THEORY OF OPERATION SECTION

Contents

NOTICE: Unless otherwise stated, "firmware version" in this section indicates DKCMAIN firmware.

1. Storage System Overview of DW850

This section describes the storage system overview and the operations.
Section 1 describes the overview of the storage systems.
The operations and the related information of the storage systems are described from section 2 and the following sections.

1.1 Overview

DW850 are the 19-inchi rack mount models and they consist of the controller chassis that controls the drive and the drive installed drive box.

Controller chassis is the hardware that plays a vital role in the storage system, and it controls the drive box. Chassis has the two clustered controllers and it provides the redundant configuration in which the all major components such as processor, memory and power supply are duplicated.
When a failure occurs on one side of the controllers, a continuous processing can be performed on the other side of the controllers. When a load is concentrated on one side of the controllers, an acceleration of the processing performance is achieved by distributing the processor resource to all CPUs of the both controllers. Furthermore, each component and firmware can minimize the influence from the suspension of the maintenance operation system as they can replace and update while operating the system.

Four types of the drive boxes are available. Also, the number of drive boxes and the size of the drive box are expandable depending on the usage purpose. Like the controller chassis, the major components of the drive box have the duplicated redundancy configuration.

1.2 Features of Hardware

DW850 have the following features.

High-performance
- Distributing the processing by the cluster configured controller
- High-speed of processing is achieved by large capacity cache memory
- High-speed of I/O processing is achieved by flash disk and FMD
- High-speed data transfer is achieved by 16/32 Gbps Fibre Channel and 10 Gbs iSCSI interface

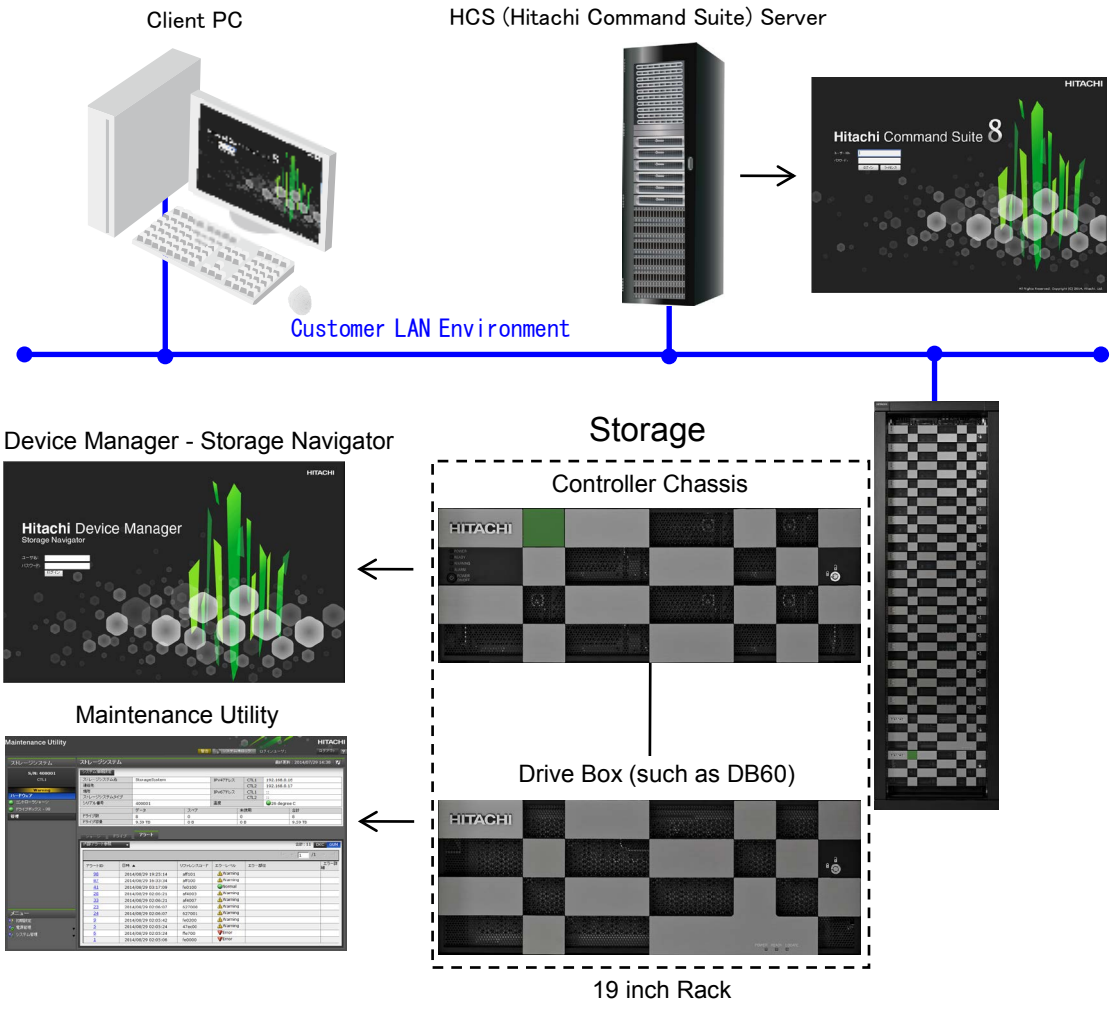
High Availability
- Continuous operation by the duplicated major components
- RAID1/5/6 are supported (RAID 6 supports up to 14D+2P)
- Data is maintained during a power failure by saving data in cash flash memory
- File can be shared between the different types of server

Scalability and Diversity
- Four types of drive box corresponding to SAS drive, flash drive and FMD can be connected
  - DBS: Up to 24 of 2.5 inch SAS drives and flash drives can be installed (2U size)
  - DBL: Up to 12 of 3.5 inch SAS drives and flash drives can be installed (2U size)
  - DB60: Up to 60 of 3.5 inch SAS drives and flash drives can be installed (4U size)
  - DBF: 12 FMD can be installed (2U size)
- High density drive box DB60 in which up to 60 drives can be installed is supported (4U size)
- OS mixed environment such as UNIX, Linux, Windows and VMware is supported

1.3 Storage System Configuration

To configure and operate the Storage System, other than the DW850 hardware, SVP (SuperVisor PC) for the management server is required.
For the storage management and the operation software, use Hitachi Device Manager - Storage Navigator, and for the maintenance software, use Maintenance Utility.
Figure 1-1 shows the outline of the Storage System configuration.

Figure 1-1 Outline of Storage System Configuration



1.3.1 Hardware Configuration

A storage system consists of one controller chassis (DKC) and multiple drive boxes (DB) and channel board box (CHBB).
Figure 1-2 shows the hardware configuration of the storage system.

Figure 1-2 Hardware Configuration (Example : VSP Gx00 Model)

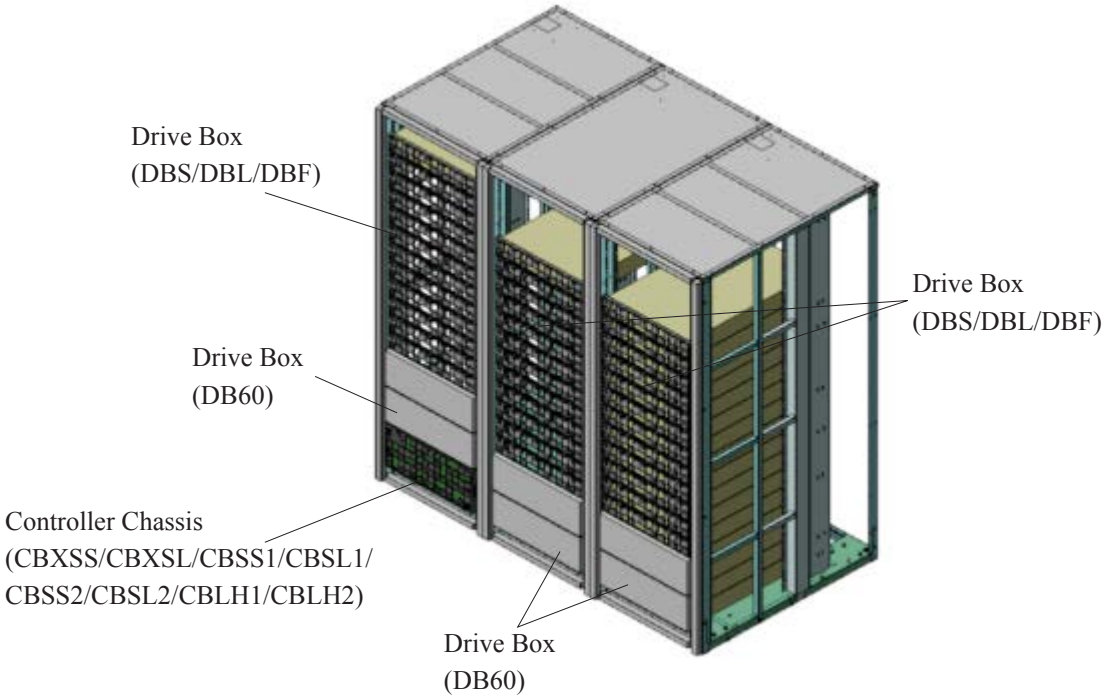
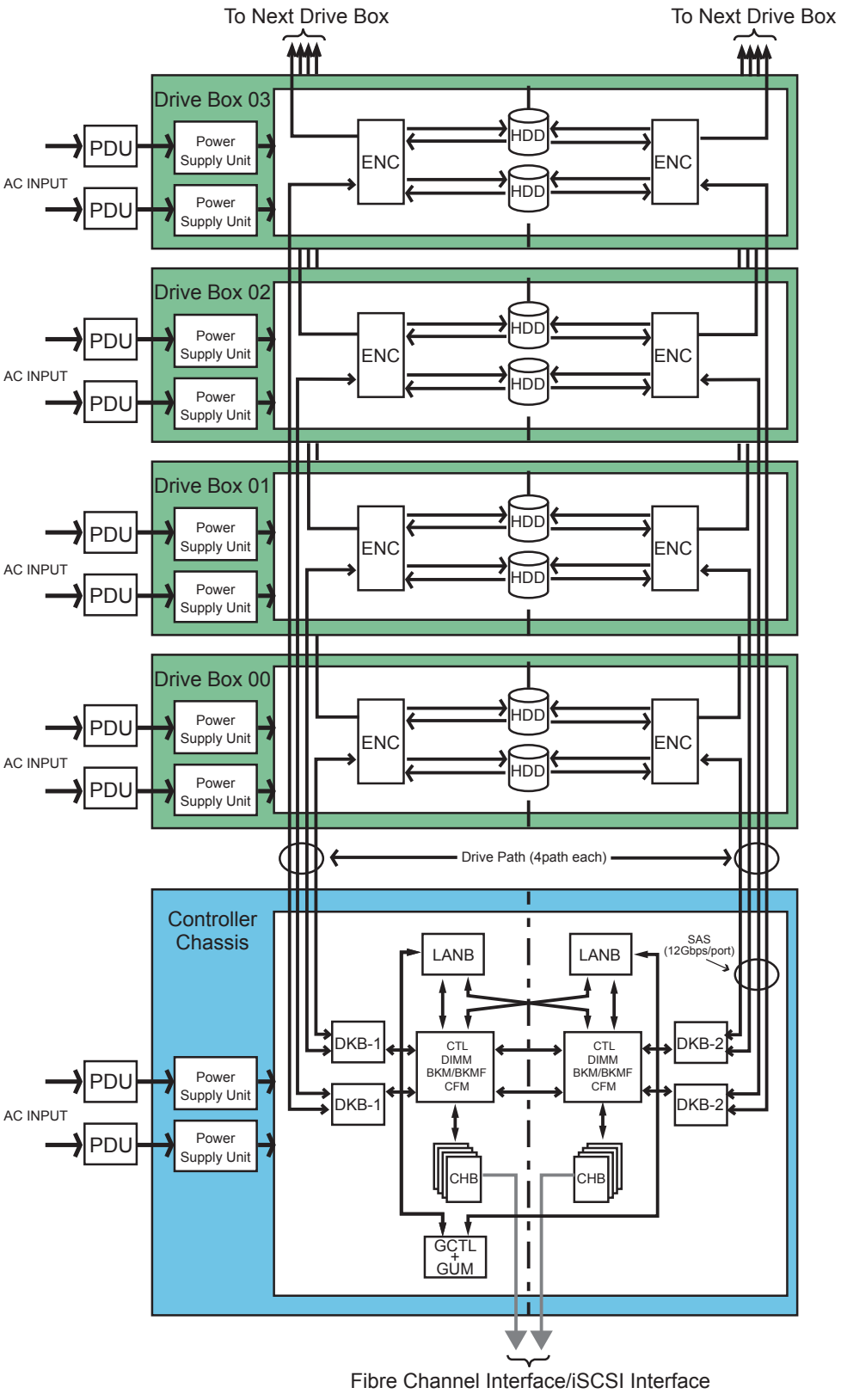


Figure 1-3 shows the system hardware configuration of the storage system.

Figure 1-3 System Hardware Configuration (Back-end)



[Controller Chassis]

It consists of a controller board, a channel board (CHB), a disk board (DKB) and a power supply that supplies the power to them.

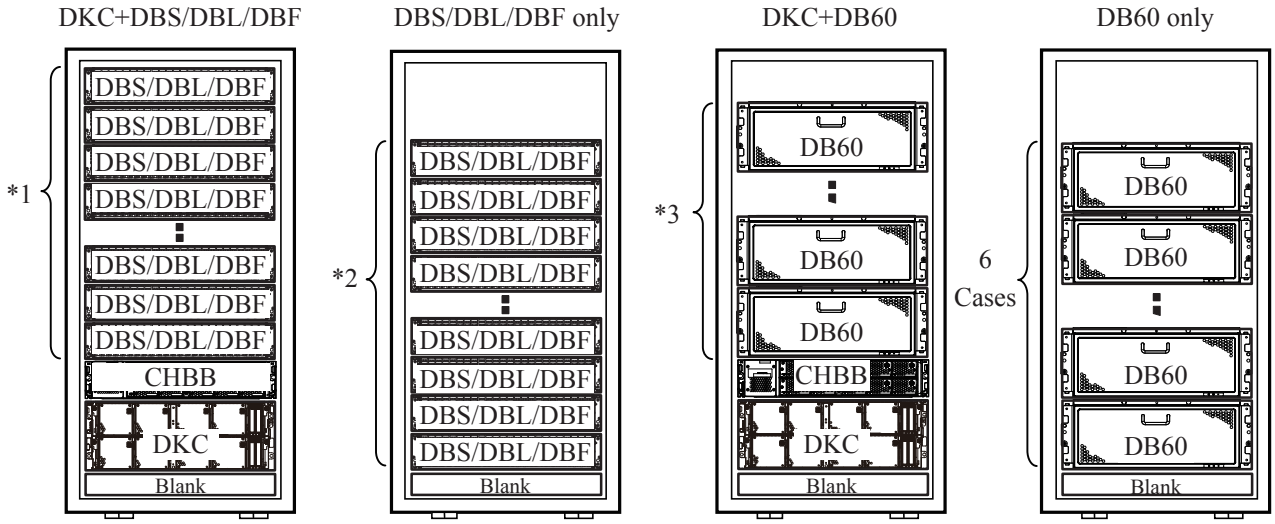
[Drive Box]

It consists of ENC, drives and the cooling fan integrated power supply.
For the drive boxes, the four types of DBS, DBL, DBF and DB60 are available.

- DBS (for 2.5 inch)
  One DKC and up to 16 drive boxes can be installed in a rack.
- DBL (for 3.5 inch)
  One DKC and up to 15 drive boxes can be installed in a rack.
- DBF (for flash module drive) (only VSP G700 and G900)
  One DKC and up to 12 drive boxes can be installed in a rack.
- DB60 (for 2.5 inch/3.5 inch) (Not supported on VSP G130.)
  One DKC and up to 5 drive boxes can be installed in DB60.

For the maximum number of drive boxes which can be installed for each model, see "Table 1-1 Storage System Specifications (VSP G130, G350, G370, G700, G900 Model)" or "Table 1-2 Storage System Specifications (VSP F350, F370, F700, F900 models)".
Figure 1-4 shows the installing configuration in a rack. DBS, DBL, DBF and DB60 can be mixed in the same system.

Figure 1-4 Installing Configuration in Rack



*1: When CHBB is not installed : 16 DBS, 15 DBL and 12 DBF
When CHBB is installed : 14 DBS, 14 DBL and 10 DBF
*2: 19 DBS, 18 DBL and 14 DBF
*3: When CHBB is not installed : 5 DB60
When CHBB is installed : 4 DB60

[Channel Board Box]

It consists of a channel board (CHB), a PCIe cable connection package (PCP), a switch package (SWPK) and a power supply (CHBBPS).

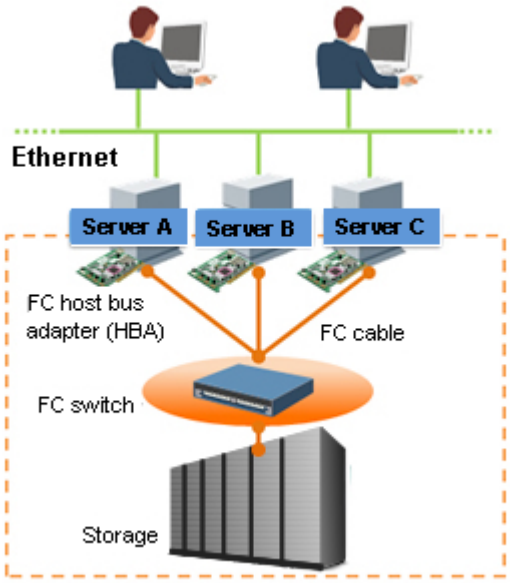
1.3.2 Software Configuration

This software configuration section describes the software to perform the data I/O, manage and maintain the storage system.
For the overview of each software, see the subsections from 1.3.2.1 to 1.3.2.3.

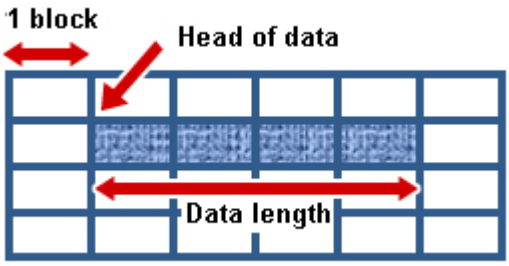
1.3.2.1 Software to Perform Data I/O

DW850 transfers data in blocks.
It assigns the address to the data for each block in the storage system to write or read the data. For how to access to the block storage, assign the address to the head of the data and access for each block.
Firmware is the micro-program to perform the data I/O, hardware failure management and the maintenance function.

Figure 1-6 How to Access to Storage



In the storage, data area is divided by blocks. Access the head of the data that is the address assigned.



1.3.2.2 Software to Manage the Storage System

Management and operation of the storage system are performed by the exclusive management software. To access to the management GUI, access from the Web browser and operate on GUI (Graphical User Interface). Management GUI uses Hitachi Device Manager - Storage Navigator (“Storage Navigator” hereinafter). Also, Hitachi Command Suite that can manage the multiple storage systems collectively can be used.

Overview of each software is as follows.

- Storage Navigator
  It is the storage management software to manage the hardware (setting the configuration information, defining the logical device and displaying the status) and the performance management (tuning) of the storage system. Install Storage Navigator in SVP to use. When installing Storage Navigator, StorageDevice List is also installed. Due to the Web application, the storage system can be operated by accessing from the Web browser on the LAN connected PC.

  NOTE: The storage management software for the DW850 storage system (VSP G130, G/F350, G/F370, G/F700, and G/F900) cannot be installed in the SVP for the DW800 storage system (VSP G200, G/F400, G/F600, and G/F800).

- Hitachi Command Suite
  It is the integrated platform management software that can manage multiple servers and storage systems collectively. Hitachi Command Suite can be used as an option. Install Hitachi Command Suite in the management PC to use. Each storage functions that can be used on Storage Navigator can use from Hitachi Command Suite.

1.3.2.3 Software to Maintain the Storage System

Maintenance of the storage system is performed by the exclusive software.
To maintain the hardware and update the firmware, use Maintenance Utility.

The overview of each software is as follows.

- Maintenance Utility
  It is the Web application to be used for the failure monitoring of the storage system, parts replacement, an upgrade of the firmware and installation of the program product.
  Maintenance Utility is incorporated into GUM (Gateway for Unified Management) controller that is mounted in the controller chassis. Installation is not required.
  Maintenance Utility is started by specifying the IP address of CTL on the Web browser or using the “Web Console” window or the “MPC” window on the Maintenance PC. Note that Maintenance Utility can still be accessed even if the power is turned off as GUM is operated as long as the controller chassis is powered on.

1.4 Specifications by Model

1.4.1 Storage System Specifications

Table 1-1 shows the storage system specifications.

Table 1-1 Storage System Specifications (VSP G130, G350, G370, G700, G900 Model)

Item			Specifications				
			VSP G900	VSP G700	VSP G370	VSP G350	VSP G130
System	Number of HDDs	Minimum	4 (Disk-in model) / 0 (Diskless model)				
		Maximum	1,440	1,200	384	264	96
	Number of Flash Drives	Minimum	4 (disk-in model) / 0 (diskless model)				
		Maximum	1,152	864	288	192	96
	Number of Flash Module Drives	Minimum	4 (disk-in model)		—		
		Maximum	576	432	—		
	RAID Level		RAID6/RAID5/RAID1				
	RAID Group Configuration	RAID6	6D+2P, 12D+2P, 14D+2P				
		RAID5	3D+1P, 4D+1P, 6D+1P, 7D+1P				
		RAID1	2D+2D, 4D+4D				
	Maximum Number of Spare Disk Drives		64 (*1)	48 (*1)	24 (*1)	16 (*1)	16 (*1)
	Maximum Number of Volumes		65,280	49,152	32,768	16,384	2,048
	Maximum Storage System Capacity (Physical Capacity)	2.4 TB 2.5” HDD used	2,656 TB	1,992 TB	664 TB	443 TB	221 TB
		10 TB 3.5” HDD used	14,098 TB	11,748 TB	3,642 TB	2,467 TB	939 TB
		15 TB 2.5” SSD used	17,335 TB	13,001 TB	4,333 TB	2,889 TB	1,444 TB
		14 TB FMD used	8,106 TB	6,080 TB	—		
	Maximum External Configuration		255 PiB	192 PiB	128 PiB	64 PiB	8 PiB
	Maximum Number of DBs (*6)		DBS/DBL/ DBF : 48 DB60 : 24	DBS/DBL/ DBF : 36 DB60 : 20	DBS/DBL : 11 DB60 : 6	DBS/DBL : 7 DB60 : 4	DBS : 3 DBL : 7
Memory	Cache Memory Capacity		256 GiB to 1,024 GiB	128 GiB to 512 GiB	128 GiB to 256 GiB	64 GiB to 128 GiB	32 GiB
	Cache Flash Memory Type		BM35/ BM45	BM35	BM15	BM15	BM05

(To be continued)

(Continued from preceding page)

Item			Specifications				
			VSP G900	VSP G700	VSP G370	VSP G350	VSP G130
Storage I/F	DKC-DB Interface		SAS/Dual Port				
	Data Transfer Rate		12 Gbps				
	Maximum Number of HDD per SAS I/F		144				
	Number of DKB PCB		8	4	—		
Device I/F	Support Channel Type		Fibre Channel Shortwave (*2)				Fibre Channel Shortwave
			iSCSI (Optic/Copper)				
	Data Transfer Rate	Fibre Channel	400/800/1600/3200 MB/s				400/800/1600 MB/s
		iSCSI	1000 MB/s (Optic) 100 / 1000 MB/s (Copper)				
	Maximum Number of CHB	CHBB is not Installed	12 (16: When DKB slot is used)	12 (16: When DKB slot is used)	4	4	—
		CHBB is installed	16 (20: When DKB slot is used)	—			
Acoustic Level LpAm (*7) (*8)	Operating	CBL	60 dB		—		
		CBSS/CBSL	—		60 dB		—
		CBXSS/CBXSL	—				60 dB
		DBL/DBS	60 dB (*3) (*4)				
		DB60	71 dB (*3) (*4) (*5)				—
		DBF	60 dB (*3) (*4)		—		
	Standby	CBL	55 dB		—		
		CBSS/CBSL	—		55 dB		—
		CBXSS/CBXSL	—				55 dB
		DBL/DBS	55 dB (*3) (*4)				
		DB60	71 dB (*3) (*4) (*5)				—
		DBF	55 dB (*3) (*4)		—		
Dimension	W × D × H (mm)	19 inch Rack	600 × 1,150 × 2,058.2				

(To be continued)

(Continued from preceding page)

Item		Specifications				
		VSP G900	VSP G700	VSP G370	VSP G350	VSP G130
Non-disruptive Maintenance	Control PCB	Supported				
	Cache Memory	Supported				
	Cache Flash Memory	Supported				
	Power Supply, Fan	Supported				
	Microcode	Supported				
	Disk Drive Flash Drive	Supported				
	Flash Module Drive	Supported		—		

*1: Available as spare or data Disks.

*2: By the replacing SFP transceiver of the fibre port on the Channel Board to DW-F800-1PL16 (SFP for 16 Gbps Longwave), the port can be used for the Longwave.

*3: Sound pressure level [LA] changes from 66 dB to 75 dB according to the ambient temperature, Drive configuration and operating status. The maximum could be 79 dB during maintenance procedure for failed ENC or Power Supply.

*4: Acoustic power level [LwA] measured by ISO7779 condition is 7.2 B. And it changes from 7.2 B to 8.1B according to the ambient temperature, Drive configuration and operating status.

*5: Do not work behind DB60 for a long time.

*6: For details, see Table 4-48 or Table 4-49.

*7: The acoustic level is measured under the following conditions in accordance with ISO7779 and the value is declared based on ISO9296.
In a normal installation area (data center/general office), the storage system is surrounded by different elements from the following measuring conditions according to ISO, such as noise sources other than the storage system (other devices) , the walls and ceilings that reflect the sound. Therefore, the values described in the table do not guarantee the acoustic level in the actual installation area.
- Measurement environment: In a semi-anechoic room whose ambient temperature is 23 degrees C ± 2 degrees C
- Device installation position: The Controller Chassis is at the bottom of the rack and the Drive Box is at a height of 1.5 meters in the rack
- Measurement position: 1 meter away from the front, rear, left, or right side of the storage system and 1.5 meters high (at four points)
- Measurement value: Energy average value of the four points (front, rear, left, and right)

*8: It is recommended to install the storage system in a computer room in a data center and the like. It is possible to install the storage system in a general office, however, take measures against noise as required.
When you replace the old Hitachi storage system with the new one in a general office, especially note the following:
The cooling fans in the storage system are downsized to enhance the high density of the storage system. As a result, the rotation number of the fan is increased than before to maintain the cooling performance. Therefore, the rate of the noise occupied by high-frequency content is high.

Table 1-2 Storage System Specifications (VSP F350, F370, F700, F900 models)

Item			Specifications			
			VSP F900	VSP F700	VSP F370	VSP F350
System	Number of Flash Drives	Minimum	4 (Disk-in model)			
		Maximum	1,152	864	288	192
	Number of Flash Module Drives	Minimum	4 (Disk-in model)		—	
		Maximum	576	432	—	—
	RAID Level		RAID6/RAID5/RAID1			
	RAID Group Configuration	RAID6	6D+2P, 12D+2P, 14D+2P			
		RAID5	3D+1P, 4D+1P, 6D+1P, 7D+1P			
		RAID1	2D+2D, 4D+4D			
	Maximum Number of Spare Disk Drives		64 (*1)	48 (*1)	24 (*1)	16 (*1)
	Maximum Number of Volumes		64 k	48 k	32 k	16 k
	Maximum Storage System Capacity (Physical Capacity)	15 TB 2.5” SSD used	17,335 TB	13,001 TB	4,333 TB	2,889 TB
		14 TB FMD used	8,106 TB	6,080 TB	—	
	Maximum External Configuration		255 PiB	192 PiB	128 PiB	64 PiB
	Maximum Number of DBs (*5)		DBS/DBF : 48	DBS/DBF : 36	DBS : 11	DBS : 7
Memory	Cache Memory Capacity		256 GiB to 1,024 GiB	128 GiB to 512 GiB	128 GiB to 256 GiB	64 GiB to 128 GiB
	Cache Flash Memory Type		BM35/BM45	BM35	BM15	BM15
Storage I/F	DKC-DB Interface		SAS/Dual Port			
	Data Transfer Rate		12 Gbps			
	Maximum Number of drive per SAS I/F		24			
Device I/F	Number of DKB PCB		8	4	—	—
	Support Channel Type		Fibre Channel Shortwave (*2)/iSCSI (Optic/Copper)			
	Data Transfer Rate (MB/s)	Fibre Channel	400/800/1600/3200 MB/s			
		iSCSI	1000 MB/s (Optic) 100/1000 MB/s (Copper)			
	Maximum Number of CHB	CHBB is not Installed	12 (16: When DKB slot is used)	12 (16: When DKB slot is used)	4	4
		CHBB is Installed	16 (20: When DKB slot is used)	—	—	—

(To be continued)

(Continued from preceding page)

Item			Specifications			
			VSP F900	VSP F700	VSP F370	VSP F350
Acoustic Level LpAm (*6) (*7)	Operating	CBL	60 dB		—	
		CBSS	—		60 dB	
		DBS	60 dB (*3) (*4)			
		DBF	60 dB (*3) (*4)		—	
	Standby	CBL	55 dB		—	
		DBSS	—		55 dB	
		DBS	55 dB (*3) (*4)			
		DBF	55 dB (*3) (*4)		—	
Dimension	W × D × H (mm)	19 inch Rack	600 × 1,150 × 2,058.2			
Non-disruptive Maintenance	Control PCB		Supported			
	Cache Memory		Supported			
	Cache Flash Memory		Supported			
	Power Supply, Fan		Supported			
	Microcode		Supported			
	Flash Drive		Supported			
	Flash Module Drive		Supported		—	

*1: Available as spare or data Disks.

*2: By the replacing SFP transceiver of the fibre port on the Channel Board to DW-F800-1PL16 (SFP for 16 Gbps Longwave), the port can be used for the Longwave.

*3: Sound pressure level [LA] changes from 66 dB to 75 dB according to the ambient temperature, Drive configuration and operating status. The maximum could be 79 dB during maintenance procedure for failed ENC or Power Supply.

*4: Acoustic power level [LwA] measured by ISO7779 condition is 7.2 B. And it changes from 7.2 B to 8.1B according to the ambient temperature, Drive configuration and operating status.

*5: For details, see Table 4-50.

*6: The acoustic level is measured under the following conditions in accordance with ISO7779 and the value is declared based on ISO9296.
In a normal installation area (data center/general office), the storage system is surrounded by different elements from the following measuring conditions according to ISO, such as noise sources other than the storage system (other devices) , the walls and ceilings that reflect the sound. Therefore, the values described in the table do not guarantee the acoustic level in the actual installation area.
- Measurement environment: In a semi-anechoic room whose ambient temperature is 23 degrees C ± 2 degrees C
- Device installation position: The Controller Chassis is at the bottom of the rack and the Drive Box is at a height of 1.5 meters in the rack
- Measurement position: 1 meter away from the front, rear, left, or right side of the storage system and 1.5 meters high (at four points)
- Measurement value: Energy average value of the four points (front, rear, left, and right)

*7: It is recommended to install the storage system in a computer room in a data center and the like. It is possible to install the storage system in a general office, however, take measures against noise as required.
When you replace the old Hitachi storage system with the new one in a general office, especially note the following:
The cooling fans in the storage system are downsized to enhance the high density of the storage system. As a result, the rotation number of the fan is increased than before to maintain the cooling performance. Therefore, the rate of the noise occupied by high-frequency content is high.

2. Descriptions for the Operations of DW850

2.1 RAID Architecture Overview

The Storage System supports RAID1, RAID5 and RAID6.
The feature of each RAID level is described below.

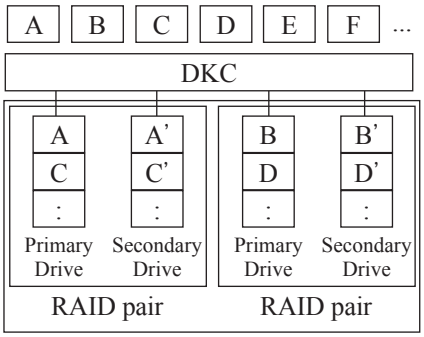
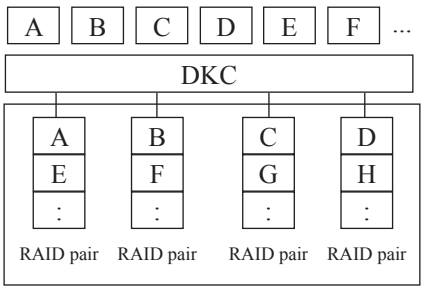
2.1.1 Overview of RAID Systems

The concept of a Storage System was announced in 1987 by the research group of University of California at Berkeley.
The research group called the Storage System RAID (Redundant Array of Inexpensive Disks: A Storage System 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.
The Storage System supports RAID1, RAID5 and RAID6. The following shows respective methods, advantages and disadvantages.

Table 2-1 RAID Configuration Supported by the Storage System

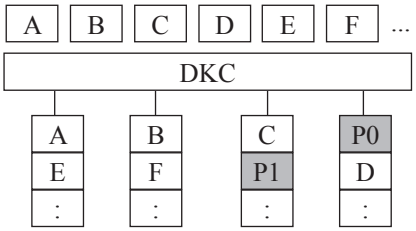
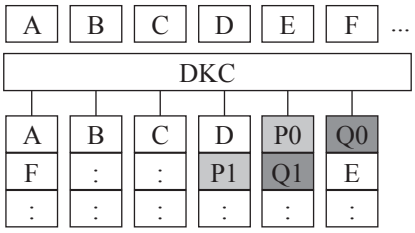
Level	Configuration
RAID1	2D+2D Two concatenation of (2D+2D)
RAID5	3D+1P
	4D+1P
	6D+1P
	7D+1P Two concatenation of (7D+1P) Four concatenation of (7D+1P)
RAID6	6D+2P
	12D+2P
	14D+2P

Table 2-2 Overview of RAID Systems

Level	Configuration		Characteristics
RAID 1	Data block  Parity group NOTE: The above diagram shows the (2D+2D) configuration.	Overview	Mirror Disks (Dual write) 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 divided into 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 Concatenation configuration	Data block  Parity group NOTE: The above diagram shows the two concatenation configuration of (2D+2D). A RAID pair consists of two Disk Drives.	Overview	Mirror Disks (Dual write) The two parity groups of RAID 1 (2D+2D) are concatenated and data is divided into 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.

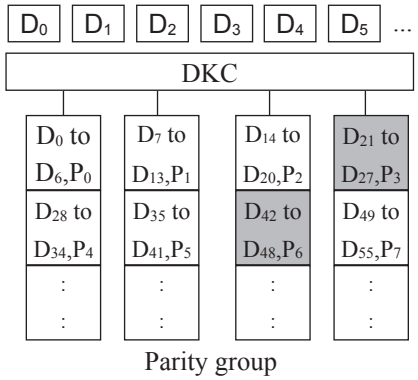
(To be continued)

(Continued from preceding page)

Level	Configuration		Characteristics
RAID5	Data block  Data Disks + Parity Disk NOTE: The above diagram shows the 3D+1P configuration.	Overview	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  Data Disks + Parity Disks P and Q NOTE: The above diagram shows the 4D+2P configuration.	Overview	Data blocks are divided into 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 write is lower than that of RAID 5 in the case where the number of Drives makes a bottleneck.

(To be continued)

(Continued from preceding page)

<table>
<tr><th>Level</th><th>Configuration</th><th></th><th>Characteristics</th></tr>
<tr><td rowspan="3">RAID5
Concatenation
configuration</td><td rowspan="3">Data block
 

Parity group

NOTE:
The above-mentioned figure is four concatenation cofiguration, but it is the same in the case of two concatenation.</td><td>Overview</td><td>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.</td></tr>
<tr><td>Advantage</td><td>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).</td></tr>
<tr><td>Disadvantage</td><td>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).</td></tr>
</table>

2.1.2 Comparison of RAID Levels

1. Space efficiency

   The space efficiency of each RAID level is based on the following contents.

   - RAID1 : The user area is half of the total Drive capacity due to mirroring.
   - RAID5, RAID6 : The data part and the parity part are in the parity group.
     The space efficiency is calculated by the ratio of the data part to the total Drive capacity.

   Table 2-3 shows the space efficiency per RAID level.

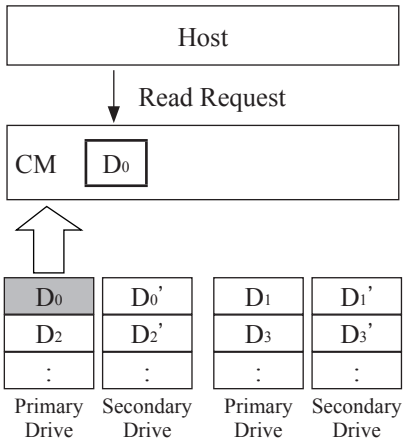
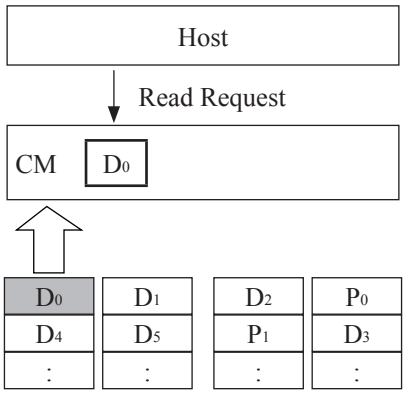
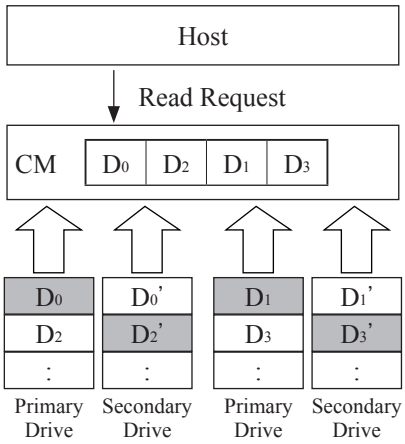
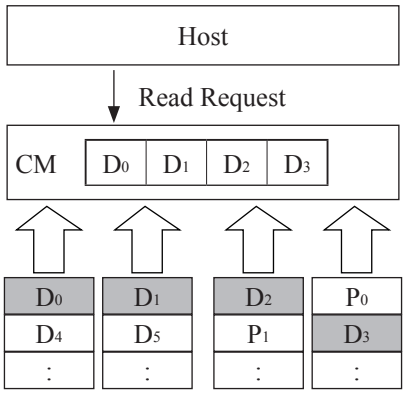
Table 2-3 Example of Space Efficiency Comparison

RAID Level	Space Efficiency (User Area/Disk Capacity)	Remarks
RAID1	50.0%	Due to mirroring
RAID5	(N – 1) / N N indicates the number of Drives which configure a parity group	Example: In case of 3D+1P, (4 – 1) / 4 = 0.75 = 75%
RAID6	(N – 2) / N N indicates the number of Drives which configure a parity group	Example: In case of 6D+2D, (8 – 2) / 8 = 0.75 = 75%

2. I/O processing operation

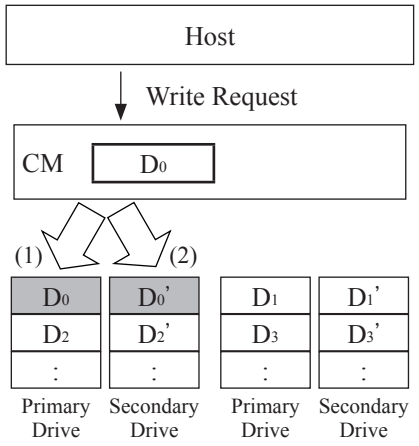
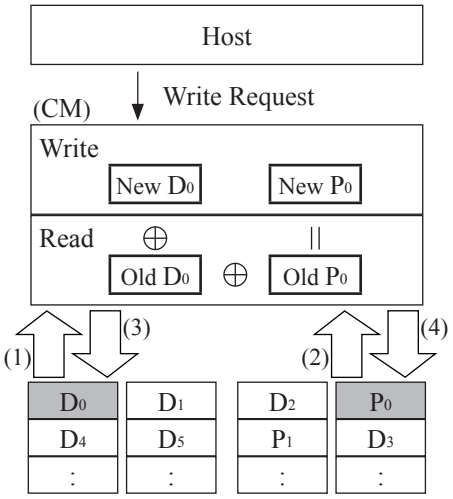
Table 2-4 shows the overview operation of front-end I/O and back-end I/O in each RAID level.

Table 2-4 Example of I/O Operation in Each RAID Level

I/O Type \ RAID Level	RAID1	RAID5, RAID6
Random read	 Perform single Drive read for single read from the host.	 Perform single Drive read for single read from the host.
Sequential read	 Perform Drive read for requests from the host. For the example in the above diagram, perform Drive read four times for four requests of D0 to D3 from the host.	 Perform Drive read for requests from the host. For the example in the above diagram, perform Drive read four times for four requests of D0 to D3 from the host.

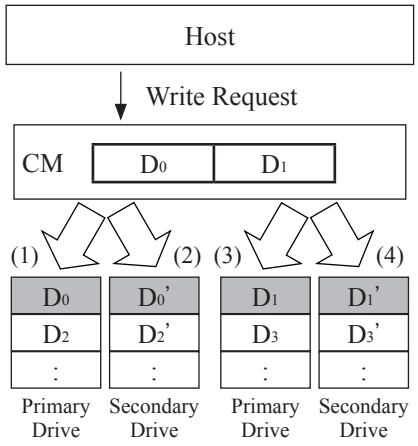
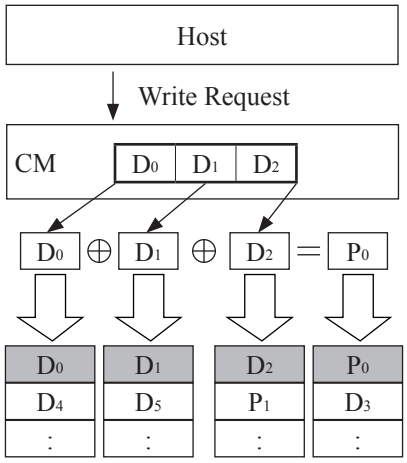
(To be continued)

(Continued from preceding page)

RAID Level / I/O Type	RAID1	RAID5, RAID6
Random write	 Perform Drive write twice as shown below for single write by the host. (1) Primary Drive (2) Secondary Drive	 • In case of RAID5: Perform the following read for single write by the host and create a new parity. (1) Read the old data (2) Read the old parity After that, perform the following write. (3) Write new data (4) Write a new parity Operate the I/O four times in total. • In case of RAID6: In addition to the case of RAID5, perform old parity read and new parity write of the second parity. Operate the I/O six times in total.

(To be continued)

(Continued from preceding page)

RAID Level / I/O Type	RAID1	RAID5, RAID6
Sequential write	 Perform write twice (write to the primary Drive and secondary Drive) for the write requests by the host. For the example in the above diagram, perform Drive write four times for the following two write requests by the host. (1) (3) Primary Drive (2) (4) Secondary Drive	 • In case of RAID5: For write requests by the host, when the crosswise data (from D0 to D2 in the above diagram) is complete, create parity and write the data from the host and the parity to the Drive. For example, in case of 3D+1P, create parity for write of three sets of data by the host and perform Drive write four times combining the data and parity. • In case of RAID6: In addition to the case of RAID5, create the second parity and write the data from the host and two sets of parity to the Drive. For example, in case of 6D+2P, create two sets of parity for write of six sets of data by the host and perform Drive write eight times combining the data and parity.

3. Limit performance comparison

Table 2-5 shows the performance per RAID level when setting the performance of a Drive to 100. (N indicates the number of Drives which configure a parity group.)

Table 2-5 I/O performance per RAID level

(1) Random Read, Sequential Read

RAID Level	Calculation	Remarks
RAID1	100 × N	Example: In case of 2D+2D, N = 4 results in 400
RAID5	100 × N	Example: In case of 3D+1P, N = 4 results in 400
RAID6	100 × N	Example: In case of 6D+2P, N = 8 results in 800

(2) Random Write

RAID Level	Calculation	Remarks
RAID1	100 × N / 2	Example: In case of 2D+2D, 100 × 4 / 2 = 200
RAID5	100 × N / 4	Example: In case of 7D+1P, 100 × 8 / 4 = 200
RAID6	100 × N / 6	Example: In case of 6D+2P, 100 × 8 / 6 = 133

(3) Sequential Write

RAID Level	Calculation	Remarks
RAID1	100 × N / 2	Example: In case of 2D+2D, 100 × 4 / 2 = 200
RAID5	100 × (N – 1)	Example: In case of 7D+1P, 100 × (8 – 1) = 700
RAID6	100 × (N – 2)	Example: In case of 6D+2P, 100 × (8 – 2) = 600

The above is the theoretical value in case of a Drive neck.
It is not limited to the above in case other parts are performance necks.

4. Reliability

Table 2-6 shows the reliability related to each RAID level.

Table 2-6 Reliability of Each RAID Level

RAID Level	Conditions to Guarantee the Data
RAID1	When a Drive failure occurs in the mirroring pair, recover the data from the Drive on the opposite side. When two Drive failures occur in the mirroring pair, the LDEV is blocked.
RAID5	When a Drive failure occurs in the parity group, recover the data using the parity data. When two Drive failures occur in the parity group, the LDEV is blocked.
RAID6	When one or two Drive failures occur in the parity group, recover the data using the parity data. When three Drive failures occur in the parity group, the LDEV is blocked.

2.2 Open Platform

2.2.1 Product Overview and Functions

The open platform optional functions can allocate a partial or full of Disk volume area of the DKC for the Open system hosts by installing Channel Board (CHB) to the Disk Controller (hereinafter called DKC). This function enables a use of high reliable and high performance Storage System 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 Internet Small Computer System Interface (iSCSI) can be used as a Channel interface.

1. Fibre Channel option (FC) / iSCSI option (iSCSI)
   Available major functions by using the Fibre Channel options are as follows.

   (1) This enables multiplatform system users to share the high reliable and high performance resource realized by the DKC.
   - 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).
   - DW850 can be connected to open system via Fibre interface by installing Fibre Channel Board (DW-F800-4HF32R). Fibre connectivity is provided as Channel option of DW850. Fibre Channel Board can be installed in any CHB location of DW850.
   - The iSCSI interface transmits and receives the block data by SCSI on the IP network. For this reason, you can configure and operate IP-SAN (IP-Storage Area Network) at a low cost using the existing network devices. The iSCSI interface board (DW-F800-2HS10S/DW-F800-2HS10B) can be inserted in an optional place of the DW-F800 CHB slot.

   (2) Fast and concurrent data transmission
   Data can be read and written at a maximum speed of 32 Gbps with use of Fibre interface.
   All of the Fibre ports can transfer data concurrently too.
   You can read/write the data by 10 Gbps using the iSCSI interface.

(3) High performance

The DKC has two independent areas of Cache Flash Memory and this mechanism also applies to the Fibre attachment / iSCSI option. Thus, compared with a conventional Disk array Controller used for open systems and not having a Cache, this Storage System has the following outstanding characteristics:

- Cache data management by LRU control
- Adoption of DFW (DASD Fast Write)
- Write data duplexing
- Cache Flash Memory

(4) 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. Fault-tolerance against path failures depends on the multi-path configuration support of the host system too.

(5) 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.

(6) TrueCopy Support

TrueCopy is a function to realize the duplication of open system data by connecting the two DW850 Storage Systems or inside parts of a single DW850 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.

2.2.2 Precautions on 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 Board or LDEV is removed, the related LUN path must be removed.
3. Before Fibre Channel Board 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.

The precautions against the iSCSI interface maintenance work are as shown below.

1. Before changing the LUN path definition, the iSCSI interface port I/O needs to be stopped.
2. Before removing the iSCSI interface board or LDEV, the LUN path definition needs to be removed.
3. Before replacing the iSCSI interface board, the I/O needs to be stopped.

2.2.3 Configuration

2.2.3.1 System Configuration

1. All Fibre Configuration
   The DKC can also have the All Fibre configuration installed only by CHB adapters.
   The all Fibre configuration example is shown below.

Figure 2-1 Minimum system configuration for All Fibre

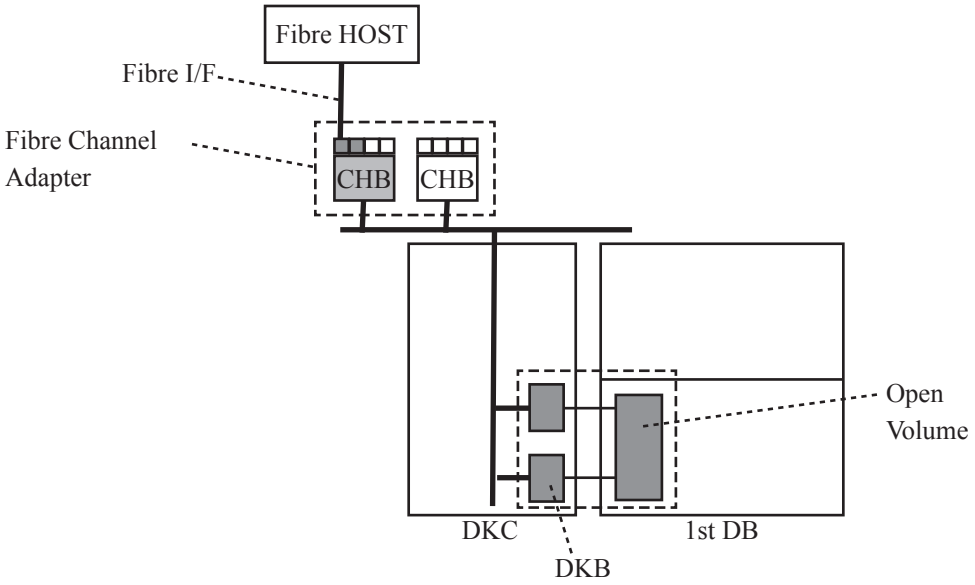
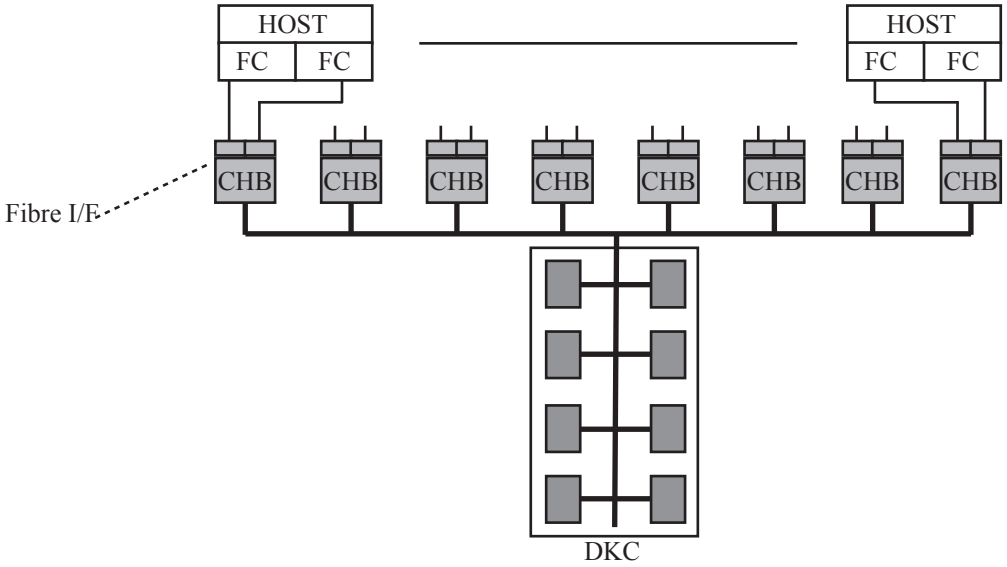


Figure 2-2 Maximum all Fibre Configuration



2.2.3.2 Channel Configuration

1. Fibre Channel Configuration
   The Fibre Channel Board (CHB) PCBs must be used in sets of 2.
   The DKC can install a maximum of 4 Fibre Channel Board packages (CHBs) in the VSP G350, G370, 12 in the VSP G700 (16 for the HDD-less configuration) and 12 in the VSP G900 (20 for the HDD-less configuration with CHBB installed).
   The Fibre Channel Board PCB is not used for the VSP G130. The fibre channel interface is integrated in the Controller Board of the VSP G130.

2. iSCSI Channel Configuration
   The iSCSI Interface Board PCBs (CHBs) must be configured in sets of 2.
   The DKC can install a maximum of 4 Fibre Channel Board packages (CHBs) in the VSP G350, G370, 12 in the VSP G700 (16 for the HDD-less configuration) and 12 in the VSP G900 (20 for the HDD-less configuration with CHBB installed).
   The iSCSI Interface Board PCB is not used for the VSP G130. The iSCSI interface is integrated in the Controller Board of the VSP G130.

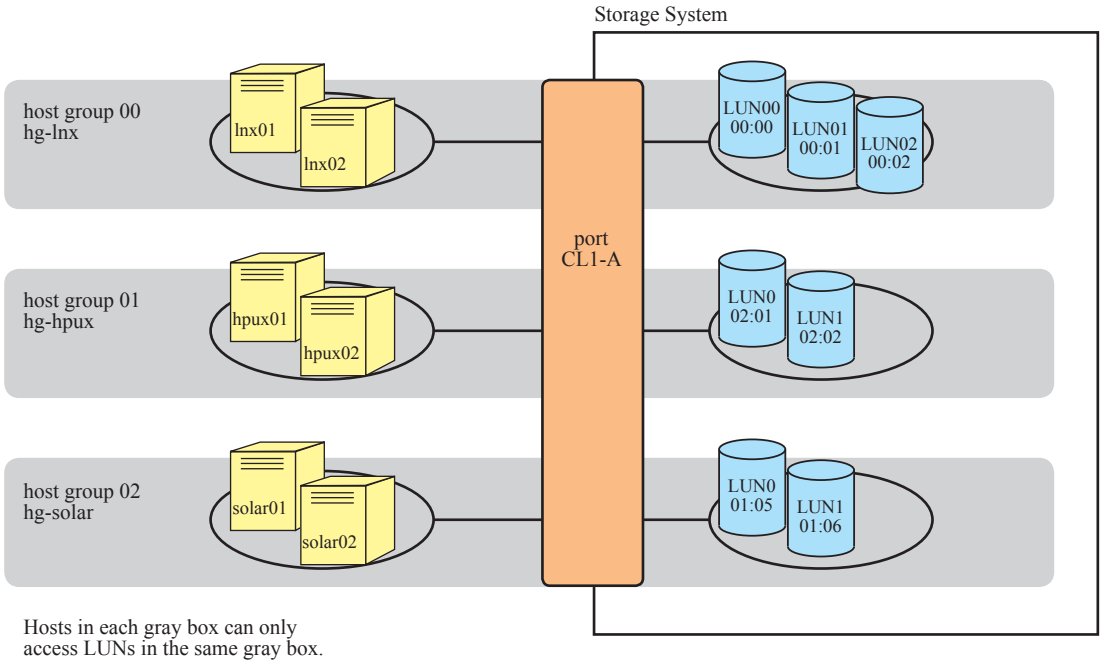
2.2.3.3 Channel Addressing

1. Fibre Channel
   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 (CHB port) ID, and LUN (Logical Unit Number) defines the addressing and access path.
   The maximum number of LUNs that can be allocated to one port is 2,048.
   The addressing configuration is shown in the Figure 2-4.

   (1) Number of connected Hosts
   For Fibre Channel, the number of connectable hosts is limited to 256 per Fibre port. (FC)
   The number of MCU connections is limited to 16 per RCU Target port. (only for FC)

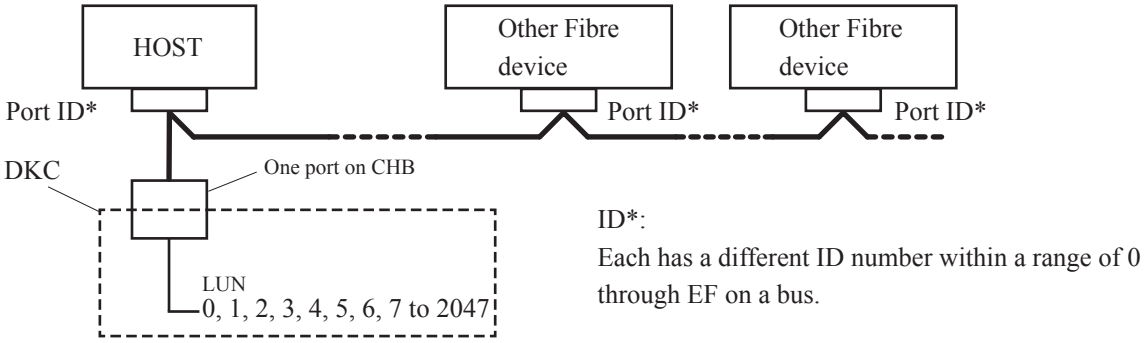
   (2) Number of Host Groups
   You can define a host group admitted access for the some LU by LUN Security as a Host Group.
   For example, the two hosts in the hg-lnx group can only access the three LUs (00:00, 00:01, and 00:02).
   The two hosts in the hg-hpux group can only access the two LUs (02:01 and 02:02).
   The two hosts in the hg-solar group can only access the two LUs (01:05 and 01:06).

Figure 2-3 Example of Host Group Definition



(3) LUN (Logical Unit Number)
LUNs can be allocated from 0 to 2,047 to each Fibre Port.

Figure 2-4 Fibre addressing configuration from Host



(4) PORT INFORMATION
A PORT address(AL_PA) and the Topology can be set as PORT INFORMATION.
The port address is selectable from EF to one (loop ID 0 to 125).
Topology information is selected from “Fabric”, “FC-AL” or “Point to point”.

2. iSCSI interface
   The iSCSI interface specifies an IPv4 address or IPv6 address and connects it to the iSCSI port.
   Up to 16 virtual ports can be added to an iSCSI physical port. Use Command Control Interface (CCI) when adding virtual ports.

   (1) The number of connected hosts
   For the iSCSI interface, the number of hosts (Initiators) connectable to a port is up to 255.

   (2) Target number
   Multiple accessible LUNs by the LUN Security function are defined as the target.
   The target is equivalent to the Fibre Channel host group.
   An iSCSI Name is allocated to each target of iSCSI. When connecting from the host by the iSCSI interface, specify a target iSCSI Name in addition to an IP address/TCP port number and connect it.

   (3) LUN (Logical Unit Number)
   The maximum number of LUNs allocatable to each iSCSI interface port is 2048.

   (4) Port information
   Use the iSCSI interface by setting the information related to the following address.
   - IP address: IPV4 or IPv6
   - Subnet mask:
   - Gateway:
   - TCP port number:

2.2.3.4 Logical Unit

1. Logical Unit Specification
   The specifications of Logical Units supported and accessible from Open system hosts are defined in the Table 2-7.

Table 2-7 LU specification

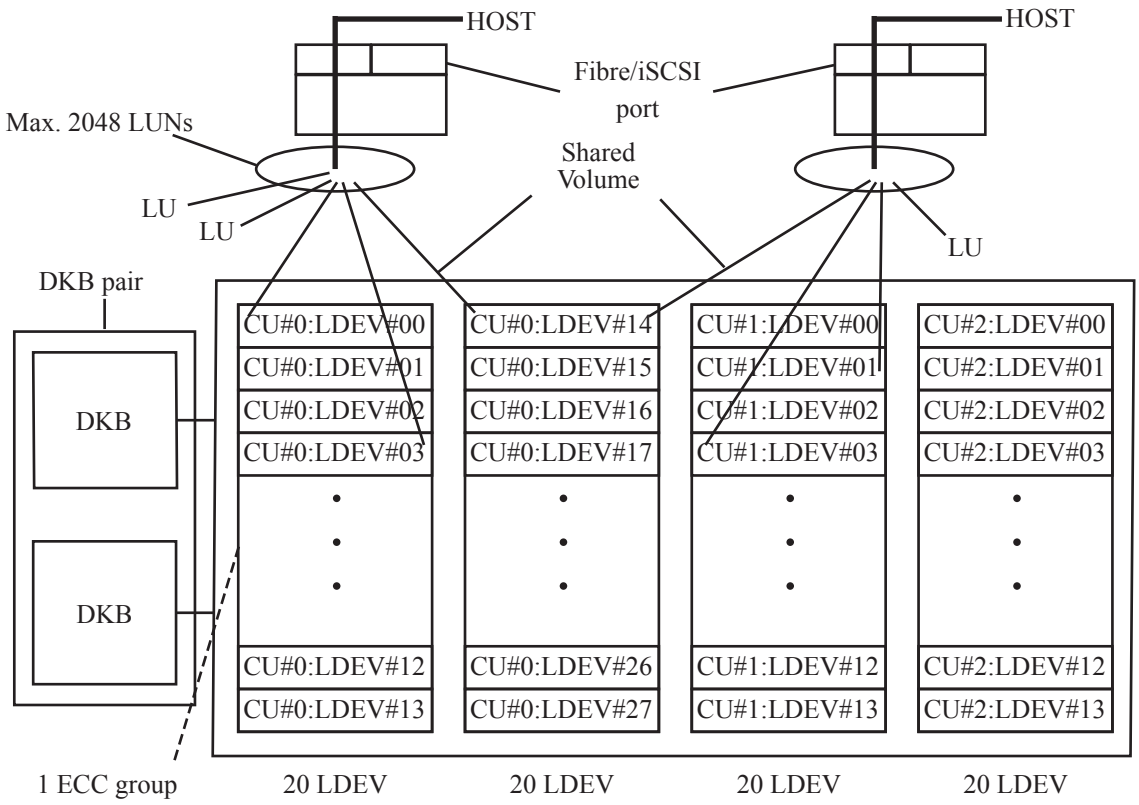
No	Item		Specification
1	Access right		Read/Write
2	Logical Unit (LU) size	G byte (10^9)	OPEN-V × n
		G byte ($1{,}024^3$)	—
3	Block size		512 Bytes
4	# of blocks		—
5	LDEV emulation name		OPEN-V

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

2. Logical Unit definition
   Each volume name, such as OPEN-V 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/iSCSI port will be mapped on any location of LDEV within DKC. This setting is performed by Maintenance PC operation.

   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.

Figure 2-5 LDEV and LU mapping for open volume



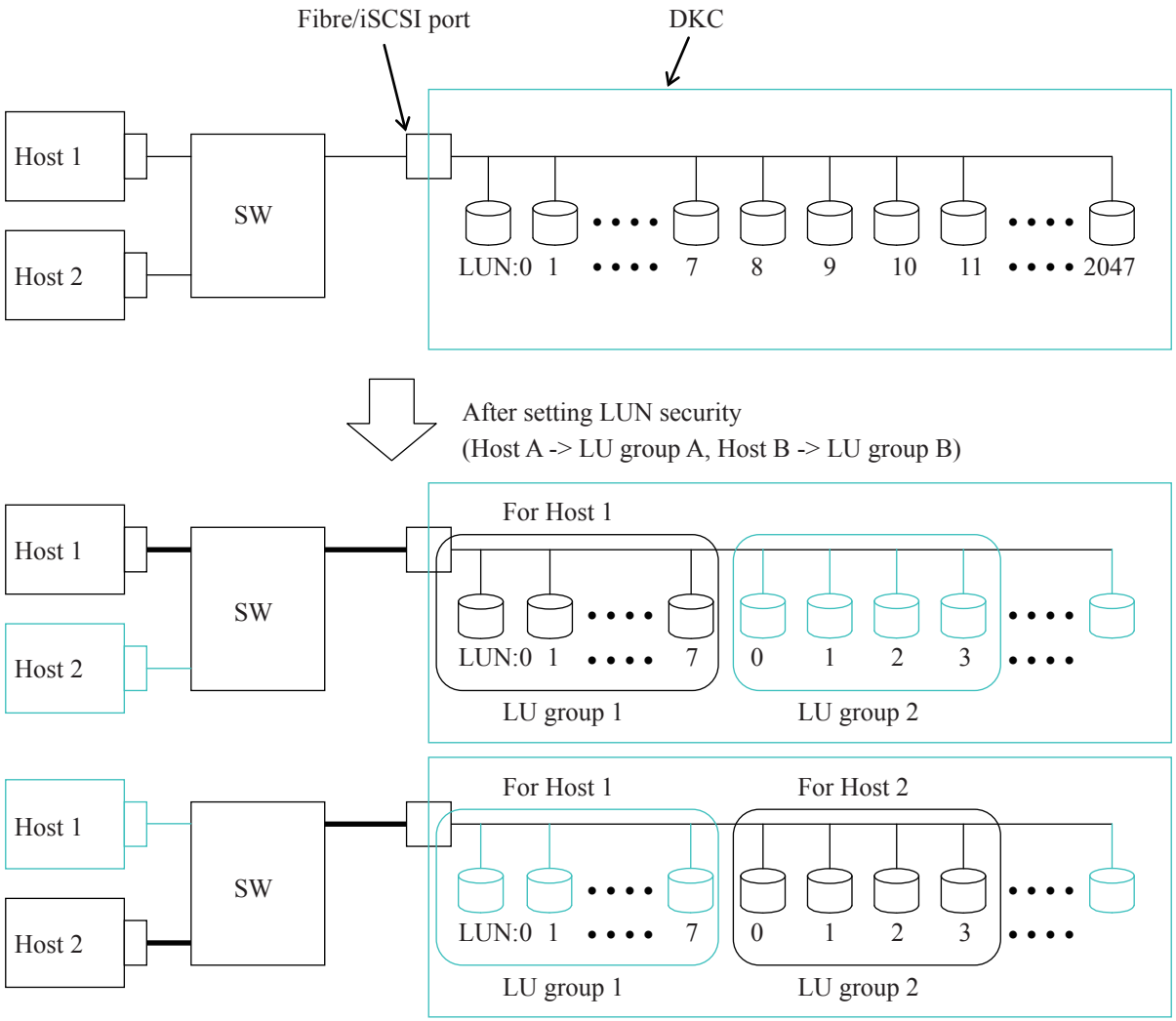
3. LUN Security

(1) Overview

This function connects various types of servers into a segregated, secure environment via the switch in the Fibre/iSCSI 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.

Figure 2-6 LUN Security



2.2.3.5 Volume Setting

1. Setting of volume space
   The volume setting procedure uses the Maintenance PC function.

2. LUN setting
   - LUN setting:

   • Select the CHB, Fibre port and the LUN, and select the CU# and LDEV# to be allocated to the LUN.
   • Repeat the above procedure as needed.
   The MCU port (Initiator port) of TrueCopy function does not support this setting.

*1: It is possible to refer to the contents which is already set on the Maintenance PC display.

*2: The above setting can be done during on-line.

*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 MAINTENANCE PC SECTION "4.1.3 Allocating the Logical Devices of a Storage System to a Host" for more detailed procedures.

2.2.3.6 Host Mode Setting

It is necessary to set Host Mode by using Maintenance PC 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  : (Deprecated) VMWare host mode (*1)
MODE 03  : HP-UX host mode
MODE 04  : Not supported
MODE 05  : OpenVMS host mode
MODE 07  : Tru64 host mode
MODE 08  : Not supported
MODE 09  : Solaris host mode
MODE 0A  : NetWare host mode
MODE 0C  : (Deprecated) Windows host mode (*2)
MODE 0F  : AIX host mode
MODE 21  : VMWare host mode (Online LU)
MODE 2C  : Windows host mode
MODE 4C  : Not supported
others   : Reserved
************************************************************
```

*1: There are no functional differences between host mode 01 and 21. When you first connect a host, it is recommended that you set host mode 21.

*2: There are no functional differences between host mode 0C and 2C. When you first connect a host, it is recommended that you set host mode 2C.

Please set the HOST MODE OPTION if required.
For details, see MAINTENANCE PC SECTION “4.1.4.1 Editing Host Group” (for fibre connection) or “4.1.4.2 Editing iSCSI Target” (for iSCSI connection).

2.2.4 Control Function

2.2.4.1 Cache Specifications (Common to Fibre/iSCSI)

The DKC has two independent areas of Cache Flash Memory for volumes by which high reliability and high performance with the following features can be achieved.

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-write 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 write to the Disk is asynchronous with host access. The host, therefore, can execute the next process without waiting for the end of data write 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. Non-volatile Cache
   Batteries and Cache Flash Memories (CFM) are installed in Controller Board in a DKC. Once a data has been written into a Cache, even if a power interruption occurs, it always holds the data because the data is transferred to the CFM.

2.2.4.2 iSCSI Command Multiprocessing

1. Command Tag Queuing
   The Command Tag Queuing function defined in the SCSI specification is supported.
   This function allows each Fibre/iSCSI port on a CHB to accept multiple iSCSI commands even for the same LUN.
   The DKC can process those queued commands in parallel because a LUN is composed of multiple physical Drives.

2. Concurrent data transfer
   Fibre ports on a CHB can perform the host I/Os and data transfer with maximum 32 Gbps transfer concurrently.
   This is also applied among different CHBs.
   iSCSI ports can perform the host I/Os and data transfer with maximum 10 Gbps transfer concurrently.

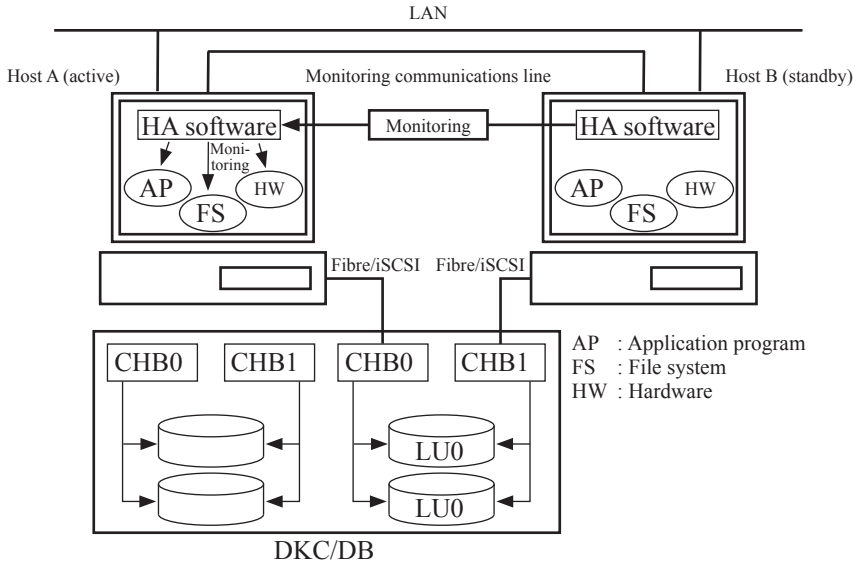
2.2.5 HA Software Linkage Configuration in a Cluster Server Environment

When this Storage System 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.

2.2.5.1 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/iSCSI cables of the active and standby hosts to different CHB Fibre/iSCSI ports.

Figure 2-7 Hot-standby configuration



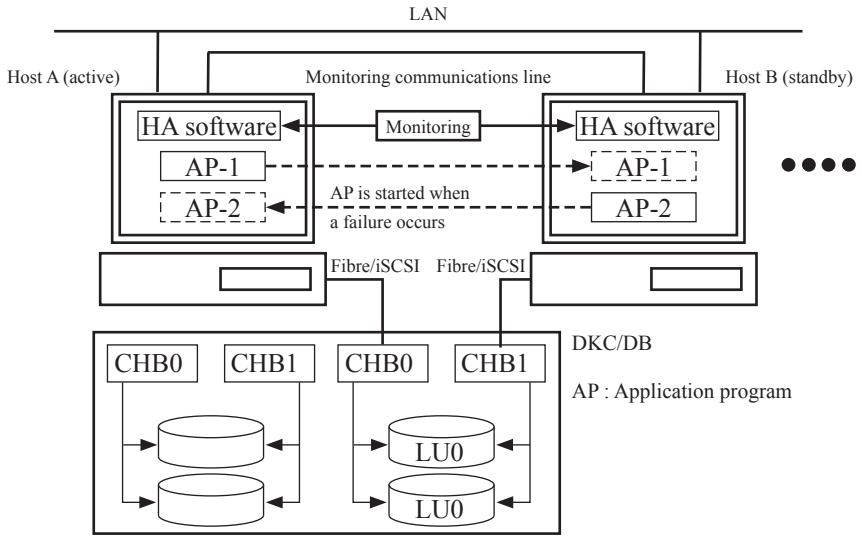
- The HA software under the hot-standby configuration operates in the following sequence:
  (1) The HA software within the active host monitors the operational status of own system by using a monitoring agent and sends the results to the standby host through the monitoring communication line (this process 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.
  (2) 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”).
  (3) 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 requirement 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 requirement may need to be executed once again.

2.2.5.2 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 Storage System has eight Fibre/iSCSI ports, it can, in particular, be applied to a large-scale cluster environment in which more than two hosts exist.

Figure 2-8 Mutual Standby System Configuration

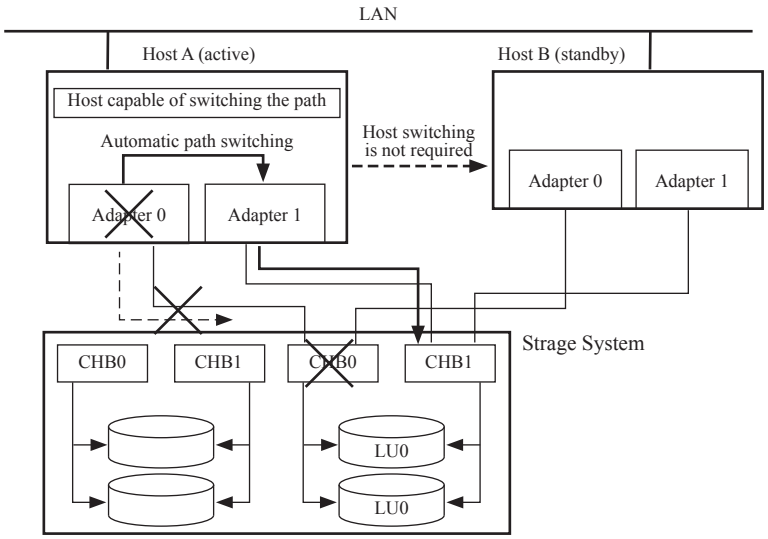


- In the mutual standby configuration, since both hosts operate as the active hosts, no resources exist that become unnecessary during normal processing. On the other hand, however, during a backup operation the disadvantages are caused that performance deteriorated and that the software configuration becomes complex.
- This Storage System is scheduled to support Oracle SUN CLUSTER, Symantec Cluster server, Hewlett-Packard MC/ServiceGuard, and IBM HACMP and so on.

2.2.5.3 Configuration Using Host Path Switching Function

When the host is linked with the HA software and has a path switching capability, if a failure occurs in the adapter, Fibre/iSCSI cable, or DKC (Fibre/iSCSI ports and the CHB) that is being used, automatic path switching will take place as shown below.

Figure 2-9 Host Path Switching Function Using Configuration



The path switching function enables processing to be continued without host switching in the event of a failure in the adapter, Fibre/iSCSI cable, Storage System or other components.

2.2.6 LUN Addition

2.2.6.1 Overview

LUN addition function makes it enable to add LUNs to DW850 Fibre ports in the I/O.
Some host operations are required before the added volumes are recognized and become usable from the host operating systems.

2.2.6.2 Specifications

1. General
   (1) LUN addition function supports Fibre interface.
   (2) LUN addition can be executed by Maintenance PC or by Web Console.
   (3) Some operating systems require reboot operation to recognize the newly added volumes.
   (4) When new LDEVs should be installed for LUN addition, install the LDEVs by Maintenance PC first. Then add LUNs by LUN addition from Maintenance PC or Web Console.

2. Platform support
   Host Platforms supported for LUN addition are shown in Table 2-8.

Table 2-8 Platform support level

Support level	Platform
(A) LUN addition and LUN recognition.	Solaris, HP-UX, AIX, Windows
(B) LUN addition only. Reboot is required before new LUNs are recognized.	Linux
(C) LUN addition is not supported. Host must be shutdown before installing LUNs and then must be rebooted.	—

2.2.6.3 Operations

1. Operations
   Step 1: Execute LUN addition from Maintenance PC.
   Step 2: Check whether or not the platform of the Fibre port supports LUN recognition with Table 2-8.
   Support (A) : Execute LUN recognition procedures in Table 2-8.
   Not support (B) : Reboot host and execute normal install procedure.

2. Host operations
   Host operations for LUN recognition are shown in Table 2-9.

Table 2-9 LUN recognition procedures overview 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
Windows	Automatically detected

2.2.7 LUN Removal

2.2.7.1 Overview

LUN removal function makes it enable to remove LUNs to DW850.

2.2.7.2 Specifications

1. General
   (1) LUN removal can be used only for the ports on which LUNs are already existing.
   (2) LUN removal can be executed by Maintenance PC or by “Web Console”.
   (3) When LUNs should be removed for LUN removal, stop Host I/O of concerned LUNs.
   (4) If necessary, execute backup of concerned LUNs.
   (5) Remove concerned LUNs from HOST.
   (6) In case of AIX, release the reserve of concerned LUNs.
   (7) In case of HP-UX do not remove LUN=0 under existing target ID.

   NOTE: If LUN removal 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 removal 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 removal are shown in Table 2-10.

Table 2-10 Support platform

Platform	OS	Fibre/iSCSI
HP	HP-UX	○
SUN	Solaris	○
RS/6000	AIX	○
PC	Windows	○

(example) ○: supported, ×: not supported

2.2.7.3 Operations

1. Operations

   Step 1: Confirm whether or not the platform supports LUN removal with Table 2-10.
   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: Remove 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 removal from Maintenance PC.

2. Host operations

   Host operations for LUN removal procedures are shown in Table 2-11.

Table 2-11 LUN removal procedures overview for each platform

Platform	LUN removal 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)

2.2.8 Prioritized Port Control (PPC) Functions

2.2.8.1 Overview

The Prioritized Port Control (PPC) function 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.
The Prioritized Port Control option cannot be used simultaneously for both the ports and WWNs for the same DKC. Up to 80 ports or 2048 WWNs can be controlled for each DKC.

*: When the number of the installed ports in the storage system is less than this value, the maximum number is the number of the installed ports in the storage system.

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.

1. 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.

2. 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.

2.2.8.2 Overview of Monitoring Functions

1. 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.

2. 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.

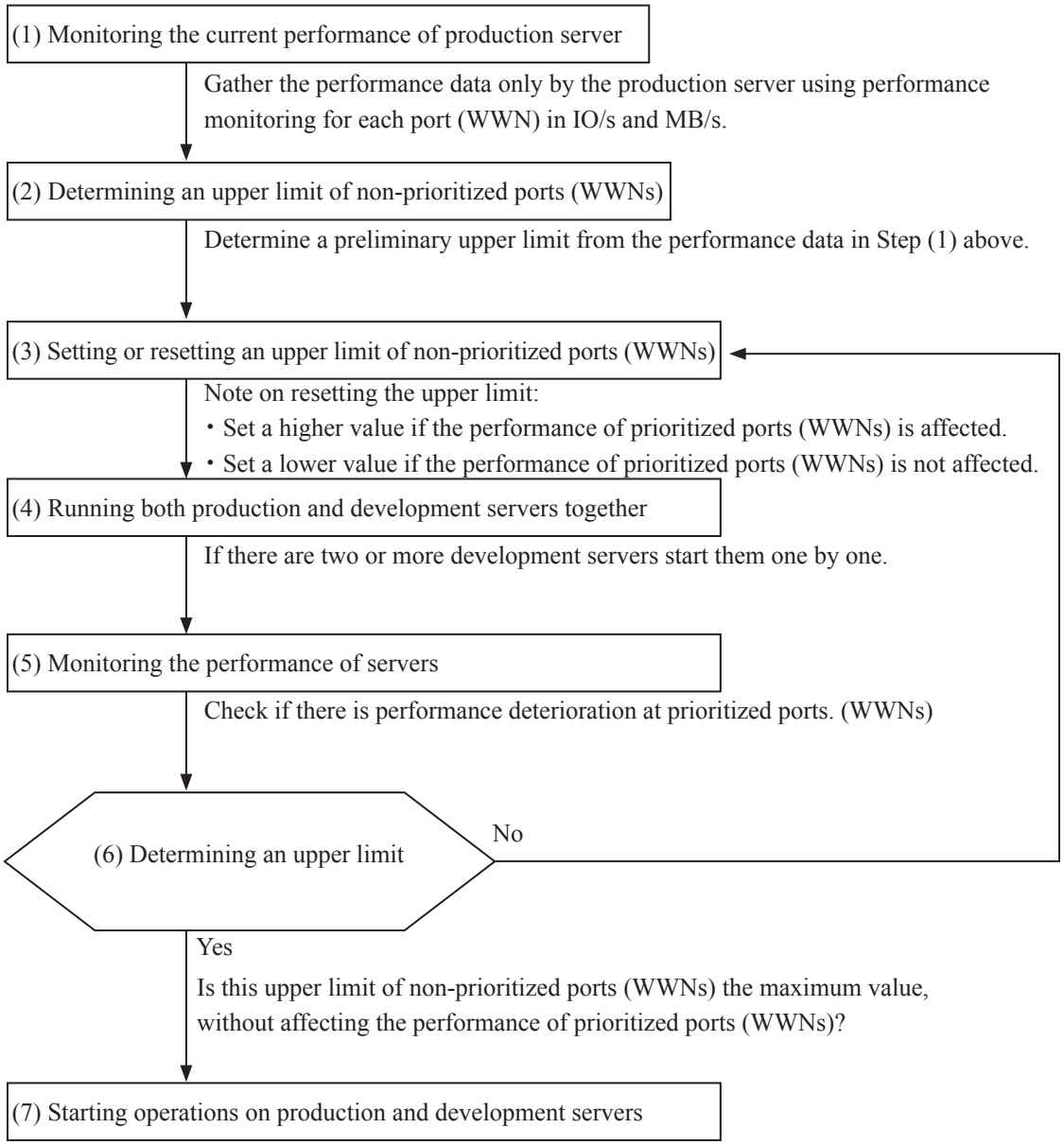
   (1) The Port/WWN Real Time Mode is recommended if you want to monitor the port or WWN performance for a specific period of time (within 24 hours) of a day to check the performance in real time.
   (2) The Port/WWN Offline Mode is recommended if you want to collect certain amount of the port or WWN performance 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.

2.2.8.3 Procedure (Flow) of Prioritized Port and WWN Control

To perform the prioritized port(WWN) control, determine the upper limit to the non-prioritized port(WWN) by checking that the performance monitoring function does not affect production. Figure 2-10 shows the procedures for prioritized port(WWN) control.

Figure 2-10 Flow of Prioritized Port(WWN) Control



2.2.9 Replacing Firmware Online

2.2.9.1 Overview

The firmware replacement during I/O is enabled by reducing the offline time of the firmware replacement significantly.
By doing this, the firmware replacement (online replacement) is enabled without stopping I/O of the host connected to the port on the Channel Board even in the system which does not have the path function.

2.3 Logical Volume Formatting

2.3.1 High-speed Format

2.3.1.1 Overviews

DKC can format two or more ECCs at the same time by providing HDDs with the Logical Volume formatting function. However, when using the encryption function, the high-speed format is unusable.

Table 2-12 Flow of Format

Item No.	Item	Contents
1	Maintenance PC operation	Specify a parity group and execute the LDEV format.
2	Display of execution status	The progress (%) is displayed in the “Task” window or in the summary of the “Parity Group” window and “LDEV” window.
3	Execution result	• Normal: Completed normally • Failed: Terminated abnormally
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 Logical Volume formatting is terminated abnormally in units of ECC when a failure occurs in the HDD.)
5	Operation of the Maintenance PC which is a high-speed Logical Volume formatting object	When the Logical Volume format for more than one ECCs is instructed, the high-speed processing is carried out(*1).
6	PS/OFF or powering off	The Logical Volume formatting is suspended. No automatic restart is executed.
7	Maintenance PC powering off during execution of an Logical Volume formatting	After the Maintenance PC is rebooted, the indication before the PC powering off is displayed in succession.
8	Execution of a high-speed Logical Volume format in the status that the spare is saved	ECC of HDD which the spare is saved fails the high-speed Logical Volume formatting, and changes to a low-speed format. (Because the low-speed formatting is executed after the high-speed format is completed, the format time becomes long.) After the high-speed Logical Volume formatting is completed, execute the copy back of HDD which the spare is saved from SIM log and restore it.

*1: Normal Format is used for ECC of SSD.

2.3.1.2 Estimation of Logical Volume Formatting Time

The standard formatting time of the high-speed LDEV format and the low-speed LDEV format for each Drive type is described below.
Note that the Storage System configuration at the time of this measurement is as shown below.

<Storage System Conditions at the Time of Format Measurement>

- The number of the installed DKBs (VSP G130, G350, G370 and F350, F370: CTL is directly installed, VSP G700, VSP F700, VSP G900 and VSP F900: Two per cluster)
- Without I/O
- Perform the formatting for the single ECC
- Define the number of LDEVs (define a maximum number of 100GB LDEVs for the single ECC)
- Measurement emulation (OPEN-V)

1. HDD
   The formatting time of HDD doesn't depend on number of logical volumes, and be decided by capacity and the rotational speed of HDD.
   (1) High speed LDEV formatting
   The high-speed format time is indicated as follows.
   It is an aim to the last in the standard time required, and the real formatting time may be different by RAID GROUP and a Drive type.

Table 2-13 High-speed format time estimation

(Unit : min)

HDD Capacity/rotation Speed	Formatting Time (*3)	Monitoring Time (*1)
600 GB / 10 krpm	100	150
1.2 TB / 10 krpm	170	260
2.4 TB / 10 krpm	285	430
6 TB / 7.2 krpm	805	1210
10 TB / 7.2 krpm	1090	1635

(2) Slow LDEV formatting

The low-speed format time is indicated as follows.

Rough formatting time per 1 TB/1 PG without host I/O is indicated as follows (*2) (*4).

Table 2-14 10 krpm

• 10 krpm : 600 GB (Unit : min)

RAID Level		600 GB Standard Formatting Time (*3)				
		VSP G130	VSP G350	VSP G370	VSP G700	VSP G900
RAID1	2D+2D	160	130	125	125	120
RAID5	3D+1P	110	85	80	85	85
	4D+1P	85	65	60	65	65
	6D+1P	60	45	45	45	45
	7D+1P	50	40	40	40	40
RAID6	6D+2P	60	50	45	45	45
	12D+2P	35	25	25	25	25
	14D+2P	30	25	20	20	20

• 10 krpm : 1.2 TB (Unit : min)

RAID Level		1.2 TB Standard Formatting Time (*3)				
		VSP G130	VSP G350	VSP G370	VSP G700	VSP G900
RAID1	2D+2D	155	135	130	130	130
RAID5	3D+1P	110	85	85	85	85
	4D+1P	85	65	65	65	65
	6D+1P	60	45	45	45	45
	7D+1P	50	40	40	40	40
RAID6	6D+2P	60	45	45	45	45
	12D+2P	35	25	25	25	25
	14D+2P	30	20	20	20	20

• 10 krpm : 2.4 TB (Unit : min)

RAID Level		2.4 TB Standard Formatting Time (*3)				
		VSP G130	VSP G350	VSP G370	VSP G700	VSP G900
RAID1	2D+2D	145	120	115	115	115
RAID5	3D+1P	100	80	75	75	75
	4D+1P	75	60	60	60	55
	6D+1P	55	40	40	40	35
	7D+1P	50	35	35	35	30
RAID6	6D+2P	50	40	40	40	35
	12D+2P	35	20	20	20	20
	14D+2P	30	20	20	20	15

Table 2-15 7.2 krpm

• 7.2 krpm : 6 TB (Unit : min)

RAID Level		6 TB Standard Formatting Time (*3)				
		VSP G130	VSP G350	VSP G370	VSP G700	VSP G900
RAID1	2D+2D	215	160	160	160	160
RAID5	3D+1P	140	100	90	90	90
	4D+1P	110	75	70	70	65
	6D+1P	75	50	45	45	45
	7D+1P	65	45	40	40	40
RAID6	6D+2P	75	50	45	45	45
	12D+2P	40	30	25	25	25
	14D+2P	35	25	25	25	20

• 7.2 krpm : 10 TB (Unit : min)

RAID Level		10 TB Standard Formatting Time (*3)				
		VSP G130	VSP G350	VSP G370	VSP G700	VSP G900
RAID1	2D+2D	210	160	160	155	155
RAID5	3D+1P	140	90	85	80	80
	4D+1P	105	75	65	60	60
	6D+1P	70	50	45	40	40
	7D+1P	65	45	40	35	35
RAID6	6D+2P	75	50	45	40	40
	12D+2P	40	30	25	20	20
	14D+2P	35	30	25	20	20

2. SSD

SSD doesn't have the self LDEV format function.
LDEV fomatting is performed by slow LDEV format only.
Rough formatting time per 1 TB/1 PG without host I/O is indicated as follows (*2) (*4).

Table 2-16 SSD format time estimation

• SSD : 480 GB (Unit : min)

RAID Level		480 GB Standard Formatting Time (*3)				
		VSP G130	VSP G350	VSP G370	VSP G700	VSP G900
RAID1	2D+2D	15	15	15	15	—
RAID5	3D+1P	20	10	10	10	—
	4D+1P	20	10	10	10	—
	6D+1P	15	5	5	5	—
	7D+1P	15	5	5	5	—
RAID6	6D+2P	20	5	5	10	—
	12D+2P	15	5	5	5	—
	14D+2P	15	5	5	5	—

• SSD : 960 GB (Unit : min)

RAID Level		960 GB Standard Formatting Time (*3)				
		VSP G130	VSP G350	VSP G370	VSP G700	VSP G900
RAID1	2D+2D	15	15	15	15	15
RAID5	3D+1P	20	10	10	10	10
	4D+1P	20	10	10	10	10
	6D+1P	15	5	5	5	5
	7D+1P	15	5	5	5	5
RAID6	6D+2P	20	5	5	5	5
	12D+2P	15	5	5	5	5
	14D+2P	15	5	5	5	5

• SSD : 1.9 TB (Unit : min)

RAID Level		1.9 TB Standard Formatting Time (*3)				
		VSP G130	VSP G350	VSP G370	VSP G700	VSP G900
RAID1	2D+2D	15	15	15	15	15
RAID5	3D+1P	20	10	10	10	10
	4D+1P	20	10	10	10	10
	6D+1P	15	5	5	5	5
	7D+1P	15	5	5	5	5
RAID6	6D+2P	20	5	5	5	5
	12D+2P	15	5	5	5	5
	14D+2P	15	5	5	5	5

(To be continued)

The formatting time becomes the same in 16 SSDs because the transmission of the format data does not arrive even at the limit of passing.

(Continued from the preceding page)

• SSD : 3.8 TB (Unit : min)

RAID Level		3.8 TB Standard Formatting Time (*3)				
		VSP G130	VSP G350	VSP G370	VSP G700	VSP G900
RAID1	2D+2D	15	15	15	15	15
RAID5	3D+1P	20	10	10	10	10
	4D+1P	20	10	10	10	10
	6D+1P	15	10	10	10	10
	7D+1P	15	5	5	5	5
RAID6	6D+2P	20	10	10	10	10
	12D+2P	20	5	5	5	5
	14D+2P	20	5	5	5	5

• SSD : 7.6 TB (Unit : min)

RAID Level		7.6 TB Standard Formatting Time (*3)				
		VSP G130	VSP G350	VSP G370	VSP G700	VSP G900
RAID1	2D+2D	15	15	15	15	15
RAID5	3D+1P	20	10	10	10	10
	4D+1P	20	10	10	10	10
	6D+1P	15	5	5	5	5
	7D+1P	15	5	5	5	5
RAID6	6D+2P	20	10	5	5	5
	12D+2P	20	5	5	5	5
	14D+2P	20	5	5	5	5

• SSD : 15 TB (Unit : min)

RAID Level		15 TB Standard Formatting Time (*3)				
		VSP G130	VSP G350	VSP G370	VSP G700	VSP G900
RAID1	2D+2D	20	20	20	20	20
RAID5	3D+1P	25	15	15	15	15
	4D+1P	25	15	15	15	15
	6D+1P	20	10	10	10	10
	7D+1P	20	10	10	10	10
RAID6	6D+2P	30	10	10	10	10
	12D+2P	20	10	10	10	10
	14D+2P	20	10	10	10	10

The formatting time becomes the same in 16 SSDs because the transmission of the format data does not arrive even at the limit of passing.

3. FMD

The formatting time of FMD doesn't depend on number of ECC, and be decided by capacity of FMD.

(1) High speed LDEV formatting

The high-speed format time is indicated as follows.

It is an aim to the last in the standard time required, and the real formatting time may be different by RAID GROUP and a Drive type.

Table 2-17 FMD High-speed format time estimation

(Unit : min)

FMD Capacity	Formatting Time (*3)	Time Out Value (*1)
3.5 TB (3.2 TiB)	5	10
7 TB	5	10
14 TB	5	10

(2) Slow LDEV formatting

The low-speed format time is indicated as follows.

Rough formatting time per 1 TB/1 PG without host I/O is indicated as follows (*2) (*4).

Table 2-18 FMD Low-speed format time estimation

• FMD : 3.5 TB (3.2 TiB) (Unit : min)

RAID Level		3.5 TB Standard Formatting Time (*3)			
		VSP G350	VSP G370	VSP G700	VSP G900
RAID1	2D+2D	-	-	5	5
RAID5	3D+1P	-	-	5	5
	4D+1P	-	-	5	5
	6D+1P	-	-	5	5
	7D+1P	-	-	5	5
RAID6	6D+2P	-	-	5	5
	12D+2P	-	-	5	5
	14D+2P	-	-	5	5

• FMD : 7 TB (Unit : min)

RAID Level		7 TB Standard Formatting Time (*3)			
		VSP G350	VSP G370	VSP G700	VSP G900
RAID1	2D+2D	-	-	10	10
RAID5	3D+1P	-	-	5	5
	4D+1P	-	-	5	5
	6D+1P	-	-	5	5
	7D+1P	-	-	5	5
RAID6	6D+2P	-	-	5	5
	12D+2P	-	-	5	5
	14D+2P	-	-	5	5

• FMD : 14 TB (Unit : min)

RAID Level		14 TB Standard Formatting Time (*3)			
		VSP G350	VSP G370	VSP G700	VSP G900
RAID1	2D+2D	-	-	10	10
RAID5	3D+1P	-	-	5	5
	4D+1P	-	-	5	5
	6D+1P	-	-	5	5
	7D+1P	-	-	5	5
RAID6	6D+2P	-	-	5	5
	12D+2P	-	-	5	5
	14D+2P	-	-	5	5

*1: After the standard formatting time has elapsed, the display on the Web Console shows 99% until it reaches to the monitoring time. Because Drive itself performs the format, 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: 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.

*3: The formatting time varies according to the generation of the Drive in standard time distance.

NOTE: The formatting time when mixing the Drive types and the configurations described in "(1) High speed LDEV formatting" and "(2) Slow LDEV formatting" divides into the following cases.

(a) When only the high speed formatting available Drives (1. HDD, 3. FMD) are mixed
The formatting time is the same as the formatting time of Drive types and configurations with the maximum standard time.

(b) When only the low speed formatting available Drives (2. SSD) are mixed
The formatting time is the same as the formatting time of Drive types and configurations with the maximum standard time.

(c) When the high speed formatting available Drives (1. HDD, 3. FMD) and the low speed formatting available Drives (2. SSD) are mixed

(1) The maximum standard time in the high speed formatting available Drive configuration is the maximum high speed formatting time.

(2) The maximum standard time in the low speed formatting available Drive configuration is the maximum low speed formatting time.

The formatting time is the sum of the above formatting time (1) and (2).

When the high speed formatting available Drives and the low speed formatting available Drives are mixed in one formatting process, the low speed formatting starts after the high speed formatting is completed. Even after the high speed formatting is completed, the logical volumes with the completed high speed formatting cannot be used until the low speed formatting is completed.

In all cases of (a), (b) and (c), the time required to start using the logical volumes takes longer than the case that the high speed formatting available Drives and the low speed formatting available Drives are not mixed.
Therefore, when formatting multiple Drive types and the configurations, we recommend dividing the formatting work and starting the work individually from a Drive type and a configuration with the shorter standard time.

*4: The time required to format the drive might be increased by up to approximately 20% in the DB on the rear stage in cascade connection.

2.3.2 Quick Format

2.3.2.1 Overviews

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

Table 2-19 Quick Format Specifications

Item No.	Item	Contents
1	Support Drive HDD type	All Drive type support
2	Number of parity groups	• Quick Format can be performed on multiple parity groups simultaneously. The number of those parity groups depends on the total of parity group entries. The number of entries is an indicator for controlling the number of parity groups on which Quick Format can be performed. The number of parity group entries depends on the drive capacity configuring each parity group. The number of entries for parity groups is as follows. • Parity group configured with drives of 32 TB or less: 1 entry • Parity group configured with drives of more than 32 TB: 2 entries The maximum number of entries on which Quick Format can be performed is as follows. • VSP G130, VSP G350/G370, VSP F350/F370: 18 entries • VSP G700, VSP F700: 36 entries • VSP G900, VSP F900: 72 entries • The number of volumes does not have a limit if it is less than or equal to the maximum number of entries. • 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.
3	Combination with various P.P.	It is operable in combination with all P.P.
4	Formatting types	When performing a format from Maintenance PC, Web Console or CLI, you can select either Quick Format or the normal format.
5	Additional start in execution	Additional Quick Format can be executed during Quick Format execution. In this case, the total number of entries during Quick Format and those to be added is limited to the maximum number of entries per model.
6	Preparing Quick Format	• When executing Quick Format, management information is created first. I/O access cannot be executed in the same way as the normal format in this period. • Creating management information 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.

(To be continued)

(Continued from the preceding page)

Item No.	Item	Contents
7	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 Storage System. When the volume is restored afterwards, the volume status becomes “Normal (Quick Format)”. Therefore, parity groups in which all volumes during Quick Format are blocked are included in the number of entries during Quick Format. The number of entries for additional Quick Format can be calculated with the following calculating formula: The maximum number of entries per model - X - Y (Legend) X: The number of entries for parity groups during Quick Format. Y: The number of entries for parity groups in which all volumes during Quick Format are blocked.
8	Operation at the time of PS OFF/ON	After P/S ON, Quick Format restarts.
9	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. • When the parity group setting is the Accelerated Compression, Quick Format cannot be performed. (If performed, it terminates abnormally)

2.3.2.2 Volume Data Assurance during Quick Formatting

The Quick Formatting management table is kept on SM. This model can prevent the management table from volatilizing by backing up the SM to an SSD, and assures the data quality during Quick Formatting.

2.3.2.3 Quick Formatting Time

Quick Format is executed in the background while I/O from and to the host is performed.
Therefore, the Quick Format time may vary significantly depending on the number of I/Os from and to the host or other conditions.
You can also calculate a rough estimation of the Quick Format time using the following formula.

Rough estimation of Quick Format time

- When executing Quick Format in the entire area of a parity group
  Format time = Format standard time (see Table 2-20)
  × Format multiplying factor (see Table 2-21) × ↑ (The number of parity groups ÷ 8) ↑
- When executing Quick Format on some LDEVs in a parity group
  Format time = Format standard time (see Table 2-20)
  × Format multiplying factor (see Table 2-21) × ↑ (The number of parity groups ÷ 8) ↑
  × (Capacity of LDEVs on which Quick Format is executed ÷ Capacity of a parity group)

NOTE: " ↑ "indicates roundup.

Table 2-20 shows the Quick Format time when no I/O is performed in the entire area of a parity group.

Table 2-20 Quick Format Time

Drive type	Formatting time
6R0H9M/6R0HLM (7.2 krpm)	78 h
10RH9M/10RHLM (7.2 krpm)	130 h
600JCMC (10 krpm)	8 h
1R2JCMC/1R2J7MC (10 krpm)	15 h
2R4JGM/2R4J8M (10 krpm)	31 h
480MGM(SSD)	2 h
960MGM(SSD)	4 h
1R9MGM (SSD)	8 h
3R8MGM(SSD)	17 h
7R6MGM (SSD)	34 h
15RMGM (SSD)	67 h
3R2FN (FMD)	16 h
7R0FP (FMD)	32 h
14RFP (FMD)	64 h

Table 2-21 Format Multiplying Factor

RAID level	I/O	Multiplying factor
RAID1	No	0.5
	Yes	2.5
RAID5, RAID6	No	1.0
	Yes	5.0

- When Quick Format is executed to parity groups with different Drive capacities at the same time, calculate the time based on the parity group with the largest capacity.

2.3.2.4 Performance during Quick Format

Quick Format executes the formatting 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 2-22 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%

2.3.2.5 Combination with Other Maintenance

Table 2-23 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	LDEV Format (high-speed / low-speed)	The LDEV Format is executable for the volumes that Quick Format is not executed.
3	Volume maintenance block	It is possible to block the volumes instructed by Web Console or CLI for the volumes during Quick Format.
4	Volume forcible restore	If forcible restore is executed after the maintenance block, 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	PK replacement	Possible as usual

2.3.2.6 SIM Output When Quick Format Completed

After Quick Format is completed, SIM = 0x410100 is output when performing Quick Format.
However, SIM is not output when Quick Format is performed by Command Control Interface (CCI).

2.4 Ownership Right

2.4.1 Requirements Definition and Sorting Out Issues

Table 2-24 Confirmation and Definitions of Requirement and issues

#	Requirement	Case
1	Maximize system performance by using MPU effectively	Initial set up (Auto-Define-Configuration) Ownership management resources are added.
2		At performance tuning
3	Troubleshoot in the case of problems related to ownership	Troubleshoot
4	Confirm resources allocated to each MPU	Ownership management resources are added. At performance tuning Troubleshoot
5	Maintain performance for resources allocated to specific MPU	Maintain performance for resources allocated to specific MPU

2.4.1.1 Requirement #1

Requirement

Maximize system performance by using MPU effectively.

Issue

Way to distribute resources to balance load of each MPU.

How to realize

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

Case

(A) At the time of initial construction (Auto-Define-Configuration)
Target resource : LDEV
Setting IF : Maintenance PC

(B) Ownership management resources are added.
Target resources : LDEV / External VOL / JNLG
Setting IF : Maintenance PC / Storage Navigator / CLI / RMLib

2.4.1.2 Requirement #2

Requirement

Maximize system performance by using MPU effectively.

Issue

Way to move resources to balance load of each MPU.

How to realize

User directly requirement s to move resources.

Case

Performance tuning

Target resources : LDEV / E xternal VOL / JNLG

Setting IF : Storage Navigator / CLI / RMLib

2.4.1.3 Requirement #3

Requirement

Troubleshooting in the case of problems related to ownership.

Issue

Way to move resources required for solving problems.

How to realize

Maintenance personnel directly requirement s to move resources.

Case

Troubleshooting

Target resources : LDEV / External VOL / JNLG

Setting IF : Storage Navigator / CLI / RMLib

2.4.1.4 Requirement #4

Requirement

Confirm resources allocated to each MPU.

Issue

Way to reference resources allocated to each MPU.

How to realize

User directly requirement to reference resources.

Case

(A) Before ownership management resources are added.
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) Troubleshooting
Target resources : LDEV / External VOL / JNLG
Referring IF : Storage Navigator / CLI / Report (XPDT) / RMLib

2.4.1.5 Requirement #5

Requirement

Maintain performance for resources allocated to specific MPU.

Issue

Way to move resources allocated to each MPU automatically and, way to prevent movement of resources during addition of MPU.

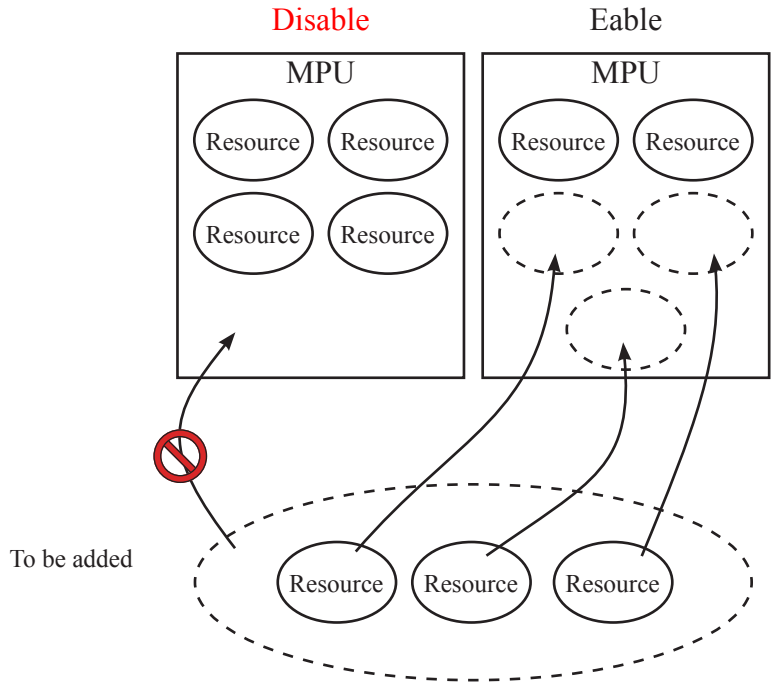
How to realize

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

Case

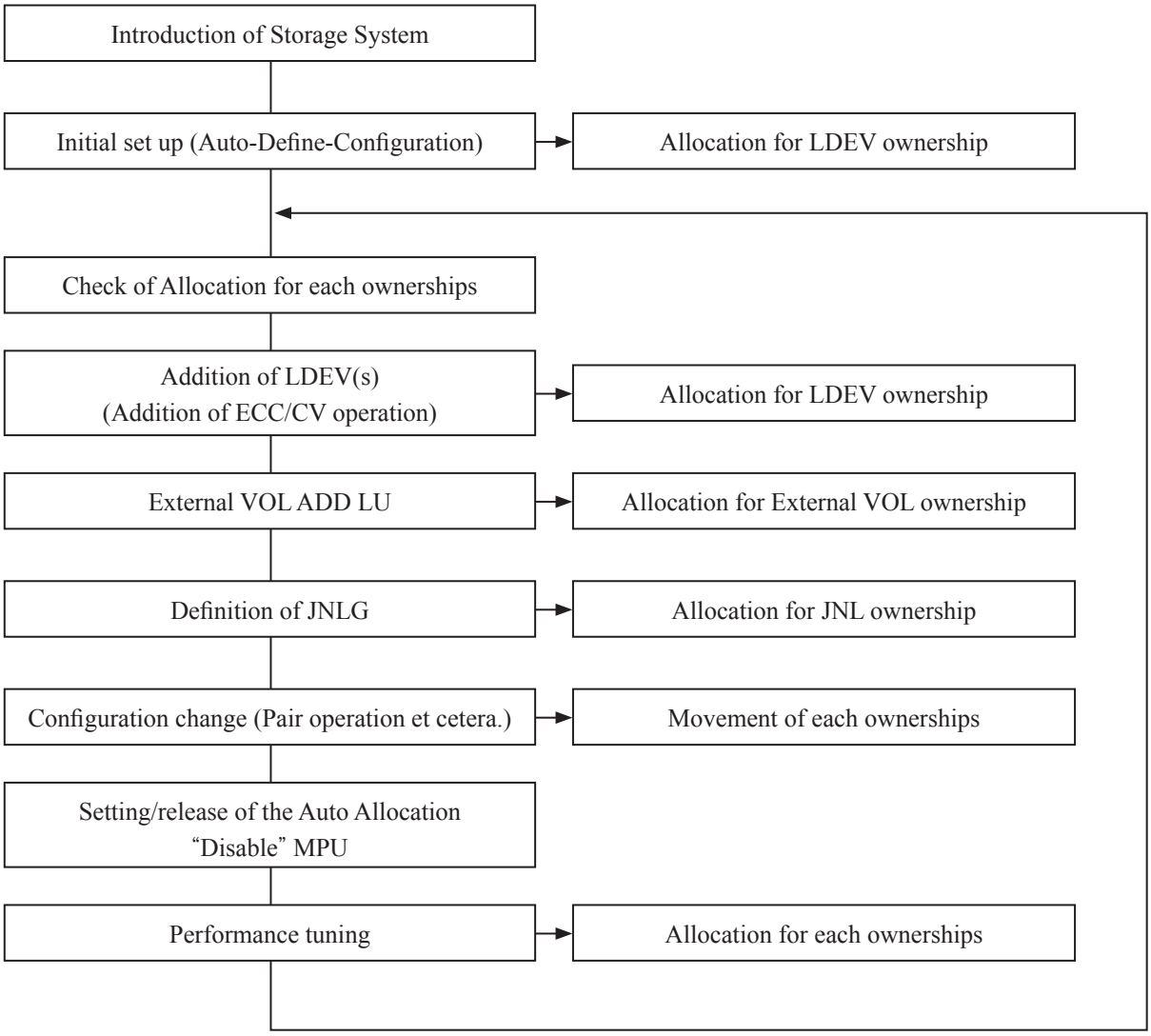
(A) When adding ownership management resources, preventing allocation of resources to the Auto Allocation “Disable” MPU.

Figure 2-11 Requirement #5 (A)



2.4.1.6 Process Flow

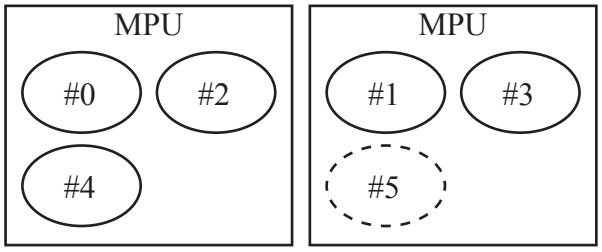
Figure 2-12 Process flow



2.4.2 Resource Allocation Policy

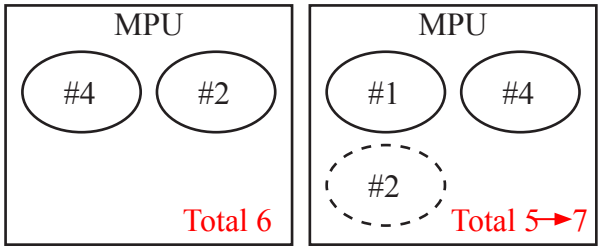
1. Both User-specific and automation allocation are based on the common policy. Allocate resources to each MPU equally.

Figure 2-13 Resource allocation Policy (1)



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

Figure 2-14 Resource allocation Policy (2)



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

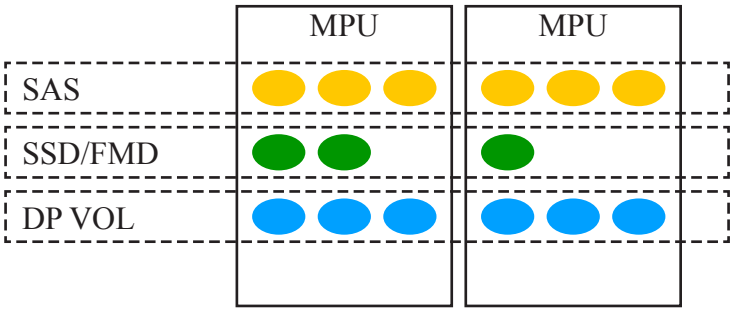
2.4.2.1 Automation Allocation

Allocate resources to each MPU equally independently in each type.

Table 2-25 Automation allocation

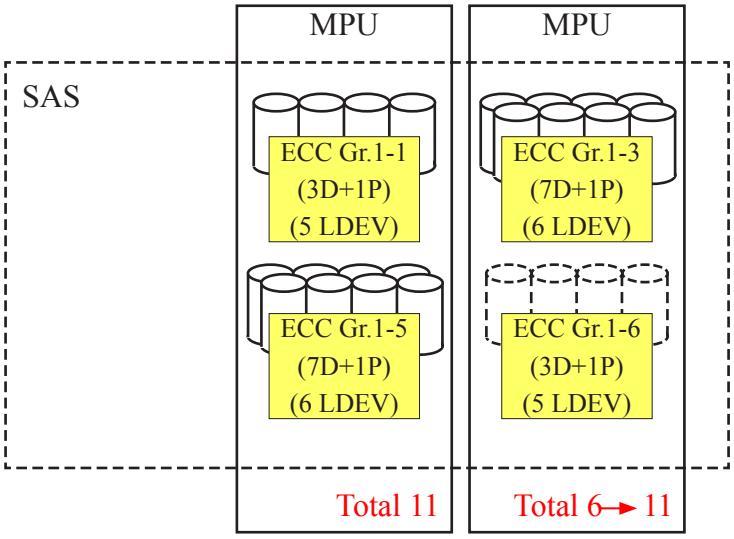
Ownership	Device type	Unit	Leveling
LDEV	SAS	ECC Gr.	Number of LDEVs
	SSD/FMD	LDEV	Number of LDEVs
	DP VOL	LDEV	Number of LDEVs
External VOL	—	Ext. VOL	Number of Ext. VOLs
JNLG	—	JNLG	Number of JNLGs.

Figure 2-15 Automation allocation



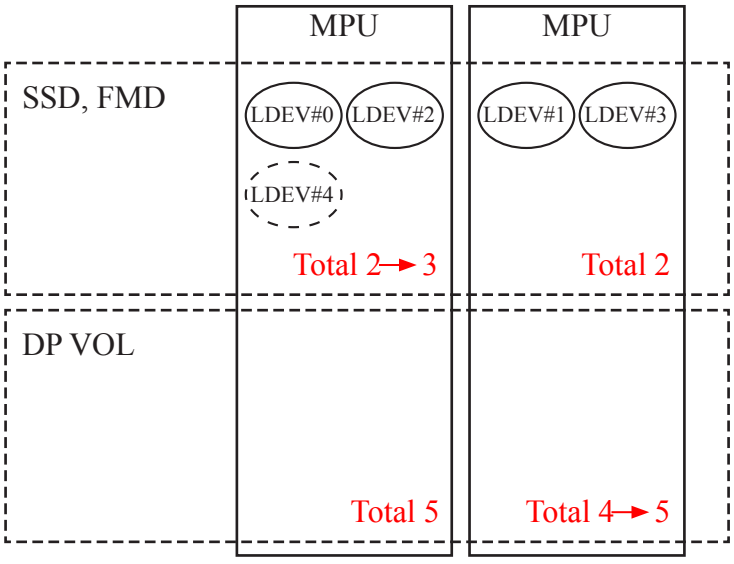
1. Automation allocation (SAS)
   Unit : ECC Gr.
   Leveling : Number of LDEVs

Figure 2-16 Automation allocation (SAS)



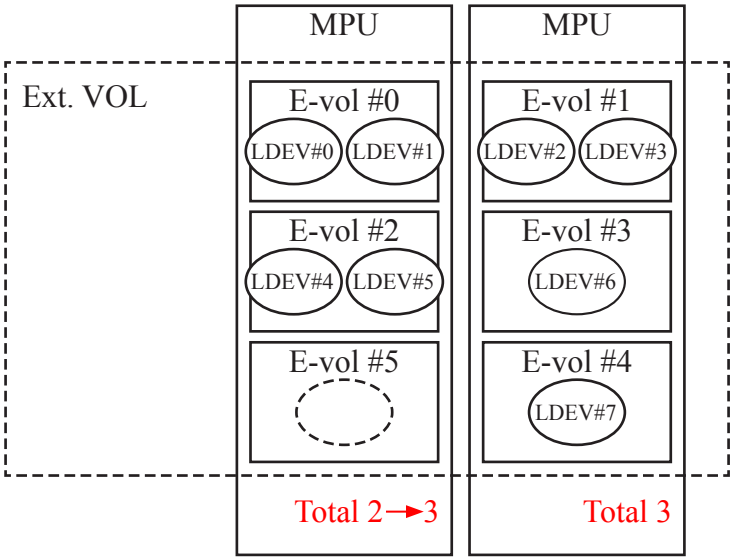
2. Automation allocation (SSD, FMD/DP VOL)
   Unit : ECC Gr.
   Leveling : Number of LDEVs

Figure 2-17 Automation allocation (SSD, FMD/DP VOL)



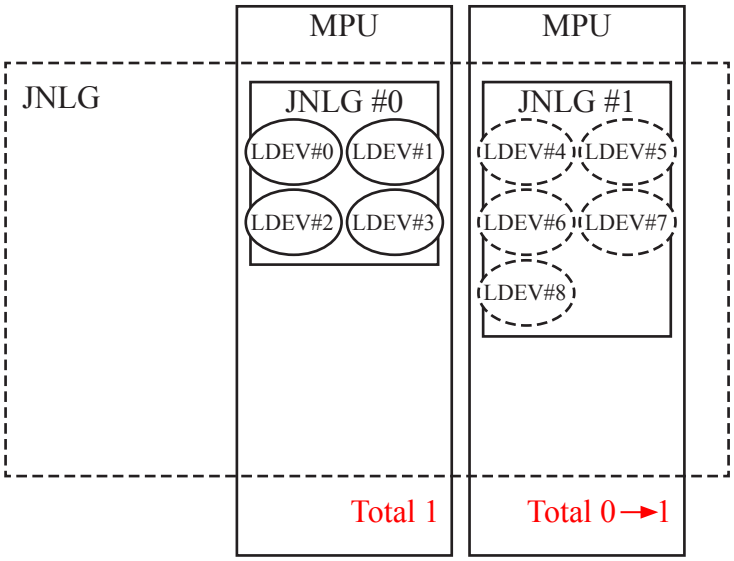
3. Automation allocation (Ext. VOL)
   Unit : Ext. VOL
   Leveling : Number of Ext. VOLs (not Ext. LDEVs)

Figure 2-18 Automation allocation (Ext. VOL)



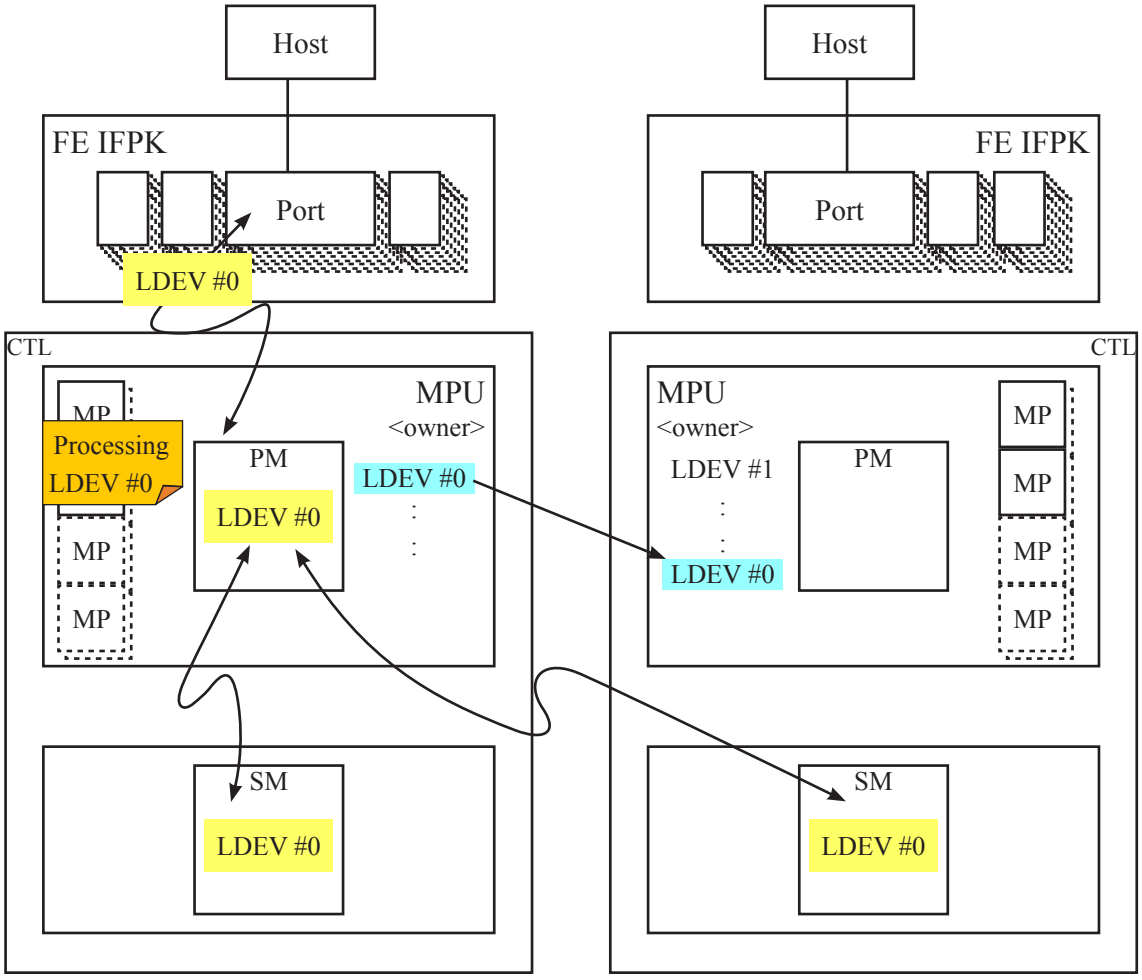
4. Automation allocation (JNLG)
   Unit : JNLG
   Leveling : Number of JNLGs (not JNL VOLs)

Figure 2-19 Automation allocation (JNLG)



2.4.3 MPU Block

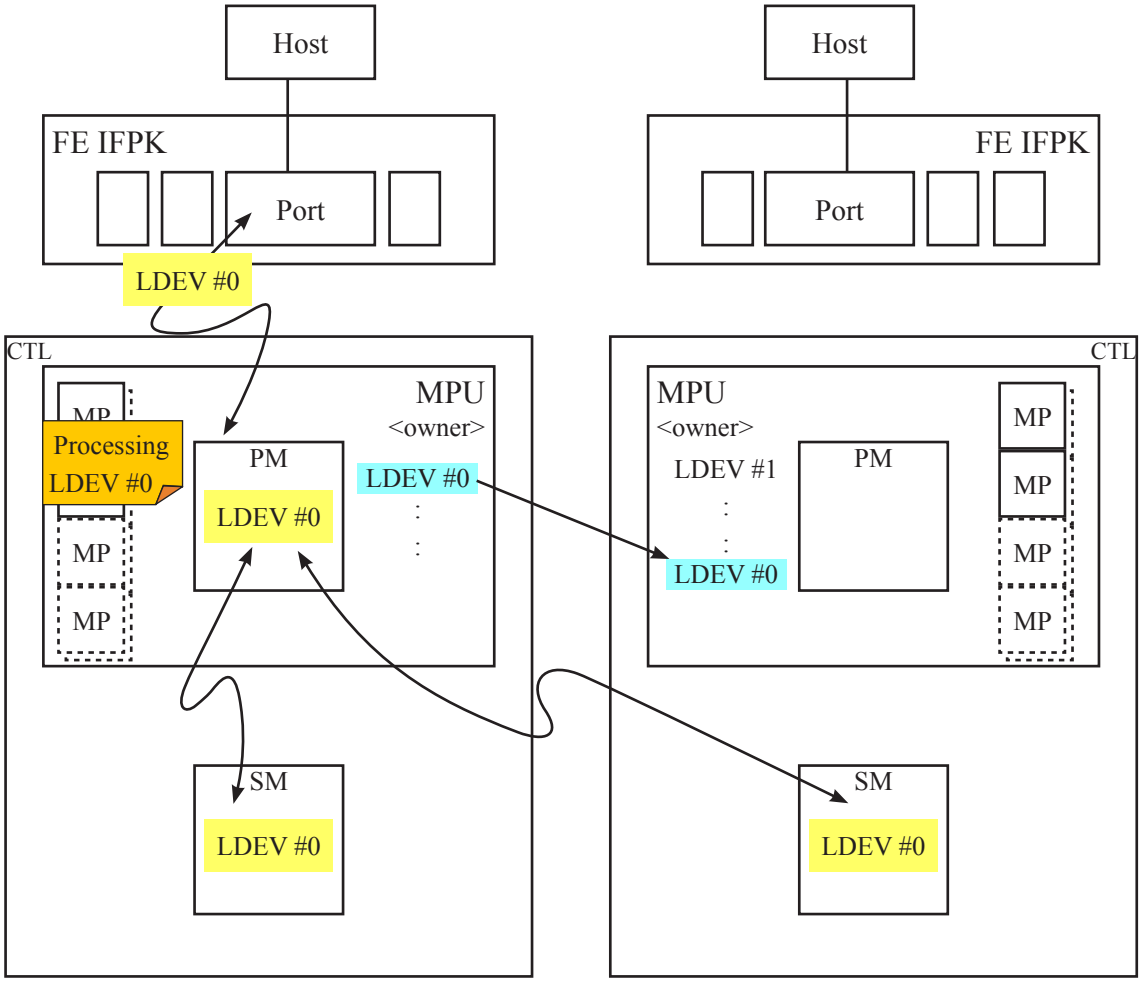
Figure 2-20 MPU block



2.4.3.1 MPU Block for Maintenance

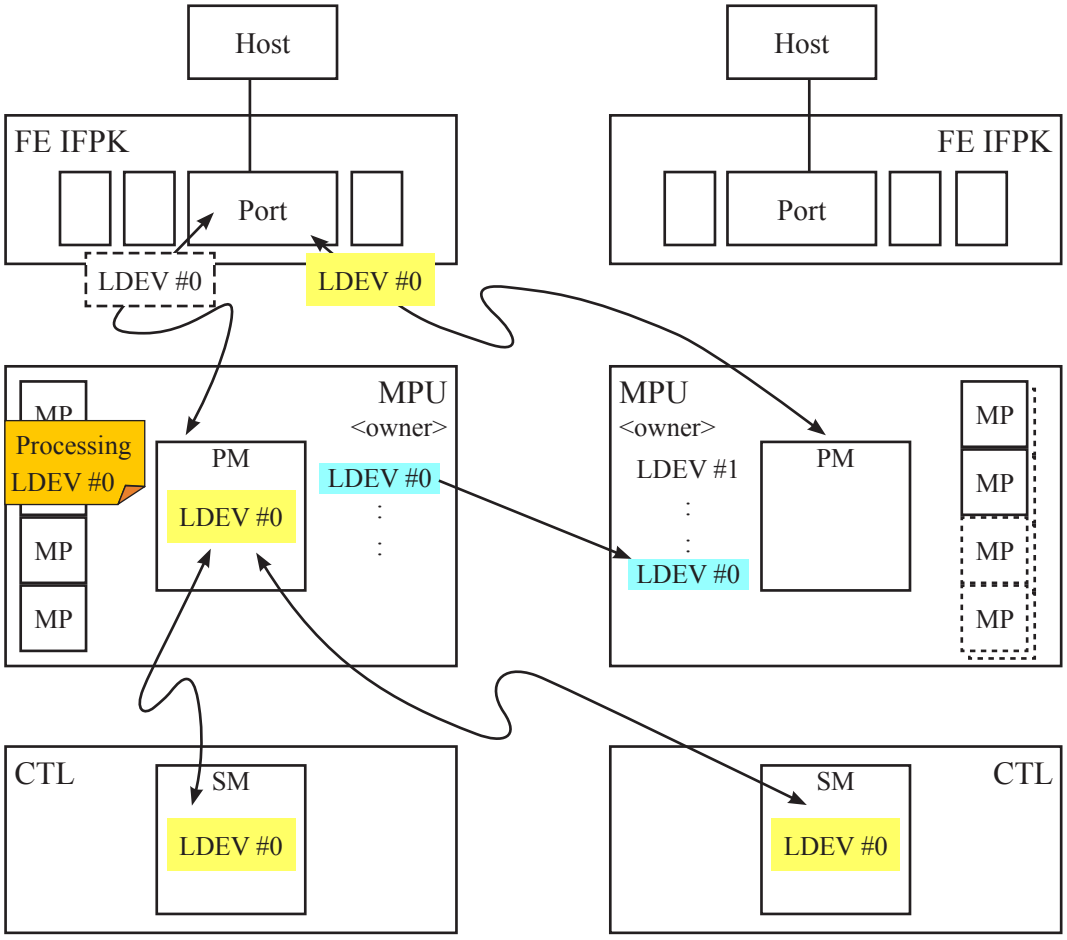
Step1. Make the ownership the moving transient state.

Figure 2-21 MPU block for maintenance (1)



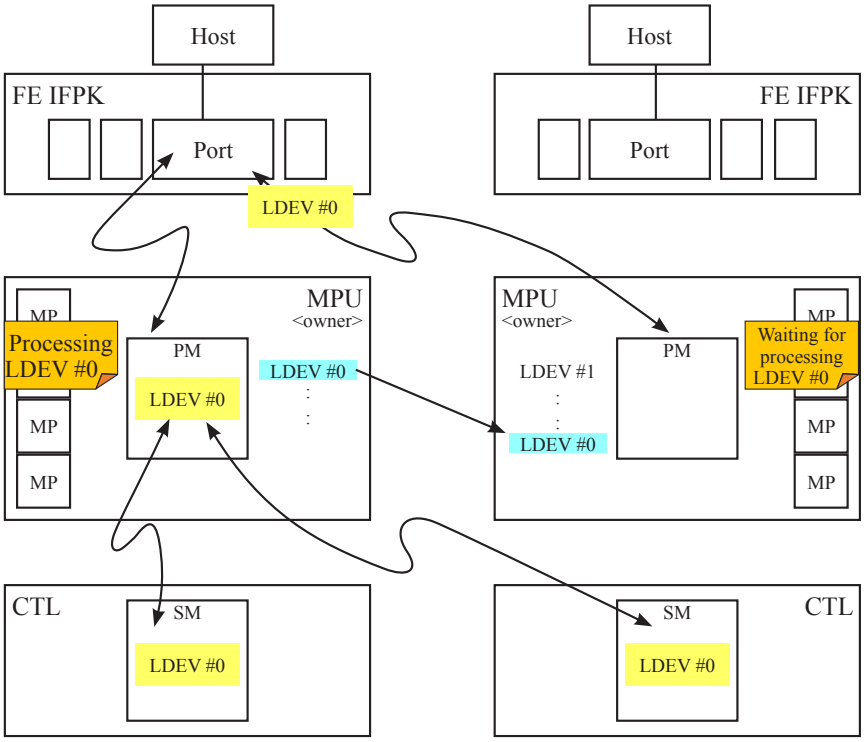
Step2. Switch MPU, to which I/O is issued, to the target MPU (to which the ownership is moved).

Figure 2-22 MPU 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.)

Figure 2-23 MPU block for maintenance (3)

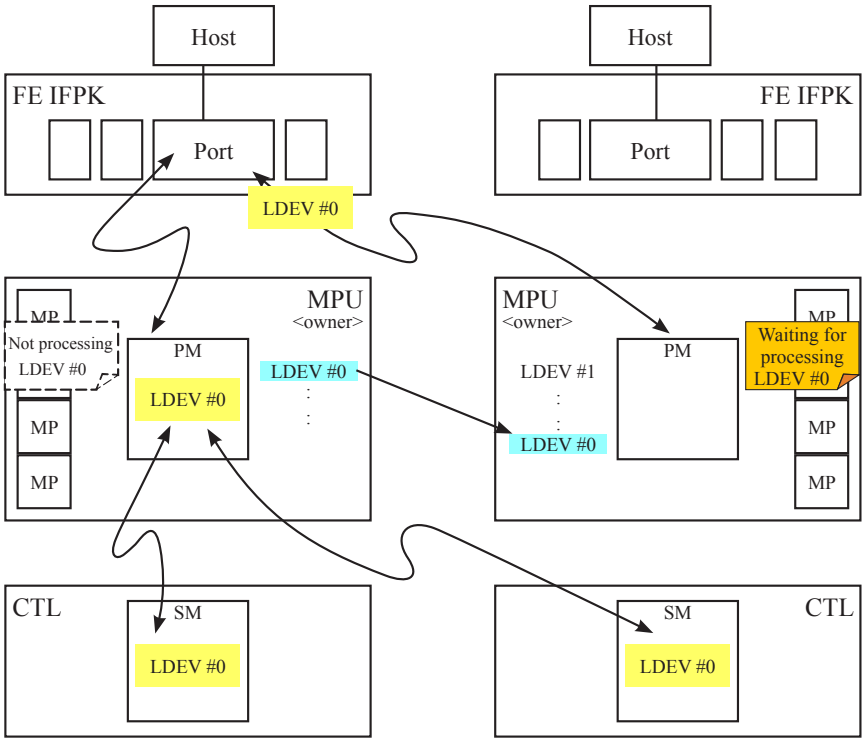


<Target MPU>
- I/O is issued to the target MPU, but processing waits until ownership is completely moved.

<Source MPU>
- Monitor until all ongoing processing is completed. After it is completed. Go on to Step4.
- When Time Out is detected, terminate ongoing processing forcibly.

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

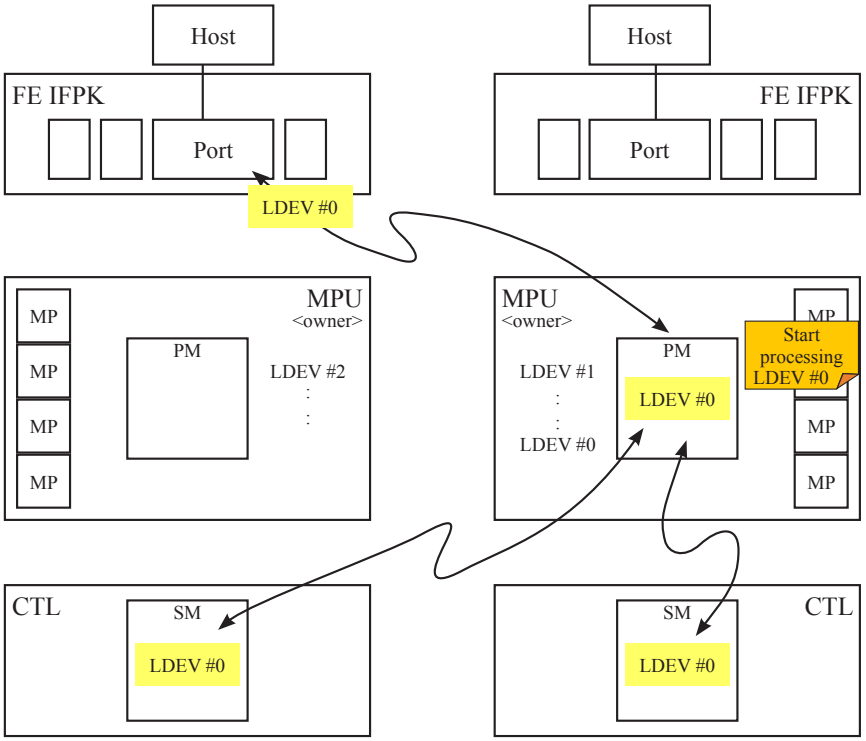
Figure 2-24 MPU block for maintenance (4)



<Source MPU>
- When disabling PM information, only representative info is rewritten, so processing time is less than 1ms.

Step5. Moving ownership is completed and the processing starts in the target MPU.

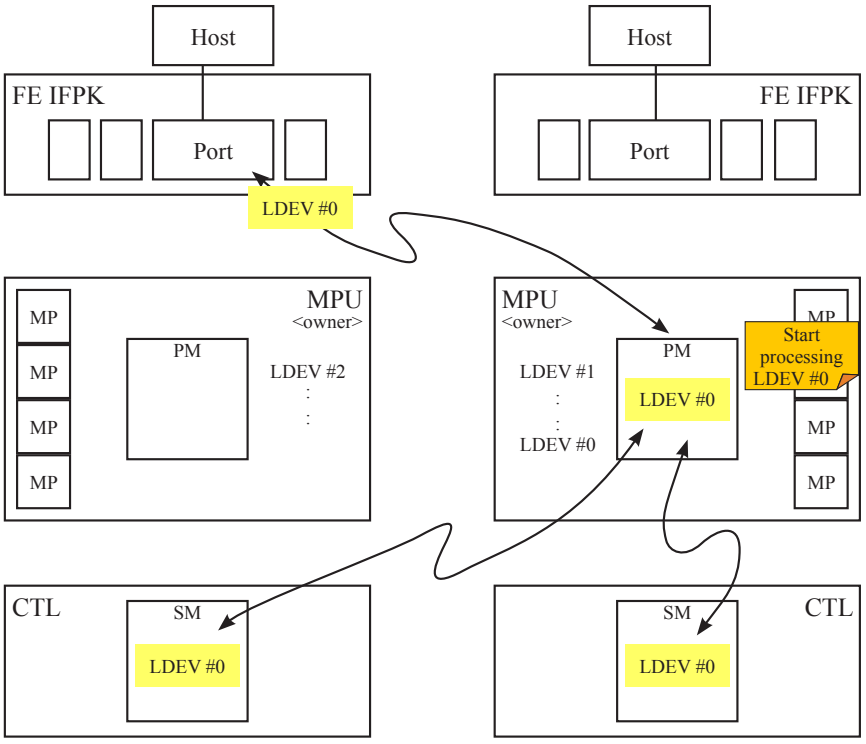
Figure 2-25 MPU block for maintenance (5)



<Target MPU>
- Immediately after processing is started, SM is accessed, so access performance to control info is degraded compared to before moving ownership.
- Along with the progress of the PM information collection, access performance to the control information is improved.

Step6. Perform Step1. to Step5. for all resources under the MPU blocked and after they are completed, block MPU.

Figure 2-26 MPU block for maintenance (6)

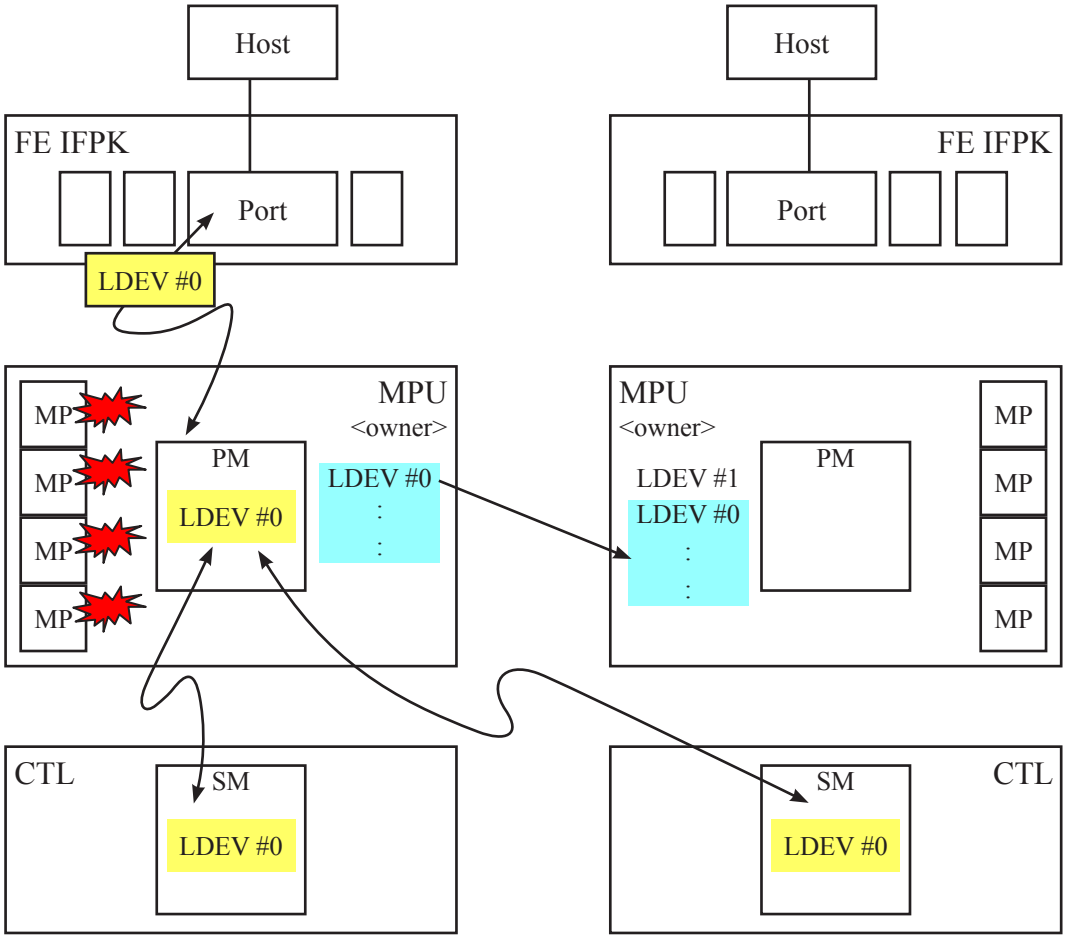


<Moving ownership>
- Move resources that are related to ShadowImage, UR, and TI synchronously.
- If they are moved at a time, performance would be affected significantly, so move them in phase as long as maintenance time is permissible.

2.4.3.2 MPU Block due to Failure

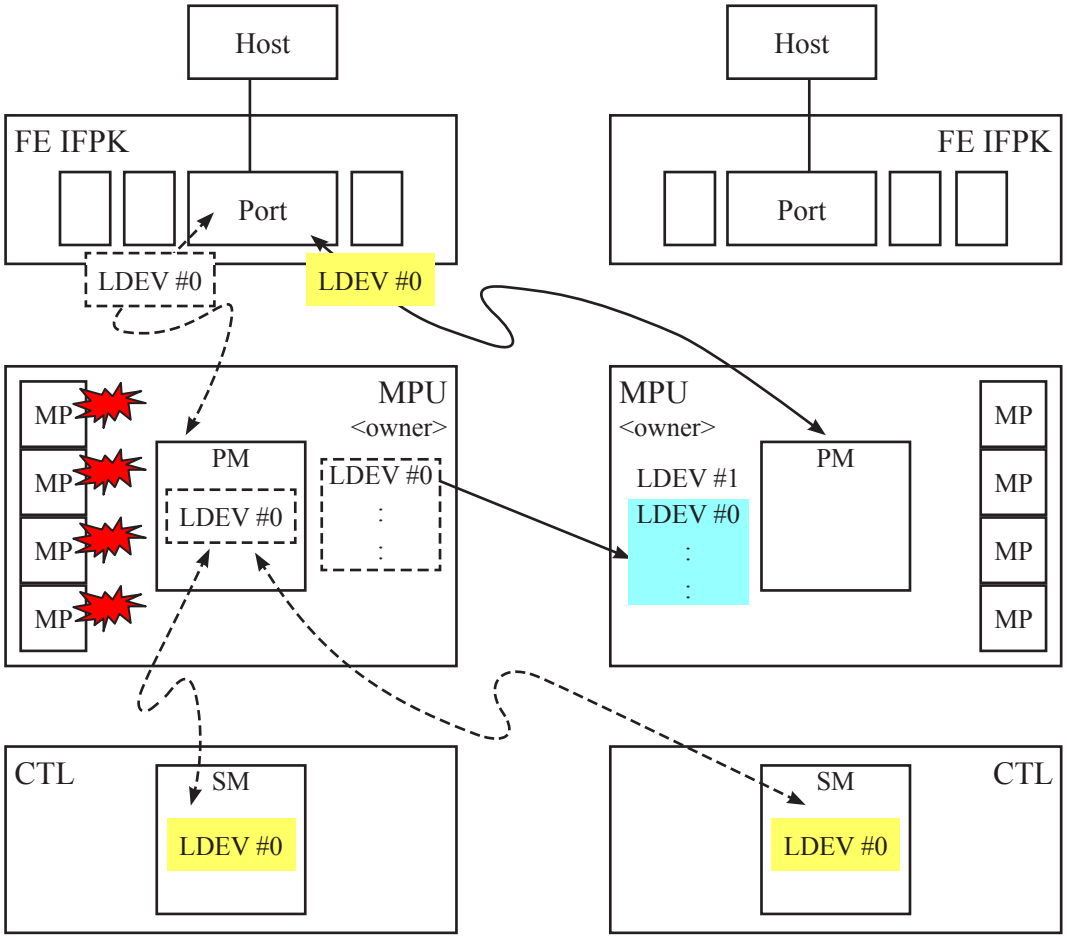
Step1. Detect that all MPs in the MPU are blocked and decide MPU that takes over the ownership.

Figure 2-27 MPU blocked due to failure (1)



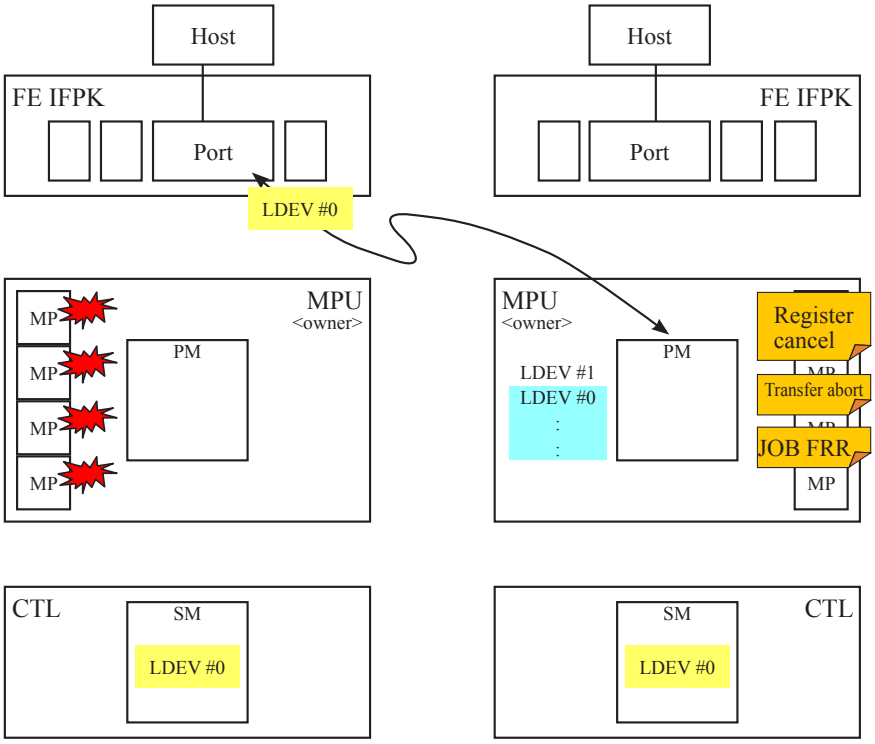
Step2. Switch MPU, to which I/O is issued, to MPU that takes over the ownership.

Figure 2-28 MPU blocked due to failure (2)



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

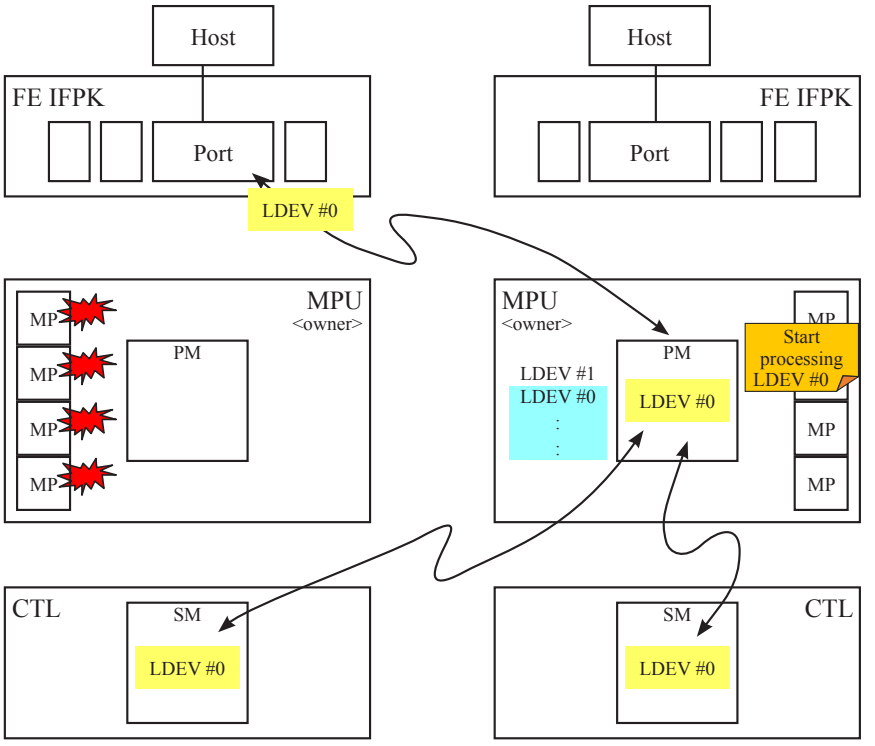
Figure 2-29 MPU blocked due to failure (3)



<WCHK1 processing>
- Issue a requirement for cancelling the requirement for processing received from WCHK1 MPU to all MPs.
- Issue an abort instruction of data transfer started from WCHK1 MPU.
- WCHK1 MPU performs post-processing of ongoing JOB.

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

Figure 2-30 MPU blocked due to failure (4)



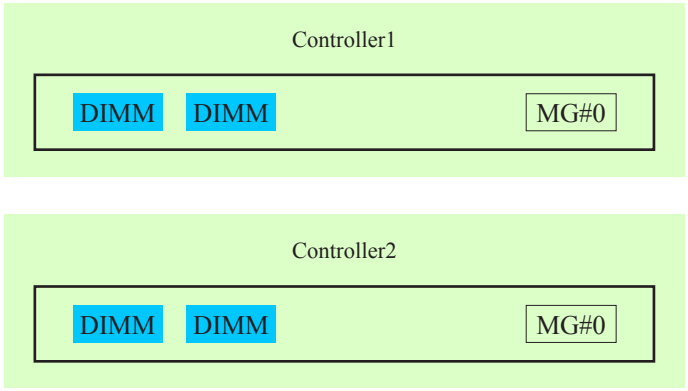
<Target MPU>
- Immediately after processing is started, SM is accessed, so access performance to control information is degraded compared to before moving ownership.
- As processes of importing information in PM progress, access performance to control info is improved.

2.5 Cache Architecture

2.5.1 Physical Addition of Controller/DIMM

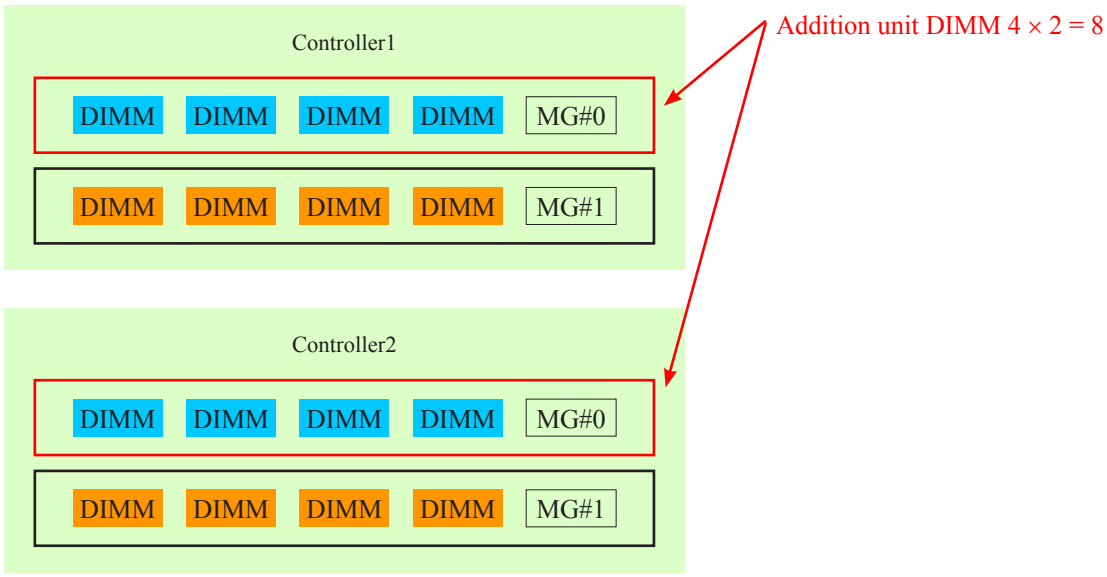
Figure 2-31 Physical addition of Controller/DIMM

VSP G370, VSP G350, VSP G130 (*1) and VSP F370, VSP F350



*1: For VSP G130, one DIMM can be installed in each controller.

VSP G900, VSP G700 and VSP F900, VSP F700



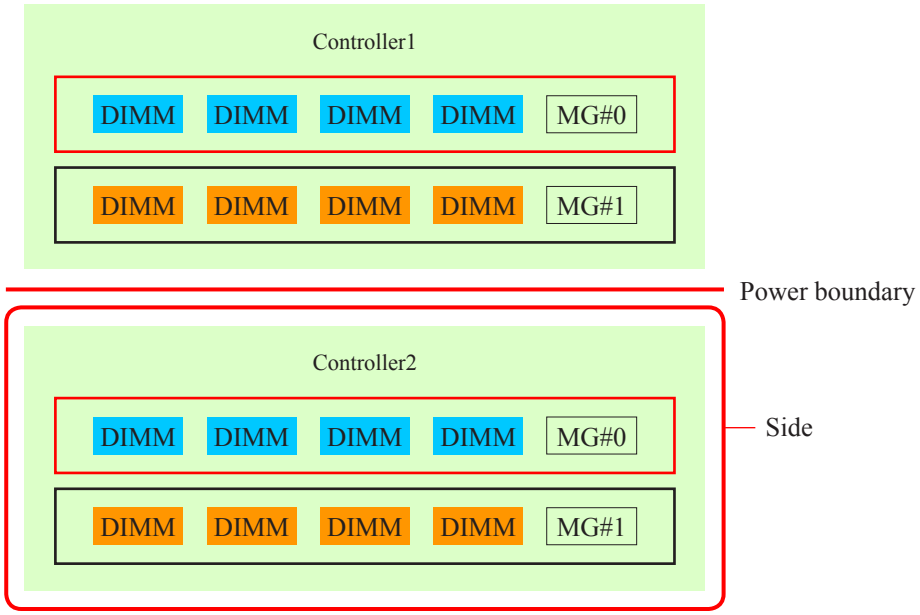
2.5.2 Maintenance/Failure Blockade Specification

2.5.2.1 Blockade Unit

The block at the time of maintenance/failure is by surface unit and the block management by MG unit is not performed.

Figure 2-32 Blockade Unit

All models

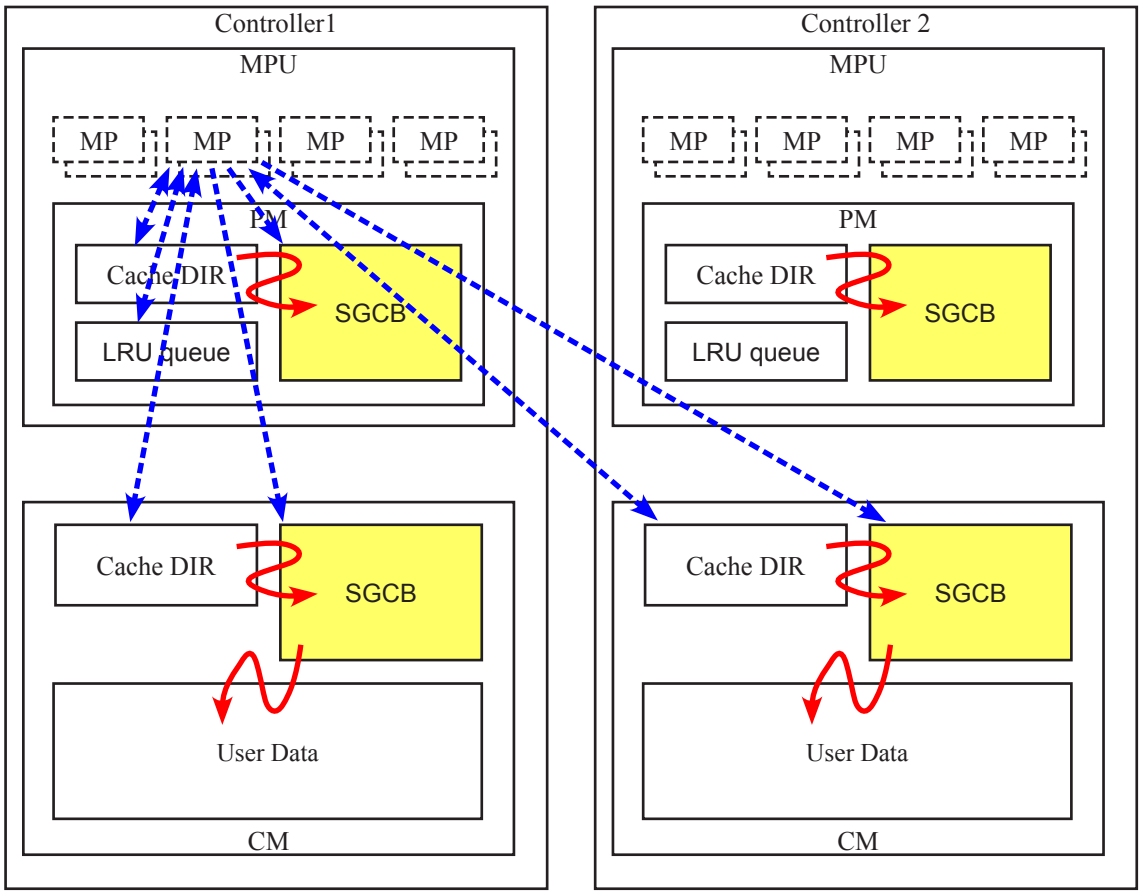


MG : Module Group

2.5.3 Cache Control

2.5.3.1 Cache Directory PM Read and PM/SM Write

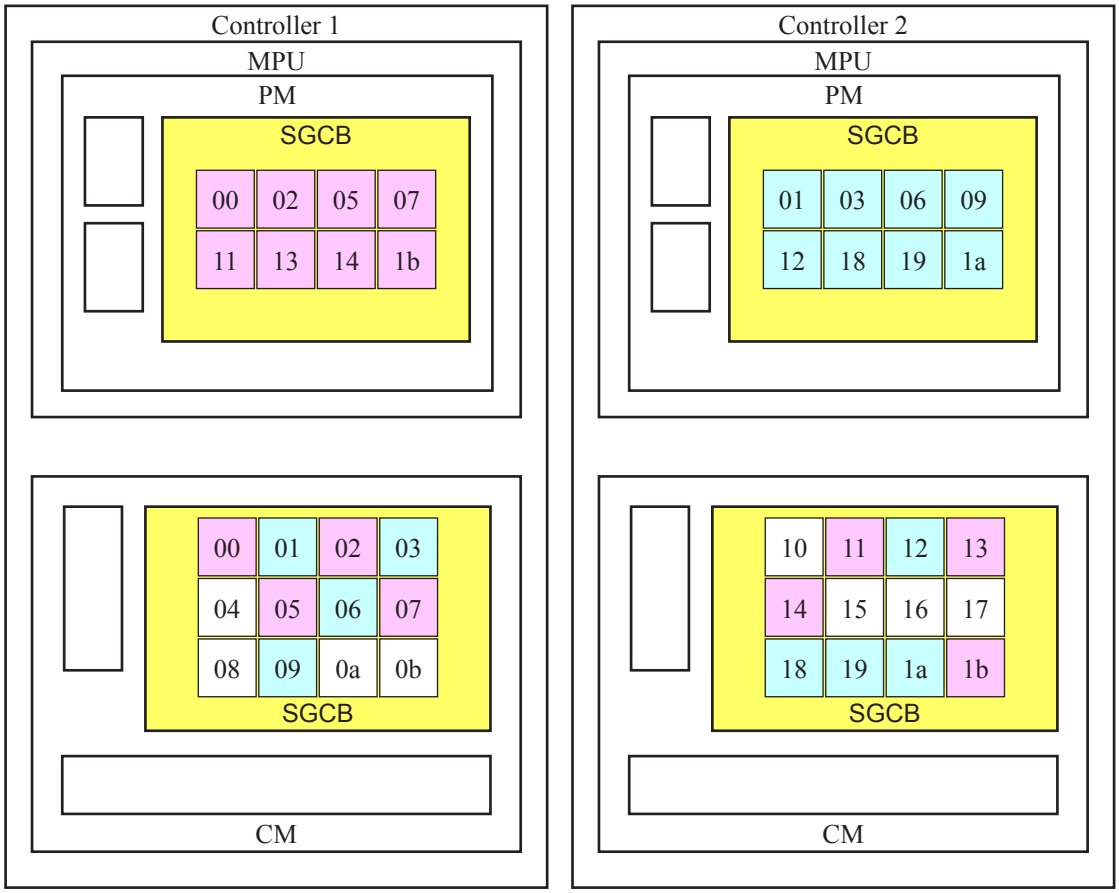
Figure 2-33 Cache Directory PM read and PM/SM write



SGCB: SeGment Control Block

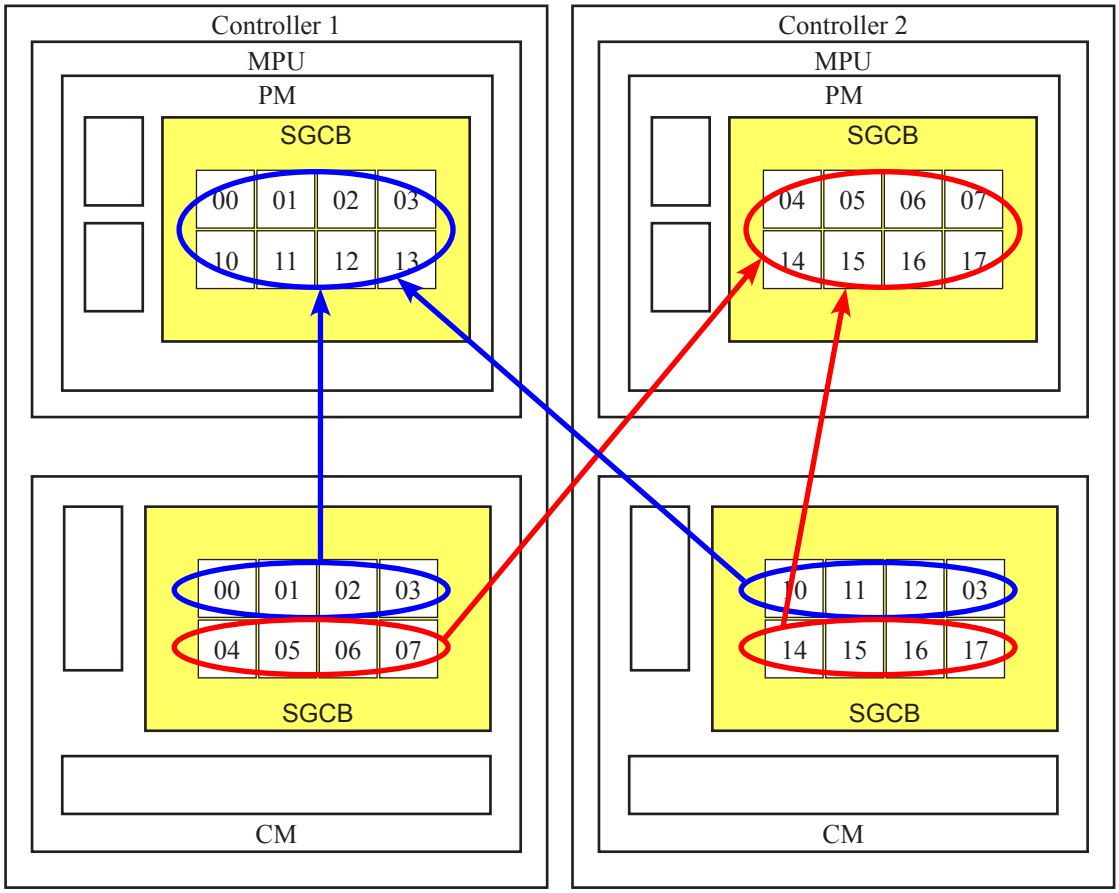
2.5.3.2 Cache Segment Control Image

Figure 2-34 Cache Segment Control Image



2.5.3.3 Initial Setting (Cache Volatilization)

Figure 2-35 Initial Setting (Cache Volatilization)



2.5.3.4 Ownership Right Movement

Figure 2-36 Ownership movement (1)

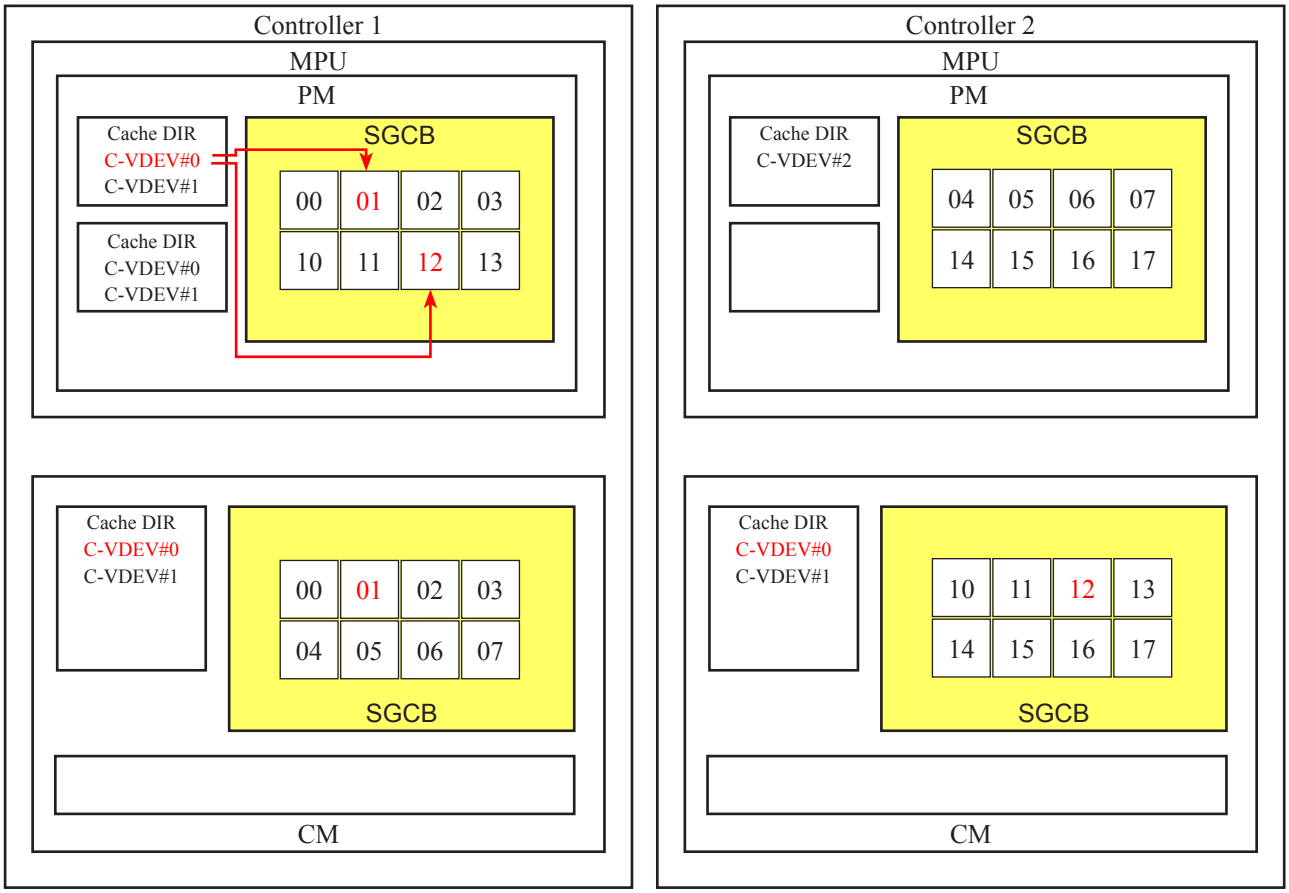
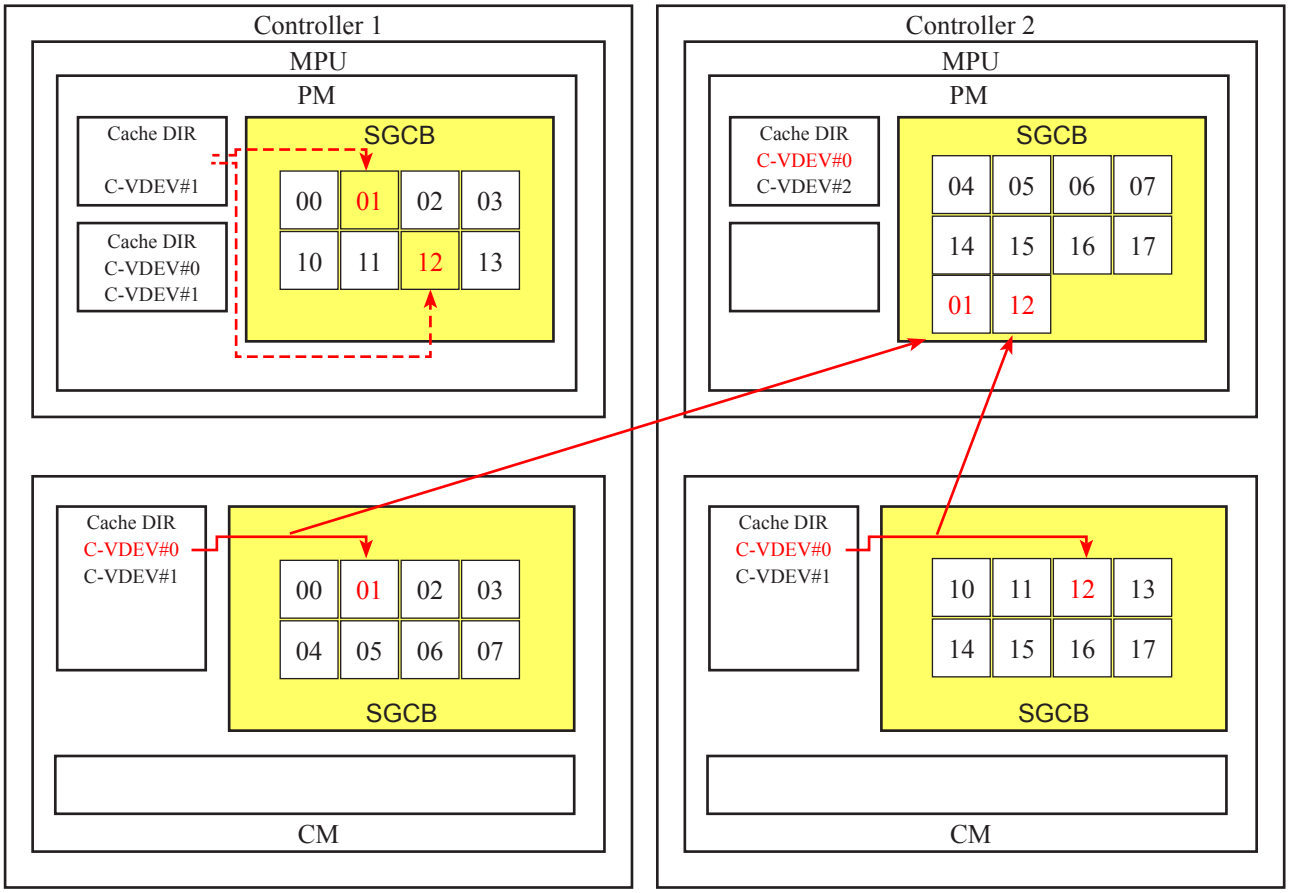
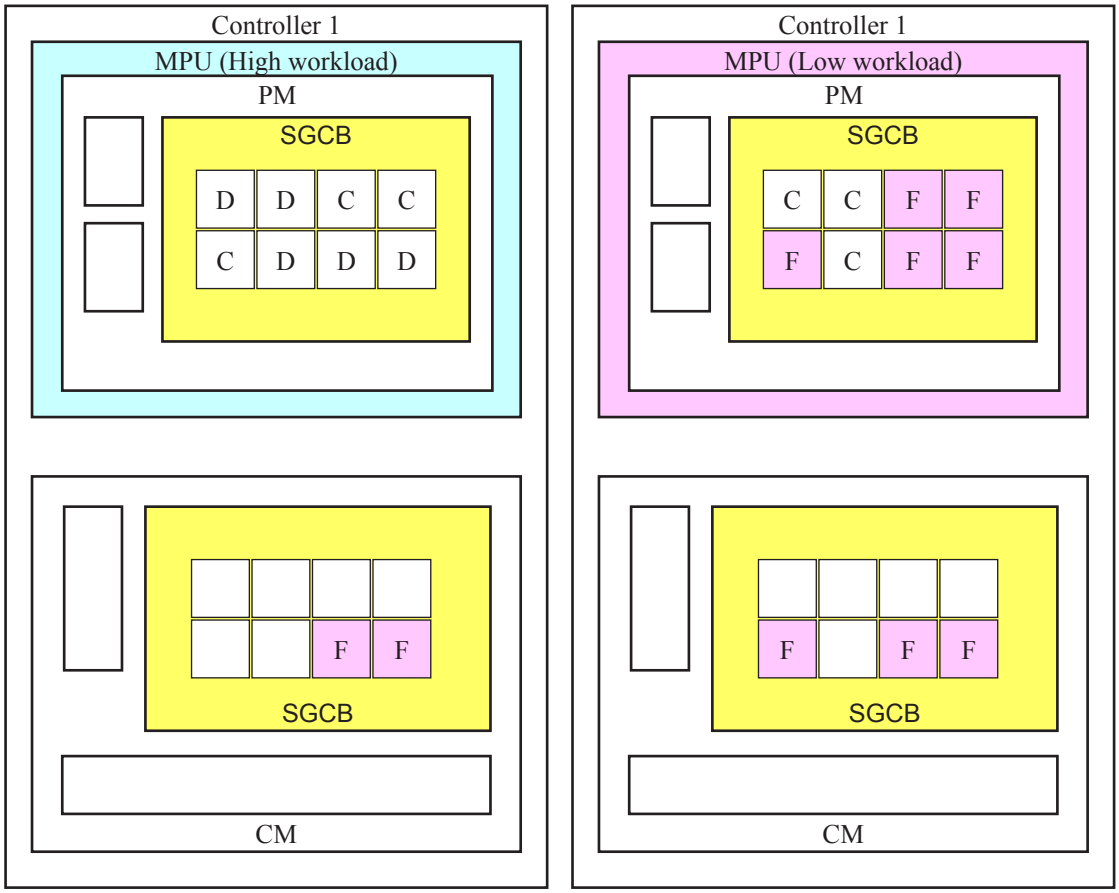


Figure 2-37 Ownership movement (2)



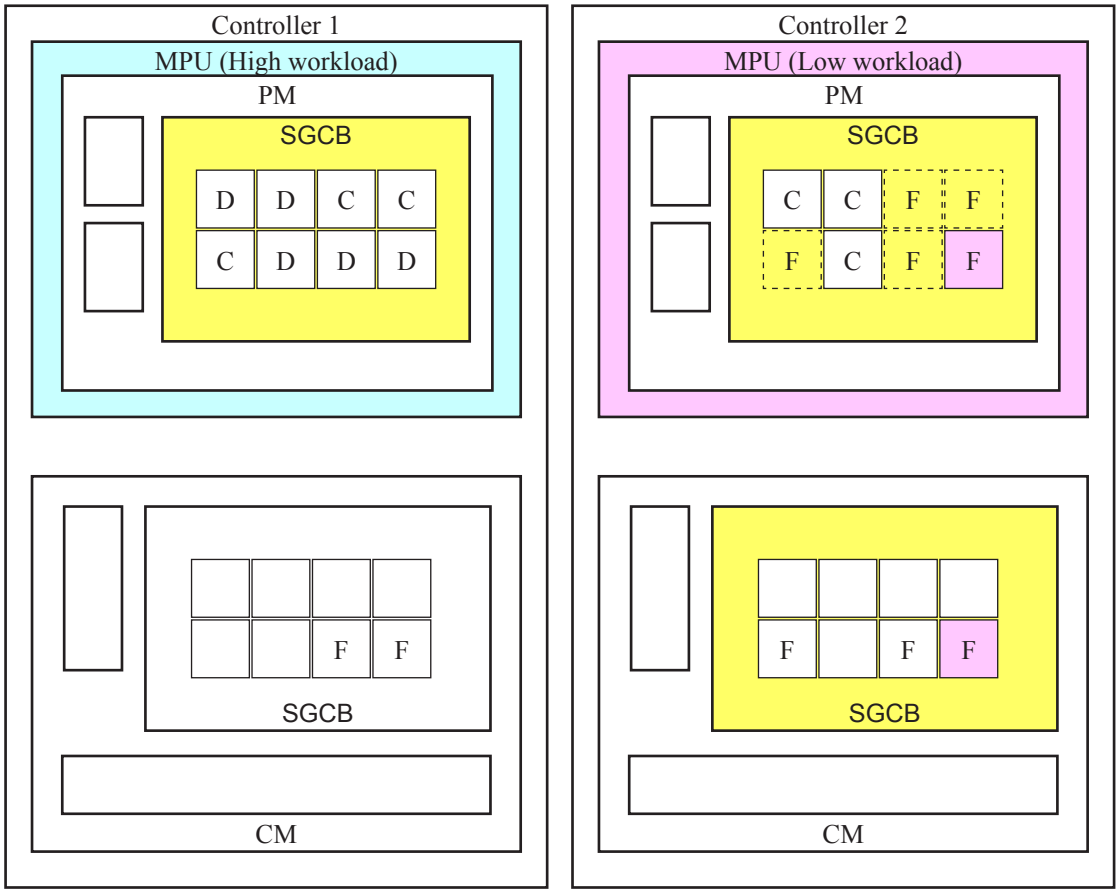
2.5.3.5 Cache Load Balance

Figure 2-38 Cache Load balance (1)



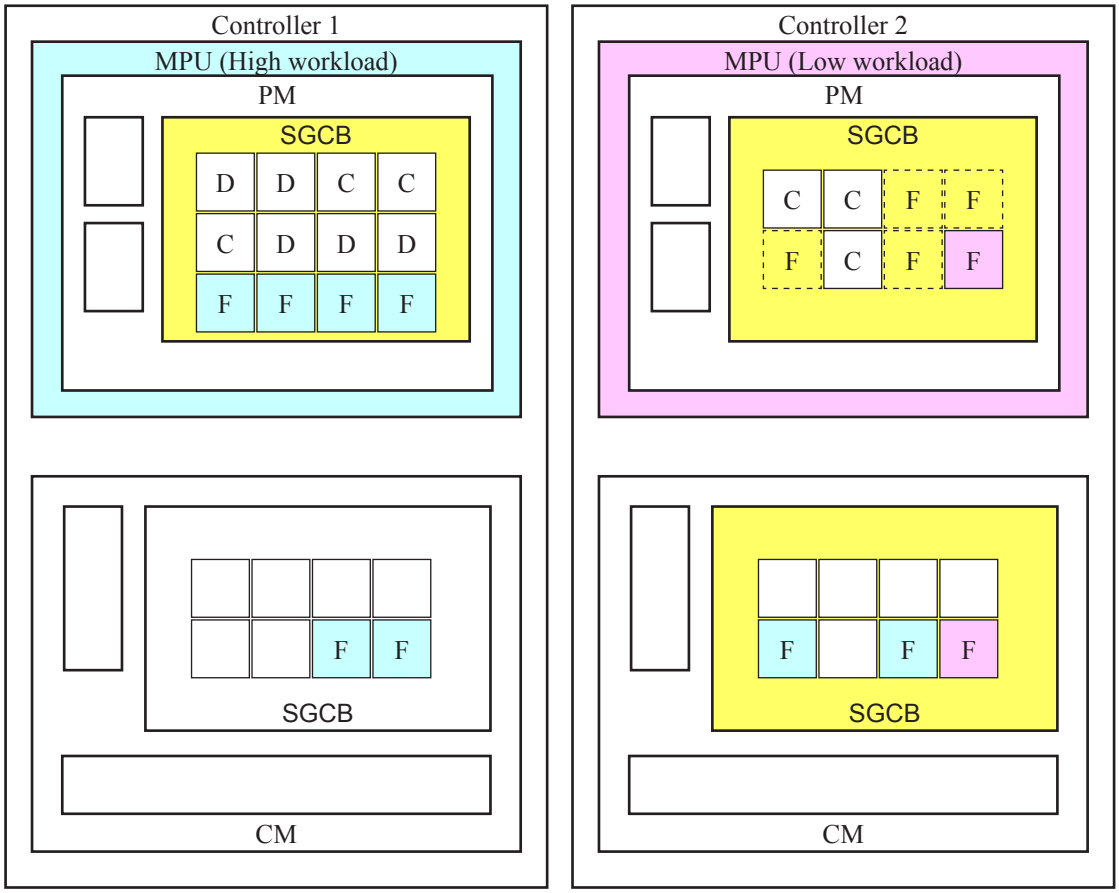
D：Dirty
C：Clean
F：Free

Figure 2-39 Cache Load balance (2)



D：Dirty
C：Clean
F：Free

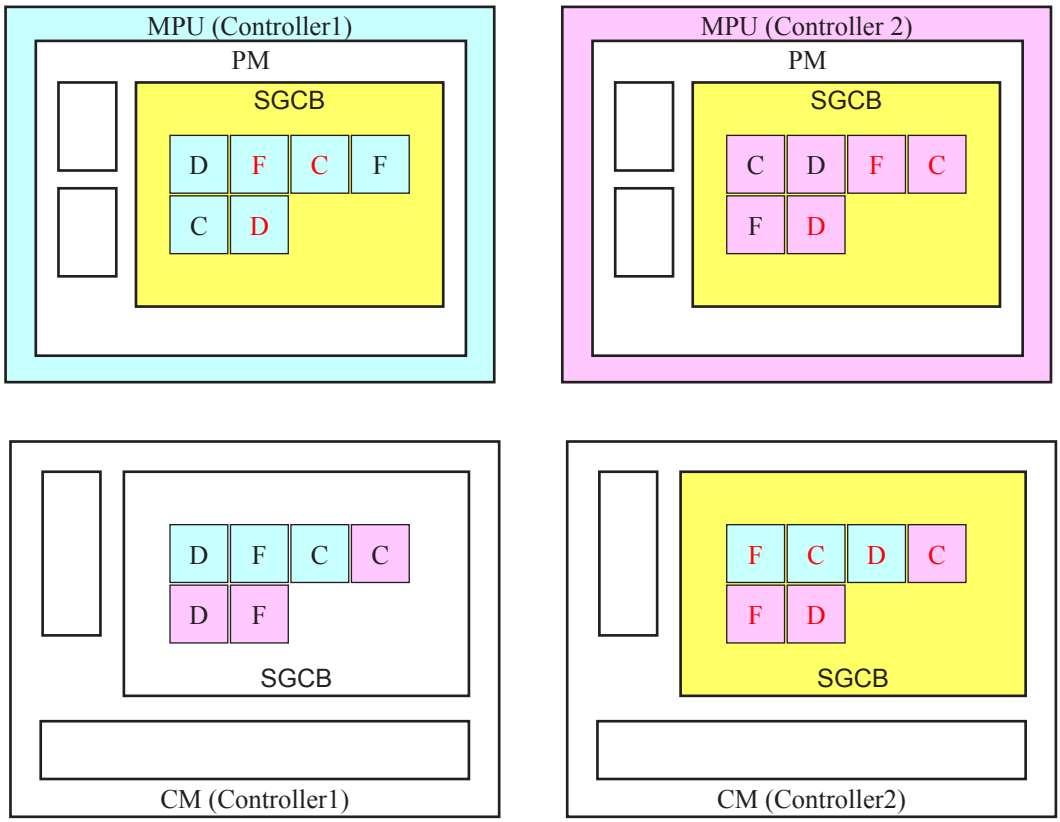
Figure 2-40 Cache Load balance (3)



D：Dirty
C：Clean
F：Free

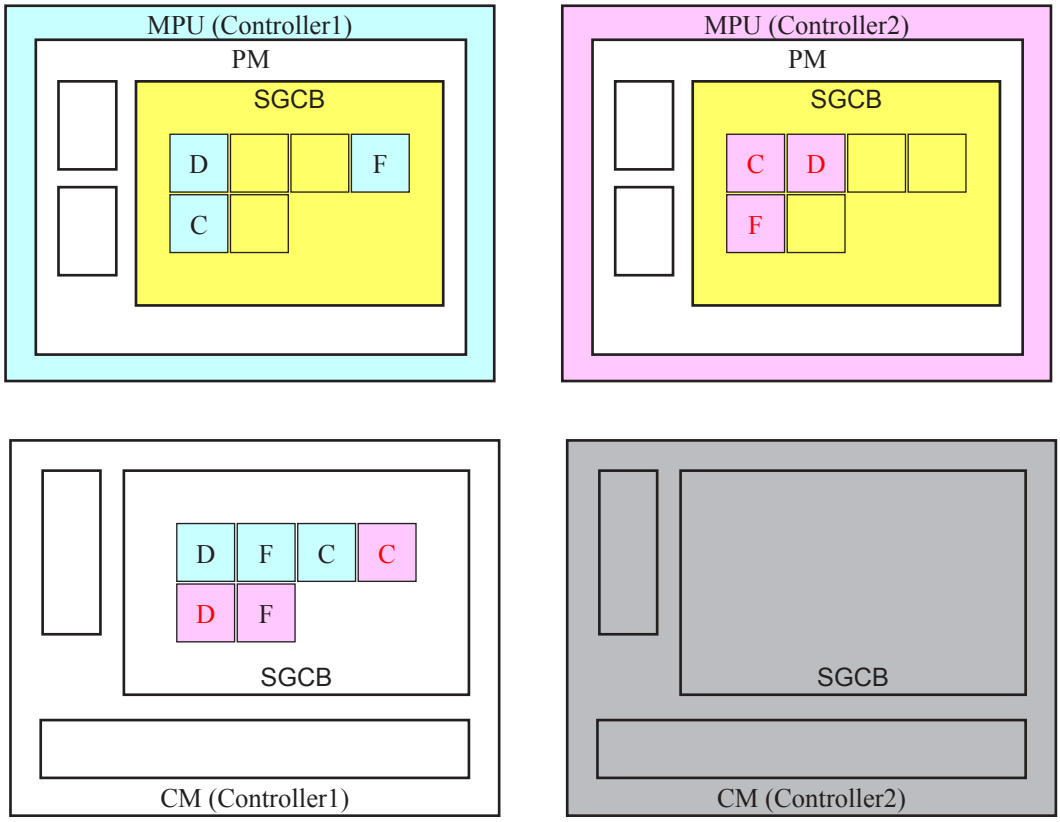
2.5.3.6 Controller Replacement

Figure 2-41 Controller Replacement (1)



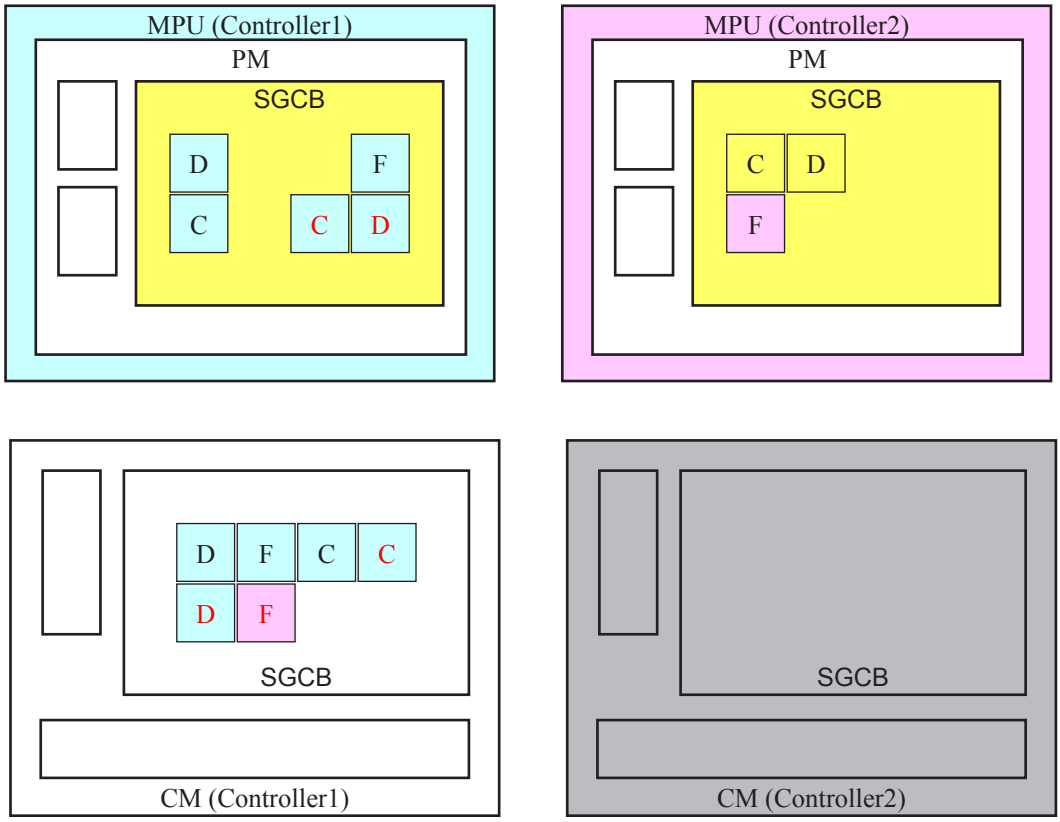
D：Dirty
C：Clean
F：Free

Figure 2-42 Controller Replacement (2)



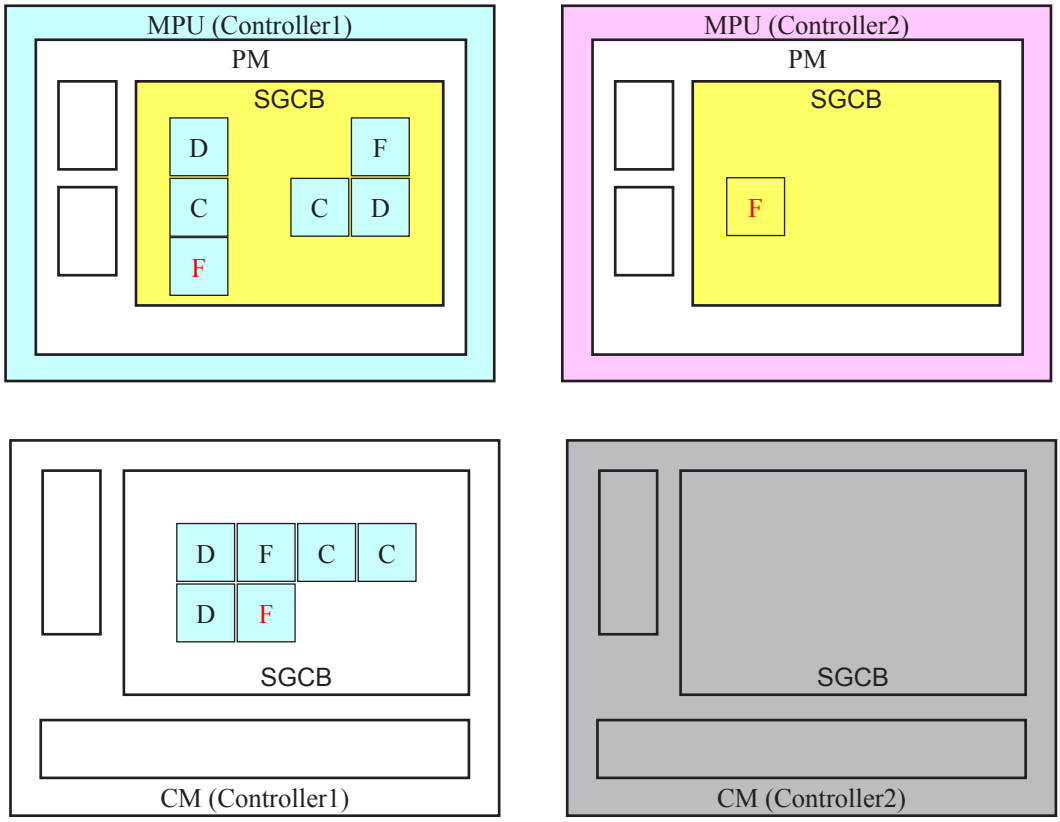
D：Dirty
C：Clean
F：Free

Figure 2-43 Controller Replacement (3)



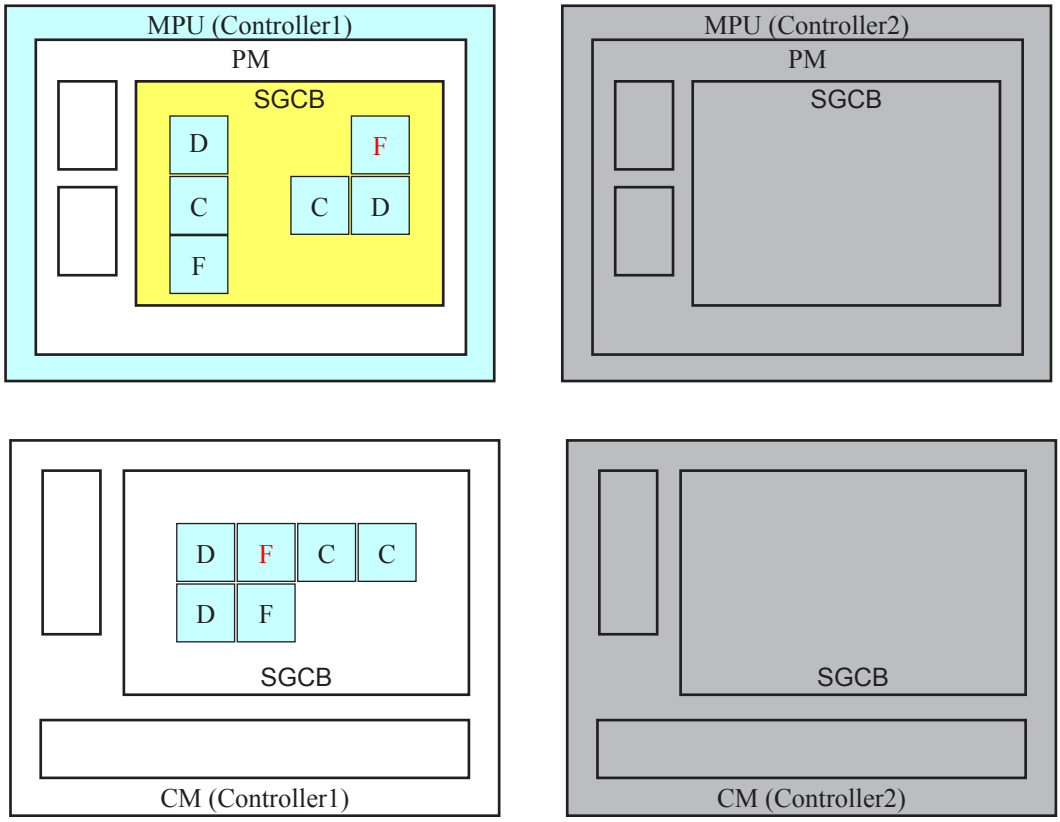
D：Dirty
C：Clean
F：Free

Figure 2-44 Controller Replacement (4)



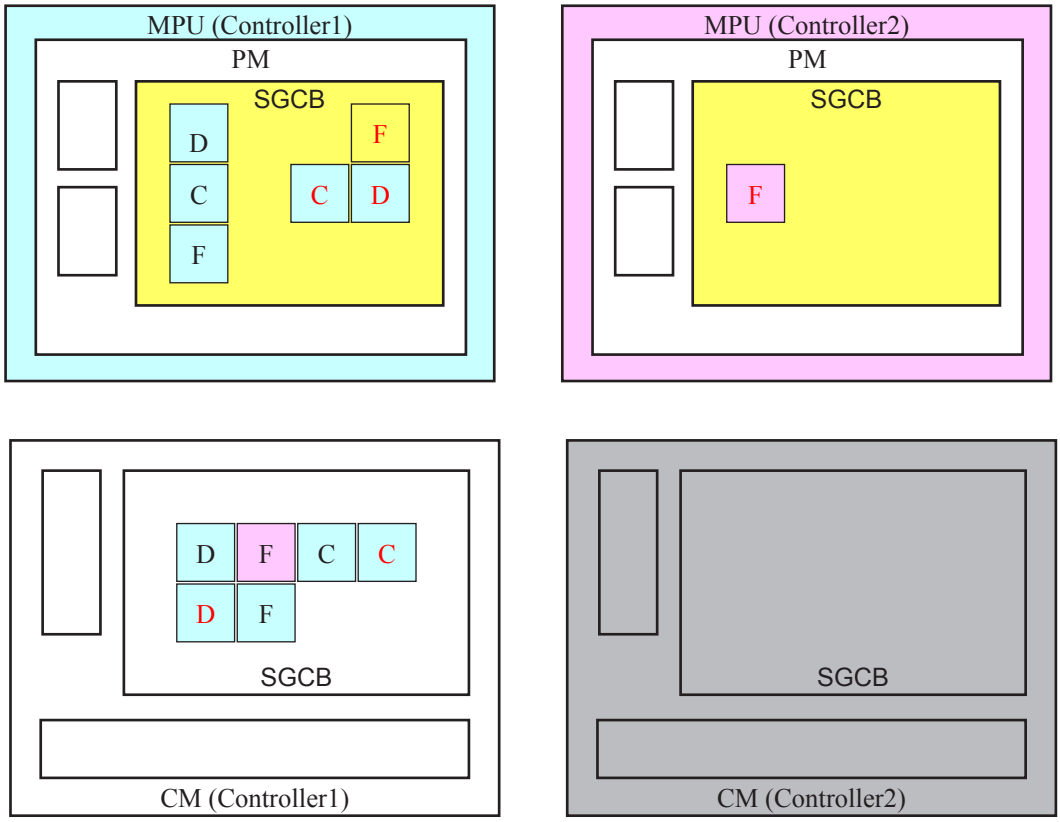
D：Dirty
C：Clean
F：Free

Figure 2-45 Controller Replacement (5)



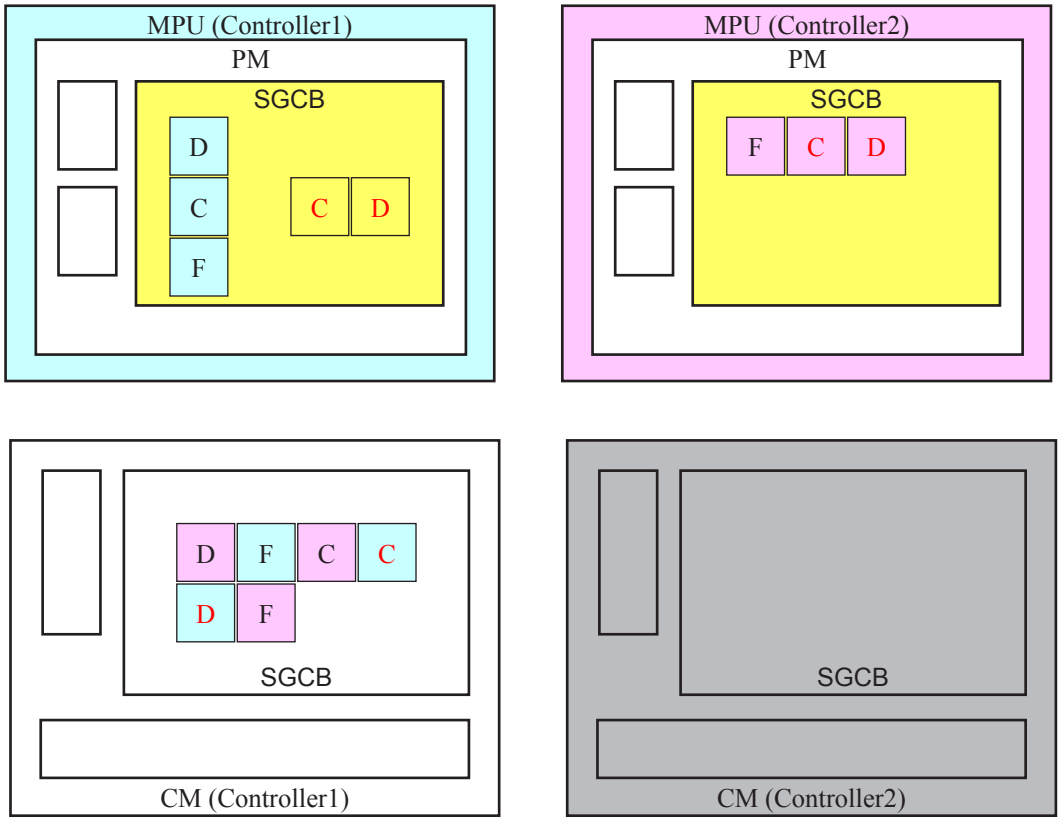
D：Dirty
C：Clean
F：Free

Figure 2-46 Controller Replacement (6)



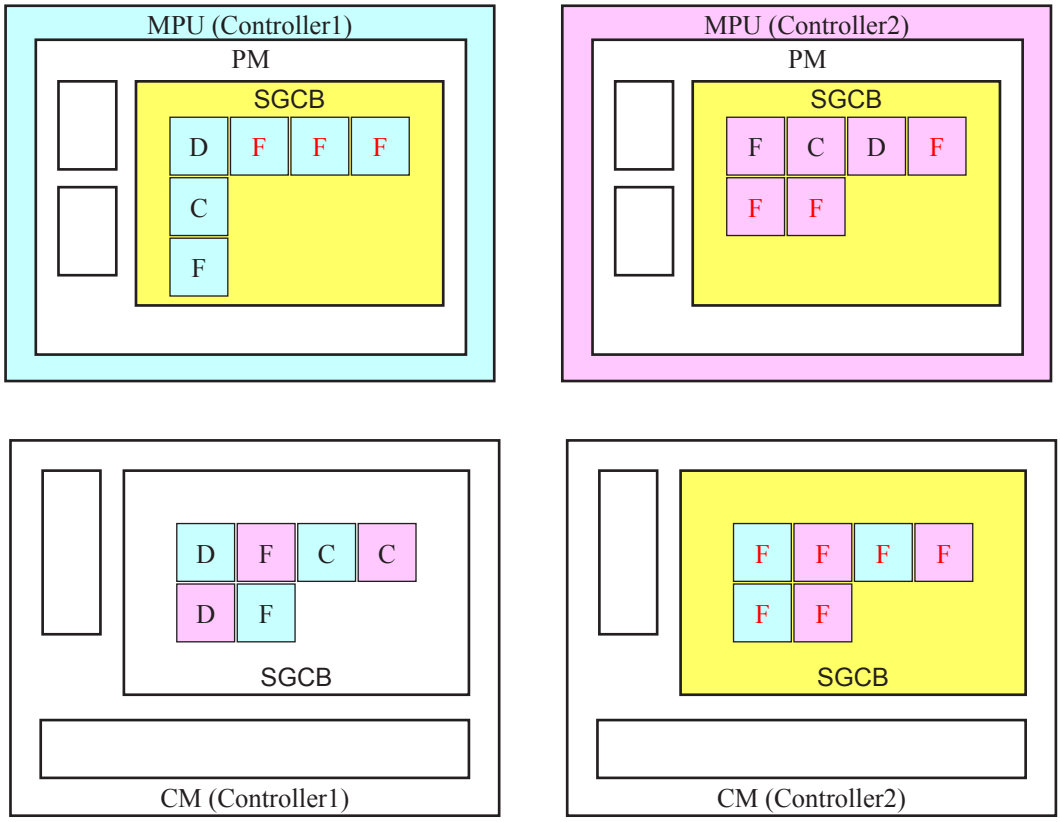
D：Dirty
C：Clean
F：Free

Figure 2-47 Controller Replacement (7)



D：Dirty
C：Clean
F：Free

Figure 2-48 Controller Replacement (8)



D：Dirty
C：Clean
F：Free

2.5.3.7 Queue/Counter Control

Figure 2-49 Queue/Counter Control (1)

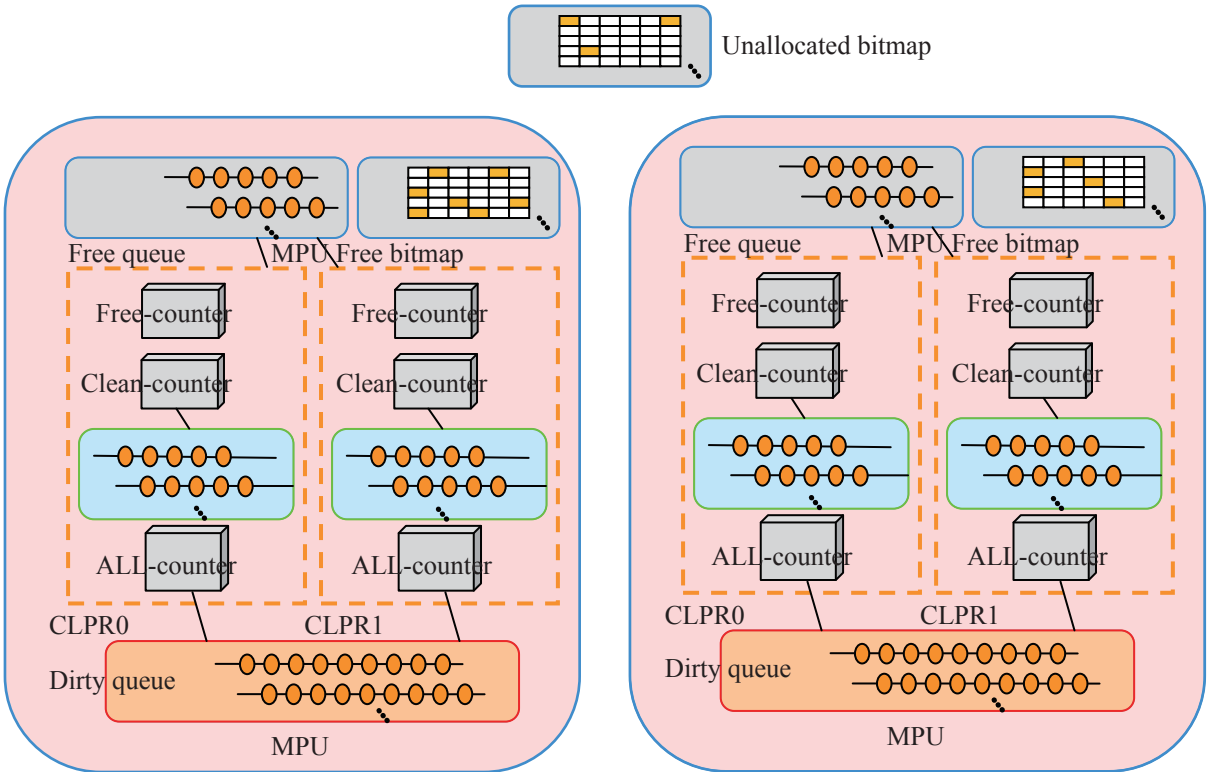
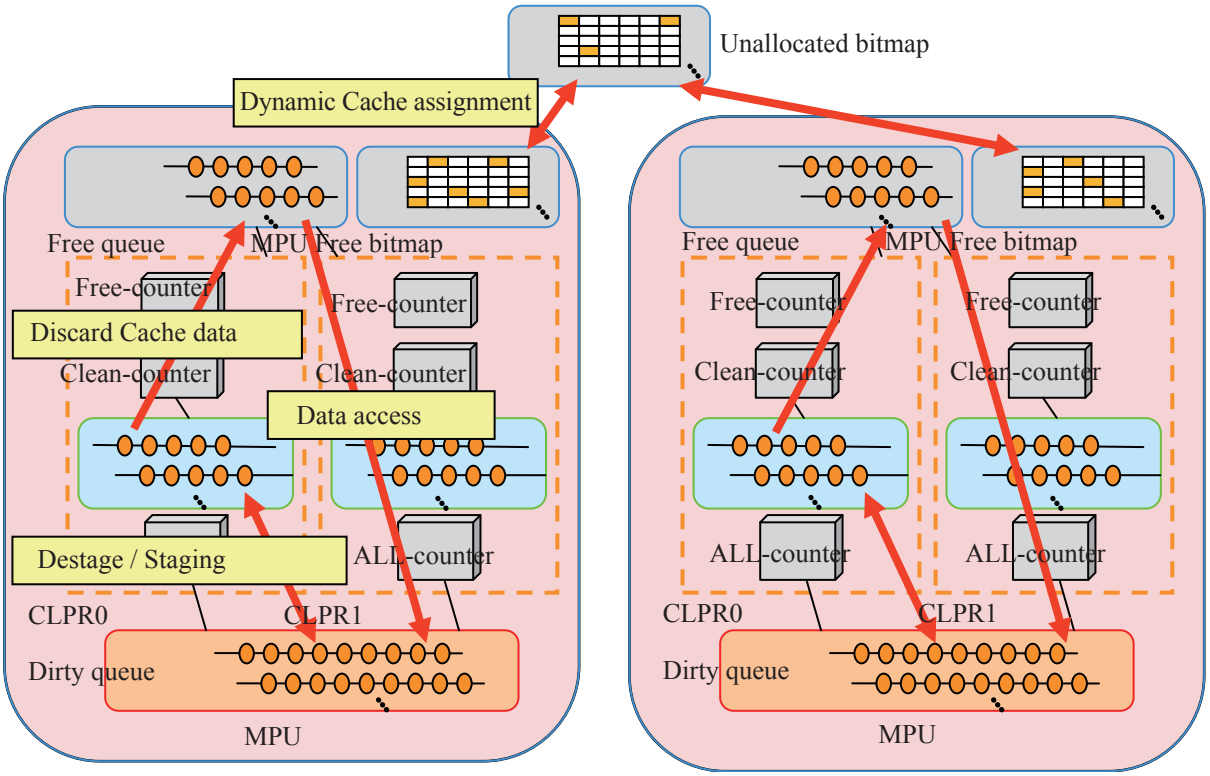


Figure 2-50 Queue/Counter Control (2)



2.6 CVS Option Function

2.6.1 Customized Volume Size (CVS) Option

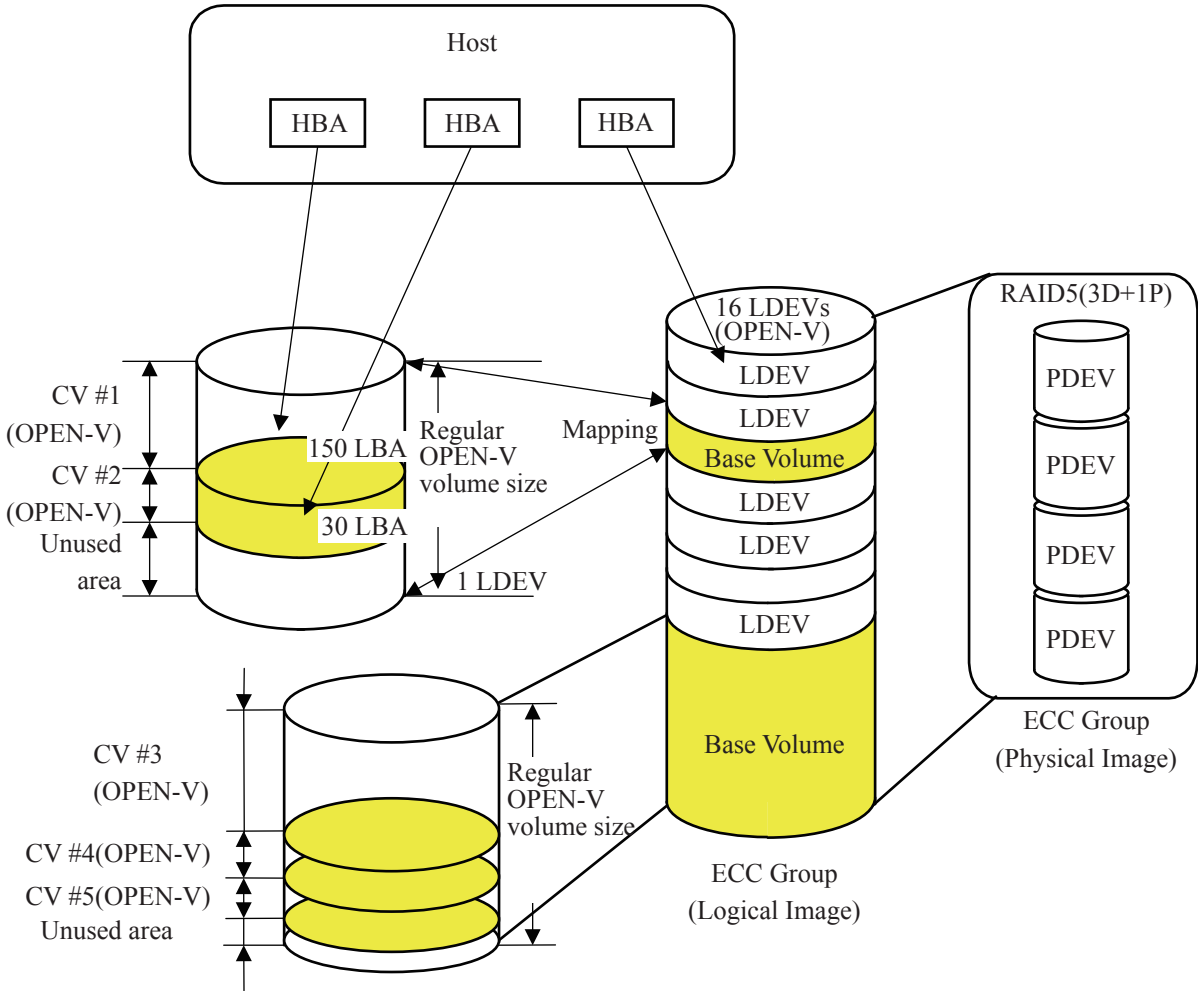
2.6.1.1 Overview

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.

2.6.1.2 Features

- The capacity of the ECC group can be fully used.

Figure 2-51 Overview of CVS Option function



2.6.1.3 Specifications

The CVS option consists of a function to provide variable capacity volumes.

1. Function to provide variable capacity volumes
   This function can create the capacity volume as required by the users.
   You can set the data by Mbytes or Logical Blocks.

Table 2-26 CVS Specifications

Parameter	Content
Track format	OPEN-V
Emulation type	OPEN-V
Maximum number of LDEVs (Base volume and CVS) per VDEV	2,048 for one parity group
Maximum number of LDEVs (Base volume and CVS) per Storage System	VSP G130: 2,048 VSP G350, VSP F350: 16,384 VSP G370, VSP F370: 32,768 VSP G700, VSP F700: 49,152 VSP G900, VSP F900: 65,280
Size increment for CV	1 MB
Disk location for CVS Volume	Anywhere

2.6.1.4 Maintenance Functions

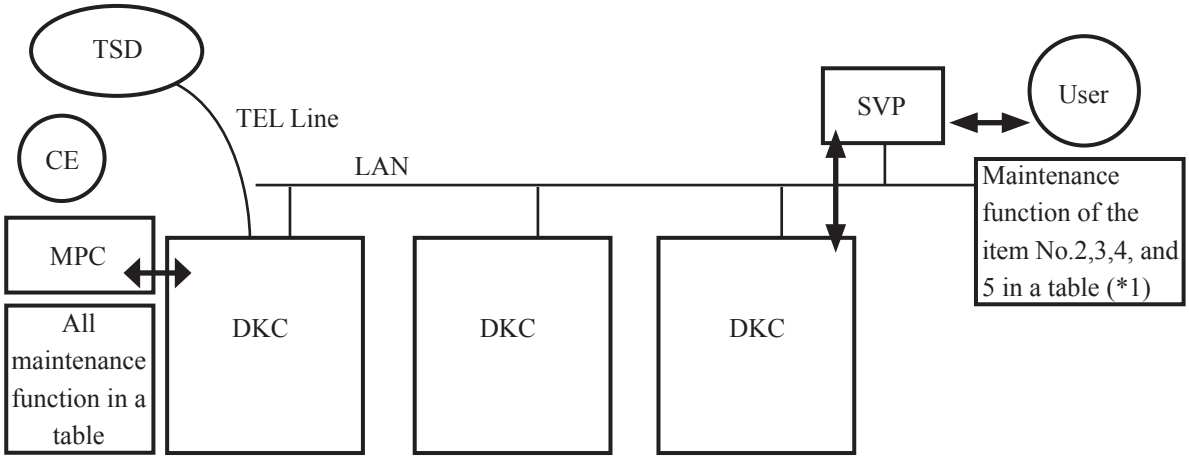
Features of the maintenance functions of the CVS option is that they allow execution of not only the conventional maintenance operations instructed by the Maintenance PC but also the maintenance operations instructed from the SVP. (Refer to Item No. 2 to 5 in Table 2-27.)
Unlike the conventional LDEV addition or reduction, the operation for the ECC group is made unnecessary, so that the volumes can be operated from the SVP. In the case of the configuration that does not contain the SVP, the maintenance can be executed from Command Control Interface.

Table 2-27 Maintenance Function List

Item No.	Maintenance function	CE	User	Remarks
1	Concurrent addition or deletion of CVs at the time of addition or removal of ECC group	✓	—	Same as the conventional addition or removal of LDEVs. (*2)
2	Addition of CVs only	✓	✓	Addition of CVs in the free area. (*1)
3	Conversion of normal volumes to CV	✓	✓	(*1), (*2)
4	Conversion of CV to normal volumes	✓	✓	(*1), (*2)
5	Deletion of CVs only	✓	✓	No removal of ECC group is involved. (*2)

*1: LDEV format operates as an extension of maintenance.
Since the deleted volume data is lost, the customer's approval is required for execution.
*2: The pending data on the Cache is also discarded with the data on the volume to be deleted.
Same as *1, the customer's approval is required for execution.

Figure 2-52 Maintenance Execution Route when CVS Is Used



*1: Operated from Command Control Interface in the case of the configuration that does not contain the SVP.

2.7 PDEV Erase

2.7.1 Overview

When the specified system option (*1) is set, the DKC deletes the data of PDEV automatically in the case according Table 2-28.

*1: Please contact to T.S.D.

Table 2-28 Overview

No.	Item	Content
1	Maintenance PC 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 complete.
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 Maintenance PC operation, and exchange PDEV that Erase wants to stop for new service parts.
7	Data Erase Pattern	Data Erase Pattern is zero data.

Table 2-29 PDEV Erase execution case

No.	Execution case
1	PDEV is blocked according to Drive Copy completion.

2.7.2 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 2-30 PDEV Erase completion expectation time (1/2)

Type of PDEV	480 GB	600 GB	960 GB	1.2 TB	1.9 TB	2.4 TB	3.5 TB (3.2 TiB)	3.8 TB
SAS (7.2 krpm)	—	—	—	—	—	—	—	—
SAS (10 krpm)	—	70 M	—	140 M	—	190 M	—	—
Flash Drive	10 M	—	20 M	—	40 M	—	—	90 M
Flash Module Drive	—	—	—	—	—	—	1 M	—

Table 2-31 PDEV Erase completion expectation time (2/2)

Type of PDEV	6.0 TB	7.0 TB	7.6 TB	10 TB	14 TB	15 TB
SAS (7.2 krpm)	590 M	—	—	880 M	—	—
SAS (10 krpm)	—	—	—	—	—	—
Flash Drive	—	—	140 M	—	—	220 M
Flash Module Drive	—	1 M	—	—	1 M	—

Table 2-32 PDEV Erase TOV (1/2)

Type of PDEV	480 GB	600 GB	960 GB	1.2 TB	1.9 TB	2.4 TB	3.5 TB (3.2 TiB)	3.8 TB
SAS (7.2 krpm)	—	—	—	—	—	—	—	—
SAS (10 krpm)	—	150 M	—	255 M	—	330 M	—	—
Flash Drive	60 M	—	75 M	—	105 M	—	—	180 M
Flash Module Drive	—	—	—	—	—	—	9 M	—

Table 2-33 PDEV Erase TOV (2/2)

Type of PDEV	6.0 TB	7.0 TB	7.6 TB	10 TB	14 TB	15 TB
SAS (7.2 krpm)	930 M	—	—	1365 M	—	—
SAS (10 krpm)	—	—	—	—	—	—
Flash Drive	—	—	255 M	—	—	375 M
Flash Module Drive	—	9 M	—	—	9 M	—

2.7.3 Influence in Combination with Other Maintenance Operation

The influence on the maintenance operation during executing PDEV Erase becomes as follows.

Table 2-34 PDEV Replace

No.	Object part	Influence	Countermeasure
1	Replace from Maintenance PC as for PDEV that does PDEV Erase.	PDEV Erase terminates abnormally.	—
2	Replace from Maintenance PC 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 2-35 DKB Replace

No.	Object part	Influence	Countermeasure
1	DKB connected with PDEV that is executed PDEV Erase	[SVP4198W] may be displayed. The DKB 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 DKB replacement might fail by [ONL2412E] when the password is entered. (*2)
2	DKB other than the above	Nothing	Nothing

Table 2-36 I/F Board Replace/I/F Board Removal

No.	Object part	Influence	Countermeasure
1	I/F Board that is executed PDEV Erase	[SVP4198W] may be displayed. The I/F Board 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 I/F Board replacement might fail by [ONL2412E] when the password is entered. (*2)
2	I/F Board other than the above	Nothing	Nothing

Table 2-37 ENC Replace

No.	Object part	Influence	Countermeasure
1	ENC connected with DKB connected with HDD that does PDEV Erase	[SVP4198W] may be displayed. The ENC 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 ENC replacement might fail by [ONL2788E][ONL3395E] when the password is entered. (*2)
2	ENC other than the above	Nothing	Nothing

Table 2-38 PDEV Addition/Removal

No.	Object part	Influence	Countermeasure
1	ANY	Addition/Removal might fail by [SVP739W].	Please wait for the Erase completion or replace PDEV (to which Erase is done) to new service parts. (*1)

Table 2-39 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	HDD	[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 2-40 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 2-41 PATH-Inline

No.	Object part	Influence	Countermeasure
1	DKB 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 2-42 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 PDEV Erase is completed or terminates abnormally.

2.7.4 Notes of Various Failures

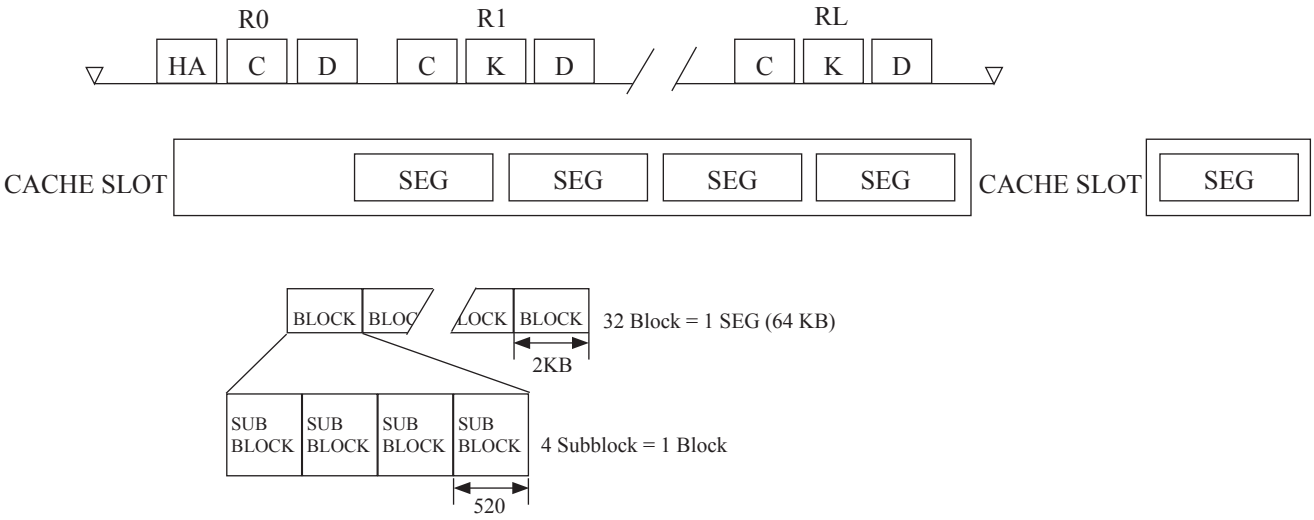
Notes of the failure during PDEV Erase become as follows.

No.	Failure	Object part	Notice	Countermeasure
1	B/K OFF/ Black Out	Drive BOX (DB)	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	Because monitor 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	I/F Board	[E/C 9470 is reported at the MP failure] JOB of the Erase monitor is reported on E/C 9470 when Abort is done due to the MP failure and completes 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 monitor 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.

2.8 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 suin-g CACHE-SLCB and CACHE-SGCB so that the segments belonging to the same slot are seemingly stored in a contiguous area in Cache.

Figure 2-53 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 = 4 segments = 256 KB

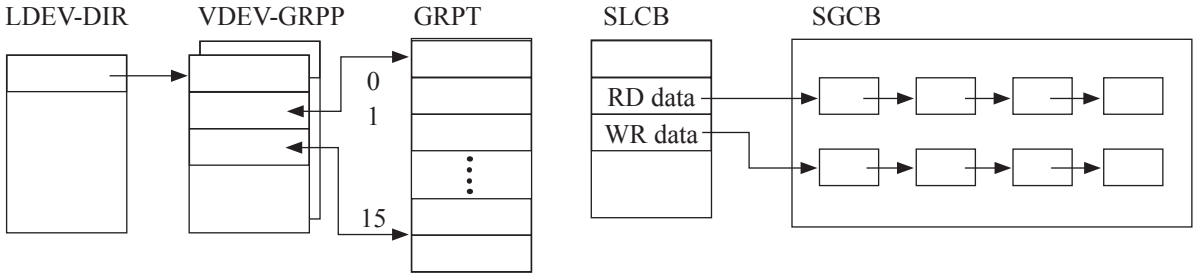
The directories VDEV-GRPP, CACHE-GRPT, CACHE-SLCB, and CACHE-SGCB are used to identify the Cache hit and miss conditions. These control tables are stored in the shared memory.

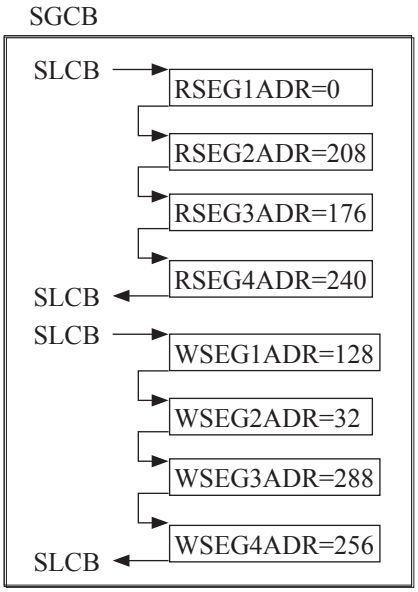
In addition to the Cache hit and miss control, the shared memory is used to classify and control the data in Cache according to its attributes. Queues are something like boxes that are used to classify data according to its attributes.

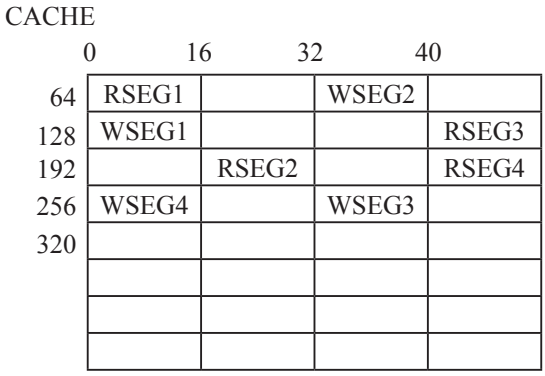
Basically, queues are controlled in slot units (some queues are controlled in segment units). Like SLCB-SGCB, queues are controlled using a queue control table so that queue data of the seemingly same attribute can be controlled as a single data group. These control tables are briefly described below.

1. Cache control tables (directories)

Figure 2-54







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 CHB.

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):

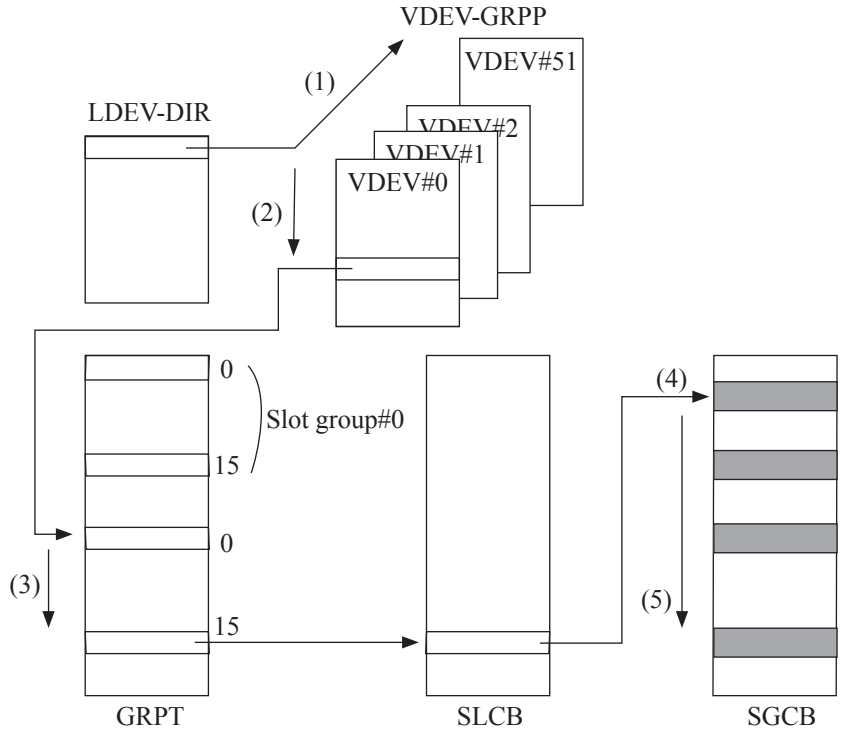
Contains the shared memory addresses of the starting and completing SGCBs in the slot. One or more SGCBs are chained. The SLCB also stores slot status and points to the queue that is connected to the slot. The status transitions of clean and dirty queues occur in slot units. The processing tasks reserve 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 status transitions of only free queues occur in segment units.

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

Figure 2-55 Overview 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 DB uses 10 types of queues to control data in Cache segments according to its attributes. These queues are described 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.

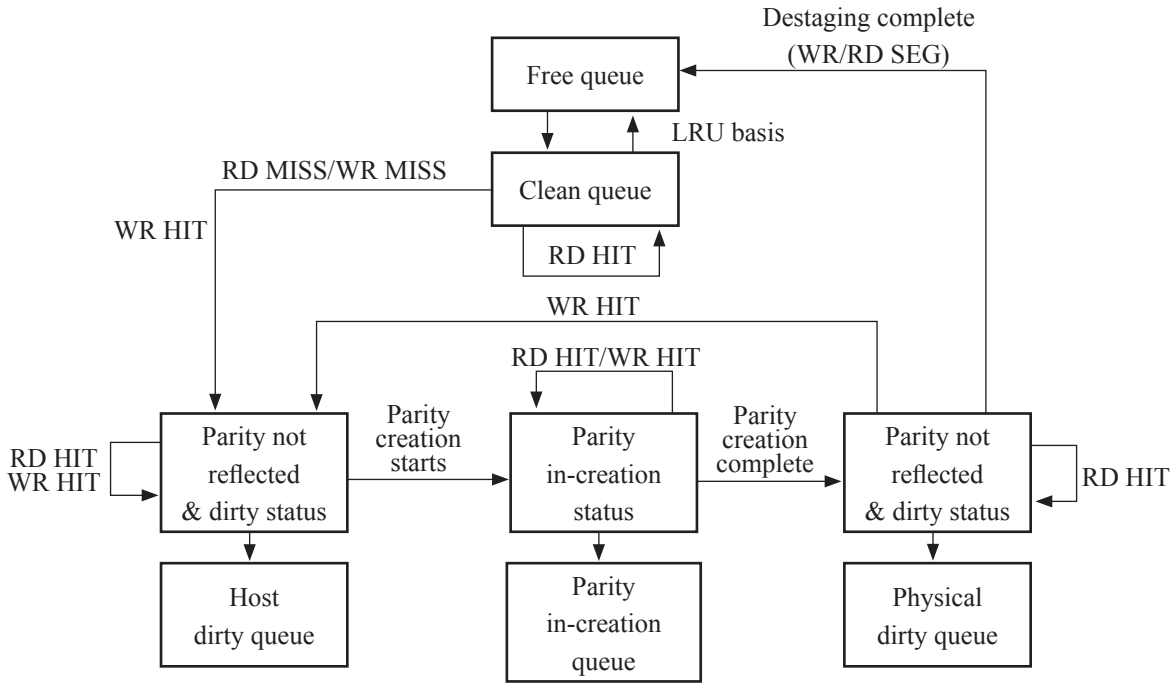
     The control table for these queues is located in the shared memory and points to the head and tail segments of the queues.

4. Queue status transitions

Figure 2-56 shows the status transitions of the queues used in. A brief description of the queue status transitions follows.

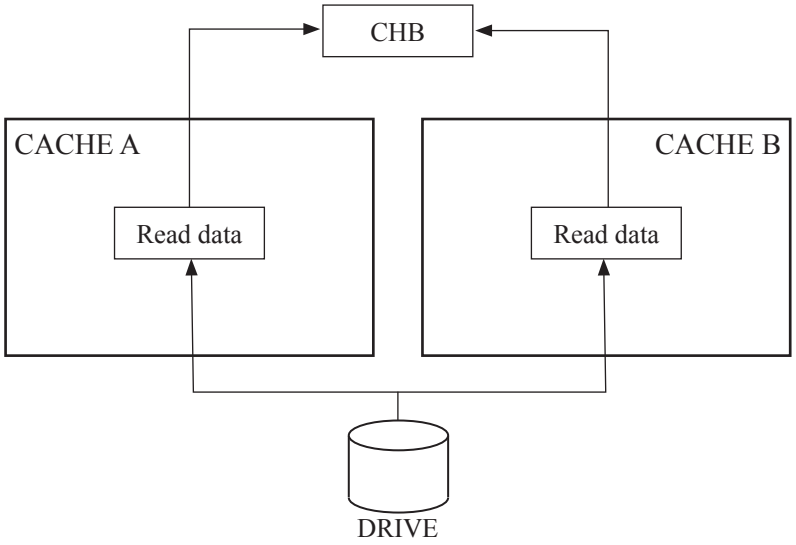
- Status transition from a free queue
  When a read miss occurs, the pertinent segment is staged and enqueued to a clean queue. When a write miss occurs, the pertinent segment is temporarily staged and enqueued to a host dirty queue.
- Status transition from a clean queue
  When a write hit occurs, the segment is enqueued to a host dirty queue. Transition from clean to free queues is performed on an LRU basis.
- Status transition from a host dirty queue
  The host dirty queue contains data that reflects no parity. When parity generation is started, a status transition occurs to the parity in-creation queue.
- Status 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.
- Status 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).

Figure 2-56 Queue Segment Status Transition Diagram



5. Cache usage in the read mode

Figure 2-57 Cache Usage in the Read Mode

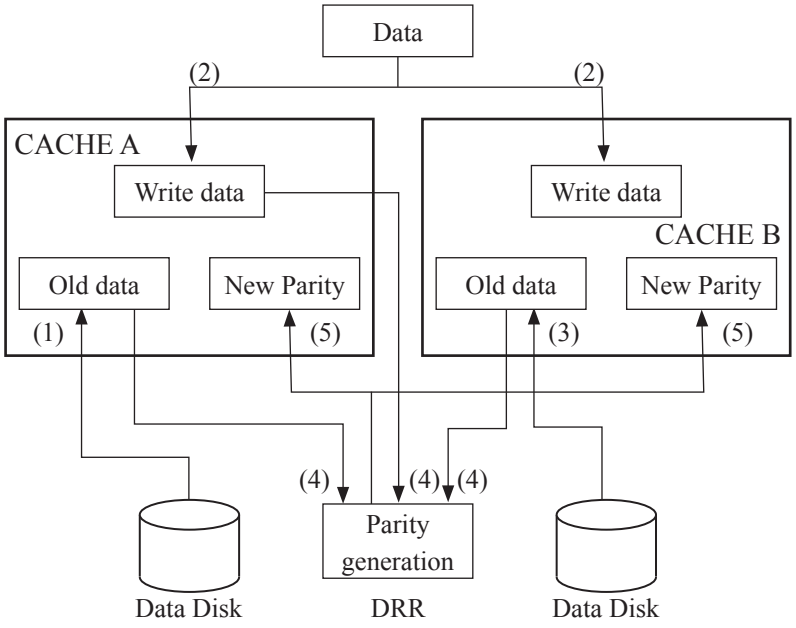


The Cache area to be used for destaging read data is determined depending on whether the result of evaluating the following expression is odd or even:
(CYL# x 15 + HD#) / 16
The read data is destaged into area A if the result is even and into area B if the result is odd.

Read data is not duplexed and its destaging Cache area is determined by the formula shown in Figure 2-57. 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

Figure 2-58 Cache Usage in the Write Mode



This system handles write data (new data) and read data (old data) in separate segments as shown in Figure 2-58 (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, create the Parity in the DRR processing of the CPU.
(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 write 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 described 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).

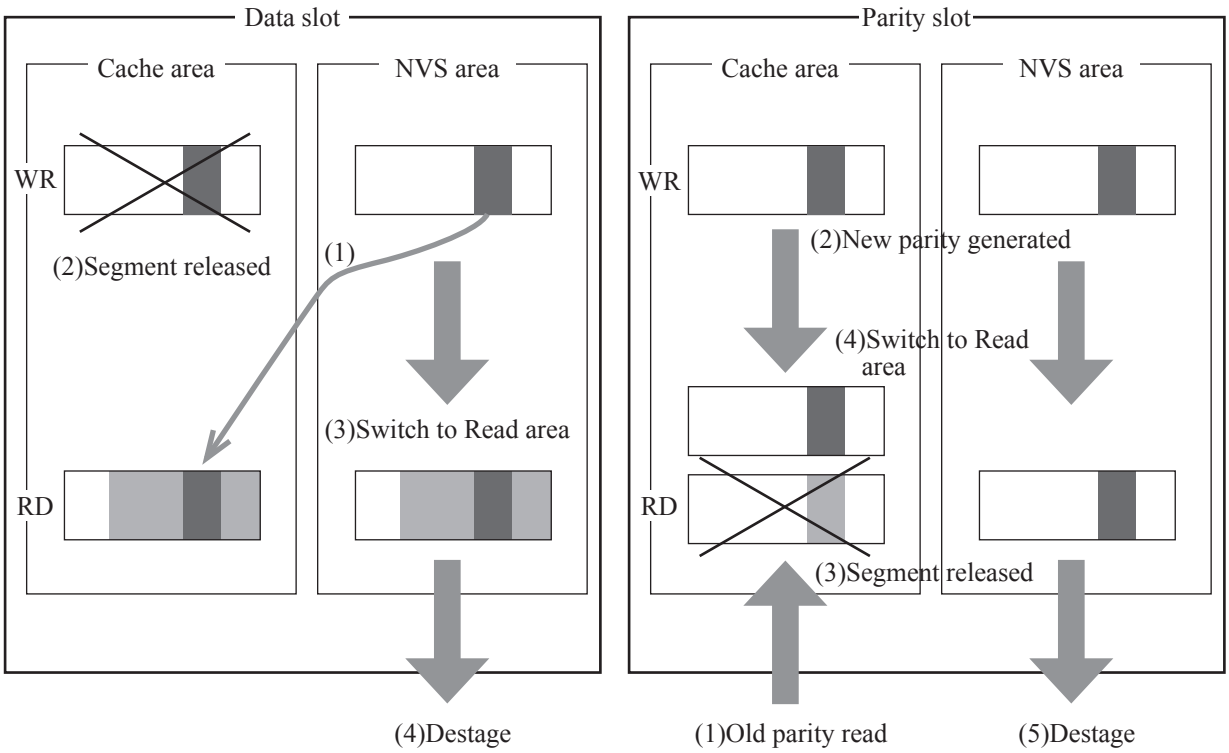
7. CFW-inhibited write-operation (with Cache single-side error)
   The non RAID-type Disk systems write data directly onto Disk storage in the form of Cache through, without performing a DFW, when a Cache error occurs. In this system, Cache must always be passed, which fact disables the through operation.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

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

2.9 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 Figure 2-59.

Figure 2-59 Cache Operation in the Destage Mode



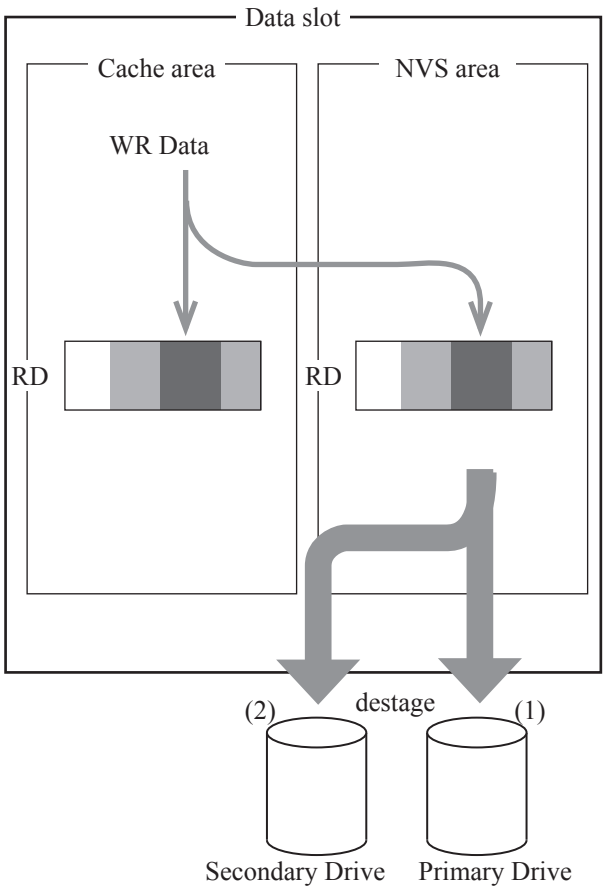
(1) The write data is copied from the NVS area into the read area.
(2) The write segment in the Cache area is released.
(3) Simultaneously, the segment in the NVS area is switched from write to read segment.
(4) Destaging.
(5) The read segment in the NVS area is released.

(1) Parity generation correction read (old parity) occurs.
(2) New parity is generated.
(3) The old parity in the read segment is released.
(4) The segments in the Cache and NVS areas are switched from write to read segment.
(5) Destaging.
(6) The read segment in the NVS area is released.

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.

Figure 2-60 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 Storage System performance. There are three modes of blocked data write: single-stripe blocking, multiple-stripe blocking and Drive blocking. These modes are briefly described 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.

2.10 Power-on Sequences

2.10.1 IMPL Sequence

The IMPL sequence, which is executed when power is turned on, is comprises 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.

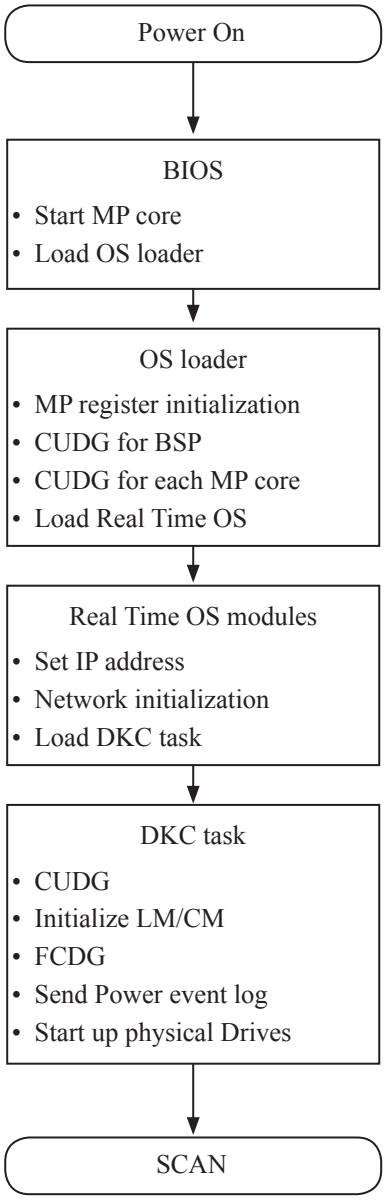
2. OS loader
   The OS loader performs the minimum necessary amount of initializations, tests the hardware resources, then loads the Real Time OS modules into the local memory and the Real Time OS is executed.

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 Maintenance PC 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 Figure 2-61.

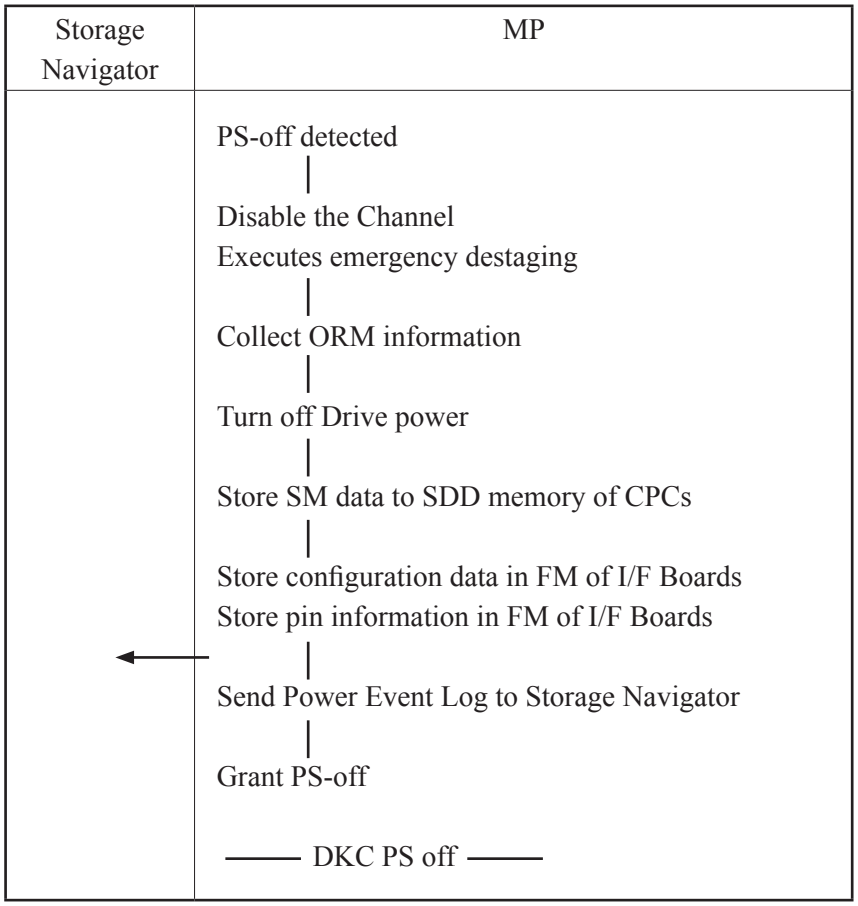
Figure 2-61 IMPL Sequence



2.10.2 Planned Power Off

When a power-off is specified by a maintenance personnel, this Storage System checks for termination of tasks that are blocked or running on all logical devices. When all the tasks are terminated, this Storage System disables the CHL and executes emergency destaging. If a track for which destaging fails (pinned track) occurs, this Storage System stores the pin information in shared memory.
Subsequently, this Storage System saves the configuration data and the pin information(which is used as hand-over information) in flash memory of I/F Boards, save all SM data (which is used as none-volatile power on) in SSD memory of CPCs. Then, sends Power Event Log to the Maintenance PC, 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.



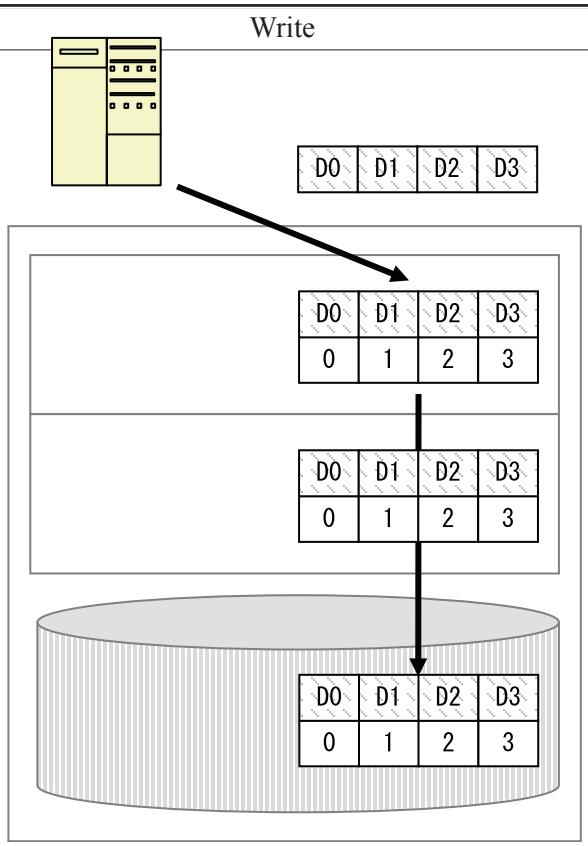
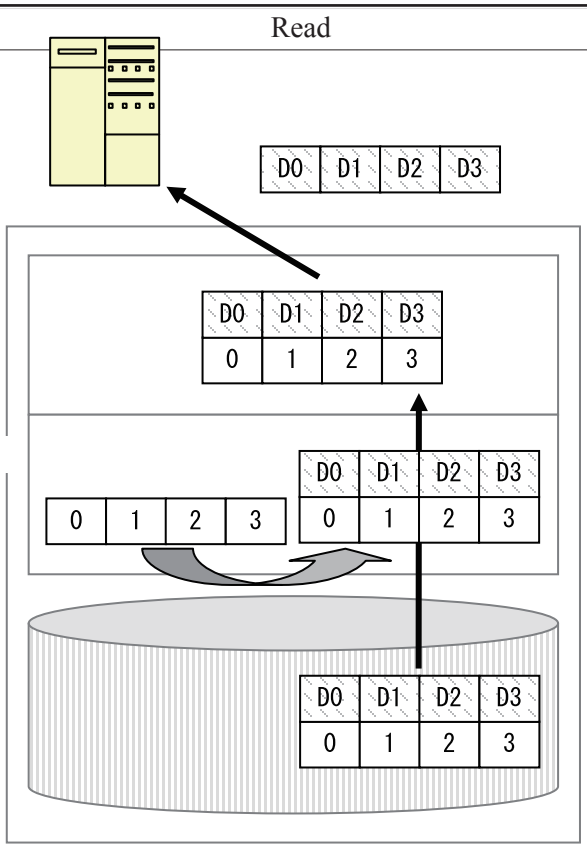
2.11 Data Guarantee

DW850 makes unique reliability improvements and performs unique preventive maintenance.

2.11.1 Data Check Using LA (Logical Address) (LA Check) (Common to SAS Drives and SSD)

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 2-43 LA check method

Write	Read
	
1. Receive Write requirement from Host. 2. CHB 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. DKB stores data on HDD.	1. DKB 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. CHB transfers data to Host by removing the LA field.

2.12 Encryption License Key

To use Encryption License Key, the SVP needs to be installed.

2.12.1 Overview of Encryption

You are able to encrypt data stored in volumes in the Storage System by using Encryption License Key. By encrypting data, you can prevent data from being leaked when you replace the Storage System or hard Disks in the Storage System or when these are stolen.

2.12.2 Specifications of Encryption

Table 2-44 shows the specifications of encryption with Encryption License Key.

Table 2-44 Specifications of encryption with Encryption License Key

Item		Specifications
Hardware spec	Encryption algorithm	AES 256 bit
Volume to encrypt	Volume type	Open volumes
	Emulation type	OPEN-V
Encryption key management	Unit of creating encryption key	HDD
	Number of encryption keys	VSP G350/G370, VSP F350/F370: 1,024 VSP G700, VSP F700, VSP G900, VSP F900: 4,096
	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 et cetera.).

2.12.3 Notes on Using Encryption License Key

Please note the following when using Encryption License Key.

Table 2-45 Notes on Encryption License Key

#	Item	Content
1	Volumes to encrypt	Only internal volumes in the Storage System 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: • 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.
4	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.
5	[Protect the Key Encryption Key at the Key Management Server] Check Box	When you select [Protect the Key Encryption Key at the Key Management Server] Check Box, the KEK (Key Encryption Key) is stored in the key management server. Registration of 2 key management servers is required for this operation. When you perform PS-ON for the DKC, the Maintenance PC gets the key from the key management server. Therefore, the communication between the SVP and the key management server should be available. Before you perform PS-ON for the DKC, make sure that the communication between the SVP and the key management server is available.

2.12.4 Creation of Encryption Key

An encryption key is used for data encryption and decryption. Up to 1,024 encryption keys can be created in the Storage System for VSP G350/G370 and VSP F350/F370, and 4,096 for VSP G700, VSP G900, VSP F700, and VSP F900.
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 Storage System, the Storage System 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.

2.12.5 Backup of Encryption Key

There are two types of encryption key backup: the primary backup to store the key in the Cache Flash Memory in the Storage System and the secondary backup to store the key in the management client or the key management server.

- Primary backup
  Encryption key created on SM is backed up in the Cache Flash Memory in the Storage System.
  Encryption key is automatically backed up within the Storage System at the time it is created, deletion, a status are changed.

- Secondary backup
  Encryption key created on SM is backed up in the management client or the key management server of the user.
  The secondary backup is performed from Storage Navigator by direction of the security administrator.

2.12.6 Restoration of Encryption Key

There are two types of encryption key restoration; restoration from primary backup and restoration from secondary backup.

- Restoration from primary backup
  When the encryption key on SM cannot be used, the encryption key primary backup is restored.
  Restoration from primary backup is automatically performed in the the Storage System.

- Restoration from secondary backup
  When encryption keys including the encryption key primary backup cannot be used in the Storage System, the encryption key secondary backup is restored.
  Restoration from secondary backup is performed when requested by the security administrator from Storage Navigator.

2.12.7 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 Storage Navigator.

NOTE:
- 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 et cetera.

2.12.8 Encryption Format

To format a RAID group in which encryption is set, format the entire Disk area by write encrypted 0 data in the entire Disk area. This is called Encryption format.
When encryption is set for a RAID group, encryption format is needed before user data is written. When encryption is released, normal format is needed 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.

2.12.9 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 et cetera.) used for conversion.

2.12.10 Deleting Encryption Keys

Only customer security administrators are able to delete encryption keys. You cannot delete the encryption key which is allocated to HDDs or DKBs. You can delete the encryption key whose attribute is Free key.

2.12.11 Reference of Encryption Setting

You can check the encryption setting (Encryption: Enable/Disable) per RAID group from Parity Groups screen of Storage Navigator.

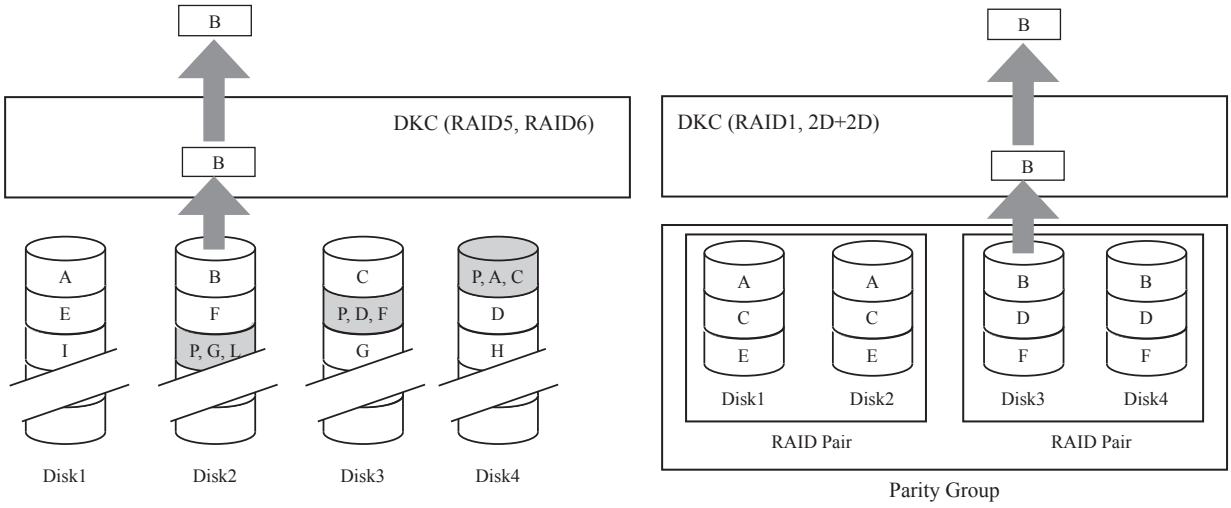
2.13 Operations Performed when Drive Errors Occur

2.13.1 I/O Operations Performed when Drive Failures Occur

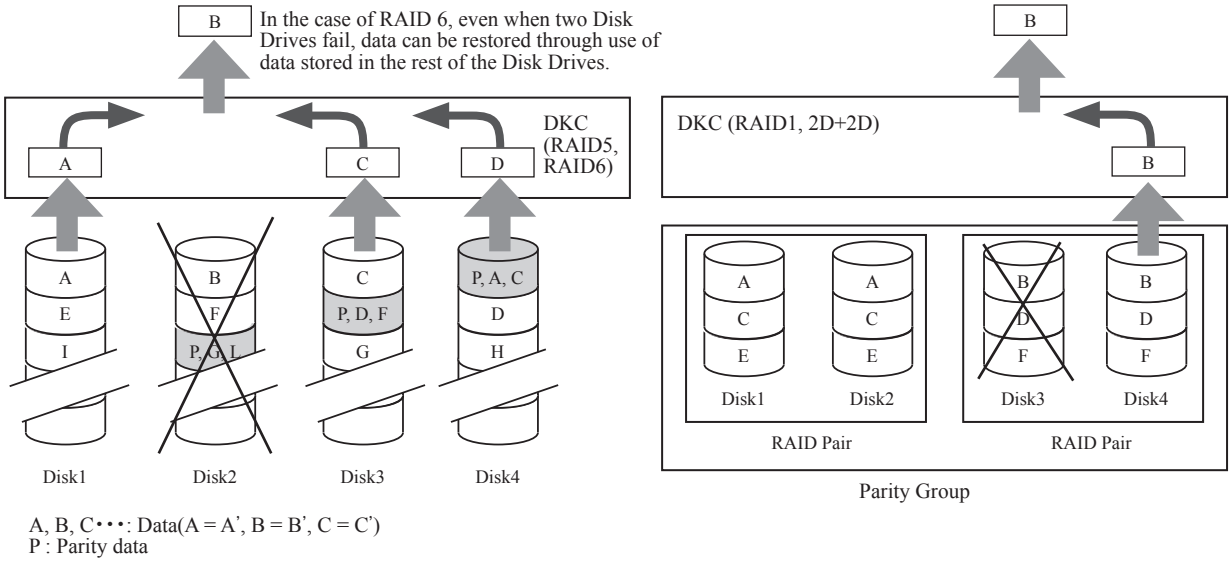
This system can recover target data using parity data and data stored on normal Disk storage even when it cannot read data due to failures occurring on physical Drives. This feature ensures non-disruptive processing of applications in case of Drive failures. This system can also continue processing for the same reason in case failures occur on physical Drives while processing write requirements.
Figure 2-62 shows the overview of data read processing in case a Drive failure occurs.

Figure 2-62 Overview of Data Read Processing (Requirement for read data B)

1. Normal time



2. When a Disk failure occurs



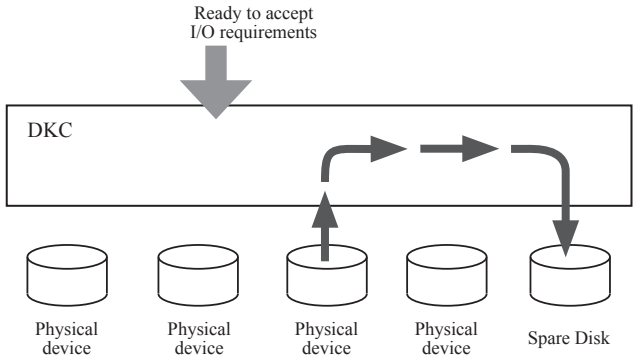
A, B, C・・・: Data(A = A', B = B', C = C')
P : Parity data

2.13.2 Data Guarantee at the Time of Drive Failures

This system uses spare Disk Drives and reconfigures any Drives that are blocked due to failures or Drives whose failure 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 requirements. The data saved on spare Disks are copied into the original location after the failure Drives are replaced with new ones. But when the copy back mode is set to “No Copy Back”, and when copying to the same capacity spare Disk, the copy back is not performed.

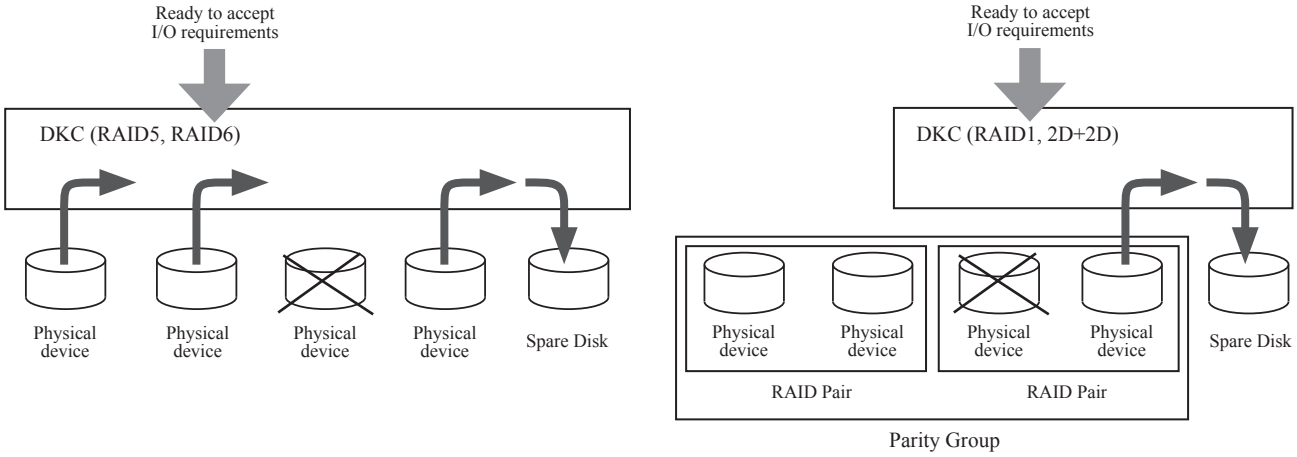
1. Dynamic sparing
   This system keeps track of the number of failures that occurred, for each Drive, when it executes normal read or write processing. If the number of failures occurring on a certain Drive exceeds a predetermined value, this system considers that the Drive is likely to cause unrecoverable failures 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.

Figure 2-63 Overview of the Dynamic Sparing Overview



2. Correction copy
   When this system cannot read or write data from or to a Drive due to an failure 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.

Figure 2-64 Overview of the Correction Copy Overview



3. Allowable number of copying operations

Table 2-46 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.

2.14 Data Guarantee at the Time of a Power Outage due to Power Outage and Others

If a power failure due to power outage and others occurs, refer to "5. Battery" of "4.6.4 Hardware Component".

2.15 Overview of DKC Compression

2.15.1 Capacity Saving and Accelerated Compression

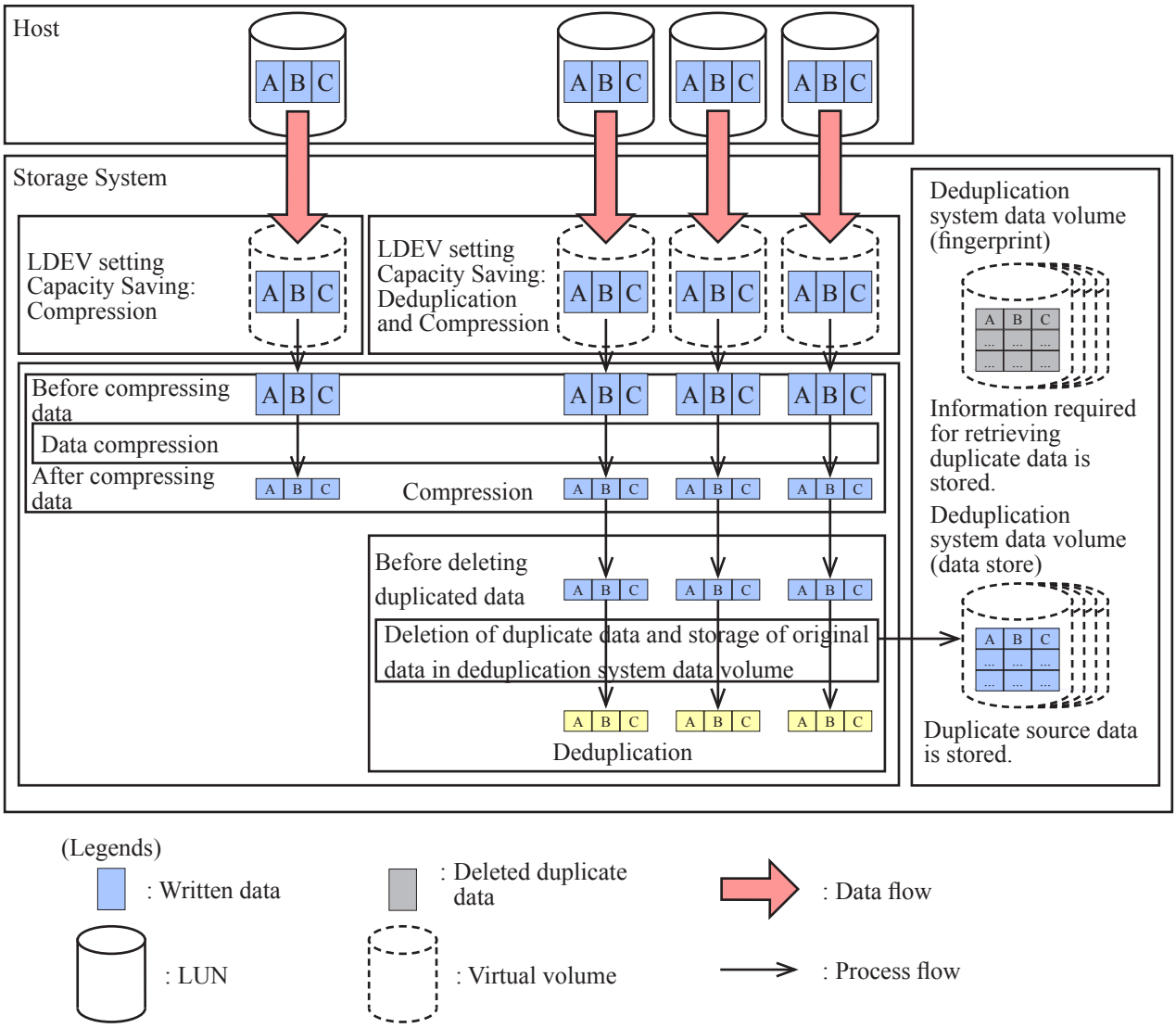
The following two functions are available for using the capacity of virtual volumes effectively.

- Capacity Saving (Compression and Deduplication)
  Capacity Saving is a function to reduce the bit-cost by the data compression (Compression) and data deduplication (Deduplication) performed by the storage system controller to compress the stored data. The post process mode or the inline mode can be selected as the mode for writing new data.
- Accelerated Compression
  Accelerated Compression is a function to expand the drive capacity and reduce the bit-cost while maintaining the high data access of the storage system by using Compression on the drive.

2.15.2 Capacity Saving

Capacity Saving is a function to perform Compression and Deduplication of stored data by using the storage system controller. Reducing data capacity allows data more than the size of drives on the system to be stored. An empty area of a pool can be increased by Capacity Saving and the users can decrease the purchase cost of drives in the product lifecycle. Capacity Saving is available for all types of drives and can be used with the encryption function.

The following describes each function.



When the Capacity Saving function is enabled, the pool capacity is consumed because the entire capacity of metadata and garbage data is stored. The capacity to be consumed is equivalent to the physical capacity of about 10% of the LDEV capacity that is processed by Capacity Saving. The pool capacity is dynamically consumed according to usage of the Capacity Saving process. When the amount of data writes from the host increases, the consumed capacity might exceed 10% of the pool capacity temporarily. When the amount of data writes decreases, the used capacity becomes about 10% of the pool capacity due to the garbage collection operation.

2.15.2.1 Compression

Compression is a function to convert a data size to a different smaller data size by encryption without reducing the amount of information. LZ4 is used for Compression as the data compression algorithm. Set this function to each virtual volume for Dynamic Provisioning.

2.15.2.2 Deduplication

Deduplication is a function to retain data on a single address and delete the duplicated data on other addresses if the same data is written on different addresses. Deduplication is set for each of the virtual volumes of the Dynamic Provisioning. When Deduplication is enabled, duplicated data among virtual volumes associated with a pool is deleted. When virtual volumes with Deduplication enabled are created, system data volumes for Deduplication (fingerprint) and system data volumes for Deduplication (data store) are created. The system data volume for Deduplication (fingerprint) stores a table to search for duplicated data among data stored in the pool. Four system data volumes for Deduplication (fingerprint) are created per pool. The system data volume for Deduplication (data store) stores the original data of the duplicated data. Four system data volume for Deduplication (data store) are created per pool.
When the settings of [Deduplication and Compression] of all virtual volumes are changed to [Disable], system data volumes for Deduplication are automatically deleted.

3. Specifications for the Operations of DW850

3.1 Precautions When Stopping the Storage System

Pay attention to the following instructions concerning the operation when the Storage System stops immediately after turning on the PDU breaker and completing the power off of the Storage System.

3.1.1 Precautions in a Power-off Mode

- Even if the PDU breaker is immediately after turning on, or the Storage System is in the status of the power off after the process of the power off is completed, the Storage System is in a standby mode.
- In this standby mode, the AC input is supplied to the Power Supply in the Storage System, and this supplies the Power Supply to the FANs, the Cache Memory modules and some boards (I/F Boards, Controller Boards, ENCs or the like).
- Please execute the following process when the standby electricity must be controlled, because the standby electricity exists in the Storage System under this condition. See Table 3-1 for standby electricity.

1. When the Storage System is powered on
   Turn on the breaker of each PDU just before the power on processing.

2. When the Storage System 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 Storage System 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 Storage System are not connected to the PDU that is turned off.
   - The management information stored in the memory is transferred to the Cache Flash Memory (CFM) in the Controller Board during the power off process, therefore, leaving the breaker of the PDUs on is needless for the data retention.

Table 3-1 Maximum Standby Electricity per Controller Chassis and Drive Box

Controller Chassis/Drive Box etc	Maximum Standby Electricity [VA]
DBS (SFF Drive Box)	200
DBL (LFF Drive Box)	140
DB60 (3.5-inch Drive Box)	560
DBF (Flash Module Drive Box)	410
CBL (Controller Chassis)	230
CBSS (Controller Chassis)	370
CBSL (Controller Chassis)	310
CBXSS (Controller Chassis)	230
CBXSL (Controller Chassis)	170
CHBB (Channel Board Box)	180

3.1.2 Operations When a Distribution Board Is Turned off

When the distribution board breaker or the PDU breaker is turned off, execute the operation after making sure that the Power Supply of the Storage System was normally turned off, by confirming the PS was normally turned off according to the Power OFF Event Log (Refer to "1.5.2 Storage System Power Off (Planned Shutdown)" in INSTALLATION SECTION.) of Maintenance PC.

When the Power OFF Event Log confirmation is impossible, suspend the operation and requirement customers to restart the Storage System to confirm that the PS is normally turned off.

NOTICE: Requirement the thoroughness in the following operations to the customer if the distribution board breaker or the PDU is impossible to keep the on-status after the power of the Storage System is turned off.

1. Point to be checked before turning the breaker off
   Requirement the customer to make sure that the power off processing of the Storage System is completed (READY 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 status of discharge when the distribution board breaker or PDU breaker is turned off after the Storage System 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 4.5 hours. Accordingly, requirement the customer to charge the battery prior to the restarting of the Storage System.

3.2 Precautions When Installing of Flash Drive and Flash Module Drive Addition

For precautions when installing of Flash Drive and Flash Module Drive, refer to INSTALLATION SECTION "1.3.4 Notes for Installing Flash Module Drive Boxes".

3.3 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 addition, 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, addition, and removal, after Dynamic Sparing, LDEV Format et cetera. is completed, based on the basic maintenance policy, but the following maintenance operations are available.

Table 3-2 Correlation List of Storage System Statuses and Maintenance Available Parts

Maintenance operation		Storage System status					
		Dynamic Sparing	Correction Copy	Copy Back	Correction Access	Copied to spare Disk	LDEV Format
Replacement	CTL	Possible	Possible	Possible	Possible (*1) (*8)	Possible	Impossible (*6)
	LANB	Possible	Possible	Possible	Possible (*1) (*8)	Possible	Impossible (*6)
	CHB	Possible	Possible	Possible	Possible (*1) (*8)	Possible	Impossible (*6)
	Power supply	Possible	Possible	Possible	Possible	Possible	Possible
	SVP	Possible	Possible	Possible	Possible	Possible	Possible
	ENC	Possible	Possible	Possible	Possible (*1) (*8)	Possible	Impossible (*6)
	DKB	Possible	Possible	Possible	Possible (*1) (*8)	Possible	Impossible (*6)
	PDEV	Possible (*15)	Possible (*15)	Possible (*15)	Possible (*1) (*8)	Possible	Possible (*4)
Addition/ Removal	CM/SM	Impossible (*7)	Impossible (*7)	Impossible (*7)	Possible (*1) (*8)	Possible	Impossible (*6)
	LANB	Impossible (*7)	Impossible (*7)	Impossible (*7)	Possible (*1) (*8)	Possible	Impossible (*6)
	CHB	Impossible (*7)	Impossible (*7)	Impossible (*7)	Possible (*1) (*8)	Possible	Impossible (*6)
	SVP	Possible	Possible	Possible	Possible	Possible	Possible
	DKB	Impossible (*7)	Impossible (*7)	Impossible (*7)	Possible (*1) (*8)	Possible	Impossible (*6)
	PDEV	Impossible (*7)	Impossible (*7)	Impossible (*7)	Possible (*1) (*8)	Possible (*2)	Impossible (*6)
Firmware exchange	Online	Possible (*3)	Possible (*3)	Possible (*3)	Possible (*1) (*8)	Possible (*1) (*3) (*9)	Impossible (*6)
	Offline	Impossible (*7)	Impossible (*7)	Impossible (*7)	Impossible (*8)	Possible	Impossible (*6)
	SVP only	Possible	Possible	Possible	Possible	Possible	Possible
LDEV maintenance	Blockade	Possible (*5) (*9) (*10)	Possible (*5) (*9) (*10)	Possible (*5) (*9) (*10)	Possible (*5)	Possible	Possible (*9) (*10)
	Restore	Possible (*5) (*9) (*11)	Possible (*5) (*9) (*11)	Possible (*5) (*9) (*11)	Possible (*5)	Possible	Possible (*9) (*11)
	Format	Possible (*5)	Possible (*5)	Possible (*5)	Possible (*5) (*9) (*13)	Possible	Impossible (*12)
	Verify	Impossible (*10)	Impossible (*10)	Impossible (*10)	Possible (*9) (*14)	Possible	Impossible (*10)

*1: It is prevented with the message. However, it is possible to perform it by checking the checkbox of "Perform forcibly without safety check".

*2: It is impossible to remove a RAID group in which data is migrated to a spare Disk and the spare Disk.

*3: Firmware-program exchange can be performed if HDD firmware-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 maintenance for LDEV defined in a RAID group in which Dynamic Sparing, Correction Copy, Copy Back or Correction Access is not running.

*6: It is prevented with message [30762-208158]. However, a different message might be displayed depending on the occurrence timing of the state regarded as a prevention condition.

*7: It is prevented with message [30762-208159]. However, a different message might be displayed depending on the occurrence timing of the state regarded as a prevention condition.

*8: It is prevented with message [33361-203503:33462-200046]. However, a different message might be displayed depending on the occurrence timing of the state regarded as a prevention condition.

*9: It is prevented with the message. However, it is possible to perform it from "Forcible task without safety check".

*10: It is prevented with message [03005-002095]. However, a different message might be displayed depending on the occurrence timing of the state regarded as a prevention condition.

*11: It is prevented with message [03005-202002]. However, a different message might be displayed depending on the occurrence timing of the state regarded as a prevention condition.

*12: It is prevented with message [03005-202001]. However, a different message might be displayed depending on the occurrence timing of the state regarded as a prevention condition.

*13: It is prevented with message [03005-202005]. However, a different message might be displayed depending on the occurrence timing of the state regarded as a prevention condition.

*14: It is prevented with message [03005-002011]]. However, a different message might be displayed depending on the occurrence timing of the state regarded as a prevention condition.

*15:It is prevented with message [30762-208159].

- When the RAID group to which the maintenance target PDEV belongs and the RAID group whose Dynamic Sparing / Correction Copy / Copy Back is operating are not identical, it is possible to perform it by checking the checkbox of "Perform forcibly without safety check".
- When the RAID group to which the maintenance target PDEV belongs and the RAID group whose Dynamic Sparing / Correction Copy / Copy Back is operating are identical and the RAID level is RAID 6, it is possible to perform it by checking the checkbox of "Perform forcibly without safety check" depending on the status of the PDEV other than the maintenance target.

However, a different message might be displayed depending on the occurrence timing of the state regarded as a prevention condition.

3.4 Inter Mix of Drives

Table 3-3 shows permitted coexistence of RAID levels and HDD types respectively.

Table 3-3 pecifications for Coexistence of Elements

<table>
<tr><th>Item</th><th>Specification</th><th>Remarks</th></tr>
<tr><td>Coexistence of RAID levels</td><td>RAID1 (2D+2D, 4D+4D), RAID5 (3D+1P, 4D+1P, 6D+1P, 7D+1P), RAID6 (6D+2P, 12D+2P, 14D+2P) can exist in the system.</td><td></td></tr>
<tr><td>Drive type</td><td>Different drive types can be mixed for each parity group.</td><td></td></tr>
<tr><td>Spare drive</td><td>When the following conditions 1 and 2 are met, the drives can be used as spare drives.
1. Capacity of the spare drives is the same as or larger than the drives in operation.
2. The type of the drives in operation and the type of the spare drives fulfill the following conditions.

<table><tr><th>Type of Drive in Operation</th><th>Type of Usable Spare Drive</th></tr><tr><td>HDD (7.2 krpm)</td><td>HDD (7.2 krpm)</td></tr><tr><td>HDD (10 krpm)</td><td>HDD (10 krpm)</td></tr><tr><td>HDD (15 krpm)</td><td>HDD (15 krpm)</td></tr><tr><td>SSD</td><td>SSD</td></tr><tr><td>FMD (xRyFN)</td><td>FMD (xRyFN, xRyFP)</td></tr><tr><td>FMD (xRyFP)</td><td>FMD (xRyFP)</td></tr></table>
NOTE: “x” and “y” are an arbitrary number. Some drives do not contain the number of “y” (e.g. 14RFP).
The numbers (x, y) of Type of Drive in Operation need not be the same as those of Type of Usable Spare Drive.
For example, when the drives in operation are 1R6FN, the drives of 1R6FN, 7R0FP, etc. can be used as spare drives.</td><td></td></tr>
</table>

4. Appendixes

4.1 DB Number - C/R Number Matrix

For 12-bit DB#/RDEV# indicated in the PLC (Parts Location Code) of ACC and the SIM-RC, the relation between the contents of bits and HDD location# is shown below. The correspondence between DB# and CDEV# for each storage system model is also shown.

1. Relation between DB#, RDEV#, and HDD location#
   DB# and RDEV# are indicated in the following format.

   • DB#/RDEV# format

X (4 bit)				Y (4 bit)				Z (4 bit)			
x	x	x	x	y	y	y	y	z	z	z	z
DB# (6 bit)								RDEV# (6 bit)			

   Example: In the case of XYZ = 5A5 (Hex) (Hex: Hexadecimal, Dec: Decimal)

5				A				5			
0	1	0	1	1	0	1	0	0	1	0	1
DB# = 16 (Hex) = 22 (Dec)								RDEV# = 25 (Hex) = 37 (Dec)			

   The relation between DB#, RDEV#, and HDD location# is shown below.

   • HDDxx-yy
   - xx: DB# (Dec)
   - yy: RDEV# (Dec)

   Example: In the case of XYZ = 5A5 (Hex)
   HDD22-37

   The following is the relation between 12-bit DB#/RDEV#, DB#, RDEV# (R#), and HDD location# for DB-00. For DB-01 or later, the relation between DB#/RDEV#, DB#, RDEV#, and HDD location# is the same as that for DB-00.

Table 4-1 DB Number - R Number Matrix (DB-00 (*1))

SIM-RC/PLC DB#/RDEV# (Hex)	Drive Box Number (DB#)	RDEV# (R#)	HDD location#
000	DB-00	00	HDD00-00
001		01	HDD00-01
002		02	HDD00-02
003		03	HDD00-03
004		04	HDD00-04
005		05	HDD00-05
006		06	HDD00-06
007		07	HDD00-07
008		08	HDD00-08
009		09	HDD00-09
00A		10	HDD00-10
00B		11	HDD00-11
00C		12	HDD00-12
00D		13	HDD00-13
00E		14	HDD00-14
00F		15	HDD00-15
010		16	HDD00-16
011		17	HDD00-17
012		18	HDD00-18
013		19	HDD00-19
014		20	HDD00-20
015		21	HDD00-21
016		22	HDD00-22
017		23	HDD00-23
018		24	HDD00-24
019		25	HDD00-25
01A		26	HDD00-26
01B		27	HDD00-27
01C		28	HDD00-28
01D		29	HDD00-29
01E		30	HDD00-30
01F		31	HDD00-31

(To be continued)

(Continued from the preceding page)

SIM-RC/PLC DB#/RDEV# (Hex)	Drive Box Number (DB#)	RDEV# (R#)	HDD location#
020	DB-00	32	HDD00-32
021		33	HDD00-33
022		34	HDD00-34
023		35	HDD00-35
024		36	HDD00-36
025		37	HDD00-37
026		38	HDD00-38
027		39	HDD00-39
028		40	HDD00-40
029		41	HDD00-41
02A		42	HDD00-42
02B		43	HDD00-43
02C		44	HDD00-44
02D		45	HDD00-45
02E		46	HDD00-46
02F		47	HDD00-47
030		48	HDD00-48
031		49	HDD00-49
032		50	HDD00-50
033		51	HDD00-51
034		52	HDD00-52
035		53	HDD00-53
036		54	HDD00-54
037		55	HDD00-55
038		56	HDD00-56
039		57	HDD00-57
03A		58	HDD00-58
03B		59	HDD00-59

*1: In the case of CBXSS/CBXSL/CBSS/CBSL, DB-00 is contained in DKC.

2. Matrix of correspondence between DB# and CDEV# (C#)
The correspondence between DB# and C# differs depending on storage system models as shown in the following matrix table.

NOTE: The number of drive boxes that can be connected depends on storage system models.

Table 4-2 DB Number - C Number Matrix

- VSP G900, VSP F900

DB# (Dec)	C# (Hex)	DB# (Dec)	C# (Hex)	DB# (Dec)	C# (Hex)	DB# (Dec)	C# (Hex)	DB# (Dec)	C# (Hex)	DB# (Dec)	C# (Hex)
DB-00	00	DB-08	02	DB-16	04	DB-24	40	DB-32	42	DB-40	44
DB-01	10	DB-09	12	DB-17	14	DB-25	50	DB-33	52	DB-41	54
DB-02	20	DB-10	22	DB-18	24	DB-26	60	DB-34	62	DB-42	64
DB-03	30	DB-11	32	DB-19	34	DB-27	70	DB-35	72	DB-43	74
DB-04	01	DB-12	03	DB-20	05	DB-28	41	DB-36	43	DB-44	45
DB-05	11	DB-13	13	DB-21	15	DB-29	51	DB-37	53	DB-45	55
DB-06	21	DB-14	23	DB-22	25	DB-30	61	DB-38	63	DB-46	65
DB-07	31	DB-15	33	DB-23	35	DB-31	71	DB-39	73	DB-47	75

- VSP G700, VSP F700

DB# (Dec)	C# (Hex)	DB# (Dec)	C# (Hex)	DB# (Dec)	C# (Hex)	DB# (Dec)	C# (Hex)	DB# (Dec)	C# (Hex)	DB# (Dec)	C# (Hex)
DB-00	00	DB-08	04	DB-16	08	DB-24	20	DB-32	24	DB-40	28
DB-01	10	DB-09	14	DB-17	18	DB-25	30	DB-33	34	DB-41	38
DB-02	01	DB-10	05	DB-18	09	DB-26	21	DB-34	25	DB-42	29
DB-03	11	DB-11	15	DB-19	19	DB-27	31	DB-35	35	DB-43	39
DB-04	02	DB-12	06	DB-20	0A	DB-28	22	DB-36	26	DB-44	2A
DB-05	12	DB-13	16	DB-21	1A	DB-29	32	DB-37	36	DB-45	3A
DB-06	03	DB-14	07	DB-22	0B	DB-30	23	DB-38	27	DB-46	2B
DB-07	13	DB-15	17	DB-23	1B	DB-31	33	DB-39	37	DB-47	3B

- VSP G370, VSP F370, VSP G350, VSP F350, VSP G130

DB# (Dec)	C# (Hex)	DB# (Dec)	C# (Hex)
DB-00 (*1)	00	DB-08	17
DB-01	10	DB-09	18
DB-02	11	DB-10	19
DB-03	12	DB-11	1A
DB-04	13		
DB-05	14		
DB-06	15		
DB-07	16		

*1: DB-00 is contained in the DKC.

4.2 Comparison of Pair Status on Storage Navigator, Command Control Interface (CCI)

Table 4-3 Comparison of Pair Status on Storage Navigator, CCI

No.	Event	Status on CCI	Status on Storage Navigator
1	Simplex Volume	P-VOL: SMPL S-VOL: SMPL	P-VOL: SMPL S-VOL: SMPL
2	Copying LU 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)/ SSUS
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)/SSUS
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)/ SSUS
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)/ SSUS
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)/ SSUS
15	MCU detected the failure of RCU	P-VOL: PSUE S-VOL: PSUE	P-VOL: PSUS (by RCU)/PSUE S-VOL: PSUE (S-VOL failure)

*1: Operation on CCI

4.3 Parts Number of Correspondence Table

Table 4-4 Relationship between Cluster # and CTL #

Cluster	CTL Location Name	Cluster# (HEX)	CTL# (HEX)
Cluster-1	CTL1	0x00	0x00
Cluster-2	CTL2	0x01	0x01

Table 4-5 Relationship between Cluster # and MPU#, MP#

Cluster	CTL Location Name	MPU# (HEX)	VSP G130 MP# (HEX)	VSP G350 MP# (HEX)	VSP G370 MP# (HEX)	VSP G700 MP# (HEX)	VSP G900 MP# (HEX)
Cluster-1	CTL1	0x00	0x00, 0x01	0x00 ~ 0x05	0x00 ~ 0x09	0x00 ~ 0x0B	0x00 ~ 0x13
Cluster-2	CTL2	0x01	0x04, 0x05	0x08 ~ 0x0D	0x20 ~ 0x29	0x20 ~ 0x2B	0x20 ~ 0x33

Table 4-6 Correspondence Table of Cluster # and MP # of VSP G130 and a Variety of Numbering

Cluster	CTL Location Name	MP#		PK#			
		Hardware	Internal Part	MPU#	MP in MP#	MPPK#	MPPK in MP#
Cluster-1	CTL1	0x00	0x00	0x00	0x00	0x00	0x00
		0x01	0x01		0x01		0x01
Cluster-2	CTL2	0x02	0x04	0x01	0x00	0x01	0x00
		0x03	0x05		0x01		0x01

Table 4-7 Correspondence Table of Cluster # and MP # of VSP G350, VSP F350 and a Variety of Numbering

Cluster	CTL Location Name	MP#		PK#			
		Hardware	Internal Part	MPU#	MP in MP#	MPPK#	MPPK in MP#
Cluster-1	CTL1	0x00	0x00	0x00	0x00	0x00	0x00
		0x01	0x01		0x01		0x01
		0x02	0x02		0x02		0x02
		0x03	0x03		0x03		0x03
		0x04	0x04		0x04		0x04
		0x05	0x05		0x05		0x05
Cluster-2	CTL2	0x06	0x08	0x01	0x00	0x01	0x00
		0x07	0x09		0x01		0x01
		0x08	0x0A		0x02		0x02
		0x09	0x0B		0x03		0x03
		0x0A	0x0C		0x04		0x04
		0x0B	0x0D		0x05		0x05

Table 4-8 Correspondence Table of Cluster # and MP # of VSP G370, VSP F370 and a Variety of Numbering

Cluster	CTL Location Name	MP#		PK#			
		Hardware	Internal Part	MPU#	MP in MP#	MPPK#	MPPK in MP#
Cluster-1	CTL1	0x00	0x00	0x00	0x00	0x00	0x00
		0x01	0x01		0x01		0x01
		0x02	0x02		0x02		0x02
		0x03	0x03		0x03		0x03
		0x04	0x04		0x04		0x04
		0x05	0x05		0x05		0x05
		0x06	0x06		0x06		0x06
		0x07	0x07		0x07		0x07
		0x08	0x08		0x08		0x08
		0x09	0x09		0x09		0x09
Cluster-2	CTL2	0x0A	0x20	0x01	0x00	0x01	0x00
		0x0B	0x21		0x01		0x01
		0x0C	0x22		0x02		0x02
		0x0D	0x23		0x03		0x03
		0x0E	0x24		0x04		0x04
		0x0F	0x25		0x05		0x05
		0x10	0x26		0x06		0x06
		0x11	0x27		0x07		0x07
		0x12	0x28		0x08		0x08
		0x13	0x29		0x09		0x09

Table 4-9 Correspondence Table of Cluster # and MP # of VSP G700, VSP F700 and a Variety of Numbering

Cluster	CTL Location Name	MP#		PK#			
		Hardware	Internal Part	MPU#	MP in MP#	MPPK#	MPPK in MP#
Cluster-1	CTL1	0x00	0x00	0x00	0x00	0x00	0x00
		0x01	0x01		0x01		0x01
		0x02	0x02		0x02		0x02
		0x03	0x03		0x03		0x03
		0x04	0x04		0x04		0x04
		0x05	0x05		0x05		0x05
		0x06	0x06		0x06		0x06
		0x07	0x07		0x07		0x07
		0x08	0x08		0x08		0x08
		0x09	0x09		0x09		0x09
		0x0A	0x0A		0x0A		0x0A
		0x0B	0x0B		0x0B		0x0B
Cluster-2	CTL2	0x0C	0x20	0x01	0x00	0x01	0x00
		0x0D	0x21		0x01		0x01
		0x0E	0x22		0x02		0x02
		0x0F	0x23		0x03		0x03
		0x10	0x24		0x04		0x04
		0x11	0x25		0x05		0x05
		0x12	0x26		0x06		0x06
		0x13	0x27		0x07		0x07
		0x14	0x28		0x08		0x08
		0x15	0x29		0x09		0x09
		0x16	0x2A		0x0A		0x0A
		0x17	0x2B		0x0B		0x0B

Table 4-10 Correspondence Table of Cluster # and MP # of VSP G900, VSP F900 and a Variety of Numbering

Cluster	CTL Location Name	MP#		PK#			
		Hardware	Internal Part	MPU#	MP in MP#	MPPK#	MPPK in MP#
Cluster-1	CTL1	0x00	0x00	0x00	0x00	0x00	0x00
		0x01	0x01		0x01		0x01
		0x02	0x02		0x02		0x02
		0x03	0x03		0x03		0x03
		0x04	0x04		0x04		0x04
		0x05	0x05		0x05		0x05
		0x06	0x06		0x06		0x06
		0x07	0x07		0x07		0x07
		0x08	0x08		0x08		0x08
		0x09	0x09		0x09		0x09
		0x0A	0x0A		0x0A		0x0A
		0x0B	0x0B		0x0B		0x0B
		0x0C	0x0C		0x0C		0x0C
		0x0D	0x0D		0x0D		0x0D
		0x0E	0x0E		0x0E		0x0E
		0x0F	0x0F		0x0F		0x0F
		0x10	0x10		0x10		0x10
		0x11	0x11		0x11		0x11
		0x12	0x12		0x12		0x12
		0x13	0x13		0x13		0x13
Cluster-2	CTL2	0x14	0x20	0x01	0x00	0x01	0x00
		0x15	0x21		0x01		0x01
		0x16	0x22		0x02		0x02
		0x17	0x23		0x03		0x03
		0x18	0x24		0x04		0x04
		0x19	0x25		0x05		0x05
		0x1A	0x26		0x06		0x06
		0x1B	0x27		0x07		0x07
		0x1C	0x28		0x08		0x08
		0x1D	0x29		0x09		0x09
		0x1E	0x2A		0x0A		0x0A
		0x1F	0x2B		0x0B		0x0B
		0x20	0x2C		0x0C		0x0C
		0x21	0x2D		0x0D		0x0D
		0x22	0x2E		0x0E		0x0E
		0x23	0x2F		0x0F		0x0F
		0x24	0x30		0x10		0x10
		0x25	0x31		0x11		0x11
		0x26	0x32		0x12		0x12
		0x27	0x33		0x13		0x13

Table 4-11 Relationship between Cluster # and CHB#, DKB#

Cluster	CHB/DKB Location Name	VSP G130		VSP G350 VSP F350		VSP G370 VSP F370		VSP G700 VSP F700		VSP G900 VSP F900	
		CHB#	DKB#	CHB#	DKB#	CHB#	DKB#	CHB#	DKB#	CHB#	DKB#
Cluster-1	CHB-1A	0x00	—	0x00	—	0x00	—	0x00	—	0x00	—
	CHB-1B	—	—	0x01	—	0x01	—	0x01	—	0x01	—
	CHB-1C / DKB-1C	—	0x00	—	0x00	—	0x00	0x02	—	0x02	—
	CHB-1D	—	—	—	—	—	—	0x03	—	0x03	—
	CHB-1E / DKB-1E	—	—	—	—	—	—	0x04	—	0x04	0x02
	CHB-1F / DKB-1F	—	—	—	—	—	—	0x05	—	0x05	0x03
	CHB-1G / DKB-1G	—	—	—	—	—	—	0x06	0x00	0x06	0x00
	CHB-1H / DKB-1H	—	—	—	—	—	—	0x07	0x01	0x07	0x01
	CHB-1J (*1)	—	—	—	—	—	—	—	—	0x08	—
	CHB-1K (*1)	—	—	—	—	—	—	—	—	0x09	—
	CHB-1L (*1)	—	—	—	—	—	—	—	—	0x0A	—
	CHB-1M (*1)	—	—	—	—	—	—	—	—	0x0B	—
Cluster-2	CHB-2A	0x01	—	0x02	—	0x10	—	0x10	—	0x10	—
	CHB-2B	—	—	0x03	—	0x11	—	0x11	—	0x11	—
	CHB-2C / DKB-2C	—	0x04	—	0x04	—	0x04	0x12	—	0x12	—
	CHB-2D	—	—	—	—	—	—	0x13	—	0x13	—
	CHB-2E / DKB-2E	—	—	—	—	—	—	0x14	—	0x14	0x06
	CHB-2F / DKB-2F	—	—	—	—	—	—	0x15	—	0x15	0x07
	CHB-2G / DKB-2G	—	—	—	—	—	—	0x16	0x04	0x16	0x04
	CHB-2H / DKB-2H	—	—	—	—	—	—	0x17	0x05	0x17	0x05
	CHB-2J (*1)	—	—	—	—	—	—	—	—	0x18	—
	CHB-2K (*1)	—	—	—	—	—	—	—	—	0x19	—
	CHB-2L (*1)	—	—	—	—	—	—	—	—	0x1A	—
	CHB-2M (*1)	—	—	—	—	—	—	—	—	0x1B	—

*1: When the Channel Board Box is mounted.

Table 4-12 Relationship between Cluster # and Channel Port#

Cluster	CHB Location Name	VSP G130 Channel Port# (HEX)	VSP G350, VSP F350 Channel Port# (HEX)	VSP G370, VSP F370 Channel Port# (HEX)	VSP G700, VSP F700 Channel Port# (HEX)	VSP G900, VSP F900 Channel Port# (HEX)
Cluster-1	CHB-1A	0x00, 0x01	0x00 to 0x03	0x00 to 0x03	0x00 to 0x03	0x00 to 0x03
	CHB-1B	—	0x04 to 0x07	0x04 to 0x07	0x04 to 0x07	0x04 to 0x07
	CHB-1C	—	—	—	0x08 to 0x0B	0x08 to 0x0B
	CHB-1D	—	—	—	0x0C to 0x0F	0x0C to 0x0F
	CHB-1E	—	—	—	0x10 to 0x13	0x10 to 0x13
	CHB-1F	—	—	—	0x14 to 0x17	0x14 to 0x17
	CHB-1G	—	—	—	0x18 to 0x1B	0x18 to 0x1B
	CHB-1H	—	—	—	0x1C to 0x1F	0x1C to 0x1F
	CHB-1J (*1)	—	—	—	—	0x20 to 0x23
	CHB-1K (*1)	—	—	—	—	0x24 to 0x27
	CHB-1L (*1)	—	—	—	—	0x28 to 0x2B
	CHB-1M (*1)	—	—	—	—	0x2C to 0x2F
Cluster-2	CHB-2A	0x04, 0x05	0x08 to 0x0B	0x40 to 0x43	0x40 to 0x43	0x40 to 0x43
	CHB-2B	—	0x0C to 0x0F	0x44 to 0x47	0x44 to 0x47	0x44 to 0x47
	CHB-2C	—	—	—	0x48 to 0x4B	0x48 to 0x4B
	CHB-2D	—	—	—	0x4C to 0x4F	0x4C to 0x4F
	CHB-2E	—	—	—	0x50 to 0x53	0x50 to 0x53
	CHB-2F	—	—	—	0x54 to 0x57	0x54 to 0x57
	CHB-2G	—	—	—	0x58 to 0x5B	0x58 to 0x5B
	CHB-2H	—	—	—	0x5C to 0x5F	0x5C to 0x5F
	CHB-2J (*1)	—	—	—	—	0x60 to 0x63
	CHB-2K (*1)	—	—	—	—	0x64 to 0x67
	CHB-2L (*1)	—	—	—	—	0x68 to 0x6B
	CHB-2M (*1)	—	—	—	—	0x6C to 0x6F

*1: When the Channel Board Box is mounted.

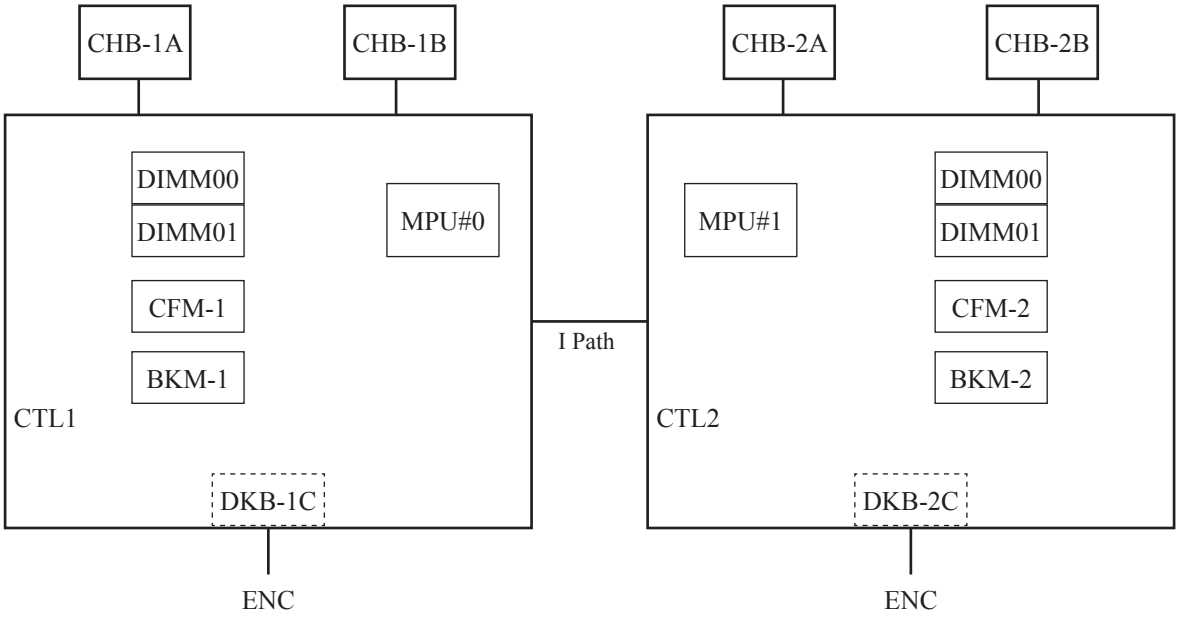
Table 4-13 Relationship between Cluster # and SASCTL#, SAS Port#

Cluster	DKB Location Name	VSP G370/G350 VSP F370/F350 VSP G130		VSP G700 VSP F700		VSP G900 VSP F900	
		SASCTL#	SASPort#	SASCTL#	SASPort#	SASCTL#	SASPort#
Cluster-1	DKB-1C	0x00	0x00 to 0x01	—	—	—	—
	DKB-1E	—	—	—	—	0x02	0x04 to 0x05
	DKB-1F	—	—	—	—	0x03	0x06 to 0x07
	DKB-1G	—	—	0x00	0x00 to 0x01	0x00	0x00 to 0x01
	DKB-1H	—	—	0x01	0x02 to 0x03	0x01	0x02 to 0x03
Cluster-2	DKB-2C	0x04	0x08 to 0x09	—	—	—	—
	DKB-2E	—	—	—	—	0x06	0x0C to 0x0D
	DKB-2F	—	—	—	—	0x07	0x0E to 0x0F
	DKB-2G	—	—	0x04	0x08 to 0x09	0x04	0x08 to 0x09
	DKB-2H	—	—	0x05	0x0A to 0x0B	0x05	0x0A to 0x0B

4.4 Connection Diagram of DKC

Figure 4-1 VSP G130/G350/G370, VSP F350/F370

- VSP G350/G370, VSP F350/F370



- VSP G130

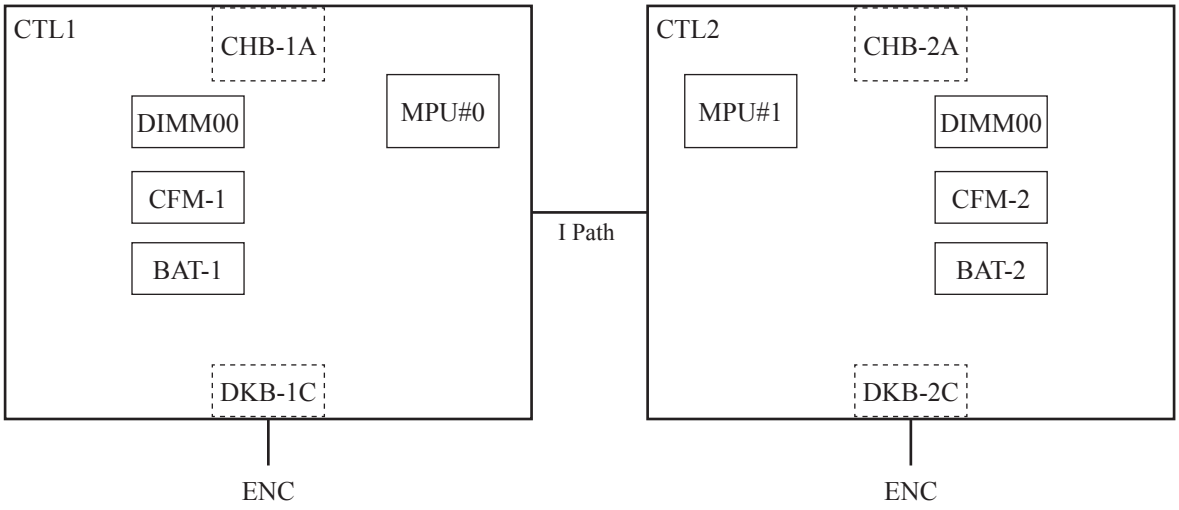


Figure 4-2 VSP G700, VSP F700

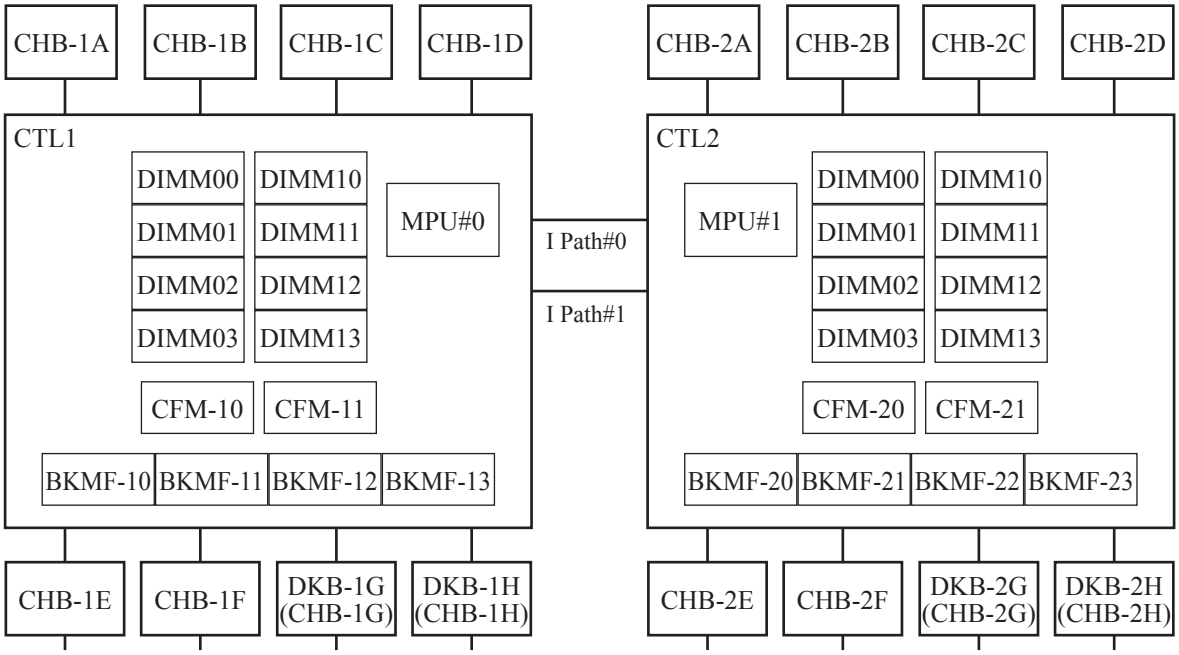
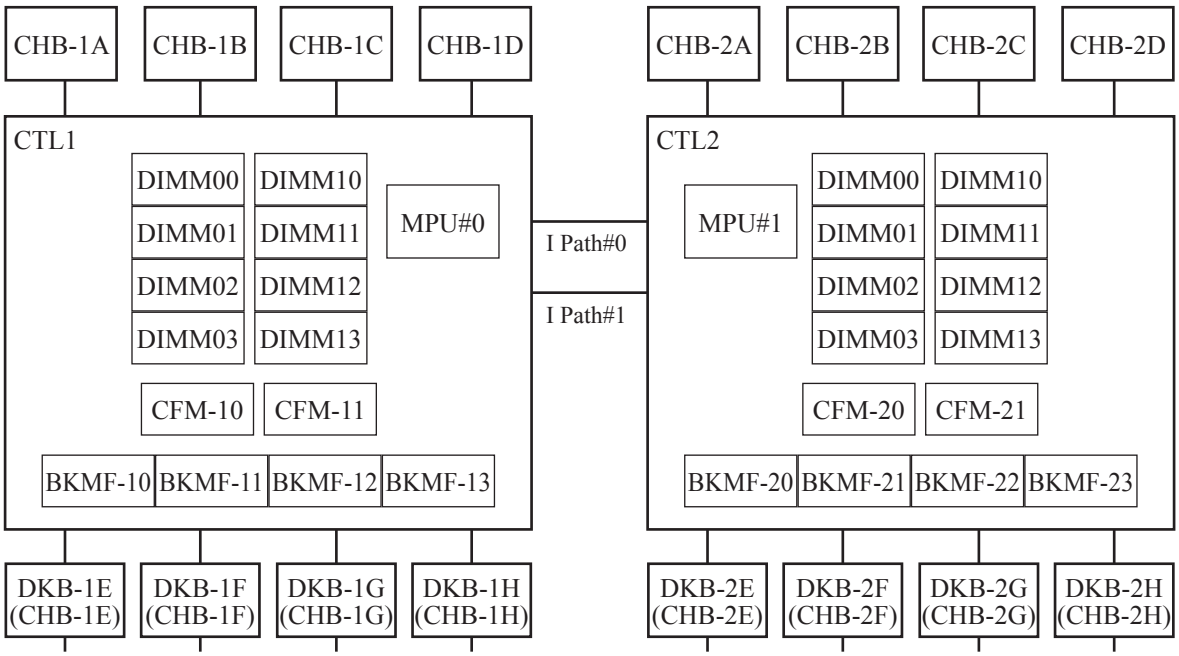


Figure 4-3 VSP G900, VSP F900



4.5 Channel Interface (Fiber and iSCSI)

4.5.1 Basic Functions

The basic specifications of the Fibre Channel Board and iSCSI Interface board are shown in Table 4-14.

Table 4-14 Basic specifications

Item		Specification	
		FC	iSCSI
Host Channel	Max. # of Ports	VSP G130 : 4 VSP G370/G350, VSP F370/F350 : 16 VSP G700, VSP F700 : 48 (HDD less : 64) VSP G900, VSP F900 : 48 (HDD less : 64) 64 (HDD less : 80) (*1)	VSP G130 : 4 VSP G370/G350, VSP F370/F350 : 8 VSP G700, VSP F700 : 24 (HDD less : 32) VSP G900, VSP F900 : 24 (HDD less : 32) 32 (HDD less : 40) (*1)
	Max. # of concurrent paths/Port	256	255
Data transfer		DW-F800-4HF32R: 4, 8, 16, 32 Gbps DW-F850-CTLXSFA: 4, 8, 16 Gbps	DW-F800-2HS10S: 10 Gbps DW-F800-2HS10B: 1, 10 Gbps DW-F850-CTLXSSA: 10 Gbps DW-F850-CTLXSCA: 1, 10 Gbps
RAID level		RAID6/RAID5/RAID1	
RAID configuration		RAID6	
		RAID5	
		RAID1	

*1: When the Channel Board Box is mounted.

4.5.2 Glossary

- iSCSI(Internet Small Computer Systems Interface)
  This is a technology to transmit and receives the block data by SCSI on the IP network.

- iSNS(Internet Storage Name Service)
  This is a technology to detect the iSCSI device on the IP network.

- NIC(Network Interface Card)
  This is an interface card for network communication to be installed in the server or PC.
  It is also called a network card, LAN card or LAN board. It includes a port installed on the motherboard in the server or PC.

- CNA(Converged Network Adapter)
  This is an integrated network adapter which supports LAN (TCP/IP) and iSCSI at a 10 Gbps Ethernet speed.

- IPv4(Internet Protocol version 4)
  This is an IP address of 32-bit address length.

- IPv6(Internet Protocol version 6)
  This is an IP address of 128-bit address length.

- VLAN(Virtual LAN)
  This is a technology to create a virtual LAN segment.

- CHAP(Challenge Handshake Authentication Protocol)
  This is a user authentication method of handshakes by encoding a user name and secret.
  In the [CHAP] authentication, the iSCSI target authenticates the iSCSI initiator.
  Furthermore, in the bidirectional CHAP authentication, the iSCSI target and the iSCSI initiator authenticate each other.

- iSCSI Digest
  iSCSI Header Digest and iSCSI Data Digest exist and checks the data consistency end to end.

- iSCSI Name
  The iSCSI node has an iSCSI name consisting of a maximum of 223 characters for node identification.

4.5.3 Interface Specifications

4.5.3.1 Fibre Channel Physical Interface Specifications

The physical interface specification supported for Fibre Channel (FC) is shown in Table 4-15 to Table 4-16.

Table 4-15 Fibre Channel Physical specification

No.	Item		Specification	Remarks
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	4, 8, 16, 32 (*1) Gbps	—
3	Cable Length	Optic single mode Fibre	10km	Longwave laser
		Optic multi mode Fibre	500 m/400 m/190 m/125m/ 100 m (*1)	Shortwave laser
4	Connector Type		LC	—
5	Topology		NL-Port (FC-AL) F-Port FL-Port	—
6	Service class		3	—
7	Protocol		FCP	—
8	Transfer code		4, 8 Gbps : 8B/10B translate 16, 32 Gbps : 64B/66B translate	—
9	Number of hosts		255/Path	—
10	Number of host groups		255/Path	—
11	Maximum number of LUs		2048/Path	—
12	PORT/PCB		4 Port 2 Port (VSP G130 only)	—

*1: See Table 4-40.

Table 4-16 Fibre Channel Port name

Cluster	CHB/DKB Location	VSP G130		VSP G350 VSP F350		VSP G370 VSP F370		VSP G700 VSP F700		VSP G900 VSP F900	
		CHB#	DKB#	CHB#	DKB#	CHB#	DKB#	CHB#	DKB#	CHB#	DKB#
Cluster-1	CHB-1A	0x00	—	0x00	—	0x00	—	0x00	—	0x00	—
	CHB-1B	—	—	0x01	—	0x01	—	0x01	—	0x01	—
	CHB-1C / DKB-1C	—	0x00	—	0x00	—	0x00	0x02	—	0x02	—
	CHB-1D	—	—	—	—	—	—	0x03	—	0x03	—
	CHB-1E / DKB-1E	—	—	—	—	—	—	0x04	—	0x04	0x02
	CHB-1F / DKB-1F	—	—	—	—	—	—	0x05	—	0x05	0x03
	CHB-1G / DKB-1G	—	—	—	—	—	—	0x06	0x00	0x06	0x00
	CHB-1H / DKB-1H	—	—	—	—	—	—	0x07	0x01	0x07	0x01
	CHB-1J (*1)	—	—	—	—	—	—	—	—	0x08	—
	CHB-1K (*1)	—	—	—	—	—	—	—	—	0x09	—
	CHB-1L (*1)	—	—	—	—	—	—	—	—	0x0A	—
	CHB-1M (*1)	—	—	—	—	—	—	—	—	0x0B	—
Cluster-2	CHB-2A	0x01	—	0x02	—	0x10	—	0x10	—	0x10	—
	CHB-2B	—	—	0x03	—	0x11	—	0x11	—	0x11	—
	CHB-2C / DKB-2C	—	0x04	—	0x04	—	0x04	0x12	—	0x12	—
	CHB-2D	—	—	—	—	—	—	0x13	—	0x13	—
	CHB-2E / DKB-2E	—	—	—	—	—	—	0x14	—	0x14	0x06
	CHB-2F / DKB-2F	—	—	—	—	—	—	0x15	—	0x15	0x07
	CHB-2G / DKB-2G	—	—	—	—	—	—	0x16	0x04	0x16	0x04
	CHB-2H / DKB-2H	—	—	—	—	—	—	0x17	0x05	0x17	0x05
	CHB-2J (*1)	—	—	—	—	—	—	—	—	0x18	—
	CHB-2K (*1)	—	—	—	—	—	—	—	—	0x19	—
	CHB-2L (*1)	—	—	—	—	—	—	—	—	0x1A	—
	CHB-2M (*1)	—	—	—	—	—	—	—	—	0x1B	—

*1: When the Channel Board Box is mounted.

4.5.3.2 iSCSI Physical Interface Specifications

The physical interface specification supported for iSCSI is shown in Table 4-17 to Table 4-18.

Table 4-17 iSCSI Physical specification

No.	Item		Specification	Remarks
1	Host interface	Physical interface	10Gbps : 10Gbps SFP+	—
		Logical interface	RFC3720	—
2	Data Transfer Rate	Optic Fibre cable	10Gbps	—
3	Cable Length	Optic single mode Fibre	(Not supported)	—
		Optic multi mode Fibre	OM2:82m, OM3:100m	—
4	Connector Type	Optic	LC	—
5	Topology		—	—
6	Service class		—	—
7	Protocol		TCP/IP, iSCSI	—
8	Transfer code		—	—
9	Number of hosts		255/Port	—
10	Number of host groups		255/Port	A target in case of iSCSI
11	Maximum number of LUs		2048/Path	(Same as Fibre)
12	PORT/PCB		2 Port	—

The iSCSI port is a 2-port/CHB and a configuration without 5x, 7x, 6x and 8x installed for the Fibre Channel port.

Table 4-18 CHB/DKB Location Name and Corresponding CHB/DKB #

Cluster	CHB/DKB Location	VSP G130		VSP G350 VSP F350		VSP G370 VSP F370		VSP G700 VSP F700		VSP G900 VSP F900	
		CHB#	DKB#	CHB#	DKB#	CHB#	DKB#	CHB#	DKB#	CHB#	DKB#
Cluster-1	CHB-1A	0x00	—	0x00	—	0x00	—	0x00	—	0x00	—
	CHB-1B	—	—	0x01	—	0x01	—	0x01	—	0x01	—
	CHB-1C / DKB-1C	—	0x00	—	0x00	—	0x00	0x02	—	0x02	—
	CHB-1D	—	—	—	—	—	—	0x03	—	0x03	—
	CHB-1E / DKB-1E	—	—	—	—	—	—	0x04	—	0x04	0x02
	CHB-1F / DKB-1F	—	—	—	—	—	—	0x05	—	0x05	0x03
	CHB-1G / DKB-1G	—	—	—	—	—	—	0x06	0x00	0x06	0x00
	CHB-1H / DKB-1H	—	—	—	—	—	—	0x07	0x01	0x07	0x01
	CHB-1J (*1)	—	—	—	—	—	—	—	—	0x08	—
	CHB-1K (*1)	—	—	—	—	—	—	—	—	0x09	—
	CHB-1L (*1)	—	—	—	—	—	—	—	—	0x0A	—
	CHB-1M (*1)	—	—	—	—	—	—	—	—	0x0B	—
Cluster-2	CHB-2A	0x01	—	0x02	—	0x10	—	0x10	—	0x10	—
	CHB-2B	—	—	0x03	—	0x11	—	0x11	—	0x11	—
	CHB-2C / DKB-2C	—	0x04	—	0x04	—	0x04	0x12	—	0x12	—
	CHB-2D	—	—	—	—	—	—	0x13	—	0x13	—
	CHB-2E / DKB-2E	—	—	—	—	—	—	0x14	—	0x14	0x06
	CHB-2F / DKB-2F	—	—	—	—	—	—	0x15	—	0x15	0x07
	CHB-2G / DKB-2G	—	—	—	—	—	—	0x16	0x04	0x16	0x04
	CHB-2H / DKB-2H	—	—	—	—	—	—	0x17	0x05	0x17	0x05
	CHB-2J (*1)	—	—	—	—	—	—	—	—	0x18	—
	CHB-2K (*1)	—	—	—	—	—	—	—	—	0x19	—
	CHB-2L (*1)	—	—	—	—	—	—	—	—	0x1A	—
	CHB-2M (*1)	—	—	—	—	—	—	—	—	0x1B	—

*1: When the Channel Board Box is mounted.

4.5.4 Volume Specification (Common to Fibre/iSCSI)

1. Volume Specification
   Model Number of Disk Drive and supported RAID Level are shown in Table 4-19.

Table 4-19 List of DW850 Model number

Model Number	Disk Drive model (type name displayed in MPC window) (*1)	RAID Level
DKC-F810I-600JCMC	DKR5D-J600SS/DKS5E-J600SS/ DKR5G-J600SS/DKS5H-J600SS/ DKS5K-J600SS	RAID1 (2D+2D/4D+4D) RAID5 (3D+1P/4D+1P/6D+1P/7D+1P) RAID6 (6D+2P/12D+2P/14D+2P)
DKC-F810I-1R2JCMC	DKR5E-J1R2SS/DKS5F-J1R2SS/ DKR5G-J1R2SS/DKS5H-J1R2SS/ DKS5K-J1R2SS	
DKC-F810I-1R2J7MC	DKR5E-J1R2SS/DKR5G-J1R2SS/ DKS5H-J1R2SS/DKS5K-J1R2SS	
DKC-F810I-2R4JGM	DKS5K-J2R4SS	
DKC-F810I-2R4J8M	DKS5K-J2R4SS	
DKC-F810I-480MGM	SLB5F-M480SS/SLB5G-M480SS	
DKC-F810I-960MGM	SLB5F-M960SS/SLB5G-M960SS	
DKC-F810I-1R9MGM	SLB5E-M1R9SS/SLB5G-M1R9SS	
DKC-F810I-3R8MGM	SLB5F-M3R8SS/SLB5G-M3R8SS/ SLR5E-M3R8SS	
DKC-F810I-7R6MGM	SLB5G-M7R6SS/SLR5E-M7R6SS	
DKC-F810I-15RMGM	SLB5H-M15RSS	
DKC-F810I-3R2FN	NFHAE-Q3R2SS	
DKC-F810I-7R0FP	NFHAF-Q6R4SS/NFHAH-Q6R4SS /NFHAJ-Q6R4SS	
DKC-F810I-14RFP	NFHAF-Q13RSS/NFHAH-Q13RSS /NFHAJ-Q13RSS	
DKC-F810I-6R0H9M	DKS2F-H6R0SS/DKR2G-H6R0SS/ DKS2H-H6R0SS	
DKC-F810I-6R0HLM	DKS2F-H6R0SS/DKR2G-H6R0SS/ DKS2H-H6R0SS	
DKC-F810I-10RH9M	DKR2H-H10RSS	
DKC-F810I-10RHLM	DKR2H-H10RSS/DKS2J-H10RSS	

*1: The disk drive type name displayed in the MPC window might differ from the one on the drive. In such a case, refer to INSTALLATION SECTION “1.2.2 Disk Drive Model”.

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.
- The Storage System capacity is different from one of Maintenance PC, because of 1GB=1000Mbyte calculation.

2. List of emulation types

NOTE: In the Accelerated Compression enabled RAID group, a logical volume that has more than or equal to the drive capacity can be created depending on the compression rate of the data to be stored. For the details, see “Provisioning Guide”.

(1) VSP G900 and VSP F900

NOTE: DBS and DBF are the Drive Box that can be mounted on VSP F900.

Table 4-20 List of emulation types

RAID Level / Storage capacity (GB/volume)			2D+2D (RAID1)	3D+1P (RAID5)	4D+1P (RAID5)	6D+1P (RAID5)
DBS	600JCMC	PG	1 - 287	1 - 287	1 - 229	1 - 164
		Capacity	1,152.7 - 330,824.9	1,729.1 - 496,251.7	2,305.5 - 528,881.7	3,458.3 - 565,679.1
	1R2JCMC	PG	1 - 287	1 - 287	1 - 229	1 - 164
		Capacity	2,305.5 - 661,678.5	3,458.3 - 992,532.1	4,611.1 - 1,057,786.3	6,916.7 - 1,131,374.5
	2R4JGM	PG	1 - 287	1 - 287	1 - 229	1 - 164
		Capacity	4,611.1 - 1,323,385.7	6,916.7 - 1,985,092.9	9,222.2 - 2,115,572.7	13,833.4 - 2,262,749.0
	960MGM	PG	1 - 287	1 - 287	1 - 229	1 - 164
		Capacity	1,890.4 - 542,544.8	2,835.6 - 813,817.2	3,780.9 - 867,338.5	5,671.3 - 927,662.6
	1R9MGM	PG	1 - 287	1 - 287	1 - 229	1 - 164
		Capacity	3,780.9 - 1,085,118.3	5,671.3 - 1,627,663.1	7,561.8 - 1,734,676.9	11,342.7 - 1,855,341.6
	3R8MGM	PG	1 - 287	1 - 287	1 - 229	1 - 164
		Capacity	7,561.8 - 2,170,236.6	11,342.7 - 3,255,354.9	15,123.6 - 3,469,353.8	22,685.5 - 3,710,699.6
	7R6MGM	PG	1 - 287	1 - 287	1 - 229	1.0 - 164
		Capacity	15,123.6 - 4,340,473.2	22,685.5 - 6,510,738.5	30,247.3 - 6,938,730.6	45,371.0 - 7,421,399.3
	15RMGM	PG	1 - 287	1 - 287	1 - 229	1.0 - 164
		Capacity	30,096.9 - 8,637,810.3	45,145.4 - 12,956,729.8	60,193.9 - 13,808,480.7	90,290.9 - 14,769,011.5
DBL	6R0H9M	PG	1 - 143	1 - 143	1 - 114	1 - 81
		Capacity	11,748.4 - 1,680,021.2	17,622.6 - 2,520,031.8	23,496.8 - 2,683,334.6	35,245.2 - 2,864,931.3
	10RH9M	PG	1 - 143	1 - 143	1 - 114	1 - 81
		Capacity	19,580.7 - 2,800,040.1	29,371.0 - 4,200,053.0	39,161.4 - 4,472,231.9	58,742.1 - 4,774,893.6
DB60	1R2J7MC	PG	1 - 359	1 - 359	1 - 287	1 - 205
		Capacity	2,305.5 - 827,674.5	3,458.3 - 1,241,529.7	4,611.1 - 1,323,385.7	6,916.7 - 1,415,947.3
	2R4J8M	PG	1 - 359	1 - 359	1 - 287	1 - 205
		Capacity	4,611.1 - 1,655,384.9	6,916.7 - 2,483,095.3	9,222.2 - 2,646,771.4	13,833.4 - 2,831,894.6
	6R0HLM	PG	1 - 359	1 - 359	1 - 287	1 - 205
		Capacity	11,748.4 - 4,217,675.6	17,622.6 - 6,326,513.4	23,496.8 - 6,743,581.6	35,245.2 - 7,215,195.9
	10RHLM	PG	1 - 359	1 - 359	1 - 287	1 - 205
		Capacity	19,580.7 - 7,029,471.3	29,371.0 - 10,544,189.0	39,161.4 - 11,239,321.8	58,742.1 - 12,025,347.0
DBF	3R2FN	PG	1 - 143	1 - 143	1 - 114	1 - 81
		Capacity	7,036.8 - 1,006,262.4	10,555.3 - 1,509,407.9	14,073.7 - 1,607,216.5	21,110.6 - 1,715,990.2
	7R0FP	PG	1 - 143	1 - 143	1 - 114	1 - 81
		Capacity	14,073.7 - 2,012,546.0	21,110.6 - 3,018,815.8	28,147.4 - 3,214,433.1	42,221.2 - 3,431,980.4
	14RFP	PG	1 - 143	1 - 143	1 - 114	1 - 81
		Capacity	28,147.5 - 4,025,091.9	42,221.2 - 6,037,631.6	56,294.9 - 6,428,877.6	84,442.4 - 6,863,960.8

(To be continued)

(Continued from the preceding page)

RAID Level / Storage capacity (GB/volume)			7D+1P (RAID5)	6D+2P (RAID6)	12D+2P (RAID6)	14D+2P (RAID6)
DBS	600JCMC	PG	1 - 143	1 - 143	1 - 81	1 - 71
		Capacity	4,034.7 - 576,962.1	3,458.3 - 494,536.9	6,916.7 - 562,228.9	8,069.5 - 572,934.5
	1R2JCMC	PG	1 - 143	1 - 143	1 - 81	1 - 71
		Capacity	8,069.5 - 1,153,938.5	6,916.7 - 989,088.1	13,833.4 - 1,124,457.8	16,139.0 - 1,145,869.0
	2R4JGM	PG	1 - 143	1 - 143	1 - 81	1 - 71
		Capacity	16,139.0 - 2,307,877.0	13,833.4 - 1,978,176.2	27,666.8 - 2,248,915.6	32,278.0 - 2,291,738.0
	960MGM	PG	1 - 143	1 - 143	1 - 81	1 - 71
		Capacity	6,616.6 - 946,173.8	5,671.3 - 810,995.9	11,342.7 - 921,999.5	13,233.2 - 939,557.2
	1R9MGM	PG	1 - 143	1 - 143	1 - 81	1 - 71
		Capacity	13,233.2 - 1,892,347.6	11,342.7 - 1,622,006.1	22,685.5 - 1,844,007.1	26,466.4 - 1,879,114.4
	3R8MGM	PG	1 - 143	1 - 143	1 - 81	1 - 71
		Capacity	26,466.4 - 3,784,695.2	22,685.5 - 3,244,026.5	45,371.0 - 3,688,014.1	52,932.9 - 3,758,235.9
	7R6MGM	PG	1 - 143	1 - 143	1 - 81	1 - 71
		Capacity	52,932.9 - 7,569,404.7	45,371.0 - 6,488,053.0	90,742.1 - 7,376,036.4	105,865.8 - 7,516,471.8
	15RMGM	PG	1 - 143	1 - 143	1 - 81	1 - 71
		Capacity	105,339.4 - 15,063,534.2	90,290.9 - 12,911,598.7	180,581.8 - 14,678,720.6	210,678.8 - 14,958,194.8
DBL	6R0H9M	PG	1 - 71	1 - 71	1 - 40	1 - 35
		Capacity	41,119.5 - 2,919,484.5	35,245.2 - 2,502,409.2	70,490.5 - 2,829,690.1	82,239.0 - 2,878,365.0
	10RH9M	PG	1 - 71	1 - 71	1 - 40	1 - 35
		Capacity	68,532.5 - 4,865,807.5	58,742.1 - 4,170,689.1	117,484.3 - 4,716,155.5	137,065.0 - 4,797,275.0
DB60	1R2J7MC	PG	1 - 179	1 - 179	1 - 102	1 - 89
		Capacity	8,069.5 - 1,444,440.5	6,916.7 - 1,238,089.3	13,833.4 - 1,409,030.6	16,139.0 - 1,436,371.0
	2R4J8M	PG	1 - 179	1 - 179	1 - 102	1 - 89
		Capacity	16,139.0 - 2,888,881.0	13,833.4 - 2,476,178.6	27,666.8 - 2,818,061.2	32,278.0 - 2,872,742.0
	6R0HLM	PG	1 - 179	1 - 179	1 - 102	1 - 89
		Capacity	41,119.5 - 7,360,390.5	35,245.2 - 6,308,890.8	70,490.5 - 7,179,960.9	82,239.0 - 7,319,271.0
	10RHLM	PG	1 - 179	1 - 179	1 - 102	1 - 89
		Capacity	68,532.5 - 12,267,317.5	58,742.1 - 10,514,835.9	117,484.3 - 11,966,615.1	137,065.0 - 12,198,785.0
DBF	3R2FN	PG	1 - 71	1 - 71	1 - 40	1 - 35
		Capacity	24,629.0 - 1,748,659.0	21,110.6 - 1,498,852.6	42,221.2 - 1,694,879.6	49,258.1 - 1,724,033.5
	7R0FP	PG	1 - 71	1 - 71	1 - 40	1 - 35
		Capacity	49,258.1 - 3,497,325.1	42,221.2 - 2,997,705.2	84,442.4 - 3,389,759.2	98,516.2 - 3,448,067.0
	14RFP	PG	1 - 71	1 - 71	1 - 40	1 - 35
		Capacity	98,516.2 - 6,994,650.2	84,442.4 - 5,995,410.4	168,884.9 - 6,779,522.4	197,032.4 - 6,896,134.0

(2) VSP G700 and VSP F700

NOTE: DBS and DBF are the Drive Box that can be mounted on VSP F700.

Table 4-21 List of emulation types

RAID Level / Storage capacity (GB/volume)			2D+2D (RAID1)	3D+1P (RAID5)	4D+1P (RAID5)	6D+1P (RAID5)
DBS	600JCMC	PG	1 - 215	1 - 215	1 - 172	1 - 122
		Capacity	1,152.7 - 247,830.5	1,729.1 - 371,756.5	2,305.5 - 396,084.9	3,458.3 - 423,394.7
	1R2JCMC	PG	1 - 215	1 - 215	1 - 172	1 - 122
		Capacity	2,305.5 - 495,682.5	3,458.3 - 743,534.5	4,611.1 - 792,187.0	6,916.7 - 846,801.7
	2R4JGM	PG	1 - 215	1 - 215	1 - 172	1 - 122
		Capacity	4,611.1 - 991,386.5	6,916.7 - 1,487,090.5	9,222.2 - 1,584,374.0	13,833.4 - 1,693,603.4
	480MGM	PG	1 - 215	1 - 215	1 - 172	1 - 122
		Capacity	945.2 - 203,218.0	1,417.8 - 304,827.0	1,890.4 - 324,770.7	2,835.6 - 347,158.5
	960MGM	PG	1 - 215	1 - 215	1 - 172	1 - 122
		Capacity	1,890.4 - 406,436.0	2,835.6 - 609,654.0	3,780.9 - 649,558.6	5,671.3 - 694,329.2
	1R9MGM	PG	1 - 215	1 - 215	1 - 172	1 - 122
		Capacity	3,780.9 - 812,893.5	5,671.3 - 1,219,329.5	7,561.8 - 1,299,117.2	11,342.7 - 1,388,670.6
	3R8MGM	PG	1 - 215	1 - 215	1 - 172	1 - 122
		Capacity	7,561.8 - 1,625,787.0	11,342.7 - 2,438,680.5	15,123.6 - 2,598,234.5	22,685.5 - 2,777,353.4
	7R6MGM	PG	1 - 215	1 - 215	1 - 172	1 - 122
		Capacity	15,123.6 - 3,251,574.0	22,685.5 - 4,877,382.5	30,247.3 - 5,196,486.1	45,371.0 - 5,554,706.7
	15RMGM	PG	1 - 215	1 - 215	1 - 172	1 - 122
		Capacity	30,096.9 - 6,470,833.5	45,145.4 - 9,706,261.0	60,193.9 - 10,341,312.0	90,290.9 - 11,054,185.9
DBL	6R0H9M	PG	1 - 107	1 - 107	1 - 85	1 - 61
		Capacity	11,748.4 - 1,257,078.8	17,622.6 - 1,885,618.2	23,496.8 - 2,006,626.7	35,245.2 - 2,139,887.1
	10RH9M	PG	1 - 107	1 - 107	1 - 85	1 - 61
		Capacity	19,580.7 - 2,095,134.9	29,371.0 - 3,142,697.0	39,161.4 - 3,344,383.6	58,742.1 - 3,566,484.6
DB60	1R2J7MC	PG	1 - 299	1 - 299	1 - 239	1 - 170
		Capacity	2,305.5 - 689,344.5	3,458.3 - 1,034,031.7	4,611.1 - 1,102,052.9	6,916.7 - 1,178,803.3
	2R4J8M	PG	1 - 299	1 - 299	1 - 239	1 - 170
		Capacity	4,611.1 - 1,378,718.9	6,916.7 - 2,068,093.3	9,222.2 - 2,204,105.8	13,833.4 - 2,357,606.6
	6R0HLM	PG	1 - 299	1 - 299	1 - 239	1 - 170
		Capacity	11,748.4 - 3,512,771.6	17,622.6 - 5,269,157.4	23,496.8 - 5,615,735.2	35,245.2 - 6,006,789.1
	10RHLM	PG	1 - 299	1 - 299	1 - 239	1 - 170
		Capacity	19,580.7 - 5,854,629.3	29,371.0 - 8,781,929.0	39,161.4 - 9,359,574.6	58,742.1 - 10,011,332.2
DBF	3R2FN	PG	1 - 107	1 - 107	1 - 85	1 - 61
		Capacity	7,036.8 - 752,937.6	10,555.3 - 1,129,417.1	14,073.7 - 1,201,894.0	21,110.6 - 1,281,715.0
	7R0FP	PG	1 - 107	1 - 107	1 - 85	1 - 61
		Capacity	14,073.7 - 1,505,891.0	21,110.6 - 2,258,834.2	28,147.4 - 2,403,788.0	42,221.2 - 2,563,430.0
	14RFP	PG	1 - 107	1 - 107	1 - 85	1 - 61
		Capacity	28,147.5 - 3,011,782.1	42,221.2 - 4,517,668.4	56,294.9 - 4,807,584.5	84,442.4 - 5,126,860.0

(To be continued)

(Continued from the preceding page)

RAID Level / Storage capacity (GB/volume)			7D+1P (RAID5)	6D+2P (RAID6)	12D+2P (RAID6)	14D+2P (RAID6)
DBS	600JCMC	PG	1 - 107	1 - 107	1 - 61	1 - 53
		Capacity	4,034.7 - 431,712.9	3,458.3 - 370,038.1	6,916.7 - 419,942.5	8,069.5 - 427,683.5
	1R2JCMC	PG	1 - 107	1 - 107	1 - 61	1 - 53
		Capacity	8,069.5 - 863,436.5	6,916.7 - 740,086.9	13,833.4 - 839,885.0	16,139.0 - 855,367.0
	2R4JGM	PG	1 - 107	1 - 107	1 - 61	1 - 53
		Capacity	16,139.0 - 1,726,873.0	13,833.4 - 1,480,173.8	27,666.8 - 1,679,770.0	32,278.0 - 1,710,734.0
	480MGM	PG	1 - 107	1 - 107	1 - 61	1 - 53
		Capacity	3,308.3 - 353,988.1	2,835.6 - 303,409.2	5,671.3 - 344,328.9	6,616.6 - 350,679.8
	960MGM	PG	1 - 107	1 - 107	1 - 61	1 - 53
		Capacity	6,616.6 - 707,976.2	5,671.3 - 606,829.1	11,342.7 - 688,663.9	13,233.2 - 701,359.6
	1R9MGM	PG	1 - 107	1 - 107	1 - 61	1 - 53
		Capacity	13,233.2 - 1,415,952.4	11,342.7 - 1,213,668.9	22,685.5 - 1,377,333.9	26,466.4 - 1,402,719.2
	3R8MGM	PG	1 - 107	1 - 107	1 - 61	1 - 53
		Capacity	26,466.4 - 2,831,904.8	22,685.5 - 2,427,348.5	45,371.0 - 2,754,667.9	52,932.9 - 2,805,443.7
	7R6MGM	PG	1 - 107	1 - 107	1 - 61	1 - 53
		Capacity	52,932.9 - 5,663,820.3	45,371.0 - 4,854,697.0	90,742.1 - 5,509,341.8	105,865.8 - 5,610,887.4
	15RMGM	PG	1 - 107	1 - 107	1 - 61	1 - 53
		Capacity	105,339.4 - 11,271,315.8	90,290.9 - 9,661,126.3	180,581.8 - 10,963,895.0	210,678.8 - 11,165,976.4
DBL	6R0H9M	PG	1 - 53	1 - 53	1 - 30	1 - 26
		Capacity	41,119.5 - 2,179,333.5	35,245.2 - 1,867,995.6	70,490.5 - 2,104,644.9	82,239.0 - 2,138,214.0
	10RH9M	PG	1 - 53	1 - 53	1 - 30	1 - 26
		Capacity	68,532.5 - 3,632,222.5	58,742.1 - 3,113,331.3	117,484.3 - 3,507,745.5	137,065.0 - 3,563,690.0
DB60	1R2J7MC	PG	1 - 149	1 - 149	1 - 85	1 - 74
		Capacity	8,069.5 - 1,202,355.5	6,916.7 - 1,030,588.3	13,833.4 - 1,171,886.6	16,139.0 - 1,194,286.0
	2R4J8M	PG	1 - 149	1 - 149	1 - 85	1 - 74
		Capacity	16,139.0 - 2,404,711.0	13,833.4 - 2,061,176.6	27,666.8 - 2,343,773.2	32,278.0 - 2,388,572.0
	6R0HLM	PG	1 - 149	1 - 149	1 - 85	1 - 74
		Capacity	41,119.5 - 6,126,805.5	35,245.2 - 5,251,534.8	70,490.5 - 5,971,552.4	82,239.0 - 6,085,686.0
	10RHLM	PG	1 - 149	1 - 149	1 - 85	1 - 74
		Capacity	68,532.5 - 10,211,342.5	58,742.1 - 8,752,572.9	117,484.3 - 9,952,598.6	137,065.0 - 10,142,810.0
DBF	3R2FN	PG	1 - 53	1 - 53	1 - 30	1 - 26
		Capacity	24,629.0 - 1,305,337.0	21,110.6 - 1,118,861.8	42,221.2 - 1,260,604.4	49,258.1 - 1,280,710.6
	7R0FP	PG	1 - 53	1 - 53	1 - 30	1 - 26
		Capacity	49,258.1 - 2,610,679.3	42,221.2 - 2,237,723.6	84,442.4 - 2,521,208.8	98,516.2 - 2,561,421.2
	14RFP	PG	1 - 53	1 - 53	1 - 30	1 - 26
		Capacity	98,516.2 - 5,221,358.6	84,442.4 - 4,475,447.2	168,884.9 - 5,042,420.6	197,032.4 - 5,122,842.4

(3) VSP G370 and VSP F370

NOTE: DBS is the only Drive Box that can be mounted on VSP F370.

Table 4-22 List of emulation types

RAID Level / Storage capacity (GB/volume)			2D+2D (RAID1)	3D+1P (RAID5)	4D+1P (RAID5)	6D+1P (RAID5)
DBS (*1)	600JCMC	PG	1 - 71	1 - 71	1 - 57	1 - 40
		Capacity	1,152.7 - 81,841.7	1,729.1 - 122,766.1	2,305.5 - 130,491.3	3,458.3 - 138,826.0
	1R2JCMC	PG	1 - 71	1 - 71	1 - 57	1 - 40
		Capacity	2,305.5 - 163,690.5	3,458.3 - 245,539.3	4,611.1 - 260,988.3	6,916.7 - 277,656.1
	2R4JGM	PG	1 - 71	1 - 71	1 - 57	1 - 40
		Capacity	4,611.1 - 327,388.1	6,916.7 - 491,085.7	9,222.2 - 521,976.5	13,833.4 - 555,312.2
	480MGM	PG	1 - 71	1 - 71	1 - 57	1 - 40
		Capacity	945.2 - 67,109.2	1,417.8 - 100,663.8	1,890.4 - 106,996.6	2,835.6 - 113,829.1
	960MGM	PG	1 - 71	1 - 71	1 - 57	1 - 40
		Capacity	1,890.4 - 134,218.4	2,835.6 - 201,327.6	3,780.9 - 213,998.9	5,671.3 - 227,662.2
	1R9MGM	PG	1 - 71	1 - 71	1 - 57	1 - 40
		Capacity	3,780.9 - 268,443.9	5,671.3 - 402,662.3	7,561.8 - 427,997.9	11,342.7 - 455,328.4
	3R8MGM	PG	1 - 71	1 - 71	1 - 57	1 - 40
		Capacity	7,561.8 - 536,887.8	11,342.7 - 805,331.7	15,123.6 - 855,995.8	22,685.5 - 910,660.8
	7R6MGM	PG	1 - 71	1 - 71	1 - 57	1 - 40
		Capacity	15,123.6 - 1,073,775.6	22,685.5 - 1,610,670.5	30,247.3 - 1,711,997.2	45,371.0 - 1,821,321.6
	15RMGM	PG	1 - 71	1 - 71	1 - 57	1 - 40
		Capacity	30,096.9 - 2,136,879.9	45,145.4 - 3,205,323.4	60,193.9 - 3,406,974.7	90,290.9 - 3,624,534.7
DBL (*2)	6R0H9M	PG	1 - 35	1 - 35	1 - 28	1 - 20
		Capacity	11,748.4 - 411,194.0	17,622.6 - 616,791.0	23,496.8 - 653,211.0	35,245.2 - 689,798.9
	10RH9M	PG	1 - 35	1 - 35	1 - 28	1 - 20
		Capacity	787.6 - 27,566.0	1,181.5 - 41,352.5	1,575.3 - 43,793.3	58,742.1 - 1,149,666.8
DB60	1R2J7MC	PG	1 - 92	1 - 92	1 - 73	1 - 52
		Capacity	2,305.5 - 212,106.0	3,458.3 - 318,163.6	4,611.1 - 338,454.7	6,916.7 - 360,656.5
	2R4J8M	PG	1 - 92	1 - 92	1 - 73	1 - 52
		Capacity	4,611.1 - 424,221.2	6,916.7 - 636,336.4	9,222.2 - 676,909.5	13,833.4 - 721,313.0
	6R0HLM	PG	1 - 92	1 - 92	1 - 73	1 - 52
		Capacity	11,748.4 - 1,080,852.8	17,622.6 - 1,621,279.2	23,496.8 - 1,724,665.1	35,245.2 - 1,837,785.4
	10RHLM	PG	1 - 92	1 - 92	1 - 73	1 - 52
		Capacity	19,580.7 - 1,801,424.4	29,371.0 - 2,702,132.0	39,161.4 - 2,874,446.8	58,742.1 - 3,062,980.9

*1: The number of parity groups includes the Disk Drives installed in the Controller Chassis (VSP G370 (CBSS2)).

*2: The number of parity groups includes the Disk Drives installed in the Controller Chassis (VSP G370 (CBSL2)).

(To be continued)

(Continued from the preceding page)

RAID Level / Storage capacity (GB/volume)			7D+1P (RAID5)	6D+2P (RAID6)	12D+2P (RAID6)	14D+2P (RAID6)
DBS (*1)	600JCMC	PG	1 - 35	1 - 35	1 - 20	1 - 17
		Capacity	4,034.7 - 141,214.5	3,458.3 - 121,040.5	6,916.7 - 135,369.7	8,069.5 - 137,181.5
	1R2JCMC	PG	1 - 35	1 - 35	1 - 20	1 - 17
		Capacity	8,069.5 - 282,432.5	6,916.7 - 242,084.5	13,833.4 - 270,739.4	16,139.0 - 274,363.0
	2R4JGM	PG	1 - 35	1 - 35	1 - 20	1 - 17
		Capacity	16,139.0 - 564,865.0	13,833.4 - 484,169.0	27,666.8 - 541,478.8	32,278.0 - 548,726.0
	480MGM	PG	1 - 35	1 - 35	1 - 20	1 - 17
		Capacity	3,308.3 - 115,790.5	2,835.6 - 99,246.0	5,671.3 - 110,995.4	6,616.6 - 112,482.2
	960MGM	PG	1 - 35	1 - 35	1 - 20	1 - 17
		Capacity	6,616.6 - 231,581.0	5,671.3 - 198,495.5	11,342.7 - 221,992.8	13,233.2 - 224,964.4
	1R9MGM	PG	1 - 35	1 - 35	1 - 20	1 - 17
		Capacity	13,233.2 - 463,162.0	11,342.7 - 396,994.5	22,685.5 - 443,987.6	26,466.4 - 449,928.8
	3R8MGM	PG	1 - 35	1 - 35	1 - 20	1 - 17
		Capacity	26,466.4 - 926,324.0	22,685.5 - 793,992.5	45,371.0 - 887,975.3	52,932.9 - 899,859.3
	7R6MGM	PG	1 - 35	1 - 35	1 - 20	1 - 17
		Capacity	52,932.9 - 1,852,651.5	45,371.0 - 1,587,985.0	90,742.1 - 1,775,952.5	105,865.8 - 1,799,718.6
	15RMGM	PG	1 - 35	1 - 35	1 - 20	1 - 17
		Capacity	105,339.4 - 3,686,879.0	90,290.9 - 3,160,181.5	180,581.8 - 3,534,243.8	210,678.8 - 3,581,539.6
DBL (*2)	6R0H9M	PG	1 - 17	1 - 17	1 - 9	1 - 8
		Capacity	41,119.5 - 699,031.5	35,245.2 - 599,168.4	70,490.5 - 654,554.6	82,239.0 - 657,912.0
	10RH9M	PG	1 - 17	1 - 17	1 - 9	1 - 8
		Capacity	68,532.5 - 1,165,052.5	58,742.1 - 998,615.7	117,484.3 - 1,090,925.6	137,065.0 - 1,096,520.0
DB60	1R2J7MC	PG	1 - 46	1 - 46	1 - 26	1 - 22
		Capacity	8,069.5 - 367,162.3	6,916.7 - 314,709.9	13,833.4 - 353,739.8	16,139.0 - 359,092.8
	2R4J8M	PG	1 - 46	1 - 46	1 - 26	1 - 22
		Capacity	16,139.0 - 734,324.5	13,833.4 - 629,419.7	27,666.8 - 707,479.6	32,278.0 - 718,185.5
	6R0HLM	PG	1 - 46	1 - 46	1 - 26	1 - 22
		Capacity	41,119.5 - 1,870,937.3	35,245.2 - 1,603,656.6	70,490.5 - 1,802,542.8	82,239.0 - 1,829,817.8
	10RHLM	PG	1 - 46	1 - 46	1 - 26	1 - 22
		Capacity	68,532.5 - 3,118,228.8	58,742.1 - 2,672,765.6	117,484.3 - 3,004,241.4	137,065.0 - 3,049,696.3

*1: The number of parity groups includes the Disk Drives installed in the Controller Chassis (VSP G370 (CBSS2)).

*2: The number of parity groups includes the Disk Drives installed in the Controller Chassis (VSP G370 (CBSL2)).

(4) VSP G350 and VSP F350

NOTE: DBS is the only Drive Box that can be mounted on VSP F350.

Table 4-23 List of emulation types

RAID Level / Storage capacity (GB/volume)			2D+2D (RAID1)	3D+1P (RAID5)	4D+1P (RAID5)	6D+1P (RAID5)
DBS (*1)	600JCMC	PG	1 - 47	1 - 47	1 - 37	1 - 26
		Capacity	1,152.7 - 54,176.9	1,729.1 - 81,267.7	2,305.5 - 86,225.7	3,458.3 - 91,397.9
	1R2JCMC	PG	1 - 47	1 - 47	1 - 37	1 - 26
		Capacity	2,305.5 - 108,358.5	3,458.3 - 162,540.1	4,611.1 - 172,455.1	6,916.7 - 182,798.5
	2R4JGM	PG	1 - 47	1 - 47	1 - 37	1 - 26
		Capacity	4,611.1 - 216,721.7	6,916.7 - 325,084.9	9,222.2 - 344,910.3	13,833.4 - 365,597.0
	480MGM	PG	1 - 47	1 - 47	1 - 37	1 - 26
		Capacity	945.2 - 44,424.4	1,417.8 - 66,636.6	1,890.4 - 70,701.0	2,835.6 - 74,940.9
	960MGM	PG	1 - 47	1 - 47	1 - 37	1 - 26
		Capacity	1,890.4 - 88,848.8	2,835.6 - 133,273.2	3,780.9 - 141,405.7	5,671.3 - 149,884.4
	1R9MGM	PG	1 - 47	1 - 47	1 - 37	1 - 26
		Capacity	3,780.9 - 177,702.3	5,671.3 - 266,551.1	7,561.8 - 282,811.3	11,342.7 - 299,771.4
	3R8MGM	PG	1 - 47	1 - 47	1 - 37	1 - 26
		Capacity	7,561.8 - 355,404.6	11,342.7 - 533,106.9	15,123.6 - 565,622.6	22,685.5 - 599,545.4
	7R6MGM	PG	1 - 47	1 - 47	1 - 37	1 - 26
		Capacity	15,123.6 - 710,809.2	22,685.5 - 1,066,218.5	30,247.3 - 1,131,249.0	45,371.0 - 1,199,090.7
	15RMGM	PG	1 - 47	1 - 47	1 - 37	1 - 26
		Capacity	30,096.9 - 1,414,554.3	45,145.4 - 2,121,833.8	60,193.9 - 2,251,251.9	90,290.9 - 2,386,259.5
DBL (*2)	6R0H9M	PG	1 - 23	1 - 23	1 - 18	1 - 13
		Capacity	11,748.4 - 270,213.2	17,622.6 - 405,319.8	23,496.8 - 427,641.8	35,245.2 - 448,117.5
	10RH9M	PG	1 - 23	1 - 23	1 - 18	1 - 13
		Capacity	19,580.7 - 450,356.1	29,371.0 - 675,533.0	39,161.4 - 712,737.5	58,742.1 - 746,863.8
DB60	1R2J7MC	PG	1 - 62	1 - 62	1 - 49	1 - 35
		Capacity	2,305.5 - 142,941.0	3,458.3 - 214,414.6	4,611.1 - 227,788.3	6,916.7 - 242,084.5
	2R4J8M	PG	1 - 62	1 - 62	1 - 49	1 - 35
		Capacity	4,611.1 - 285,888.2	6,916.7 - 428,835.4	9,222.2 - 455,576.7	13,833.4 - 484,169.0
	6R0HLM	PG	1 - 62	1 - 62	1 - 49	1 - 35
		Capacity	11,748.4 - 728,400.8	17,622.6 - 1,092,601.2	23,496.8 - 1,160,741.9	35,245.2 - 1,233,582.0
	10RHLM	PG	1 - 62	1 - 62	1 - 49	1 - 35
		Capacity	19,580.7 - 1,214,003.4	29,371.0 - 1,821,002.0	39,161.4 - 1,934,573.2	58,742.1 - 2,055,973.5

*1: The number of parity groups includes the Disk Drives installed in the Controller Chassis (VSP G350 (CBSS1)).

*2: The number of parity groups includes the Disk Drives installed in the Controller Chassis (VSP G350 (CBSL1)).

(To be continued)

(Continued from the preceding page)

RAID Level / Storage capacity (GB/volume)			7D+1P (RAID5)	6D+2P (RAID6)	12D+2P (RAID6)	14D+2P (RAID6)
DBS (*1)	600JCMC	PG	1 - 23	1 - 23	1 - 13	1 - 11
		Capacity	4,034.7 - 92,798.1	3,458.3 - 79,540.9	6,916.7 - 87,940.9	8,069.5 - 88,764.5
	1R2JCMC	PG	1 - 23	1 - 23	1 - 13	1 - 11
		Capacity	8,069.5 - 185,598.5	6,916.7 - 159,084.1	13,833.4 - 175,881.8	16,139.0 - 177,529.0
	2R4JGM	PG	1 - 23	1 - 23	1 - 13	1 - 11
		Capacity	16,139.0 - 371,197.0	13,833.4 - 318,168.2	27,666.8 - 351,763.6	32,278.0 - 355,058.0
	480MGM	PG	1 - 23	1 - 23	1 - 13	1 - 11
		Capacity	3,308.3 - 76,090.9	2,835.6 - 65,218.8	5,671.3 - 72,106.5	6,616.6 - 72,782.6
	960MGM	PG	1 - 23	1 - 23	1 - 13	1 - 11
		Capacity	6,616.6 - 152,181.8	5,671.3 - 130,439.9	11,342.7 - 144,214.3	13,233.2 - 145,565.2
	1R9MGM	PG	1 - 23	1 - 23	1 - 13	1 - 11
		Capacity	13,233.2 - 304,363.6	11,342.7 - 260,882.1	22,685.5 - 288,429.9	26,466.4 - 291,130.4
	3R8MGM	PG	1 - 23	1 - 23	1 - 13	1 - 11
		Capacity	26,466.4 - 608,727.2	22,685.5 - 521,766.5	45,371.0 - 576,859.9	52,932.9 - 582,261.9
	7R6MGM	PG	1 - 23	1 - 23	1 - 13	1 - 11
		Capacity	52,932.9 - 1,217,456.7	45,371.0 - 1,043,533.0	90,742.1 - 1,153,721.0	105,865.8 - 1,164,523.8
	15RMGM	PG	1 - 23	1 - 23	1 - 13	1 - 11
		Capacity	105,339.4 - 2,422,806.2	90,290.9 - 2,076,690.7	180,581.8 - 2,295,968.6	210,678.8 - 2,317,466.8
DBL (*2)	6R0H9M	PG	1 - 11	1 - 11	1 - 6	1 - 5
		Capacity	41,119.5 - 452,314.5	35,245.2 - 387,697.2	70,490.5 - 412,872.9	82,239.0 - 411,195.0
	10RH9M	PG	1 - 11	1 - 11	1 - 6	1 - 5
		Capacity	68,532.5 - 753,857.5	58,742.1 - 646,163.1	117,484.3 - 688,122.3	137,065.0 - 685,325.0
DB60	1R2J7MC	PG	1 - 31	1 - 31	1 - 17	1 - 15
		Capacity	8,069.5 - 246,119.8	6,916.7 - 210,959.4	13,833.4 - 235,167.8	16,139.0 - 238,050.3
	2R4J8M	PG	1 - 31	1 - 31	1 - 17	1 - 15
		Capacity	16,139.0 - 492,239.5	13,833.4 - 421,918.7	27,666.8 - 470,335.6	32,278.0 - 476,100.5
	6R0HLM	PG	1 - 31	1 - 31	1 - 17	1 - 15
		Capacity	41,119.5 - 1,254,144.8	35,245.2 - 1,074,978.6	70,490.5 - 1,198,338.5	82,239.0 - 1,213,025.3
	10RHLM	PG	1 - 31	1 - 31	1 - 17	1 - 15
		Capacity	68,532.5 - 2,090,241.3	58,742.1 - 1,791,634.1	117,484.3 - 1,997,233.1	137,065.0 - 2,021,708.8

*1: The number of parity groups includes the Disk Drives installed in the Controller Chassis (VSP G350 (CBSS1)).

*2: The number of parity groups includes the Disk Drives installed in the Controller Chassis (VSP G350 (CBSL1)).

(5) VSP G130

Table 4-24 List of emulation types

RAID Level / Storage capacity (GB/volume)			2D+2D (RAID1)	3D+1P (RAID5)	4D+1P (RAID5)	6D+1P (RAID5)
DBS (*1)	600JCMC	PG	1 - 23	1 - 23	1 - 18	1 - 13
		Capacity	1,152.7 - 26,512.1	1,729.1 - 39,769.3	2,305.5 - 41,960.1	3,458.3 - 43,969.8
	1R2JCMC	PG	1 - 23	1 - 23	1 - 18	1 - 13
		Capacity	2,305.5 - 53,026.5	3,458.3 - 79,540.9	4,611.1 - 83,922.0	6,916.7 - 87,940.9
	2R4JGM	PG	1 - 23	1 - 23	1 - 18	1 - 13
		Capacity	4,611.1 - 106,055.3	6,916.7 - 159,084.1	9,222.2 - 167,844.0	13,833.4 - 175,881.8
	480MGM	PG	1 - 23	1 - 23	1 - 18	1 - 13
		Capacity	945.2 - 21,739.6	1,417.8 - 32,609.4	1,890.4 - 34,405.3	2,835.6 - 36,052.6
	960MGM	PG	1 - 23	1 - 23	1 - 18	1 - 13
		Capacity	1,890.4 - 43,479.2	2,835.6 - 65,218.8	3,780.9 - 68,812.4	5,671.3 - 72,106.5
	1R9MGM	PG	1 - 23	1 - 23	1 - 18	1 - 13
		Capacity	3,780.9 - 86,960.7	5,671.3 - 130,439.9	7,561.8 - 137,624.8	11,342.7 - 144,214.3
	3R8MGM	PG	1 - 23	1 - 23	1 - 18	1 - 13
		Capacity	7,561.8 - 173,921.4	11,342.7 - 260,882.1	15,123.6 - 275,249.5	22,685.5 - 288,429.9
	7R6MGM	PG	1 - 23	1 - 23	1 - 18	1 - 13
		Capacity	15,123.6 - 347,842.8	22,685.5 - 521,766.5	30,247.3 - 550,500.9	45,371.0 - 576,859.9
	15RMGM	PG	1 - 23	1 - 23	1 - 18	1 - 13
		Capacity	30,096.9 - 692,228.7	45,145.4 - 1,038,344.2	60,193.9 - 1,095,529.0	90,290.9 - 1,147,984.3
DBL (*2)	6R0H9M	PG	1 - 23	1 - 23	1 - 18	1 - 13
		Capacity	11,748.4 - 270,213.2	17,622.6 - 405,319.8	23,496.8 - 427,641.8	35,245.2 - 448,117.5
	10RH9M	PG	1 - 23	1 - 23	1 - 18	1 - 13
		Capacity	19,580.7 - 450,356.1	29,371.0 - 675,533.0	39,161.4 - 712,737.5	58,742.1 - 746,863.8

*1: The number of parity groups includes the Disk Drives installed in the Controller Chassis (VSP G130 (CBXSS)).

*2: The number of parity groups includes the Disk Drives installed in the Controller Chassis (VSP G130 (CBXSL)).

(To be continued)

(Continued from the preceding page)

RAID Level / Storage capacity (GB/volume)			7D+1P (RAID5)	6D+2P (RAID6)	12D+2P (RAID6)	14D+2P (RAID6)
DBS (*1)	600JCMC	PG	1 - 11	1 - 11	1 - 6	1 - 5
		Capacity	4,034.7 - 44,381.7	3,458.3 - 38,041.3	6,916.7 - 40,512.1	8,069.5 - 40,347.5
	1R2JCMC	PG	1 - 11	1 - 11	1 - 6	1 - 5
		Capacity	8,069.5 - 88,764.5	6,916.7 - 76,083.7	13,833.4 - 81,024.2	16,139.0 - 80,695.0
	2R4JGM	PG	1 - 11	1 - 11	1 - 6	1 - 5
		Capacity	16,139.0 - 177,529.0	13,833.4 - 152,167.4	27,666.8 - 162,048.4	32,278.0 - 161,390.0
	480MGM	PG	1 - 11	1 - 11	1 - 6	1 - 5
		Capacity	3,308.3 - 36,391.3	2,835.6 - 31,191.6	5,671.3 - 33,217.6	6,616.6 - 33,083.0
	960MGM	PG	1 - 11	1 - 11	1 - 6	1 - 5
		Capacity	6,616.6 - 72,782.6	5,671.3 - 62,384.3	11,342.7 - 66,435.8	13,233.2 - 66,166.0
	1R9MGM	PG	1 - 11	1 - 11	1 - 6	1 - 5
		Capacity	13,233.2 - 145,565.2	11,342.7 - 124,769.7	22,685.5 - 132,872.2	26,466.4 - 132,332.0
	3R8MGM	PG	1 - 11	1 - 11	1 - 6	1 - 5
		Capacity	26,466.4 - 291,130.4	22,685.5 - 249,540.5	45,371.0 - 265,744.4	52,932.9 - 264,664.5
	7R6MGM	PG	1 - 11	1 - 11	1 - 6	1 - 5
		Capacity	52,932.9 - 582,261.9	45,371.0 - 499,081.0	90,742.1 - 531,489.4	105,865.8 - 529,329.0
	15RMGM	PG	1 - 11	1 - 11	1 - 6	1 - 5
		Capacity	105,339.4 - 1,158,733.4	90,290.9 - 993,199.9	180,581.8 - 1,057,693.4	210,678.8 - 1,053,394.0
DBL (*2)	6R0H9M	PG	1 - 11	1 - 11	1 - 6	1 - 5
		Capacity	41,119.5 - 452,314.5	35,245.2 - 387,697.2	70,490.5 - 412,872.9	82,239.0 - 411,195.0
	10RH9M	PG	1 - 11	1 - 11	1 - 6	1 - 5
		Capacity	68,532.5 - 753,857.5	58,742.1 - 646,163.1	117,484.3 - 688,122.3	137,065.0 - 685,325.0

*1: The number of parity groups includes the Disk Drives installed in the Controller Chassis (VSP G130 (CBXSS)).

*2: The number of parity groups includes the Disk Drives installed in the Controller Chassis (VSP G130 (CBXSL)).

3. The number of Drives and blocks for each RAID level

Table 4-25 The number of Drives and blocks for each RAID level

RAID Levcel		Drive Type	Capacity	
			MB	Logical Block
RAID1	2D+2D	DKR5x-J600SS/DKS5x-J600SS	1,099,383	2,251,536,384
		DKR5x-J1R2SS/DKS5x-J1R2SS	2,198,767	4,503,073,792
		DKS5x-J2R4SS	4,397,534	9,006,148,608
		DKS2x-H6R0SS/DKR2x-H6R0SS	11,204,177	22,946,153,472
		DKR2x-H10RSS/DKS2x-H10RSS	18,673,627	38,243,589,120
		SLB5x-M480SS	901,442	1,846,153,216
		SLB5x-M960SS	1,802,884	3,692,307,456
		SLB5x-M1R9SS	3,605,769	7,384,614,912
		SLB5x-M3R8SS/SLR5x-M3R8SS	7,211,538	14,769,230,848
		SLB5x-M7R6SS/SLR5x-M7R6SS	14,423,077	29,538,461,696
		SLB5x-M15RSS	28,702,715	58,783,161,344
		NFHAx-Q3R2SS	6,710,884	13,743,889,408
		NFHAx-Q6R4SS	13,421,772	27,487,788,032
		NFHAx-Q13RSS	26,843,543	54,975,577,088
RAID5	3D+1P	DKR5x-J600SS/DKS5x-J600SS	1,649,075	3,377,304,576
		DKR5x-J1R2SS/DKS5x-J1R2SS	3,298,150	6,754,610,688
		DKS5x-J2R4SS	6,596,300	13,509,222,912
		DKS2x-H6R0SS/DKR2x-H6R0SS	16,806,265	34,419,230,208
		DKR2x-H10RSS/DKS2x-H10RSS	28,010,441	57,365,383,680
		SLB5x-M480SS	1,352,163	2,769,229,824
		SLB5x-M960SS	2,704,326	5,538,461,184
		SLB5x-M1R9SS	5,408,653	11,076,922,368
		SLB5x-M3R8SS/SLR5x-M3R8SS	10,817,307	22,153,846,272
		SLB5x-M7R6SS/SLR5x-M7R6SS	21,634,616	44,307,692,544
		SLB5x-M15RSS	43,054,073	88,174,742,016
		NFHAx-Q3R2SS	10,066,325	20,615,834,112
		NFHAx-Q6R4SS	20,132,657	41,231,682,048
		NFHAx-Q13RSS	40,265,315	82,463,365,632

x: A, B, C, ...

(To be continued)

(Continued from the preceding page)

RAID Levcel		Drive Type	Capacity	
			MB	Logical Block
RAID5	4D+1P	DKR5x-J600SS/DKS5x-J600SS	2,198,766	4,503,072,768
		DKR5x-J1R2SS/DKS5x-J1R2SS	4,397,533	9,006,147,584
		DKS5x-J2R4SS	8,795,067	18,012,297,216
		DKS2x-H6R0SS/DKR2x-H6R0SS	22,408,353	45,892,306,944
		DKR2x-H10RSS/DKS2x-H10RSS	37,347,255	76,487,178,240
		SLB5x-M480SS	1,802,884	3,692,306,432
		SLB5x-M960SS	3,605,769	7,384,614,912
		SLB5x-M1R9SS	7,211,538	14,769,229,824
		SLB5x-M3R8SS/SLR5x-M3R8SS	14,423,077	29,538,461,696
		SLB5x-M7R6SS/SLR5x-M7R6SS	28,846,154	59,076,923,392
		SLB5x-M15RSS	57,405,431	117,566,322,688
		NFHAx-Q3R2SS	13,421,767	27,487,778,816
		NFHAx-Q6R4SS	26,843,543	54,975,576,064
		NFHAx-Q13RSS	53,687,087	109,951,154,176
	6D+1P	DKR5x-J600SS/DKS5x-J600SS	3,298,149	6,754,609,152
		DKR5x-J1R2SS/DKS5x-J1R2SS	6,596,300	13,509,221,376
		DKS5x-J2R4SS	13,192,601	27,018,445,824
		DKS2x-H6R0SS/DKR2x-H6R0SS	33,612,530	68,838,460,416
		DKR2x-H10RSS/DKS2x-H10RSS	56,020,882	114,730,767,360
		SLB5x-M480SS	2,704,326	5,538,459,648
		SLB5x-M960SS	5,408,653	11,076,922,368
		SLB5x-M1R9SS	10,817,307	22,153,844,736
		SLB5x-M3R8SS/SLR5x-M3R8SS	21,634,615	44,307,692,544
		SLB5x-M7R6SS/SLR5x-M7R6SS	43,269,231	88,615,385,088
		SLB5x-M15RSS	86,108,146	176,349,484,032
		NFHAx-Q3R2SS	20,132,651	41,231,668,224
		NFHAx-Q6R4SS	40,265,315	82,463,364,096
		NFHAx-Q13RSS	80,530,630	164,926,731,264

x: A, B, C, ...

(To be continued)

(Continued from the preceding page)

RAID Levcel		Drive Type	Capacity	
			MB	Logical Block
RAID5	7D+1P	DKR5x-J600SS/DKS5x-J600SS	3,847,841	7,880,377,344
		DKR5x-J1R2SS/DKS5x-J1R2SS	7,695,683	15,760,758,272
		DKS5x-J2R4SS	15,391,367	31,521,520,128
		DKS2x-H6R0SS/DKR2x-H6R0SS	39,214,618	80,311,537,152
		DKR2x-H10RSS/DKS2x-H10RSS	65,357,696	133,852,561,920
		SLB5x-M480SS	3,155,047	6,461,536,256
		SLB5x-M960SS	6,310,095	12,923,076,096
		SLB5x-M1R9SS	12,620,191	25,846,152,192
		SLB5x-M3R8SS/SLR5x-M3R8SS	25,240,384	51,692,307,968
		SLB5x-M7R6SS/SLR5x-M7R6SS	50,480,770	103,384,615,936
		SLB5x-M15RSS	100,459,504	205,741,064,704
		NFHAx-Q3R2SS	23,488,092	48,103,612,928
		NFHAx-Q6R4SS	46,976,200	96,207,258,112
		NFHAx-Q13RSS	93,952,402	192,414,519,808
RAID6	6D+2P	DKR5x-J600SS/DKS5x-J600SS	3,298,149	6,754,609,152
		DKR5x-J1R2SS/DKS5x-J1R2SS	6,596,300	13,509,221,376
		DKS5x-J2R4SS	13,192,601	27,018,445,824
		DKS2x-H6R0SS/DKR2x-H6R0SS	33,612,530	68,838,460,416
		DKR2x-H10RSS/DKS2x-H10RSS	56,020,882	114,730,767,360
		SLB5x-M480SS	2,704,326	5,538,459,648
		SLB5x-M960SS	5,408,653	11,076,922,368
		SLB5x-M1R9SS	10,817,307	22,153,844,736
		SLB5x-M3R8SS/SLR5x-M3R8SS	21,634,615	44,307,692,544
		SLB5x-M7R6SS/SLR5x-M7R6SS	43,269,231	88,615,385,088
		SLB5x-M15RSS	86,108,146	176,349,484,032
		NFHAx-Q3R2SS	20,132,651	41,231,668,224
		NFHAx-Q6R4SS	40,265,315	82,463,364,096
		NFHAx-Q13RSS	80,530,630	164,926,731,264

x: A, B, C, ...

(To be continued)

(Continued from the preceding page)

RAID Levcel		Drive Type	Capacity	
			MB	Logical Block
RAID6	12D+2P	DKR5x-J600SS/DKS5x-J600SS	6,596,298	13,509,218,304
		DKR5x-J1R2SS/DKS5x-J1R2SS	13,192,599	27,018,442,752
		DKS5x-J2R4SS	26,385,201	54,036,891,648
		DKS2x-H6R0SS/DKR2x-H6R0SS	67,225,059	137,676,920,832
		DKR2x-H10RSS/DKS2x-H10RSS	112,041,765	229,461,534,720
		SLB5x-M480SS	5,408,652	11,076,919,296
		SLB5x-M960SS	10,817,307	22,153,844,736
		SLB5x-M1R9SS	21,634,614	44,307,689,472
		SLB5x-M3R8SS/SLR5x-M3R8SS	43,269,231	88,615,385,088
		SLB5x-M7R6SS/SLR5x-M7R6SS	86,538,462	177,230,770,176
		SLB5x-M15RSS	172,216,293	352,698,968,064
		NFHAx-Q3R2SS	40,265,301	82,463,336,448
		NFHAx-Q6R4SS	80,530,629	164,926,728,192
		NFHAx-Q13RSS	161,061,261	329,853,462,528
	14D+2P	DKR5x-J600SS/DKS5x-J600SS	7,695,681	15,760,754,688
		DKR5x-J1R2SS/DKS5x-J1R2SS	15,391,366	31,521,516,544
		DKS5x-J2R4SS	30,782,735	63,043,040,256
		DKS2x-H6R0SS/DKR2x-H6R0SS	78,429,236	160,623,074,304
		DKR2x-H10RSS/DKS2x-H10RSS	130,715,392	267,705,123,840
		SLB5x-M480SS	6,310,094	12,923,072,512
		SLB5x-M960SS	12,620,191	25,846,152,192
		SLB5x-M1R9SS	25,240,383	51,692,304,384
		SLB5x-M3R8SS/SLR5x-M3R8SS	50,480,769	103,384,615,936
		SLB5x-M7R6SS/SLR5x-M7R6SS	100,961,539	206,769,231,872
		SLB5x-M15RSS	200,919,008	411,482,129,408
		NFHAx-Q3R2SS	46,976,185	96,207,225,856
		NFHAx-Q6R4SS	93,952,401	192,414,516,224
		NFHAx-Q13RSS	187,904,804	384,829,039,616

x: A, B, C, ...

4.5.5 SCSI Commands

4.5.5.1 Common to Fibre/iSCSI

The DASD commands defined under the SCSI-3 standards and those supported by the DKC are listed in Table 4-26.

Table 4-26 SCSI-3 DASD commands and DKC-supported commands

Group	Op Code	Name of Command	Type	○:Supported	Remarks
0 (00H -1FH)	00H	Test Unit Ready	CTL/SNS	○	—
	01H	Rezero Unit	CTL/SNS	Nop	—
	03H	Requirement Sense	CTL/SNS	○	—
	04H	Format Unit	DIAG	Nop	—
	07H	Reassign Blocks	DIAG	Nop	—
	08H	Read (6)	RD/WR	○	—
	0AH	Write (6)	RD/WR	○	—
	0BH	Seek (6)	CTL/SNS	Nop	—
	12H	Inquiry	CTL/SNS	○	—
	15H	Mode Select (6)	CTL/SNS	○	—
	16H	Reserve	CTL/SNS	○	—
	17H	Release	CTL/SNS	○	—
	1AH	Mode Sense (6)	CTL/SNS	○	—
	1BH	Start/Stop Unit	CTL/SNS	Nop	—
	1CH	Receive Diagnostic Results	DIAG	—	—
	1DH	Send Diagnostic	DIAG	Nop	Supported only for self-test.
1 (20H -3FH)	25H	Read Capacity (10)	CTL/SNS	○	—
	28H	Read (10)	RD/WR	○	—
	2AH	Write (10)	RD/WR	○	—
	2BH	Seek (10)	CTL/SNS	Nop	—
	2EH	Write And Verify (10)	RD/WR	○	Supported only Write.
	2FH	Verify (10)	RD/WR	Nop	—
	35H	Synchronize Cache (10)	CTL/SNS	Nop	—
	37H	Read Defect Data (10)	DIAG	—	No defect always reported.
	3BH	Write Buffer	DIAG	○	—
	3CH	Read Buffer	DIAG	○	—
2 (40H -5FH)	42H	Unmap	CTL/SNS	○	—
	4DH	Log Sense	CTL/SNS	○	—
	55H	Mode Select (10)	CTL/SNS	○	—
	56H	Reserve (10)	CTL/SNS	○	—
	57H	Release (10)	CTL/SNS	○	—
	5AH	Mode Sense (10)	CTL/SNS	○	—
	5EH	Persistent Reserve IN	CTL/SNS	○	—
	5FH	Persistent Reserve OUT	CTL/SNS	○	—

(To be continued)

(Continued from preceding page)

Group	Op Code	Name of Command	Type	○:Supported	Remarks
3 (80H -9FH)	83H/00H	Extended Copy	CTL/SNS	○	—
	83H/11H	Write Using Token	CTL/SNS	○	—
	84H/03H	Receive Copy Result	CTL/SNS	○	—
	84H/07H	Receive ROD Token Information	CTL/SNS	○	—
	88H	Read (16)	RD/WR	○	—
	89H	Compare and Write	RD/WR	○	—
	8AH	Write (16)	RD/WR	○	—
	8EH	Write And Verify (16)	RD/WR	○	Supported only Write.
	8FH	Verify (16)	RD/WR	Nop	—
	91H	Synchronized Cache (16)	CTL/SNS	Nop	—
	93H	Write Same (16)	CTL/SNS	○	—
	9E/10H	Read Capacity (16)	CTL/SNS	○	—
	9E/12H	Get LBA Status	CTL/SNS	○	—
4 (A0H -BFH)	A0H	Report LUN	CTL/SNS	○	—
	A3H/05H	Report Device Identifier	CTL/SNS	○	—
	A3H/0AH	Report Target Port Groups	CTL/SNS	—	—
	A3H/0BH	Report Aliases	CTL/SNS	—	—
	A3H/0CH	Report Supported Operation Codes	CTL/SNS	—	—
	A3H/0DH	Report Supported Task Management Functions	CTL/SNS	—	—
	A3H/0EH	Report Priority	CTL/SNS	—	—
	A3H/0FH	Report Timestamp	CTL/SNS	—	—
	A4H/XXH	Maintenance OUT	CTL/SNS	—	—
	A4H/06H	Set Device Identifier	CTL/SNS	—	—
	A4H/0AH	Set Target Port Groups	CTL/SNS	○	—
	A4H/0BH	Change Aliases	CTL/SNS	—	—
	A4H/0EH	Set Priority	CTL/SNS	—	—
	A4H/0FH	Set Timestamp	CTL/SNS	—	—
	A8H	Read (12)	RD/WR	○	—
	AAH	Write (12)	RD/WR	○	—
	AEH	Write And Verify (12)	RD/WR	○	However, only the Write operation.
	AFH	Verify (12)	RD/WR	Nop	—
	B7H	Read Defect Data (12)	CTL/SNS	○	It always reports on No defect.
5 (E0H -FFH)	E8H	Read With Skip Mask (IBM-unique)	CTL/SNS	—	—
	EAH	Write With Skip Mask (IBM-unique)	CTL/SNS	—	—

4.6 Outline of Hardware

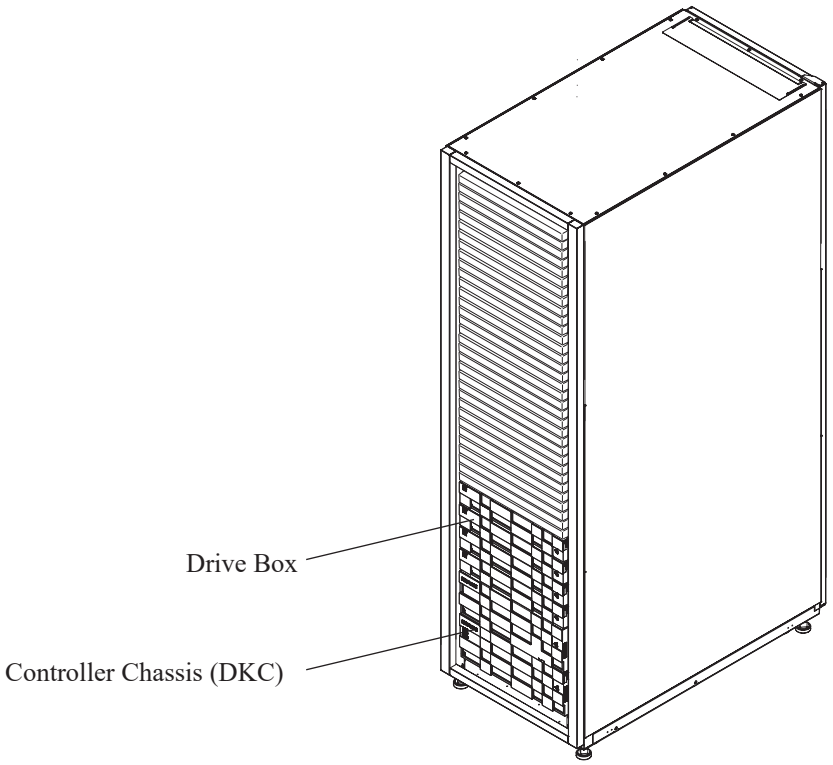
DW850 is a new Storage System of a high midrange-class that offers high performance of the enterprise-class.
DW850 consists of the Controller Chassis and the Drive Box as well as the Storage System of the midrange-class, and they are installed in a 19-inch rack.

Drives can be installed in the Controller Chassis and the Drive Box.
The maximum number of installable drives is shown below.

- VSP G130 : 96 (CBXSS + DBS x 3)
- VSP G350 : 264 (CBSS + DB60 x 4)
- VSP G370 : 384 (CBSS + DB60 x 6)
- VSP G700 : 1,200 (DB60 x 20)
- VSP G900 : 1,440 (DB60 x 24)
- VSP F350 : 192 (CBSS + DBS x 7)
- VSP F370 : 288 (CBSS + DBS x 11)
- VSP F700 : 864 (DBS x 36)
- VSP F900 : 1,152 (DBS x 48)

The Dual Controller configuration is adopted in the controller part that is installed in the Controller Chassis.
The Channel I/F supports only open systems and does not support Mainframe.
The Power Supply is single phase AC100V/200V for the VSP G130, G350, G370 model and single phase AC200V for the VSP G700, G900 models and DB60.

Figure 4-4 DW850 Storage System



For information about the service processor used with HDS VSP storage systems, refer to the “Service Processor (SVP) Technical Reference” (FE-94HM8036).

4.6.1 Outline Features

1. Scalability
   DW850 provides a variety of storage system configurations according to the types and the numbers of selected options: Channel Boards, Cache Memory, Disk Drive, Flash Drive and Flash Module Drive (FMD).
   - Number of installed Channel options: 12 to 20
     (Number of installed Channel option is 20 only when Channel Board Box is installed.)
   - Capacity of Cache Memory: 32 GiB to 1,024 GiB
   - Number of HDDs (VSP G900) : Up to 1,440 (When using DB60)

2. High-performance
   - DW850 supports three types of high-speed Disk Drives at the speed of 7,200 min^{-1}, 10,000 min^{-1} and 15,000 min^{-1}.
   - DW850 supports Flash Drives with ultra high-speed response.
   - DW850 supports Flash Module Drive (FMD) with ultra high-speed response and high capacity.
   - The high-speed data transfer between DKB and HDDs at a rate of 12 Gbps with the SAS interface is achieved.
   - DW850 uses Intel processor with brand new technology which performs as excellent as that of the enterprise device DKC810I.

3. Large Capacity
   - DW850 supports Disk Drives with capacities of 600 GB, 1.2 TB, 2.4 TB, 6 TB and 10 TB.
   - DW850 supports Flash Drives with capacities of 480 GB, 960 GB, 1.9 TB, 3.8 TB, 7.6 TB and 15 TB.
   - DW850 supports Flash Module Drive (FMD) with capacities of 3.5 TB, 7 TB and 14 TB.
   - DW850 controls up to 65,280 logical volumes and up to 1,440 Disk Drives and provides a physical Disk capacity of approximately 14,098 TB 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 12 Gbps SAS same as that of the HDD/SDD.
   The FMD uses MLC/TLC-NAND Flash Memory and features high performance, long service life and superior cost performance by virtue of its original control methods.

5. Connectivity
   DW850 supports OS's for various UNIX servers and PC servers, 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 4-27 Support OS Type

Manufacturer	OS
HPE	HP-UX
	Tru64
	OpenVMS
Oracle	Solaris
IBM	AIX 5L
Microsoft	Windows
NOVELL	NetWare
	SUSE Linux
Red Hat	Red Hat Linux
VMware	ESX Server

A Channel interface supported by the DW850 is shown below.
- Fibre Channel
- iSCSI

6. High reliability
   - DW850 supports RAID6 (6D+2P/12D+2P/14D+2P), RAID5 (3D+1P, 4D+1P, 6D+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 occurs, the Storage System can continue the operation.
   - However, when the failure of the Controller Board with the Cache Memory is addressed, the Channel ports and the Drive ports of the cluster concerned are blocked.

7. Non-disruptive maintenance
   - Main components can be added, removed and replaced without shutting down a device while the Storage System is in operation.
     However, when the addition of the Cache Memory is executed, the Channel ports and the Drive ports of the cluster concerned are blocked.
   - The firmware can be upgraded without shutting down the Storage System.

4.6.2 External View of Hardware

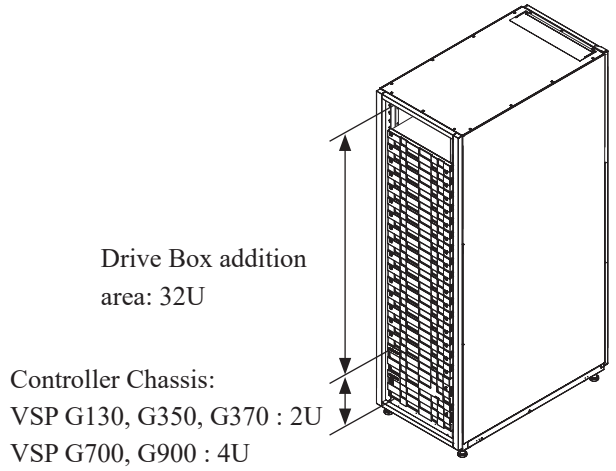
DW850 consists of the Controller Chassis installed with Control Boards and the Drive Box to be installed with various types of HDDs. The Controller Chassis and the Drive Box are mounted in a 19-inch rack.

1. VSP G130, G350, G370, G700, G900 models
   There are four types of Drive Boxes.
   - The Drive Box (DBS) can be installed with up to 24 2.5-inch HDDs.
   - The Drive Box (DBL) can be installed with up to 12 3.5-inch HDDs.
   - The Drive Box (DB60) can be installed with up to 60 3.5-inch HDDs. (Not supported on VSP G130.)
   - The Drive Box (DBF) can be installed with up to 12 FMDs. (only VSP G700 and G900)

   - The Drive Box (DBS), the Drive Box (DBL), the Drive Box (DB60) and the Drive Box (DBF) can be mixed in the Storage System.
   - The number of installable Drives changes depending on the Storage System models and Drive Boxes.

   The size of each unit is as shown below.
   - VSP G130, G350, G370 Controller Chassis : 2U
   - VSP G700, G900 Controller Chassis : 4U
   - Drive Boxes (DBS/DBL/DBF) : 2U
   - Drive Box (DB60) : 4U
   - The minimum configuration of the Storage System consists of one Controller Chassis and one Drive Box because DW850 allows free allocation of HDDs to make a RAID group. However, to configure the Storage System with super performance, it is recommended to install or add the Drive Box (DBS/DBL/DBF) in units of four at a time or the Drive Box (DB60) in units of two at a time per Controller Chassis.

Figure 4-5 DW850 Configuration



This page is for editorial purpose only.

4.6.3 Hardware Architecture

1. Controller Chassis (DKC)
   - The VSP G130 Controller Chassis (DKC) consists of Controller Board (CTL), Power Supply (DKCPS) and Drives.
   - The VSP G350, G370 Controller Chassis (DKC) consists of Controller Board (CTL), Channel Board (CHB), Power Supply (DKCPS), Backup Module (BKM), Cache Flash Memory (CFM) and Drives.
   - The VSP G700, G900 Controller Chassis (DKC) consists of Controller Board (CTL), Channel Board (CHB), Disk Board (DKB), Power Supply (DKCPS), Backup Module (BKMF) and Cache Flash Memory (CFM).
   - The Cache Memory is installed in the Controller Boards.
   - The Battery and the Cache Flash Memory are also installed in the Controller Boards to prevent data loss in case of a power outage or the like.
   - The Storage System continues to operate when a single point of failure occurs, by adopting a duplexed configuration for each Controller Board (CTL, LANB, CHB, DKB) and the Power Supply Unit, and a redundant configuration for the Power Supply Unit and the cooling fan. The addition and the replacement of the components and the upgrading of the firmware can be processed while the Storage System is in operation. However, when performing the maintenance and replacement of the Controller Boards, the Channel Boards and the Disk Boards in the cluster are blocked.

2. Drive Box (DBS)
   - The Drive Box (DBS) is a chassis to install the 2.5-inch Disk Drives and the 2.5-inch Flash Drives, and it consists of ENC and the integrated cooling fan power supply.
   - The duplex configuration is adopted in ENC and Power Supply Unit, and the redundant configuration is adopted in Power Supply Unit and the cooling fan. All the components can be replaced and added while the Storage System is in operation.

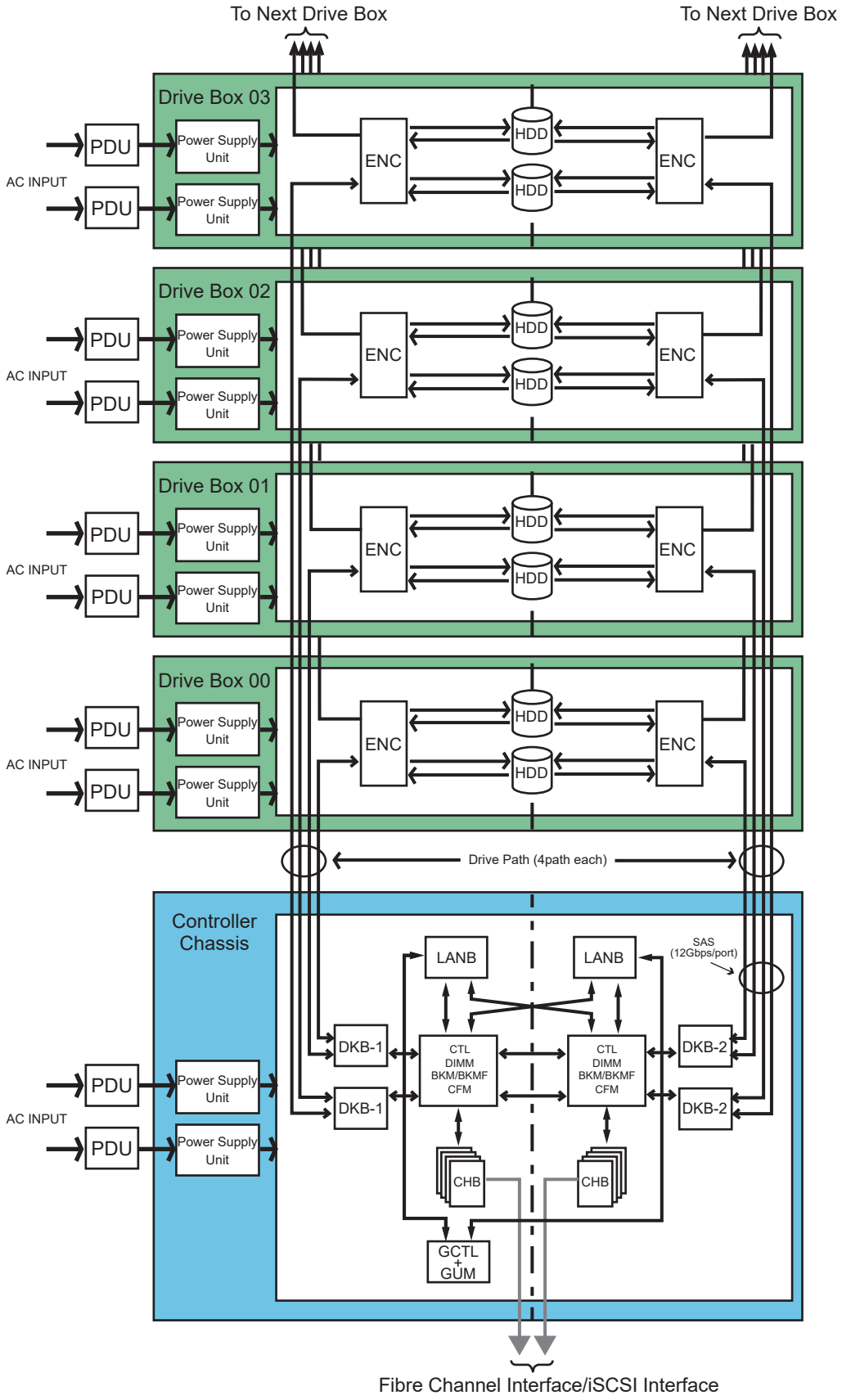
3. Drive Box (DBL)
   - The Drive Box (DBL) is a chassis to install the 3.5-inch Disk Drives and it consists of ENC and the integrated cooling fan power supply.
   - The duplex configuration is adopted in ENC and Power Supply Unit, and the redundant configuration is adopted in Power Supply Unit and the cooling fan. All the components can be replaced and added while the Storage System is in operation.

4. Drive Box (DB60)
   - The Drive Box (DB60) is a chassis to install the 2.5/3.5-inch Disk Drives and it consists of ENC and the integrated cooling fan power supply.
   - The duplex configuration is adopted in ENC and Power Supply Unit, and the redundant configuration is adopted in Power Supply Unit and the cooling fan. All the components can be replaced and added while the Storage System is in operation.

5. Drive Box (DBF)
   - The Drive Box (DBF) is a chassis to install the Flash Module Drives (FMD), and consists of ENC, and it consists of ENC and the integrated cooling fan power supply.
   - The duplex configuration is adopted in ENC and Power Supply Unit, and the redundant configuration is adopted in Power Supply Unit and the cooling fan. All the components can be replaced and added while the Storage System is in operation.

6. Channel Board Box (CHBB)
   - The Channel Board Box (CHBB) is a chassis to install the channel options, and consists of PCIe-cable Connecting Package (PCP), Power Supply and Switch Package (SWPK).
   - Channel Board Box (CHBB) can connect only to VSP G900 model and VSP F900 model.
   - The duplex configuration is adopted in SWPK and Power Supply Unit, and the redundant configuration is adopted in Power Supply Unit. All the components can be replaced and added while the storage system is in operation.

Figure 4-6 DW850 Hardware Configuration Overviews

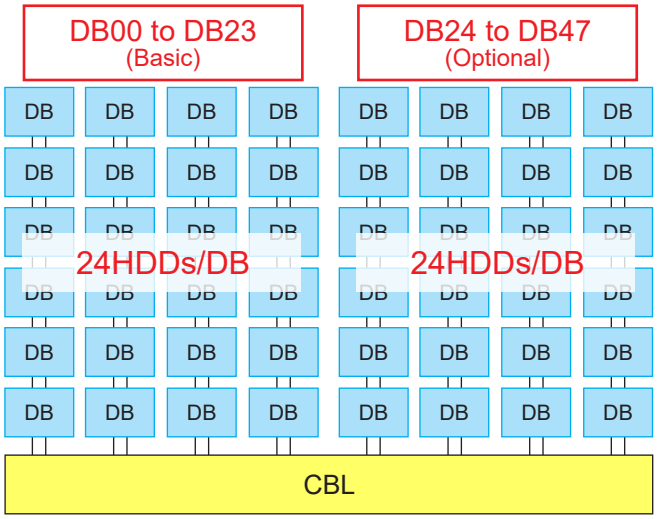


7. Drive Path

(1) When using 2.5-inch HDD (SFF)

DW850 controls 1,152 HDDs with eight paths.

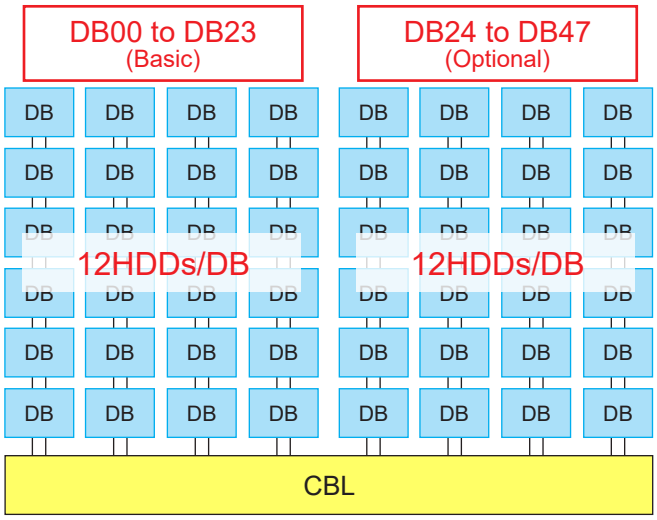
Figure 4-7 Drive Path Connection Overview when using 2.5-inch Drives



(2) When using 3.5-inch HDD (LFF)

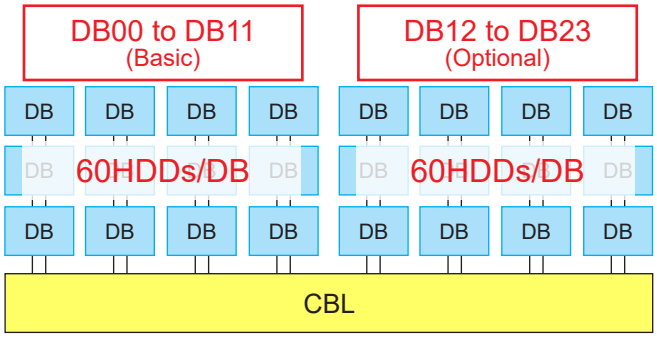
DW850 controls 576 HDDs with eight paths.

Figure 4-8 Drive Path Connection Overview when using 3.5-inch Drives



(3) When using 3.5-inch HDD
DW850 controls 1,440 HDDs with eight paths.

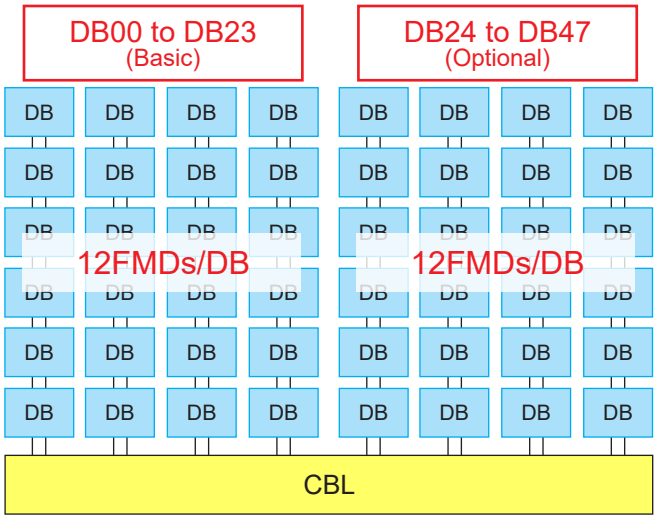
Figure 4-9 Drive Path Connection Overview when using 3.5-inch Drives



NOTICE: Up to six DB60 can be installed in a rack. Up to five DB60 can be installed in a rack when a DKC (H model) is installed there.
Install the DB60 at a height of 1,300 mm or less above the ground (at a range between 2U and 26U).

(4) When using Flash Module Drive (FMD) (DBF)
DW850 controls 576 FMDs with eight paths.

Figure 4-10 Drive Path Connection Overview when using FMDs (DBF)



4.6.4 Hardware Component

1. Controller Chassis (DKC)
   (1) VSP G130 Model
   The Controller Chassis for the VSP G130 model has a Controller Board (CTL), Power Supply (PS) and Disk Drives.

Figure 4-11 Controller Chassis (CBXSS)

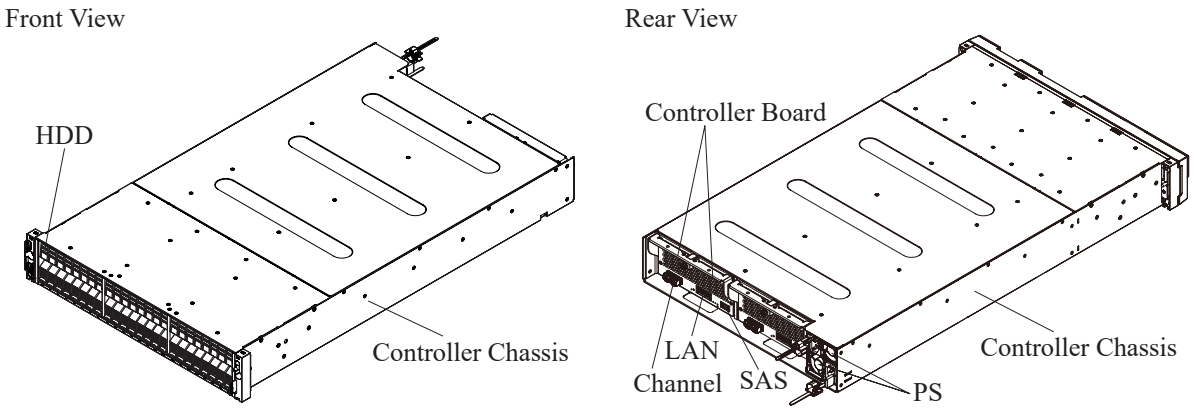
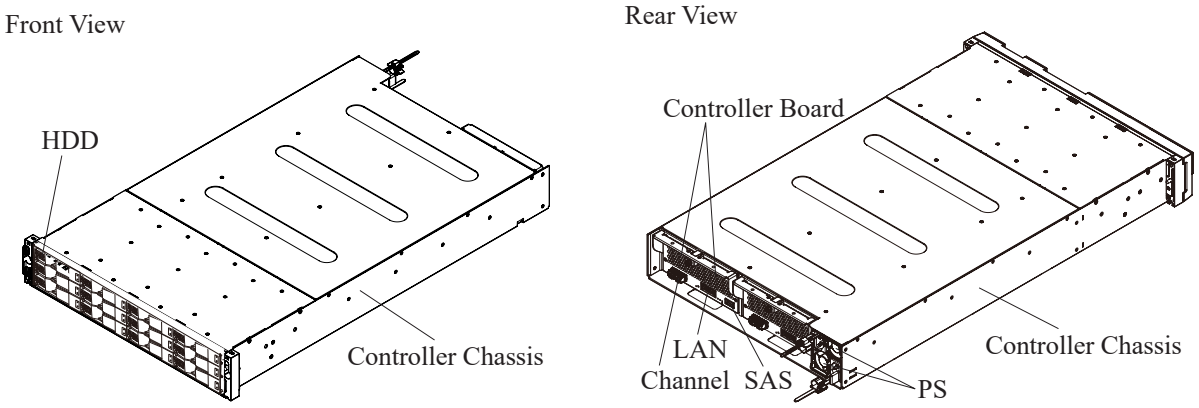


Figure 4-12 Controller Chassis (CBXSL)



(2) VSP G350, G370 Model

The Controller Chassis for the VSP G350, G370 model has a Controller Board (CTL), Channel Board (CHB), Power Supply (PS), Cache Flash Memories (CFMs) and Disk Drives.

- Channel Boards (CHB) is installed two or more. The addition unit of Channel Boards (CHB) is two. A maximum of four Channel Boards is installable.

Figure 4-13 Controller Chassis (CBSS1/CBSS2)

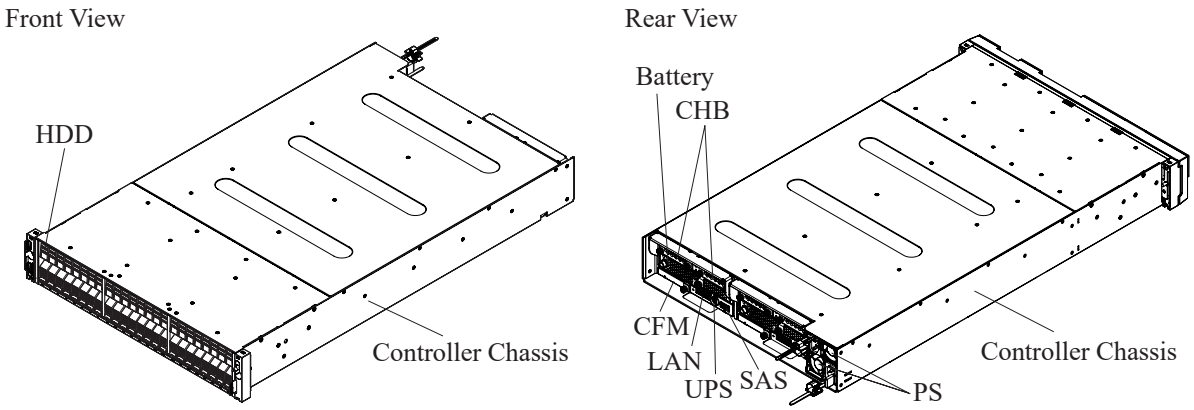
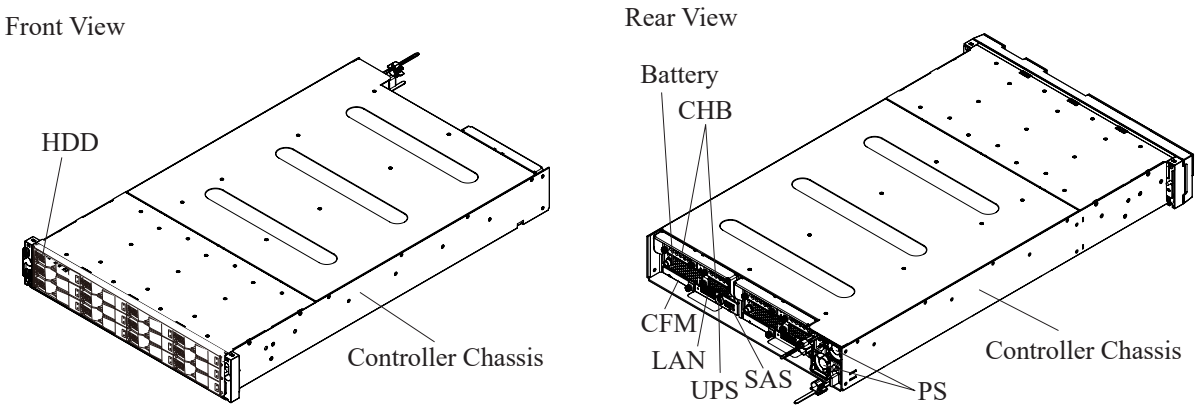


Figure 4-14 Controller Chassis (CBSL1/CBSL2)



(3) VSP G700, G900 Model

The Controller Chassis of the VSP G700, G900 model installs Controller Board (CTL), Channel Board (CHB), Power Supply (PS) and Cache Flash Memories (CFMs).

- When installing Disk Drives (HDD) in the VSP G700, G900 model Disk Boards (DKB) need to be installed in the Controller Chassis. In a disk-less configuration Disk Boards (DKB) are not required.
- Up to 4 Disk Boards (DKB) (for VSP G700 model) or 8 Disk Boards (DKB) (for VSP G900 model) can be inserted into the Disk Board slots. In the VSP G900 model, you can add up to two Controller Boards (up to four Controller Chassis).
- In the configuration using Channel Boards (CHB), the VSP G700 model can install a maximum of 14 Channel Boards and the VSP G900 model can install a maximum of 12 Channel Boards. In the disk-less configuration, the VSP G700, G900 model can install a maximum of 16 Channel Boards (The Channel Board Box can mount 20 Channel Boards).

Figure 4-15 Controller Chassis (VSP G700, G900 model)

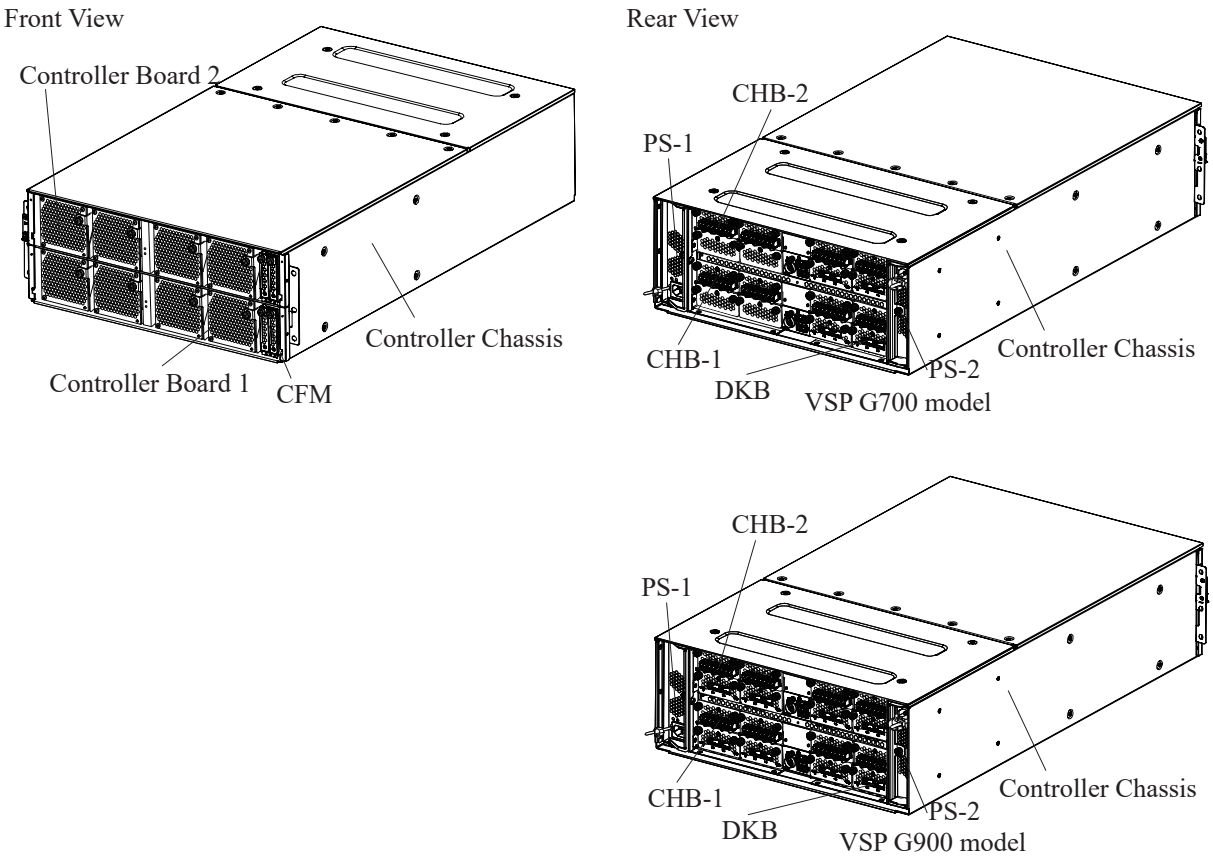
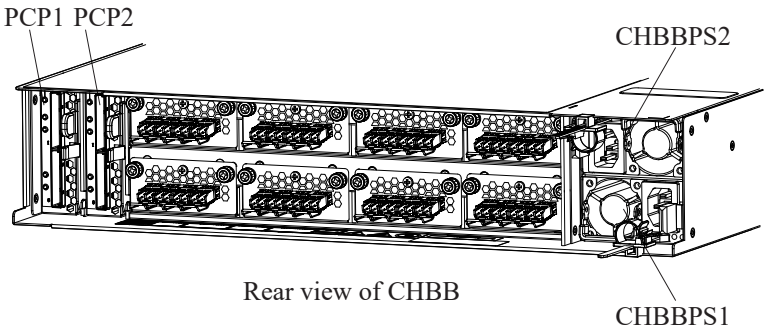


Figure 4-16 Channel Board Box (CHBB)

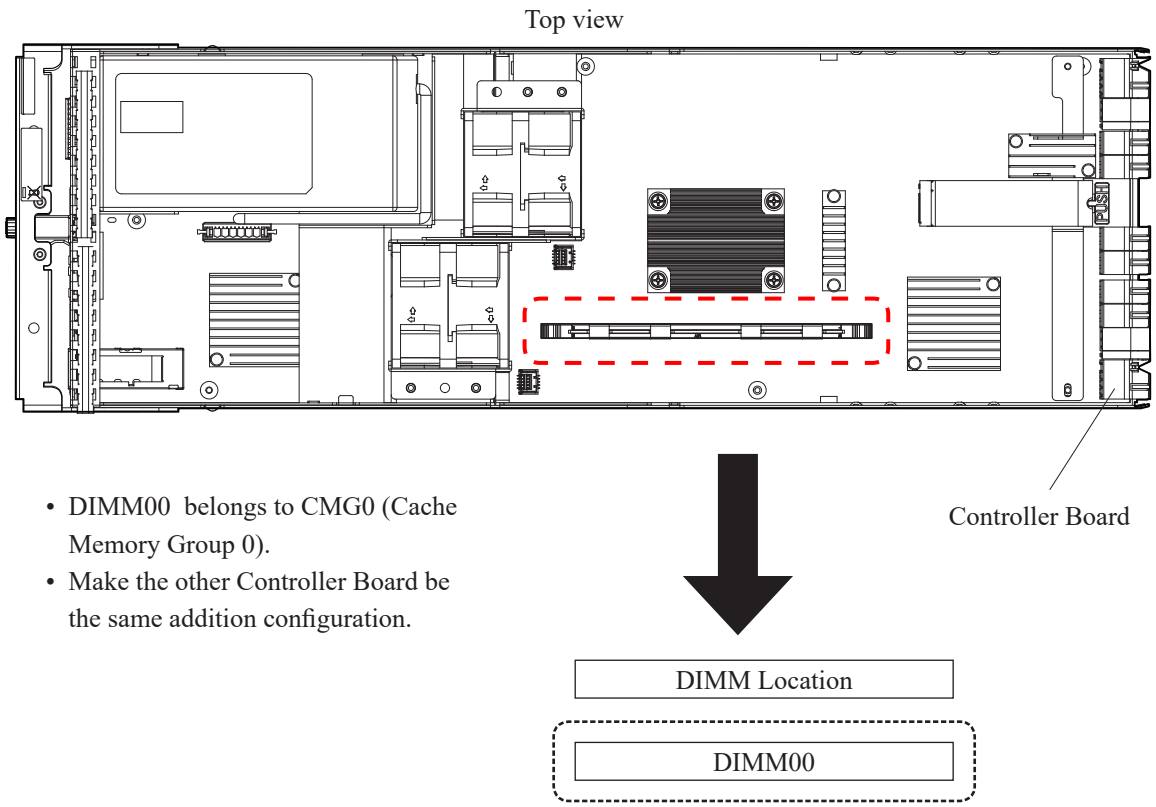


2. Controller Boards (CTL)
The Controller Board has Cache Memories (DIMMs) and Cache Flash Memories (CFMs).

Table 4-28 Controller Boards Specifications

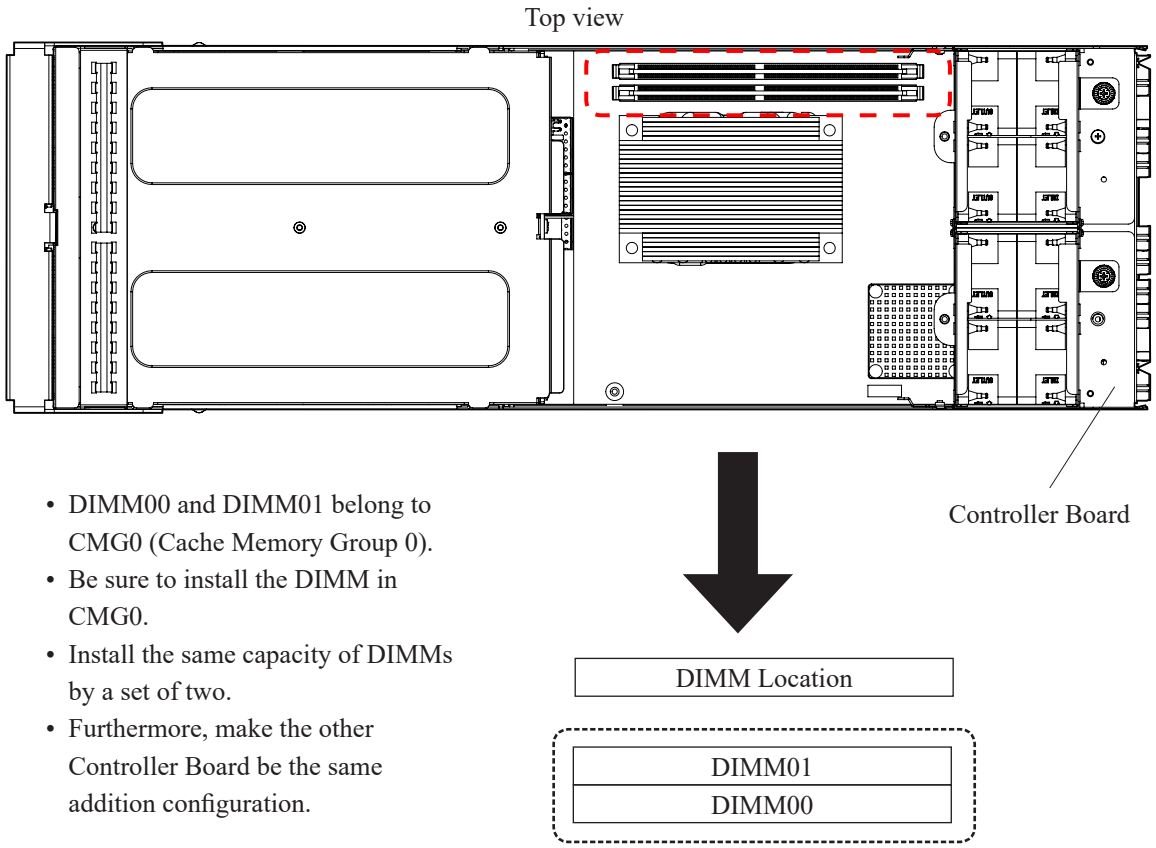
Support Model	VSP G130	VSP G350		VSP G370		VSP G700	VSP G900
Model Name	DW-F850-CTLXS	DW-F850-CTLS	DW-F850-CTLSE	DW-F850-CTLSH	DW-F850-CTLSHE	DW-F850-CTLM	DW-F850-CTLH
Number of PCB	1	1		1		1	1
Necessary number of PCB per Controller Chassis	2	2		2		2	2
Number of DIMM slot	1	2		2		2	2
Cache Memory Capacity	16 GiB	32 GiB to 64 GiB		64 GiB to 128 GiB		64 GiB to 256 GiB	128 GiB to 512 GiB
Data encryption	Not supported	Not supported	Supported	Not supported	Supported	-	-

Figure 4-17 Top of Controller Board (VSP G130 Model)



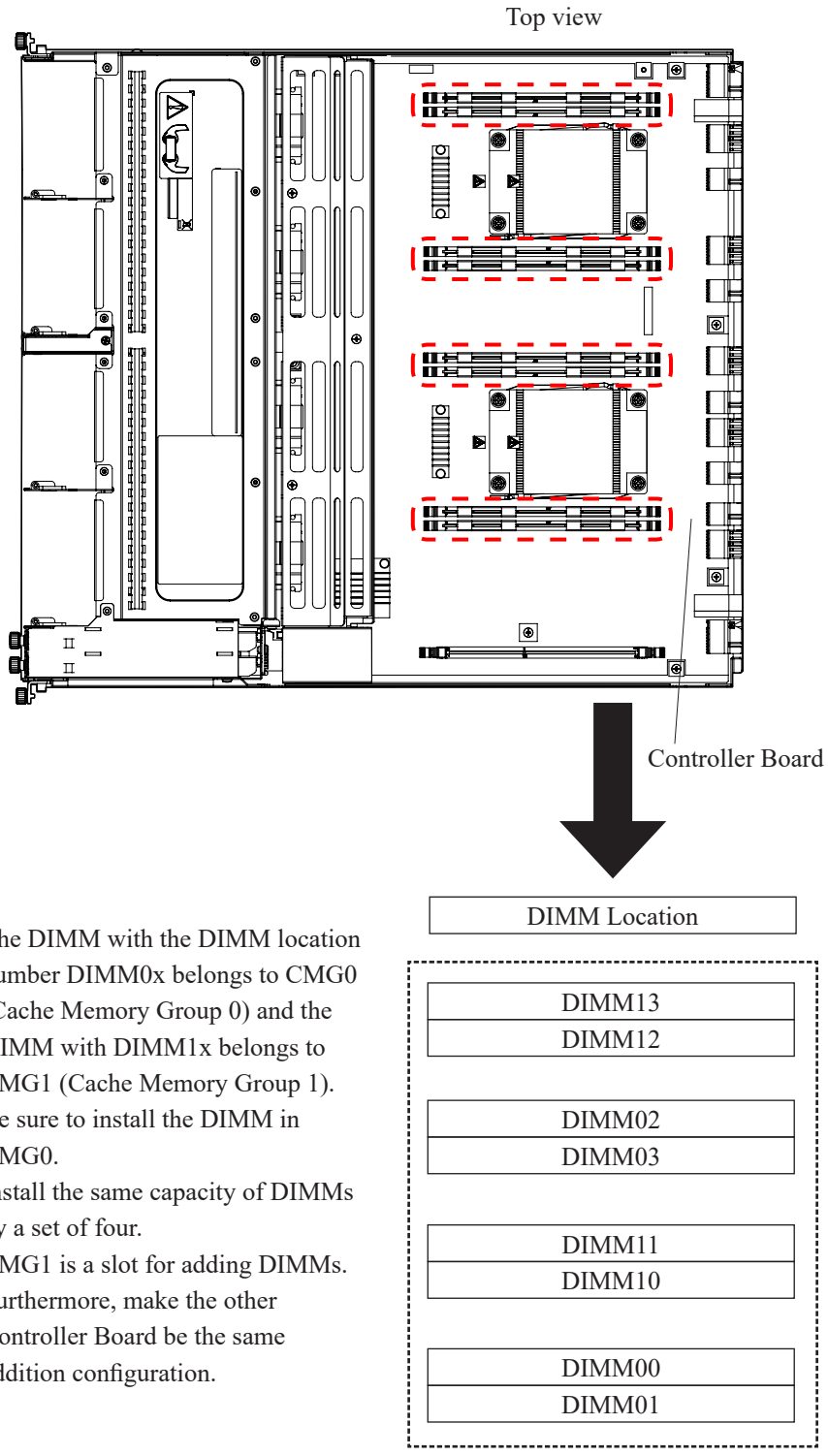
- DIMM00 belongs to CMG0 (Cache Memory Group 0).
- Make the other Controller Board be the same addition configuration.

Figure 4-18 Top of Controller Board (VSP G350, G370 Model)



- DIMM00 and DIMM01 belong to CMG0 (Cache Memory Group 0).
- Be sure to install the DIMM in CMG0.
- Install the same capacity of DIMMs by a set of two.
- Furthermore, make the other Controller Board be the same addition configuration.

Figure 4-19 Top of Controller Board (VSP G700, G900 Model)



- The DIMM with the DIMM location number DIMM0x belongs to CMG0 (Cache Memory Group 0) and the DIMM with DIMM1x belongs to CMG1 (Cache Memory Group 1).
- Be sure to install the DIMM in CMG0.
- Install the same capacity of DIMMs by a set of four.
- CMG1 is a slot for adding DIMMs.
- Furthermore, make the other Controller Board be the same addition configuration.

CFM/Battery addition of the VSP G700, G900 model is as shown below.

- VSP G700 model :
  For DIMM capacity CTL of 256 GiB or more, add CFM to CFM-11/21.
- VSP G900 model :
  For 32 GiB DIMM capacity CTL of 256 GiB or more, add CFM to CFM-11/21.
  For 64 GiB DIMM capacity CTL of 512 GiB or more, add CFM to CFM-11/21.

The installable CFMs are shown below by models.

- VSP G130 model : BM05
- VSP G350,G370 model : BM15
- VSP G700 model : BM35
- VSP 900 model : BM35 or BM45

NOTE :
- It is necessary to match the type (model name) of CFM-10/20 and CFM-11/21 (addition side).
  When adding Cache Memories, check the model name of CFM-10/20 and add the same model.
- When replacing Cache Flash Memories, it is necessary to match the type (model name) defined in the configuration information.
  Example: When the configuration information is defined as BM35, replacing to BM45 is impossible.

Table 4-29 Controller Board (VSP G130 Model)

Model	DIMM Capacity (GiB)	Number of DIMMs/CTL	Capacity of DIMMs (GiB)/CTL	Capacity of DIMMs (GiB)/System	Types of CFM installed in CFM-1/2	Number of Batteries Installed in System (BAT-1/2)
VSP G130	16	1	16	32	BM05	2

Figure 4-20 Controller Board (VSP G130 Model)

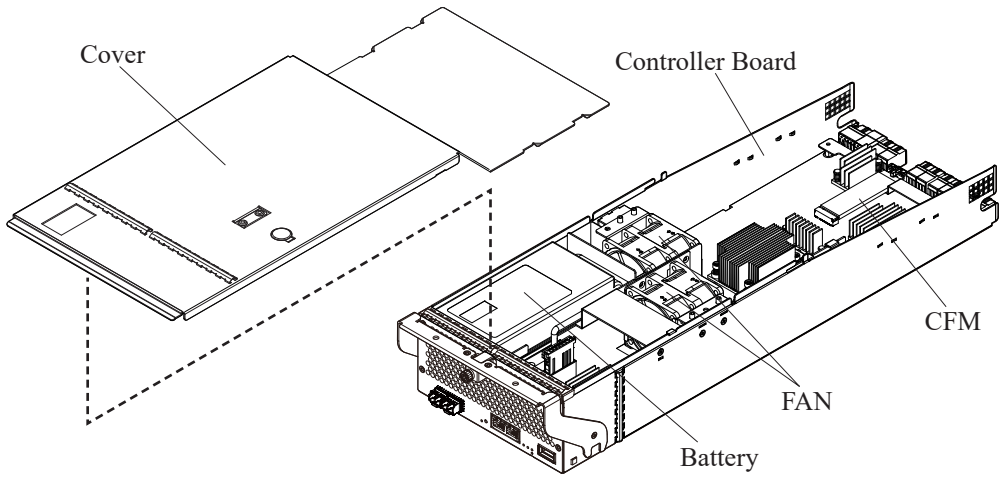


Table 4-30 Correspondence List of DIMM Capacity and CFM, BKM (VSP G350, G370 model)

Model	DIMM Capacity (GiB)	Number of DIMMs/CTL	Capacity of DIMMs (GiB)/CTL	Capacity of DIMMs (GiB)/System	Types of CFM installed in CFM-1/2	Number of Batteries Installed in System (BAT-1/2)
VSP G370	64	2	128	256	BM15	2
	32	2	64	128	BM15	2
VSP G350	32	2	64	128	BM15	2
	16	2	32	64	BM15	2

Figure 4-21 Controller Board (VSP G350, G370 Model)

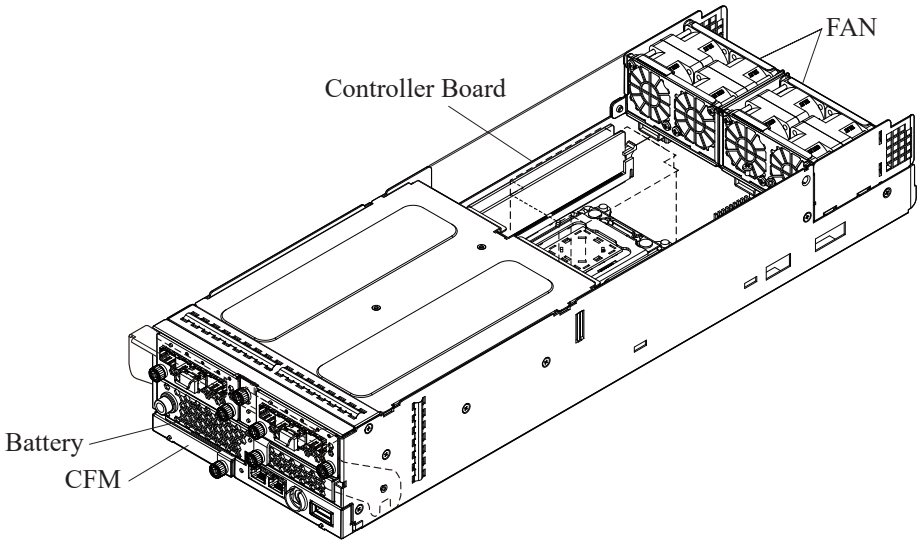


Table 4-31 Correspondence List of DIMM Capacity and CFM, BKMF (VSP G700, G900 model)

Model	DIMM Capacity (GiB)	Number of DIMMs/ CTL	Capacity of DIMMs (GiB)/ CTL	Capacity of DIMMs (GiB)/ System	Types of CFM installed in CFM-10/20 (*2)	Types of CFM installed in CFM-11/21 (*2)	Number of Batteries Installed in System (*1)
VSP G900	64	8	512	1,024	BM45	BM45	6
		4	256	512	BM45	-	6
	32	8	256	512	BM35	BM35	6
		4	128	256	BM35	-	6
VSP G700	32	8	256	512	BM35	BM35	6
		4	128	256	BM35	-	6
	16	8	128	256	BM35	-	6
		4	64	128	BM35	-	6

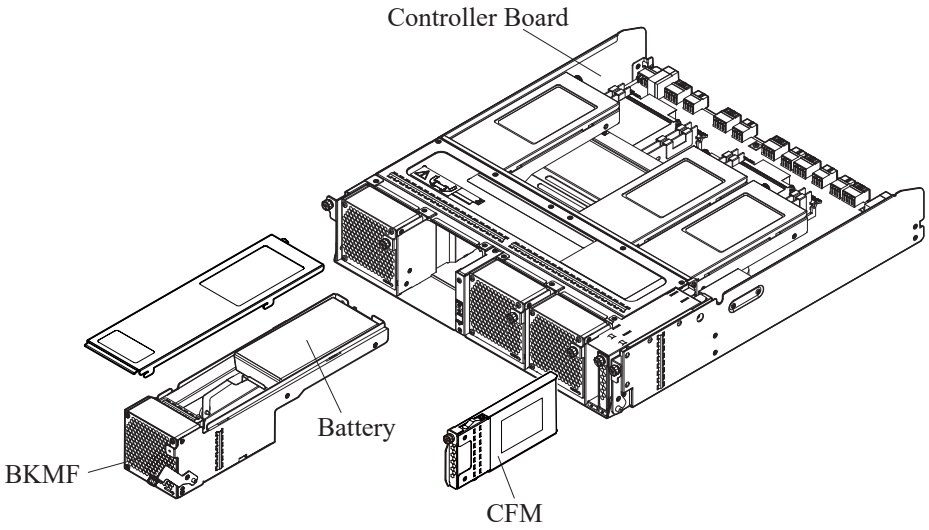
*1 : (BKMF-x1/x2/x3)

*2 : • It is necessary to match the type (model name) of CFM-10/20 and CFM-11/21 (additional side). When adding Cache Memories, check the model name of CFM-10/20 and add the same model.

• When replacing Cache Memories, it is necessary to match the type (model name) defined in the configuration information.
Example: When the configuration information is defined as BM35, replacing to BM45 is impossible.

NOTICE: Adding a battery for BKMF-10 and BKMF-20 is impossible.

Figure 4-22 Controller Board (VSP G700, G900 Model)



3. Cache Memory (DIMM)
   DW850 can use three types of DIMM capacity.

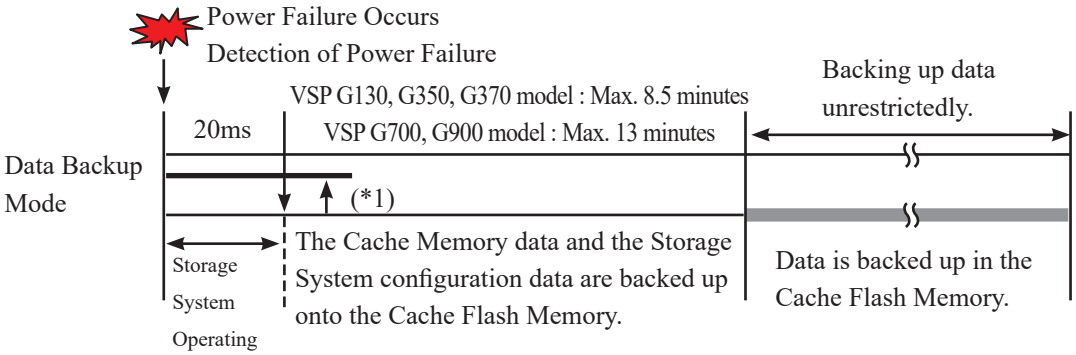
Table 4-32 Cache Memory Specifications

Capacity	Component	Model Number
16 GiB	16 GiB DIMM × 1	DW-F850-CM16G
32 GiB	32 GiB DIMM × 1	DW-F850-CM32G
64 GiB	64 GiB DIMM × 1	DW-F850-CM64G

4. Cache Flash Memory (CFM)
   The Cache Flash Memory saves the Cache Memory data when a power failure occurs.

5. Battery
   (1) The battery for the data saving is installed on each Controller Board in DW850.
   - When the power failure continues for more than 20 milliseconds, the Storage System uses power from the batteries to back up 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.

Figure 4-23 Data Backup Process



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

(2) Installation Location of Battery

The Storage System has the Batteries shown in Figure 4-24, Figure 4-25 and Figure 4-26.

Figure 4-24 Battery Location (CBLH)

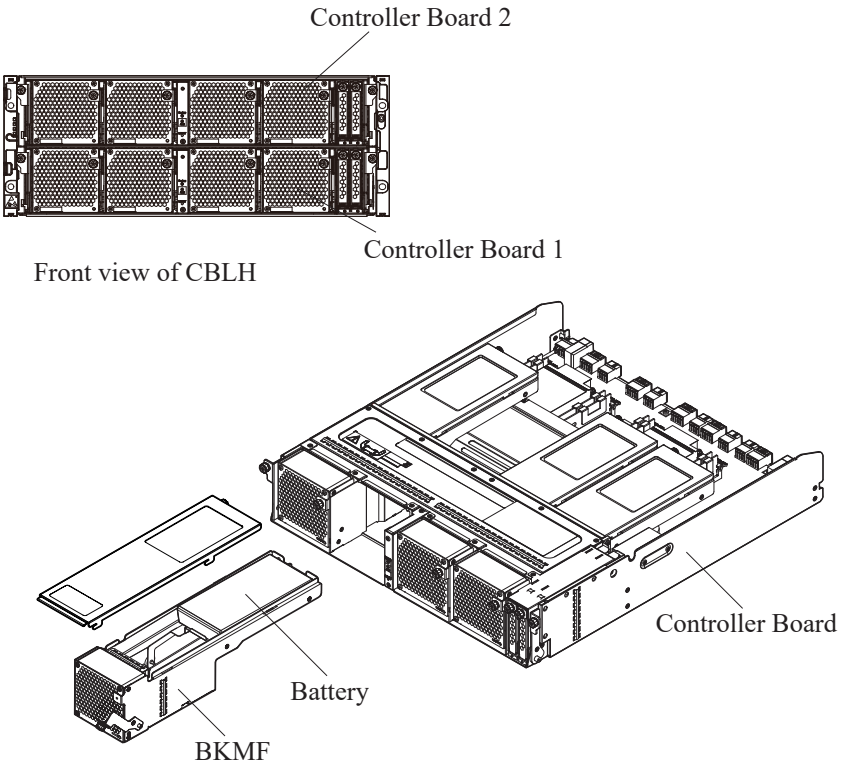


Figure 4-25 Battery Location (CBSS/CBSL)

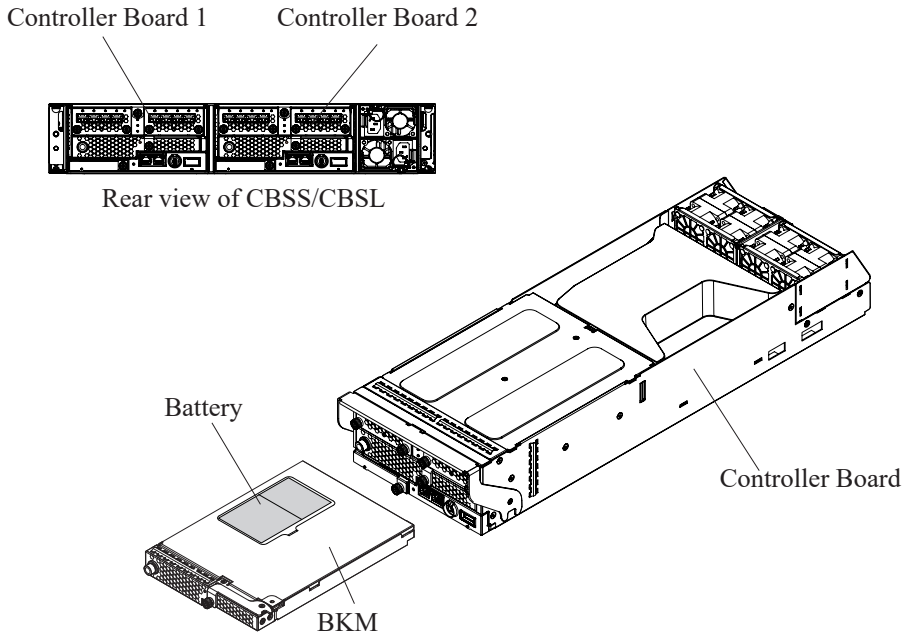
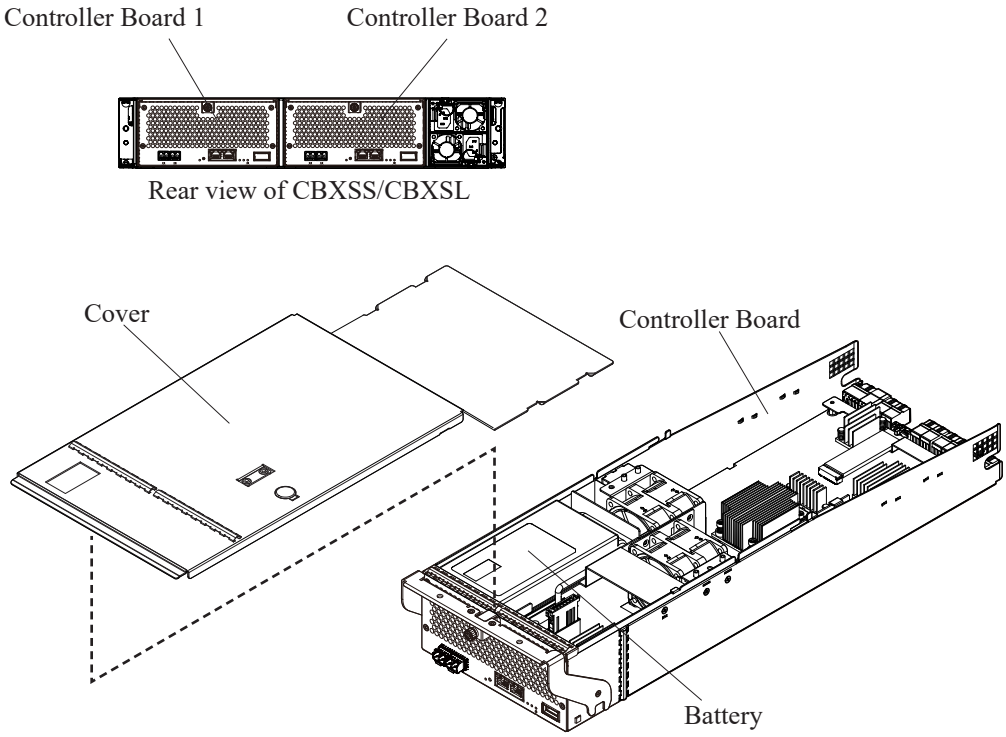


Figure 4-26 Battery Location (CBXSS/CBXSL)



(3) Battery lifetime

The battery life time is affected by the battery temperature. The battery temperature changes depending on the intake temperature and height of the Storage System, the configuration and operation of the Controllers and Drives (VSP G130, G350, G370 only), charge-discharge count, variation in parts and others, the battery lifetime will be two to five years.

The battery lifetime (expected value) in the standard environment is as shown below.

Storage System Intake Temperature	CBLH	CBXSS/CBSS	CBXSL/CBSL
Up to 24 degrees Celsius	5 years	5 years	5 years
Up to 30 degrees Celsius	5 years	5 years	4 years
Up to 34 degrees Celsius	4 years	4 years	3 years
Up to 40 degrees Celsius	3 years	3 years	2 years

(4) Relation between Battery Charge Level and System Startup Action

No.	Power Status	Battery Charge Level	System Startup Action
1	PS ON	<Case1> The battery charge level of both the Controller Boards is below 30%.	The system does not start up until the battery charge level of either or both of the Controller Boards becomes 30% or more. (It takes a maximum of 90 minutes (*2).) (*1)
2		<Case2> The battery charge level of both the Controller Boards is below 50%. (In the case other than Case1)	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 either or both of the Controller Boards becomes 50% or more. (It takes a maximum of 60 minutes (*2).)
3		<Case3> Other than <Case1>, <Case2>. (The battery charge level of either or both of the Controller Boards is 50% or more.)	The system starts up normally. If the condition changed from Case2 to Case3 during startup, SIM that shows the completion of battery charge is reported.

*1: Action when System Option Mode 837 is off (default setting).
*2: Battery charge time: 4.5 hours to charge from 0% to 100%.

(5) 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 CFM before PS OFF is completed. If PIN data exists, all the CM data including PIN data is also stored.	SM data is restored from CFM. If CM data was stored, CM data is also restored from CFM.
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 CFM.	SM/CM data in memory is used.
3		Power outage while the system is in operation	All the SM/CM data is stored in CFM. If a power outage occurred after the system started up in the condition of Case2 (the battery charge level of both the Controller Boards had been below 50%), only SM data is stored.	All the SM/CM data is restored from CFM. 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 CFM 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 CFM.

(6) Action When CFM Error Occurs

No.	DKC Status	Description of Error	Action When Error Occurs
1	In operation	CFM error or data comparing error was detected at the time of CFM health check (*1).	• CFM Failure SIMRC = 30750x (Environmental error: CFM Failure) is output.
2	Planed power off or power outage	CFM 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.	• DKC power off process is executed. • Blockage occurs in Controller Board or CMG in Controller Board depending on the location of the failed memory. For details, refer to "2.5.2 Maintenance/ Failure Blockade Specification".
3	When powered on -1 (In the case that data storing was successfully done in No.2)	CFM error or protection cord (*2) error occurred during data restoring.	• Blockage occurs in Controller Board or CMG in Controller Board depending on the location of the failed memory. • If the failed memory is in CMG0, the Controller Board concerned becomes blocked. If the failed memory is in CMG1, the CACHE concerned is volatilized and the system starts up. (If data in the other Controller Board can be restored, the data is not lost.)
4	When powered on -2 (In the case that data storing failed in No.2)	—	• Blockage occurs in Controller Board or CMG in Controller Board depending on the location of data storing error. (Same as described in No.2.)

*1: CFM health check: Function that executes the test of read and write of a certain amount of data at specified intervals to CFM while the DKC is in operation.

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

NOTE: CFM handles only the data in the Controller Board in which it is installed.

e.g.: Cache data in CTL1 is not stored in CFM which is installed in CTL2.
Similarly, CFM data in the CTL1 is not restored to Cache Memory in CTL2.

(7) Notes during Planned Power Off (PS OFF)

Removing the Controller Board when the system is off and the breakers on the PDU are on may result in <Case1> of (1) because of the lack of battery charge.
Therefore, to remove the board and the battery, replace them when the system is on, or remove them after the breakers on the PDU are powered off.

6. Disk Board (DKB)
The Disk Board (DKB) controls data transfer between the Drive and Cache Memory. Controller 1 and 2 should be in the same configuration on the Disk Board.

Table 4-33 Disk Board Specifications

Model Number	DW-F800-BS12G	DW-F800-BS12GE
Number of PCB	1	1
Necessary number of PCB per Controller Chassis	1	1
Data Encryption	Not Supported	Supported
Performance of SAS Port	12 Gbps	12 Gbps

Table 4-34 The Number of Installed DKBs and SAS Ports by Model

Item	VSP G130, G350, G370	VSP G700	VSP G900
Number of DKB	Built into CTL	2 piece / cluster (4 piece / system)	2, 4 piece / cluster (4, 8 piece / system)
Number of SAS Port	1 port / cluster (2 port / system)	4 port / cluster (8 port / system)	4, 8 port / cluster (8, 16 port / system)

The VSP G700, G900 model also supports the HDD-less configuration without DKB installed.

7. Channel Board (CHB)
   The Channel Board controls data transfer between the upper host and the Cache Memory.
   It supports the following CHBs. The addition is common to the VSP G350, G370, G700, G900 models.
   The number of CHBs and CHB types needs to be in the same configuration between clusters.
   The Channel Board (CHB) for the VSP G130 is not an independent package board (PCB). It is integrated in the Controller Board of the VSP G130.

Table 4-35 Types CHB

Type	Option Name
32 G 4Port FC	DW-F800-4HF32R
10 G 2Port iSCSI (Optic)	DW-F800-2HS10S
10 G 2Port iSCSI (Copper)	DW-F800-2HS10B

Table 4-36 Types CHB Function for VSP G130

Type	Option Name
16G 2Port FC	DW-F850-CTLXSFA
10G 2Port iSCSI (Optic)	DW-F850-CTLXSSA
10G 2Port iSCSI (Copper)	DW-F850-CTLXSCA

The number of installable CHBs is shown below.

Table 4-37 The Number of Installable CHBs by Model (VSP G130, G350, G370)

Item	VSP G130	VSP G350, G370
Minimum installable number	Built into CTL 2 port/cluster (4 port/system)	1 piece/cluster (2 piece/system)
Maximum installable number (HDD)		2 piece/cluster (4 piece/system)
Maximum installable number (HDD less)		2 piece/cluster (4 piece/system)

Table 4-38 The Number of Installable CHBs by Model (VSP G700)

Item	VSP G700
Minimum installable number	1 piece/cluster (2 piece/system)
Maximum installable number (HDD)	6 piece/cluster (12 piece/system)
Maximum installable number (HDD less)	8 piece/cluster (16 piece/system)

Table 4-39 The Number of Installable CHBs by Model (VSP G900)

Item	VSP G900	
	CHBB is not installed	CHBB is installed
Minimum installable number	1 piece/cluster (2 piece/system)	2 piece/cluster (4 piece/system)
Maximum installable number (HDD)	4 piece/cluster (8 piece/system) (*1)	6 piece/cluster (12 piece/system) (*1)
	6 piece/cluster (12 piece/system)	8 piece/cluster (16 piece/system)
Maximum installable number (HDD less)	8 piece/cluster (16 piece/system)	10 piece/cluster (20 piece/system)

*1: When installing four DKBs per cluster.

The CHB for Fibre Channel connection can correspond to Shortwave or Longwave by port unit by selecting a transceiver to be installed in each port.
Note that a port of each CHB installs a transceiver for Shortwave as standard.
When changing to a Longwave supported port, addition of DKC-F810I-1PL16 (SFP for 16Gbps Longwave) is required.

Table 4-40 Maximum cable length (Fibre Channel, Shortwave)

Item	Maximum cable length		
Data Transfer Rate	OM2 (50/125 µm multi-mode fibre)	OM3 (50/125 µm laser optimized multi-mode fibre)	OM4 (50/125 µm laser optimized multi-mode fibre)
400 MB/s	150 m	380 m	400 m
800 MB/s	50 m	150 m	190 m
1600 MB/s	35 m	100 m	125 m
3200 MB/s	20 m	70 m	100 m

Table 4-41 Maximum cable length (iSCSI, Shortwave)

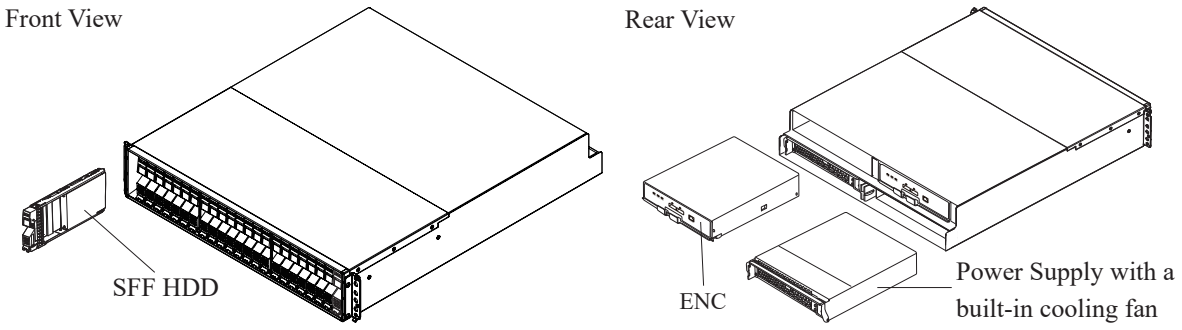
Item	Maximum cable length		
Data Transfer Rate	OM2 (50/125µm multi-mode fibre	OM3 (50/125µm laser optimized multi-mode fibre)	OM4 (50/125µm laser optimized multi-mode fibre)
1000 MB/s	82 m	300 m	550 m

Table 4-42 Maximum cable length (iSCSI (Copper))

Item	Maximum cable length	
Data Transfer Rate	Cable type : Category 5e LAN cable Corresponding Transmission Band : 1000 BASE-T	Cable type : Category 6a LAN cable Corresponding Transmission Band : 10G BASE-T
100 MB/s	100 m	100 m
1000 MB/s	-	50 m

8. Drive Box (DBS)
The Drive Box (DBS) is a chassis to install the 2.5-inch Disk Drives and the 2.5-inch Flash Drives, and consists of two ENCs and two Power Supplies with a built-in cooling fan.

Figure 4-27 Drive Box (DBS)

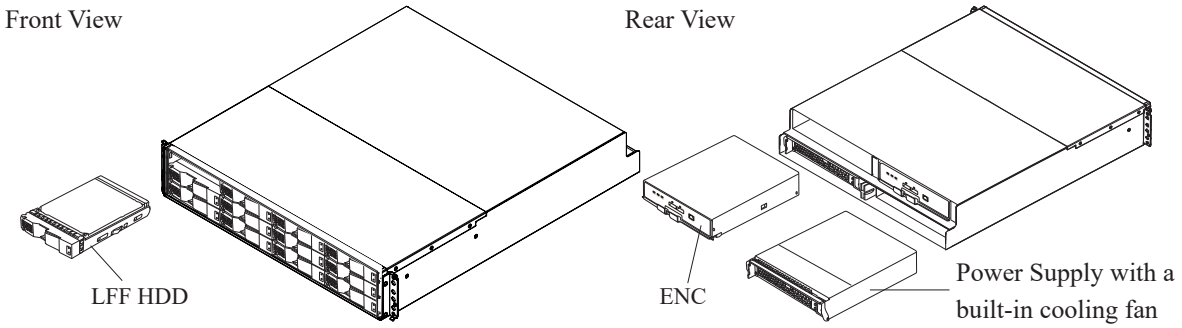


24 SFF HDDs can be installed.

ENC and Power Supply take a duplex configuration.

9. Drive Box (DBL)
The Drive Box (DBL) is a chassis to install the 3.5-inch Disk Drives and consists of two ENCs and two Power Supplies with a built-in cooling fan.

Figure 4-28 Drive Box (DBL)



12 LFF HDDs can be installed.

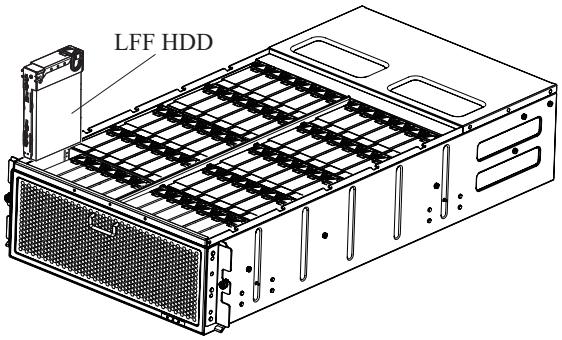
ENC and Power Supply take a duplex configuration.

10. Drive Box (DB60)

The Drive Box (DB60) is a chassis to install the 2.5/3.5-inch Disk Drives consists of two ENCs and two Power Supplies with a built-in cooling fan.

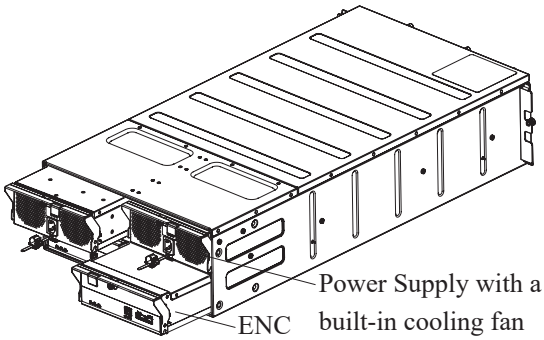
Figure 4-29 Drive Box (DB60)

Front View



60 LFF HDDs can be installed.

Rear View



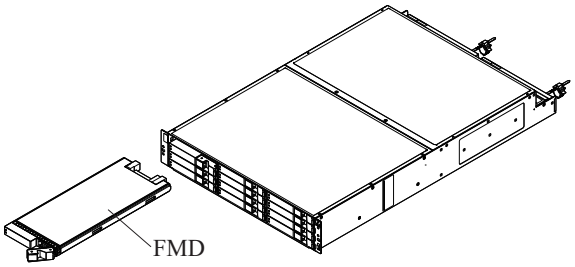
ENC and Power Supply take a duplex configuration.

11. Drive Box (DBF)

The Drive Box (DBF) is a chassis to install the Flash Module Drives (FMD), and consists of two ENCs and two Power Supplies with a built-in cooling fan.

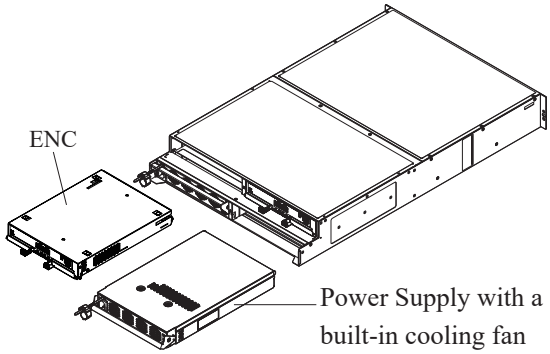
Figure 4-30 Drive Box (DBF)

Front View



12 FMDs can be installed.

Rear View

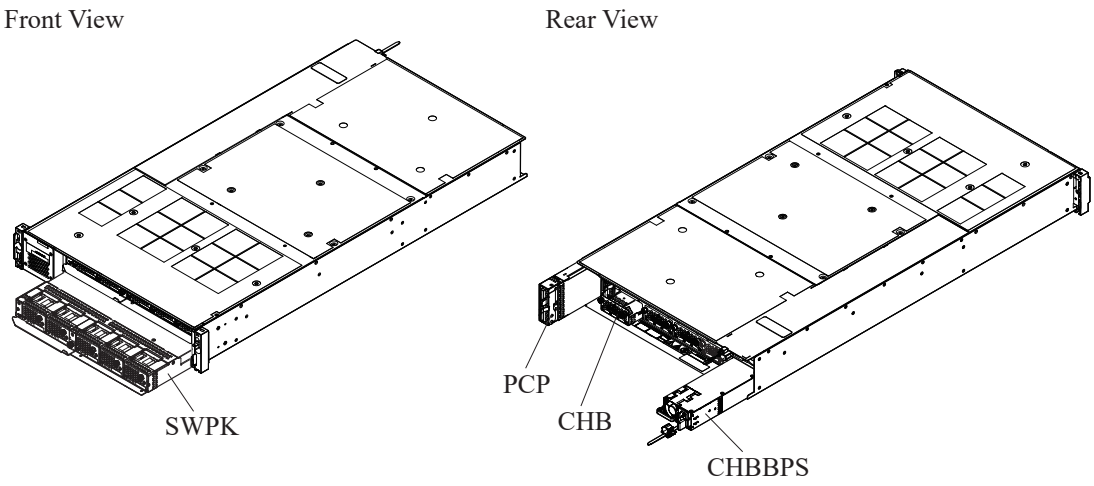


ENC and Power Supply take a duplex configuration.

12. Channel Board Box (CHBB)

The Channel Board Box (CHBB) is a chassis to install the Channel Board (CHB), and consists of two PCIe-cable Connecting Packages (PCP), two power supplies and two Switch Packages (SWPK).

Figure 4-31 Channel Board Box (CHBB)



8 CHBs can be installed.

13. Disk Drive, Flash Drive and Flash Module Drive

The Disk Drives, Flash Drives and Flash Module Drives supported by DW850 are shown below.

Table 4-43 Disk Drive, Flash Drive and Flash Module Drive Support Type

Group	I/F	Size (inch)	Maximum Transfer Rate (Gbps)	Revolution Speed (min^{-1}) or Flash Memory Type	Capacity
Disk Drive (HDD)	SAS	2.5 (SFF)	6	10,000	600 GB, 1.2 TB
			12	10,000	600 GB, 1.2 TB, 2.4 TB
	SAS	3.5 (LFF)	6	10,000	1.2 TB
			12	10,000	1.2 TB, 2.4 TB
			12	7,200	6 TB, 10 TB
Flash Drive (SSD)	SAS	2.5 (SFF)	12	MLC/TLC	480 GB, 960 GB, 1.9 TB, 3.8 TB, 7.6 TB, 15 TB
Flash Module Drive (FMD)	SAS	—	12	MLC	3.5 TB
				MLC/TLC	7 TB, 14 TB

Table 4-44 LFF Disk Drive Specifications

Item		DKC-F810I-1R2J7MC	DKC-F810I-2R4J8M
Disk Drive Model Name	Seagate	DKS5H-J1R2SS/ DKS5K-J1R2SS	DKS5K-J2R4SS
	HGST	DKR5E-J1R2SS/ DKR5G-J1R2SS	—
User Capacity		1152.79 GB	2305.58 GB
Number of heads		DKS5H : 6 DKS5K : 4 DKR5E : 8 DKR5G : 6	8
Number of Disks		DKS5H : 3 DKS5K : 2 DKR5E : 4 DKR5G : 3	4
Seek Time (ms) (Read/Write)	Average (*1)	DKS5H : 4.4/4.8 DKS5K : 4.2/4.6 DKR5E : 4.6/5.0 DKR5G : 3.5/4.2	4.4/4.8
Average latency time (ms)		DKS5H : 2.9 DKS5K : 2.9 DKR5E : 3.0 DKR5G : 2.85	2.9
Revolution speed (min^{-1})		10,000	10,000
Data transfer rate (Gbps)		DKS5H : 12 DKS5K : 12 DKR5E : 6 DKR5G : 12	12
Internal data transfer rate (MB/s)		DKS5H : - DKS5K: - DKR5E : Max. 279 DKR5G : Max. 357.4	—

(To be continued)

*1: The Controller Board overhead is excluded.

(Continued from preceding page)

Item		DKC-F810I-6R0H9M/ DKC-F810I-6R0HLM	DKC-F810I-10RH9M/ DKC-F810I-10RHLM
Disk Drive Model Name	Seagate	DKS2F-H6R0SS/ DKS2H-H6R0SS	DKS2J-H10RSS
	HGST	DKR2G-H6R0SS	DKR2H-H10RSS
User Capacity		5874.22 GB	9790.36 GB
Number of heads		DKS2F : 12 DKS2H : 10 DKR2G : 10	14
Number of Disks		DKS2F : 6 DKS2H : 5 DKR2G : 5	7
Seek Time (ms) (Read/Write)	Average (*1)	DKS2F : 8.5/9.5 DKS2H : 8.5/9.5 DKR2G : 7.6/8.0	DKR2H : 8.0/8.6 DKS2J : 8.5/9.5
Average latency time (ms)		DKS2F : 4.16 DKS2H : 4.16 DKR2G : 4.2	4.16
Revolution speed (min^{-1})		7,200	7,200
Data transfer rate (Gbps)		12	12
Internal data transfer rate (MB/s)		DKS2F : Max. 226 DKS2H : Max. 304 DKR2G : Max. 270	DKR2H : Max. 277.75 DKS2J : Max. 266.2

*1: The Controller Board overhead is excluded.

Table 4-45 SFF Disk Drive Specifications

Item		DKC-F810I-600JCMC	DKC-F810I-1R2JCMC
Disk Drive Model Name	Seagate	DKS5E-J600SS/ DKS5H-J600SS/ DKS5K-J600SS	DKS5F-J1R2SS/ DKS5H-J1R2SS/ DKS5K-J1R2SS
	HGST	DKR5D-J600SS/ DKR5G-J600SS	DKR5E-J1R2SS/ DKR5G-J1R2SS
User Capacity		576.39 GB	1152.79 GB
Number of heads		DKS5E : 4 DKS5H : 3 DKS5K : 2 DKR5D : 4 DKR5G : 3	DKS5F : 8 DKS5H : 6 DKS5K : 4 DKR5E : 8 DKR5G : 6
Number of Disks		DKS5E : 2 DKS5H : 2 DKS5K : 1 DKR5D : 2 DKR5G : 2	DKS5F : 4 DKS5H : 3 DKS5K : 2 DKR5E : 4 DKR5G : 3
Seek Time (ms) (Read/Write)	Average (*1)	DKS5E : 3.6/4.1 DKS5H : 4.2/4.6 DKS5K : 4.2/4.6 DKR5D : 3.8/4.2 DKR5G : 3.3/3.8	DKS5F : 3.7/4.3 DKS5H : 4.4/4.8 DKS5K : 4.2/4.6 DKR5E : 4.6/5.0 DKR5G : 3.5/4.2
Average latency time (ms)		DKS5E : 2.9 DKS5H : 2.9 DKS5K : 2.9 DKR5D : 3.0 DKR5G : 2.85	DKS5F : 3.0 DKS5H : 2.9 DKS5K : 2.9 DKR5E : 3.0 DKR5G : 2.85
Revolution speed (min^{-1})		10,000	10,000
Interface data transfer rate (Gbps)		DKS5E : 6 DKS5H : 12 DKS5K : 12 DKR5D : 6 DKR5G : 12	DKS5F : 6 DKS5H : 12 DKS5K : 12 DKR5E : 6 DKR5G : 12
Internal data transfer rate (MB/s)		DKS5E : Max. 293.8 DKS5H : - DKS5K : - DKR5D : Max. 279 DKR5G : Max. 357.4	DKS5F : Max. 293.8 DKS5H : - DKS5K : - DKR5E : Max. 279 DKR5G : Max. 357.4

(To be continued)

*1: The Controller Board overhead is excluded.

(Continued from preceding page)

Item		DKC-F810I-2R4JGM
Disk Drive Model Name	Seagate	DKS5K-J2R4SS
	HGST	—
User Capacity		2305.58 GB
Number of heads		8
Number of Disks		4
Seek Time (ms) (Read/Write)	Average (*1)	4.4/4.8
Average latency time (ms)		2.9
Revolution speed (min^{-1})		10,000
Interface data transfer rate (Gbps)		12
Internal data transfer rate (MB/s)		—

*1: The Controller Board overhead is excluded.

Table 4-46 SFF Flash Drive Specifications

Item		DKC-F810I-480MGM	DKC-F810I-960MGM	DKC-F810I-1R9MGM
Flash Drive Model Name	Toshiba	SLB5F-M480SD/ SLB5G-M480SD	SLB5F-M960SD/ SLB5G-M960SS	SLB5E-M1R9SD/ SLB5G-M1R9SS
	HGST	—	—	—
Form Factor		2.5 inch	2.5 inch	2.5 inch
User Capacity		472.61 GB	945.23 GB	1890.46 GB
Flash memory type		SLB5F: MLC SLB5G: TLC	SLB5F: MLC SLB5G: TLC	SLB5E: MLC SLB5G: TLC
Interface data transfer rate (Gbps)		12	12	12

Item		DKC-F810I-3R8MGM	DKC-F810I-7R6MGM	DKC-F810I-15RMGM
Flash Drive Model Name	Toshiba	SLB5F-M3R8SS/ SLB5G-M3R8SS	SLB5G-M7R6SS	SLB5H-M15RSS
	HGST	SLR5E-M3R8SS	SLR5E-M7R6SS	—
Form Factor		2.5 inch	2.5 inch	2.5 inch
User Capacity		3780.92 GB	7561.85 GB	15048 GB
Flash memory type		SLB5F: MLC SLB5G: TLC SLR5E: TLC	TLC	TLC
Interface data transfer rate (Gbps)		12	12	12

Table 4-47 Flash Module Drive Specifications

Item	DKC-F810I-3R2FN	DKC-F810I-7R0FP	DKC-F810I-14RFP
Flash Module Drive Model Name	NFHAE-Q3R2SS	NFHAF-Q6R4SS/ NFHAH-Q6R4SS/ NFHAJ-Q6R4SS	NFHAF-Q13RSS/ NFHAH-Q13RSS/ NFHAJ-Q13RSS
Form Factor	—	—	—
User Capacity	3518.43 GB	7036.87 GB	14073.74 GB
Flash memory type	MLC	NFHAF: MLC NFHAH: TLC NFHAJ: TLC	NFHAF: MLC NFHAH: TLC NFHAJ: TLC
Interface data transfer rate (Gbps)	12	12	12

4.7 Mounted Numbers of Drive Box and the Maximum Mountable Number of Drive

Table 4-48 Mounted numbers of Drive Box and the maximum mountable number of drive (VSP G130)

Model name	Number of mounted Drive Box (*1)		Maximum mountable number of drives (*2)
	DBS	DBL	DBS+DBL
VSP G130 (CBXSS)	3	0	96
	2	2	96
	1	4	96
	0	6	96
VSP G130 (CBXSL)	3	1	96
	2	3	96
	1	5	96
	0	7	96

*1: The maximum number of boxes that can be installed per PATH
VSP G130 : 7

*2: VSP G130 includes the drive to be installed in Controller Chassis.

Table 4-49 Mounted numbers of Drive Box and the maximum mountable number of drive (VSP G350, G370, G700, G900)

Model name	Number of mounted Drive Box (*1)		Maximum mountable number of drives (*2)	
	DBS/DBL/DBF	DB60	DBS+DB60	DBL/DBF+DB60
VSP G350 (CBSS1/ CBSS1E) (*3)	7	0	192	108
	5	1	204	144
	3	2	216	180
	1	3	228	216
	0	4	264	264
VSP G350 (CBSL1/ CBSL1E) (*3)	7	0	180	96
	5	1	192	132
	3	2	204	168
	1	3	216	204
	0	4	252	252
VSP G370 (CBSS2/ CBSS2E) (*3)	11	0	288	156
	9	1	300	192
	7	2	312	228
	5	3	324	264
	3	4	336	300
	1	5	348	336
	0	6	384	384
VSP G370 (CBSL2/ CBSL2E) (*3)	11	0	276	144
	9	1	288	180
	7	2	300	216
	5	3	312	252
	3	4	324	288
	1	5	336	324
	0	6	372	372

(To be continued)

(Continued from preceding page)

Model name	Number of mounted Drive Box (*1)		Maximum mountable number of drives (*2)	
	DBS/DBL/DBF	DB60	DBS+DB60	DBL/DBF+DB60
VSP G700	36	0	864	432
	33	1	852	456
	32	2	888	504
	29	3	876	528
	28	4	912	576
	25	5	900	600
	24	6	936	648
	21	7	924	672
	20	8	960	720
	17	9	948	744
	16	10	984	792
	13	11	972	816
	12	12	1,008	864
	9	13	996	888
	8	14	1,032	936
	5	15	1,020	960
	4	16	1,056	1,008
	1	17	1,044	1,032
	0	18	1,080	1,080
	0	19	1,140	1,140
	0	20	1,200	1,200

(To be continued)

(Continued from preceding page)

Model name	Number of mounted Drive Box (*1)		Maximum mountable number of drives (*2)	
	DBS/DBL/DBF	DB60	DBS+DB60	DBL/DBF+DB60
VSP G900	48	0	1,152	576
	45	1	1,140	600
	44	2	1,176	648
	41	3	1,164	672
	40	4	1,200	720
	37	5	1,188	744
	36	6	1,224	792
	33	7	1,212	816
	32	8	1,248	864
	29	9	1,236	888
	28	10	1,272	936
	25	11	1,260	960
	24	12	1,296	1,008
	21	13	1,284	1,032
	20	14	1,320	1,080
	17	15	1,308	1,104
	16	16	1,344	1,152
	13	17	1,332	1,176
	12	18	1,368	1,224
	9	19	1,356	1,248
	8	20	1,392	1,296
	5	21	1,380	1,320
	4	22	1,416	1,368
	1	23	1,404	1,392
	0	24	1,440	1,440

*1: The maximum number of boxes that can be installed per PATH
VSP G350 : 7
VSP G370 : 11
VSP G700 : 12
VSP G900 : 6

*2: VSP G350, G370 includes the drive to be installed in Controller Chassis.

*3: The DBF cannot be connected.

Table 4-50 Mounted numbers of Drive Box and the maximum mountable number of drive (VSP F350, F370, F700, F900 models)

Model name	Number of mounted Drive Box (*1)		Maximum mountable number of drives	
	DBS	DBF	DBS (SSD)	DBF (FMD)
VSP F350	7	—	192	—
VSP F370	11	—	288	—
VSP F700	36	—	864	—
	—	36	—	432
VSP F900	48	—	1,152	—
	—	48	—	576

*1: The maximum number of boxes that can be installed per PATH
VSP F350 : 7
VSP F370 : 11
VSP F700 : 12
VSP F900 : 6

4.8 Storage System Physical Specifications

Table 4-51 Storage System Physical Specifications

#	Model Number	Weight (kg)	Heat Output (W)	Power Consumption (VA) (*1)	Dimension (mm)			Air Flow (m^3/min)
					Width	Depth	Height	
1	DW850-CBL (VSP G900)	29.8	453	493	483.0	808.1	174.3	6.0
2	DW850-CBL (VSP G700)	29.8	338	363	483.0	808.1	174.3	6.0
3	DW800-CBSS (VSP G370)	16.1	218	226	483.0	813.0	88.0	4.0
4	DW800-CBSS (VSP G350)	16.1	218	226	483.0	813.0	88.0	4.0
5	DW800-CBSS (VSP G130)	16.1	196	200	483.0	813.0	88.0	2.3
6	DW800-CBSL (VSP G370)	15.9	192	200	483.0	813.0	88.0	3.5
7	DW800-CBSL (VSP G350)	15.9	192	200	483.0	813.0	88.0	3.5
8	DW800-CBSL (VSP G130)	15.9	191	195	483.0	813.0	88.0	1.6
9	DW-F800-DBSC	17.0	116	126	482.0	565.0	88.2	2.2
10	DW-F800-DBLC	17.4	124	144	482.0	565.0	88.2	2.2
11	DW-F800-DB60C	36.0	184	191	482.0	1029.0	176.0	5.1
12	DW-F850-DBF	19.3	120	130	483.0	762.0	87.0	1.6
13	DW-F800-CHBB	33.2	222	230	483.0	891.7	88.0	2.0
14	DW-F800-SCQ1	0.2	—	—	—	—	—	—
15	DW-F800-SCQ1F	0.2	—	—	—	—	—	—
16	DW-F800-SCQ3	0.45	—	—	—	—	—	—
17	DW-F800-SCQ5	0.6	—	—	—	—	—	—
18	DW-F800-SCQ10A	0.2	—	—	—	—	—	—
19	DW-F800-SCQ30A	0.4	—	—	—	—	—	—
20	DW-F800-SCQ1HA	1.0	—	—	—	—	—	—
21	DW-F800-BS12G	0.5	16	17.2	—	—	—	—
22	DW-F800-BS12GE	0.5	16	17.2	—	—	—	—
23	DW-F850-CM16G	0.022	4	4.2	—	—	—	—
24	DW-F850-CM32G	0.054	4	4.2	—	—	—	—
25	DW-F850-CM64G	0.054	4.8	5.0	—	—	—	—
26	DW-F850-BM15	0.15	5	5.2	—	—	—	—
27	DW-F850-BM35	0.2	5	5.2	—	—	—	—
28	DW-F850-BM45	0.2	6.5	6.8	—	—	—	—
29	DW-F800-BAT	0.6	24.4	25.7	—	—	—	—

(To be continued)

(Continued from preceding page)

#	Model Number	Weight (kg)	Heat Output (W)	Power Consumption (VA) (*1)	Dimension (mm)			Air Flow (m^3/min)
					Width	Depth	Height	
30	DW-F800-4HF32R	0.5	17.9	19.9	—	—	—	—
31	DW-F800-2HS10S	0.5	18.0	18.9	—	—	—	—
32	DW-F800-2HS10B	0.5	28.5	30.0	—	—	—	—
33	DKC-F810I-1PL16	0.02	1.09	1.21	—	—	—	—
34	DKC-F810I-1PS16	0.02	0.99	1.10	—	—	—	—
35	DKC-F810I-1PS32	0.02	0.99	1.10	—	—	—	—
36	DKC-F810I-600JCMC	0.3	8.0	8.4	—	—	—	—
37	DKC-F810I-1R2JCMC	0.3	8.3	8.7	—	—	—	—
38	DKC-F810I-1R2J7MC	0.4	8.3	8.7	—	—	—	—
39	DKC-F810I-2R4JGM	0.3	9.0	9.4	—	—	—	—
40	DKC-F810I-2R4J8M	0.4	9.0	9.4	—	—	—	—
41	DKC-F810I-6R0H9M	0.85	12.9	13.5	—	—	—	—
42	DKC-F810I-6R0HLM	0.96	12.9	13.5	—	—	—	—
43	DKC-F810I-10RH9M	0.73	12.9	13.5	—	—	—	—
44	DKC-F810I-10RHLM	0.84	12.9	13.5	—	—	—	—
45	DKC-F810I-480MGM	0.23	6.7	7.0	—	—	—	—
46	DKC-F810I-960MGM	0.23	6.7	7.0	—	—	—	—
47	DKC-F810I-1R9MGM	0.23	6.7	7.0	—	—	—	—
48	DKC-F810I-3R8MGM	0.23	6.7	7.0	—	—	—	—
49	DKC-F810I-7R6MGM	0.23	7.9	8.3	—	—	—	—
50	DKC-F810I-15RMGM	0.23	7.9	8.3	—	—	—	—
51	DKC-F810I-3R2FN	1.4	25.0	26.0	—	—	—	—
52	DKC-F810I-7R0FP	1.4	25.0	26.0	—	—	—	—
53	DKC-F810I-14RFP	1.4	25.0	26.0	—	—	—	—

*1: Actual values at a typical I/O condition. (Random Read and Write, 50 IOPSs for HDD, 2500 IOPSs for SSD, Data Length: 8 kbytes. All fans rotate at normal.) These values may increase for future compatible drives.

4.8.1 Environmental Specifications

The environmental specifications are shown in the following table.

1. Environmental Conditions

Table 4-52 Usage Environment Conditions

Item	Condition			
	Operating (*1) (*5)			
Model Name	CBL/ CBSS2/CBSL2/ CBSS1/CBSL1/ CBXSS/CBXSL/ CHBB	DBS/DBL	DBF	DB60
Temperature range (ºC)	10 to 40	10 to 40	10 to 40	10 to 35
Relative humidity (%) (*4)	8 to 80	8 to 80	8 to 80	8 to 80
Maximum wet-bulb temperature (ºC)	29	29	29	29
Temperature gradient (ºC/hour)	10	10	10	10
Dust (mg/m3)	0.15 or less	0.15 or less	0.15 or less	0.15 or less
Gaseous contaminants (*7)	G1 classification levels			
Altitude (m) (Ambient temperature)	(*8) ~ 3,050 (10 ºC ~ 28 ºC) ~ 950 (10 ºC ~40 ºC)	(*8) ~3,050 (10 ºC ~28 ºC) ~ 950 (10 ºC ~40 ºC)	(*8) ~ 3,050 (10 ºC ~ 28 ºC) ~ 950 (10 ºC ~ 40 ºC)	(*9) ~3,050 (10 ºC ~ 28 ºC) ~ 950 (10 ºC ~ 35 ºC)
Noise Level (Recommended)	90 dB or less (*6)			

Item	Condition			
	Non-Operating (*2)			
Model Name	CBL/ CBSS2/CBSL2/ CBSS1/CBSL1/ CBXSS/CBXSL/ CHBB	DBS/DBL	DBF	DB60
Temperature range (ºC)	-10 to 50	-10 to 50	-10 to 50	-10 to 50
Relative humidity (%) (*4)	8 to 90	8 to 90	8 to 90	8 to 90
Maximum wet-bulb temperature (ºC)	29	29	29	29
Temperature gradient (ºC/hour)	10	10	10	10
Dust (mg/m^3)	—	—	—	—
Gaseous contaminants (*7)	G1 classification levels			
Altitude (m)	-60 to 12,000	-60 to 12,000	-60 to 12,000	-60 to 12,000

Item	Condition			
	Transportation, Storage (*3)			
Model Name	CBL/ CBSS2/CBSL2/ CBSS1/CBSL1/ CBXSS/CBXSL/ CHBB	DBS/DBL	DBF	DB60
Temperature range (ºC)	-30 to 60	-30 to 60	-30 to 60	-30 to 60
Relative humidity (%) (*4)	5 to 95	5 to 95	5 to 95	5 to 95
Maximum wet-bulb temperature (ºC)	29	29	29	29
Temperature gradient (ºC/hour)	10	10	10	10
Dust (mg/m^3)	—	—	—	—
Gaseous contaminants (*7)	—			
Altitude (m)	-60 to 12,000	-60 to 12,000	-60 to 12,000	-60 to 12,000

*1: Environmental conditions of operation should be completed before switch on a system.
*2: "Non-operation" includes conditions of both packing and unpacking.
*3: Transportation and storage should be conducted in the packing of initial shipping.
*4: No dew condensation.
*5: The system monitors the intake temperature and the internal temperature of the Controller and the Power Supply. It executes the following operations in accordance with the temperatures.
*6: Fire suppression systems and acoustic noise:
Some data center inert gas fire suppression systems when activated release gas from pressurized cylinders that moves through the pipes at very high velocity. The gas exits through multiple nozzles in the data center. The release through the nozzles could generate high-level acoustic noise. Similarly, pneumatic sirens could also generate high-level acoustic noise. These acoustic noises may cause vibrations to the hard disk drives in the storage systems resulting in I/O errors, performance degradation in and to some extent damage to the hard disk drives. Hard disk drives (HDD) noise level tolerance may vary among different models, designs, capacities and manufactures. The acoustic noise level of 90dB or less in the operating environment table represents the current operating environment guidelines in which Hitachi storage systems are designed and manufactured for reliable operation when placed 2 meters from the source of the noise.
Hitachi does not test storage systems and hard disk drives for compatibility with fire suppression systems and pneumatic sirens. Hitachi also does not provide recommendations or claim compatibility with any fire suppression systems and pneumatic sirens. Customer is responsible to follow their local or national regulations.
To prevent unnecessary I/O error or damages to the hard disk drives in the storage systems, Hitachi recommends the following options:
(1) Install noise-reducing baffles to mitigate the noise to the hard disk drives in the storage systems.

(2) Consult the fire suppression system manufacturers on noise reduction nozzles to reduce the acoustic noise to protect the hard disk drives in the storage systems.
(3) Locate the storage system as far as possible from noise sources such as emergency sirens.
(4) If it can be safely done without risk of personal injury, shut down the storage systems to avoid data loss and damages to the hard disk drives in the storage systems.

DAMAGE TO HARD DISK DRIVES FROM FIRE SUPPRESSION SYSTEMS OR PNEUMATIC SIRENS WILL VOID THE HARD DISK DRIVE WARRANTY.

*7: See ANSI/ISA-71.04-2013 Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants.

*8: Meets the highest allowable temperature conditions and complies with ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) 2011 Thermal Guidelines Class A3. The maximum value of the ambient temperature and the altitude is from 40 degrees C at an altitude of 950 meters (3000 feet) to 28 degrees C at an altitude of 3050 meters (10000 feet). The allowable ambient temperature is decreased by 1 degree C for every 175-meter increase in altitude above 950 meters.

*9: Meets the highest allowable temperature conditions and complies with ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) 2011 Thermal Guidelines Class A2. The maximum value of the ambient temperature and the altitude is from 35 degrees C at an altitude of 950 meters (3000 feet) to 28 degrees C at an altitude of 3050 meters (10000 feet). The allowable ambient temperature is decreased by 1 degree C for every 300-meter increase in altitude above 950 meters.

(1) VSP G130, G350, G370

- If the use environment temperature rises to 43 degrees C or higher, the external temperature warning (SIM-RC = af110x) is notified.
- If the use environment temperature rises to 58 degrees C or higher or the Controller Board internal temperature rises to 96 degrees C or higher, the external temperature alarm (SIM-RC = af120x) is notified.
  If both Controller Boards are alarmed, the system executes the power-off processing (planned power off) automatically.
- If the use environment temperature is 5 degrees C or lower, the external temperature warning (SIM-RC = af110x) is notified.
- If the temperature of the CPU exceeds its operation guarantee value, the MP temperature abnormality warning (SIM-RC = af100x) is notified.
- If the temperature of the Controller Board exceeds its operation guarantee value, the thermal monitor warning (SIM-RC = af130x) is notified.

(2) VSP G700, G900

- If the use environment temperature rises to 43 degrees C or higher, the external temperature warning (SIM-RC = af110x) is notified.
- If the use environment temperature rises to 50 degrees C or higher or the Controller Board internal temperature rises to 69 degrees C or higher, the external temperature alarm (SIM-RC = af120x) is notified.
  If both Controller Boards are alarmed, the system executes the power-off processing (planned power off) automatically.
- If the use environment temperature is 5 degrees C or lower, the external temperature warning (SIM-RC = af110x) is notified.
- If the temperature of the CPU exceeds its operation guarantee value, the MP temperature abnormality warning (SIM-RC = af100x) is notified.
- If the temperature of the Controller Board exceeds its operation guarantee value, the thermal monitor warning (SIM-RC = af130x) is notified.

(3) DBS/DBL

- If the internal temperature of the Power Supply rises to 55 degrees C or higher, the DB external temperature warning (SIM-RC = af7000) is notified.
- If the internal temperature of the Power Supply rises to 64.5 degrees C or higher, the DB external temperature alarm (SIM-RC = af7100) is notified.

(4) DBF

- If the internal temperature of the Power Supply rises to 62 degrees C or higher, the DB external temperature warning (SIM-RC = af7000) is notified.
- If the internal temperature of the Power Supply rises to 78 degrees C or higher, the DB external temperature alarm (SIM-RC = af7100) is notified.

(5) DB60

- If the internal temperature of the Power Supply rises to 60 degrees C or higher, the DB external temperature warning (SIM-RC = af7000) is notified.
- If the internal temperature of the Power Supply rises to 70 degrees C or higher, the DB external temperature alarm (SIM-RC = af7100) is notified.

(6) CHBB

- If the use environment temperature rises to 43 degrees C or higher, the CHBB temperature warning (SIM-RC = af46xx) is notified.

2. Mechanical Environmental Conditions

Table 4-53 Mechanical Environmental Conditions

Item	In operating	In non-operating
Guaranteed value to vibration (*1)	0.98 m/s^2 or less (0.1 G) [Frequencies 5 to 100 Hz] Compliant with NEBS (Network Equipment-Building System) Office Vibration standards (GR-63-CORE issue 4) (*2)	Same as left column
Guaranteed value to impact	No impact	78.4 m/s^2 (8.0 G), 15 ms
Guaranteed value to seismic wave	2.5 m/s^2 or less (0.25 G) (250 gal approx.) (*3)	3.9 m/s^2 (0.4 G) (400 gal) or less No critical damage for product function. (Normal operating with part replacement)
		9.8 m/s^2 (1.0 G) (1000 gal) or less Ensure own safety with fall prevention.

*1: Vibration that is constantly applied to the storage system due to construction works and so on

*2: Compliant with NEBS (Network Equipment-Building System) Office Vibration standards (GR-63-CORE issue 4)

*3: Compliant with IEC (International Electrotechnical Commission) standards, IEC 61584-5/Ed1 and IEC60297-Part5 (scenic test at the maximum acceleration rate of 9.8 m/s^2 (1.0 G) equivalent to NEBS (Network Equipment-Building System) Level 3)

4.9 Power Specifications

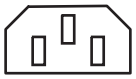
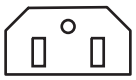
4.9.1 Storage System Current

DW850 input power specifications are shown below.

Model	Rated Power
CBL (VSP G700, G900)	1600 VA
CBSS/CBSL	800 VA
DBS	480 VA
DBL	380 VA
DB60	1200 VA
DBF	520 VA
CHBB	560 VA

DW850 input current are shown as each Power Supply.

Table 4-54 Input Power Specifications

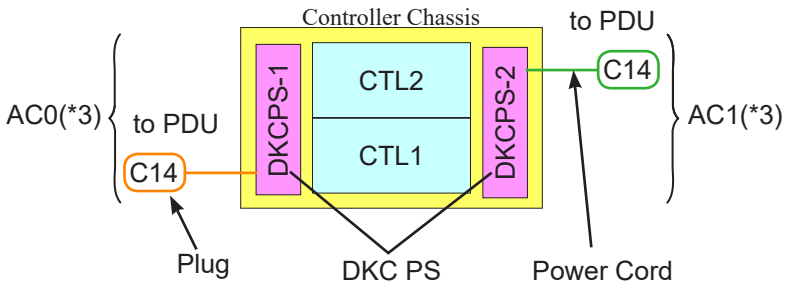
Item	Input Power	Input Current (*1)	Rated Current (*2)	Leakage Current	Inrush Current			Power Cord Plug Type
					1st (0-p)	2nd (0-p)	1st (0-p) Time (-25%)	
DKC (VSP G700, G900) PS	Single phase, AC200V to AC240V	8.0 A	4.0 A	1.75 mA	30 A	20 A	25 ms	
DKC (VSP G130, G350, G370) PS		4.0 A	2.0 A	1.75 mA	30 A	28 A	25 ms	
DBS/DBL PS		2.4 A	1.2 A	1.75 mA	30 A	25 A	25 ms	
DB60 PS		6.0 A	3.0 A	1.75 mA	45 A	35 A	25 ms	
DBF PS		2.6 A	1.3 A	1.75 mA	20 A	15 A	80 ms	
CHBB PS		4.0 A	2.0 A	1.75 mA	30 A	28 A	25 ms	
DKC (VSP G130, G350, G370) PS	Single phase, AC100V to AC120V	8.0 A	4.0 A	1.75 mA	30 A	28 A	25 ms	
DBS/DBL PS		4.8 A	2.4 A	1.75 mA	30 A	25 A	25 ms	
DB60 PS		—	—	—	—	—	—	
DBF PS		5.2 A	2.6 A	1.75 mA	20 A	15 A	80 ms	

*1: The maximum current in case AC input is not a redundant configuration.

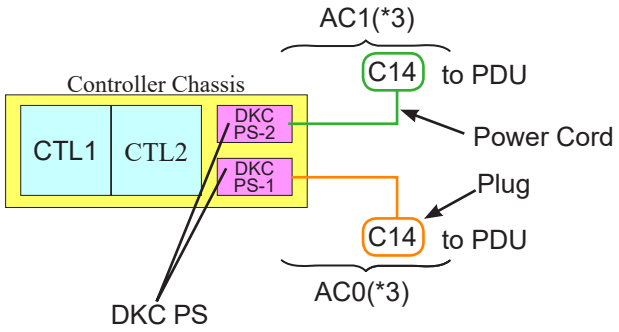
*2: The maximum current in case AC input is a redundant configuration.

Figure 4-32 Power Supply Locations

1. Controller Chassis (VSP G700, G900)

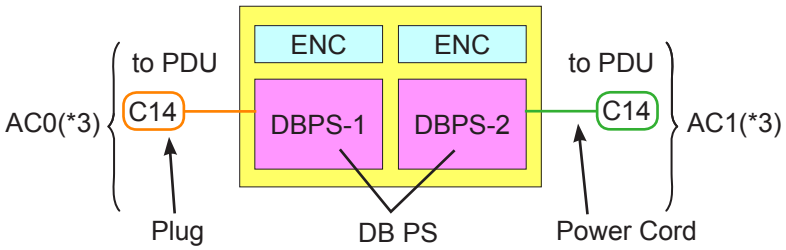


2. Controller Chassis (VSP G130, G350, G370 (AC model))

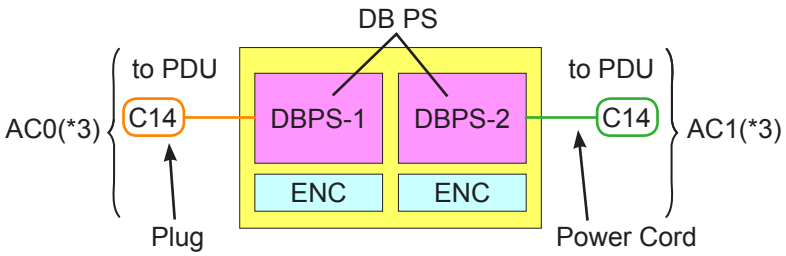


*3: It is necessary to separate AC0 and AC1 for AC redundant.

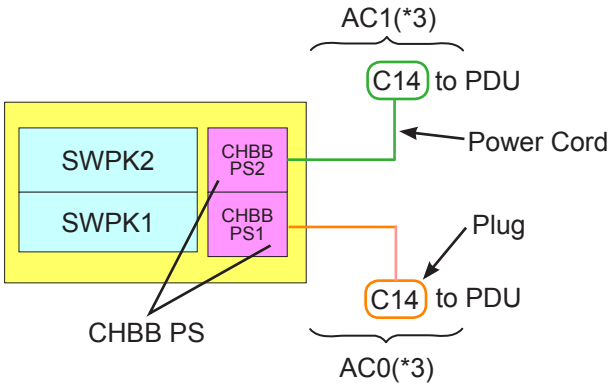
3. Drive Box (DBS/DBL/DBF (AC model))



4. Drive Box (DB60)



5. Channel Board Box (CHBB)



*3: It is necessary to separate AC0 and AC1 for AC redundant.

4.9.2 Input Voltage and Frequency

The following shows the electric power system specifications for feeding to the Storage System.

1. Input Voltage and Frequency
   The following shows the input voltage and frequency to be supported.

   • CBLH1/CBLH2/DB60

Input Voltage	Voltage Tolerance	Frequency	Wire Connection
200V to 240V	+10% or -11%	50Hz ± 2Hz 60Hz ± 2Hz	1 Phase 2 Wire + Ground

   • CBXSS/CBXSL/CBSS1/CBSL1/CBSS2/CBSL2/DBS/DBL/DBF/CHBB

Input Voltage (AC)	Voltage Tolerance	Frequency	Wire Connection
100V to 120V/ 200V to 240V	+10% or -11%	50Hz ± 2Hz 60Hz ± 2Hz	1 Phase 2 Wire + Ground

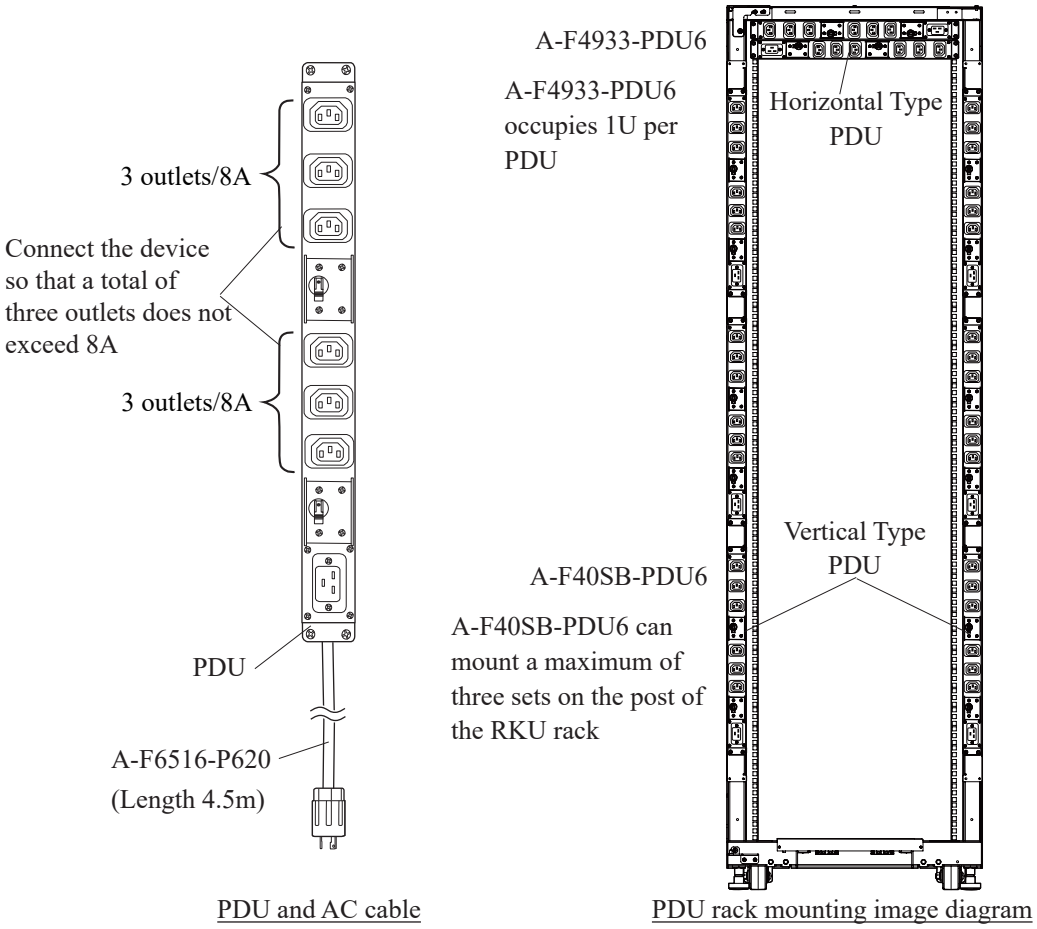
2. PDU specifications
   The two types of the PDU (Power Distribution Unit) are a vertical PDU mounted on a rack frame post and a horizontal PDU of 1U size. Order the required number of PDUs together with the PDU AC cables in accordance with the configuration of the device to be mounted on the rack frame.

Table 4-55 PDU Device Specifications

Item		Vertical Type	Horizontal Type
Model Name	PDU	A-F6516-PDU6	A-F4933-PDU6
	AC cable	A-F6516-P620	
AC Input		AC200V	
PDU Output		6 outlets: A circuit breaker is available for every three outlets (8 rated amperes)	
Remarks		Two-set configuration per model name for both PDU/ AC cable options	

For information about the Hitachi Universal V2 rack used with HDS VSP storage systems, refer to the Hitachi Universal V2 Rack Reference Guide, MK-97RK000-00.

Figure 4-33 PDU Specifications



PDU and AC cable　　PDU rack mounting image diagram

When using AC100V, request the customer to prepare the PDU.

The following shows the specifications of the PDU power codes and connectors.
The available cable lengths of the PDU power codes differ according to the installation location of the PDU.

PDU Location	Available Cable Length (*1)	Plug			Receptacle	
		Rating	Manufacturer	Parts No.	Manufacturer	Parts No.
Upper PDU	2.7 m	20A	AMERICAN DENKI CO.,LTD.	L6-20P	—	L6-20R (*2)
Mid PDU	3.2 m					
Lower PDU	3.7 m					

*1 : This is a length outside the rack chassis.
*2 : When the receptacle is L6-30R, select P630 as an option.