-11
	HDD076-0B	06/7B	30-12	29-12	
	HDD076-0C	06/7C	30-13	29-13	29-13
	HDD076-0D	06/7D	30-14	29-14	
	HDD076-0E	06/7E	30-15	29-15	29-15
	HDD076-0F	06/7F	30-16/Spare	29-16/Spare	29-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(120/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-077	HDD077-00	07/70	30-01	29-01	29-01
	HDD077-01	07/71	30-02	29-02	
	HDD077-02	07/72	30-03	29-03	29-03
	HDD077-03	07/73	30-04	29-04	
	HDD077-04	07/74	30-05	29-05	29-05
	HDD077-05	07/75	30-06	29-06	
	HDD077-06	07/76	30-07	29-07	29-07
	HDD077-07	07/77	30-08	29-08	
	HDD077-08	07/78	30-09	29-09	29-09
	HDD077-09	07/79	30-10	29-10	
	HDD077-0A	07/7A	30-11	29-11	29-11
	HDD077-0B	07/7B	30-12	29-12	
	HDD077-0C	07/7C	30-13	29-13	29-13
	HDD077-0D	07/7D	30-14	29-14	
	HDD077-0E	07/7E	30-15	29-15	29-15
	HDD077-0F	07/7F	30-16/Spare	29-16/Spare	29-15/Spare

THEORY05-610**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(121/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-170	HDD170-00	08/70	31-01	31-01	31-01
	HDD170-01	08/71	31-02	31-02	
	HDD170-02	08/72	31-03	31-03	31-03
	HDD170-03	08/73	31-04	31-04	
	HDD170-04	08/74	31-05	31-05	31-05
	HDD170-05	08/75	31-06	31-06	
	HDD170-06	08/76	31-07	31-07	31-07
	HDD170-07	08/77	31-08	31-08	
	HDD170-08	08/78	31-09	31-09	31-09
	HDD170-09	08/79	31-10	31-10	
	HDD170-0A	08/7A	31-11	31-11	31-11
	HDD170-0B	08/7B	31-12	31-12	
	HDD170-0C	08/7C	31-13	31-13	31-13
	HDD170-0D	08/7D	31-14	31-14	
	HDD170-0E	08/7E	31-15	31-15	31-15
	HDD170-0F	08/7F	31-16/Spare	31-16/Spare	31-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(122/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-171	HDD171-00	09/70	31-01	31-01	31-01
	HDD171-01	09/71	31-02	31-02	
	HDD171-02	09/72	31-03	31-03	31-03
	HDD171-03	09/73	31-04	31-04	
	HDD171-04	09/74	31-05	31-05	31-05
	HDD171-05	09/75	31-06	31-06	
	HDD171-06	09/76	31-07	31-07	31-07
	HDD171-07	09/77	31-08	31-08	
	HDD171-08	09/78	31-09	31-09	31-09
	HDD171-09	09/79	31-10	31-10	
	HDD171-0A	09/7A	31-11	31-11	31-11
	HDD171-0B	09/7B	31-12	31-12	
	HDD171-0C	09/7C	31-13	31-13	31-13
	HDD171-0D	09/7D	31-14	31-14	
	HDD171-0E	09/7E	31-15	31-15	31-15
	HDD171-0F	09/7F	31-16/Spare	31-16/Spare	31-15/Spare

THEORY05-620**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(123/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-172	HDD172-00	0A/70	31-01	31-01	31-01
	HDD172-01	0A/71	31-02	31-02	
	HDD172-02	0A/72	31-03	31-03	31-03
	HDD172-03	0A/73	31-04	31-04	
	HDD172-04	0A/74	31-05	31-05	31-05
	HDD172-05	0A/75	31-06	31-06	
	HDD172-06	0A/76	31-07	31-07	31-07
	HDD172-07	0A/77	31-08	31-08	
	HDD172-08	0A/78	31-09	31-09	31-09
	HDD172-09	0A/79	31-10	31-10	
	HDD172-0A	0A/7A	31-11	31-11	31-11
	HDD172-0B	0A/7B	31-12	31-12	
	HDD172-0C	0A/7C	31-13	31-13	31-13
	HDD172-0D	0A/7D	31-14	31-14	
	HDD172-0E	0A/7E	31-15	31-15	31-15
	HDD172-0F	0A/7F	31-16/Spare	31-16/Spare	31-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(124/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-173	HDD173-00	0B/70	31-01	31-01	31-01
	HDD173-01	0B/71	31-02	31-02	
	HDD173-02	0B/72	31-03	31-03	31-03
	HDD173-03	0B/73	31-04	31-04	
	HDD173-04	0B/74	31-05	31-05	31-05
	HDD173-05	0B/75	31-06	31-06	
	HDD173-06	0B/76	31-07	31-07	31-07
	HDD173-07	0B/77	31-08	31-08	
	HDD173-08	0B/78	31-09	31-09	31-09
	HDD173-09	0B/79	31-10	31-10	
	HDD173-0A	0B/7A	31-11	31-11	31-11
	HDD173-0B	0B/7B	31-12	31-12	
	HDD173-0C	0B/7C	31-13	31-13	31-13
	HDD173-0D	0B/7D	31-14	31-14	
	HDD173-0E	0B/7E	31-15	31-15	31-15
	HDD173-0F	0B/7F	31-16/Spare	31-16/Spare	31-15/Spare

THEORY05-630**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(125/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-174	HDD174-00	0C/70	32-01	31-01	31-01
	HDD174-01	0C/71	32-02	31-02	
	HDD174-02	0C/72	32-03	31-03	31-03
	HDD174-03	0C/73	32-04	31-04	
	HDD174-04	0C/74	32-05	31-05	31-05
	HDD174-05	0C/75	32-06	31-06	
	HDD174-06	0C/76	32-07	31-07	31-07
	HDD174-07	0C/77	32-08	31-08	
	HDD174-08	0C/78	32-09	31-09	31-09
	HDD174-09	0C/79	32-10	31-10	
	HDD174-0A	0C/7A	32-11	31-11	31-11
	HDD174-0B	0C/7B	32-12	31-12	
	HDD174-0C	0C/7C	32-13	31-13	31-13
	HDD174-0D	0C/7D	32-14	31-14	
	HDD174-0E	0C/7E	32-15	31-15	31-15
	HDD174-0F	0C/7F	32-16/Spare	31-16/Spare	31-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(126/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-175	HDD175-00	0D/70	32-01	31-01	31-01
	HDD175-01	0D/71	32-02	31-02	
	HDD175-02	0D/72	32-03	31-03	31-03
	HDD175-03	0D/73	32-04	31-04	
	HDD175-04	0D/74	32-05	31-05	31-05
	HDD175-05	0D/75	32-06	31-06	
	HDD175-06	0D/76	32-07	31-07	31-07
	HDD175-07	0D/77	32-08	31-08	
	HDD175-08	0D/78	32-09	31-09	31-09
	HDD175-09	0D/79	32-10	31-10	
	HDD175-0A	0D/7A	32-11	31-11	31-11
	HDD175-0B	0D/7B	32-12	31-12	
	HDD175-0C	0D/7C	32-13	31-13	31-13
	HDD175-0D	0D/7D	32-14	31-14	
	HDD175-0E	0D/7E	32-15	31-15	31-15
	HDD175-0F	0D/7F	32-16/Spare	31-16/Spare	31-15/Spare

THEORY05-640**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(127/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-176	HDD176-00	0E/70	32-01	31-01	31-01
	HDD176-01	0E/71	32-02	31-02	
	HDD176-02	0E/72	32-03	31-03	31-03
	HDD176-03	0E/73	32-04	31-04	
	HDD176-04	0E/74	32-05	31-05	31-05
	HDD176-05	0E/75	32-06	31-06	
	HDD176-06	0E/76	32-07	31-07	31-07
	HDD176-07	0E/77	32-08	31-08	
	HDD176-08	0E/78	32-09	31-09	31-09
	HDD176-09	0E/79	32-10	31-10	
	HDD176-0A	0E/7A	32-11	31-11	31-11
	HDD176-0B	0E/7B	32-12	31-12	
	HDD176-0C	0E/7C	32-13	31-13	31-13
	HDD176-0D	0E/7D	32-14	31-14	
	HDD176-0E	0E/7E	32-15	31-15	31-15
	HDD176-0F	0E/7F	32-16/Spare	31-16/Spare	31-15/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH BOX)
(128/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-177	HDD177-00	0F/70	32-01	31-01	31-01
	HDD177-01	0F/71	32-02	31-02	
	HDD177-02	0F/72	32-03	31-03	31-03
	HDD177-03	0F/73	32-04	31-04	
	HDD177-04	0F/74	32-05	31-05	31-05
	HDD177-05	0F/75	32-06	31-06	
	HDD177-06	0F/76	32-07	31-07	31-07
	HDD177-07	0F/77	32-08	31-08	
	HDD177-08	0F/78	32-09	31-09	31-09
	HDD177-09	0F/79	32-10	31-10	
	HDD177-0A	0F/7A	32-11	31-11	31-11
	HDD177-0B	0F/7B	32-12	31-12	
	HDD177-0C	0F/7C	32-13	31-13	31-13
	HDD177-0D	0F/7D	32-14	31-14	
	HDD177-0E	0F/7E	32-15	31-15	31-15
	HDD177-0F	0F/7F	32-16/Spare	31-16/Spare	31-15/Spare

THEORY05-650**5.2 Physical-Logical Device Matrixes (3.5 INCH BOX)****RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(1/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-000	HDD000-00	00/00	01-01	01-01	01-01
	HDD000-01	00/01	01-02	01-02	
	HDD000-02	00/02	01-03	01-03	01-03
	HDD000-03	00/03	01-04	01-04	
	HDD000-04	00/04	01-05	01-05	01-05
	HDD000-05	00/05	01-06	01-06	
	HDD000-06	00/06	01-07	01-07	01-07
	HDD000-07	00/07	01-08	01-08	
	HDD000-08	00/08	01-09	01-09	01-09
	HDD000-09	00/09	01-10/Spare	01-10/Spare	01-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(2/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-001	HDD001-00	01/00	01-01	01-01	01-01
	HDD001-01	01/01	01-02	01-02	
	HDD001-02	01/02	01-03	01-03	01-03
	HDD001-03	01/03	01-04	01-04	
	HDD001-04	01/04	01-05	01-05	01-05
	HDD001-05	01/05	01-06	01-06	
	HDD001-06	01/06	01-07	01-07	01-07
	HDD001-07	01/07	01-08	01-08	
	HDD001-08	01/08	01-09	01-09	01-09
	HDD001-09	01/09	01-10/Spare	01-10/Spare	01-09/Spare

THEORY05-660**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(3/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-002	HDD002-00	02/00	01-01	01-01	01-01
	HDD002-01	02/01	01-02	01-02	
	HDD002-02	02/02	01-03	01-03	01-03
	HDD002-03	02/03	01-04	01-04	
	HDD002-04	02/04	01-05	01-05	01-05
	HDD002-05	02/05	01-06	01-06	
	HDD002-06	02/06	01-07	01-07	01-07
	HDD002-07	02/07	01-08	01-08	
	HDD002-08	02/08	01-09	01-09	01-09
	HDD002-09	02/09	01-10/Spare	01-10/Spare	01-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(4/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-003	HDD003-00	03/00	01-01	01-01	01-01
	HDD003-01	03/01	01-02	01-02	
	HDD003-02	03/02	01-03	01-03	01-03
	HDD003-03	03/03	01-04	01-04	
	HDD003-04	03/04	01-05	01-05	01-05
	HDD003-05	03/05	01-06	01-06	
	HDD003-06	03/06	01-07	01-07	01-07
	HDD003-07	03/07	01-08	01-08	
	HDD003-08	03/08	01-09	01-09	01-09
	HDD003-09	03/09	01-10/Spare	01-10/Spare	01-09/Spare

THEORY05-670**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(5/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-004	HDD004-00	04/00	02-01	01-01	01-01
	HDD004-01	04/01	02-02	01-02	
	HDD004-02	04/02	02-03	01-03	01-03
	HDD004-03	04/03	02-04	01-04	
	HDD004-04	04/04	02-05	01-05	01-05
	HDD004-05	04/05	02-06	01-06	
	HDD004-06	04/06	02-07	01-07	01-07
	HDD004-07	04/07	02-08	01-08	
	HDD004-08	04/08	02-09	01-09	01-09
	HDD004-09	04/09	02-10/Spare	01-10/Spare	01-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(6/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-005	HDD005-00	05/00	02-01	01-01	01-01
	HDD005-01	05/01	02-02	01-02	
	HDD005-02	05/02	02-03	01-03	01-03
	HDD005-03	05/03	02-04	01-04	
	HDD005-04	05/04	02-05	01-05	01-05
	HDD005-05	05/05	02-06	01-06	
	HDD005-06	05/06	02-07	01-07	01-07
	HDD005-07	05/07	02-08	01-08	
	HDD005-08	05/08	02-09	01-09	01-09
	HDD005-09	05/09	02-10/Spare	01-10/Spare	01-09/Spare

THEORY05-680**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(7/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-006	HDD006-00	06/00	02-01	01-01	01-01
	HDD006-01	06/01	02-02	01-02	
	HDD006-02	06/02	02-03	01-03	01-03
	HDD006-03	06/03	02-04	01-04	
	HDD006-04	06/04	02-05	01-05	01-05
	HDD006-05	06/05	02-06	01-06	
	HDD006-06	06/06	02-07	01-07	01-07
	HDD006-07	06/07	02-08	01-08	
	HDD006-08	06/08	02-09	01-09	01-09
	HDD006-09	06/09	02-10/Spare	01-10/Spare	01-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(8/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-007	HDD007-00	07/00	02-01	01-01	01-01
	HDD007-01	07/01	02-02	01-02	
	HDD007-02	07/02	02-03	01-03	01-03
	HDD007-03	07/03	02-04	01-04	
	HDD007-04	07/04	02-05	01-05	01-05
	HDD007-05	07/05	02-06	01-06	
	HDD007-06	07/06	02-07	01-07	01-07
	HDD007-07	07/07	02-08	01-08	
	HDD007-08	07/08	02-09	01-09	01-09
	HDD007-09	07/09	02-10/Spare	01-10/Spare	01-09/Spare

THEORY05-690**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(9/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-100	HDD100-00	08/00	03-01	03-01	03-01
	HDD100-01	08/01	03-02	03-02	
	HDD100-02	08/02	03-03	03-03	03-03
	HDD100-03	08/03	03-04	03-04	
	HDD100-04	08/04	03-05	03-05	03-05
	HDD100-05	08/05	03-06	03-06	
	HDD100-06	08/06	03-07	03-07	03-07
	HDD100-07	08/07	03-08	03-08	
	HDD100-08	08/08	03-09	03-09	03-09
	HDD100-09	08/09	03-10/Spare	03-10/Spare	03-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(10/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-101	HDD101-00	09/00	03-01	03-01	03-01
	HDD101-01	09/01	03-02	03-02	
	HDD101-02	09/02	03-03	03-03	03-03
	HDD101-03	09/03	03-04	03-04	
	HDD101-04	09/04	03-05	03-05	03-05
	HDD101-05	09/05	03-06	03-06	
	HDD101-06	09/06	03-07	03-07	03-07
	HDD101-07	09/07	03-08	03-08	
	HDD101-08	09/08	03-09	03-09	03-09
	HDD101-09	09/09	03-10/Spare	03-10/Spare	03-09/Spare

THEORY05-700**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(11/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-102	HDD102-00	0A/00	03-01	03-01	03-01
	HDD102-01	0A/01	03-02	03-02	
	HDD102-02	0A/02	03-03	03-03	
	HDD102-03	0A/03	03-04	03-04	03-03
	HDD102-04	0A/04	03-05	03-05	
	HDD102-05	0A/05	03-06	03-06	
	HDD102-06	0A/06	03-07	03-07	03-05
	HDD102-07	0A/07	03-08	03-08	
	HDD102-08	0A/08	03-09	03-09	
	HDD102-09	0A/09	03-10/Spare	03-10/Spare	03-07

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(12/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-103	HDD103-00	0B/00	03-01	03-01	03-01
	HDD103-01	0B/01	03-02	03-02	
	HDD103-02	0B/02	03-03	03-03	
	HDD103-03	0B/03	03-04	03-04	03-03
	HDD103-04	0B/04	03-05	03-05	
	HDD103-05	0B/05	03-06	03-06	
	HDD103-06	0B/06	03-07	03-07	03-05
	HDD103-07	0B/07	03-08	03-08	
	HDD103-08	0B/08	03-09	03-09	
	HDD103-09	0B/09	03-10/Spare	03-10/Spare	03-07

THEORY05-710**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(13/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-104	HDD104-00	0C/00	04-01	03-01	03-01
	HDD104-01	0C/01	04-02	03-02	
	HDD104-02	0C/02	04-03	03-03	03-03
	HDD104-03	0C/03	04-04	03-04	
	HDD104-04	0C/04	04-05	03-05	03-05
	HDD104-05	0C/05	04-06	03-06	
	HDD104-06	0C/06	04-07	03-07	03-07
	HDD104-07	0C/07	04-08	03-08	
	HDD104-08	0C/08	04-09	03-09	03-09
	HDD104-09	0C/09	04-10/Spare	03-10/Spare	03-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(14/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-105	HDD105-00	0D/00	04-01	03-01	03-01
	HDD105-01	0D/01	04-02	03-02	
	HDD105-02	0D/02	04-03	03-03	03-03
	HDD105-03	0D/03	04-04	03-04	
	HDD105-04	0D/04	04-05	03-05	03-05
	HDD105-05	0D/05	04-06	03-06	
	HDD105-06	0D/06	04-07	03-07	03-07
	HDD105-07	0D/07	04-08	03-08	
	HDD105-08	0D/08	04-09	03-09	03-09
	HDD105-09	0D/09	04-10/Spare	03-10/Spare	03-09/Spare

THEORY05-720**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(15/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-106	HDD106-00	0E/00	04-01	03-01	03-01
	HDD106-01	0E/01	04-02	03-02	
	HDD106-02	0E/02	04-03	03-03	03-03
	HDD106-03	0E/03	04-04	03-04	
	HDD106-04	0E/04	04-05	03-05	03-05
	HDD106-05	0E/05	04-06	03-06	
	HDD106-06	0E/06	04-07	03-07	03-07
	HDD106-07	0E/07	04-08	03-08	
	HDD106-08	0E/08	04-09	03-09	03-09
	HDD106-09	0E/09	04-10/Spare	03-10/Spare	03-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(16/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-107	HDD107-00	0F/00	04-01	03-01	03-01
	HDD107-01	0F/01	04-02	03-02	
	HDD107-02	0F/02	04-03	03-03	03-03
	HDD107-03	0F/03	04-04	03-04	
	HDD107-04	0F/04	04-05	03-05	03-05
	HDD107-05	0F/05	04-06	03-06	
	HDD107-06	0F/06	04-07	03-07	03-07
	HDD107-07	0F/07	04-08	03-08	
	HDD107-08	0F/08	04-09	03-09	03-09
	HDD107-09	0F/09	04-10/Spare	03-10/Spare	03-09/Spare

THEORY05-730**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(17/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-010	HDD010-00	00/10	05-01	05-01	05-01
	HDD010-01	00/11	05-02	05-02	
	HDD010-02	00/12	05-03	05-03	
	HDD010-03	00/13	05-04	05-04	05-03
	HDD010-04	00/14	05-05	05-05	
	HDD010-05	00/15	05-06	05-06	
	HDD010-06	00/16	05-07	05-07	05-05
	HDD010-07	00/17	05-08	05-08	
	HDD010-08	00/18	05-09	05-09	
	HDD010-09	00/19	05-10/Spare	05-10/Spare	05-07
					05-09
					05-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(18/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-011	HDD011-00	01/10	05-01	05-01	05-01
	HDD011-01	01/11	05-02	05-02	
	HDD011-02	01/12	05-03	05-03	
	HDD011-03	01/13	05-04	05-04	05-03
	HDD011-04	01/14	05-05	05-05	
	HDD011-05	01/15	05-06	05-06	
	HDD011-06	01/16	05-07	05-07	05-05
	HDD011-07	01/17	05-08	05-08	
	HDD011-08	01/18	05-09	05-09	
	HDD011-09	01/19	05-10/Spare	05-10/Spare	05-07
					05-09
					05-09/Spare

THEORY05-740**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(19/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-012	HDD012-00	02/10	05-01	05-01	05-01
	HDD012-01	02/11	05-02	05-02	
	HDD012-02	02/12	05-03	05-03	05-03
	HDD012-03	02/13	05-04	05-04	
	HDD012-04	02/14	05-05	05-05	05-05
	HDD012-05	02/15	05-06	05-06	
	HDD012-06	02/16	05-07	05-07	05-07
	HDD012-07	02/17	05-08	05-08	
	HDD012-08	02/18	05-09	05-09	05-09
	HDD012-09	02/19	05-10/Spare	05-10/Spare	05-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(20/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-013	HDD013-00	03/10	05-01	05-01	05-01
	HDD013-01	03/11	05-02	05-02	
	HDD013-02	03/12	05-03	05-03	05-03
	HDD013-03	03/13	05-04	05-04	
	HDD013-04	03/14	05-05	05-05	05-05
	HDD013-05	03/15	05-06	05-06	
	HDD013-06	03/16	05-07	05-07	05-07
	HDD013-07	03/17	05-08	05-08	
	HDD013-08	03/18	05-09	05-09	05-09
	HDD013-09	03/19	05-10/Spare	05-10/Spare	05-09/Spare

THEORY05-750**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(21/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-014	HDD014-00	04/10	06-01	05-01	05-01
	HDD014-01	04/11	06-02	05-02	
	HDD014-02	04/12	06-03	05-03	05-03
	HDD014-03	04/13	06-04	05-04	
	HDD014-04	04/14	06-05	05-05	05-05
	HDD014-05	04/15	06-06	05-06	
	HDD014-06	04/16	06-07	05-07	05-07
	HDD014-07	04/17	06-08	05-08	
	HDD014-08	04/18	06-09	05-09	05-09
	HDD014-09	04/19	06-10/Spare	05-10/Spare	05-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(22/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-015	HDD015-00	05/10	06-01	05-01	05-01
	HDD015-01	05/11	06-02	05-02	
	HDD015-02	05/12	06-03	05-03	05-03
	HDD015-03	05/13	06-04	05-04	
	HDD015-04	05/14	06-05	05-05	05-05
	HDD015-05	05/15	06-06	05-06	
	HDD015-06	05/16	06-07	05-07	05-07
	HDD015-07	05/17	06-08	05-08	
	HDD015-08	05/18	06-09	05-09	05-09
	HDD015-09	05/19	06-10/Spare	05-10/Spare	05-09/Spare

THEORY05-760**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(23/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-016	HDD016-00	06/10	06-01	05-01	05-01
	HDD016-01	06/11	06-02	05-02	
	HDD016-02	06/12	06-03	05-03	05-03
	HDD016-03	06/13	06-04	05-04	
	HDD016-04	06/14	06-05	05-05	05-05
	HDD016-05	06/15	06-06	05-06	
	HDD016-06	06/16	06-07	05-07	05-07
	HDD016-07	06/17	06-08	05-08	
	HDD016-08	06/18	06-09	05-09	05-09
	HDD016-09	06/19	06-10/Spare	05-10/Spare	05-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(24/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-017	HDD017-00	07/10	06-01	05-01	05-01
	HDD017-01	07/11	06-02	05-02	
	HDD017-02	07/12	06-03	05-03	05-03
	HDD017-03	07/13	06-04	05-04	
	HDD017-04	07/14	06-05	05-05	05-05
	HDD017-05	07/15	06-06	05-06	
	HDD017-06	07/16	06-07	05-07	05-07
	HDD017-07	07/17	06-08	05-08	
	HDD017-08	07/18	06-09	05-09	05-09
	HDD017-09	07/19	06-10/Spare	05-10/Spare	05-09/Spare

THEORY05-770**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(25/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-110	HDD110-00	08/10	07-01	07-01	07-01
	HDD110-01	08/11	07-02	07-02	
	HDD110-02	08/12	07-03	07-03	07-03
	HDD110-03	08/13	07-04	07-04	
	HDD110-04	08/14	07-05	07-05	07-05
	HDD110-05	08/15	07-06	07-06	
	HDD110-06	08/16	07-07	07-07	07-07
	HDD110-07	08/17	07-08	07-08	
	HDD110-08	08/18	07-09	07-09	07-09
	HDD110-09	08/19	07-10/Spare	07-10/Spare	07-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(26/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-111	HDD111-00	09/10	07-01	07-01	07-01
	HDD111-01	09/11	07-02	07-02	
	HDD111-02	09/12	07-03	07-03	07-03
	HDD111-03	09/13	07-04	07-04	
	HDD111-04	09/14	07-05	07-05	07-05
	HDD111-05	09/15	07-06	07-06	
	HDD111-06	09/16	07-07	07-07	07-07
	HDD111-07	09/17	07-08	07-08	
	HDD111-08	09/18	07-09	07-09	07-09
	HDD111-09	09/19	07-10/Spare	07-10/Spare	07-09/Spare

THEORY05-780**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(27/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-112	HDD112-00	0A/10	07-01	07-01	07-01
	HDD112-01	0A/11	07-02	07-02	
	HDD112-02	0A/12	07-03	07-03	07-03
	HDD112-03	0A/13	07-04	07-04	
	HDD112-04	0A/14	07-05	07-05	07-05
	HDD112-05	0A/15	07-06	07-06	
	HDD112-06	0A/16	07-07	07-07	07-07
	HDD112-07	0A/17	07-08	07-08	
	HDD112-08	0A/18	07-09	07-09	07-09
	HDD112-09	0A/19	07-10/Spare	07-10/Spare	07-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(28/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-113	HDD113-00	0B/10	07-01	07-01	07-01
	HDD113-01	0B/11	07-02	07-02	
	HDD113-02	0B/12	07-03	07-03	07-03
	HDD113-03	0B/13	07-04	07-04	
	HDD113-04	0B/14	07-05	07-05	07-05
	HDD113-05	0B/15	07-06	07-06	
	HDD113-06	0B/16	07-07	07-07	07-07
	HDD113-07	0B/17	07-08	07-08	
	HDD113-08	0B/18	07-09	07-09	07-09
	HDD113-09	0B/19	07-10/Spare	07-10/Spare	07-09/Spare

THEORY05-790**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(29/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-114	HDD114-00	0C/10	08-01	07-01	07-01
	HDD114-01	0C/11	08-02	07-02	
	HDD114-02	0C/12	08-03	07-03	07-03
	HDD114-03	0C/13	08-04	07-04	
	HDD114-04	0C/14	08-05	07-05	07-05
	HDD114-05	0C/15	08-06	07-06	
	HDD114-06	0C/16	08-07	07-07	07-07
	HDD114-07	0C/17	08-08	07-08	
	HDD114-08	0C/18	08-09	07-09	07-09
	HDD114-09	0C/19	08-10/Spare	07-10/Spare	07-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(30/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-115	HDD115-00	0D/10	08-01	07-01	07-01
	HDD115-01	0D/11	08-02	07-02	
	HDD115-02	0D/12	08-03	07-03	07-03
	HDD115-03	0D/13	08-04	07-04	
	HDD115-04	0D/14	08-05	07-05	07-05
	HDD115-05	0D/15	08-06	07-06	
	HDD115-06	0D/16	08-07	07-07	07-07
	HDD115-07	0D/17	08-08	07-08	
	HDD115-08	0D/18	08-09	07-09	07-09
	HDD115-09	0D/19	08-10/Spare	07-10/Spare	07-09/Spare

THEORY05-800**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(31/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-116	HDD116-00	0E/10	08-01	07-01	07-01
	HDD116-01	0E/11	08-02	07-02	
	HDD116-02	0E/12	08-03	07-03	07-03
	HDD116-03	0E/13	08-04	07-04	
	HDD116-04	0E/14	08-05	07-05	07-05
	HDD116-05	0E/15	08-06	07-06	
	HDD116-06	0E/16	08-07	07-07	07-07
	HDD116-07	0E/17	08-08	07-08	
	HDD116-08	0E/18	08-09	07-09	07-09
	HDD116-09	0E/19	08-10/Spare	07-10/Spare	07-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(32/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-117	HDD117-00	0F/10	08-01	07-01	07-01
	HDD117-01	0F/11	08-02	07-02	
	HDD117-02	0F/12	08-03	07-03	07-03
	HDD117-03	0F/13	08-04	07-04	
	HDD117-04	0F/14	08-05	07-05	07-05
	HDD117-05	0F/15	08-06	07-06	
	HDD117-06	0F/16	08-07	07-07	07-07
	HDD117-07	0F/17	08-08	07-08	
	HDD117-08	0F/18	08-09	07-09	07-09
	HDD117-09	0F/19	08-10/Spare	07-10/Spare	07-09/Spare

THEORY05-810**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(33/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-020	HDD020-00	00/20	09-01	09-01	09-01
	HDD020-01	00/21	09-02	09-02	
	HDD020-02	00/22	09-03	09-03	09-03
	HDD020-03	00/23	09-04	09-04	
	HDD020-04	00/24	09-05	09-05	09-05
	HDD020-05	00/25	09-06	09-06	
	HDD020-06	00/26	09-07	09-07	09-07
	HDD020-07	00/27	09-08	09-08	
	HDD020-08	00/28	09-09	09-09	09-09
	HDD020-09	00/29	09-10/Spare	09-10/Spare	09-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(34/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-021	HDD021-00	01/20	09-01	09-01	09-01
	HDD021-01	01/21	09-02	09-02	
	HDD021-02	01/22	09-03	09-03	09-03
	HDD021-03	01/23	09-04	09-04	
	HDD021-04	01/24	09-05	09-05	09-05
	HDD021-05	01/25	09-06	09-06	
	HDD021-06	01/26	09-07	09-07	09-07
	HDD021-07	01/27	09-08	09-08	
	HDD021-08	01/28	09-09	09-09	09-09
	HDD021-09	01/29	09-10/Spare	09-10/Spare	09-09/Spare

THEORY05-820**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(35/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-022	HDD022-00	02/20	09-01	09-01	09-01
	HDD022-01	02/21	09-02	09-02	
	HDD022-02	02/22	09-03	09-03	09-03
	HDD022-03	02/23	09-04	09-04	
	HDD022-04	02/24	09-05	09-05	09-05
	HDD022-05	02/25	09-06	09-06	
	HDD022-06	02/26	09-07	09-07	09-07
	HDD022-07	02/27	09-08	09-08	
	HDD022-08	02/28	09-09	09-09	09-09
	HDD022-09	02/29	09-10/Spare	09-10/Spare	09-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(36/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-023	HDD023-00	03/20	09-01	09-01	09-01
	HDD023-01	03/21	09-02	09-02	
	HDD023-02	03/22	09-03	09-03	09-03
	HDD023-03	03/23	09-04	09-04	
	HDD023-04	03/24	09-05	09-05	09-05
	HDD023-05	03/25	09-06	09-06	
	HDD023-06	03/26	09-07	09-07	09-07
	HDD023-07	03/27	09-08	09-08	
	HDD023-08	03/28	09-09	09-09	09-09
	HDD023-09	03/29	09-10/Spare	09-10/Spare	09-09/Spare

THEORY05-830**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(37/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-024	HDD024-00	04/20	10-01	09-01	09-01
	HDD024-01	04/21	10-02	09-02	
	HDD024-02	04/22	10-03	09-03	09-03
	HDD024-03	04/23	10-04	09-04	
	HDD024-04	04/24	10-05	09-05	09-05
	HDD024-05	04/25	10-06	09-06	
	HDD024-06	04/26	10-07	09-07	09-07
	HDD024-07	04/27	10-08	09-08	
	HDD024-08	04/28	10-09	09-09	09-09
	HDD024-09	04/29	10-10/Spare	09-10/Spare	09-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(38/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-025	HDD025-00	05/20	10-01	09-01	09-01
	HDD025-01	05/21	10-02	09-02	
	HDD025-02	05/22	10-03	09-03	09-03
	HDD025-03	05/23	10-04	09-04	
	HDD025-04	05/24	10-05	09-05	09-05
	HDD025-05	05/25	10-06	09-06	
	HDD025-06	05/26	10-07	09-07	09-07
	HDD025-07	05/27	10-08	09-08	
	HDD025-08	05/28	10-09	09-09	09-09
	HDD025-09	05/29	10-10/Spare	09-10/Spare	09-09/Spare

THEORY05-840**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(39/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-026	HDD026-00	06/20	10-01	09-01	09-01
	HDD026-01	06/21	10-02	09-02	
	HDD026-02	06/22	10-03	09-03	09-03
	HDD026-03	06/23	10-04	09-04	
	HDD026-04	06/24	10-05	09-05	09-05
	HDD026-05	06/25	10-06	09-06	
	HDD026-06	06/26	10-07	09-07	09-07
	HDD026-07	06/27	10-08	09-08	
	HDD026-08	06/28	10-09	09-09	09-09
	HDD026-09	06/29	10-10/Spare	09-10/Spare	09-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(40/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-027	HDD027-00	07/20	10-01	09-01	09-01
	HDD027-01	07/21	10-02	09-02	
	HDD027-02	07/22	10-03	09-03	09-03
	HDD027-03	07/23	10-04	09-04	
	HDD027-04	07/24	10-05	09-05	09-05
	HDD027-05	07/25	10-06	09-06	
	HDD027-06	07/26	10-07	09-07	09-07
	HDD027-07	07/27	10-08	09-08	
	HDD027-08	07/28	10-09	09-09	09-09
	HDD027-09	07/29	10-10/Spare	09-10/Spare	09-09/Spare

THEORY05-850**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(41/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-120	HDD120-00	08/20	11-01	11-01	11-01
	HDD120-01	08/21	11-02	11-02	
	HDD120-02	08/22	11-03	11-03	11-03
	HDD120-03	08/23	11-04	11-04	
	HDD120-04	08/24	11-05	11-05	11-05
	HDD120-05	08/25	11-06	11-06	
	HDD120-06	08/26	11-07	11-07	11-07
	HDD120-07	08/27	11-08	11-08	
	HDD120-08	08/28	11-09	11-09	11-09
	HDD120-09	08/29	11-10/Spare	11-10/Spare	11-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(42/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-121	HDD121-00	09/20	11-01	11-01	11-01
	HDD121-01	09/21	11-02	11-02	
	HDD121-02	09/22	11-03	11-03	11-03
	HDD121-03	09/23	11-04	11-04	
	HDD121-04	09/24	11-05	11-05	11-05
	HDD121-05	09/25	11-06	11-06	
	HDD121-06	09/26	11-07	11-07	11-07
	HDD121-07	09/27	11-08	11-08	
	HDD121-08	09/28	11-09	11-09	11-09
	HDD121-09	09/29	11-10/Spare	11-10/Spare	11-09/Spare

THEORY05-860**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(43/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-122	HDD122-00	0A/20	11-01	11-01	11-01
	HDD122-01	0A/21	11-02	11-02	
	HDD122-02	0A/22	11-03	11-03	11-03
	HDD122-03	0A/23	11-04	11-04	
	HDD122-04	0A/24	11-05	11-05	11-05
	HDD122-05	0A/25	11-06	11-06	
	HDD122-06	0A/26	11-07	11-07	11-07
	HDD122-07	0A/27	11-08	11-08	
	HDD122-08	0A/28	11-09	11-09	11-09
	HDD122-09	0A/29	11-10/Spare	11-10/Spare	11-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(44/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-123	HDD123-00	0B/20	11-01	11-01	11-01
	HDD123-01	0B/21	11-02	11-02	
	HDD123-02	0B/22	11-03	11-03	11-03
	HDD123-03	0B/23	11-04	11-04	
	HDD123-04	0B/24	11-05	11-05	11-05
	HDD123-05	0B/25	11-06	11-06	
	HDD123-06	0B/26	11-07	11-07	11-07
	HDD123-07	0B/27	11-08	11-08	
	HDD123-08	0B/28	11-09	11-09	11-09
	HDD123-09	0B/29	11-10/Spare	11-10/Spare	11-09/Spare

THEORY05-870**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(45/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-124	HDD124-00	0C/20	12-01	11-01	11-01
	HDD124-01	0C/21	12-02	11-02	
	HDD124-02	0C/22	12-03	11-03	11-03
	HDD124-03	0C/23	12-04	11-04	
	HDD124-04	0C/24	12-05	11-05	11-05
	HDD124-05	0C/25	12-06	11-06	
	HDD124-06	0C/26	12-07	11-07	11-07
	HDD124-07	0C/27	12-08	11-08	
	HDD124-08	0C/28	12-09	11-09	11-09
	HDD124-09	0C/29	12-10/Spare	11-10/Spare	11-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(46/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-125	HDD125-00	0D/20	12-01	11-01	11-01
	HDD125-01	0D/21	12-02	11-02	
	HDD125-02	0D/22	12-03	11-03	11-03
	HDD125-03	0D/23	12-04	11-04	
	HDD125-04	0D/24	12-05	11-05	11-05
	HDD125-05	0D/25	12-06	11-06	
	HDD125-06	0D/26	12-07	11-07	11-07
	HDD125-07	0D/27	12-08	11-08	
	HDD125-08	0D/28	12-09	11-09	11-09
	HDD125-09	0D/29	12-10/Spare	11-10/Spare	11-09/Spare

THEORY05-880**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(47/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-126	HDD126-00	0E/20	12-01	11-01	11-01
	HDD126-01	0E/21	12-02	11-02	
	HDD126-02	0E/22	12-03	11-03	11-03
	HDD126-03	0E/23	12-04	11-04	
	HDD126-04	0E/24	12-05	11-05	11-05
	HDD126-05	0E/25	12-06	11-06	
	HDD126-06	0E/26	12-07	11-07	11-07
	HDD126-07	0E/27	12-08	11-08	
	HDD126-08	0E/28	12-09	11-09	11-09
	HDD126-09	0E/29	12-10/Spare	11-10/Spare	11-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(48/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-127	HDD127-00	0F/20	12-01	11-01	11-01
	HDD127-01	0F/21	12-02	11-02	
	HDD127-02	0F/22	12-03	11-03	11-03
	HDD127-03	0F/23	12-04	11-04	
	HDD127-04	0F/24	12-05	11-05	11-05
	HDD127-05	0F/25	12-06	11-06	
	HDD127-06	0F/26	12-07	11-07	11-07
	HDD127-07	0F/27	12-08	11-08	
	HDD127-08	0F/28	12-09	11-09	11-09
	HDD127-09	0F/29	12-10/Spare	11-10/Spare	11-09/Spare

THEORY05-890**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(49/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-030	HDD030-00	00/30	13-01	13-01	13-01
	HDD030-01	00/31	13-02	13-02	
	HDD030-02	00/32	13-03	13-03	13-03
	HDD030-03	00/33	13-04	13-04	
	HDD030-04	00/34	13-05	13-05	13-05
	HDD030-05	00/35	13-06	13-06	
	HDD030-06	00/36	13-07	13-07	13-07
	HDD030-07	00/37	13-08	13-08	
	HDD030-08	00/38	13-09	13-09	13-09
	HDD030-09	00/39	13-10/Spare	13-10/Spare	13-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(50/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-031	HDD031-00	01/30	13-01	13-01	13-01
	HDD031-01	01/31	13-02	13-02	
	HDD031-02	01/32	13-03	13-03	13-03
	HDD031-03	01/33	13-04	13-04	
	HDD031-04	01/34	13-05	13-05	13-05
	HDD031-05	01/35	13-06	13-06	
	HDD031-06	01/36	13-07	13-07	13-07
	HDD031-07	01/37	13-08	13-08	
	HDD031-08	01/38	13-09	13-09	13-09
	HDD031-09	01/39	13-10/Spare	13-10/Spare	13-09/Spare

THEORY05-900**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(51/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-032	HDD032-00	02/30	13-01	13-01	13-01
	HDD032-01	02/31	13-02	13-02	
	HDD032-02	02/32	13-03	13-03	13-03
	HDD032-03	02/33	13-04	13-04	
	HDD032-04	02/34	13-05	13-05	13-05
	HDD032-05	02/35	13-06	13-06	
	HDD032-06	02/36	13-07	13-07	13-07
	HDD032-07	02/37	13-08	13-08	
	HDD032-08	02/38	13-09	13-09	13-09
	HDD032-09	02/39	13-10/Spare	13-10/Spare	13-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(52/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-033	HDD033-00	03/30	13-01	13-01	13-01
	HDD033-01	03/31	13-02	13-02	
	HDD033-02	03/32	13-03	13-03	13-03
	HDD033-03	03/33	13-04	13-04	
	HDD033-04	03/34	13-05	13-05	13-05
	HDD033-05	03/35	13-06	13-06	
	HDD033-06	03/36	13-07	13-07	13-07
	HDD033-07	03/37	13-08	13-08	
	HDD033-08	03/38	13-09	13-09	13-09
	HDD033-09	03/39	13-10/Spare	13-10/Spare	13-09/Spare

THEORY05-910**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(53/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-034	HDD034-00	04/30	14-01	13-01	13-01
	HDD034-01	04/31	14-02	13-02	
	HDD034-02	04/32	14-03	13-03	13-03
	HDD034-03	04/33	14-04	13-04	
	HDD034-04	04/34	14-05	13-05	13-05
	HDD034-05	04/35	14-06	13-06	
	HDD034-06	04/36	14-07	13-07	13-07
	HDD034-07	04/37	14-08	13-08	
	HDD034-08	04/38	14-09	13-09	13-09
	HDD034-09	04/39	14-10/Spare	13-10/Spare	13-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(54/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-035	HDD035-00	05/30	14-01	13-01	13-01
	HDD035-01	05/31	14-02	13-02	
	HDD035-02	05/32	14-03	13-03	13-03
	HDD035-03	05/33	14-04	13-04	
	HDD035-04	05/34	14-05	13-05	13-05
	HDD035-05	05/35	14-06	13-06	
	HDD035-06	05/36	14-07	13-07	13-07
	HDD035-07	05/37	14-08	13-08	
	HDD035-08	05/38	14-09	13-09	13-09
	HDD035-09	05/39	14-10/Spare	13-10/Spare	13-09/Spare

THEORY05-920**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(55/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-036	HDD036-00	06/30	14-01	13-01	13-01
	HDD036-01	06/31	14-02	13-02	
	HDD036-02	06/32	14-03	13-03	13-03
	HDD036-03	06/33	14-04	13-04	
	HDD036-04	06/34	14-05	13-05	13-05
	HDD036-05	06/35	14-06	13-06	
	HDD036-06	06/36	14-07	13-07	13-07
	HDD036-07	06/37	14-08	13-08	
	HDD036-08	06/38	14-09	13-09	13-09
	HDD036-09	06/39	14-10/Spare	13-10/Spare	13-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(56/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-037	HDD037-00	07/30	14-01	13-01	13-01
	HDD037-01	07/31	14-02	13-02	
	HDD037-02	07/32	14-03	13-03	13-03
	HDD037-03	07/33	14-04	13-04	
	HDD037-04	07/34	14-05	13-05	13-05
	HDD037-05	07/35	14-06	13-06	
	HDD037-06	07/36	14-07	13-07	13-07
	HDD037-07	07/37	14-08	13-08	
	HDD037-08	07/38	14-09	13-09	13-09
	HDD037-09	07/39	14-10/Spare	13-10/Spare	13-09/Spare

THEORY05-930**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(57/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-130	HDD130-00	08/30	15-01	15-01	15-01
	HDD130-01	08/31	15-02	15-02	
	HDD130-02	08/32	15-03	15-03	15-03
	HDD130-03	08/33	15-04	15-04	
	HDD130-04	08/34	15-05	15-05	15-05
	HDD130-05	08/35	15-06	15-06	
	HDD130-06	08/36	15-07	15-07	15-07
	HDD130-07	08/37	15-08	15-08	
	HDD130-08	08/38	15-09	15-09	15-09
	HDD130-09	08/39	15-10/Spare	15-10/Spare	15-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(58/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-131	HDD131-00	09/30	15-01	15-01	15-01
	HDD131-01	09/31	15-02	15-02	
	HDD131-02	09/32	15-03	15-03	15-03
	HDD131-03	09/33	15-04	15-04	
	HDD131-04	09/34	15-05	15-05	15-05
	HDD131-05	09/35	15-06	15-06	
	HDD131-06	09/36	15-07	15-07	15-07
	HDD131-07	09/37	15-08	15-08	
	HDD131-08	09/38	15-09	15-09	15-09
	HDD131-09	09/39	15-10/Spare	15-10/Spare	15-09/Spare

THEORY05-940**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(59/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-132	HDD132-00	0A/30	15-01	15-01	15-01
	HDD132-01	0A/31	15-02	15-02	
	HDD132-02	0A/32	15-03	15-03	15-03
	HDD132-03	0A/33	15-04	15-04	
	HDD132-04	0A/34	15-05	15-05	15-05
	HDD132-05	0A/35	15-06	15-06	
	HDD132-06	0A/36	15-07	15-07	15-07
	HDD132-07	0A/37	15-08	15-08	
	HDD132-08	0A/38	15-09	15-09	15-09
	HDD132-09	0A/39	15-10/Spare	15-10/Spare	15-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(60/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-133	HDD133-00	0B/30	15-01	15-01	15-01
	HDD133-01	0B/31	15-02	15-02	
	HDD133-02	0B/32	15-03	15-03	15-03
	HDD133-03	0B/33	15-04	15-04	
	HDD133-04	0B/34	15-05	15-05	15-05
	HDD133-05	0B/35	15-06	15-06	
	HDD133-06	0B/36	15-07	15-07	15-07
	HDD133-07	0B/37	15-08	15-08	
	HDD133-08	0B/38	15-09	15-09	15-09
	HDD133-09	0B/39	15-10/Spare	15-10/Spare	15-09/Spare

THEORY05-950**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(61/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-134	HDD134-00	0C/30	16-01	15-01	15-01
	HDD134-01	0C/31	16-02	15-02	
	HDD134-02	0C/32	16-03	15-03	15-03
	HDD134-03	0C/33	16-04	15-04	
	HDD134-04	0C/34	16-05	15-05	15-05
	HDD134-05	0C/35	16-06	15-06	
	HDD134-06	0C/36	16-07	15-07	15-07
	HDD134-07	0C/37	16-08	15-08	
	HDD134-08	0C/38	16-09	15-09	15-09
	HDD134-09	0C/39	16-10/Spare	15-10/Spare	15-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(62/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-135	HDD135-00	0D/30	16-01	15-01	15-01
	HDD135-01	0D/31	16-02	15-02	
	HDD135-02	0D/32	16-03	15-03	15-03
	HDD135-03	0D/33	16-04	15-04	
	HDD135-04	0D/34	16-05	15-05	15-05
	HDD135-05	0D/35	16-06	15-06	
	HDD135-06	0D/36	16-07	15-07	15-07
	HDD135-07	0D/37	16-08	15-08	
	HDD135-08	0D/38	16-09	15-09	15-09
	HDD135-09	0D/39	16-10/Spare	15-10/Spare	15-09/Spare

THEORY05-960**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(63/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-136	HDD136-00	0E/30	16-01	15-01	15-01
	HDD136-01	0E/31	16-02	15-02	
	HDD136-02	0E/32	16-03	15-03	15-03
	HDD136-03	0E/33	16-04	15-04	
	HDD136-04	0E/34	16-05	15-05	15-05
	HDD136-05	0E/35	16-06	15-06	
	HDD136-06	0E/36	16-07	15-07	15-07
	HDD136-07	0E/37	16-08	15-08	
	HDD136-08	0E/38	16-09	15-09	15-09
	HDD136-09	0E/39	16-10/Spare	15-10/Spare	15-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(64/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-137	HDD137-00	0F/30	16-01	15-01	15-01
	HDD137-01	0F/31	16-02	15-02	
	HDD137-02	0F/32	16-03	15-03	15-03
	HDD137-03	0F/33	16-04	15-04	
	HDD137-04	0F/34	16-05	15-05	15-05
	HDD137-05	0F/35	16-06	15-06	
	HDD137-06	0F/36	16-07	15-07	15-07
	HDD137-07	0F/37	16-08	15-08	
	HDD137-08	0F/38	16-09	15-09	15-09
	HDD137-09	0F/39	16-10/Spare	15-10/Spare	15-09/Spare

THEORY05-970**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(65/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-040	HDD040-00	00/40	17-01	17-01	17-01
	HDD040-01	00/41	17-02	17-02	
	HDD040-02	00/42	17-03	17-03	17-03
	HDD040-03	00/43	17-04	17-04	
	HDD040-04	00/44	17-05	17-05	17-05
	HDD040-05	00/45	17-06	17-06	
	HDD040-06	00/46	17-07	17-07	17-07
	HDD040-07	00/47	17-08	17-08	
	HDD040-08	00/48	17-09	17-09	17-09
	HDD040-09	00/49	17-10/Spare	17-10/Spare	17-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(66/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-041	HDD041-00	01/40	17-01	17-01	17-01
	HDD041-01	01/41	17-02	17-02	
	HDD041-02	01/42	17-03	17-03	17-03
	HDD041-03	01/43	17-04	17-04	
	HDD041-04	01/44	17-05	17-05	17-05
	HDD041-05	01/45	17-06	17-06	
	HDD041-06	01/46	17-07	17-07	17-07
	HDD041-07	01/47	17-08	17-08	
	HDD041-08	01/48	17-09	17-09	17-09
	HDD041-09	01/49	17-10/Spare	17-10/Spare	17-09/Spare

THEORY05-980**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(67/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-042	HDD042-00	02/40	17-01	17-01	17-01
	HDD042-01	02/41	17-02	17-02	
	HDD042-02	02/42	17-03	17-03	17-03
	HDD042-03	02/43	17-04	17-04	
	HDD042-04	02/44	17-05	17-05	17-05
	HDD042-05	02/45	17-06	17-06	
	HDD042-06	02/46	17-07	17-07	17-07
	HDD042-07	02/47	17-08	17-08	
	HDD042-08	02/48	17-09	17-09	17-09
	HDD042-09	02/49	17-10/Spare	17-10/Spare	17-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(68/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-043	HDD043-00	03/40	17-01	17-01	17-01
	HDD043-01	03/41	17-02	17-02	
	HDD043-02	03/42	17-03	17-03	17-03
	HDD043-03	03/43	17-04	17-04	
	HDD043-04	03/44	17-05	17-05	17-05
	HDD043-05	03/45	17-06	17-06	
	HDD043-06	03/46	17-07	17-07	17-07
	HDD043-07	03/47	17-08	17-08	
	HDD043-08	03/48	17-09	17-09	17-09
	HDD043-09	03/49	17-10/Spare	17-10/Spare	17-09/Spare

THEORY05-990**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(69/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-044	HDD044-00	04/40	18-01	17-01	17-01
	HDD044-01	04/41	18-02	17-02	
	HDD044-02	04/42	18-03	17-03	17-03
	HDD044-03	04/43	18-04	17-04	
	HDD044-04	04/44	18-05	17-05	17-05
	HDD044-05	04/45	18-06	17-06	
	HDD044-06	04/46	18-07	17-07	17-07
	HDD044-07	04/47	18-08	17-08	
	HDD044-08	04/48	18-09	17-09	17-09
	HDD044-09	04/49	18-10/Spare	17-10/Spare	17-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(70/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-045	HDD045-00	05/40	18-01	17-01	17-01
	HDD045-01	05/41	18-02	17-02	
	HDD045-02	05/42	18-03	17-03	17-03
	HDD045-03	05/43	18-04	17-04	
	HDD045-04	05/44	18-05	17-05	17-05
	HDD045-05	05/45	18-06	17-06	
	HDD045-06	05/46	18-07	17-07	17-07
	HDD045-07	05/47	18-08	17-08	
	HDD045-08	05/48	18-09	17-09	17-09
	HDD045-09	05/49	18-10/Spare	17-10/Spare	17-09/Spare

THEORY05-1000**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(71/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-046	HDD046-00	06/40	18-01	17-01	17-01
	HDD046-01	06/41	18-02	17-02	
	HDD046-02	06/42	18-03	17-03	17-03
	HDD046-03	06/43	18-04	17-04	
	HDD046-04	06/44	18-05	17-05	17-05
	HDD046-05	06/45	18-06	17-06	
	HDD046-06	06/46	18-07	17-07	17-07
	HDD046-07	06/47	18-08	17-08	
	HDD046-08	06/48	18-09	17-09	17-09
	HDD046-09	06/49	18-10/Spare	17-10/Spare	17-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(72/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-047	HDD047-00	07/40	18-01	17-01	17-01
	HDD047-01	07/41	18-02	17-02	
	HDD047-02	07/42	18-03	17-03	17-03
	HDD047-03	07/43	18-04	17-04	
	HDD047-04	07/44	18-05	17-05	17-05
	HDD047-05	07/45	18-06	17-06	
	HDD047-06	07/46	18-07	17-07	17-07
	HDD047-07	07/47	18-08	17-08	
	HDD047-08	07/48	18-09	17-09	17-09
	HDD047-09	07/49	18-10/Spare	17-10/Spare	17-09/Spare

THEORY05-1010**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(73/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-140	HDD140-00	08/40	19-01	19-01	19-01
	HDD140-01	08/41	19-02	19-02	
	HDD140-02	08/42	19-03	19-03	19-03
	HDD140-03	08/43	19-04	19-04	
	HDD140-04	08/44	19-05	19-05	19-05
	HDD140-05	08/45	19-06	19-06	
	HDD140-06	08/46	19-07	19-07	19-07
	HDD140-07	08/47	19-08	19-08	
	HDD140-08	08/48	19-09	19-09	19-09
	HDD140-09	08/49	19-10/Spare	19-10/Spare	19-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(74/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-141	HDD141-00	09/40	19-01	19-01	19-01
	HDD141-01	09/41	19-02	19-02	
	HDD141-02	09/42	19-03	19-03	19-03
	HDD141-03	09/43	19-04	19-04	
	HDD141-04	09/44	19-05	19-05	19-05
	HDD141-05	09/45	19-06	19-06	
	HDD141-06	09/46	19-07	19-07	19-07
	HDD141-07	09/47	19-08	19-08	
	HDD141-08	09/48	19-09	19-09	19-09
	HDD141-09	09/49	19-10/Spare	19-10/Spare	19-09/Spare

THEORY05-1020**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(75/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-142	HDD142-00	0A/40	19-01	19-01	19-01
	HDD142-01	0A/41	19-02	19-02	
	HDD142-02	0A/42	19-03	19-03	19-03
	HDD142-03	0A/43	19-04	19-04	
	HDD142-04	0A/44	19-05	19-05	19-05
	HDD142-05	0A/45	19-06	19-06	
	HDD142-06	0A/46	19-07	19-07	19-07
	HDD142-07	0A/47	19-08	19-08	
	HDD142-08	0A/48	19-09	19-09	19-09
	HDD142-09	0A/49	19-10/Spare	19-10/Spare	19-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(76/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-143	HDD143-00	0B/40	19-01	19-01	19-01
	HDD143-01	0B/41	19-02	19-02	
	HDD143-02	0B/42	19-03	19-03	19-03
	HDD143-03	0B/43	19-04	19-04	
	HDD143-04	0B/44	19-05	19-05	19-05
	HDD143-05	0B/45	19-06	19-06	
	HDD143-06	0B/46	19-07	19-07	19-07
	HDD143-07	0B/47	19-08	19-08	
	HDD143-08	0B/48	19-09	19-09	19-09
	HDD143-09	0B/49	19-10/Spare	19-10/Spare	19-09/Spare

THEORY05-1030**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(77/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-144	HDD144-00	0C/40	20-01	19-01	19-01
	HDD144-01	0C/41	20-02	19-02	
	HDD144-02	0C/42	20-03	19-03	19-03
	HDD144-03	0C/43	20-04	19-04	
	HDD144-04	0C/44	20-05	19-05	19-05
	HDD144-05	0C/45	20-06	19-06	
	HDD144-06	0C/46	20-07	19-07	19-07
	HDD144-07	0C/47	20-08	19-08	
	HDD144-08	0C/48	20-09	19-09	19-09
	HDD144-09	0C/49	20-10/Spare	19-10/Spare	19-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(78/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-145	HDD145-00	0D/40	20-01	19-01	19-01
	HDD145-01	0D/41	20-02	19-02	
	HDD145-02	0D/42	20-03	19-03	19-03
	HDD145-03	0D/43	20-04	19-04	
	HDD145-04	0D/44	20-05	19-05	19-05
	HDD145-05	0D/45	20-06	19-06	
	HDD145-06	0D/46	20-07	19-07	19-07
	HDD145-07	0D/47	20-08	19-08	
	HDD145-08	0D/48	20-09	19-09	19-09
	HDD145-09	0D/49	20-10/Spare	19-10/Spare	19-09/Spare

THEORY05-1040**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(79/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-146	HDD146-00	0E/40	20-01	19-01	19-01
	HDD146-01	0E/41	20-02	19-02	
	HDD146-02	0E/42	20-03	19-03	19-03
	HDD146-03	0E/43	20-04	19-04	
	HDD146-04	0E/44	20-05	19-05	19-05
	HDD146-05	0E/45	20-06	19-06	
	HDD146-06	0E/46	20-07	19-07	19-07
	HDD146-07	0E/47	20-08	19-08	
	HDD146-08	0E/48	20-09	19-09	19-09
	HDD146-09	0E/49	20-10/Spare	19-10/Spare	19-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(80/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-147	HDD147-00	0F/40	20-01	19-01	19-01
	HDD147-01	0F/41	20-02	19-02	
	HDD147-02	0F/42	20-03	19-03	19-03
	HDD147-03	0F/43	20-04	19-04	
	HDD147-04	0F/44	20-05	19-05	19-05
	HDD147-05	0F/45	20-06	19-06	
	HDD147-06	0F/46	20-07	19-07	19-07
	HDD147-07	0F/47	20-08	19-08	
	HDD147-08	0F/48	20-09	19-09	19-09
	HDD147-09	0F/49	20-10/Spare	19-10/Spare	19-09/Spare

THEORY05-1050**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(81/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-050	HDD050-00	00/50	21-01	21-01	21-01
	HDD050-01	00/51	21-02	21-02	
	HDD050-02	00/52	21-03	21-03	21-03
	HDD050-03	00/53	21-04	21-04	
	HDD050-04	00/54	21-05	21-05	21-05
	HDD050-05	00/55	21-06	21-06	
	HDD050-06	00/56	21-07	21-07	21-07
	HDD050-07	00/57	21-08	21-08	
	HDD050-08	00/58	21-09	21-09	21-09
	HDD050-09	00/59	21-10/Spare	21-10/Spare	21-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(82/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-051	HDD051-00	01/50	21-01	21-01	21-01
	HDD051-01	01/51	21-02	21-02	
	HDD051-02	01/52	21-03	21-03	21-03
	HDD051-03	01/53	21-04	21-04	
	HDD051-04	01/54	21-05	21-05	21-05
	HDD051-05	01/55	21-06	21-06	
	HDD051-06	01/56	21-07	21-07	21-07
	HDD051-07	01/57	21-08	21-08	
	HDD051-08	01/58	21-09	21-09	21-09
	HDD051-09	01/59	21-10/Spare	21-10/Spare	21-09/Spare

THEORY05-1060**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(83/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-052	HDD052-00	02/50	21-01	21-01	21-01
	HDD052-01	02/51	21-02	21-02	
	HDD052-02	02/52	21-03	21-03	21-03
	HDD052-03	02/53	21-04	21-04	
	HDD052-04	02/54	21-05	21-05	21-05
	HDD052-05	02/55	21-06	21-06	
	HDD052-06	02/56	21-07	21-07	21-07
	HDD052-07	02/57	21-08	21-08	
	HDD052-08	02/58	21-09	21-09	21-09
	HDD052-09	02/59	21-10/Spare	21-10/Spare	21-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(84/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-053	HDD053-00	03/50	21-01	21-01	21-01
	HDD053-01	03/51	21-02	21-02	
	HDD053-02	03/52	21-03	21-03	21-03
	HDD053-03	03/53	21-04	21-04	
	HDD053-04	03/54	21-05	21-05	21-05
	HDD053-05	03/55	21-06	21-06	
	HDD053-06	03/56	21-07	21-07	21-07
	HDD053-07	03/57	21-08	21-08	
	HDD053-08	03/58	21-09	21-09	21-09
	HDD053-09	03/59	21-10/Spare	21-10/Spare	21-09/Spare

THEORY05-1070**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(85/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-054	HDD054-00	04/50	22-01	21-01	21-01
	HDD054-01	04/51	22-02	21-02	
	HDD054-02	04/52	22-03	21-03	21-03
	HDD054-03	04/53	22-04	21-04	
	HDD054-04	04/54	22-05	21-05	21-05
	HDD054-05	04/55	22-06	21-06	
	HDD054-06	04/56	22-07	21-07	21-07
	HDD054-07	04/57	22-08	21-08	
	HDD054-08	04/58	22-09	21-09	21-09
	HDD054-09	04/59	22-10/Spare	21-10/Spare	21-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(86/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-055	HDD055-00	05/50	22-01	21-01	21-01
	HDD055-01	05/51	22-02	21-02	
	HDD055-02	05/52	22-03	21-03	21-03
	HDD055-03	05/53	22-04	21-04	
	HDD055-04	05/54	22-05	21-05	21-05
	HDD055-05	05/55	22-06	21-06	
	HDD055-06	05/56	22-07	21-07	21-07
	HDD055-07	05/57	22-08	21-08	
	HDD055-08	05/58	22-09	21-09	21-09
	HDD055-09	05/59	22-10/Spare	21-10/Spare	21-09/Spare

THEORY05-1080**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(87/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-056	HDD056-00	06/50	22-01	21-01	21-01
	HDD056-01	06/51	22-02	21-02	
	HDD056-02	06/52	22-03	21-03	21-03
	HDD056-03	06/53	22-04	21-04	
	HDD056-04	06/54	22-05	21-05	21-05
	HDD056-05	06/55	22-06	21-06	
	HDD056-06	06/56	22-07	21-07	21-07
	HDD056-07	06/57	22-08	21-08	
	HDD056-08	06/58	22-09	21-09	21-09
	HDD056-09	06/59	22-10/Spare	21-10/Spare	21-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(88/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-057	HDD057-00	07/50	22-01	21-01	21-01
	HDD057-01	07/51	22-02	21-02	
	HDD057-02	07/52	22-03	21-03	21-03
	HDD057-03	07/53	22-04	21-04	
	HDD057-04	07/54	22-05	21-05	21-05
	HDD057-05	07/55	22-06	21-06	
	HDD057-06	07/56	22-07	21-07	21-07
	HDD057-07	07/57	22-08	21-08	
	HDD057-08	07/58	22-09	21-09	21-09
	HDD057-09	07/59	22-10/Spare	21-10/Spare	21-09/Spare

THEORY05-1090**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(89/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-150	HDD150-00	08/50	23-01	23-01	23-01
	HDD150-01	08/51	23-02	23-02	
	HDD150-02	08/52	23-03	23-03	23-03
	HDD150-03	08/53	23-04	23-04	
	HDD150-04	08/54	23-05	23-05	23-05
	HDD150-05	08/55	23-06	23-06	
	HDD150-06	08/56	23-07	23-07	23-07
	HDD150-07	08/57	23-08	23-08	
	HDD150-08	08/58	23-09	23-09	23-09
	HDD150-09	08/59	23-10/Spare	23-10/Spare	23-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(90/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-151	HDD151-00	09/50	23-01	23-01	23-01
	HDD151-01	09/51	23-02	23-02	
	HDD151-02	09/52	23-03	23-03	23-03
	HDD151-03	09/53	23-04	23-04	
	HDD151-04	09/54	23-05	23-05	23-05
	HDD151-05	09/55	23-06	23-06	
	HDD151-06	09/56	23-07	23-07	23-07
	HDD151-07	09/57	23-08	23-08	
	HDD151-08	09/58	23-09	23-09	23-09
	HDD151-09	09/59	23-10/Spare	23-10/Spare	23-09/Spare

THEORY05-1100**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(91/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-152	HDD152-00	0A/50	23-01	23-01	23-01
	HDD152-01	0A/51	23-02	23-02	
	HDD152-02	0A/52	23-03	23-03	23-03
	HDD152-03	0A/53	23-04	23-04	
	HDD152-04	0A/54	23-05	23-05	23-05
	HDD152-05	0A/55	23-06	23-06	
	HDD152-06	0A/56	23-07	23-07	23-07
	HDD152-07	0A/57	23-08	23-08	
	HDD152-08	0A/58	23-09	23-09	23-09
	HDD152-09	0A/59	23-10/Spare	23-10/Spare	23-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(92/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-153	HDD153-00	0B/50	23-01	23-01	23-01
	HDD153-01	0B/51	23-02	23-02	
	HDD153-02	0B/52	23-03	23-03	23-03
	HDD153-03	0B/53	23-04	23-04	
	HDD153-04	0B/54	23-05	23-05	23-05
	HDD153-05	0B/55	23-06	23-06	
	HDD153-06	0B/56	23-07	23-07	23-07
	HDD153-07	0B/57	23-08	23-08	
	HDD153-08	0B/58	23-09	23-09	23-09
	HDD153-09	0B/59	23-10/Spare	23-10/Spare	23-09/Spare

THEORY05-1110**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(93/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-154	HDD154-00	0C/50	24-01	23-01	23-01
	HDD154-01	0C/51	24-02	23-02	
	HDD154-02	0C/52	24-03	23-03	23-03
	HDD154-03	0C/53	24-04	23-04	
	HDD154-04	0C/54	24-05	23-05	23-05
	HDD154-05	0C/55	24-06	23-06	
	HDD154-06	0C/56	24-07	23-07	23-07
	HDD154-07	0C/57	24-08	23-08	
	HDD154-08	0C/58	24-09	23-09	23-09
	HDD154-09	0C/59	24-10/Spare	23-10/Spare	23-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(94/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-155	HDD155-00	0D/50	24-01	23-01	23-01
	HDD155-01	0D/51	24-02	23-02	
	HDD155-02	0D/52	24-03	23-03	23-03
	HDD155-03	0D/53	24-04	23-04	
	HDD155-04	0D/54	24-05	23-05	23-05
	HDD155-05	0D/55	24-06	23-06	
	HDD155-06	0D/56	24-07	23-07	23-07
	HDD155-07	0D/57	24-08	23-08	
	HDD155-08	0D/58	24-09	23-09	23-09
	HDD155-09	0D/59	24-10/Spare	23-10/Spare	23-09/Spare

THEORY05-1120**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(95/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-156	HDD156-00	0E/50	24-01	23-01	23-01
	HDD156-01	0E/51	24-02	23-02	
	HDD156-02	0E/52	24-03	23-03	23-03
	HDD156-03	0E/53	24-04	23-04	
	HDD156-04	0E/54	24-05	23-05	23-05
	HDD156-05	0E/55	24-06	23-06	
	HDD156-06	0E/56	24-07	23-07	23-07
	HDD156-07	0E/57	24-08	23-08	
	HDD156-08	0E/58	24-09	23-09	23-09
	HDD156-09	0E/59	24-10/Spare	23-10/Spare	23-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(96/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-157	HDD157-00	0F/50	24-01	23-01	23-01
	HDD157-01	0F/51	24-02	23-02	
	HDD157-02	0F/52	24-03	23-03	23-03
	HDD157-03	0F/53	24-04	23-04	
	HDD157-04	0F/54	24-05	23-05	23-05
	HDD157-05	0F/55	24-06	23-06	
	HDD157-06	0F/56	24-07	23-07	23-07
	HDD157-07	0F/57	24-08	23-08	
	HDD157-08	0F/58	24-09	23-09	23-09
	HDD157-09	0F/59	24-10/Spare	23-10/Spare	23-09/Spare

THEORY05-1130**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(97/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-060	HDD060-00	00/60	25-01	25-01	25-01
	HDD060-01	00/61	25-02	25-02	
	HDD060-02	00/62	25-03	25-03	25-03
	HDD060-03	00/63	25-04	25-04	
	HDD060-04	00/64	25-05	25-05	25-05
	HDD060-05	00/65	25-06	25-06	
	HDD060-06	00/66	25-07	25-07	25-07
	HDD060-07	00/67	25-08	25-08	
	HDD060-08	00/68	25-09	25-09	25-09
	HDD060-09	00/69	25-10/Spare	25-10/Spare	25-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(98/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-061	HDD061-00	01/60	25-01	25-01	25-01
	HDD061-01	01/61	25-02	25-02	
	HDD061-02	01/62	25-03	25-03	25-03
	HDD061-03	01/63	25-04	25-04	
	HDD061-04	01/64	25-05	25-05	25-05
	HDD061-05	01/65	25-06	25-06	
	HDD061-06	01/66	25-07	25-07	25-07
	HDD061-07	01/67	25-08	25-08	
	HDD061-08	01/68	25-09	25-09	25-09
	HDD061-09	01/69	25-10/Spare	25-10/Spare	25-09/Spare

THEORY05-1140**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(99/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-062	HDD062-00	02/60	25-01	25-01	25-01
	HDD062-01	02/61	25-02	25-02	
	HDD062-02	02/62	25-03	25-03	25-03
	HDD062-03	02/63	25-04	25-04	
	HDD062-04	02/64	25-05	25-05	25-05
	HDD062-05	02/65	25-06	25-06	
	HDD062-06	02/66	25-07	25-07	25-07
	HDD062-07	02/67	25-08	25-08	
	HDD062-08	02/68	25-09	25-09	25-09
	HDD062-09	02/69	25-10/Spare	25-10/Spare	25-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(100/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-063	HDD063-00	03/60	25-01	25-01	25-01
	HDD063-01	03/61	25-02	25-02	
	HDD063-02	03/62	25-03	25-03	25-03
	HDD063-03	03/63	25-04	25-04	
	HDD063-04	03/64	25-05	25-05	25-05
	HDD063-05	03/65	25-06	25-06	
	HDD063-06	03/66	25-07	25-07	25-07
	HDD063-07	03/67	25-08	25-08	
	HDD063-08	03/68	25-09	25-09	25-09
	HDD063-09	03/69	25-10/Spare	25-10/Spare	25-09/Spare

THEORY05-1150**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(101/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-064	HDD064-00	04/60	26-01	25-01	25-01
	HDD064-01	04/61	26-02	25-02	
	HDD064-02	04/62	26-03	25-03	25-03
	HDD064-03	04/63	26-04	25-04	
	HDD064-04	04/64	26-05	25-05	25-05
	HDD064-05	04/65	26-06	25-06	
	HDD064-06	04/66	26-07	25-07	25-07
	HDD064-07	04/67	26-08	25-08	
	HDD064-08	04/68	26-09	25-09	25-09
	HDD064-09	04/69	26-10/Spare	25-10/Spare	25-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(102/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-065	HDD065-00	05/60	26-01	25-01	25-01
	HDD065-01	05/61	26-02	25-02	
	HDD065-02	05/62	26-03	25-03	25-03
	HDD065-03	05/63	26-04	25-04	
	HDD065-04	05/64	26-05	25-05	25-05
	HDD065-05	05/65	26-06	25-06	
	HDD065-06	05/66	26-07	25-07	25-07
	HDD065-07	05/67	26-08	25-08	
	HDD065-08	05/68	26-09	25-09	25-09
	HDD065-09	05/69	26-10/Spare	25-10/Spare	25-09/Spare

THEORY05-1160**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(103/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-066	HDD066-00	06/60	26-01	25-01	25-01
	HDD066-01	06/61	26-02	25-02	
	HDD066-02	06/62	26-03	25-03	25-03
	HDD066-03	06/63	26-04	25-04	
	HDD066-04	06/64	26-05	25-05	25-05
	HDD066-05	06/65	26-06	25-06	
	HDD066-06	06/66	26-07	25-07	25-07
	HDD066-07	06/67	26-08	25-08	
	HDD066-08	06/68	26-09	25-09	25-09
	HDD066-09	06/69	26-10/Spare	25-10/Spare	25-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(104/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-067	HDD067-00	07/60	26-01	25-01	25-01
	HDD067-01	07/61	26-02	25-02	
	HDD067-02	07/62	26-03	25-03	25-03
	HDD067-03	07/63	26-04	25-04	
	HDD067-04	07/64	26-05	25-05	25-05
	HDD067-05	07/65	26-06	25-06	
	HDD067-06	07/66	26-07	25-07	25-07
	HDD067-07	07/67	26-08	25-08	
	HDD067-08	07/68	26-09	25-09	25-09
	HDD067-09	07/69	26-10/Spare	25-10/Spare	25-09/Spare

THEORY05-1170**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(105/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-160	HDD160-00	08/60	27-01	27-01	27-01
	HDD160-01	08/61	27-02	27-02	
	HDD160-02	08/62	27-03	27-03	27-03
	HDD160-03	08/63	27-04	27-04	
	HDD160-04	08/64	27-05	27-05	27-05
	HDD160-05	08/65	27-06	27-06	
	HDD160-06	08/66	27-07	27-07	27-07
	HDD160-07	08/67	27-08	27-08	
	HDD160-08	08/68	27-09	27-09	27-09
	HDD160-09	08/69	27-10/Spare	27-10/Spare	27-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(106/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-161	HDD161-00	09/60	27-01	27-01	27-01
	HDD161-01	09/61	27-02	27-02	
	HDD161-02	09/62	27-03	27-03	27-03
	HDD161-03	09/63	27-04	27-04	
	HDD161-04	09/64	27-05	27-05	27-05
	HDD161-05	09/65	27-06	27-06	
	HDD161-06	09/66	27-07	27-07	27-07
	HDD161-07	09/67	27-08	27-08	
	HDD161-08	09/68	27-09	27-09	27-09
	HDD161-09	09/69	27-10/Spare	27-10/Spare	27-09/Spare

THEORY05-1180**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(107/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-162	HDD162-00	0A/60	27-01	27-01	27-01
	HDD162-01	0A/61	27-02	27-02	
	HDD162-02	0A/62	27-03	27-03	27-03
	HDD162-03	0A/63	27-04	27-04	
	HDD162-04	0A/64	27-05	27-05	27-05
	HDD162-05	0A/65	27-06	27-06	
	HDD162-06	0A/66	27-07	27-07	27-07
	HDD162-07	0A/67	27-08	27-08	
	HDD162-08	0A/68	27-09	27-09	27-09
	HDD162-09	0A/69	27-10/Spare	27-10/Spare	27-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(108/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-163	HDD163-00	0B/60	27-01	27-01	27-01
	HDD163-01	0B/61	27-02	27-02	
	HDD163-02	0B/62	27-03	27-03	27-03
	HDD163-03	0B/63	27-04	27-04	
	HDD163-04	0B/64	27-05	27-05	27-05
	HDD163-05	0B/65	27-06	27-06	
	HDD163-06	0B/66	27-07	27-07	27-07
	HDD163-07	0B/67	27-08	27-08	
	HDD163-08	0B/68	27-09	27-09	27-09
	HDD163-09	0B/69	27-10/Spare	27-10/Spare	27-09/Spare

THEORY05-1190**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(109/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-164	HDD164-00	0C/60	28-01	27-01	27-01
	HDD164-01	0C/61	28-02	27-02	
	HDD164-02	0C/62	28-03	27-03	27-03
	HDD164-03	0C/63	28-04	27-04	
	HDD164-04	0C/64	28-05	27-05	27-05
	HDD164-05	0C/65	28-06	27-06	
	HDD164-06	0C/66	28-07	27-07	27-07
	HDD164-07	0C/67	28-08	27-08	
	HDD164-08	0C/68	28-09	27-09	27-09
	HDD164-09	0C/69	28-10/Spare	27-10/Spare	27-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(110/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-165	HDD165-00	0D/60	28-01	27-01	27-01
	HDD165-01	0D/61	28-02	27-02	
	HDD165-02	0D/62	28-03	27-03	27-03
	HDD165-03	0D/63	28-04	27-04	
	HDD165-04	0D/64	28-05	27-05	27-05
	HDD165-05	0D/65	28-06	27-06	
	HDD165-06	0D/66	28-07	27-07	27-07
	HDD165-07	0D/67	28-08	27-08	
	HDD165-08	0D/68	28-09	27-09	27-09
	HDD165-09	0D/69	28-10/Spare	27-10/Spare	27-09/Spare

THEORY05-1200**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(111/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-166	HDD166-00	0E/60	28-01	27-01	27-01
	HDD166-01	0E/61	28-02	27-02	
	HDD166-02	0E/62	28-03	27-03	27-03
	HDD166-03	0E/63	28-04	27-04	
	HDD166-04	0E/64	28-05	27-05	27-05
	HDD166-05	0E/65	28-06	27-06	
	HDD166-06	0E/66	28-07	27-07	27-07
	HDD166-07	0E/67	28-08	27-08	
	HDD166-08	0E/68	28-09	27-09	27-09
	HDD166-09	0E/69	28-10/Spare	27-10/Spare	27-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(112/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-167	HDD167-00	0F/60	28-01	27-01	27-01
	HDD167-01	0F/61	28-02	27-02	
	HDD167-02	0F/62	28-03	27-03	27-03
	HDD167-03	0F/63	28-04	27-04	
	HDD167-04	0F/64	28-05	27-05	27-05
	HDD167-05	0F/65	28-06	27-06	
	HDD167-06	0F/66	28-07	27-07	27-07
	HDD167-07	0F/67	28-08	27-08	
	HDD167-08	0F/68	28-09	27-09	27-09
	HDD167-09	0F/69	28-10/Spare	27-10/Spare	27-09/Spare

THEORY05-1210**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(113/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-070	HDD070-00	00/70	29-01	29-01	29-01
	HDD070-01	00/71	29-02	29-02	
	HDD070-02	00/72	29-03	29-03	29-03
	HDD070-03	00/73	29-04	29-04	
	HDD070-04	00/74	29-05	29-05	29-05
	HDD070-05	00/75	29-06	29-06	
	HDD070-06	00/76	29-07	29-07	29-07
	HDD070-07	00/77	29-08	29-08	
	HDD070-08	00/78	29-09	29-09	29-09
	HDD070-09	00/79	29-10/Spare	29-10/Spare	29-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(114/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-071	HDD071-00	01/70	29-01	29-01	29-01
	HDD071-01	01/71	29-02	29-02	
	HDD071-02	01/72	29-03	29-03	29-03
	HDD071-03	01/73	29-04	29-04	
	HDD071-04	01/74	29-05	29-05	29-05
	HDD071-05	01/75	29-06	29-06	
	HDD071-06	01/76	29-07	29-07	29-07
	HDD071-07	01/77	29-08	29-08	
	HDD071-08	01/78	29-09	29-09	29-09
	HDD071-09	01/79	29-10/Spare	29-10/Spare	29-09/Spare

THEORY05-1220**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(115/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-072	HDD072-00	02/70	29-01	29-01	29-01
	HDD072-01	02/71	29-02	29-02	
	HDD072-02	02/72	29-03	29-03	29-03
	HDD072-03	02/73	29-04	29-04	
	HDD072-04	02/74	29-05	29-05	29-05
	HDD072-05	02/75	29-06	29-06	
	HDD072-06	02/76	29-07	29-07	29-07
	HDD072-07	02/77	29-08	29-08	
	HDD072-08	02/78	29-09	29-09	29-09
	HDD072-09	02/79	29-10/Spare	29-10/Spare	29-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(116/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-073	HDD073-00	03/70	29-01	29-01	29-01
	HDD073-01	03/71	29-02	29-02	
	HDD073-02	03/72	29-03	29-03	29-03
	HDD073-03	03/73	29-04	29-04	
	HDD073-04	03/74	29-05	29-05	29-05
	HDD073-05	03/75	29-06	29-06	
	HDD073-06	03/76	29-07	29-07	29-07
	HDD073-07	03/77	29-08	29-08	
	HDD073-08	03/78	29-09	29-09	29-09
	HDD073-09	03/79	29-10/Spare	29-10/Spare	29-09/Spare

THEORY05-1230**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(117/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-074	HDD074-00	04/70	30-01	29-01	29-01
	HDD074-01	04/71	30-02	29-02	
	HDD074-02	04/72	30-03	29-03	29-03
	HDD074-03	04/73	30-04	29-04	
	HDD074-04	04/74	30-05	29-05	29-05
	HDD074-05	04/75	30-06	29-06	
	HDD074-06	04/76	30-07	29-07	29-07
	HDD074-07	04/77	30-08	29-08	
	HDD074-08	04/78	30-09	29-09	29-09
	HDD074-09	04/79	30-10/Spare	29-10/Spare	29-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(118/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-075	HDD075-00	05/70	30-01	29-01	29-01
	HDD075-01	05/71	30-02	29-02	
	HDD075-02	05/72	30-03	29-03	29-03
	HDD075-03	05/73	30-04	29-04	
	HDD075-04	05/74	30-05	29-05	29-05
	HDD075-05	05/75	30-06	29-06	
	HDD075-06	05/76	30-07	29-07	29-07
	HDD075-07	05/77	30-08	29-08	
	HDD075-08	05/78	30-09	29-09	29-09
	HDD075-09	05/79	30-10/Spare	29-10/Spare	29-09/Spare

THEORY05-1240**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(119/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-076	HDD076-00	06/70	30-01	29-01	29-01
	HDD076-01	06/71	30-02	29-02	
	HDD076-02	06/72	30-03	29-03	29-03
	HDD076-03	06/73	30-04	29-04	
	HDD076-04	06/74	30-05	29-05	29-05
	HDD076-05	06/75	30-06	29-06	
	HDD076-06	06/76	30-07	29-07	29-07
	HDD076-07	06/77	30-08	29-08	
	HDD076-08	06/78	30-09	29-09	29-09
	HDD076-09	06/79	30-10/Spare	29-10/Spare	29-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(120/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-077	HDD077-00	07/70	30-01	29-01	29-01
	HDD077-01	07/71	30-02	29-02	
	HDD077-02	07/72	30-03	29-03	29-03
	HDD077-03	07/73	30-04	29-04	
	HDD077-04	07/74	30-05	29-05	29-05
	HDD077-05	07/75	30-06	29-06	
	HDD077-06	07/76	30-07	29-07	29-07
	HDD077-07	07/77	30-08	29-08	
	HDD077-08	07/78	30-09	29-09	29-09
	HDD077-09	07/79	30-10/Spare	29-10/Spare	29-09/Spare

THEORY05-1250**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(121/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-170	HDD170-00	08/70	31-01	31-01	31-01
	HDD170-01	08/71	31-02	31-02	
	HDD170-02	08/72	31-03	31-03	31-03
	HDD170-03	08/73	31-04	31-04	
	HDD170-04	08/74	31-05	31-05	31-05
	HDD170-05	08/75	31-06	31-06	
	HDD170-06	08/76	31-07	31-07	31-07
	HDD170-07	08/77	31-08	31-08	
	HDD170-08	08/78	31-09	31-09	31-09
	HDD170-09	08/79	31-10/Spare	31-10/Spare	31-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(122/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-171	HDD171-00	09/70	31-01	31-01	31-01
	HDD171-01	09/71	31-02	31-02	
	HDD171-02	09/72	31-03	31-03	31-03
	HDD171-03	09/73	31-04	31-04	
	HDD171-04	09/74	31-05	31-05	31-05
	HDD171-05	09/75	31-06	31-06	
	HDD171-06	09/76	31-07	31-07	31-07
	HDD171-07	09/77	31-08	31-08	
	HDD171-08	09/78	31-09	31-09	31-09
	HDD171-09	09/79	31-10/Spare	31-10/Spare	31-09/Spare

THEORY05-1260**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(123/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-172	HDD172-00	0A/70	31-01	31-01	31-01
	HDD172-01	0A/71	31-02	31-02	
	HDD172-02	0A/72	31-03	31-03	31-03
	HDD172-03	0A/73	31-04	31-04	
	HDD172-04	0A/74	31-05	31-05	31-05
	HDD172-05	0A/75	31-06	31-06	
	HDD172-06	0A/76	31-07	31-07	31-07
	HDD172-07	0A/77	31-08	31-08	
	HDD172-08	0A/78	31-09	31-09	31-09
	HDD172-09	0A/79	31-10/Spare	31-10/Spare	31-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(124/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-173	HDD173-00	0B/70	31-01	31-01	31-01
	HDD173-01	0B/71	31-02	31-02	
	HDD173-02	0B/72	31-03	31-03	31-03
	HDD173-03	0B/73	31-04	31-04	
	HDD173-04	0B/74	31-05	31-05	31-05
	HDD173-05	0B/75	31-06	31-06	
	HDD173-06	0B/76	31-07	31-07	31-07
	HDD173-07	0B/77	31-08	31-08	
	HDD173-08	0B/78	31-09	31-09	31-09
	HDD173-09	0B/79	31-10/Spare	31-10/Spare	31-09/Spare

THEORY05-1270**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(125/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-174	HDD174-00	0C/70	32-01	31-01	31-01
	HDD174-01	0C/71	32-02	31-02	
	HDD174-02	0C/72	32-03	31-03	31-03
	HDD174-03	0C/73	32-04	31-04	
	HDD174-04	0C/74	32-05	31-05	31-05
	HDD174-05	0C/75	32-06	31-06	
	HDD174-06	0C/76	32-07	31-07	31-07
	HDD174-07	0C/77	32-08	31-08	
	HDD174-08	0C/78	32-09	31-09	31-09
	HDD174-09	0C/79	32-10/Spare	31-10/Spare	31-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(126/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-175	HDD175-00	0D/70	32-01	31-01	31-01
	HDD175-01	0D/71	32-02	31-02	
	HDD175-02	0D/72	32-03	31-03	31-03
	HDD175-03	0D/73	32-04	31-04	
	HDD175-04	0D/74	32-05	31-05	31-05
	HDD175-05	0D/75	32-06	31-06	
	HDD175-06	0D/76	32-07	31-07	31-07
	HDD175-07	0D/77	32-08	31-08	
	HDD175-08	0D/78	32-09	31-09	31-09
	HDD175-09	0D/79	32-10/Spare	31-10/Spare	31-09/Spare

THEORY05-1280**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(127/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-176	HDD176-00	0E/70	32-01	31-01	31-01
	HDD176-01	0E/71	32-02	31-02	
	HDD176-02	0E/72	32-03	31-03	31-03
	HDD176-03	0E/73	32-04	31-04	
	HDD176-04	0E/74	32-05	31-05	31-05
	HDD176-05	0E/75	32-06	31-06	
	HDD176-06	0E/76	32-07	31-07	31-07
	HDD176-07	0E/77	32-08	31-08	
	HDD176-08	0E/78	32-09	31-09	31-09
	HDD176-09	0E/79	32-10/Spare	31-10/Spare	31-09/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH BOX)
(128/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-177	HDD177-00	0F/70	32-01	31-01	31-01
	HDD177-01	0F/71	32-02	31-02	
	HDD177-02	0F/72	32-03	31-03	31-03
	HDD177-03	0F/73	32-04	31-04	
	HDD177-04	0F/74	32-05	31-05	31-05
	HDD177-05	0F/75	32-06	31-06	
	HDD177-06	0F/76	32-07	31-07	31-07
	HDD177-07	0F/77	32-08	31-08	
	HDD177-08	0F/78	32-09	31-09	31-09
	HDD177-09	0F/79	32-10/Spare	31-10/Spare	31-09/Spare

THEORY05-1290**5.3 Physical-Logical Device Matrixes (FBX DKU)****RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(1/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-000	HDD000-00	00/00	01-01	01-01	01-01
	HDD000-01	00/01	01-02	01-02	
	HDD000-02	00/02	01-03	01-03	01-03
	HDD000-03	00/03	01-04	01-04	
	HDD000-04	00/04	01-05	01-05	01-05
	HDD000-05	00/05	01-06/Spare	01-06/Spare	01-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(2/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-001	HDD001-00	01/00	01-01	01-01	01-01
	HDD001-01	01/01	01-02	01-02	
	HDD001-02	01/02	01-03	01-03	01-03
	HDD001-03	01/03	01-04	01-04	
	HDD001-04	01/04	01-05	01-05	01-05
	HDD001-05	01/05	01-06/Spare	01-06/Spare	01-05/Spare

THEORY05-1300

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)

(3/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-002	HDD002-00	02/00	01-01	01-01	01-01
	HDD002-01	02/01	01-02	01-02	
	HDD002-02	02/02	01-03	01-03	01-03
	HDD002-03	02/03	01-04	01-04	
	HDD002-04	02/04	01-05	01-05	01-05
	HDD002-05	02/05	01-06/Spare	01-06/Spare	01-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)

(4/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-003	HDD003-00	03/00	01-01	01-01	01-01
	HDD003-01	03/01	01-02	01-02	
	HDD003-02	03/02	01-03	01-03	01-03
	HDD003-03	03/03	01-04	01-04	
	HDD003-04	03/04	01-05	01-05	01-05
	HDD003-05	03/05	01-06/Spare	01-06/Spare	01-05/Spare

THEORY05-1310

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)

(5/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-004	HDD004-00	04/00	02-01	01-01	01-01
	HDD004-01	04/01	02-02	01-02	
	HDD004-02	04/02	02-03	01-03	01-03
	HDD004-03	04/03	02-04	01-04	
	HDD004-04	04/04	02-05	01-05	01-05
	HDD004-05	04/05	02-06/Spare	01-06/Spare	01-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)

(6/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-005	HDD005-00	05/00	02-01	01-01	01-01
	HDD005-01	05/01	02-02	01-02	
	HDD005-02	05/02	02-03	01-03	01-03
	HDD005-03	05/03	02-04	01-04	
	HDD005-04	05/04	02-05	01-05	01-05
	HDD005-05	05/05	02-06/Spare	01-06/Spare	01-05/Spare

THEORY05-1320

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (7/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-006	HDD006-00	06/00	02-01	01-01	01-01
	HDD006-01	06/01	02-02	01-02	
	HDD006-02	06/02	02-03	01-03	01-03
	HDD006-03	06/03	02-04	01-04	
	HDD006-04	06/04	02-05	01-05	01-05
	HDD006-05	06/05	02-06/Spare	01-06/Spare	01-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (8/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-007	HDD007-00	07/00	02-01	01-01	01-01
	HDD007-01	07/01	02-02	01-02	
	HDD007-02	07/02	02-03	01-03	01-03
	HDD007-03	07/03	02-04	01-04	
	HDD007-04	07/04	02-05	01-05	01-05
	HDD007-05	07/05	02-06/Spare	01-06/Spare	01-05/Spare

THEORY05-1330

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (9/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-100	HDD100-00	08/00	03-01	03-01	03-01
	HDD100-01	08/01	03-02	03-02	
	HDD100-02	08/02	03-03	03-03	03-03
	HDD100-03	08/03	03-04	03-04	
	HDD100-04	08/04	03-05	03-05	03-05
	HDD100-05	08/05	03-06/Spare	03-06/Spare	03-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (10/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-101	HDD101-00	09/00	03-01	03-01	03-01
	HDD101-01	09/01	03-02	03-02	
	HDD101-02	09/02	03-03	03-03	03-03
	HDD101-03	09/03	03-04	03-04	
	HDD101-04	09/04	03-05	03-05	03-05
	HDD101-05	09/05	03-06/Spare	03-06/Spare	03-05/Spare

THEORY05-1340

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (11/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-102	HDD102-00	0A/00	03-01	03-01	03-01
	HDD102-01	0A/01	03-02	03-02	
	HDD102-02	0A/02	03-03	03-03	03-03
	HDD102-03	0A/03	03-04	03-04	
	HDD102-04	0A/04	03-05	03-05	03-05
	HDD102-05	0A/05	03-06/Spare	03-06/Spare	03-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (12/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-103	HDD103-00	0B/00	03-01	03-01	03-01
	HDD103-01	0B/01	03-02	03-02	
	HDD103-02	0B/02	03-03	03-03	03-03
	HDD103-03	0B/03	03-04	03-04	
	HDD103-04	0B/04	03-05	03-05	03-05
	HDD103-05	0B/05	03-06/Spare	03-06/Spare	03-05/Spare

THEORY05-1350

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (13/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-104	HDD104-00	0C/00	04-01	03-01	03-01
	HDD104-01	0C/01	04-02	03-02	
	HDD104-02	0C/02	04-03	03-03	03-03
	HDD104-03	0C/03	04-04	03-04	
	HDD104-04	0C/04	04-05	03-05	03-05
	HDD104-05	0C/05	04-06/Spare	03-06/Spare	03-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (14/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-105	HDD105-00	0D/00	04-01	03-01	03-01
	HDD105-01	0D/01	04-02	03-02	
	HDD105-02	0D/02	04-03	03-03	03-03
	HDD105-03	0D/03	04-04	03-04	
	HDD105-04	0D/04	04-05	03-05	03-05
	HDD105-05	0D/05	04-06/Spare	03-06/Spare	03-05/Spare

THEORY05-1360

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (15/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-106	HDD106-00	0E/00	04-01	03-01	03-01
	HDD106-01	0E/01	04-02	03-02	
	HDD106-02	0E/02	04-03	03-03	03-03
	HDD106-03	0E/03	04-04	03-04	
	HDD106-04	0E/04	04-05	03-05	03-05
	HDD106-05	0E/05	04-06/Spare	03-06/Spare	03-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (16/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-107	HDD107-00	0F/00	04-01	03-01	03-01
	HDD107-01	0F/01	04-02	03-02	
	HDD107-02	0F/02	04-03	03-03	03-03
	HDD107-03	0F/03	04-04	03-04	
	HDD107-04	0F/04	04-05	03-05	03-05
	HDD107-05	0F/05	04-06/Spare	03-06/Spare	03-05/Spare

THEORY05-1370

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (17/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-010	HDD010-00	00/10	05-01	05-01	05-01
	HDD010-01	00/11	05-02	05-02	
	HDD010-02	00/12	05-03	05-03	05-03
	HDD010-03	00/13	05-04	05-04	
	HDD010-04	00/14	05-05	05-05	05-05
	HDD010-05	00/15	05-06/Spare	05-06/Spare	05-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (18/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-011	HDD011-00	01/10	05-01	05-01	05-01
	HDD011-01	01/11	05-02	05-02	
	HDD011-02	01/12	05-03	05-03	05-03
	HDD011-03	01/13	05-04	05-04	
	HDD011-04	01/14	05-05	05-05	05-05
	HDD011-05	01/15	05-06/Spare	05-06/Spare	05-05/Spare

THEORY05-1380

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (19/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-012	HDD012-00	02/10	05-01	05-01	05-01
	HDD012-01	02/11	05-02	05-02	
	HDD012-02	02/12	05-03	05-03	05-03
	HDD012-03	02/13	05-04	05-04	
	HDD012-04	02/14	05-05	05-05	05-05
	HDD012-05	02/15	05-06/Spare	05-06/Spare	05-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (20/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-013	HDD013-00	03/10	05-01	05-01	05-01
	HDD013-01	03/11	05-02	05-02	
	HDD013-02	03/12	05-03	05-03	05-03
	HDD013-03	03/13	05-04	05-04	
	HDD013-04	03/14	05-05	05-05	05-05
	HDD013-05	03/15	05-06/Spare	05-06/Spare	05-05/Spare

THEORY05-1390

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (21/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-014	HDD014-00	04/10	06-01	05-01	05-01
	HDD014-01	04/11	06-02	05-02	
	HDD014-02	04/12	06-03	05-03	05-03
	HDD014-03	04/13	06-04	05-04	
	HDD014-04	04/14	06-05	05-05	05-05
	HDD014-05	04/15	06-06/Spare	05-06/Spare	05-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (22/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-015	HDD015-00	05/10	06-01	05-01	05-01
	HDD015-01	05/11	06-02	05-02	
	HDD015-02	05/12	06-03	05-03	05-03
	HDD015-03	05/13	06-04	05-04	
	HDD015-04	05/14	06-05	05-05	05-05
	HDD015-05	05/15	06-06/Spare	05-06/Spare	05-05/Spare

THEORY05-1400

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (23/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-016	HDD016-00	06/10	06-01	05-01	05-01
	HDD016-01	06/11	06-02	05-02	
	HDD016-02	06/12	06-03	05-03	05-03
	HDD016-03	06/13	06-04	05-04	
	HDD016-04	06/14	06-05	05-05	05-05
	HDD016-05	06/15	06-06/Spare	05-06/Spare	05-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (24/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-017	HDD017-00	07/10	06-01	05-01	05-01
	HDD017-01	07/11	06-02	05-02	
	HDD017-02	07/12	06-03	05-03	05-03
	HDD017-03	07/13	06-04	05-04	
	HDD017-04	07/14	06-05	05-05	05-05
	HDD017-05	07/15	06-06/Spare	05-06/Spare	05-05/Spare

THEORY05-1410

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (25/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-110	HDD110-00	08/10	07-01	07-01	07-01
	HDD110-01	08/11	07-02	07-02	
	HDD110-02	08/12	07-03	07-03	07-03
	HDD110-03	08/13	07-04	07-04	
	HDD110-04	08/14	07-05	07-05	07-05
	HDD110-05	08/15	07-06/Spare	07-06/Spare	07-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (26/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-111	HDD111-00	09/10	07-01	07-01	07-01
	HDD111-01	09/11	07-02	07-02	
	HDD111-02	09/12	07-03	07-03	07-03
	HDD111-03	09/13	07-04	07-04	
	HDD111-04	09/14	07-05	07-05	07-05
	HDD111-05	09/15	07-06/Spare	07-06/Spare	07-05/Spare

THEORY05-1420

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (27/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-112	HDD112-00	0A/10	07-01	07-01	07-01
	HDD112-01	0A/11	07-02	07-02	
	HDD112-02	0A/12	07-03	07-03	07-03
	HDD112-03	0A/13	07-04	07-04	
	HDD112-04	0A/14	07-05	07-05	07-05
	HDD112-05	0A/15	07-06/Spare	07-06/Spare	07-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (28/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-113	HDD113-00	0B/10	07-01	07-01	07-01
	HDD113-01	0B/11	07-02	07-02	
	HDD113-02	0B/12	07-03	07-03	07-03
	HDD113-03	0B/13	07-04	07-04	
	HDD113-04	0B/14	07-05	07-05	07-05
	HDD113-05	0B/15	07-06/Spare	07-06/Spare	07-05/Spare

THEORY05-1430

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (29/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-114	HDD114-00	0C/10	08-01	07-01	07-01
	HDD114-01	0C/11	08-02	07-02	
	HDD114-02	0C/12	08-03	07-03	07-03
	HDD114-03	0C/13	08-04	07-04	
	HDD114-04	0C/14	08-05	07-05	07-05
	HDD114-05	0C/15	08-06/Spare	07-06/Spare	07-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (30/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-115	HDD115-00	0D/10	08-01	07-01	07-01
	HDD115-01	0D/11	08-02	07-02	
	HDD115-02	0D/12	08-03	07-03	07-03
	HDD115-03	0D/13	08-04	07-04	
	HDD115-04	0D/14	08-05	07-05	07-05
	HDD115-05	0D/15	08-06/Spare	07-06/Spare	07-05/Spare

THEORY05-1440

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (31/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-116	HDD116-00	0E/10	08-01	07-01	07-01
	HDD116-01	0E/11	08-02	07-02	
	HDD116-02	0E/12	08-03	07-03	07-03
	HDD116-03	0E/13	08-04	07-04	
	HDD116-04	0E/14	08-05	07-05	07-05
	HDD116-05	0E/15	08-06/Spare	07-06/Spare	07-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (32/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-117	HDD117-00	0F/10	08-01	07-01	07-01
	HDD117-01	0F/11	08-02	07-02	
	HDD117-02	0F/12	08-03	07-03	07-03
	HDD117-03	0F/13	08-04	07-04	
	HDD117-04	0F/14	08-05	07-05	07-05
	HDD117-05	0F/15	08-06/Spare	07-06/Spare	07-05/Spare

THEORY05-1450

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (33/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-020	HDD020-00	00/20	09-01	09-01	09-01
	HDD020-01	00/21	09-02	09-02	
	HDD020-02	00/22	09-03	09-03	09-03
	HDD020-03	00/23	09-04	09-04	
	HDD020-04	00/24	09-05	09-05	09-05
	HDD020-05	00/25	09-06/Spare	09-06/Spare	09-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (34/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-021	HDD021-00	01/20	09-01	09-01	09-01
	HDD021-01	01/21	09-02	09-02	
	HDD021-02	01/22	09-03	09-03	09-03
	HDD021-03	01/23	09-04	09-04	
	HDD021-04	01/24	09-05	09-05	09-05
	HDD021-05	01/25	09-06/Spare	09-06/Spare	09-05/Spare

THEORY05-1460

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (35/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-022	HDD022-00	02/20	09-01	09-01	09-01
	HDD022-01	02/21	09-02	09-02	
	HDD022-02	02/22	09-03	09-03	09-03
	HDD022-03	02/23	09-04	09-04	
	HDD022-04	02/24	09-05	09-05	09-05
	HDD022-05	02/25	09-06/Spare	09-06/Spare	09-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (36/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-023	HDD023-00	03/20	09-01	09-01	09-01
	HDD023-01	03/21	09-02	09-02	
	HDD023-02	03/22	09-03	09-03	09-03
	HDD023-03	03/23	09-04	09-04	
	HDD023-04	03/24	09-05	09-05	09-05
	HDD023-05	03/25	09-06/Spare	09-06/Spare	09-05/Spare

THEORY05-1470

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (37/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-024	HDD024-00	04/20	10-01	09-01	09-01
	HDD024-01	04/21	10-02	09-02	
	HDD024-02	04/22	10-03	09-03	09-03
	HDD024-03	04/23	10-04	09-04	
	HDD024-04	04/24	10-05	09-05	09-05
	HDD024-05	04/25	10-06/Spare	09-06/Spare	09-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (38/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-025	HDD025-00	05/20	10-01	09-01	09-01
	HDD025-01	05/21	10-02	09-02	
	HDD025-02	05/22	10-03	09-03	09-03
	HDD025-03	05/23	10-04	09-04	
	HDD025-04	05/24	10-05	09-05	09-05
	HDD025-05	05/25	10-06/Spare	09-06/Spare	09-05/Spare

THEORY05-1480

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (39/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-026	HDD026-00	06/20	10-01	09-01	09-01
	HDD026-01	06/21	10-02	09-02	
	HDD026-02	06/22	10-03	09-03	09-03
	HDD026-03	06/23	10-04	09-04	
	HDD026-04	06/24	10-05	09-05	09-05
	HDD026-05	06/25	10-06/Spare	09-06/Spare	09-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (40/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-027	HDD027-00	07/20	10-01	09-01	09-01
	HDD027-01	07/21	10-02	09-02	
	HDD027-02	07/22	10-03	09-03	09-03
	HDD027-03	07/23	10-04	09-04	
	HDD027-04	07/24	10-05	09-05	09-05
	HDD027-05	07/25	10-06/Spare	09-06/Spare	09-05/Spare

THEORY05-1490

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (41/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-120	HDD120-00	08/20	11-01	11-01	11-01
	HDD120-01	08/21	11-02	11-02	
	HDD120-02	08/22	11-03	11-03	11-03
	HDD120-03	08/23	11-04	11-04	
	HDD120-04	08/24	11-05	11-05	11-05
	HDD120-05	08/25	11-06/Spare	11-06/Spare	11-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (42/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-121	HDD121-00	09/20	11-01	11-01	11-01
	HDD121-01	09/21	11-02	11-02	
	HDD121-02	09/22	11-03	11-03	11-03
	HDD121-03	09/23	11-04	11-04	
	HDD121-04	09/24	11-05	11-05	11-05
	HDD121-05	09/25	11-06/Spare	11-06/Spare	11-05/Spare

THEORY05-1500

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (43/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-122	HDD122-00	0A/20	11-01	11-01	11-01
	HDD122-01	0A/21	11-02	11-02	
	HDD122-02	0A/22	11-03	11-03	11-03
	HDD122-03	0A/23	11-04	11-04	
	HDD122-04	0A/24	11-05	11-05	11-05
	HDD122-05	0A/25	11-06/Spare	11-06/Spare	11-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (44/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-123	HDD123-00	0B/20	11-01	11-01	11-01
	HDD123-01	0B/21	11-02	11-02	
	HDD123-02	0B/22	11-03	11-03	11-03
	HDD123-03	0B/23	11-04	11-04	
	HDD123-04	0B/24	11-05	11-05	11-05
	HDD123-05	0B/25	11-06/Spare	11-06/Spare	11-05/Spare

THEORY05-1510

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (45/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-124	HDD124-00	0C/20	12-01	11-01	11-01
	HDD124-01	0C/21	12-02	11-02	
	HDD124-02	0C/22	12-03	11-03	11-03
	HDD124-03	0C/23	12-04	11-04	
	HDD124-04	0C/24	12-05	11-05	11-05
	HDD124-05	0C/25	12-06/Spare	11-06/Spare	11-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (46/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-125	HDD125-00	0D/20	12-01	11-01	11-01
	HDD125-01	0D/21	12-02	11-02	
	HDD125-02	0D/22	12-03	11-03	11-03
	HDD125-03	0D/23	12-04	11-04	
	HDD125-04	0D/24	12-05	11-05	11-05
	HDD125-05	0D/25	12-06/Spare	11-06/Spare	11-05/Spare

THEORY05-1520

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (47/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-126	HDD126-00	0E/20	12-01	11-01	11-01
	HDD126-01	0E/21	12-02	11-02	
	HDD126-02	0E/22	12-03	11-03	11-03
	HDD126-03	0E/23	12-04	11-04	
	HDD126-04	0E/24	12-05	11-05	11-05
	HDD126-05	0E/25	12-06/Spare	11-06/Spare	11-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (48/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-127	HDD127-00	0F/20	12-01	11-01	11-01
	HDD127-01	0F/21	12-02	11-02	
	HDD127-02	0F/22	12-03	11-03	11-03
	HDD127-03	0F/23	12-04	11-04	
	HDD127-04	0F/24	12-05	11-05	11-05
	HDD127-05	0F/25	12-06/Spare	11-06/Spare	11-05/Spare

THEORY05-1530

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (49/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-030	HDD030-00	00/30	13-01	13-01	13-01
	HDD030-01	00/31	13-02	13-02	
	HDD030-02	00/32	13-03	13-03	13-03
	HDD030-03	00/33	13-04	13-04	
	HDD030-04	00/34	13-05	13-05	13-05
	HDD030-05	00/35	13-06/Spare	13-06/Spare	13-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (50/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-031	HDD031-00	01/30	13-01	13-01	13-01
	HDD031-01	01/31	13-02	13-02	
	HDD031-02	01/32	13-03	13-03	13-03
	HDD031-03	01/33	13-04	13-04	
	HDD031-04	01/34	13-05	13-05	13-05
	HDD031-05	01/35	13-06/Spare	13-06/Spare	13-05/Spare

THEORY05-1540

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (51/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-032	HDD032-00	02/30	13-01	13-01	13-01
	HDD032-01	02/31	13-02	13-02	
	HDD032-02	02/32	13-03	13-03	13-03
	HDD032-03	02/33	13-04	13-04	
	HDD032-04	02/34	13-05	13-05	13-05
	HDD032-05	02/35	13-06/Spare	13-06/Spare	13-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (52/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-033	HDD033-00	03/30	13-01	13-01	13-01
	HDD033-01	03/31	13-02	13-02	
	HDD033-02	03/32	13-03	13-03	13-03
	HDD033-03	03/33	13-04	13-04	
	HDD033-04	03/34	13-05	13-05	13-05
	HDD033-05	03/35	13-06/Spare	13-06/Spare	13-05/Spare

THEORY05-1550

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (53/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-034	HDD034-00	04/30	14-01	13-01	13-01
	HDD034-01	04/31	14-02	13-02	
	HDD034-02	04/32	14-03	13-03	13-03
	HDD034-03	04/33	14-04	13-04	
	HDD034-04	04/34	14-05	13-05	13-05
	HDD034-05	04/35	14-06/Spare	13-06/Spare	13-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (54/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-035	HDD035-00	05/30	14-01	13-01	13-01
	HDD035-01	05/31	14-02	13-02	
	HDD035-02	05/32	14-03	13-03	13-03
	HDD035-03	05/33	14-04	13-04	
	HDD035-04	05/34	14-05	13-05	13-05
	HDD035-05	05/35	14-06/Spare	13-06/Spare	13-05/Spare

THEORY05-1560

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (55/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-036	HDD036-00	06/30	14-01	13-01	13-01
	HDD036-01	06/31	14-02	13-02	
	HDD036-02	06/32	14-03	13-03	13-03
	HDD036-03	06/33	14-04	13-04	
	HDD036-04	06/34	14-05	13-05	13-05
	HDD036-05	06/35	14-06/Spare	13-06/Spare	13-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (56/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-037	HDD037-00	07/30	14-01	13-01	13-01
	HDD037-01	07/31	14-02	13-02	
	HDD037-02	07/32	14-03	13-03	13-03
	HDD037-03	07/33	14-04	13-04	
	HDD037-04	07/34	14-05	13-05	13-05
	HDD037-05	07/35	14-06/Spare	13-06/Spare	13-05/Spare

THEORY05-1570

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (57/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-130	HDD130-00	08/30	15-01	15-01	15-01
	HDD130-01	08/31	15-02	15-02	
	HDD130-02	08/32	15-03	15-03	15-03
	HDD130-03	08/33	15-04	15-04	
	HDD130-04	08/34	15-05	15-05	15-05
	HDD130-05	08/35	15-06/Spare	15-06/Spare	15-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (58/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-131	HDD131-00	09/30	15-01	15-01	15-01
	HDD131-01	09/31	15-02	15-02	
	HDD131-02	09/32	15-03	15-03	15-03
	HDD131-03	09/33	15-04	15-04	
	HDD131-04	09/34	15-05	15-05	15-05
	HDD131-05	09/35	15-06/Spare	15-06/Spare	15-05/Spare

THEORY05-1580

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (59/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-132	HDD132-00	0A/30	15-01	15-01	15-01
	HDD132-01	0A/31	15-02	15-02	
	HDD132-02	0A/32	15-03	15-03	15-03
	HDD132-03	0A/33	15-04	15-04	
	HDD132-04	0A/34	15-05	15-05	15-05
	HDD132-05	0A/35	15-06/Spare	15-06/Spare	15-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (60/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-133	HDD133-00	0B/30	15-01	15-01	15-01
	HDD133-01	0B/31	15-02	15-02	
	HDD133-02	0B/32	15-03	15-03	15-03
	HDD133-03	0B/33	15-04	15-04	
	HDD133-04	0B/34	15-05	15-05	15-05
	HDD133-05	0B/35	15-06/Spare	15-06/Spare	15-05/Spare

THEORY05-1590

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (61/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-134	HDD134-00	0C/30	16-01	15-01	15-01
	HDD134-01	0C/31	16-02	15-02	
	HDD134-02	0C/32	16-03	15-03	15-03
	HDD134-03	0C/33	16-04	15-04	
	HDD134-04	0C/34	16-05	15-05	15-05
	HDD134-05	0C/35	16-06/Spare	15-06/Spare	15-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (62/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-135	HDD135-00	0D/30	16-01	15-01	15-01
	HDD135-01	0D/31	16-02	15-02	
	HDD135-02	0D/32	16-03	15-03	15-03
	HDD135-03	0D/33	16-04	15-04	
	HDD135-04	0D/34	16-05	15-05	15-05
	HDD135-05	0D/35	16-06/Spare	15-06/Spare	15-05/Spare

THEORY05-1600

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (63/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-136	HDD136-00	0E/30	16-01	15-01	15-01
	HDD136-01	0E/31	16-02	15-02	
	HDD136-02	0E/32	16-03	15-03	15-03
	HDD136-03	0E/33	16-04	15-04	
	HDD136-04	0E/34	16-05	15-05	15-05
	HDD136-05	0E/35	16-06/Spare	15-06/Spare	15-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (64/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-137	HDD137-00	0F/30	16-01	15-01	15-01
	HDD137-01	0F/31	16-02	15-02	
	HDD137-02	0F/32	16-03	15-03	15-03
	HDD137-03	0F/33	16-04	15-04	
	HDD137-04	0F/34	16-05	15-05	15-05
	HDD137-05	0F/35	16-06/Spare	15-06/Spare	15-05/Spare

THEORY05-1610

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (65/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-040	HDD040-00	00/40	17-01	17-01	17-01
	HDD040-01	00/41	17-02	17-02	
	HDD040-02	00/42	17-03	17-03	17-03
	HDD040-03	00/43	17-04	17-04	
	HDD040-04	00/44	17-05	17-05	17-05
	HDD040-05	00/45	17-06/Spare	17-06/Spare	17-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (66/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-041	HDD041-00	01/40	17-01	17-01	17-01
	HDD041-01	01/41	17-02	17-02	
	HDD041-02	01/42	17-03	17-03	17-03
	HDD041-03	01/43	17-04	17-04	
	HDD041-04	01/44	17-05	17-05	17-05
	HDD041-05	01/45	17-06/Spare	17-06/Spare	17-05/Spare

THEORY05-1620

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (67/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-042	HDD042-00	02/40	17-01	17-01	17-01
	HDD042-01	02/41	17-02	17-02	
	HDD042-02	02/42	17-03	17-03	17-03
	HDD042-03	02/43	17-04	17-04	
	HDD042-04	02/44	17-05	17-05	17-05
	HDD042-05	02/45	17-06/Spare	17-06/Spare	17-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (68/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-043	HDD043-00	03/40	17-01	17-01	17-01
	HDD043-01	03/41	17-02	17-02	
	HDD043-02	03/42	17-03	17-03	17-03
	HDD043-03	03/43	17-04	17-04	
	HDD043-04	03/44	17-05	17-05	17-05
	HDD043-05	03/45	17-06/Spare	17-06/Spare	17-05/Spare

THEORY05-1630

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (69/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-044	HDD044-00	04/40	18-01	17-01	17-01
	HDD044-01	04/41	18-02	17-02	
	HDD044-02	04/42	18-03	17-03	17-03
	HDD044-03	04/43	18-04	17-04	
	HDD044-04	04/44	18-05	17-05	17-05
	HDD044-05	04/45	18-06/Spare	17-06/Spare	17-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (70/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-045	HDD045-00	05/40	18-01	17-01	17-01
	HDD045-01	05/41	18-02	17-02	
	HDD045-02	05/42	18-03	17-03	17-03
	HDD045-03	05/43	18-04	17-04	
	HDD045-04	05/44	18-05	17-05	17-05
	HDD045-05	05/45	18-06/Spare	17-06/Spare	17-05/Spare

THEORY05-1640

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (71/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-046	HDD046-00	06/40	18-01	17-01	17-01
	HDD046-01	06/41	18-02	17-02	
	HDD046-02	06/42	18-03	17-03	17-03
	HDD046-03	06/43	18-04	17-04	
	HDD046-04	06/44	18-05	17-05	17-05
	HDD046-05	06/45	18-06/Spare	17-06/Spare	17-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (72/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-047	HDD047-00	07/40	18-01	17-01	17-01
	HDD047-01	07/41	18-02	17-02	
	HDD047-02	07/42	18-03	17-03	17-03
	HDD047-03	07/43	18-04	17-04	
	HDD047-04	07/44	18-05	17-05	17-05
	HDD047-05	07/45	18-06/Spare	17-06/Spare	17-05/Spare

THEORY05-1650

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (73/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-140	HDD140-00	08/40	19-01	19-01	19-01
	HDD140-01	08/41	19-02	19-02	
	HDD140-02	08/42	19-03	19-03	19-03
	HDD140-03	08/43	19-04	19-04	
	HDD140-04	08/44	19-05	19-05	19-05
	HDD140-05	08/45	19-06/Spare	19-06/Spare	19-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (74/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-141	HDD141-00	09/40	19-01	19-01	19-01
	HDD141-01	09/41	19-02	19-02	
	HDD141-02	09/42	19-03	19-03	19-03
	HDD141-03	09/43	19-04	19-04	
	HDD141-04	09/44	19-05	19-05	19-05
	HDD141-05	09/45	19-06/Spare	19-06/Spare	19-05/Spare

THEORY05-1660

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (75/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-142	HDD142-00	0A/40	19-01	19-01	19-01
	HDD142-01	0A/41	19-02	19-02	
	HDD142-02	0A/42	19-03	19-03	19-03
	HDD142-03	0A/43	19-04	19-04	
	HDD142-04	0A/44	19-05	19-05	19-05
	HDD142-05	0A/45	19-06/Spare	19-06/Spare	19-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (76/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-143	HDD143-00	0B/40	19-01	19-01	19-01
	HDD143-01	0B/41	19-02	19-02	
	HDD143-02	0B/42	19-03	19-03	19-03
	HDD143-03	0B/43	19-04	19-04	
	HDD143-04	0B/44	19-05	19-05	19-05
	HDD143-05	0B/45	19-06/Spare	19-06/Spare	19-05/Spare

THEORY05-1670

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (77/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-144	HDD144-00	0C/40	20-01	19-01	19-01
	HDD144-01	0C/41	20-02	19-02	
	HDD144-02	0C/42	20-03	19-03	19-03
	HDD144-03	0C/43	20-04	19-04	
	HDD144-04	0C/44	20-05	19-05	19-05
	HDD144-05	0C/45	20-06/Spare	19-06/Spare	19-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (78/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-145	HDD145-00	0D/40	20-01	19-01	19-01
	HDD145-01	0D/41	20-02	19-02	
	HDD145-02	0D/42	20-03	19-03	19-03
	HDD145-03	0D/43	20-04	19-04	
	HDD145-04	0D/44	20-05	19-05	19-05
	HDD145-05	0D/45	20-06/Spare	19-06/Spare	19-05/Spare

THEORY05-1680

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (79/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-146	HDD146-00	0E/40	20-01	19-01	19-01
	HDD146-01	0E/41	20-02	19-02	
	HDD146-02	0E/42	20-03	19-03	19-03
	HDD146-03	0E/43	20-04	19-04	
	HDD146-04	0E/44	20-05	19-05	19-05
	HDD146-05	0E/45	20-06/Spare	19-06/Spare	19-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (80/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-147	HDD147-00	0F/40	20-01	19-01	19-01
	HDD147-01	0F/41	20-02	19-02	
	HDD147-02	0F/42	20-03	19-03	19-03
	HDD147-03	0F/43	20-04	19-04	
	HDD147-04	0F/44	20-05	19-05	19-05
	HDD147-05	0F/45	20-06/Spare	19-06/Spare	19-05/Spare

THEORY05-1690

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (81/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-050	HDD050-00	00/50	21-01	21-01	21-01
	HDD050-01	00/51	21-02	21-02	
	HDD050-02	00/52	21-03	21-03	21-03
	HDD050-03	00/53	21-04	21-04	
	HDD050-04	00/54	21-05	21-05	21-05
	HDD050-05	00/55	21-06/Spare	21-06/Spare	21-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (82/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-051	HDD051-00	01/50	21-01	21-01	21-01
	HDD051-01	01/51	21-02	21-02	
	HDD051-02	01/52	21-03	21-03	21-03
	HDD051-03	01/53	21-04	21-04	
	HDD051-04	01/54	21-05	21-05	21-05
	HDD051-05	01/55	21-06/Spare	21-06/Spare	21-05/Spare

THEORY05-1700

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (83/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-052	HDD052-00	02/50	21-01	21-01	21-01
	HDD052-01	02/51	21-02	21-02	
	HDD052-02	02/52	21-03	21-03	21-03
	HDD052-03	02/53	21-04	21-04	
	HDD052-04	02/54	21-05	21-05	21-05
	HDD052-05	02/55	21-06/Spare	21-06/Spare	21-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (84/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-053	HDD053-00	03/50	21-01	21-01	21-01
	HDD053-01	03/51	21-02	21-02	
	HDD053-02	03/52	21-03	21-03	21-03
	HDD053-03	03/53	21-04	21-04	
	HDD053-04	03/54	21-05	21-05	21-05
	HDD053-05	03/55	21-06/Spare	21-06/Spare	21-05/Spare

THEORY05-1710

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (85/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-054	HDD054-00	04/50	22-01	21-01	21-01
	HDD054-01	04/51	22-02	21-02	
	HDD054-02	04/52	22-03	21-03	21-03
	HDD054-03	04/53	22-04	21-04	
	HDD054-04	04/54	22-05	21-05	21-05
	HDD054-05	04/55	22-06/Spare	21-06/Spare	21-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (86/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-055	HDD055-00	05/50	22-01	21-01	21-01
	HDD055-01	05/51	22-02	21-02	
	HDD055-02	05/52	22-03	21-03	21-03
	HDD055-03	05/53	22-04	21-04	
	HDD055-04	05/54	22-05	21-05	21-05
	HDD055-05	05/55	22-06/Spare	21-06/Spare	21-05/Spare

THEORY05-1720

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (87/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-056	HDD056-00	06/50	22-01	21-01	21-01
	HDD056-01	06/51	22-02	21-02	
	HDD056-02	06/52	22-03	21-03	21-03
	HDD056-03	06/53	22-04	21-04	
	HDD056-04	06/54	22-05	21-05	21-05
	HDD056-05	06/55	22-06/Spare	21-06/Spare	21-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (88/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-057	HDD057-00	07/50	22-01	21-01	21-01
	HDD057-01	07/51	22-02	21-02	
	HDD057-02	07/52	22-03	21-03	21-03
	HDD057-03	07/53	22-04	21-04	
	HDD057-04	07/54	22-05	21-05	21-05
	HDD057-05	07/55	22-06/Spare	21-06/Spare	21-05/Spare

THEORY05-1730

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (89/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-150	HDD150-00	08/50	23-01	23-01	23-01
	HDD150-01	08/51	23-02	23-02	
	HDD150-02	08/52	23-03	23-03	23-03
	HDD150-03	08/53	23-04	23-04	
	HDD150-04	08/54	23-05	23-05	23-05
	HDD150-05	08/55	23-06/Spare	23-06/Spare	23-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (90/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-151	HDD151-00	09/50	23-01	23-01	23-01
	HDD151-01	09/51	23-02	23-02	
	HDD151-02	09/52	23-03	23-03	23-03
	HDD151-03	09/53	23-04	23-04	
	HDD151-04	09/54	23-05	23-05	23-05
	HDD151-05	09/55	23-06/Spare	23-06/Spare	23-05/Spare

THEORY05-1740

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (91/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-152	HDD152-00	0A/50	23-01	23-01	23-01
	HDD152-01	0A/51	23-02	23-02	
	HDD152-02	0A/52	23-03	23-03	23-03
	HDD152-03	0A/53	23-04	23-04	
	HDD152-04	0A/54	23-05	23-05	23-05
	HDD152-05	0A/55	23-06/Spare	23-06/Spare	23-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (92/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-153	HDD153-00	0B/50	23-01	23-01	23-01
	HDD153-01	0B/51	23-02	23-02	
	HDD153-02	0B/52	23-03	23-03	23-03
	HDD153-03	0B/53	23-04	23-04	
	HDD153-04	0B/54	23-05	23-05	23-05
	HDD153-05	0B/55	23-06/Spare	23-06/Spare	23-05/Spare

THEORY05-1750

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (93/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-154	HDD154-00	0C/50	24-01	23-01	23-01
	HDD154-01	0C/51	24-02	23-02	
	HDD154-02	0C/52	24-03	23-03	23-03
	HDD154-03	0C/53	24-04	23-04	
	HDD154-04	0C/54	24-05	23-05	23-05
	HDD154-05	0C/55	24-06/Spare	23-06/Spare	23-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (94/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-155	HDD155-00	0D/50	24-01	23-01	23-01
	HDD155-01	0D/51	24-02	23-02	
	HDD155-02	0D/52	24-03	23-03	23-03
	HDD155-03	0D/53	24-04	23-04	
	HDD155-04	0D/54	24-05	23-05	23-05
	HDD155-05	0D/55	24-06/Spare	23-06/Spare	23-05/Spare

THEORY05-1760

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (95/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-156	HDD156-00	0E/50	24-01	23-01	23-01
	HDD156-01	0E/51	24-02	23-02	
	HDD156-02	0E/52	24-03	23-03	23-03
	HDD156-03	0E/53	24-04	23-04	
	HDD156-04	0E/54	24-05	23-05	23-05
	HDD156-05	0E/55	24-06/Spare	23-06/Spare	23-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (96/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-157	HDD157-00	0F/50	24-01	23-01	23-01
	HDD157-01	0F/51	24-02	23-02	
	HDD157-02	0F/52	24-03	23-03	23-03
	HDD157-03	0F/53	24-04	23-04	
	HDD157-04	0F/54	24-05	23-05	23-05
	HDD157-05	0F/55	24-06/Spare	23-06/Spare	23-05/Spare

THEORY05-1770

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (97/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-060	HDD060-00	00/60	25-01	25-01	25-01
	HDD060-01	00/61	25-02	25-02	
	HDD060-02	00/62	25-03	25-03	25-03
	HDD060-03	00/63	25-04	25-04	
	HDD060-04	00/64	25-05	25-05	25-05
	HDD060-05	00/65	25-06/Spare	25-06/Spare	25-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (98/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-061	HDD061-00	01/60	25-01	25-01	25-01
	HDD061-01	01/61	25-02	25-02	
	HDD061-02	01/62	25-03	25-03	25-03
	HDD061-03	01/63	25-04	25-04	
	HDD061-04	01/64	25-05	25-05	25-05
	HDD061-05	01/65	25-06/Spare	25-06/Spare	25-05/Spare

THEORY05-1780

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (99/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-062	HDD062-00	02/60	25-01	25-01	25-01
	HDD062-01	02/61	25-02	25-02	
	HDD062-02	02/62	25-03	25-03	25-03
	HDD062-03	02/63	25-04	25-04	
	HDD062-04	02/64	25-05	25-05	25-05
	HDD062-05	02/65	25-06/Spare	25-06/Spare	25-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (100/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-063	HDD063-00	03/60	25-01	25-01	25-01
	HDD063-01	03/61	25-02	25-02	
	HDD063-02	03/62	25-03	25-03	25-03
	HDD063-03	03/63	25-04	25-04	
	HDD063-04	03/64	25-05	25-05	25-05
	HDD063-05	03/65	25-06/Spare	25-06/Spare	25-05/Spare

THEORY05-1790**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(101/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-064	HDD064-00	04/60	26-01	25-01	25-01
	HDD064-01	04/61	26-02	25-02	
	HDD064-02	04/62	26-03	25-03	25-03
	HDD064-03	04/63	26-04	25-04	
	HDD064-04	04/64	26-05	25-05	25-05
	HDD064-05	04/65	26-06/Spare	25-06/Spare	25-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(102/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-065	HDD065-00	05/60	26-01	25-01	25-01
	HDD065-01	05/61	26-02	25-02	
	HDD065-02	05/62	26-03	25-03	25-03
	HDD065-03	05/63	26-04	25-04	
	HDD065-04	05/64	26-05	25-05	25-05
	HDD065-05	05/65	26-06/Spare	25-06/Spare	25-05/Spare

THEORY05-1800

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (103/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-066	HDD066-00	06/60	26-01	25-01	25-01
	HDD066-01	06/61	26-02	25-02	
	HDD066-02	06/62	26-03	25-03	25-03
	HDD066-03	06/63	26-04	25-04	
	HDD066-04	06/64	26-05	25-05	25-05
	HDD066-05	06/65	26-06/Spare	25-06/Spare	25-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (104/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-067	HDD067-00	07/60	26-01	25-01	25-01
	HDD067-01	07/61	26-02	25-02	
	HDD067-02	07/62	26-03	25-03	25-03
	HDD067-03	07/63	26-04	25-04	
	HDD067-04	07/64	26-05	25-05	25-05
	HDD067-05	07/65	26-06/Spare	25-06/Spare	25-05/Spare

THEORY05-1810

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (105/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-160	HDD160-00	08/60	27-01	27-01	27-01
	HDD160-01	08/61	27-02	27-02	
	HDD160-02	08/62	27-03	27-03	27-03
	HDD160-03	08/63	27-04	27-04	
	HDD160-04	08/64	27-05	27-05	27-05
	HDD160-05	08/65	27-06/Spare	27-06/Spare	27-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (106/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-161	HDD161-00	09/60	27-01	27-01	27-01
	HDD161-01	09/61	27-02	27-02	
	HDD161-02	09/62	27-03	27-03	27-03
	HDD161-03	09/63	27-04	27-04	
	HDD161-04	09/64	27-05	27-05	27-05
	HDD161-05	09/65	27-06/Spare	27-06/Spare	27-05/Spare

THEORY05-1820**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(107/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-162	HDD162-00	0A/60	27-01	27-01	27-01
	HDD162-01	0A/61	27-02	27-02	
	HDD162-02	0A/62	27-03	27-03	27-03
	HDD162-03	0A/63	27-04	27-04	
	HDD162-04	0A/64	27-05	27-05	27-05
	HDD162-05	0A/65	27-06/Spare	27-06/Spare	27-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(108/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-163	HDD163-00	0B/60	27-01	27-01	27-01
	HDD163-01	0B/61	27-02	27-02	
	HDD163-02	0B/62	27-03	27-03	27-03
	HDD163-03	0B/63	27-04	27-04	
	HDD163-04	0B/64	27-05	27-05	27-05
	HDD163-05	0B/65	27-06/Spare	27-06/Spare	27-05/Spare

THEORY05-1830

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (109/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-164	HDD164-00	0C/60	28-01	27-01	27-01
	HDD164-01	0C/61	28-02	27-02	
	HDD164-02	0C/62	28-03	27-03	27-03
	HDD164-03	0C/63	28-04	27-04	
	HDD164-04	0C/64	28-05	27-05	27-05
	HDD164-05	0C/65	28-06/Spare	27-06/Spare	27-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (110/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-165	HDD165-00	0D/60	28-01	27-01	27-01
	HDD165-01	0D/61	28-02	27-02	
	HDD165-02	0D/62	28-03	27-03	27-03
	HDD165-03	0D/63	28-04	27-04	
	HDD165-04	0D/64	28-05	27-05	27-05
	HDD165-05	0D/65	28-06/Spare	27-06/Spare	27-05/Spare

THEORY05-1840**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(111/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-166	HDD166-00	0E/60	28-01	27-01	27-01
	HDD166-01	0E/61	28-02	27-02	
	HDD166-02	0E/62	28-03	27-03	27-03
	HDD166-03	0E/63	28-04	27-04	
	HDD166-04	0E/64	28-05	27-05	27-05
	HDD166-05	0E/65	28-06/Spare	27-06/Spare	27-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(112/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-167	HDD167-00	0F/60	28-01	27-01	27-01
	HDD167-01	0F/61	28-02	27-02	
	HDD167-02	0F/62	28-03	27-03	27-03
	HDD167-03	0F/63	28-04	27-04	
	HDD167-04	0F/64	28-05	27-05	27-05
	HDD167-05	0F/65	28-06/Spare	27-06/Spare	27-05/Spare

THEORY05-1850**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(113/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-070	HDD070-00	00/70	29-01	29-01	29-01
	HDD070-01	00/71	29-02	29-02	
	HDD070-02	00/72	29-03	29-03	29-03
	HDD070-03	00/73	29-04	29-04	
	HDD070-04	00/74	29-05	29-05	29-05
	HDD070-05	00/75	29-06/Spare	29-06/Spare	29-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(114/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-071	HDD071-00	01/70	29-01	29-01	29-01
	HDD071-01	01/71	29-02	29-02	
	HDD071-02	01/72	29-03	29-03	29-03
	HDD071-03	01/73	29-04	29-04	
	HDD071-04	01/74	29-05	29-05	29-05
	HDD071-05	01/75	29-06/Spare	29-06/Spare	29-05/Spare

THEORY05-1860**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(115/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-072	HDD072-00	02/70	29-01	29-01	29-01
	HDD072-01	02/71	29-02	29-02	
	HDD072-02	02/72	29-03	29-03	29-03
	HDD072-03	02/73	29-04	29-04	
	HDD072-04	02/74	29-05	29-05	29-05
	HDD072-05	02/75	29-06/Spare	29-06/Spare	29-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(116/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-073	HDD073-00	03/70	29-01	29-01	29-01
	HDD073-01	03/71	29-02	29-02	
	HDD073-02	03/72	29-03	29-03	29-03
	HDD073-03	03/73	29-04	29-04	
	HDD073-04	03/74	29-05	29-05	29-05
	HDD073-05	03/75	29-06/Spare	29-06/Spare	29-05/Spare

THEORY05-1870**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(117/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-074	HDD074-00	04/70	30-01	29-01	29-01
	HDD074-01	04/71	30-02	29-02	
	HDD074-02	04/72	30-03	29-03	29-03
	HDD074-03	04/73	30-04	29-04	
	HDD074-04	04/74	30-05	29-05	29-05
	HDD074-05	04/75	30-06/Spare	29-06/Spare	29-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(118/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-075	HDD075-00	05/70	30-01	29-01	29-01
	HDD075-01	05/71	30-02	29-02	
	HDD075-02	05/72	30-03	29-03	29-03
	HDD075-03	05/73	30-04	29-04	
	HDD075-04	05/74	30-05	29-05	29-05
	HDD075-05	05/75	30-06/Spare	29-06/Spare	29-05/Spare

THEORY05-1880

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (119/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-076	HDD076-00	06/70	30-01	29-01	29-01
	HDD076-01	06/71	30-02	29-02	
	HDD076-02	06/72	30-03	29-03	29-03
	HDD076-03	06/73	30-04	29-04	
	HDD076-04	06/74	30-05	29-05	29-05
	HDD076-05	06/75	30-06/Spare	29-06/Spare	29-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU) (120/128)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-077	HDD077-00	07/70	30-01	29-01	29-01
	HDD077-01	07/71	30-02	29-02	
	HDD077-02	07/72	30-03	29-03	29-03
	HDD077-03	07/73	30-04	29-04	
	HDD077-04	07/74	30-05	29-05	29-05
	HDD077-05	07/75	30-06/Spare	29-06/Spare	29-05/Spare

THEORY05-1890**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(121/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-170	HDD170-00	08/70	31-01	31-01	31-01
	HDD170-01	08/71	31-02	31-02	
	HDD170-02	08/72	31-03	31-03	31-03
	HDD170-03	08/73	31-04	31-04	
	HDD170-04	08/74	31-05	31-05	31-05
	HDD170-05	08/75	31-06/Spare	31-06/Spare	31-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(122/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-171	HDD171-00	09/70	31-01	31-01	31-01
	HDD171-01	09/71	31-02	31-02	
	HDD171-02	09/72	31-03	31-03	31-03
	HDD171-03	09/73	31-04	31-04	
	HDD171-04	09/74	31-05	31-05	31-05
	HDD171-05	09/75	31-06/Spare	31-06/Spare	31-05/Spare

THEORY05-1900**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(123/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-172	HDD172-00	0A/70	31-01	31-01	31-01
	HDD172-01	0A/71	31-02	31-02	
	HDD172-02	0A/72	31-03	31-03	31-03
	HDD172-03	0A/73	31-04	31-04	
	HDD172-04	0A/74	31-05	31-05	31-05
	HDD172-05	0A/75	31-06/Spare	31-06/Spare	31-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(124/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-173	HDD173-00	0B/70	31-01	31-01	31-01
	HDD173-01	0B/71	31-02	31-02	
	HDD173-02	0B/72	31-03	31-03	31-03
	HDD173-03	0B/73	31-04	31-04	
	HDD173-04	0B/74	31-05	31-05	31-05
	HDD173-05	0B/75	31-06/Spare	31-06/Spare	31-05/Spare

THEORY05-1910**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(125/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-174	HDD174-00	0C/70	32-01	31-01	31-01
	HDD174-01	0C/71	32-02	31-02	
	HDD174-02	0C/72	32-03	31-03	31-03
	HDD174-03	0C/73	32-04	31-04	
	HDD174-04	0C/74	32-05	31-05	31-05
	HDD174-05	0C/75	32-06/Spare	31-06/Spare	31-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(126/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-175	HDD175-00	0D/70	32-01	31-01	31-01
	HDD175-01	0D/71	32-02	31-02	
	HDD175-02	0D/72	32-03	31-03	31-03
	HDD175-03	0D/73	32-04	31-04	
	HDD175-04	0D/74	32-05	31-05	31-05
	HDD175-05	0D/75	32-06/Spare	31-06/Spare	31-05/Spare

THEORY05-1920**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(127/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-176	HDD176-00	0E/70	32-01	31-01	31-01
	HDD176-01	0E/71	32-02	31-02	
	HDD176-02	0E/72	32-03	31-03	31-03
	HDD176-03	0E/73	32-04	31-04	
	HDD176-04	0E/74	32-05	31-05	31-05
	HDD176-05	0E/75	32-06/Spare	31-06/Spare	31-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FBX DKU)
(128/128)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-177	HDD177-00	0F/70	32-01	31-01	31-01
	HDD177-01	0F/71	32-02	31-02	
	HDD177-02	0F/72	32-03	31-03	31-03
	HDD177-03	0F/73	32-04	31-04	
	HDD177-04	0F/74	32-05	31-05	31-05
	HDD177-05	0F/75	32-06/Spare	31-06/Spare	31-05/Spare

5.4 Commands

These subsystem commands are classified into the following eight categories:

(1) Read commands

The read commands transfer the readout data from devices to channels.

(2) Write commands

The write commands write the transfer data from channels to devices.

(3) Search commands

The search commands follow a control command and logically search for the target data.

(4) Control commands

The control commands include the SEEK command that positions cylinder and head positions. The SET SECTOR command that executes latency time processing, the LOCATE RECORD command that specifies the operation of the ECKD command, the SET FILE MASK command that defines the permissible ranges for the WRITE and SEEK operations, and the DEFINE EXTENT command that defines the permissible ranges for the WRITE and SEEK operations and that defines the cache access mode.

(5) Sense commands

The sense commands transfer sense bytes and device specifications.

(6) Path control commands

The path control commands enable and disable the exclusive control of devices.

(7) TEST I/O command

The TEST I/O command transfers the specified device and its path state to a given channel in the form of DSBs.

(8) Subsystem commands

The subsystem commands include the commands which define cache control information in the DKCs and the commands which transfer cache-related information to channels.

Table 5.4-1 Command Summary (1/3)

Command Name			Command Code	
			Single Track	Multitrack
Read commands	READ INITIAL PROGRAM LOAD	(RD IPL)	02	—
	READ HOME ADDRESS	(RD HA)	1A	9A
	READ RECORD ZERO	(RD R0)	16	96
	READ COUNT,KEY,DATA	(RD CKD)	1E	9E
	READ KEY,DATA	(RD KD)	0E	8E
	READ DATA	(RD D)	06	86
	READ COUNT	(RD C)	12	92
	READ MULTIPLE COUNT,KEY AND DATA	(RD MCKD)	5E	—
	READ TRACK	(RD TRK)	DE	—
	READ SPECIAL HOME ADDRESS	(RD SP HA)	0A	—
WRITE commands	WRITE HOME ADDRESS	(WR HA)	19	—
	WRITE RECORD ZORO	(WR R0)	15	—
	WRITE COUNT,KEY,DATA	(WR CKD)	1D	—
	WRITE COUNT,KEY,DATA NEXT TRACK	(WR CKD NT)	9D	—
	ERASE	(ERS)	11	—
	WRITE KEY AND DATA	(WR KD)	0D	—
	WRITE UPDATE KEY AND DATA	(WR UP KD)	8D	—
	WRITE DATA	(WR D)	05	—
	WRITE UPDATE DATA	(WR UP D)	85	—
	WRITE SPECIAL HOME ADDRESS	(WR SP HA)	09	—
SEARCH commands	SEARCH HOME ADDRESS	(SCH HA EQ)	39	B9
	SEARCH ID EQUAL	(SCH ID EQ)	31	B1
	SEARCH ID HIGH	(SCH ID HI)	51	D1
	SEARCH ID HIGH OR EQUAL	(SCH ID HE)	71	F1
	SEARCH KEY EQUAL	(SCH KEY EQ)	29	A9
	SEARCH KEY HIGH	(SCH KEY HI)	49	C9
	SEARCH KEY HIGH OR EQUAL	(SCH KEYD HE)	69	E9

Table 5.4-1 Command Summary (2/3)

Command Name			Command Code	
			Single Track	Multitrack
CONTROL commands	DEFINE EXTENT	(DEF EXT)	63	—
	LOCATE RECORD	(LOCATE)	47	—
	LOCATE RECORD EXTENDED	(LOCATE EXT)	4B	—
	SEEK	(SK)	07	—
	SEEK CYLINDER	(SK CYL)	0B	—
	SEEK HEAD	(SK HD)	1B	—
	RECALIBRATE	(RECAL)	13	—
	SET SECTOR	(SET SECT)	23	—
	SET FILE MASK	(SET FM)	1F	—
	READ SECTOR	(RD SECT)	22	—
	SPACE COUNT	(SPC)	0F	—
	NO OPERATION	(NOP)	03	—
	RESTORE	(REST)	17	—
	DIAGNOSTIC CONTROL	(DIAG CTL)	F3	—
SENSE commands	SENSE	(SNS)	04	—
	READ AND RESET BUFFERED LOG	(RRBL)	A4	—
	SENSE IDENTIFICATION	(SNS ID)	E4	—
	READ DEVICE CHARACTERISTICS	(RD CHR)	64	—
	DIAGNOSTIC SENSE/READ	(DIAG SNS/RD)	C4	—
PATH CONTROL commands	DEVICE RESERVE	(RSV)	B4	—
	DEVICE RELEASE	(RLS)	94	—
	UNCONDITIONAL RESERVE	(UNCON RSV)	14	—
	SET PATH GROUP ID	(SET PI)	AF	—
	SENSE SET PATH GROUP ID	(SNS PI)	34	—
	SUSPEND MULTIPATH RECONNECTION	(SUSP MPR)	5B	—
	RESET ALLEGIANCE	(RST ALG)	44	—
TST I/O	TEST I/O	(TIO)	00	—
TIC	TRANSFER IN CHANNEL	(TIC)	X8	—

Table 5.4-1 Command Summary (3/3)

Command Name		Command Code	
		Single Track	Multitrack
SUBSYSTEM commands	SET SUBSYSTEM MODE (SET SUB MD)	87	—
	PERFORM SUBSYSTEM FUNCTION (PERF SUB FUNC)	27	—
	READ SUBSYSTEM DATA (RD SUB DATA)	3E	—
	SENSE SUBSYSTEM STATUS (SNS SUB STS)	54	—
	READ MESSAGE ID (RD MSG IDL)	4E	—

Note:

- Command Reject, format 0, and message 1 are issued for the commands that are not listed in this table.
- TEST I/O is a CPU instruction and cannot be specified directly. However, it appears as a command to the interface.
- TIC is a type of command but runs only on a channel. It will never be visible to the interface.

5.5 Comparison of pair status on SVP, Web Console, RAID Manager

Table.5.5-1 Comparison of pair status on SVP, Web Console, RAID Manager

NO	Event	Status on RAID Manager	Status on SVP, Web Console
1	Simplex Volume	P-VOL: SMPL S-VOL: SMPL	P-VOL: SMPL S-VOL: SMPL
2	Copying LUSE Volume Partly completed (SYNC only)	P-VOL: PDUB S-VOL: PDUB	P-VOL: PDUB S-VOL: PDUB
3	Copying Volume	P-VOL: COPY S-VOL: COPY	P-VOL: COPY S-VOL: COPY
4	Pair volume	P-VOL: PAIR S-VOL: PAIR	P-VOL: PAIR S-VOL: PAIR
5	Pairsplit operation to P-VOL	P-VOL: PSUS S-VOL: SSUS	P-VOL: PSUS (S-VOL by operator) S-VOL: PSUS (S-VOL by operator)
6	Pairsplit operation to S-VOL	P-VOL: PSUS S-VOL: PSUS	P-VOL: PSUS (S-VOL by operator) S-VOL: PSUS (S-VOL by operator)
7	Pairsplit -P operation *1 (P-VOL failure, SYNC only)	P-VOL: PSUS S-VOL: SSUS	P-VOL: PSUS (P-VOL by operator) S-VOL: PSUS (by MCU)
8	Pairsplit -R operation *1	P-VOL: PSUS S-VOL: SMPL	P-VOL: PSUS (Delete pair to RCU) S-VOL: SMPL
9	P-VOL Suspend (failure)	P-VOL: PSUE S-VOL: SSUS	P-VOL: PSUE (S-VOL failure) S-VOL: PSUE (S-VOL failure)
10	S-VOL Suspend (failure)	P-VOL: PSUE S-VOL: PSUE	P-VOL: PSUE (S-VOL failure) S-VOL: PSUE (S-VOL failure)
11	PS ON failure	P-VOL: PSUE S-VOL: —	P-VOL: PSUE (MCU IMPL) S-VOL: —
12	Copy failure (P-VOL failure)	P-VOL: PSUE S-VOL: SSUS	P-VOL: PSUE (Initial copy failed) S-VOL: PSUE (Initial copy failed)
13	Copy failure (S-VOL failure)	P-VOL: PSUE S-VOL: PSUE	P-VOL: PSUE (Initial copy failed) S-VOL: PSUE (Initial copy failed)
14	RCU accepted the notification of MCU's P/S-OFF	P-VOL: — S-VOL: SSUS	P-VOL: — S-VOL: PSUE (MCU P/S OFF)

*1: Operation on RAID Manager

5.6 CHA/DKA PCB-LR#, DMA#, DRR#, SASCTL#, Port# Matrixes

Table 5.6-1 Relationship between CHA/DKA PCB and LR#, DMA#, DRR#, SASCTL#, Port# (1/2)

Device Module	Location	LR#	DMA#	MFDMA#	DRR#	Channel Port#	SASCTL#	SASPort#
Basic Module (Module#0)	CHA-1EU	x00	x00 - x03	x000 - x00F	x00 - x01	x00 - x07	-	-
	CHA-1EL	x01	x04 - x07	x010 - x01F	x02 - x03	x10 - x17	-	-
	CHA-1FU	x02	x08 - x0B	x020 - x02F	x04 - x05	x08 - x0F	-	-
	CHA-1FL	x03	x0C - x0F	x030 - x03F	x06 - x07	x18 - x1F	-	-
	CHA-1AU	x04	x10 - x13	x040 - x04F	x08 - x09	x40 - x47	-	-
	CHA-1AL	x06	x18 - x1B	x060 - x06F	x0C - x0D	x50 - x57	-	-
	CHA-2QU	x08	x20 - x23	x080 - x08F	x10 - x11	x80 - x87	-	-
	CHA-2QL	x09	x24 - x27	x090 - x09F	x12 - x13	x90 - x97	-	-
	CHA-2RU	x0A	x28 - x2B	x0A0 - x0AF	x14 - x15	x88 - x8F	-	-
	CHA-2RL	x0B	x2C - x2F	x0B0 - x0BF	x16 - x17	x98 - x9F	-	-
	CHA-2MU	x0C	x30 - x33	x0C0 - x0CF	x18 - x19	xC0 - xC7	-	-
	CHA-2ML	x0E	x38 - x3B	x0E0 - x0EF	x1C - x1D	xD0 - xD7	-	-
	DKA-1AU	x04	x10 - x13	-	x08 - x09	-	x00	x00 - x01
		x05	x14 - x17	-	x0A - x0B	-	x01	x02 - x03
	DKA-1AL	x06	x18 - x1B	-	x0C - x0D	-	x02	x04 - x05
		x07	x1C - x1F	-	x0E - x0F	-	x03	x06 - x07
	DKA-2MU	x0C	x30 - x33	-	x18 - x19	-	x04	x08 - x09
		x0D	x34 - x37	-	x1A - x1B	-	x05	x0A - x0B
	DKA-2ML	x0E	x38 - x3B	-	x1C - x1D	-	x06	x0C - x0D
		x0F	x3C - x3F	-	x1E - x1F	-	x07	x0E - x0F

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Table 5.6-1 Relationship between CHA/DKA PCB and LR#, DMA#, DRR#, SASCTL#, Port# (2/2)

Device Module	Location	LR#	DMA#	MFDMA#	DRR#	Channel Port#	SASCTL#	SASPort#
Option Module (Module#1)	CHA-1GU	x10	x40 - x43	x100 - x10F	x20 - x21	x20 - x27	-	-
	CHA-1GL	x11	x44 - x47	x110 - x11F	x22 - x23	x30 - x37	-	-
	CHA-1HU	x12	x48 - x4B	x120 - x12F	x24 - x25	x28 - x2F	-	-
	CHA-1HL	x13	x4C - x4F	x130 - x13F	x26 - x27	x38 - x3F	-	-
	CHA-1LU	x14	x50 - x53	x140 - x14F	x28 - x29	x60 - x67	-	-
	CHA-1LL	x16	x58 - x5B	x160 - x16F	x2C - x2D	x70 - x77	-	-
	CHA-2TU	x18	x60 - x63	x180 - x18F	x30 - x31	xA0 - xA7	-	-
	CHA-2TL	x19	x64 - x67	x190 - x19F	x32 - x33	xB0 - xB7	-	-
	CHA-2UU	x1A	x68 - x6B	x1A0 - x1AF	x34 - x35	xA8 - xAF	-	-
	CHA-2UL	x1B	x6C - x6F	x1B0 - x1BF	x36 - x37	xB8 - xBF	-	-
	CHA-2XU	x1C	x70 - x73	x1C0 - x1CF	x38 - x39	xE0 - xE7	-	-
	CHA-2XL	x1E	x78 - x7B	x1E0 - x1EF	x3C - x3D	xF0 - xF7	-	-
	DKA-1LU	x14	x50 - x53	-	x28 - x29	-	x08	x10 - x11
		x15	x54 - x57	-	x2A - x2B	-	x09	x12 - x13
	DKA-1LL	x16	x58 - x5B	-	x2C - x2D	-	x0A	x14 - x15
		x17	x5C - x5F	-	x2E - x2F	-	x0B	x16 - x17
	DKA-2XU	x1C	x70 - x73	-	x38 - x39	-	x0C	x18 - x19
		x1D	x74 - x77	-	x3A - x3B	-	x0D	x1A - x1B
	DKA-2XL	x1E	x78 - x7B	-	x3C - x3D	-	x0E	x1C - x1D
		x1F	x7C - x7F	-	x3E - x3F	-	x0F	x1E - x1F

5.7 MPB - MPB#, MP# Matrixes

Table 5.7-1 Relationship between MPB Location and MPB#, MP#

Device Module	Location	MPB#	MP#
Basic Module (Module#0)	MPB-1MA	x00	x00 - x03
	MPB-1MB	x01	x04 - x07
	MPB-2MC	x02	x08 - x0B
	MPB-2MD	x03	x0C - x0F
Option Module (Module#1)	MPB-1ME	x04	x10 - x13
	MPB-1MF	x05	x14 - x17
	MPB-2MG	x06	x18 - x1B
	MPB-2MH	x07	x1C - x1F

5.8 Connection Diagram of DKC

Fig. 5.8-1 and Fig. 5.8-2 show the connection of each CHAs, DKAs, ESWs and CPCs in DKC.

In case of CHA or DKA, connected ESWs is different according to the installed location.

So, for example, when you newly install a pair of CHAs to a single DKC module system in which CHA-1EU/2QU, DKA-1AU/2MU, 1AL/2ML are installed (4 CHA/DKAs are connected with ESW-1SA/2SC and 2 CHA/DKAs are connected with ESW-1SB/2SD), installing CHAs to CHA-1FU/2RU can equalize load between ESWs more then installing CHAs to CHA-1EL/2QL. And there is thereby possibility that the throughput of the system can be improved.

As an example different, In a double DKC module system in which CHA-1EU/2QU, CHA-1FU/2RU, DKA-1AU/2MU, DKA-1LU/2XU are installed, move CHAs from CHA-1EU/2QU to CHA-1HU/2UU can equalize load between ESWs more. As a result, the throughput of the system may be improved.

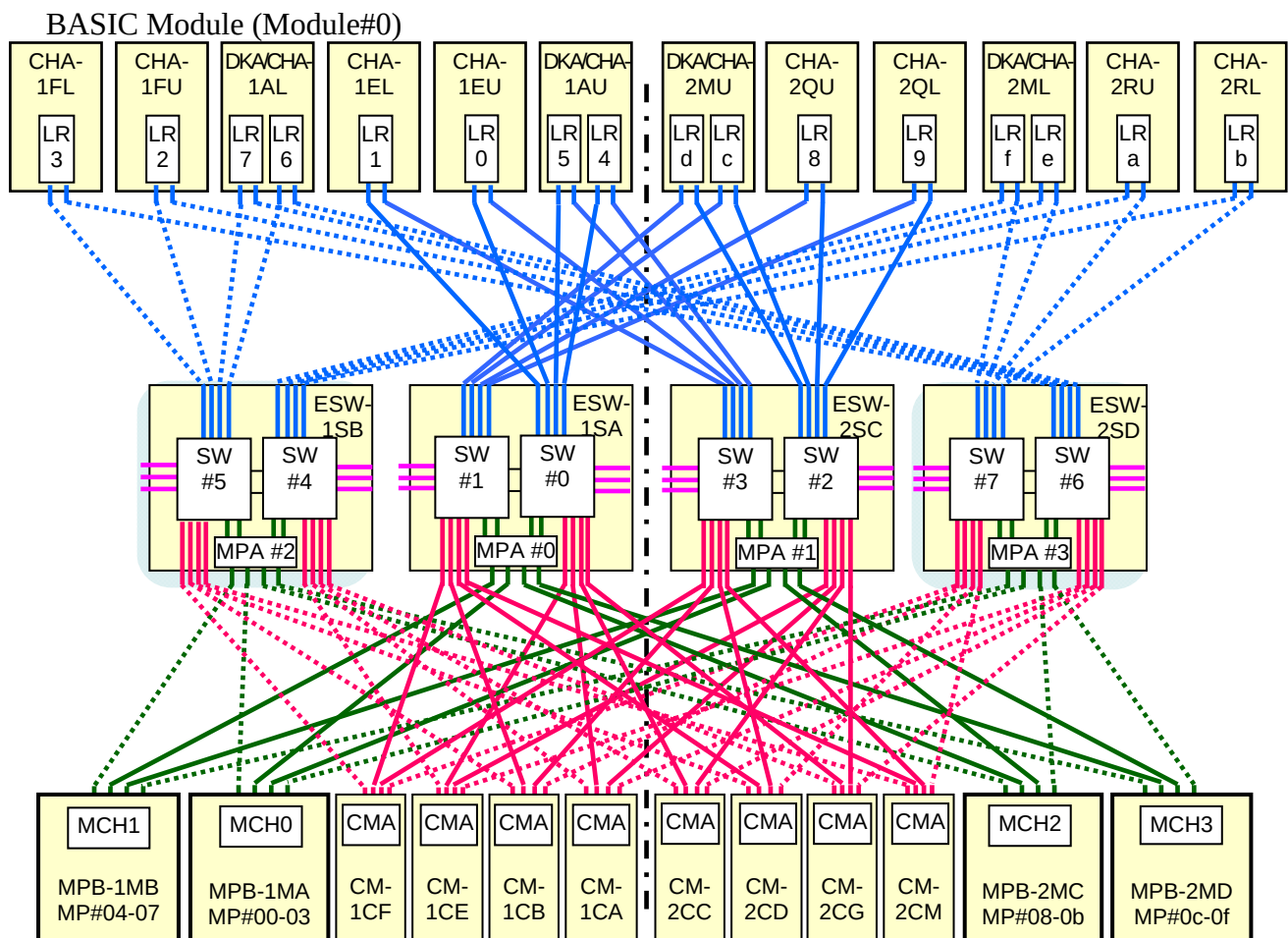


Fig. 5.8-1 Parts connection image in DKC Module#0

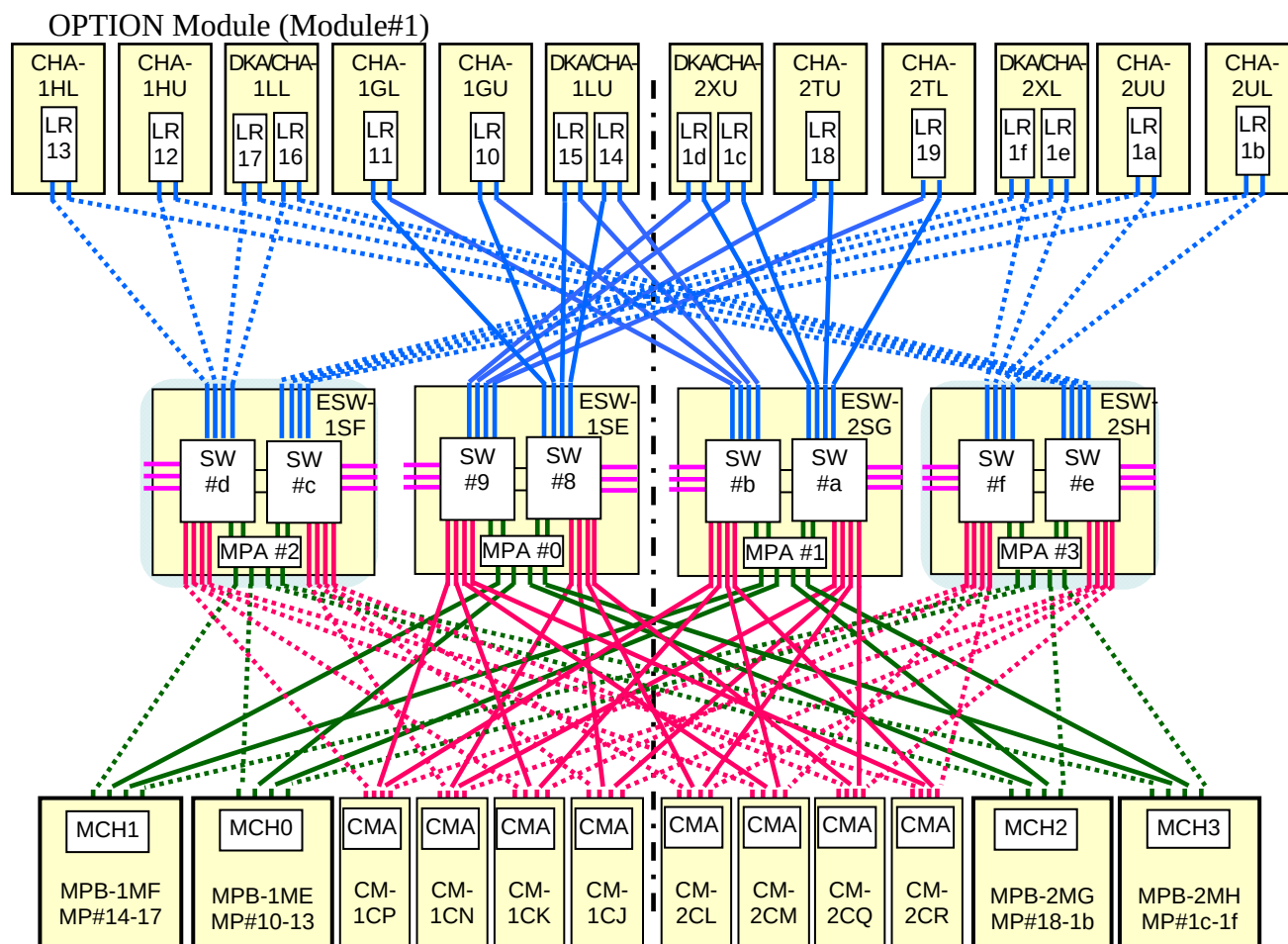


Fig. 5.8-2 Parts connection image in DKC Module#1