DF500

Disk Array Subsystem

Specifications

REV.6

Read this manual carefully and keep it.
• Before starting operation, read the safety instructions carefully and fully understand them. • After reading this manual, keep it at hand for your reference.

HITACHI

Preface

- This document describes specifications of Disk Array Subsystem and its interface.
- Hitachi, Ltd. is not liable for any troubles or accidents which caused by operation performed according to information contained in this document only.
- For the operation or works concerning the subsystem, refer to the User's Guide.
- The DF500 is a 'class 1 laser system' which emits no hazardous laser beam. When handling it, be sure to follow the related manual.
- Hitachi, Ltd. owns the copyrights of this document. No part of this document may be reused or reproduced without permission of Hitachi, Ltd.
- This document may be revised without prior notice.
- Although the subsystem with a RAID configuration provides data reliability enhanced by means of redundancy(‡1), a possibility remains that data is lost owing to an unexpected failure of a host computer or hardware/software of the subsystem itself. Therefore, users are requested to backup all data for restoration in case where the original data is lost.
- It is recommended to use the UPS (uninterruptible power supply) to provide against a sudden power failure, etc.

Guarantee

The term of guarantee for the DF500 is three years after the original date of purchase.

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‡1 : However, RAID 0 has no redundancy.

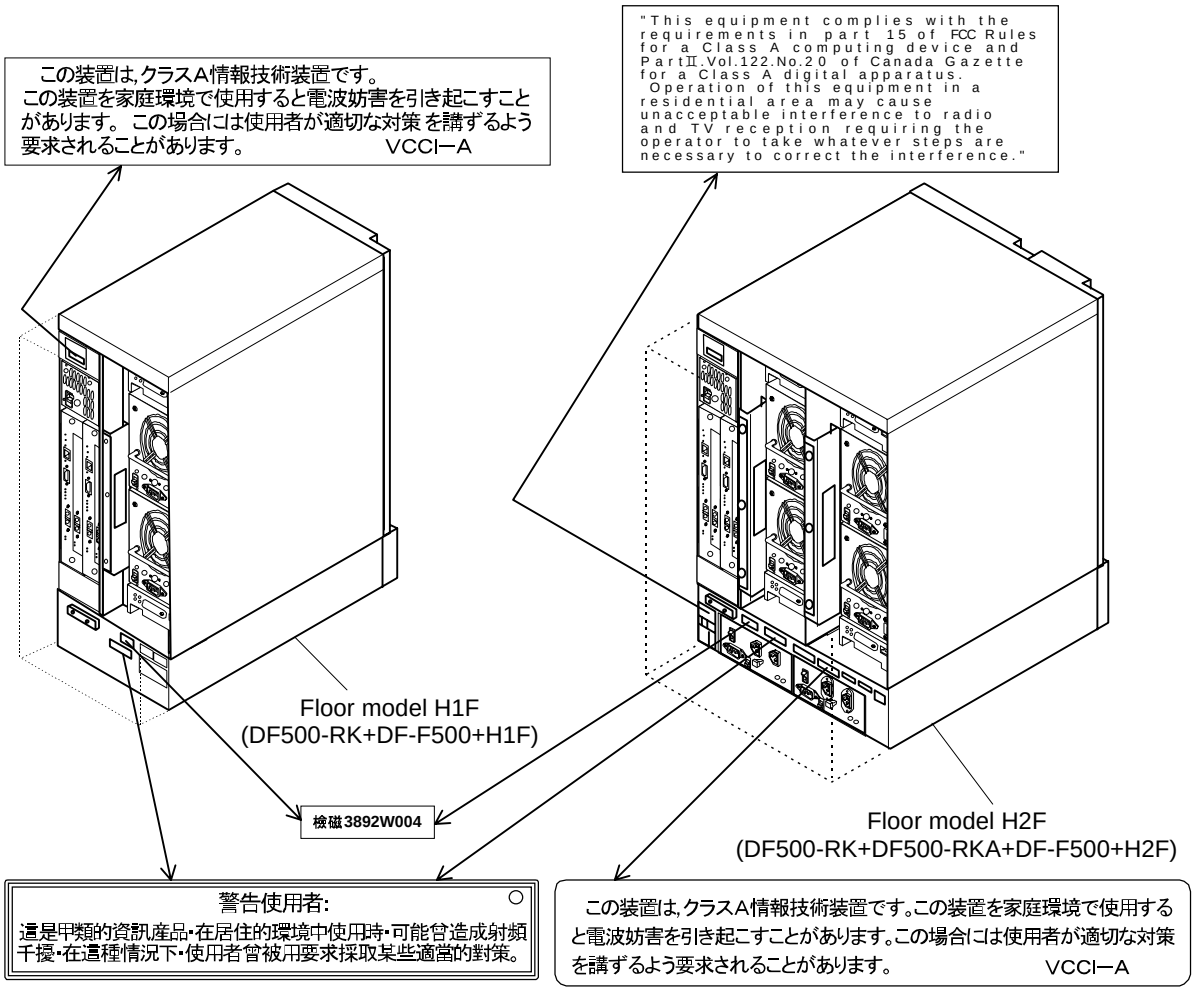
Note

EMI Regulation

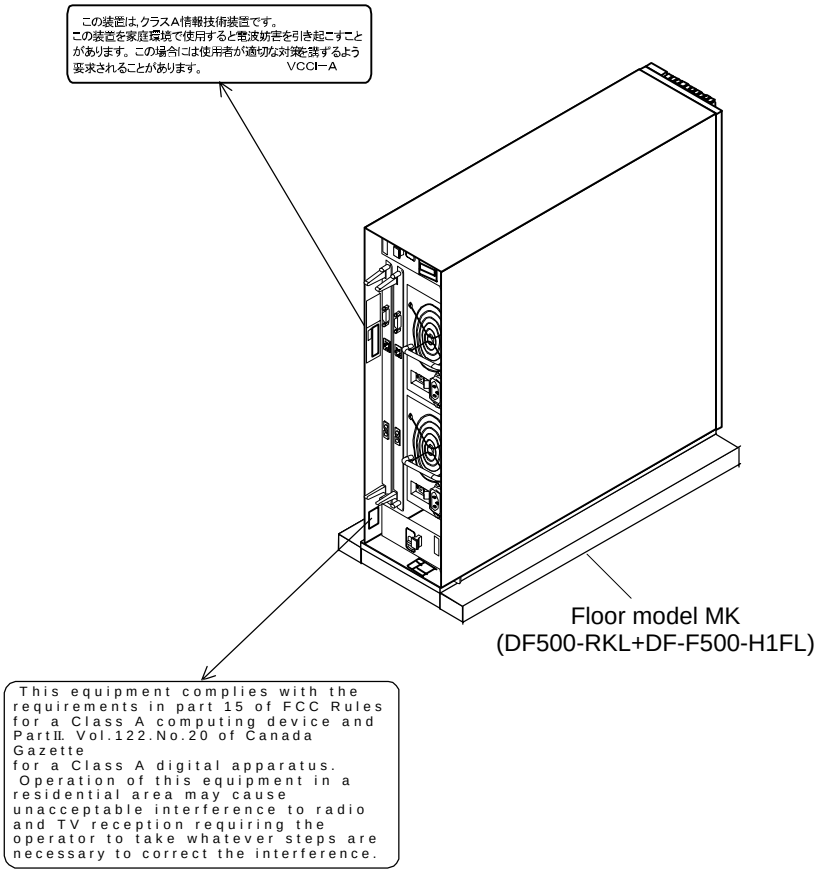
This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference in which case the user will be required to correct the interference at his own expense. Testing was done with shielded cables. Therefore, in order to comply with the FCC regulations, you must use shielded cables with you installation.

EMI Regulation Labels Affixed on the Subsystem.

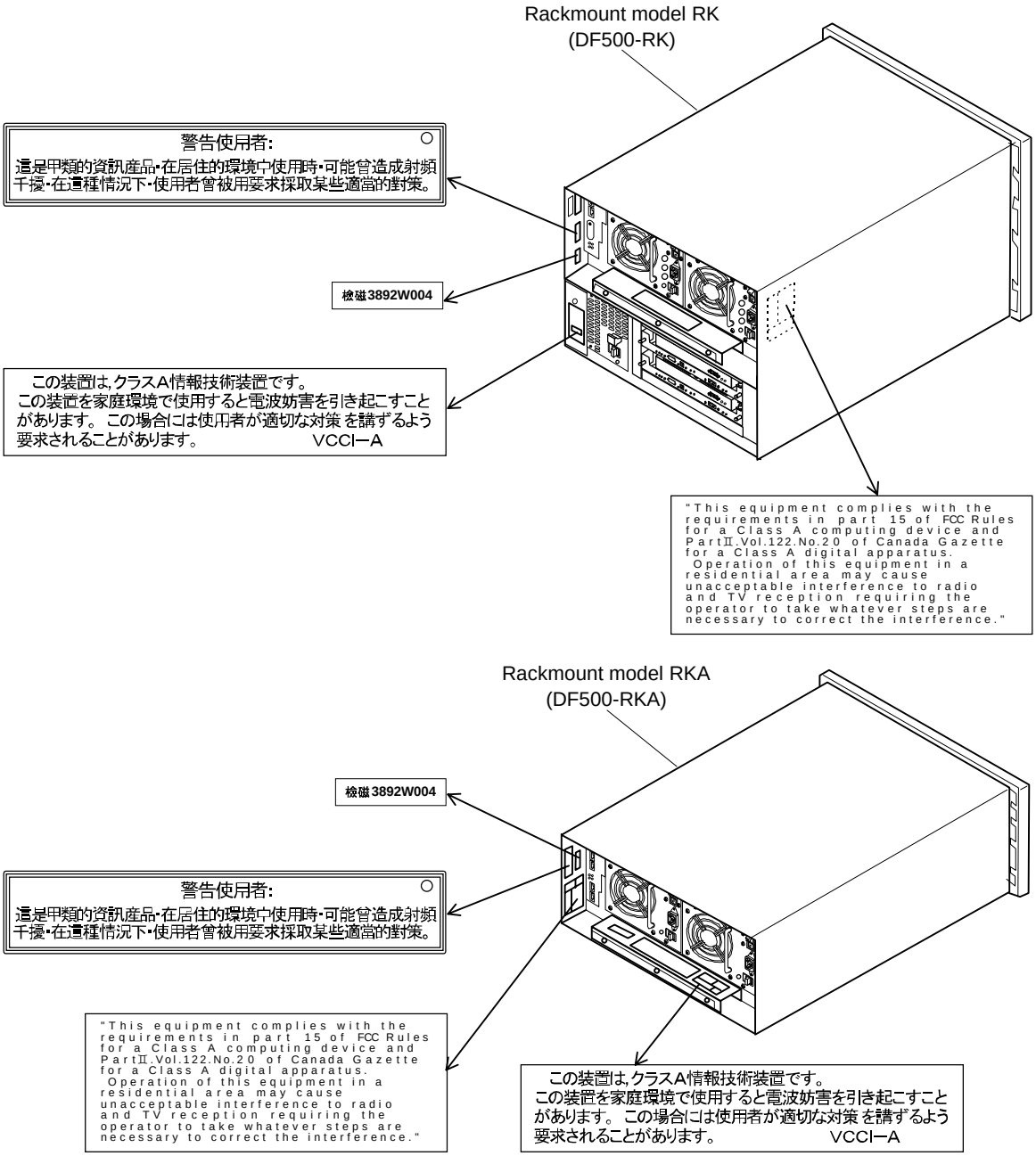
Floor model H1F/H2F



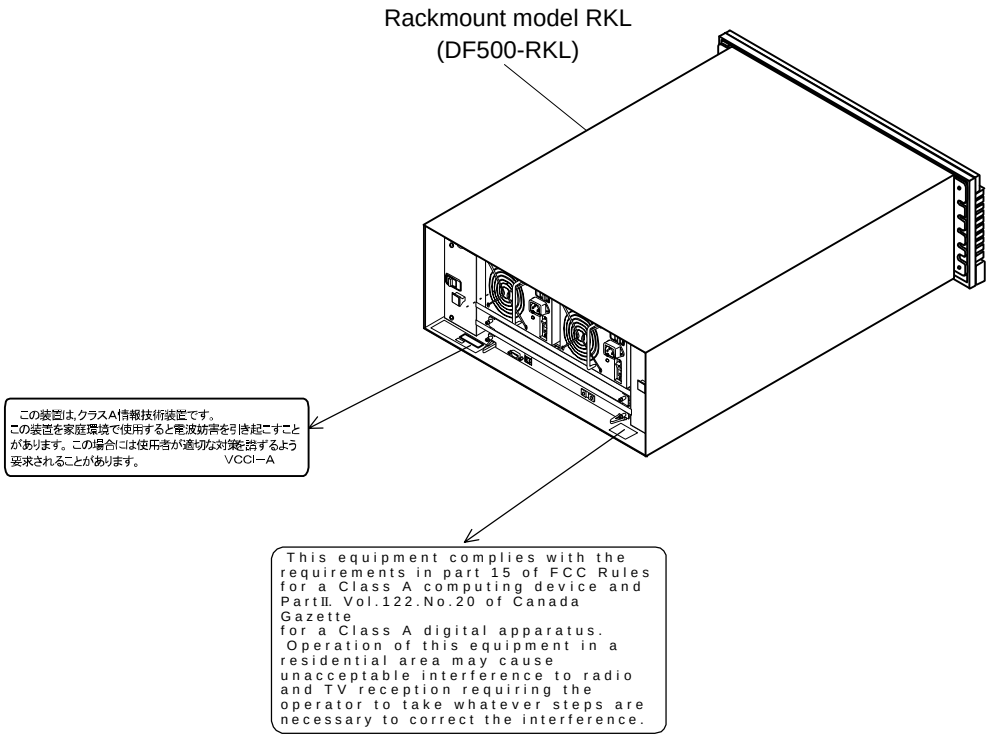
Floor model MK



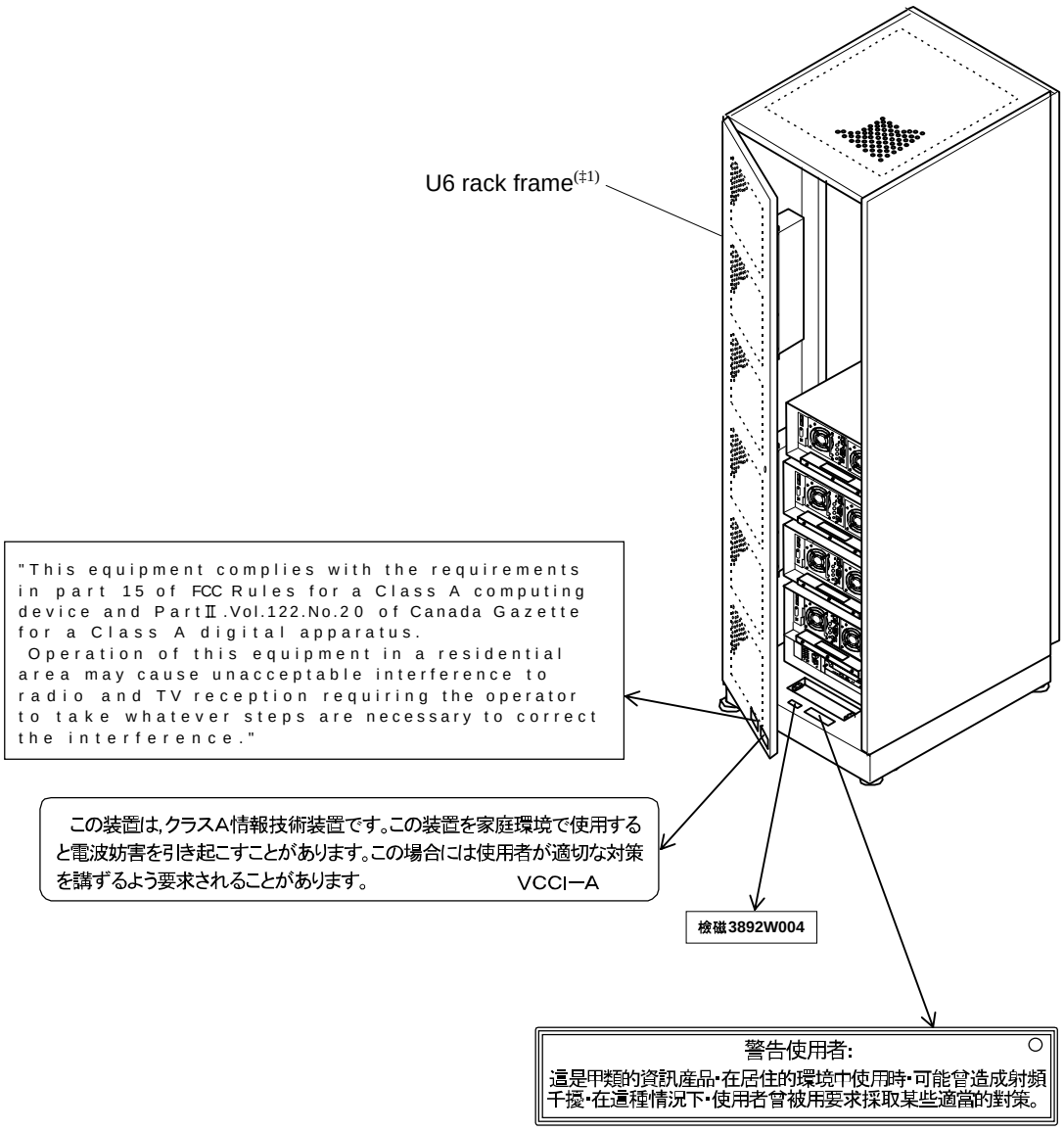
Rackmount model RK/RKA



Rackmount model RKL



Rackmount model with U6 rack frame



‡1 : The illustration shows an example of the disk array subsystem in which the DF500-RK/RKA is installed.

Model Name Conversion

The model name which is used in this document	The model name replace to DF500	Type
DF500-××××	A-6542-××××	Rackmount model (DF500-RK) Rackmount model (DF500-RKA) Rackmount model (DF500-RKL) Floor model H1F (DF500-RK + DF-F500-H1F) Floor model H2F (DF500-RK + DF500-RKA + DF-F500-H2F) Floor model MK (DF500-RKL + DF-F500-H1FL)
DF-F500-××××	A-F6542-××××	Optional component Accessory component

Throughout this document, product model name is written as “DF500”. When you want to use this document for the A-6542 series, please replace the model name “DF500” with “A-6542” .

Specification

All values of storage capacity shown in this document are calculated as
1 G bytes = 1,000,000,000 bytes.
This definition is different from that (1 k bytes = 1,024 bytes) shown on PCs you are using.

Contents

Chapter 1 Outline

DF500 subsystem has two models: floor model and rackmouunt model.
There are three types of the floor model : one is a combination of the RK and the floor standing kit (hereafter referred to as floor model H1F) and one is a combination of the RK, the RKA, and the floor standing kit (hereafter referred to as floor model H2F) and the other is a combination of the RKL and the floor standing kit (hereafter referred to as floor model MK).
The rackmount model is a subsystem which is used in the form of a combination of the DF500-RK (hereafter referred to as RK) and the DF500-RKA (hereafter referred to as RKA) and the DF500-RKL (hereafter referred to as RKL).
Features of the subsystem are explained below.

- The floor model H1F mounts up to ten Disk drives and controls them as RAID by a Controller.
- The floor model H2F mounts up to twenty Disk drives and controls them as RAID by a Controller.
- The floor model MK mounts up to twelve Disk drives and controls them as RAID by a Controller.
- The RK mounts up to ten Disk drives and controls them as RAID by a Controller.
- The RKA mounts up to ten Disk drives and can be used being connected with the RK.
- The RKL mounts up to twelve Disk drives and controls them as RAID by a Controller.
- The subsystem uses either Fibre Channel (1 G bps/2 G bps, Non-OFC) or SCSI (LVD, Wide-differential, or Single-ended) as an interface with a host computer.
- The RK, RKA and RKL are models to be mounted on the 19-type rack frame, however, they can also be used as floor models when combined with the optional kits.
- Up to nine RKAs can be connected with a single RK using special cables so that you can configure a system with a set of 100 Disk drives using the controller of the RK(‡1).
- A special rack frame (DF-F500-U6) is provided, which can mount a various combination of the RK(s) (6 EIA units high) and RKA(s) (3.5 EIA units high) up to a height of 38 EIA units.
- A special rack frame (DF-F500-U4) is provided, which can mount a various combination of the RK(s) and RKA(s) up to a height of 32 EIA units.
- Up to the nine and five(‡1) RKL(s) (4 EIA units high each) can be mounted on the rack frames for exclusive use, that is, DF-F500-U6 and DF-F500-U4, respectively.

‡1 : Up to the seven RKLs can be mounted through an addition of the UPDU (optional).

- The 2 G bps Fibre Channel interface board of DF500 (DF-F500-DF2G2) has downward compatibility with the 1 G bps Fibre Channel Interface board (DF-F500-DFMM5 or DF-F500-DFFM6).
- The 1 G bps Fibre Channel Interface board of DF500 (DF-F500-DFFM6) is an Interface board that supports the F-Port and has downward compatibility with the DF-F500-DFFM5.

1.1 Outline of Functions

Functions of DF500 are explained below.

(1) Scalability(RK/RKA/H1F/H2F)

- You can construct any system that meets wide variety of demands, from a system with ten Disk drives by using a single RK to a system with the maximum of 100 Disk drives expanded by connecting up to nine RKAs to the RK.
- By using special rack frame (U6), you can construct a system conforming to your demand such as one RK and nine RKAs, and four RKs and four RKAs.
- By using special rack frame (U4), you can construct a system conforming to your demand such as one RK and five RKAs, and three RKs and three RKAs.
- Spare disk(s), up to five of which can be set up, can be mounted in any location(s).(‡1) You can use the system effectively by mounting each Spare disk in a Disk drive slot left unused as a result of a system construction.
- From the host computer, the subsystem can be used not only as a single large scale Disk drive but also as 64 logical disks (LUs) at the maximum.
- The subsystem enables you to construct a system which can connect up to 126 Fibre Channel devices by using the Fibre Channel interface and connecting the HUB and switch (hereafter, referred to as “SW”.).

(2) Scalability(RKL/MK)

- Spare disk(s), up to five of which can be set up, can be mounted in any location(s).(‡1) You can use the system effectively by mounting each spare disk in a Disk drive slot left unused as a result of a system construction.
- From the host computer, the subsystem can be used not only as a single large scale Disk drive but also as 64 logical disks (LUs) at the maximum.
- The subsystem enables you to construct a system which can connect up to 126 Fibre Channel devices by using the Fibre Channel interface and connecting the FC-AL and FC-SW.

(3) Multi-RAID configuration

To put RAID to practical use, some techniques such as striping, mirroring, and parity disk are used.

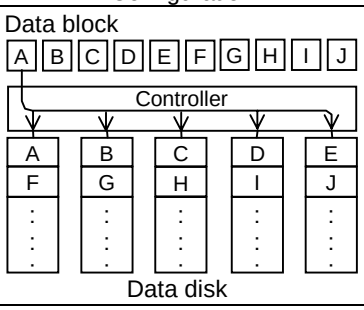
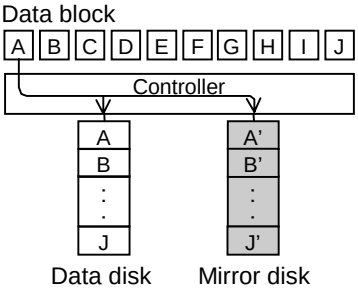
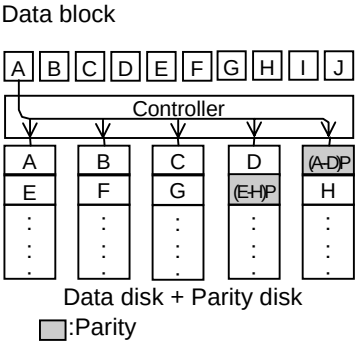
- Striping
  It means to store data spreading it on several Disk drives. Since a datum is written on several Disk drives, time required to access each Disk drive is shortened and thus, time required for reading or writing is shortened.
- Mirroring
  It means to copy all the contents of one Disk drive to one or more Disk drives at the same time in order to enhance reliability.

‡1 : Some Disk drive slots cannot b used for the installation of the Spare disk because of restriction of the system configuration. For the details of it, please inquire at us.

- Parity disk
  It is a data writing method used when configure RAID with three or more Disk drives. Parity of data in the corresponding positions of two or more Disk drives is generated and stored on another Disk drive.

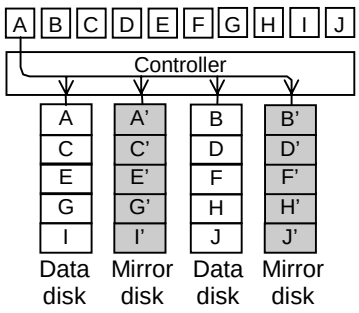
It is necessary to understand the nature of each RAID level to make the environment most suitable for the intended system.
Four RAID levels, that is, RAID 0 (2D to 16D), RAID 1, RAID 5 (2D+1P to 15D+1P), and RAID 0+1 (2D+2P to 8D+8P) can be set up. When the RKL and MK, that is, RAID 0 (2D to 12D), RAID 1, RAID 5 (2D+1P to 11D+1P), and RAID 0+1 (2D+2P to 6D+6P) can be set up(For the outline of each RAID level, see Table 1.1.1.).

Table 1.1.1 Outline of RAID Levels(*1)

Level	Configuration		Characteristics
RAID 0		Outline	RAID 0 stripes data across Disk drives (five Disk drives in the DF500) to attain higher throughput.
		Advantages	Because Disk drives having redundant data is not needed, Disk drives can be used efficiently.
		Disadvantage	Data is lost in any failure of the Disk drive.
RAID 1		Outline	RAID 1 provides data redundancy by copying all the contents of two Disk drive to another (mirroring). Read/write performance is a little better than the individual Disk drive.
		Advantages	Data is not lost even if a failure occurs in any Disk drive. Performance is not lowered even when a Disk drive fails.
		Disadvantage	RAID 1 is expensive because it requires twice the Disk capacity.
RAID 5		Outline	RAID 5 consists of three or more Disk drives. It uses one of them as a parity disk and writes divided data on the other Disk drives. Recovery from a failure of a data is possible by utilizing the parity data. Since the parity data is stored on all the Disk drives, a bottleneck of the parity disk does not occur.
		Advantages	When reading data, RAID 5 stripes data across Disk drives in the same way as that in RAID 0 to attain higher throughput.
		Disadvantage	When writing data, since parity data is required to be updated, performance of writing small random data is lowered although there is no problem regarding writing of continuous data. The performance is also lowered when a Disk drive fails.

*1 : Only the RAID levels supported by DF500 are explained.

*1 : RKL is six sets.

Level	Configuration		Characteristics
RAID 0+1		Outline	RAID 0+1 provides data redundancy like RAID 1 by copying all the contents of two Disk drive to another. Different from RAID 1, data striping is performed over two to eight (6)(*1) sets of two Disk drives.
		Advantages	Data is not lost even if any Disk drive fails. Besides, since RAID 0+1 stripes data, it can make the performance of dealing with small size random accesses higher comparing with RAID 1. Performance is not lowered even when a Disk drive fails.
		Disadvantage	RAID 0+1 is expensive because it requires twice the disk capacity.
	*1 : RKL is six sets.		

(4) High-speed data transfer

- The subsystem can read and write data at a high-speed by activating Disk drives in parallel.
- With the Fibre Channel connection, the subsystem can transfer data between the host computer and the subsystem at a maximum speed of 100 M bytes/s.
  Enough throughput can be got even when connecting devices and making a multiple access.
- With the 2 G bps Fibre Channel connection, the subsystem can transfer data at a maximum speed of 200 M bytes/s.
- With the Ultra_2-Wide SCSI (LVD) connection, the subsystem can transfer data at a maximum speed of 80 M bytes/s.
- By using a non volatile large-capacity cache memory (256 M bytes to 2 G bytes/CTL, RKL and MK is 256 M bytes/CTL), speed-up of command execution at the time of read/write hit was achieved.

(5) Large capacity

- The maximum capacity of 716 G bytes(‡1) can be realized with the system consisting of the only one RK.
- The maximum capacity of 859.2 G bytes(‡1) can be realized with the system consisting of the RKL or MK.
- The maximum capacity of 7.1 T bytes(‡1) can be realized with the system consisting of the one RK connected with the nine RKAs.
- The number of blocks for each RAID level can be calculated using the following formula.

  For conversion into the storage capacity, multiply the number of blocks by 512.

  ① RAID 0 (nD n=2 to 16)
  Number of blocks = m × n × Number of RAID group

  ② RAID 1
  Number of blocks = m × (number of mounted Disk drives/2)(‡2)

  ③ RAID 5 (nD+1P n=2 to 15)
  Number of blocks = m × n × Number of RAID group

  ④ RAID 0+1 (nD+nP n=2 to 8)
  Number of blocks = m × n × Number of RAID group

‡1 : The Disk drive use of 71.6 G bytes. The time of RAID 0 configuration.

‡2 : Number of less than one is to be omitted.

For the number of blocks (m) per Disk drive, see Table 1.1.2.

Table 1.1.2 Number of Blocks (m) and Capacity per Disk Drive

Disk drive model name		DF-F500-AAF8	DF-F500-AAF18 DF-F500-AAH18 DF-F500-ACF18 DF-F500-ACH18	DF-F500-AAF36 DF-F500-ACF36	DF-F500-AAF72 DF-F500-ACF72
Capacity		8.7 G bytes	17.8 G bytes	35.6 G bytes	71.6 G bytes
Capacity (user area size)per Disk drive	Number of blocks (m)	17,017,088	34,756,224	69,689,344	139,912,192
	Capacity (G bytes)	8.712	17.795	35.681	71.635

Relations between the configurations of Disk drives and the storage capacities are shown in Table 1.1.3 and Table 1.1.4. Details of the storage capacities depending on the RAID level and subsystem configuration are shown in Appendix A.

Table 1.1.3 Configuration Example with Disk Drive Capacity (RK/RKA)

Type / Configuration	RAID level(*1)		1 RK		1 RK + 1 RKA		1 RK + 9 RKA (mounted on U6 rack model)	
			Capacity (G bytes)	Number of the Disk drive unit	Capacity (G bytes)	Number of the Disk drive unit	Capacity (G bytes)	Number of the Disk drive unit
Minimum configuration (with 8.7-G byte Disk drive)	0	2D	17.4	2	17.4	2	17.4	2
		5D	43.6	5	43.6	5	43.6	5
		10D	87.2	10	87.2	10	87.2	10
		16D	—	—	139.4	16	139.4	16
	1		8.7	2	8.7	2	8.7	2
	5	2D+1P	17.4	3	17.4	3	17.4	3
		4D+1P	34.8	5	34.8	5	34.8	5
		9D+1P	78.4	10	78.4	10	78.4	10
		15D+1P	—	—	130.6	16	130.6	16
	0+1	2D+2P	17.4	4	17.4	4	17.4	4
		5D+5P	43.6	10	43.6	10	43.6	10
		8D+8P	—	—	70.0	16	70.0	16
Maximum configuration (with 71.6-G byte Disk drive)	0	2D	716	10	1,433	20	7,164	100
		5D	716	10	1,433	20	7,164	100
		10D	716	10	1,433	20	7,164	100
		16D	—	—	1,146	16(*2)	6,877	96(*2)
	1		358	10	716	20	3,582	100
	5	2D+1P	430	9(*2)	860	18(*2)	4,728	99(*1)
		4D+1P	573	10	1,146	20	5,731	100
		9D+1P	645	10	1,289	20	6,447	100
		15D+1P	—	—	1,075	16(*2)	6,447	96(*2)
	0+1	2D+2P	287	8(*2)	716	20	3,582	100
		5D+5P	358	10	716	20	3,582	100
		8D+8P	—	—	573	16(*2)	3,438	96(*2)

*1 : D : Data disk
P : Parity disk

*2 : This is not the maximum configuration of the subsystem.
The maximum capacity can be increased when the subsystem uses other RAID level.

Table 1.1.4 Configuration Example with Disk Drive Capacity (RKL)

Type / Configuration	RAID level(*1)		1 RKL	
			Capacity (G bytes)	Number of the Disk drive unit
Minimum configuration (with 17.8-G byte Disk drive)	0	2D	35.5	2
		5D	88.9	5
		10D	177.9	10
		12D	213.5	12
	1		17.7	2
	5	2D+1P	35.5	3
		4D+1P	71.1	5
		9D+1P	160.1	10
		11D+1P	195.7	12
	0+1	2D+2P	35.5	4
		5D+5P	88.9	10
		6D+6P	106.7	12
Maximum configuration (with 71.6-G byte Disk drive)	0	2D	859	12
		6D	859	12
		12D	859	12
	1		429	12
	5	2D+1P	573	12
		4D+1P	573	10(*2)
		9D+1P	644	10(*2)
		11D+1P	787	12
	0+1	2D+2P	429	12
		5D+5P	358	10(*2)
		6D+6P	429	12

*1 : D : Data disk
P : Parity disk
*2 : This is not the maximum configuration of the subsystem. The maximum capacity can be increased when the subsystem uses other RAID level.

(6) High data availability
- With the RAID configuration(‡1), even when a Disk drive failed, the subsystem can continuously read or write data without shutting down the subsystem by using the parity and mirror disks.

(7) High data reliability
- The Controller of the DF500 adds the original 8-byte data assurance codes to data from a host computer by automatically generating them, writes them in the Disk drive together with the data, and checks them when reading the data, and thus the data reliability is improved.
- On the data bus in the controller, the automatic generation of the data assurance codes and the check are executed to enhance data reliability in data distribution/concentration control which is peculiar to the disk array.

‡1 : However, RAID 0 has no redundancy.

(8) Diagnostic and maintenance functions

- Diagnosis and maintenance of the subsystem can be done on a screen of a PC connected to the subsystem via a LAN.
- Status of the subsystem can be checked and a faulty part can be identified by the Disk Array management program.
- Diagnosis of the subsystem can be done from a distant place by using the remote maintenance function (SNMP).

1.2 System Configuration

System outlines of DF500 rackmount and floor models are shown in Figures 1.2.1 and 1.2.2 respectively.

(1) Rackmount model RK/RKA/RKL

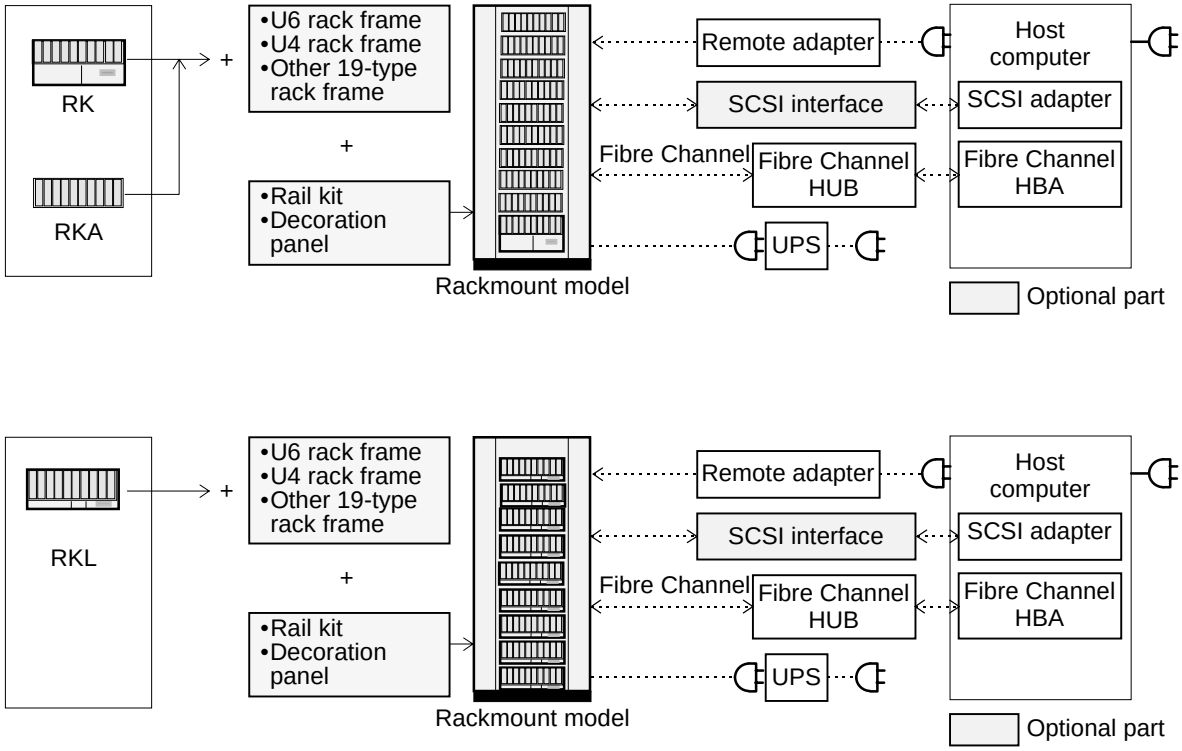


Figure 1.2.1 System Outline (Rackmount Model)

(2) Floor model H1F/H2F/MK

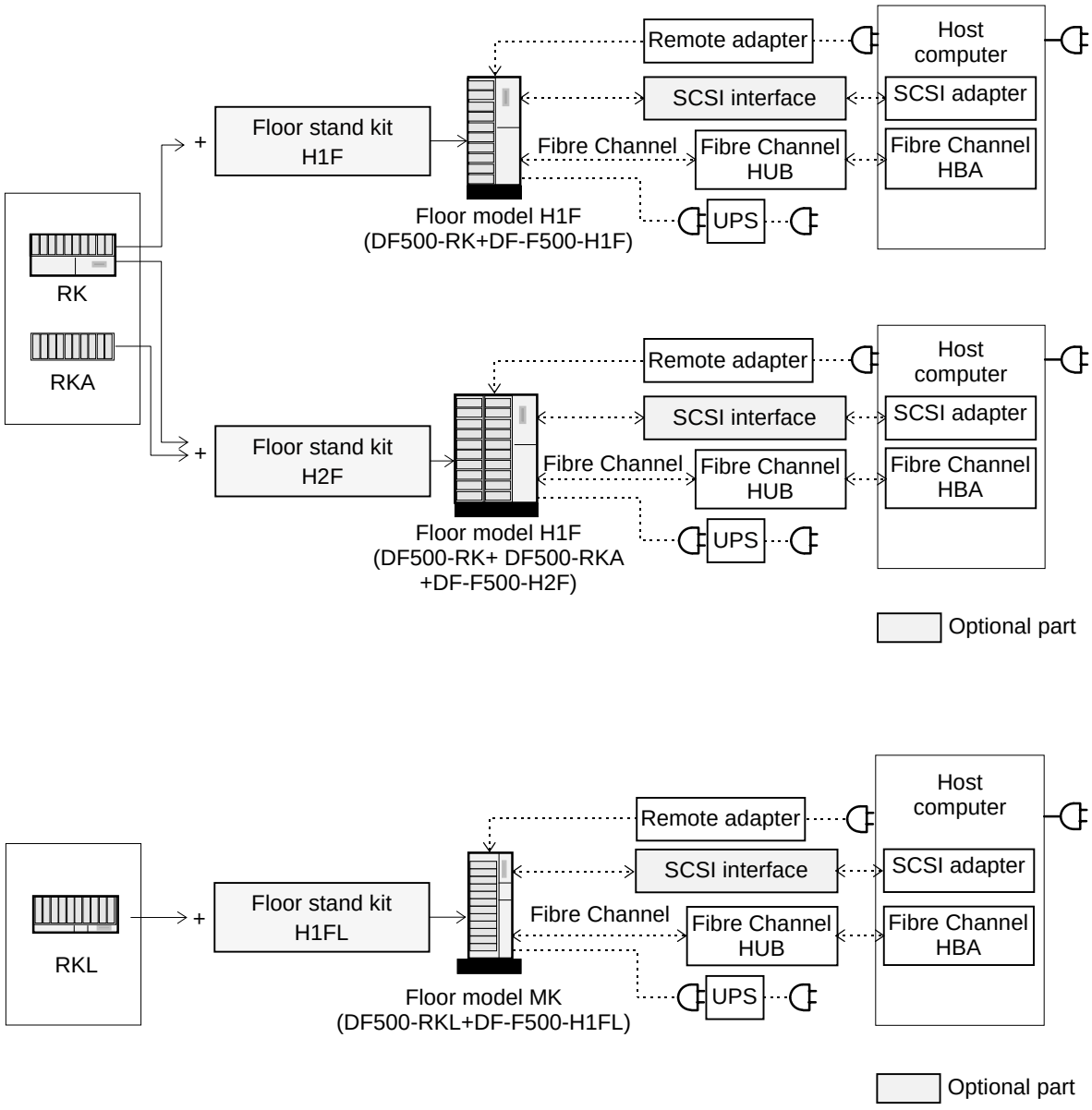


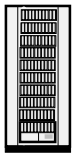
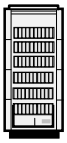
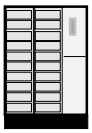
Figure 1.2.2 System Outline (Floor Model)

Chapter 2 Basic Specifications

Basic specifications of DF500 disk array subsystem and its optional devices are shown in this chapter.

2.1 Basic Specifications of the Subsystem

(1) RK/RKA/ H1F/H2F

Item \ Model		Rackmount model				Floor model	
		RK	RKA	With U6 rack frame	With U4 rack frame	H1F	H2F
Confi-guration	Configuration	1 RK	1 RKA	1 RK + RKA (9units) (Maximum configuration) + U6 rack frame (Optional)	1 RK + RKA (5units) (Maximum configuration) + U4 rack frame (Optional)	1 RK + H1F Floor stand kit (Optional)	1 RK + 1 RKA + H2F Floor stand kit (Optional)
	Subsystem appearance						
Disk drive used	Disk drive size (W×D×H) (mm)	Thin type : 101.6×146.1×25.4 Thick type : 101.6×146.1×41.5					
	Data capacity (G byte)	8.7/17.8/35.7/71.6					
	Rotational speed (min^{-1})	10,000/15,000					
	Maximum mountable quantity (unit)	10	10	100	60	10	20
Host interface	Interface type	•2 G bps Fibre Channel Optical (Non-OFC) •Fibre Channel Optical (Non-OFC) •Ultra_2-Wide low voltage differential (LVD) SCSI •Ultra-Wide single-ended/ differential SCSI	—	•2 G bps Fibre Channel Optical (Non-OFC) •Fibre Channel Optical (Non-OFC) •Ultra_2-Wide low voltage differential (LVD) SCSI •Ultra-Wide single-ended/differential SCSI			
	Data transfer speed (i.e. maximum speed for transfer to host)	•200 M bytes/s (Fibre Channel) •100 M bytes/s (Fibre Channel) •80 M bytes/s (Ultra_2-Wide SCSI) •40 M bytes/s (Ultra-Wide SCSI)	—	•200 M bytes/s (Fibre Channel) •100 M bytes/s (Fibre Channel) • 80 M bytes/s (Ultra_2-Wide SCSI) • 40 M bytes/s (Ultra-Wide SCSI)			

Item \ Model			Rackmount model				Floor model	
			RK	RKA	With U6 rack frame	With U4 rack frame	H1F	H2F
Host interface	Number of ports	Single controller	Fibre Channel : 1 to 2 SCSI : 1	—	Fibre Channel :1 to 2 SCSI : 1			
		Dual controller	Fibre Channel : 2 to 4 SCSI : 2	—	Fibre Channel : 2 to 4 SCSI : 2			
	Transferred block size (bytes)		512					
RAID specifications (*1, *2)	RAID level(*3)		0/1/5/0+1					
	RAID configuration (unit of addition)	RAID 0	2D to 10D	—	2D to 16D		2D to 10D	2D to 16D
		RAID 1	1D+1P	—	1D+1P			
		RAID 5	2D+1P to 9D+1P	—	2D+1P to 15D+1P		2D+1P to 9D+1P	2D+1P to 15D+1P
		RAID 0+1	2D+2P to 5D+5P	—	2D+2P to 8D+8P		2D+2P to 5D+5P	2D+2P to 8D+8P
Internal logic specifications	Control CPU		MPC750e (300 MHz)	—	MPC750e (300 MHz)			
	Control OS		VxWorks	—	VxWorks			
	Control memory		•Flash memory : 2 M bytes •L2 Cache memory : 512 k bytes •SRAM : 64 M bytes	—	•Flash memory : 2 M bytes •L2 Cache memory : 512 k bytes •SRAM : 64 M bytes			
	Data bus performance		Cache access : 610 M bytes/s	—	Cache access : 610 M bytes/s			
	Data assurance method		•Data bus : Through-parity •Cache memory : ECC (1 bit for correction, 2 bits for detection) •Disk drive : Data assurance code	—	•Data bus : Through-parity •Cache memory : ECC (1 bit for correction, 2 bits for detection) •Disk drive : Data assurance code			
Physical Specifications	Start-up time (min)		Standard : 3(*8)	—	Standard : 3(*8)			
	Chassis size (W×D×H) (mm)		482.6×656×262	482.6×656×152	610×813×1,880	596×996×1,606	262×737×600	417×737×600
	Mass(*4) (kg)		65 approx.	40 approx.	620 approx.	400 approx.	85 approx.	140 approx.
	Acoustic noise(*5)(dB)		60 or less		65 or less		60 or less	65 or less
	Required height (EIA unit)(*6) (*7)		6	3.5	Max. 38	Max. 32	—	

*1 : D : Data disk
P : Parity disk

*2 : For the details of the available minimum or maximum storage capacity, refer to Appendix A, "List of Storage Capacities Corresponding to RAID Levels and Configurations (7000)".

*3 : Although the subsystem with a configuration of RAID 5, RAID 1, or RAID 0+1 provides data reliability enhanced by means of redundancy, a possibility remains that user data is lost owing to an unexpected failure of a host computer or hardware/software of the subsystem itself. Therefore, users are requested to back up all data for restoration in case where the original data is lost.

*4 : Value of maximum configuration (in the case where all the mountable Disk drives and Controller are mounted).

*5 : A noise emitted at the time of start is not included.

*6 : Can be mounted on the Hitachi special rack frame (U6). For the mounting, special rails for the rack frame and decoration panel(s) are required separately depending on the number of the mounted subsystem(s).

*7 : Can be mounted on the Hitachi special rack frame (U4). For the mounting, special rails for the rack frame are required separately depending on the number of the mounted subsystem(s).

*8 : The start-up time may be longer than three minutes depending on the configuration.

Item			Model: Rackmount model RK	Rackmount model RKA	Rackmount model With U6 rack frame	Rackmount model With U4 rack frame	Floor model H1F	Floor model H2F
Input power specifications	Input voltage (V)		AC 100/200 (89 to 127/178 to 254)		AC 200 (178 to 254)		AC 100/200 (89 to 127/178 to 254)	
	Frequency (Hz)		50/60 ± 1					
	Number of phases, cabling		Single-phase with protective grounding					
	Steady-state current(*1) (A)		3.5×2/1.8×2 (When the one power supply is connected : (5.8/2.9))	2.8×2/1.4×2 (When the one power supply is connected : (4.4/2.2))	-/16.0 (One PDB)	-/16.0 (One PDU)	3.5×2/1.8×2 (When the one power supply is connected : (5.8/2.9))	6.7×2/3.4×2
	Breaking current (A)		20.0	15.0	20.0			
	Required power	Steady state (VA)	700 (When the one power supply is connected : (580))	550 (When the one power supply is connected : (450))	3,200 (One PDB)	3,200 (One PDU)	700 (When the one power supply is connected : (580))	1,250
		Starting state(*2) (VA)	800 (When the one power supply is connected : (700))	650 (When the one power supply is connected : (550))	3,200 (One PDB)	3,200 (One PDU)	800 (When the one power supply is connected : (700))	1,450
Cache specifications	Capacity (M bytes/CTL)		256 to 2,048	—	256 to 2,048			
	Control method		Read LRU /Write after	—	Read LRU/Write after			
	Battery backup		Provided	—	Provided			
	Backup duration(*3) (h)		48 (When cache of 4,096 M bytes/ subsystem is installed)	—	48 (When cache of 4,096 M bytes/subsystem is installed)			

*1 : For the both systems, plan the facilities for supplying power to the subsystem according to the specifications for the single power supply because when a failure occurs, only the one power supply operates.

*2 : Power requirement in the case of the maximum configuration is shown. When planning facilities such as the uninterrupted power supply (UPS), specify the power factor as 100% for calculation. Value at 100 V/200 V is shown.
(Example : 300 W=300 VA)
The actual required power may exceed the value shown in the table when the tolerance is included.

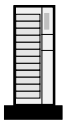
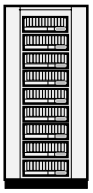
*3 :
- Non-volatility of data in the cache memory is ensured against power trouble such as a sudden power failure. It transfers data in the Cache memory to Disk drives by turning off the power normally, and prevents the battery charge from being wasted.
- When the subsystem enters the Cache Backup mode, a warning (lighting of the orange LED) informing of a voltage drop of the battery may be issued when the subsystem is started. It shows that the remaining capacity of the battery is not sufficient, and in this state, the subsystem operates disabling the Write Cache function automatically.
  When the battery is charged, the warning indication disappears, and the subsystem continues the operation enabling the Write Cache function.
  The warning indication disappears within 24 hours at the latest. Even when the warning is being indicated, normal functional operation is assured although the operation is performed in the Write-Through mode and the R/W performance is lowered because the Write Cache function is disabled.
- If the subsystem is not energized for more than a month, the over discharging of the battery occurs and it may cause the battery an unrecoverable damage. In this case, the battery must be energized more than 24 hours at least once a month, or store the subsystem with the switch of the battery turned off. Even when the switch is turned off, the battery discharges naturally. Even in this case, however, charge the battery once per three months for longer than 24 hours because spontaneous discharge is done.

Item		Model: Rackmount model RK	Rackmount model RKA	Rackmount model With U6 rack frame	Rackmount model With U4 rack frame	Floor model H1F	Floor model H2F
Maintenance specifications/ anti-fault specifications	Parts to which hot replacement is applicable (*1)	•Controller •Disk drive •AC/DC power supply (RK) •Interface board •Cache memory •Fan unit •Battery unit(*2) •ENC (RK) board	•Disk drive •AC/DC power supply (RKA) •ENC (RKA) board	•Controller •Disk drive •AC/DC power supply (RK) •AC/DC power supply (RKA) •Interface board •Cache memory •Fan unit •Battery unit(*2) •ENC (RK) board •ENC (RKA) board •PDB	•Controller •Disk drive •AC/DC power supply (RK) •AC/DC power supply (RKA) •Interface board •Cache memory •Fan unit •Battery unit(*2) •ENC (RK) board •ENC (RKA) board •PDU	•Controller •Disk drive •AC/DC power supply (RK) •Interface board •Cache memory •Fan unit •Battery unit(*2) •ENC (RK) board	•Controller •Disk drive •AC/DC power supply (RK) •AC/DC power supply (RKA) •Interface board •Cache memory •Fan unit •Battery unit(*2) •ENC (RK) board •ENC (RKA) board •PDB
	Microprogram installation method	Flash memory/ Disk drive (resident)	—	Flash memory/Disk drive (resident)			
	SVP (built-in exclusive tool) function	•Failure information logging/Power control •Controlling microprogram patching •Disk drive controlling microprogram down loading • Configuration information change •Disk drive recovery initiating process (This process is automatically executed when Disk drive is replaced.)	—	•Failure information logging/Power control •Controlling microprogram patching •Disk drive controlling microprogram down loading •Configuration information change •Disk drive recovery initiating process (This process is automatically executed when Disk drive is replaced.)			
	Spare disk	Up to five of mounted Disk drives can be set to Spare disks					
	Floppy Disk drive	•Failure and statistics information logging •Controlling program patching/Disk drive down load	—	•Failure and statistics information logging •Controlling program patching/Disk drive down loading			
	Display function	•Status LEDs (POWER, READY, WARNING, and ALARM) •LED of maintenance part					
Insulation performance	Insulation withstand voltage	AC 1,500 V (10 mA, 1 min)		AC 1,500 V (100 mA, 1 min)	AC 1,500 V (10 mA, 1 min)		AC 1,500 V (100 mA, 1 min)
	Insulation resistance	DC 500 V, 10 MΩ or more					

*1 : Only the trained service personnel can perform a hot replacement.

*2 : The battery in the Battery unit is a part to be recycled.

(2) RKL/ MK

Item			Model: Floor model	Rackmount model		
			MK	RKL	With U6 rack frame	With U4 rack frame
Confi-guration	Configuration		1 RKL + H1FL Floor stand kit (Optional)	1 RKL	RKL (1 to 9 units) + U6 rack frame (Optional)	RKL (1 to 5 units)(*1) + U4 rack frame (Optional)
	Subsystem appearance					
Disk drive used	Disk drive size (W×D×H) (mm)		Thin type : 101.6×146.1×25.4			
	Data capacity (G byte)		17.8/35.7/71.6			
	Rotational speed (min^{-1})		10,000/15,000			
	Maximum mountable quantity (unit)		12		108	60
Host interface	Interface type		•Fibre Channel Optical (Non-OFC) •Ultra_2-Wide low voltage differential (LVD) SCSI •Ultra-Wide single-ended/differential SCSI			
	Data transfer speed (i.e. maximum speed for transfer to host)		•100 M bytes/s (Fibre Channel) • 80 M bytes/s (Ultra_2-Wide SCSI) • 40 M bytes/s (Ultra-Wide SCSI)			
Host interface	Number of ports	Single controller	Fibre Channel : 1 SCSI : 1			
		Dual controller	Fibre Channel : 2 SCSI : 2			
	Transferred block size (bytes)		512			
RAID specifi-cations (*2, *3)	RAID level(*4)		0/1/5/0+1			
	RAID con-figuration (unit of addition)	RAID 0	2D to 12D			
		RAID 1	1D+1P			
		RAID 5	2D+1P to 11D+1P			
		RAID 0+1	2D+2P to 6D+6P			

*1 : Up to the seven RKLs can be mounted through an addition of the UPDU (optional).

*2 : D : Data disk
P : Parity disk

*3 : For the data capacity of each configuration unit, refer to “Appendix A List of Storage Capacities Corresponding to RAID Levels and Configurations” on page 7000.

*4 : Although the subsystem with a configuration of RAID 5, RAID 1, or RAID 0+1 provides data reliability enhanced by means of redundancy, a possibility remains that user data is lost owing to an unexpected failure of a host computer or hardware/software of the subsystem itself. Therefore, users are requested to back up all data for restoration in case where the original data is lost.

Item		Model	Floor model	Rackmount model		
			MK	RKL	With U6 rack frame	With U4 rack frame
Internal logic specifications	Control CPU		MPC750e (300 MHz)			
	Control OS		VxWorks			
	Control memory		•Flash memory : 2 M bytes •L2 Cache memory : 512 k bytes •SRAM : 64 M bytes			
	Data bus performance		Cache access : 610 M bytes/s			
	Data assurance method		•Data bus : Through-parity •Cache memory : ECC (1 bit for correction, 2 bits for detection) •Disk drive : Data assurance code			
Physical Specifications	Start-up time (min)		Standard : 3(*8)			
	Chassis size (W×D×H) (mm)		260×657×540	482.6×656×174	610×813×1,880	596×996×1,606
	Mass(*1) (kg)		70 approx.	60 approx.	670 approx.	400 approx.(*2)
	Acoustic noise(*3) (dB)		60 or less		65 or less	
	Required height(*4) (*5) (EIA unit)		—	4	Max. 36	Max. 20
Input power specifications	Input voltage (V)		AC 100/200 (89 to 127/178 to 254)		AC 200 (178 to 254)	
	Frequency (Hz)		50/60 ± 1			
	Number of phases, cabling		Single-phase with protective grounding			
	Steady-state current(*6) (A)		3.2×2/1.6×2 (When the one power supply is connected : (5.8/2.9))		-/16.0 (One PDB)	-/16.0 (One PDU)
	Breaking current (A)		15.0		20.0	
	Required power	Steady state (VA)	640 (When the one power supply is connected : (500))		3,200 (One PDB)	3,200 (One PDU)
		Starting state(*7) (VA)	720 (When the one power supply is connected : (580))		3,200 (One PDB)	3,200 (One PDU)

*1 : Value of maximum configuration (in the case where all the mountable Disk drives and Controller are mounted).

*2 : Approximately 510 kg when the seven RKLs are installed.

*3 : A noise emitted at the time of start is not included.

*4 : Can be mounted on the Hitachi special rack frame (U6). For the mounting, special rails for the rack frame and decoration panel(s) are required separately depending on the number of the mounted subsystem(s).

*5 : Can be mounted on the Hitachi special rack frame (U4). For the mounting, special rails for the rack frame are required separately depending on the number of the mounted subsystem(s).

*6 : For the both systems, plan the facilities for supplying power to the subsystem according to the specifications for the single power supply because when a failure occurs, only the one power supply operates.

*7 : Power requirement in the case of the maximum configuration is shown. When planning facilities such as the uninterrupted power supply (UPS), specify the power factor as 100% for calculation. Value at 100 V/200 V is shown. (Example : 300 W=300 VA)
The actual required power may exceed the value shown in the table when the tolerance is included.

*8 : The start-up time may be longer than three minutes depending on the configuration.

Item		Model: Floor model — MK	Rackmount model — RKL	Rackmount model — With U6 rack frame	Rackmount model — With U4 rack frame
Cache specifications	Capacity (M bytes/CTL)	256			
	Control method	Read LRU/Write after			
	Battery backup	Provided			
	Backup duration(*1) (h)	48 (When cache of 512 M bytes/subsystem is installed)			
Maintenance specifications/ anti-fault specifications	Parts to which hot replacement is applicable(*2)	•Controller •Disk drive •AC/DC power supply (RKL) •Fan unit •Battery unit(*3) •ENC (RKL) board		•Controller •Disk drive •AC/DC power supply (RKL) •Fan unit •Battery unit(*3) •ENC (RKL) board •PDB	•Controller •Disk drive •AC/DC power supply (RKL) •Fan unit •Battery unit(*3) •ENC (RKL) board •PDU
	Microprogram installation method	Flash memory/Disk drive (resident)			
	SVP (built-in exclusive tool) function	• Failure information logging/Power control • Controlling microprogram patching • Disk drive controlling microprogram down loading • Configuration information change • Disk drive recovery initiating process (This process is automatically executed when Disk drive is replaced.)			
	Spare disk	Up to five of mounted Disk drives can be set to Spare disks			
	Floppy Disk drive	• Failure and statistics information logging • Controlling program patching/Disk drive down loading			
	Display function	• Status LEDs (POWER, READY, WARNING, and ALARM) • LED of maintenance part			

*1 :• Non-volatility of data in the cache memory is ensured against power trouble such as a sudden power failure. It transfers data in the Cache memory to Disk drives by turning off the power normally, and prevents the battery charge from being wasted.

- When the subsystem enters the Cache Backup mode, a warning (lighting of the orange LED) informing of a voltage drop of the battery may be issued when the subsystem is started. It shows that the remaining capacity of the battery is not sufficient, and in this state, the subsystem operates disabling the Write Cache function automatically.
  When the battery is charged, the warning indication disappears, and the subsystem continues the operation enabling the Write Cache function.
  The warning indication disappears within 24 hours at the latest. Even when the warning is being indicated, normal functional operation is assured although the operation is performed in the Write-Through mode and the R/W performance is lowered because the Write Cache function is disabled.
- If the subsystem is not energized for more than a month, the over discharging of the battery occurs and it may cause the battery an unrecoverable damage. In this case, the battery must be energized more than 24 hours at least once a month, or store the subsystem with the switch of the battery turned off. Even when the switch is turned off, the battery discharges naturally. Even in this case, however, charge the battery once per three months for longer than 24 hours because spontaneous discharge is done.

*2 : Only the trained service personnel can perform a hot replacement.

*3 : The battery in the Battery unit is a part to be recycled.

Item \ Model		Floor model	Rackmount model		
		MK	RKL	With U6 rack frame	With U4 rack frame
Insulation performance	Insulation withstand voltage	AC 1,500 V (10 mA, 1 min)		AC 1,500 V (100 mA, 1 min)	AC 1,500 V (10 mA, 1 min)
	Insulation resistance	DC 500 V, 10 MΩ or more			

2.2 External Appearances

2.2.1 External appearances of the rackmouunt model

(1) Rackmouunt model RK and RKA

Figure 2.2.1 shows the external appearances and dimensions of the RK and RKA, and Figure 2.2.2 shows major components of them.

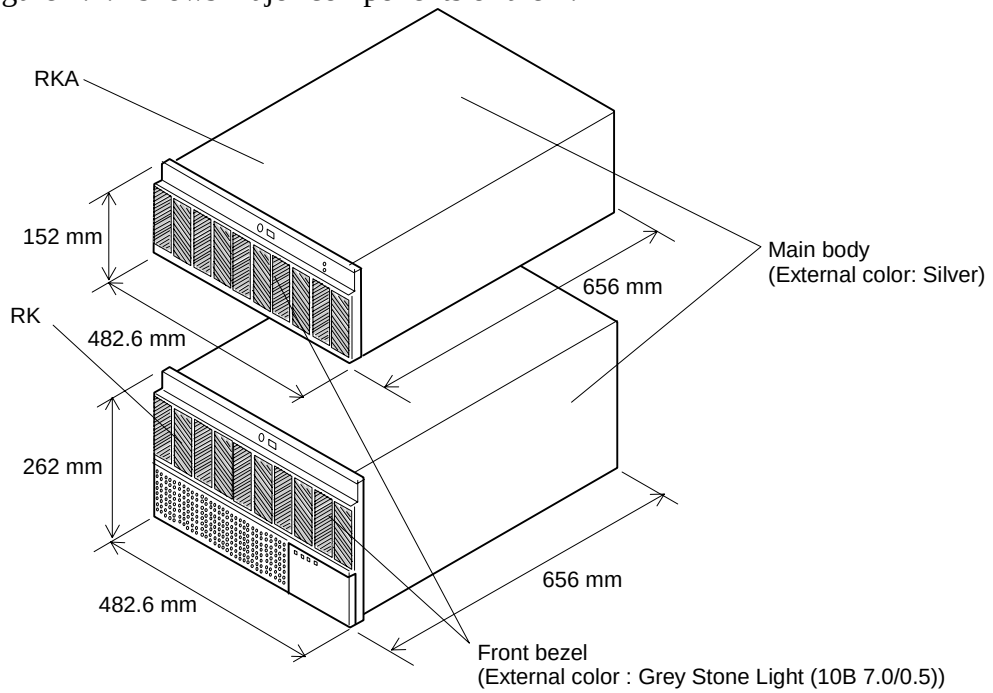


Figure 2.2.1 Appearances and Dimensions of the RK and RKA

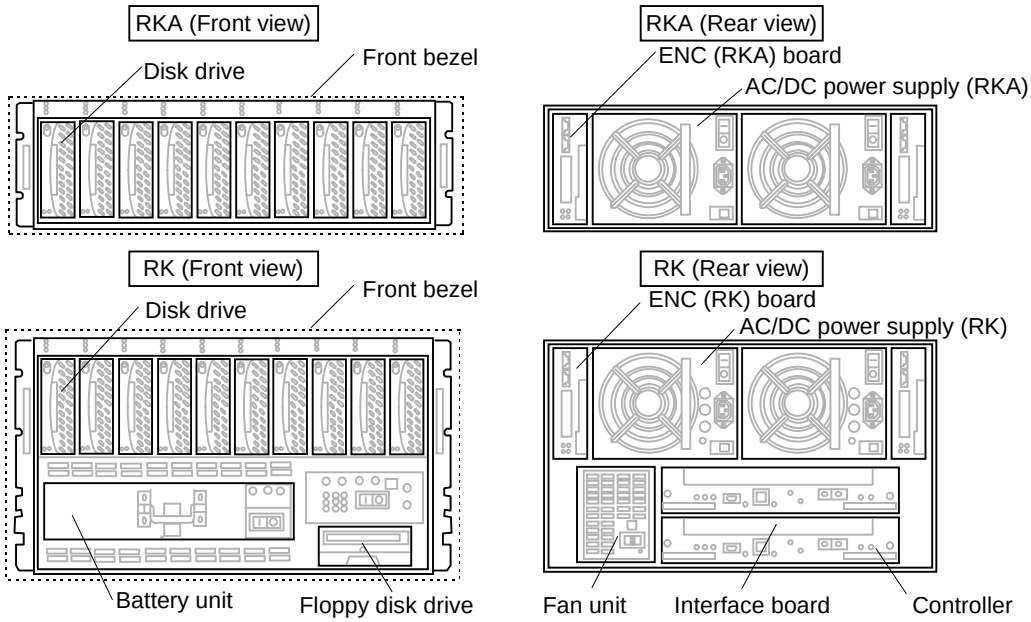


Figure 2.2.2 Major Components of the RK and RKA

(2) Rackmouunt model RKL

Figure 2.2.3 shows the external appearances and dimensions of the RKL, and Figure 2.2.4 shows major components of them.

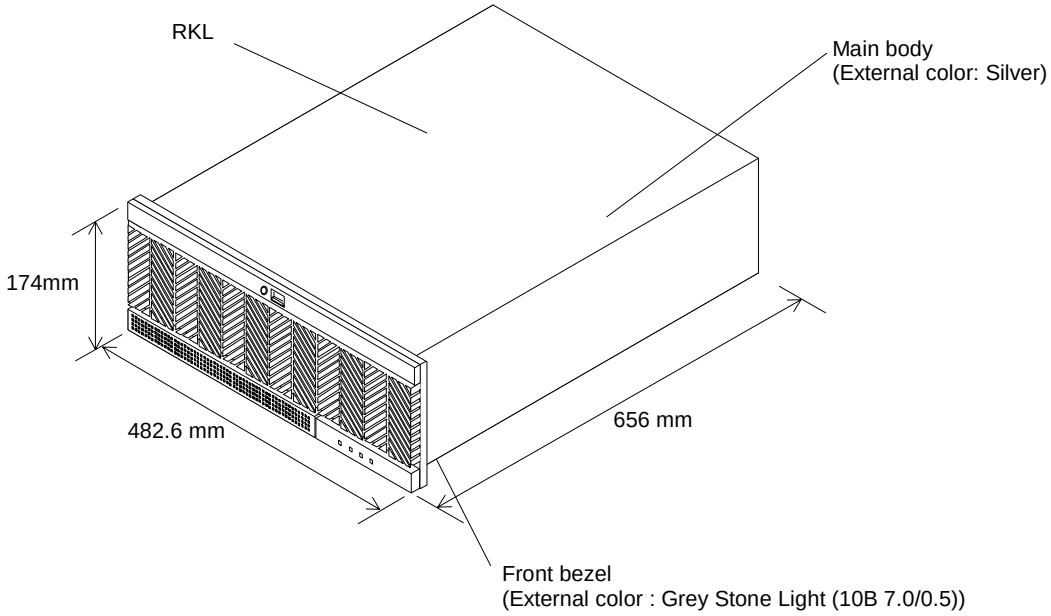


Figure 2.2.3 Appearances and Dimensions of the RKL

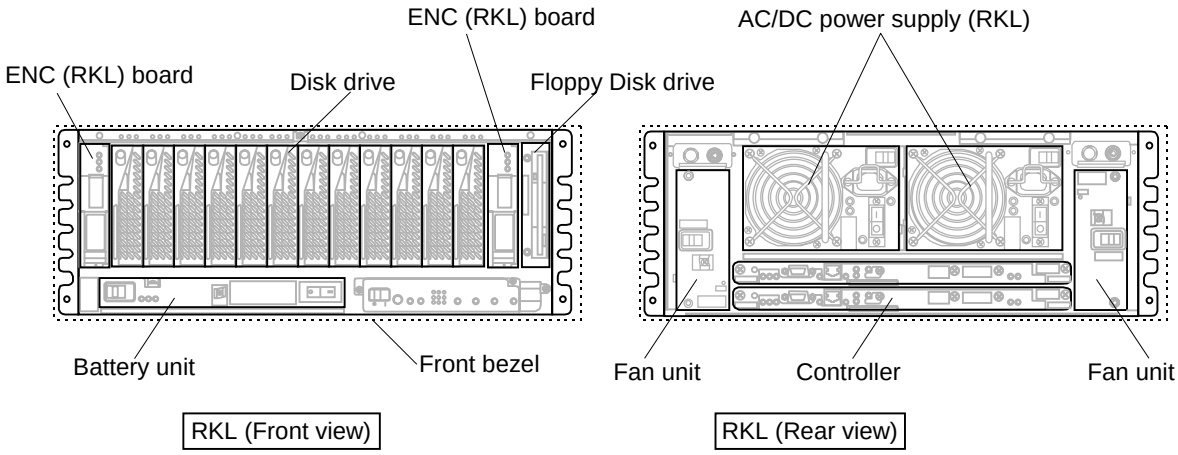
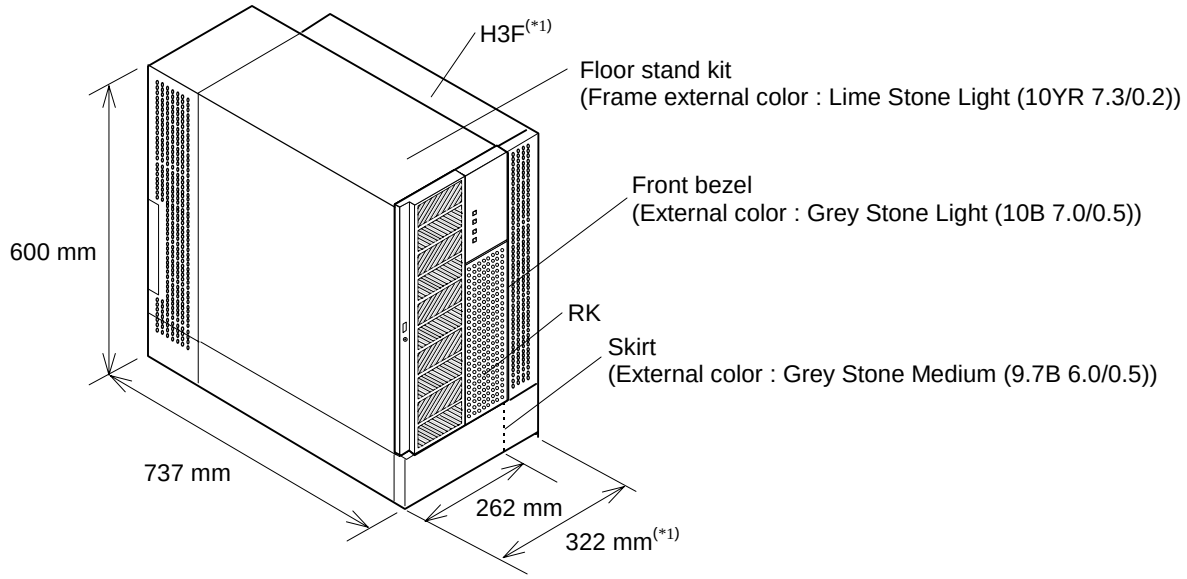


Figure 2.2.4 Major Components of the RKL

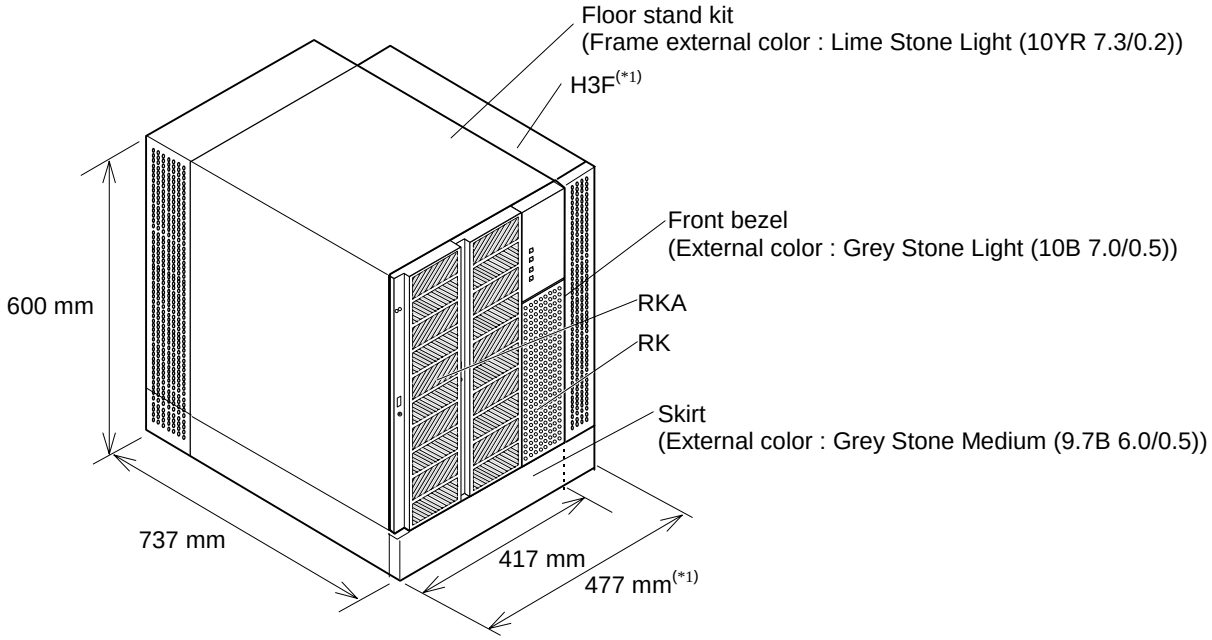
2.2.2 External appearances of the floor model

(1) Floor models H1F and H2F

Figure 2.2.5 shows the external appearances and dimensions of the floor models H1F and H2F.



(a) Floor model H1F



(b) Floor model H2F

*1 : The H3F is a frame kit which can be joined as an accessory.

Figure 2.2.5 Appearances and Dimensions of the Floor Models

(2) Floor model MK

Figure 2.2.6 shows the external appearances and dimensions of the floor model MK.

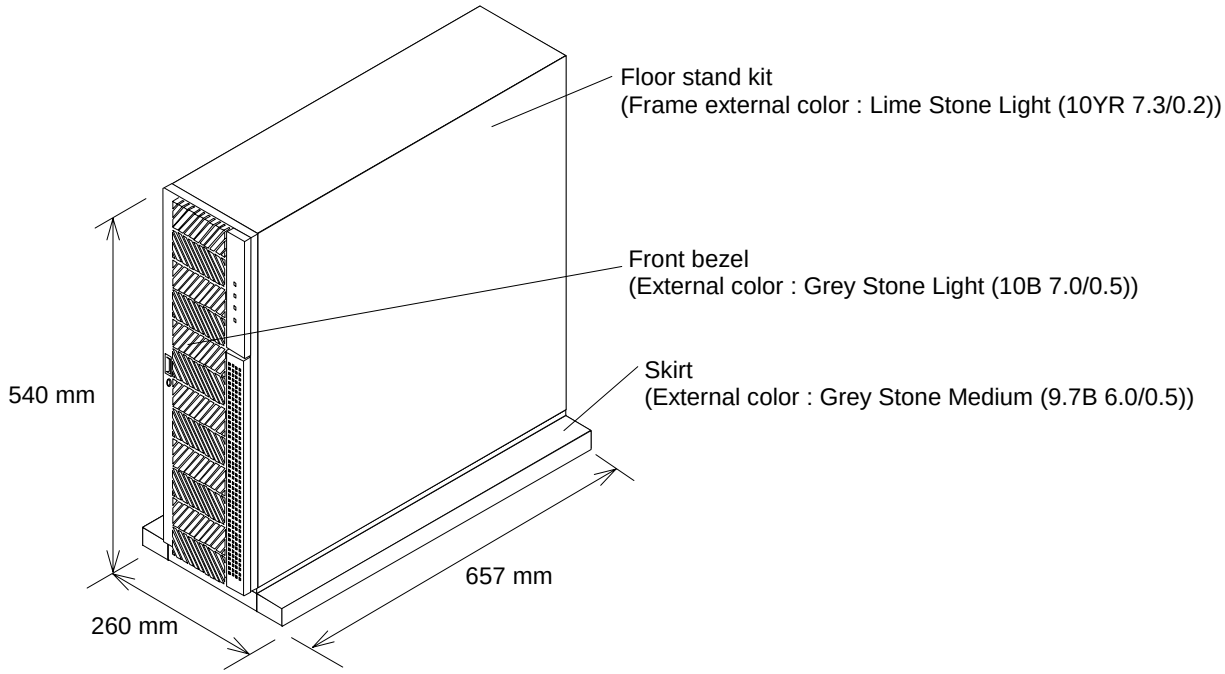
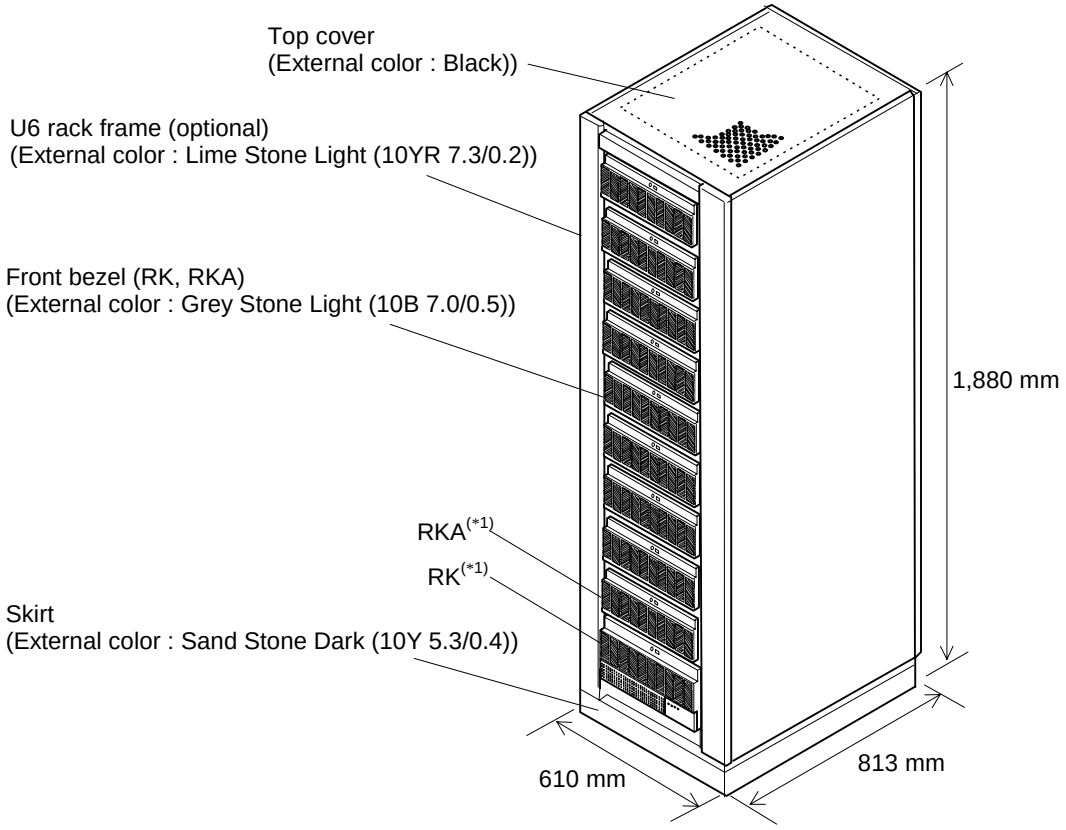


Figure 2.2.6 Appearances and Dimensions of the Floor Model

2.2.3 Rackmount model with U6 rack frame

Figure 2.2.7 shows the external appearance and dimensions of the rackmount model with U6 rack frame.

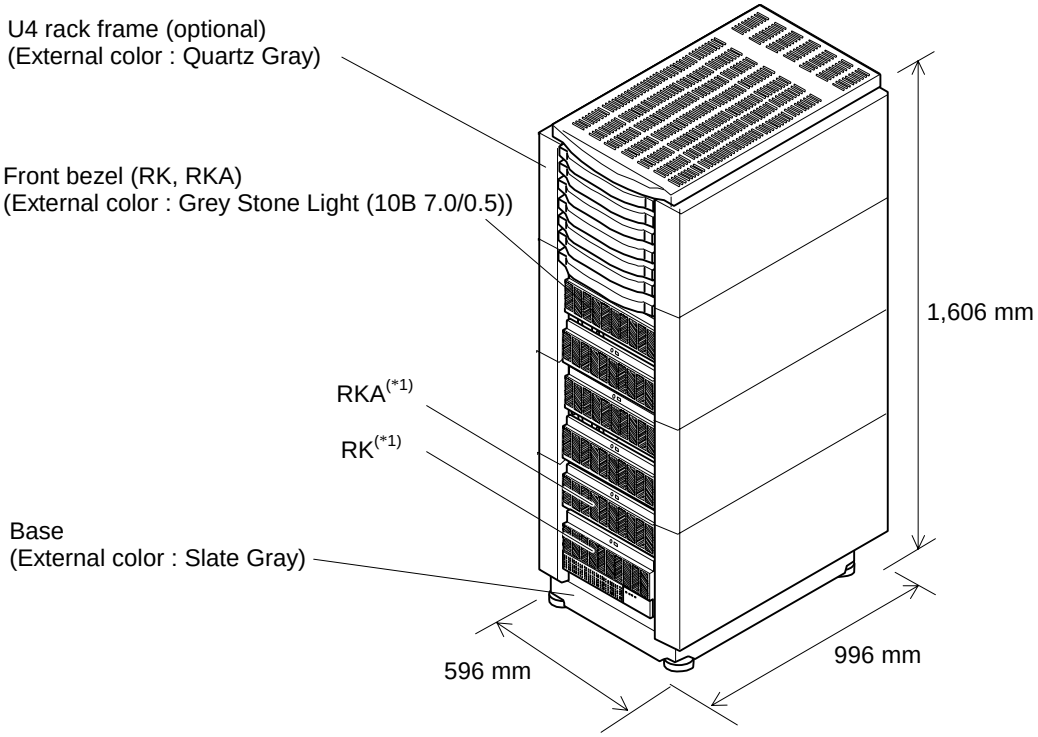


*1 : This figure shows an example of a subsystem with the one RK and nine RKAs.

Figure 2.2.7 Appearances and Dimensions of the Rackmount Model with U6 Rack Frame

2.2.4 Rackmount model with U4 rack frame

Figure 2.2.8 shows the external appearance and dimensions of the rackmount model with U4 rack frame.



*1 : This figure shows an example of a subsystem with the one RK and five RKAs.

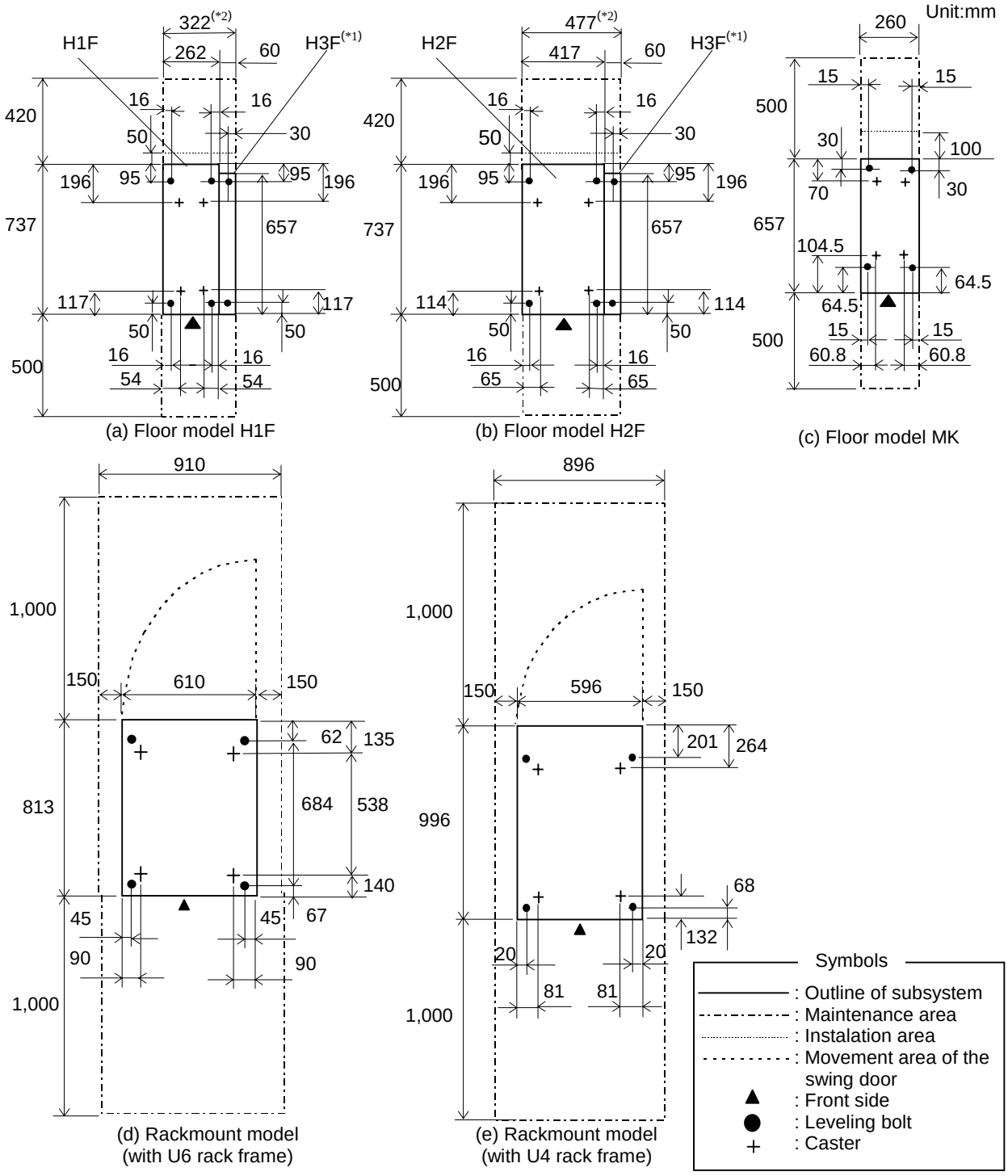
Figure 2.2.8 Appearances and Dimensions of the Rackmount Model with U4 Rack Frame

2.3 Installation

In this section, installation and maintenance areas of DF500 are shown.
External dimensions of the subsystem are those of the rackmount model and the floor model composed of the RK(s) , RKA(s).and RKL(s).
The installation area is that required to ensure a space for ventilation.
The maintenance area is that required for maintenance of the subsystem.

2.3.1 Installation area and maintenance area

Installation and maintenance areas of the subsystem are shown in Figure 2.3.1.
Notes on installation are shown in Item (1).



*1 : The H3F is a frame kit which can be joined as an accessory.

*2 : This shows a dimension of the area required for installation and maintenance when the H3F kit is joined to the floor model H1F or floor model H2F.

Figure 2.3.1 Installation Area and Maintenance Area

(1) Notes on installation

- The subsystem is provided with ventilating holes on external covers in order to prevent overheating. Therefore, be sure to secure spaces of more than 5 cm in front and rear of the subsystem not block those holes. The subsystem will be overheated and a fire or failure may be caused.
- Use specified optional parts, cables, and connectors. Otherwise, a fire, a personal injury, or a failure of the subsystem may be caused as well as the deterioration of the performance.
- If an abnormal odor, generation of heat, or smoke is sensed, turn off the power supplied to the subsystem from the distribution panel immediately and contact your service personnel.
  Continuous use of the subsystem can cause a fire or an electric shock.
- Do not sit on the subsystem nor put anything heavy on it. Otherwise, the subsystem may fall and cause personal injury.
- Do not put containers with water or metal articles on top of the subsystem.
  They can cause a fire, an electric shock, or a failure of the subsystem if the water spills and gets in the subsystem.

2.4 Environmental Specifications and Reliability

2.4.1 Environmental specifications

An appropriate environment and handling are necessary to use the subsystem for a long period of time without its functions being deteriorated. Do not install the subsystem in any of places shown below. Otherwise, the life of the subsystem may be shortened or the subsystem may become out of order.

- A place exposed to direct sunlight
- A place where the temperature and /or humidity change rapidly (A place close to an air-conditioner for example.)
- A place close to a device which generates electrical noises such as an ungrounded motors of an air conditioner and washing machine
- Close to a device which generates a strong magnetic field (Do not bring a magnet close to the subsystem.)
- A dusty or dirty place
- A place where vibration is transmitted

Table 2.4.1 are shows of Environmental Specifications the DF500.

Table 2.4.1 Environmental Specifications

Item \ Model		Rackmount model				Floor model		Remarks
		RK/RKL	RKA	With U6 rack frame	With U4 rack frame	H1F/MK	H2F	
Temperature	In operation (°C)	10 to 40						
	In non-operation (°C)	–10 to 50						
	In transport/storage (°C)	–30 to 60						
	Temperature change rate (°C/h)	10						
Humidity	In operation (%)	8 to 80						
	In non-operation (%)	8 to 90						
	Maximum wet bulb temperature (°C)	29						No dew condensation is allowed.
Vibration	In operation (m/s^2)	2.5 or less						
	In non-operation (m/s^2)	5.0 or less						
	In transport (packed) (m/s^2)	5.0 or less						
Impact	In operation (m/s^2)	20 or less						10 ms, half sine wave impact.
	In non-operation (m/s^2)	50 or less						
	In transport (packed) (m/s^2)	80 or less						
Angle at which the subsystem will turn over		15° or more						To be measured when installed on leveling bolts.
Atmosphere		No corrosive gas and salty air must be found.						
Acoustic noise (dB)		60 or less		65 or less		60 or less	65 or less	Measured in the A scale at the position one meter away from the front end of the subsystem and one meter high.

2.4.2 Reliability

Reliability of DF500 is shown in Figure 2.4.2.

Table 2.4.2 Reliability

Item \ Model	Rackmount model				Floor model		Remarks
	RK/RKL	RKA	With U6 rack frame	With U4 rack frame	H1F/MK	H2F	
MTBF(*1)	MTBF of longer than 50,000 hours is expected.						For the subsystem with minimum construction.
MTBDL(*2)	$\left(\frac{(\text{MTBF of the Disk drive})^2}{n(n-1)^{(*4)} \times \text{Number of RAID group} \times \text{MTTR}^{(*3)}} \right)$ About 20 million hour or longer						
Drop in package (JIS Z 0200-1994)	No abnormality must be caused by a free drop of level IV.		No abnormality must be caused by a drop of level IV. (one end is dropped while another end is supported.)		No abnormality must be caused by a free drop of level IV.	No abnormality must be caused by a drop of level IV. (one end is dropped while another end is supported.)	
Radio frequency radiation	Conforms to VCCI Class A 0 dB						
Instantaneous power failure	10 ms (100% dip)						

*1 : Mean Time Between Failure

*2 : Mean Time Between Data Lost

*3 : Mean Time To Repair

*4 : n = Number of mounted Disk drives

RAID 5 : n(n-1)

RAID 0 : n^2

RAID 1 and RAID 0+1 : $\frac{n^2}{2}$

2.5 Handling and Maintenance Service

The subsystem is sensitive to vibration, shock, and dust. In addition, take care not to apply static electricity or an excessive force to it.

2.5.1 Handling

(1) Packing

(a) Take care of the environment of the packing shop not to give the subsystem rapid temperature change. Apply moisture-proof packing to the subsystem.

(b) When packing the subsystem, use the inner, outer, and shock absorbing materials used when it was delivered from the factory, or use another shock absorbing package that can protect the subsystem from direct shock.

(c) Mark the “UP” indication clearly on the outer surface of the package, and show the instruction not to put the package upside down.

(2) Transport

During transport, do not allow any shock and vibration higher than specified values to be applied to the subsystem.

(3) Storage

Store the subsystem in the specified storage environment applying moisture-proof packing to it.

2.5.2 Periodical replacement parts and parts with limited lives

In the subsystem, periodical replacement parts and parts with limited lives are used. Periodical part replacement is required to maintain high-quality operation performance.

- Periodical replacement of the parts concerned is basically covered by the maintenance service contract. Otherwise, customer is requested to purchase the genuine replacement parts periodically and to replace the parts by them selves.
- Concerning the parts with limited lives, it is required to apply the special maintenance (overhaul) to the subsystem to replace them.
- The battery mounted in the subsystem is a periodical replacement part with an indication of part to be recycled.

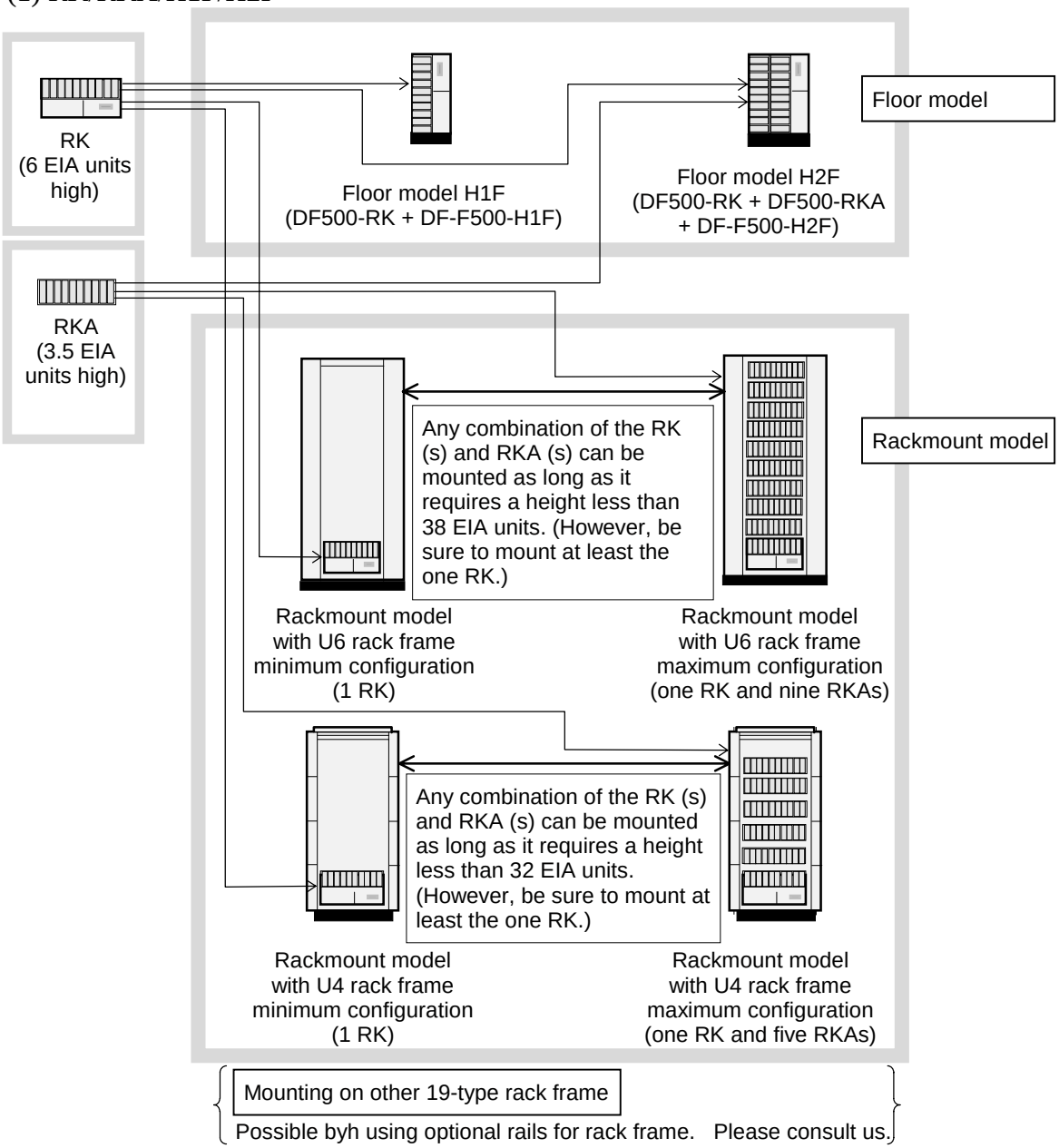
Classification	Part name	Life	Treatment
Periodical replacement part	Battery unit	Two years	• Periodical replacement is required. • When the maintenance service contract is made, the periodical replacement is performed as a part of maintenance service. • If not, the periodical replacement must be performed basically by the user. The genuine parts must be used. • Follow the given procedure to dispose of the used battery.
Part with limited life	Disk drive	Five years (*1)	This part must be replaced through the special maintenance when its life is expires. (After the time limit, possibility of failure occurrence will be higher and it is feared that data may be lost.) Life of the subsystem main body is eight years after the shipping from the factory even though the special maintenance is performed.
*1 : The expected useful life of the Disk drive varies depending on the environment in which the customer uses it. For details, please consult us.			

Chapter 3 System Configurations

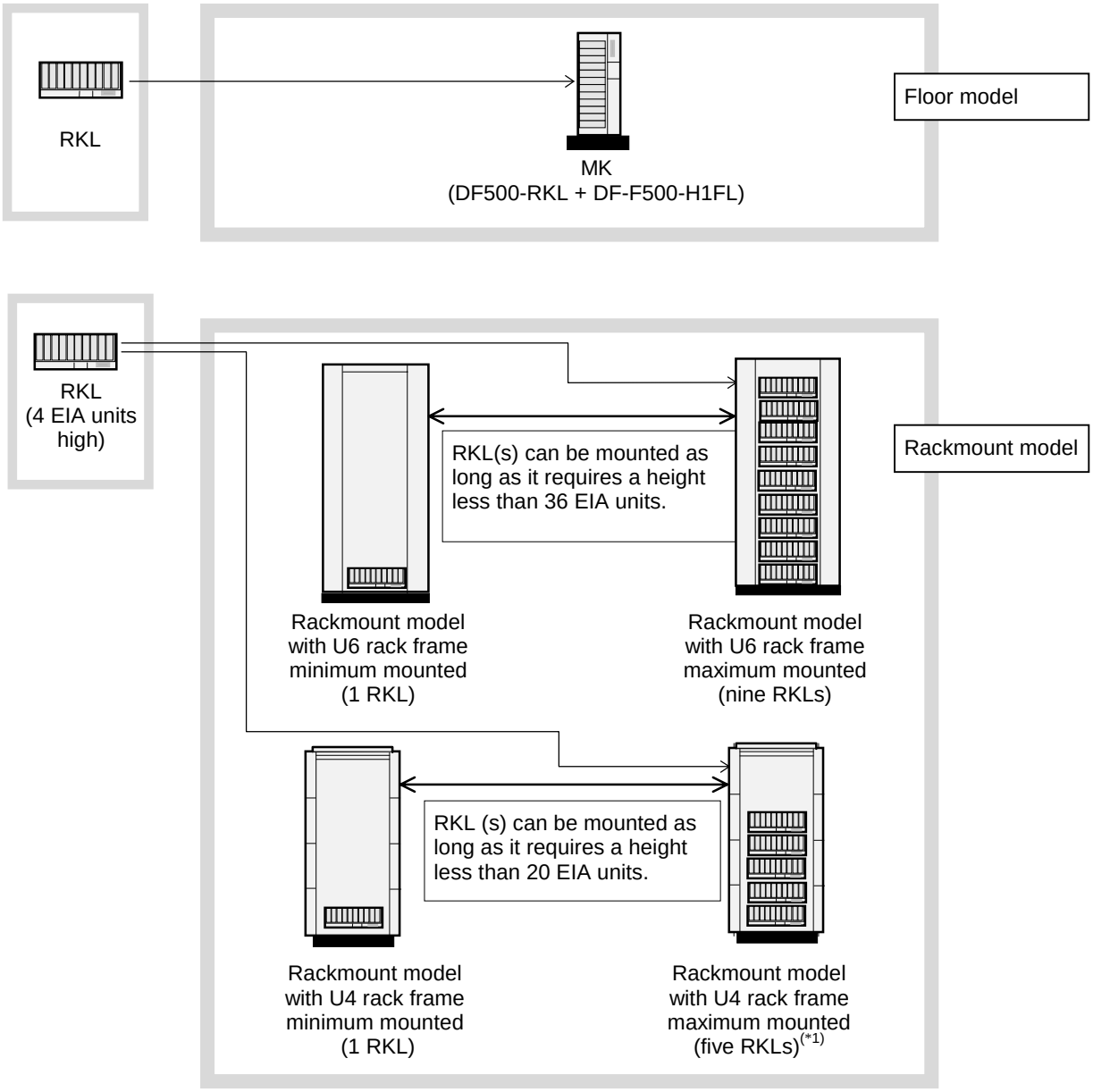
3.1 System Configurations

DF500 is composed of a combination of the RK(s) ,RKA(s) and RKL(s).
The floor model subsystem has three models, that is, a model configured with the one RK and configured with the one RK and one RKA, and another model one RKL.
When using an U6 rack frame which is an optional component, a system with one RK and up to nine RKAs (with 100 Disk drives at the maximum) can be configured.

(1) RK/RKA/H1F/H2F



(2) RKL/MK



*1: Up to the seven RKLs can be mounted through an addition of the UPDU (optional).

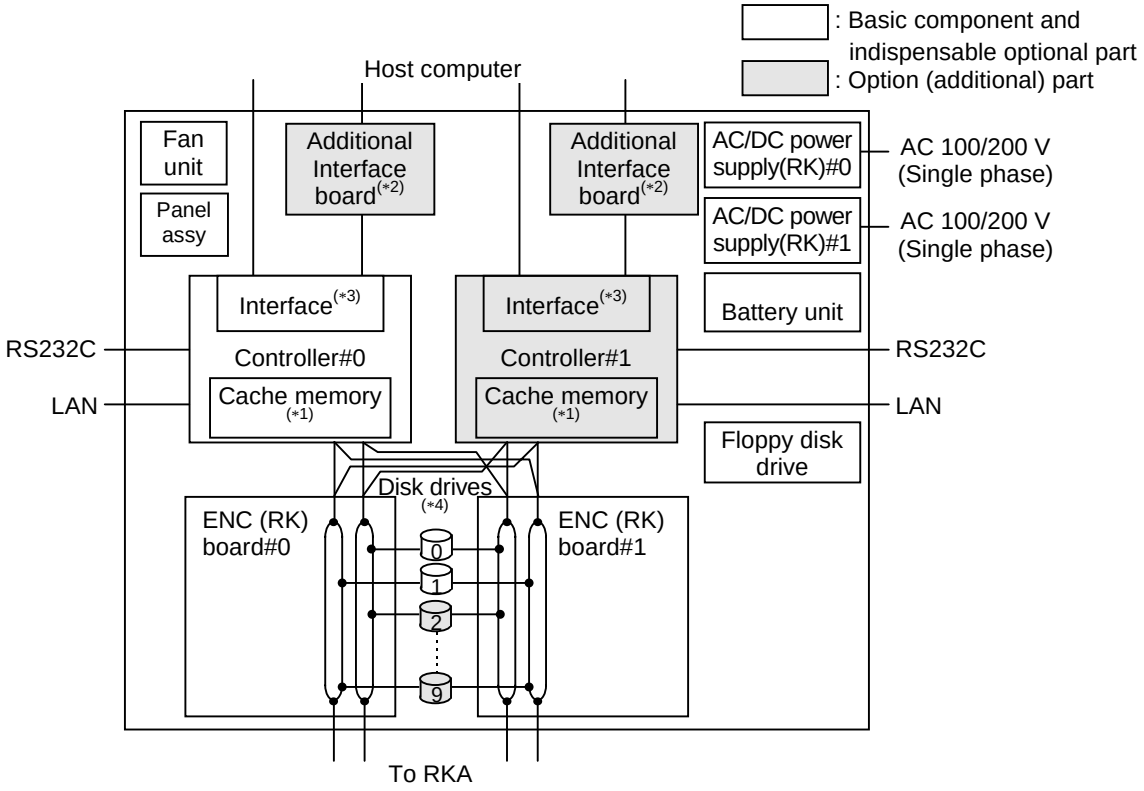
Mounting on other 19-type rack frame

Possible byh using optional rails for rack frame. Please consult us.

3.1.1 System configurations of the rackmount model

Configuration block diagram of the RK, RKA and RKL are shown below.
The RK, RKA, and RKL can mount up to 10, 10, and 12 Disk drives respectively.
(The RK has a Controller that can control up to 100 Disk drives as RAID.)
The Disk drives can be assigned to data disk(s), parity disk(s) (mirror disk(s)) depending on the RAID level. The RK is equipped with a controller which can control up to 100 Disk drives.
Up to five Spare disks can be mounted in any locations within the configuration.
Figure 3.1.1 and 3.1.2 shows configuration block diagrams of the RK and RKA respectively.

(1) Rackmount model RK



*1 : Cache memory :
DF-F500-C256, DF-F500-C512, or DF-F500-C1G

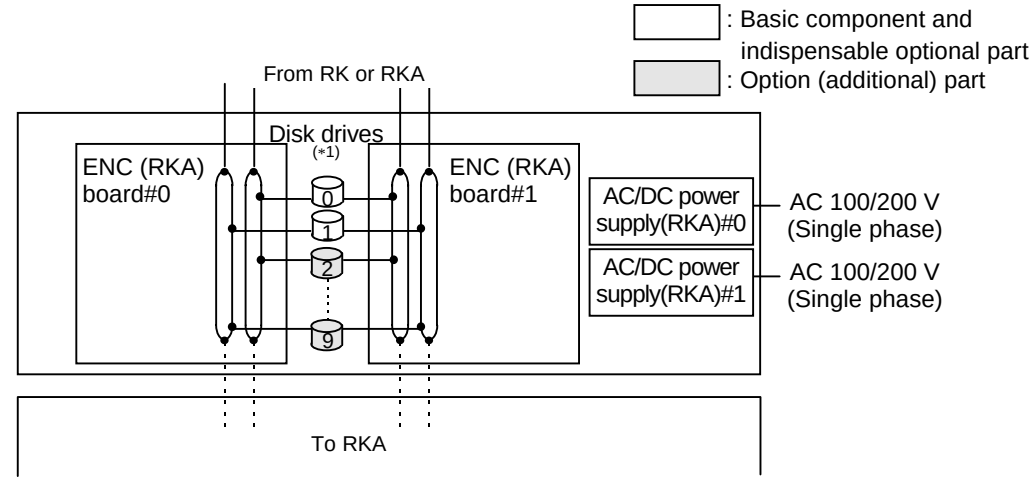
*2 : Interface board (for extension) :
DF-F500-DFFM5, DF-F500-DFFM6, DF-F500-DF2G2, DF-F500-DFUDS, or DF-F500-DFU2S

*3 : Interface (mounted in the controller) : 1 Gbps Fibre Channel (Non-OFC)
However, when the DF2G2, DFUDS or DFU2S board are selected for an additional Interface board, the 1 G bps Fibre Channel cannot be used.

*4 : Disk drive :
DF-F500-AAF8, DF-F500-AAF18, DF-F500-AAH18, DF-F500-AAF36, or DF-F500-AAF72

Figure 3.1.1 System Configuration of the RK

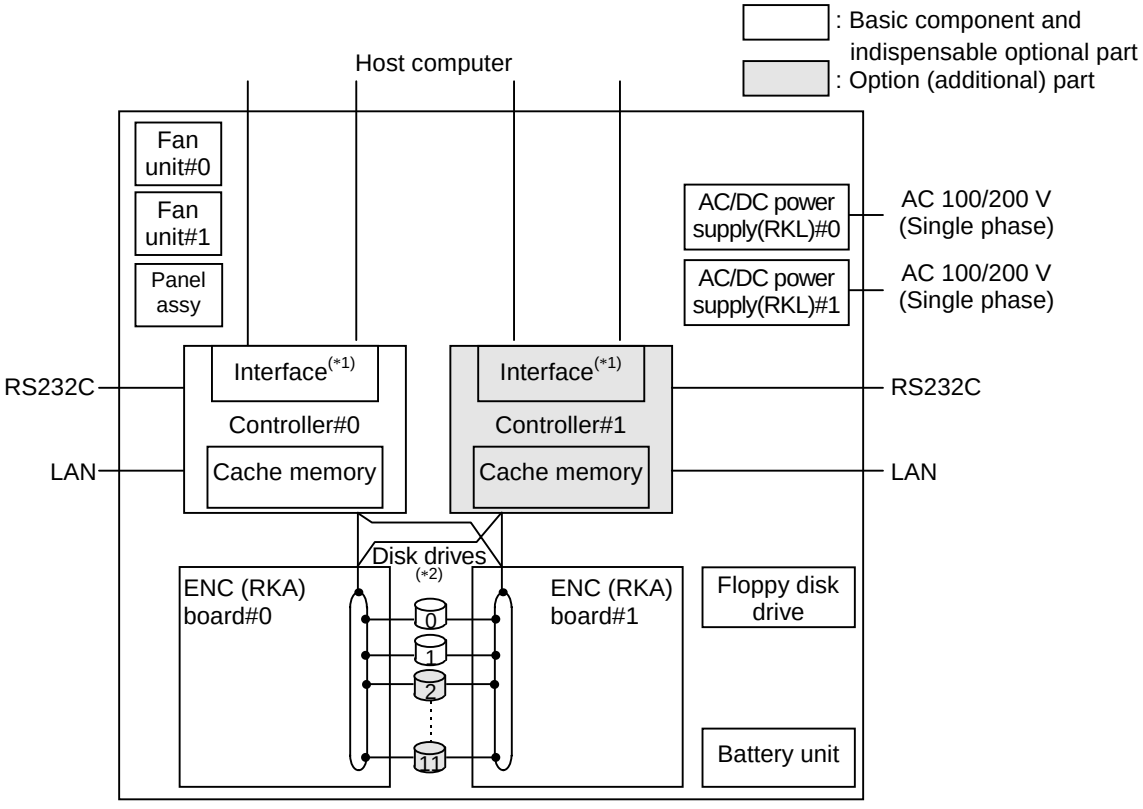
(2) Rackmount model RKA



*1 : Disk drive:
DF-F500-AAF8, DF-F500-AAF18, DF-F500-AAH18, DF-F500-AAF36, or DF-F500-AAF72

Figure 3.1.2 System Configurations of the RKA

(3) Rackmount model RKL



*1 : Interface (mounted in the controller) : Fibre Channel (Non-OFC) and SCSI(LVD/Single-ended, HVD)
DF-F500-F1FL, DF-F500-F2FL, or DF-F500-F3FL

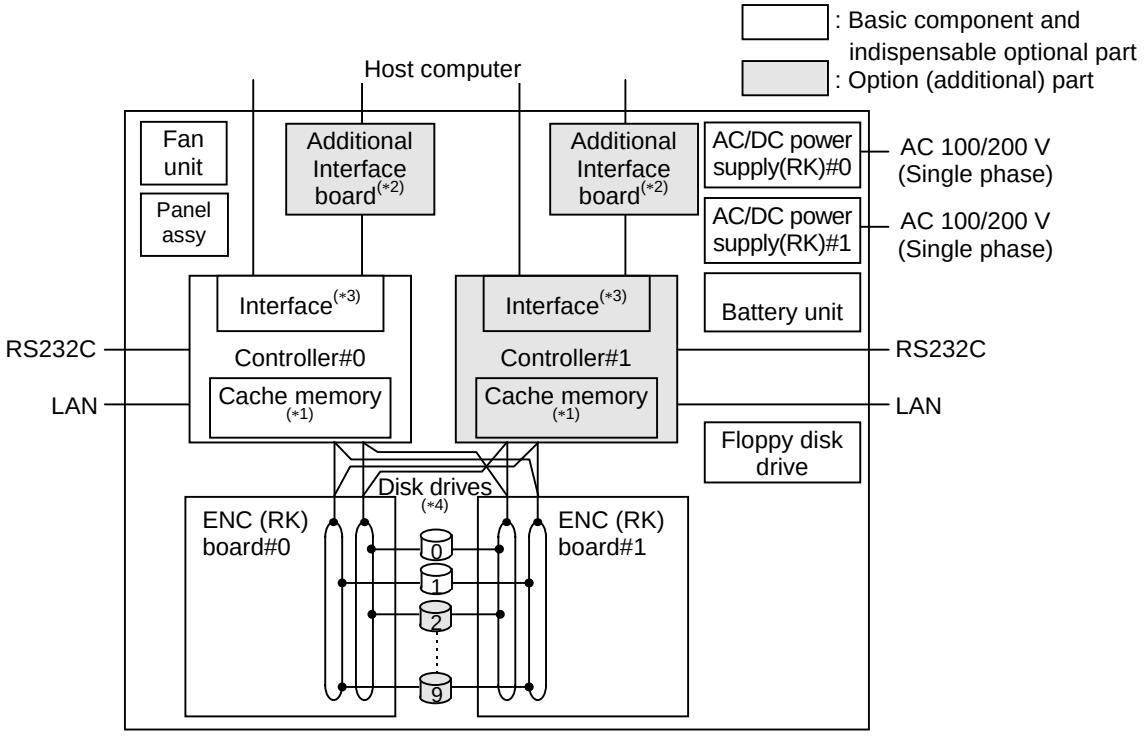
*2 : Disk drive :DF-F500-ACF18, DF-F500-ACH18, DF-F500-ACF36, or DF-F500-ACF72

Figure 3.1.3 System Configuration of the RKL

3.1.2 System configurations of the floor model

Configuration block diagram of the H1F, H2F and MK are shown below.
The H1F, H2F, and MK can mount up 10, 20, and 12 Disk drives respecively and each of them kas a controller that can control the Disk drives as RAID.
The Disk drives can be assigned to data disk(s), parity disk(s) (mirror disk(s)) depending on the RAID level. The RK is equipped with a controller which can control up to 100 Disk drives.
Up to five Spare disks can be mounted in any locations within the configuration.(‡1)
Figure 3.1.4 , 3.1.5 and 3.1.6 shows configuration block diagrams of the H1F, H2F and MK respectively.

(1) Floor model H1F



*1 : Cache memory :
DF-F500-C256, DF-F500-C512, or DF-F500-C1G

*2 : Interface board (for extension) :
DF-F500-DFFM5, DF-F500-DFFM6, DF-F500-DF2G2, DF-F500-DFUDS, or DF-F500-DFU2S

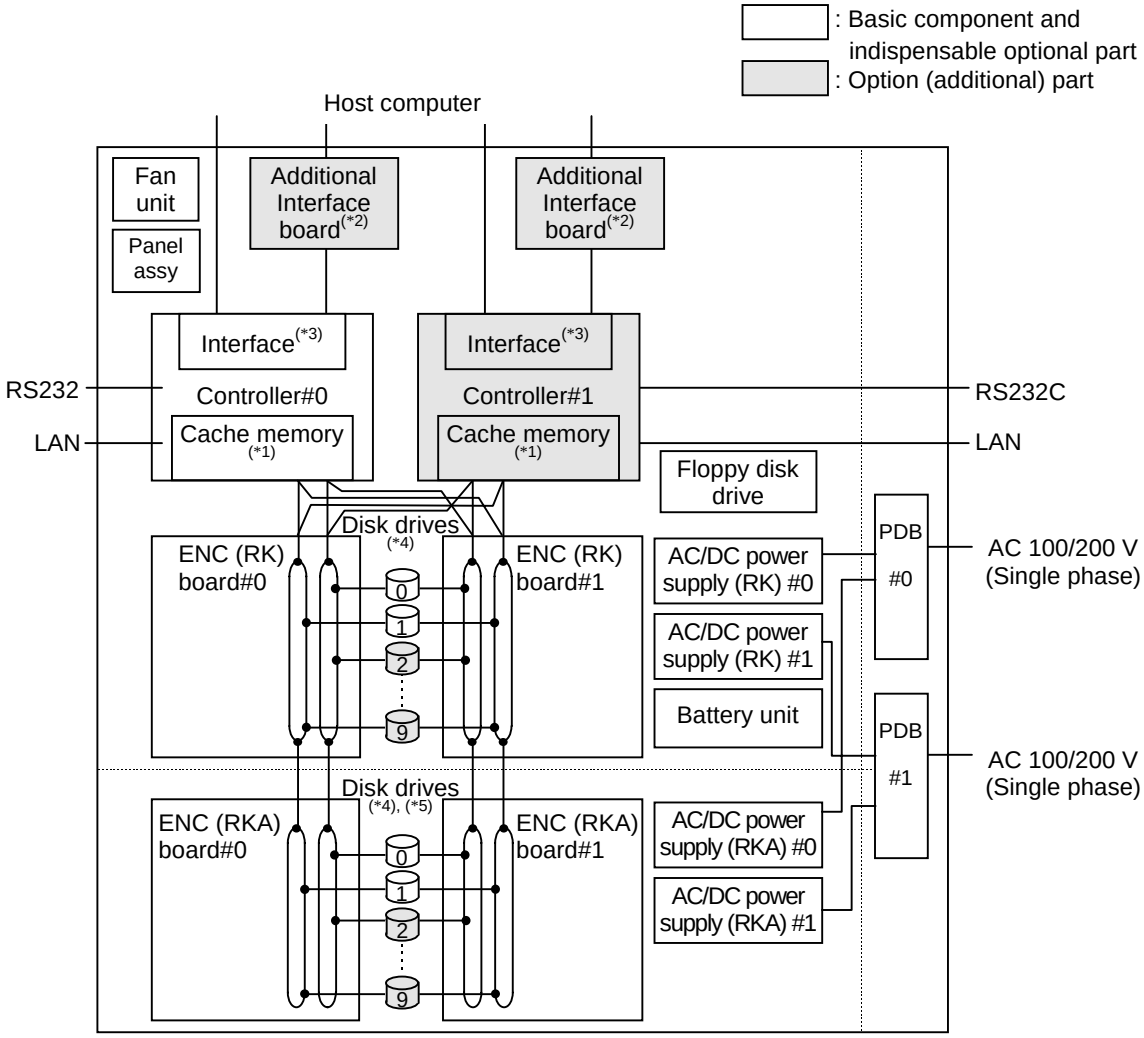
*3 : Interface (mounted in the controller) : 1 Gbps Fibre Channel (Non-OFC)
However, when the DF2G2, DFUDS or DFU2S board are selected for an additional Interface board, the 1 G bps Fibre Channel cannot be used.

*4 : Disk drive :
DF-F500-AAF8, DF-F500-AAF18, DF-F500-AAH18, DF-F500-AAF36, or DF-F500-AAF72

Figure 3.1.4 System Configuration of the H1F

‡1 : No Spare disk can be set for the Disk drives #0 and #1 of the RK, RKA, and RKL.

(2) Floor model H2F



*1 : Cache memory :
DF-F500-C256, DF-F500-C512, or DF-F500-C1G

*2 : Interface board (for extension) :
DF-F500-DFFM5, DF-F500-DFFM6, DF-F500-DF2G2, DF-F500-DFUDS, or DF-F500-DFU2S

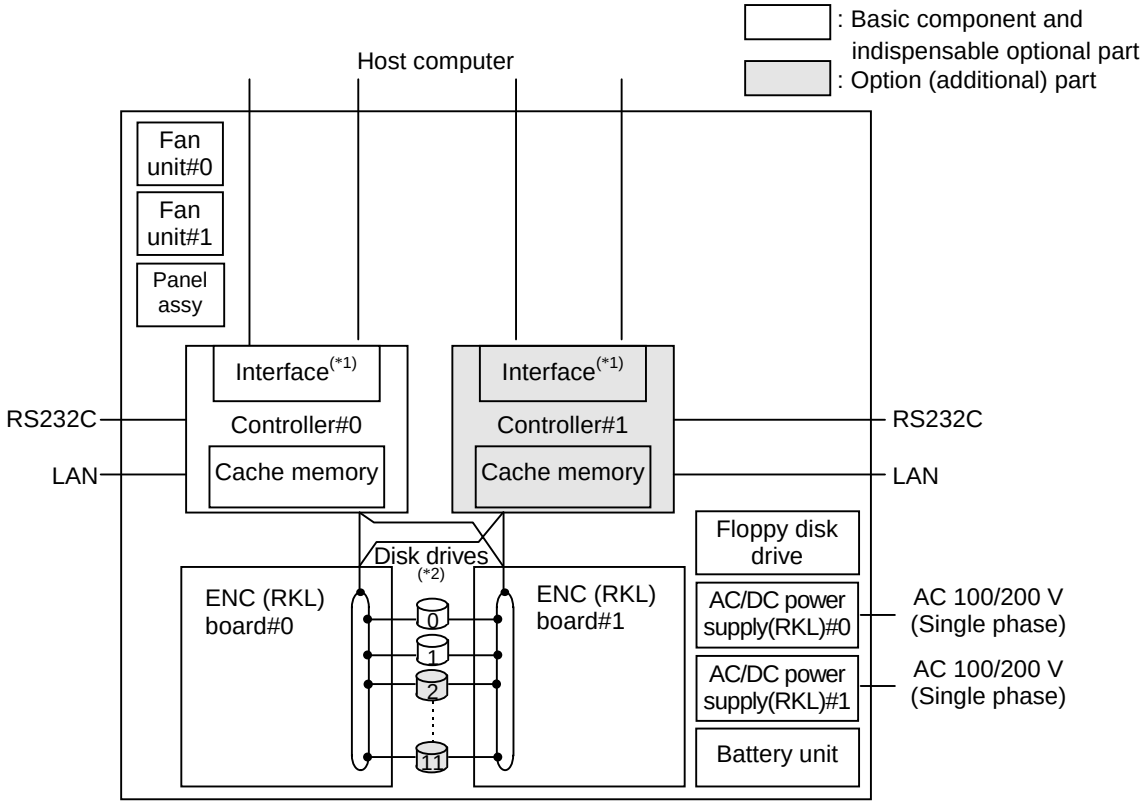
*3 : Interface (mounted in the controller) : 1 Gbps Fibre Channel (Non-OFC)
However, when the DF2G2, DFUDS or DFU2S board are selected for an additional Interface board, the 1 G bps Fibre Channel cannot be used.

*4 : Disk drive :
DF-F500-AAF8, DF-F500-AAF18, DF-F500-AAH18, DF-F500-AAF36, or DF-F500-AAF72

*5 : When no additional Disk drive is installed, turn off the power supplied to the AC/DC power supply (RKA)'s.

Figure 3.1.5 System Configuration of the H2F

(3) Floor model MK



*1 : Interface (mounted in the controller) : Fibre Channel (Non-OFC) and SCSI(LVD/Single-ended, HVD)
DF-F500-F1FL, DF-F500-F2FL, or DF-F500-F3FL

*2 : Disk drive :DF-F500-ACF18, DF-F500-ACH18, DF-F500-ACF36, or DF-F500-ACF72

Figure 3.1.6 System Configuration of the MK

3.1.3 Configuration of rackmount model with U6 rack frame

The DF-F500-U6 is an exclusive rack frame use for mounting a combination of the RK(s) (6 EIA units high) and the RKA(s) (3.5 EIA units high) up to a height of 38 EIA units(‡1), (‡2). It can mount up to nine RKLs (4 EIA units high each), that is, up to a height of 36 EIA units.

It consists of a rack frame main body and PDBs to be used to supply AC power to power supply units of the mounted RK(s) , RKA(s) and RKL(s). The four PDBs are installed to allow the power system to be duplicated.

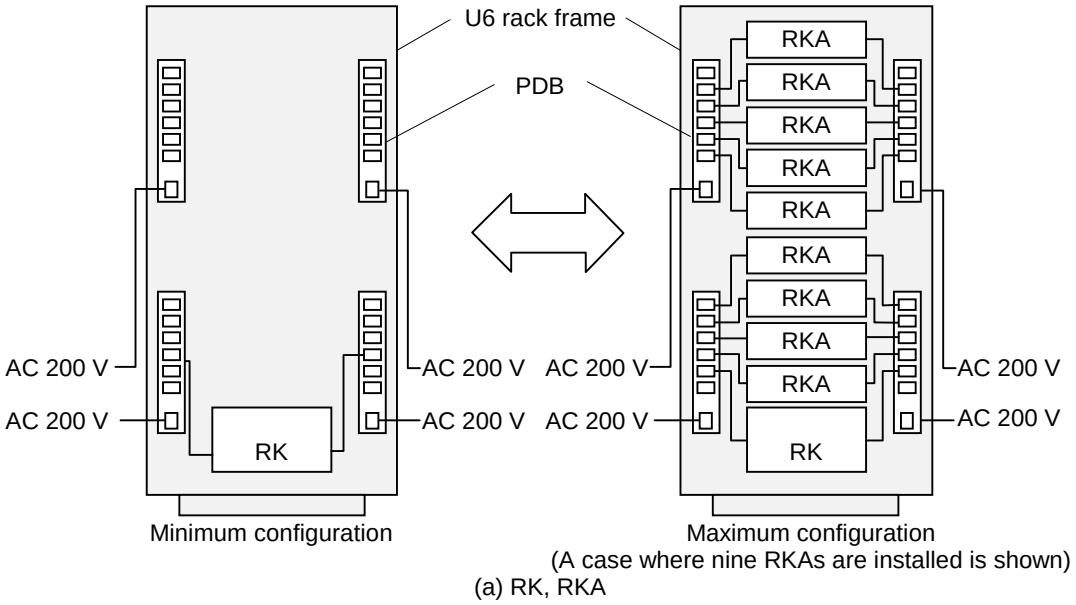


Figure 3.1.7 System Configuration of Rackmount Model with U6 Rack Frame

‡1 : At least one RK is required per system.

‡2 : Install the RK and RKL in the bottom position of the rack frame. When connecting the RKAs, install them above the RK adjacently to each other.

3.1.4 Configuration of rackmount model with U4 rack frame

The DF-F500-U4 is an exclusive rack frame use for mounting a combination of the RK(s) (6 EIA units high) and the RKA(s) (3.5 EIA units high) up to a height of 32 EIA units(‡1), (‡2). It can mount up to five(‡3) RKLs (4 EIA units high each), that is, up to a height of 20 EIA units.

It consists of a rack frame main body and PDUs to be used to supply AC power to power supply units of the mounted RK(s), RKA(s) and RKL(s). The two PDUs are installed to allow the power system to be duplicated.

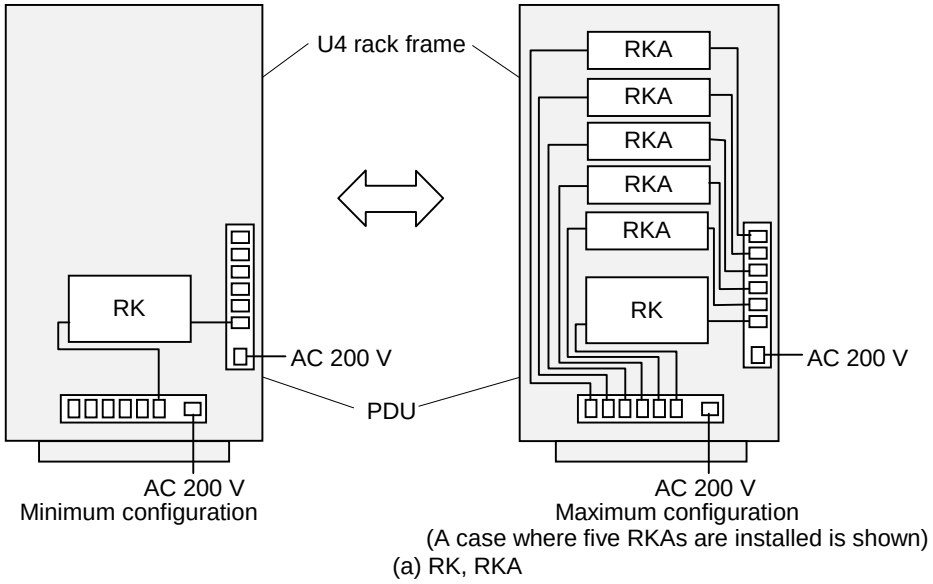


Figure 3.1.8 System Configuration of Rackmount Model with U4 rack frame

‡1 : At least one RK is required per system.

‡2 : Install the RK and RKL in the bottom position of the rack frame. When connecting the RKAs, install them above the RK adjacently to each other.

‡3: Up to the seven RKLs can be mounted through an addition of the UPDU (optional).

3.2 Components and Optional Parts of DF500

3.2.1 DF500-RK

(1) Configuration of the RK

Components and indispensable optional parts are shown below.

Table 3.2.1 Components and Indispensable Optional Parts of the RK

Classification	Model	Name	Configuration and specification	Selection
RK	DF500-RK	Disk array system	Frame (1), Controller (including Fibre Channel interface) (1), AC/DC power supply (RK) (2), Battery unit (1), Fan unit (1), Floppy disk drive (1), ENC (RK) board (2), Key (2), J2F power cable (2)	—
Disk drive (Indispensable option)	DF-F500-AAF8	3.5-type Disk drive (8.7 G bytes)	3.5-type Disk drive (8.7 G bytes) installed in a canister. (Disk rotational speed : 10,000 min^{-1})	Refer to Table 3.2.2. • Select a necessary number of Disk drives from the models shown on the left according to required storage the capacity.
	DF-F500-AAF18	3.5-type Disk drive (17.8 G bytes)	3.5-type Disk drive (17.8 G bytes) installed in a canister. (Disk rotational speed : 10,000 min^{-1})	
	DF-F500-AAH18	3.5-type Disk drive (17.8 G bytes)	3.5-type Disk drive (17.8 G bytes) installed in a canister. (Disk rotational speed : 15,000 min^{-1})	
	DF-F500-AAF36	3.5-type Disk drive (35.6 G bytes)	3.5-type Disk drive (35.6 G bytes) installed in a canister. (Disk rotational speed : 10,000 min^{-1})	
	DF-F500-AAF72	3.5-type Disk drive (71.6 G bytes)	3.5-type Disk drive (71.6 G bytes) installed in a canister. (Disk rotational speed : 10,000 min^{-1})	
Cache memory (Indispensable option)	DF-F500-C256	Cache memory (256 M bytes)	Cache memory of 256 M bytes (128 M bytes×2)	Select a Cache memory to be installed in the Controller from the models shown on the left. • Install any one model of Cache memory.
	DF-F500-C512	Cache memory (512 M bytes)	Cache memory of 512 M bytes (256 M bytes×2)	
	DF-F500-C1G	Cache memory (1,024 M bytes)	Cache memory of 1,024 M bytes (512 M bytes×2)	

Table 3.2.2 Configuration Unit of Disk Drive

RAID level (*1) \ Configuration		Number of Disk drives contained in unit of configuration	
		Minimum configuration(*2)	Unit of additional Disk drive
0	n (n=2 to 16)	2	2 to 16(*3)
1	1D+1P	2	2
5	nD+1P (n=2 to 15)	3	3 to 16(*3)
0+1	nD+nP (n=2 to 8)	4	4, 8, 12(*3), 16(*3)

*1 : D : Data disk
P : Parity disk

*2 : For the data capacity of each configuration unit, refer to "Appendix A List of Storage Capacities Corresponding to RAID Levels and Configurations" on page 7000.

*3 : Only when the RKA is connected to the RK.

(2) Optional parts of RK

Optional parts of the RK are shown below.

Table 3.2.3 Optional Parts of the RK

Classification	Model	Name	Configuration and specification	Selection
Disk drive	DF-F500-AAF8	3.5-type Disk drive (8.7 G bytes)	3.5-type Disk drive (8.7 G bytes) installed in a canister. (Rotational speed : 10,000 min^{-1})	Refer to Table 3.2.2. • Select a necessary number of Disk drive each of which has a capacity within a range of 8.7 to 71.6 G bytes according to the total capacity you want to provide. Spare disks : • Up to five Spare disks can be set for a subsystem. • The Spare disk requires no power supply. • Use Disk drive(s) with a capacity as large as the maximum one that the installed Disk drives have.
	DF-F500-AAF18	3.5-type Disk drive (17.8 G bytes)	3.5-type Disk drive (17.8 G bytes) installed in a canister. (Rotational speed : 10,000 min^{-1})	
	DF-F500-AAH18	3.5-type Disk drive (17.8 G bytes)	3.5-type Disk drive (17.8 G bytes) installed in a canister. (Rotational speed : 15,000 min^{-1})	
	DF-F500-AAF36	3.5-type Disk drive (35.6 G bytes)	3.5-type Disk drive (35.6 G bytes) installed in a canister. (Rotational speed : 10,000 min^{-1})	
	DF-F500-AAF72	3.5-type Disk drive (71.6 G bytes)	3.5-type Disk drive (71.6 G bytes) installed in a canister. (Rotational speed : 10,000 min^{-1})	
Cache memory	DF-F500-C256	Cache memory (256 M bytes)	Cache memory of 256 M bytes (128 M bytes×2)	Select a Cache memory to be installed in the Controller from the models shown on the left.
	DF-F500-C512	Cache memory (512 M bytes)	Cache memory of 512 M bytes (256 M bytes×2)	
	DF-F500-C1G	Cache memory (1,024 M bytes)	Cache memory of 1,024 M bytes (512 M bytes×2)	
Interface board	DF-F500-DFFM5	Interface 1 G bps Fibre Channel (Optical) Non-OFC	1 G bps Fibre Channel optical (Non-OFC) 100-M5-SN-I, DC connector For additional port	Select any one board from the models shown on the left according to the interface to be used.
	DF-F500-DFFM6 (*1)	Interface 1 G bps Fibre Channel (Optical) Non-OFC	1 G bps Fibre Channel optical (Non-OFC) 100-M5-SN-I, DC connector For additional port	
	DF-F500-DF2G2 (*2)	Interface 2 G bps Fibre Channel ×2 port (Optical) Non-OFC	2 G bps Fibre Channel optical (Non-OFC) 200-M5-SN-I, LC connector For additional port	
	DF-F500-DFUDS (*2)	Interface W/D	Wide differential, 68-pin, pin-type, screw-locked (with built in terminator)	
	DF-F500-DFU2S (*2)	Interface U/2	LVD, 68-pin, pin-type, screw-locked (with built in terminator)	
Controller	DF-F500-F1F	Controller for duplicating the system	Array Controller for duplicating the system. For Fibre Channel interface.	• The Controller can be duplicated. • Install a Cache memory with the same capacity as that of the Cache memory installed in the basic Controller.

*1 : This is an Interface board that supports the F-Port and has downward compatibility with the DF-F500-DFFM5.

*2 : When installing DF2G2, DFUDS or DFU2S, 1 G bps Fibre Channel interface on the Controller can not be used.

3.2.2 DF500-RKA

(1) Configuration of the RKA

Components and indispensable optional parts are shown below.

Table 3.2.4 Components and Indispensable Optional Parts of the RKA

Classification	Model	Name	Configuration and specification	Selection
RKA	DF500-RKA	Additional disk array	Frame (1), AC/DC power supply (RKA) (2), ENC (RKA) board (2), J2F Power cable (2), ENC cable (4)	—
Disk drive (Indispensable option)	DF-F500-AAF8	3.5-type Disk drive (8.7 G bytes)	3.5-type Disk drive (8.7 G bytes) installed in a canister. (Rotational speed : 10,000 min^{-1})	Select a necessary number of Disk drives each of which has a capacity within a range of 8.7 to 71.6 G bytes according to the total capacity you want to provide. Spare disks : •Up to five Spare disks can be set for a subsystem. • The Spare disk requires no power supply. • Use Disk drive(s) with a capacity as large as the maximum one that the installed Disk drives have.
	DF-F500-AAF18	3.5-type Disk drive (17.8 G bytes)	3.5-type Disk drive (17.8 G bytes) installed in a canister. (Rotational speed : 10,000 min^{-1})	
	DF-F500-AAH18	3.5-type Disk drive (17.8 G bytes)	3.5-type Disk drive (17.8 G bytes) installed in a canister. (Rotational speed : 15,000 min^{-1})	
	DF-F500-AAF36	3.5-type Disk drive (35.6 G bytes)	3.5-type Disk drive (35.6 G bytes) installed in a canister. (Rotational speed : 10,000 min^{-1})	
	DF-F500-AAF72	3.5-type Disk drive (71.6 G bytes)	3.5-type Disk drive (71.6 G bytes) installed in a canister. (Rotational speed : 10,000 min^{-1})	

(2) Optional parts of RKA

Optional parts of the RKA are shown below.

Table 3.2.5 Optional Parts of the RKA

Classification	Model	Name	Configuration and specification	Selection
Disk drive	DF-F500-AAF8	3.5-type Disk drive (8.7 G bytes)	3.5-type Disk drive (8.7 G bytes) installed in a canister. (Rotational speed : 10,000 min^{-1})	Select a necessary number of Disk drive each of which has a capacity within a range of 8.7 to 71.6 G bytes according to the total capacity you want to provide. Spare disks : • Up to five Spare disks can be set for a subsystem. • The Spare disk requires no power supply. • Use Disk drive(s) with a capacity as large as the maximum one that the installed Disk drives have.
	DF-F500-AAF18	3.5-type Disk drive (17.8 G bytes)	3.5-type Disk drive (17.8 G bytes) installed in a canister. (Rotational speed : 10,000 min^{-1})	
	DF-F500-AAH18	3.5-type Disk drive (17.8 G bytes)	3.5-type Disk drive (17.8 G bytes) installed in a canister. (Rotational speed : 15,000 min^{-1})	
	DF-F500-AAF36	3.5-type Disk drive (35.6 G bytes)	3.5-type Disk drive (35.6 G bytes) installed in a canister. (Rotational speed : 10,000 min^{-1})	
	DF-F500-AAF72	3.5-type Disk drive (71.6 G bytes)	3.5-type Disk drive (71.6 G bytes) installed in a canister. (Rotational speed : 10,000 min^{-1})	

3.2.3 DF500-RKL

(1) Configuration of the RKL

Components and indispensable optional parts are shown below.

Table 3.2.6 Components and Indispensable Optional Parts of the RKL

Classification	Model	Name	Configuration and specification	Selection
RKL	DF500-RKL	Disk array system	Frame (1), AC/DC power supply (RKL) (2), Battery unit (1), Fan unit (2), Floppy disk drive (1), ENC (RKL) board (2), Key (2), J2F power cable (2)	—
Disk drive (Indispensable option)	DF-F500-ACF18	3.5-type Disk drive (17.8 G bytes)	3.5-type Disk drive (17.8 G bytes) installed in a canister. (Disk rotational speed : 10,000 min^{-1})	Refer to Table 3.2.6. • Select a necessary number of Disk drives from the models shown on the left according to the required storage capacity.
	DF-F500-ACH18	3.5-type Disk drive (17.8 G bytes)	3.5-type Disk drive (17.8 G bytes) installed in a canister. (Disk rotational speed : 15,000 min^{-1})	
	DF-F500-ACF36	3.5-type Disk drive (17.8 G bytes)	3.5-type Disk drive (35.6 G bytes) installed in a canister. (Disk rotational speed : 10,000 min^{-1})	
	DF-F500-ACF72	3.5-type Disk drive (17.8 G bytes)	3.5-type Disk drive (71.6 G bytes) installed in a canister. (Disk rotational speed : 10,000 min^{-1})	
Controller	DF-F500-F1FL	Controller	Array Controller (Including Fibre Channel interface)	• Select any one board from the models shown on the left according to the interface to be used.
	DF-F500-F2FL	Controller	Array Controller (Including SCSI LVD/single-ended interface)	
	DF-F500-F3FL	Controller	Array Controller (Including SCSI Wide differential interface)	

Table 3.2.7 Configuration Unit of Disk Drive

RAID level (*1) \ Configuration		Number of Disk drives contained in unit of configuration	
		Minimum configuration (*2)	Unit of additional Disk drive
0	n (n=2 to 12)	2	2 to 10
1	1D+1P	2	2
5	nD+1P (n=2 to 11)	3	3 to 9
0+1	nD+nP (n=2 to 6)	4	2, 4, 6, 8

*1 : D : Data disk
P : Parity disk

*2 : For the data capacity of each configuration unit, refer to “Appendix A List of Storage Capacities Corresponding to RAID Levels and Configurations” on page 7000.

(2) Optional parts of RKL

Optional parts of the RKL are shown below.

Table 3.2.8 Optional Parts of the RKL

Classification	Model	Name	Configuration and specification	Selection
Disk drive	DF-F500-ACF18	3.5-type Disk drive (17.8 G bytes)	3.5-type Disk drive (17.8 G bytes) installed in a canister. (Disk rotational speed : 10,000 min^{-1})	Select a necessary number of Disk drive each of which has a capacity within a range of 17.8 to 71.6 G bytes according to the total capacity you want to provide. Spare disks : • Up to five Spare disks can be set for a subsystem. • The Spare disk requires no power supply. • Use Disk drive(s) with a capacity as large as the maximum one that the installed Disk drives have.
	DF-F500-ACH18	3.5-type Disk drive (17.8 G bytes)	3.5-type Disk drive (17.8 G bytes) installed in a canister. (Disk rotational speed : 15,000 min^{-1})	
	DF-F500-ACF36	3.5-type Disk drive (17.8 G bytes)	3.5-type Disk drive (35.6 G bytes) installed in a canister. (Disk rotational speed : 10,000 min^{-1})	
	DF-F500-ACF72	3.5-type Disk drive (17.8 G bytes)	3.5-type Disk drive (71.6 G bytes) installed in a canister. (Disk rotational speed : 10,000 min^{-1})	
Controller	DF-F500-F1FL	Controller for duplicating the system	Array Controller for duplicating the system. For Fibre Channel interface.	• The Controller can be duplicated.
	DF-F500-F2FL	Controller for duplicating the system	Array Controller for duplicating the system. For SCSI LVD/single-ended interface.	
	DF-F500-F3FL	Controller for duplicating the system	Array Controller for duplicating the system. For SCSI Wide differential interface.	

3.3 Accessory Parts of the RK , RKA and RKL

Accessory parts of the RK, RKA and RKL are shown below.
The optional parts of the RK , RKA and RKL are shown in Section 3.2, “Components and Optional Parts of DF500” on page 0520.

Table 3.3.1 Accessory Parts of the RK, RKA and RKL

Classification	Model	Name	Usage	Remarks
Floor stand kit	DF-F500-H1F	Floor stand kit (for one RK)	Kit for remaking the RK to floor model.	
	DF-F500-H2F	Floor stand kit (for one RK + one RKA)	Kit for connecting the RK and RKA and remaking them to floor model.	
	DF-F500-H3F	Additional slot kit	A frame unit to be joined to the floor model H1F or floor model H2F in order to install an accessory device such as a Remote adapter.	
	DF-F500-H1FL	Floor stand kit (for one RKL)	Kit for remaking the RKL to floor model.	
Rack frame	DF-F500-U4	U4 rack frame	Exclusive rack frame for mount ing an RK and RKA(s), and RKL(s). Supplied with two AC power cables. • Can mount the RK(s) and RKA(s) up to a height of 32 EIA units. • Can mount the RKL(s) up to a height of 20 EIA units.	
	DF-F500-U6	U6 rack frame	Exclusive rack frame for mounting an RK and RKA(s), and RKL(s). Supplied with four AC power cables. • Can mount the RK(s) and RKA(s) up to a height of 38 EIA units. • Can mount the RKL(s) up to a height of 36 EIA units.	
Rack rail	DF-F500-URHT5	Rack rails for the U6	Rail kit for mounting the RK(s) and RKA(s) on the U6 rack frame.	As many kits as the subsystems to be added are required.
	DF-F500-URHP5	Rack rails for the HP	Rail kit for mounting the RK(s), RKA(s) and .RKL(s) on the U4 or HP rack frame.	
	DF-F500-URRA5	Rail kit for mounting the Hitachi common rack frame (for 3500, HA8000, FLORA)	Rails for mounting the RK(s), RKA(s) and RKLs) on the Hitachi common rack frame. (for 3500, HA8000, and FLORA)	
	DF-F500-URSU5	Rack rails for the Sun	Rails for mounting the RK(s), RKA(s) and RKL(s) on the Sun StorEdge rack frame.	
Decoration panel	DF-F500-U10D	Decoration panel (1U) for the U6	Panel to cover vacant space (1U) of the U6 rack frame.	
	DF-F500-U05D	Decoration panel (0.5U)	Panel to cover vacant space (0.5U) of the rack frame.	
PDU	DF-F500-UPDU	For U4	PDU for U4 rack frame.	

3.4 Accessory Parts

Model names and specifications of accessory parts are shown below.

Table 3.4.1 Accessory Parts

Classification	Model	Name	Specification	Remarks
Power cable	DF-F500-J1F	Power cable	2.5 m, 2-pole power cable with grounding terminal (AC 125 V, 13 A)	Plug : 5-15P of NEMA standard (Refer to page 1130)
	DF-F500-J2F	Power cable	2.5 m, 2-pole power cable with grounding terminal (AC 250 V, 10 A)	Refer to page 1130.
	DF-F500-J4	Power cable	5.0 m, 2-pole power cable with grounding terminal (AC 250 V, 10 A)	Cable clamps cannot be used.
	DF-F500-J5	Power cable	10.0 m, 2-pole power cable with grounding terminal (AC 250 V, 10 A)	(Refer to page 1130.)
Interface cable (Fibre Channel)	DF-F500-K1OP	Fibre Channel cable	For optical, 5 m	Refer to page 0670.
	DF-F500-K2OP	Fibre Channel cable	For Optical, 10 m	
	DF-F500-K3OP	Fibre Channel cable	For Optical, 20 m	
	DF-F500-K4OP	Fibre Channel cable	For Optical, 50 m	
	DF-F500-K5OP	Fibre Channel cable	For Optical, 100 m	
	DF-F500-KB1P	LC-SC(*1) conversion cable	For optical, 5 m	
	DF-F500-KB2P	LC-SC(*1) conversion cable	For optical, 10 m	
	DF-F500-KB3P	LC-SC(*1) conversion cable	For optical, 20 m	
	DF-F500-KB4P	LC-SC(*1) conversion cable	For optical, 50 m	
	DF-F500-KB5P	LC-SC(*1) conversion cable	For optical, 100 m	
	DF-F500-KC1P	LC-LC(*1) cable	For optical, 5 m	
	DF-F500-KC2P	LC-LC(*1) cable	For optical, 10 m	
	DF-F500-KC3P	LC-LC(*1) cable	For optical, 20 m	
	DF-F500-KC4P	LC-LC(*1) cable	For optical, 50 m	
	DF-F500-KC5P	LC-LC(*1) cable	For optical, 100 m	
	DF-F500-K1B	Fibre Channel cable for additional	FC cable 0.5 m × 2	ENC cable
Interface cable (SCSI)	DF-F500-K350L	SCSI cable	5 m, 50-pin, pin/latch type	Refer to page 0940.
	DF-F500-K450L	SCSI cable	5 m, 50-pin, bellows/latch type	

*1 : General specifications for connectors are shown below.

1 G bps (100 M bytes/s) Fibre Channel connectors : SC or LC connectors are to be used. (For the DF500, SC connectors are to be used.)

2 G bps (200 M bytes/s) Fibre Channel connectors : LC connectors are to be used. (For the DF500, LC connectors are to be used also.)

Classification	Model	Name	Specification	Remarks
Interface cable (SCSI)	DF-F500-K550L	SCSI cable	1.5 m, 50-pin, pin/latch type	Refer to page 0940.
	DF-F500-K650L	SCSI cable	3 m, 50-pin, pin/latch type	
	DF-F500-K750L	SCSI cable	1.5 m, 50-pin, bellows/latch type	
	DF-F500-K850L	SCSI cable	3 m, 50-pin, bellows/latch type	
	DF-F500-K068L	SCSI cable	1.5 m, 68-pin, bellows/latch type	
	DF-F500-K168L	SCSI cable	3 m, 68-pin, bellows/latch type	
	DF-F500-K268L	SCSI cable	5 m, 68-pin, bellows/latch type	
	DF-F500-K568L	SCSI cable	20 m, 68-pin, bellows/latch type	
	DF-F500-K068M	SCSI cable	1.5 m, 68-pin, mini bellows/screw-locked type	
	DF-F500-K168M	SCSI cable	3 m, 68-pin, mini bellows/screw-locked type	
	DF-F500-K268M	SCSI cable	5 m, 68-pin, mini bellows/screw-locked type	
	DF-F500-K368M	SCSI cable	15 m, 68-pin, mini bellows/screw-locked type	
	DF-F500-K468M	SCSI cable	10 m, 68-pin, mini bellows/screw-locked type	
	DF-F500-K068S	SCSI cable	1.5 m, 68-pin, pin/screw-locked type	
	DF-F500-K168S	SCSI cable	5 m, 68-pin, pin/screw-locked type	
	DF-F500-K268S	SCSI cable	3 m, 68-pin, pin/screw-locked type	
	DF-F500-K368S	SCSI cable	10 m, 68-pin, pin/screw-locked type	
	DF-F500-K468S	SCSI cable	15 m, 68-pin, pin/screw-locked type	
	DF-F500-K568S	SCSI cable	0.5 m, 68-pin, pin/screw-locked type	
RS232C cable	DF-F500-S1	RS232C cable	9 pins - 9 pins, 5 m	Refer to page 1090.
	DF-F500-S2	RS232C cable	9 pins - 9 pins, 10 m	
	DF-F500-SH2	RS232C cable	9 pins - 25 pins, 5 m	Refer to page 1100.
	DF-F500-SH3	RS232C cable	9 pins - 25 pins, 10 m	
	DF-F500-SS2	RS232C cable	9 pins - 25 pins, 5 m	Refer to page 1110.
	DF-F500-SS3	RS232C cable	9 pins - 25 pins, 10 m	
	DF-F500-SR2	RS232C cable	9 pins - 25 pins, 5 m	Refer to page 1120.
	DF-F500-SR3	RS232C cable	9 pins - 25 pins, 10 m	

3.5 Software of DF500

Model names and specifications of function enhancement software and application software of DF500 are shown below.

(1) Function enhancement software

Table 3.5.1 List of Function Enhancement Software

Classification	Model	Name	Specification	Remarks
Turbo LU residence function	DF-F500-WLU	Turbo LU residence function	Turbo LU residence function	
Fibre security function	DF-F500-WSEC	Fibre security control function	Fibre security control function for supporting SAN system (Port, LUN security)	
ID take-over function	DF-F500-WD	ID take-over control function	SCSI ID/Port ID take-over control function (SCSI Hot Standby + FC Port ID Dual Active ID Succession)	
SNMP support function	DF-F500-WS	SNMP support control function	SNMP support control function	
Password protection function	DF-F500-WSPS	Password protection control function	Password protection control function	
MRCF-Lite function	DF-F500-WCFL	MRCF-Lite control function	MRCF-Lite function	

(2) The application software

Table 3.5.2 List of Application software

Classification	Model	Name	Specification	Remarks
Utility program	P-242Z-J101	Utility program for supporting Web	Utility program for Windows	
	P-242Z-J102	Disk Array management program /Disk Array management program 2 (*1)	GUI for Windows	
	P-242Z-J103		CLI for Windows	
	P-242Z-J104		GUI + CLI for Windows	
	P-242Z-J105		GUI + CLI for Windows	A version in cooperation and integrates with the network management software.
	P-9D2Z-J301		GUI for Solaris	
	P-9D2Z-J302		CLI for Solaris	
	P-9D2Z-J303		GUI + CLI for Solaris	
	P-9H2Z-J000		GUI for IRIX	
	P-9H2Z-J001		CLI for IRIX	
	P-9H2Z-J002		GUI + CLI for IRIX	
	P-922Z-J002		CLI for HP-UX	
Failure notification program	P-9Z2S-J001	Failure notification program	For Hitachi 9000V series server (using HP-UX10.01 or later) Medium : DAT	• Hitachi 9000V series workstations are not supported. • RS232C cable is required separately.
	P-9Z2S-J002	Failure notification program	For SUN SPARC Station (using Sun OS4.1.3 or later) Medium : CD-R	• Solaris version of the program cannot operate on Sun OS. • RS232C cable ordered separately is required.
	P-9Z2S-J003	Failure notification program	For SUN SPARC Station (using Solaris 2.4 or later) Medium : 3.5-inch FD	• Sun OS version of the program cannot operates on Solaris. • RS232C cable is required separately.
	P-9Z2S-J004	Failure notification program	For IBM RS/6000 (using AIX3.2.5 or later) Medium : 3.5-inch FD	• RS232C cable ordered separately is required.
	P-222Z-J001	Failure notification program	Failure monitoring program needed for the failure monitoring service (SD-5110-2601) by means of LAN configuration with PC and TCP/IP	

*1 : The Disk Array management program 2 is provided by Disk Array management program Ver.5.10 or later.

Classification	Model	Name	Specification	Remarks
Path manager	P-242Z-J013	Path manager	Path Manager (for Windows NT) with alternative path function only	• These are for SCSI. For the Fibre Channel version, please consult us.
	P-912Z-J013	Path manager	Path Manager (for AIX entry machine) with alternative path function only	
	P-912Z-J014	Path manager	Path Manager (for AIX enterprise machine) with alternative path function only	
	P-9D2Z-J113	Path manager	Path Manager (for Solaris) with alternative path function only	

Chapter 4 Interface

There are two interfaces with a host computer available, that is, Fibre Channel (Non-OFC) and SCSI. The Fibre Channel interface as the standard by RK, H1F and H2F, however, the subsystem can support the SCSI interface by using the optional Interface board.

4.1 Fibre Channel Connection Specifications

4.1.1 System configuration

The maximum number of devices connectable to the FC-AL or FC-SW is 126 including DF500, host computers, and other Fibre Channel devices. However, the number of host computers which can access subsystem at the same time is limited to 15.

When constructing a system with the FC-AL or AC-SW, take the following in consideration.

- Use the HUB which conforms to the FC-AL standard.
- If you use the least Fibre Channel devices connected when loop the Fibre Channel, you can get higher performance.
- Since high-speed serial data transfer is performed via Fibre Channel, use high-quality Fibre Channel cables which conform to the FC-PH standard.

(1) Notes on the case of the Fibre Channel configuration

(a) Setting of the 1 G bps mode or 2 G bps mode for the DF2G2

(i) The auto-negotiation for a selection of the 1 G bps mode or 2 G bps mode cannot be done.
A selection of the 1 G bps mode or 2 G bps mode must be done manually because specifications for the case of the Fibre Channel configuration are cot fixed yet.

(ii) A switching between the 1 G bps and 2 G bps modes performed with the subsystem power on.
A switching between the 1 G bps and 2 G bps modes can be done while the subsystem power is on.

(b) The dual CTL configuration

(i) In the mode other than the ID Take-Over

No restrictions are placed (the 1 G bps and 2 G bps modes can coexist).
For the details, refer to Table 4.1.1.

Table 4.1.1 Possibility for Setting I/F Port in the Mode Other than the ID Take-Over

			CTL1		
			DFFM5/DFFM6	DF2G2	
			1 G bps	1 G bps mode	2 G bps mode
CTL0	DFFM5/DFFM6	1 G bps	○	○	○
	DF2G2	1 G bps mode	○	○	○
		2 G bps mode	○	○	○

(ii) In the ID Take-Over mode

The CTL0 and CTL1 must have the same hardware configuration.
For the details, refer to Table 4.1.2.

Table 4.1.2 Possibility for Setting I/F Port in the ID Take-Over Mode

			CTL1(*1)		
			DFFM5/DFFM6	DF2G2	
			1 G bps	1 G bps mode	2 G bps mode
CTL0(*1)	DFFM5/DFFM6	1 G bps	○	×	×
	DF2G2	1 G bps mode	×	○	×
		2 G bps mode	×	×	○

*1 : A different mode setting can be made for each of the A and B ports. However, the same setting must be made for the corresponding ports of the CTL0 and CTL1 (0A and 1A ports and 0B and 1B ports).

(c) Usability of FL and F ports

Table 4.1.3 shows whether the ports are supported or not.

Table 4.1.3 Scope of Support for FL and F Ports

		1 G bps	1 G bps mode
DFFM5	1G bps	○	×
DFFM6	1G bps	○	○
DF2G2	1 G bps mode	○	○
	2 G bps mode	○	○

(d) ID take-over in the Quick Loop mode (for the DF2G2 only)

A take-over can be done with the DF2G2 (in the 1 G bps mode) in the Quick Loop mode.

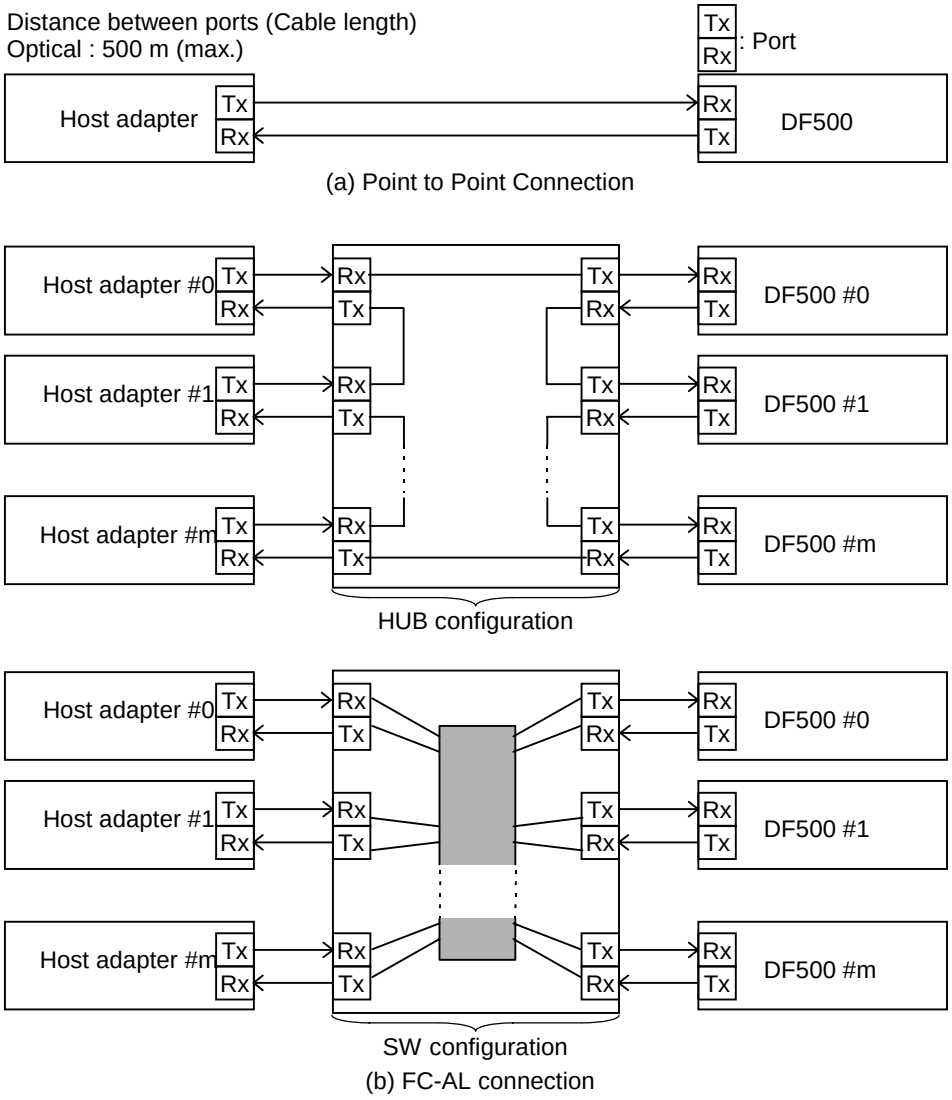


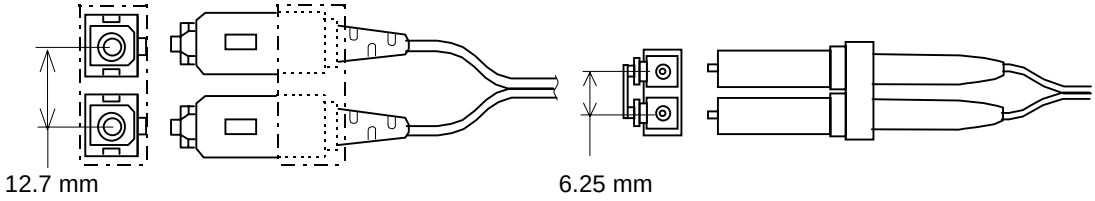
Figure 4.1.1 Fibre Channel Connection Specifications

4.1.2 Cable

Table 4.1.4 shows specifications of the Fibre Channel interface cable. Figure 4.1.2 shows the type of connector for the optical interface on the cable side.

Table 4.1.4 Cable Specification

Cable type	Interface type	Cable mode name	Nominal		
			Cable	Connector	
				one side	other side
SC-SC cable	Optical	Equivalent to sumitomo 3M 170AA-11A1-XXX	50/125 μm Multimode Wavelength : 780 nm	SC connector (JIS C 5973) (Figure 4.1.2 (a))	SC connector (JIS C 5973) (Figure 4.1.2 (a))
SC-LC cable		Equivalent to sumitomo 3M 170AC-AAAA-XXX	50/125 μm Multimode Wavelength : 850 nm	SC connector (JIS C 5973) (Figure 4.1.2 (a))	LC connector (Figure 4.1.2 (b))
LC-LC cable				LC connector (Figure 4.1.2 (b))	LC connector (Figure 4.1.2 (b))



(a) SC connector type (b) LC connector type

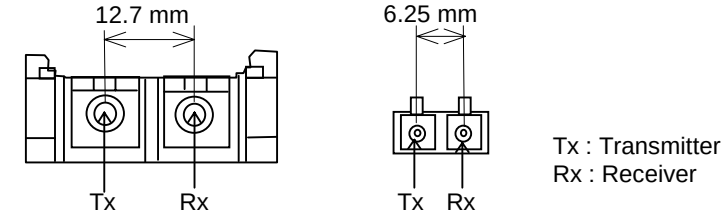
Figure 4.1.2 Cable side Connector

4.1.3 Connector on the subsystem side

Figure 4.1.3 shows the type of connector for the optical interface on the subsystem side.

(1) SC connector type (for DF-F500-DFFM5/DF-F500-DFFM6/DF-F500-F1F)
Connector type : SC duplex receptacle connector (JIS C 5973-1994)
Interval : 12.7 mm flat type, two rows

(2) LC connector type (for DF-F500-DF2G2)
Connector type : LC duplex receptacle connector
Interval : 6.25 mm flat type, two rows



(a) SC connector type (b) LC connector type

Figure 4.1.3 Shape of Connector on DF500

4.1.4 Ordered set

The Table 4.1.5 shows the Ordered Sets defined by the Fibre Channel interface.

Table 4.1.5 Ordered Set

No.	Classification	Name	Remarks
1	Frame Delimiters	SOF (Start of Frame)	
2		EOF (End of Frame)	
3	Primitive Signals	IDLE	
4		R_RDY (Receiver_Ready)	
5		ARBx (Arbitrate)	
6		OPNyx (Open full-duplex)	
7		OPNyy (Open half-duplex)	
8		OPNfr (Open broadcast replicate)	
9		OPNyr (Open selective replicate)	
10		CLS (Close)	
11		MRKtx (Mark)	
12	Primitive Sequence	NOS (Not Operational)	
13		OLS (Off-line)	
14		LR (Link Reset)	
15		LRR (Link Reset Response)	
16		LIP (Loop Initialization)	
17		LPEyx (Loop Port Enable)	
18		LPEfx (Loop Port Enable all)	
19		LPByx (Loop Port Bypass)	

(1) Frame Delimiters

The Frame Delimiter is an Ordered Sets that immediately precedes or follows a frame context, and consists of the SOF (Start of Frame) and the EOF (End of Frame).

(a) SOF (Start of Frame)

The SOF delimiter is an Ordered Set that immediately precedes the context of a frame. There are following SOF delimiters, shown in the Table 4.1.6, based on the service class, etc.

Table 4.1.6 SOF Delimiters

No.	Name	Meaning	Remarks
1	SOFc1	A frame delimiter to be used to require the exclusive connection of the Class 1 service. Since the subsystem does not support the Class 1 service yet, it responds with R_RJT (Class not Supported) as to the frame.	
2	SOFi1	A frame delimiter to be used when starting the sequence following the exclusive connection of the Class 1 service. Since the subsystem does not support the Class 1 service yet, it responds with R_RJT (Class not Supported) as to the frame.	
3	SOFi2	This is used for the first frame that starts the sequence of the Class 2 service. Since the subsystem does not support the Class 2 service yet, it responds with R_RJT (Class not Supported) as to the frame.	
4	SOFi3	This is used for the first frame that starts the sequence of the Class 3 service.	
5	SOFn1	This is used for frames other than the first frame of the sequence of the Class 1 service. Since the subsystem does not support the Class 1 service yet, it responds with R_RJT (Class not Supported) as to the frame.	
6	SOFn2	This is used for frames other than the first frame of the sequence of the Class 2 service. Since the subsystem does not support the Class 2 service yet, it responds with R_RJT (Class not Supported) as to the frame.	
7	SOFn3	This is used for frames other than the first frame of the sequence of the Class 3 service.	

(b) EOF (End of Frame)

The EOF delimiter is an Ordered Set that immediately follows the context of a frame. There are following EOF delimiters, shown in the Table 4.1.7, based on the service class, etc.

Table 4.1.7 EOF Delimiters

No.	Name	Meanings	Remarks
1	EOFt	This shows that the sequence of the SEQ_ID which is owned by a frame.	
2	EOFdt	This is used to cancel the exclusive connection. This identifies the final ACK of the sequence and shows that the sequence of the SEQ_ID owned by a frame has completed.	Class 1 is not supported.
3	EOFn	This is used when no other EOF delimiter (EOFt or EOFdt) which shows valid frame contents is required.	
4	EOFdti	When the EOFdt has illegal contents, it is replaced with the EOFdti.	
5	EOFni	When the EOFt or EOFn has illegal contents, it is replaced with the EOFni.	
6	EOFa	This is used to terminate a partial frame owing to an error occurred during a transfer. A receiver must abandon the frame without making any response.	

(2) Primitive Signals

A Primitive Signal a signal that has special meaning. The following Primitive Signals are defined.

(a) IDLE

An IDLE is a Primitive Signal transmitted on the link to indicate an operational Port facility is ready for frame transmission and reception. The IDLE is transferred when no frame, R_RDY, or primitive sequence is being transferred on a link.

(b) R_RDY(Receiver Ready)

The R_RDY indicates that a single Class 1 connect-request (SOFc1), Class 2, or Class 3 frame was received and that the interface buffer which received the frame is available for further frame reception.

(c) ARBx (Arbitrate) --- FC-AL

An ARBx is a Primitive Signal transmitted on a Loop by a participating L_Port to request access to the Loop. It may be sent instead of the IDLE when DF500 is connected to the FC-AL.

(d) OPNyx (Open full-duplex) --- FC-AL

An OPNyx is a Primitive Signal transmitted on a Loop by a participating L_Port to indicate that it is ready for Data and Link Control frame transmission and reception.

(e) OPNyy (Open half-duplex) --- FC-AL

An OPNyy is a Primitive Signal transmitted on a Loop by a participating N_Port to indicate that it is ready for Data and Link Control frame transmission and Link Control frame reception.

(f) OPNfr (Open broadcast replicate) --- FC-AL

An OPNyy is a Primitive Signal transmitted on a Loop by a participating L_Port which desires to communicate with all participating L_Ports on the Loop.

(g) OPNyr (Open selective replicate) --- FC-AL

An OPNyr is a Primitive Signal transmitted on a Loop by a participating L_Port which desires to communicate with a subset of L_Ports on the Loop.

(h) CLS (Close) --- FC-AL

A CLS is sent by the L_Port. When the L_Port sends the CLS , it does not transfer the frame and the R_RDY to the current circuit.

The CLS shows that the control of the loop is ready to be abandoned or has already been abandoned.

(i) MRKtx (Mark) --- FC-AL

A MRKtx is a Primitive Signal transmitting on a Loop by a master control point to synchronize other Nodes.

(3) Primitive Sequences

A Primitive sequences form an ordered set and they are transferred repeatedly and continuously while the certain condition exists. Types of the primitive sequence are shown below.

(a) NOS (Not Operational)

The NOS Primitive Sequence is transmitted to indicate that the Port transmitting this Sequence has detected a Link Failure condition or is Off-line, waiting for OLS to be received.

(b) OLS (Off-line)

The OLS Primitive Sequence is transmitted to indicate that the port transmitting this Sequence is:

- initiating the Link Initialization Protocol,
- receiving and recognizing NOS, or
- entering the Off-line State

(c) LR (Link Reset)

The LR Primitive Sequence is transmitted by a Port to initiate the Link Reset Protocol or to recover from a Link Time-out. Besides, the LR is possible to be sent when the N_Port which supports the Class 1 service becomes unable to decide the connection status.

(d) LRR (Link Reset Response)

The LRR Primitive Sequence is transmitted by a Port to indicate that it is receiving and recognizes the LR Primitive Sequence.

(e) LIP (Loop Initialization) --- FC-AL

The LIP Primitive Sequence is used by an L_Port to detect if it is part of a Loop or to recover from certain Loop errors.

(f) LPEyx (Loop Port Enable) ---FC-AL

The LPEyx is sent on the loop to reset the bypass circuit of the L_Port which was bypassed before and to put the L_Port in the enabled status.

(g) LPEfx (Loop Port Enable all) --- FC-AL

The LPEfx Primitive Sequence is transmitted on a Loop to reset all Bypass Circuit(s) that may have been previously set and enable all L_Port to participate on the Loop.

(h) LPByx (Loop Port Bypass) --- FC-AL

The LPByx Primitive Sequence is transmitted on a Loop to set the Bypass Circuit and to bypass an L_Port.

4.1.5 Frames

(1) Frame Format

The Table 4.1.8 shows the frame format used with the Fibre Channel.

Table 4.1.8 Frame format

Start of Frame (SOF)	Frame Header	Data File	CRC	End of Frame (EOF)
4 bytes	24 bytes	0 to 2112 bytes	4 bytes	4 bytes

(a) Start of Frame

The Start of Frame (SOF) delimiter is an Ordered Set that immediately precedes the frame context.

For the types of the SOF, refer to “Subsection 4.1.4, Ordered Set” on page 0680.

(b) Frame Header

The Frame Header is used by the link control facility to control link operations, control device protocol transfers, and detect missing or out of order frames.

For the Frame Header, refer to “Section 4.1.5 (2) Header” on page 0730.

(c) Data Field

This field can take the following size depending on the frame type(‡1).

- Link control frame : Data Field length = 0
- Data frame : Data Field length = 0 to 2112

The optional header(‡1) may be supplied at the top of the Data Field of the data frame. The data described in the data frame is Data Field excluding the option header. This portion is called payload.

(d) CRC

The CRC is the Cyclic Redundancy Check code for checking data in the Frame Header and Data Field.

(e) End of Frame

The End of Frame (EOF) is a frame delimiter for identifying the end of a frame.

For the types of the EOF, refer to “Subsection 4.1.4, Ordered Set” on page 0680.

‡1 : The frame type and presence or absence of the optional header are prescribed by the Frame Header. For details, refer to “Subsection 4.1.5 (2) Header” (0730).

(2) Header

(a) Frame Header

The format of the Frame Header is shown in the Table 4.1.9.

Table 4.1.9 Frame format

Word \ Bits	31 to 24	23 to 16	15 to 08	07 to 00
0	R_CTL	D_ID		
1	Reserved	S_ID		
2	TYPE	F_CTL		
3	SEQ_ID	DF_CTL	SEQ_CNT	
4	OX_ID		RX_ID	
5	Parameter			

(i) R_CTL (Routing Control)

The R_CTL field is used to categorize the frame function. Classification into the link control frame and data frame is done by the R_CTL.

(ii) D_ID (Destination ID)

The D_ID field contains the address identifier of an N_Port or F_Port within the destination entity.

(iii) S_ID (Source ID)

The S_ID field contains the address identifier of an N_Port or F_Port within the source entity.

(iv) TYPE (Data Structure Type)

The TYPE field identifies the protocol of the frame content for Data Frames.

(v) F_CTL (Frame Control)

The F_CTL field contains control information relating to the frame contents.
The control information includes the Exchange Context, Sequence Context, etc.

(vi) SEQ_ID (Sequence ID)

The SEQ_ID field contains the SEQ_ID assigned by the Sequence Initiator, and it shall be unique for a specific D_ID and S_ID pair while the Sequence is Open.

(vii) DF_CTL (Data Field Control)

The DF_CTL field specifies the presence of optional headers at the beginning of the Data Field.

(viii) SEQ_CNT

The SEQ_CNT field indicates the sequential order of Data Frame transmission within a single sequence or multiple consecutive sequences for the same Exchange.

(ix) OX_ID (Originator Exchange ID)

The OX_ID field identifies the Exchange ID assigned by the Originator of the Exchange.
Each Exchange shall be assigned an identifier unique to the Originator or Originator-Responder Pair.

(x) RX_ID (Responder Exchange ID)

The RX_ID is an identifier of the exchange assigned by the responder of the exchange. It is unique and locally significant for the responder.

(xi) Parameter

In the link control frame, the parameter is used to transmit original information of the individual link control frame and in the data frame, it is used for the relative offset.

(b) Optional Headers

The presence of the Optional Headers is indicated by the DF_CTL field.
The treatment of the Optional Headers with the DF500 is shown in the Table 4.1.10.

Table 4.1.10 Optional Headers

No.	Name	Usage	Treatment with the Disk Array	Remarks
1	Expiration_Security Header	Used to specify the expiration time, etc. of the frame.	Ignores this header and processes the command.	16 bytes
2	Network Header	Used by a bridge or a gateway node which interfaces to an external Network.	Ignores this header and processes the command.	16 bytes
3	Association Header	Used to identify the process or process group.	Ignores this header and processes the command.	32 bytes
4	Device Header	Used by the upper level protocol.	Ignores this header and processes the command.	16 bytes 32 bytes 64 bytes

DF500 does not add Optional Headers in a Data frame to be sent to other N_Ports.
The host computer shall not add Optional Headers in a frame sent to the DF500.
If the Optional Headers are added in the Data frames sent to the subsystem, correct operation in DF500 is not guaranteed.

(3) Link Control Frames

The Table 4.1.11 shown the defined Link Control frames (FT-0) and supported Link Control frames. DF500 supports link control frames shown in Table 4.1.12 on page 0760.

Table 4.1.11 Link Control Frames

No.	Name	Meaning	Support(*1)	Remarks
1	ACK_1 (Acknowledge_1)	Indicates that a single Data frame is being acknowledged.	○(*2)	
2	ACK_0 (Acknowledge_0)	Indicates that all Data frames of a Sequence are being acknowledged.	×	
3	ACK_N (Acknowledge_N)	Indicates that N consecutive Data frames of a Sequence are being acknowledged.	×	
4	P_RJT (N_Port Reject)	Indicates that delivery of a frame is being denied. A four byte reject action and reason code is contained in the Parameter field.	○	
5	F_RJT (Fabric Reject)	Indicates that delivery of a frame is being denied. A four byte reject action and reason code is contained in the Parameter field.	○	
6	P_BSY (N_Port Busy)	Indicates that the responding N_Port is temporarily occupied with other link activity and is not able to accept the frame. A reason code is contained in the Parameter field.	○	
7	F_BSY (Fabric Busy)	Indicates that the fabric or the destination N_Port is temporarily occupied with other link activity and the fabric is unable to deliver the frame. A reason code is contained in bits 31-28 of the TYPE field.	○	
8	LCR (Link Credit Reset)	Indicates that the N_Port specified by the S_ID requests that the N_Port specified by the D_ID reset any buffers containing Data frames from the S_ID in order to allow the S_ID to reset its end-to-end Credit to its Login value.	○	

*1 : ○: Supported
× : Not Supported
*2 : Support for the ACK_1 is given in the limited case where the PLOGI of the Class 2 is used.

(4) Data Frames

The Data frames defined include:

- FC-4 Device_Data
- FC-4 Video_Data
- Link_Data

FC-4 Device_Data is a frame which is used by the protocol prescribed by upper levels. (FCP Information Unit, etc.) (For details on FCP Information Unit, refer to Section 4.4.)
FC-4 Video_Data is not supported by this equipment.
Link_Data defines link services. For link services, refer to Subsection 4.1.6 “Link Service” on page 0760.

4.1.6 Link service

The Table 4.1.12 shows the Link Service frames supported by DF500.

Table 4.1.12 Link Service Frames

No.	Classification	Name	Support(*1)		Remarks
			Issue	Receive	
1	Basic Link Service	ABTS (Abort Sequence)	×	○	
2		BA_ACC (Basic_Accept)	○	○	
3		BA_RJT (Basic_Reject)	○	○	
4		NOP (No Operation)	×	○	
5		RMC (Remove Connection)	×	×	
6	Extended Link Service	ABTX (Abort_Exchange)	×	○	
7		ACC (Accept)	○	○	
8		ADVC (Advice Credit)	×	×	
9		ECHO (Echo)	×	×	
10		ESTC (Estimate Credit)	×	×	
11		PLOGI (N_Port Login)	○	○	
12		LOGO (Logout)	○	○	
13		LS_RJT (Link Service Reject)	○	○	
14		FLOGI (Fabric Login)	○	×	
15		RCS (Read Connection Status)	×	×	
16		RES (Read Exchange Status Block)	×	×	
17		RLS (Read Link Status)	×	×	
18		RRQ (Reinstate Recovery Qualifier)	×	○	
19		RSI (Request Sequence Initiative)	×	×	
20		RSS (Read Sequence Status Block)	×	×	
21		RTV (Read Time-out Value)	×	×	
22		TEST (Test)	×	×	
23		SCR (State Change Registration)	○	×	
24		RSCN (Registered Status Change Notification)	○	○	
25		FAN	×	○	
26	Extended Link	PRLI (Process Login)	×	○	
27	Service- Proc.	PRLO (Process Logout)	×	○	
28		SCN (State Change Notification)	×	×	
29		TPLS (Test Process Login State)	×	×	
30	Extended Link	GAID (Get Alias_ID)	×	×	
31	Service - Alias	FACT (Fabric Activate Alias_ID)	×	×	
32		FDACT (Fabric Deactivate Alias_ID)	×	×	
33		NACT (N_Port Activate Alias_ID)	×	×	
34		NDACT (N_Port Deactivate Alias_ID)	×	×	
35	Extended Link	QoSR (Quality of Service Request)	×	×	
36	Service - Class 4	RVCS (Read Virtual Circuit Status)	×	×	
37	Extended Link Service	PDISC (Discover N_Port Service Parm)	×	○	
38	- FC-AL	FDISC (Discover F_Port Service Parm)	×	×	
39		ADISC (Discover Address)	×	○	
40		TPRLO (Third Party Process Logout)	×	○	

*1 : ○ : Supported
× : Not Supported

4.1.7 FCP

(1) Frame format

DF500 supports the 6 Information Units (IU) shown in the following table.

Table 4.1.13 Information Unit

No.	Information Unit Name	Function	Support (*1)	Remarks
1	FCP_CMND	Transfers SCSI Command or Task Management	○	
2	FCP_XFER_READY	Notifies FCP_DATA will be transferred.	○	
3	FCP_DATA	Transfers Data.	○	
4	FCP_RSP	Transfers Status Information	○	
5	FCP_CMND+FCP_DATA	Transfers SCSI Command and the first Data within a single Information Unit. (Write Type Command)	×	
6	FCP_DATA+FCP_RSP	Transfers last Data and the Status Information within a single Information Unit. (Read Type Command)	×	

*1 : ○ : Supported
× : Not Supported

The format of the standard frame header used in the FCP is shown in Table 4.1.14.

Table 4.1.14 Frame Header Format

Word \ Bits	31 to 24	23 to 16	15 to 08	07 to 00
0	R_CTL	D_ID		
1	Reserved	S_ID		
2	TYPE	F_CTL		
3	SEQ_ID	DF_CTL	SEQ_CNT	
4	OX_ID		RX_ID	
5	RLTV_OFF			

(a) R_CTL (Routing control)

This is used to identify the information category of the FCP frame.

1 : FCP_DATA (Data In action, Data Out action)
5 : FCP_XFER_RDY (Data delivery request)
6 : FCP_CMND (Command/Task Management Request)
7 : FCP_RSP (Command/Task Management Response)

(b) D_ID (Destination ID)

This indicates the transmission destination of a frame. D_ID of the frame from the SCSI command issuer side (Exchange originator) is the target ID of SCSI-3.

(c) S_ID

This indicates the transmission destination of a frame. S_ID of the frame from the SCSI command issuer side (Exchange originator) is the initiator ID of SCSI-3.

(d) TYPE (Data structure type)

In the TYPE field of all frames of the FCP sequence, 0x08 is set.

(e) F_CTL (Frame control)

This consists of fields for controlling start of the sequence and exchange, and normal and abnormal terminations. For further details, refer to the FC-PH standard.

(f) SEQ_ID (Sequence ID)
This indicates an order of the frames in the sequence. For further details, refer to the FC-PH standard.

(g) DF_CTL (Data field control)
This indicates whether there is an optional header or not. The FCP requires no optional header.

(h) OX_ID (Originator exchange ID)
This indicates the exchange ID on the starting side of the exchange (initiator) and corresponds to the tag number of SCSI-3. (OxFFFF cannot be specified.)

(i) RX_ID (Responder exchange ID)
This indicates the exchange ID on the responding side of the exchange (target). Any value may be given to this. The responding side of the exchange can assign a unique value to OX_ID (tag).

(j) RLTV_OFF (Relative offset)
In the FCP-DATA IU, the offset (offset on the buffer allocated by the host) of the top byte of the payload of each frame is set. In other IU frames, 0 is set.

(2) FCP_CMND

The FCP_CMND is sent from a host and is used for the task management instruction such as SCSI command issue and target reset.

The payload of FCP_CMND is shown in table 4.1.15.

Table 4.1.15 FCP_CMND Payload

Field Name	Definition	Size
FCP_LUN	Logical Unit Number	8 bytes
FCP_CNTL	byte 0 : Reserved	4 bytes
	byte 1 : Task Codes bit 7 to 3 : Reserved bit 2 to 0 : Task Attribute 000 : SIMPLE_Q 001 : HEAD_OF_Q 001 : ORDERED_Q 100 : ACA_Q (Not Supported) 101 : UNTAGGED	
	byte 2 : Task Management Flags bit 7 : TERMINATE TASK (Not Supported) bit 6 : CLEAR ACA bit 5 : TARGET RESET bit 4 to 3 : Reserved bit 2 : CLEAR TASK SET bit 1 : ABORT TASK SET bit 0 : Reserved	
	byte 3 : Execution Management Codes bit 7 to 2 : Reserved bit 1 : READ DATA bit 0 : WRITE DATA	
FCP_CDB	SCSI Command Descriptor Block	16 bytes
FCP_DL	Data Length	4 bytes

(a) FCP_LUN

The FCP_LUN field specifies the Logical Unit Number in which the issued SCSI Command is executed.

The Table 4.1.16 shows the format of the FCP_LUN field.

Table 4.1.16 FCP_LUN Format

Byte	0	1	2	3	4	5	6	7
Logical unit number	0x00	LUN	0x00	0x00	0x00	0x00	0x00	0x00

(b) FCP_CNTL

The FCP_CNTL field contains the following control information.

(i) Task Codes

One of the following task attributes can be specified.

- SIMPLE_QUEUE
  The SIMPLE_QUEUE attribute is specified when the task can be executed with the order that the array controller determines.
- HEAD_OF_QUEUE
  The HEAD_OF_QUEUE attribute is specified when the task should be executed with the highest priority.
- ORDERED_QUEUE
  The HEAD_OF_QUEUE attribute is specified when the task should be executed with the order of the task is issued.
- ACA_QUEUE
  This attribute is not supported by the DF500.
- UNTAGGED
  This attribute shows that a command has no tag.

(ii) Task Management Flags

One of the following Task Management Flags can be specified.

- TERMINATE TASK
  This Task Management Flag is not supported by the DF500.
- CLEAR ACA
  This Task Management Flag is not supported by the DF500.
- TARGET RESET
  The TARGET RESET is used to clear all tasks in the DF500.
  (Same as the SCSI-2 Bus Device Reset message)
- CLEAR TASK SET
  The CLEAR TASK SET is used to clear all tasks in the specified Logical Unit.
  (Same as the SCSI-2 Clear Queue message)
- ABORT TASK SET
  The ABORT TASK SET is used to clear all tasks in the specified Logical Unit for the Initiator. (Same as the SCSI-2 Abort message)
  The ABORT TASK (Same as the SCSI-2 Abort Tag message) is specified by the ABTS Link Service.

(iii) Execution Management

The direction of the SCSI data transfer is specified in the Execution Management. The direction depends on the SCSI Command.

(c) FCP_CDB

The SCSI CDB (Command Descriptor Block) is contained in the FCP_CDB field. The NACA (Normal Auto Contingent Allegiance) bit defined in the Control Byte of the CDB is not supported by the DF500. The NACA bit of 0 shall be specified. And the Command Link is not supported by the array controller. The Link bit shall be set to 0.

When one of these bits is set to 1, the array controller terminates the command with a CHECK ONDITION status (Sense Key = ILLEGAL REQUEST).

(d) FCP_DL

The total length bytes of the SCSI data is set in the FCP_DL field. Data described with the number of bytes according to the data length set in the FCP_CDB is transferred irrespective of the value set in this field. The value in this field is checked when the status is sent, and the check result is reflected on the FCP_RSP.

4.1.8 FC-4 device data frame/name server request commands

Table 4.1.17 shows the FC-4 Device Data Frame/Name Server Request commands that the subsystem supports.

Table 4.1.17 FC-4 Device Data Frame

No.	Name
1	FS_ACC
2	FS_RJT
3	RFT_ID (Register FC-4 TYPE)
4	RCS_ID (Register Class of Service)
5	RPT_ID (Register Port TYPE)
6	GPN_ID (Get Port Name)

4.1.9 Initialization process

(1) Link Initialization

When the array unit is turned on and becomes ready, the DF500 performs the Link Initialization process. The LR, LRR, NOS, OLS, and IDLE are exchanged between subsystem and the connected N_Port, and frames cannot be transmitted until the Active state.

The details of the Link Initialization process is shown in the Table 4.1.18.

At the beginning, the DF500 becomes OLS Transmit state, and the Link Initialization process continues until the Active state.

Table 4.1.18 Link Initialization Process

Current State	Input and Next State					
	LR	LRR	NOS	OLS	IDLE	Los of Sync, Timeout
(OLS Transmit) Transmits OLS for min. 5 ms	(LR Receive)	–	(NOS Receive)	(OLS Receive)	–	(Wait for OLS)
(LR Receive) Transmits LRR	–	(LRR Receive)	(NOS Receive)	(OLS Receive)	(Active)	(NOS Transmit)
(OLS Receive) Transmits LR	(LR Receive)	(LRR Receive)	(NOS Receive)	–	–	(Wait for OLS)
(LRR Receive) Transmits IDLE	(LR Receive)	–	(NOS Receive)	(OLS Receive)	(Active)	(NOS Transmit)
(NOS Receive) Transmits OLS	(LR Receive)	–	–	(OLS Receive)	–	(NOS Transmit)
(Wait for OLS) Transmits NOS	(NOS Transmit)	(NOS Transmit)	(NOS Receive)	(OLS Receive)	–	–
(NOS Transmit) Transmits NOS	–	–	(NOS Receive)	(OLS Receive)	–	(NOS Transmit)
(Active)	(LR Receive)	(LRR Receive)	(NOS Receive)	(OLS Receive)	–	–

– : State is not changed.

(2) Loop Initialization

When the array unit is turned on and becomes ready and the Arbitrated Loop is detected, the DF500 performs the Loop Initialization process.

The Loop Initialization is performed by ARBx (Arbitrate), LIP (Loop Initialization), CLS (Close), and the following Loop Initialization frames.

LISM : Select Master based on 8-byte Port_Name
LIFA : Fabric Assign AL_PA bit map
LIPA : Previously Acquired AL_PA bit map
LIHA : Hard Assigned AL_PA bit map
LISA : Soft Assigned AL_PA bit map
LIRP : Report AL_PA position map
LILP : Loop AL_PA position map

The DF500 transmits LIP at first. When s LIP is detected by the DF500, then the array controller transmits LISM.

When the same LISM as the DF500 has transmitted is received at the array controller, the subsystem becomes a Loop Master, and the subsystem transmits and receives ARBx, LIFA, LIPA, LIHA, LISA, LIRP, and LILP with address map, and determines the AL_PA of each L_Port.

At the end of the Loop Initialization, the subsystem transmits and receives CLS.

When the DF500 does not become a Loop Master, the transmission of LIFA, LIHA, LISA, LIRP, and LILP are initiated by the Loop Master. DF500 receives bit map information, and may add own AL_PA, and transmits it to the next L_Port. At the end of the Loop Initialization, the subsystem receives and transmits CLS.

4.1.10 Fibre Channel sequence example

(1) FCP information unit

(a) Read commands

Sending all data with the one FCP_DATA

Initiator IU	Direction	Target IU
FCP_CMND	---------->	
	<----------	FCP_XFER_READY
	<----------	FCP_DATA
	<----------	FCP_RSP

Sending all data dividing them into the two or more FCP_DATAs

Initiator IU	Direction	Target IU
FCP_CMND	---------->	
	<----------	FCP_XFER_READY
	<----------	FCP_DATA
	<----------	FCP_XFER_READY
	<----------	FCP_DATA
	<----------	FCP_XFER_READY
	<----------	FCP_DATA
	<----------	FCP_RSP

At the time of the Read Xfer Ready Disabled

Initiator IU	Direction	Target IU
FCP_CMND	---------->	
	<----------	FCP_XFER_DATA
	<----------	FCP_XFER_DATA
	<----------	FCP_RSP

The FCP_XFER_RDY is not sent before sending the FCP_XFER_DATA.

(b) Write commands

Sending all data with the one FCP_DATA.

Initiator IU	Direction	Target IU
FCP_CMND	---------->	
	<----------	FCP_XFER_READY
FCP_DATA	---------->	
	<----------	FCP_RSP

Sending all data with the two or more FCP_DATAs

Initiator IU	Direction	Target IU
FCP_CMND	---------->	
	<----------	FCP_XFER_READY
FCP_DATA	---------->	
	<----------	FCP_XFER_READY
FCP_DATA	---------->	
	<----------	FCP_XFER_READY
FCP_DATA	---------->	
	<----------	FCP_RSP

At the time of the Xfer Ready Disabled (not supported)

Initiator IU	Direction	Target IU
FCP_CMND	---------->	
FCP_DATA	---------->	
	<----------	FCP_XFER_READY
FCP_DATA	---------->	
	<----------	FCP_XFER_READY
FCP_DATA	---------->	
	<----------	FCP_RSP

The FCP_XFER_RDY is not sent before sending the first FCP_DATA.

(c) Control commands (with no data transfer)

Initiator IU	Direction	Target IU
FCP_CMND	---------->	
	<----------	FCP_RSP

(d) Queue Full, Busy, and Check Condition (before data transfer)

Initiator IU	Direction	Target IU
FCP_CMND	---------->	
	<----------	FCP_RSP

Status such as the Queue Full and Busy are stored in the FCP_RSP.

(e) Task management FCP_CMND (Target, Reset, Clear Task Set, and Abort Task Set)

Initiator IU	Direction	Target IU
FCP_CMND	---------->	
	<----------	FCP_RSP

(2) Link service

(a) FLOGI, PLOGI, LOGO, PRLI, and PRLO

When the command is accepted normally

LS_Command	Direction	LS_Command
Host Login (PLOGI)	---------->	
	<----------	Accept (ACC)

When the command is rejected

LS_Command	Direction	LS_Command
Host Login (PLOGI)	---------->	
	<----------	Link Service Reject (LS_RJT)

(3) Loop initialization

(a) When the subsystem becomes the loop master

Subsystem	Direction	
LIP, LIP	---------->	
	<----------	LIP, LIP
LISM, LISM(*1)	---------->	
	<----------	LISM, LISM
ARB (F0), ARB (F0)	---------->	
	<----------	ARB (F0), ARB (F0)
LIFA	---------->	
	<----------	LIFA
LIPA	---------->	
	<----------	LIPA
LIHA	---------->	
	<----------	LIHA
LISA	---------->	
	<----------	LISA
LIRP	---------->	
	<----------	LIRP
LILP	---------->	
	<----------	LILP
CLS (Close)	---------->	

*1 : The subsystem becomes the loop master when it sends the LISM with AL_PA = EF and the same LISM is returned. The AL_PA is decided by the LIFA, LIPA, LIHA, LISA, LIRP, and LILP frames and the initialization is completed by the CLS.

(b) The case where another loop master exists

Subsystem	Direction	
LIP, LIP	---------->	
	<----------	LIP, LIP
LISM, LISM	---------->	
	<----------	LISM, LISM
	<----------	ARB (F0), ARB (F0)
ARB (F0), ARB (F0)	---------->	
	<----------	LIFA
LIFA	---------->	
	<----------	LIPA
LIPA	---------->	
	<----------	LIHA
LIHA	---------->	
	<----------	LISA
LISA	---------->	
	<----------	LIRP
LIRP	---------->	
	<----------	LILP
LILP	---------->	
	<----------	CLS (Close)

(4) Fabric connection

Table 4.1.19 shows the basic sequence of the frame at the time of start-up when the subsystem is in the fabric connection.

Table 4.1.19 Basic Sequence at the Time of Start-Up in the Fabric Connection

No	Opponent party	Frame	Direction	Frame	<DF500>
1	<Fabric>	FAN	→		Is monitoring the PR_TOV timer
	<Fabric>		←	FLOGI	S_IDis issued with : PtoP=0x000000 FC_AL=0x0000AL_PA
		ACC	→		
2	<Name Server>		←	PLOGI	Logs in the name server.
		ACC	→		
3	<Name Server>		←	RCS_ID	Registers the support class.
		FS_ACC	→		
4	<Name Server>		←	RFT_ID	Registers the FC-4 type.
		FS_ACC	→		
5	<Name Server>		←	RPT_ID	Registers the type of own port as the N/NL.
		FS_ACC	→		
6	<Fabric Controller>		←	SCR	Receives and registers the RSCN. (=3 : Full Registration)
		ACC	→		
7	<Fabric Controller>		←	RSCN	Requires a host computer for an issue of RSCN again. (ADR format = 0 Affected N_Port ID = Own port address)
		ACC	→		

(5) Response when receiving the ELS without the PLOGI.
Table 4.1.20 shows the response made when receiving the ELS without the PLOGI.

Table 4.1.20 Response When Receiving ELS without PLOGI

Frame recived	Response	
	In FC_AL	In point to point (fabric) connection
FCP_CMND	No response (frame is abandoned.)	No response (frame is abandoned.)
PLOGI	Usual operation (Response in normal state : ACC Response when an error occurs : LS_RJT)	Usual operation (Response in normal state : ACC Response when an error occurs : LS_RJT)
FLOGI	Response with LS_RJT	Response with LS_RJT
LOGO	Usual operation (Response in normal state : ACC Response when an error occurs : LS_RJT)	Usual operation (Response in normal state : ACC Response when an error occurs : LS_RJT)
PRLI	Response with LOGO	Response with LOGO
PRLO	Response with LOGO	Response with LOGO
ADISC	Response with LOGO	Response with LOGO
PDISC	Response with LOGO	Response with LOGO
TPRLO	Response with LOGO	Response with LOGO
Other	Response with LOGO	Response with LOGO

The following response is made while the basic sequence (FLOGI to RSCN) of the frame is being executed when the subsystem starts up in the fabric connection described in Item (4).

- When the received frame is the FAN, normal operation is done.
- When the received frame is the PLOGI, ADISC, or PDISC, a response is made with the LS_RJT.
- When the other frame is received, no response is made (the frame is abandoned).

4.2 SCSI Connection Specifications

4.2.1 Interface cables (for daisy chain connection)

The maximum number of devices connectable to the SCSI bus including DF500, host computers, and other SCSI devices is six in the case of differential SCSI and three in the cases of the LVD and single-ended SCSI.

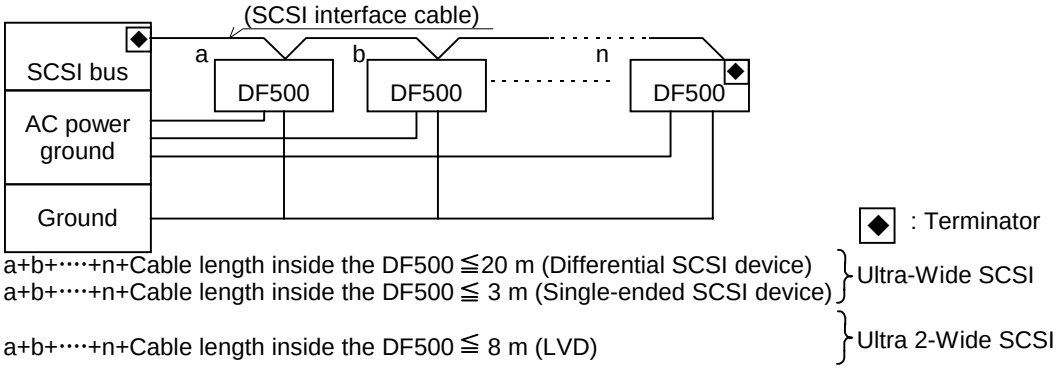


Figure 4.2.1 SCSI Connection Specifications

Since the required cable length inside the DF500 is approximately 1.0 m, pay attention to the cables length when connecting the SCSI cables. When connecting devices in a daisy chain, stability of the system operation is affected by connected devices and the cable type.

When constructing a system, take the following in consideration.

- The least Disk drives connected will result in higher performance.
- Make the total cable length as shorter as possible.
- Make the cable lengths the same as far as possible.
- Use cables with the same characteristics.

DF500 cannot respond with a selection to a command issued by a host computer for about three seconds after it has been started. Therefore, the initiator must suspend the command issue or connect the host computer after confirming that the subsystem becomes ready.
Incidentally, until the subsystem becomes ready, a reading/writing from/to it cannot be done.

When the main switch is turned off (or when the SCSI terminator power becomes low level in the Remote mode), all data, remaining in the cache memory and not yet reflected on the disk, is written onto the Disk drive (i.e. de-staging process). It takes a few seconds to ten odd minutes until this process completes, and then the subsystem is powered off. When the power is turned off directly with the breaker, the de-staging process is not allowed to be performed.
Therefore, the Cache memory enters the Cache Backup mode. In this case, the data assurance time is the cache backup time shown in Chapter 2, “Basic Specifications” (0220). Normally, to power off the subsystem, be sure to turn off the main switch (or set the SCSI terminator power to low level in the Remote mode) and turn off the breaker after making sure that the POWER LED goes out. When performing a maintenance work such as a part replacement, turn the power off following this procedure.

4.2.2 System configurations

Attach a terminator to the terminal one of the connected SCSI devices. When the DF500 is a terminal device, because it has a built-in terminator, make it effective by setting a jumper on the interface board(‡1).

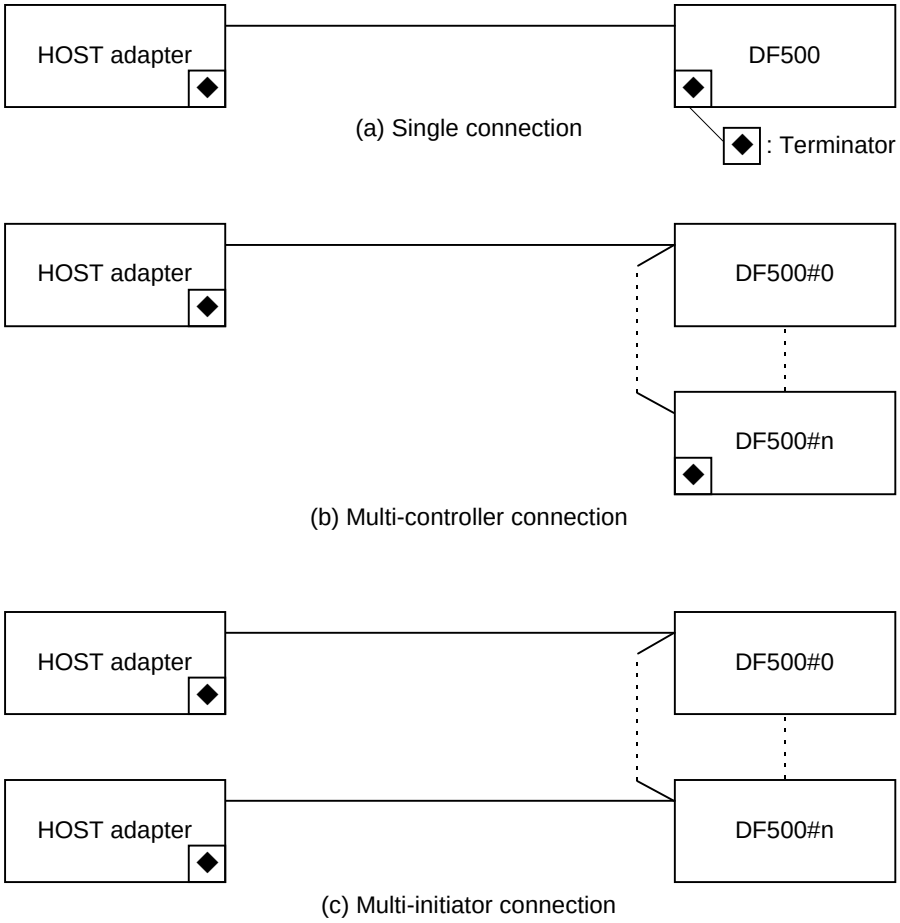


Figure 4.2.2 System Configuration

‡1 : The terminator which is built in the initiator board of DF500 is automatically validated when no SCSI cable is connected to the connector on the OUT side and the "automatic setting" (default) is set.

4.2.3 SCSI interface connector on the subsystem side

Table 4.2.1 Subsystem-Side Connector specifications

Connector name	Number of pins	Manufacturer's model name	Interface specification	Connector form
Half pitch pin-type connector	68	AMP 750737-7	Wide SCSI Single-ended Differential Low Voltage Differential	See Figure 4.2.3. Pin-type connector

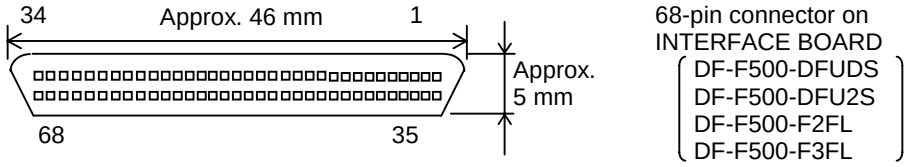


Figure 4.2.3 Form of Subsystem-Side Interface Signal Connector

4.2.4 SCSI cables

Table 4.2.2 Cable Specifications

Cable name	Cable type/rating	
Control signal cable	50-pin	Shielded cable 34P × 30 AWG.
	68-pin	Cable impedance : 90 ± 10 Ω at TDR or equivalent

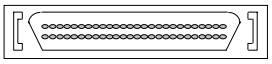
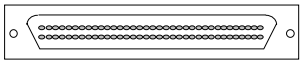
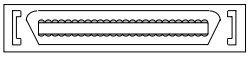
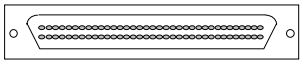
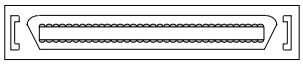
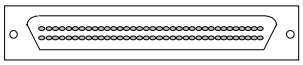
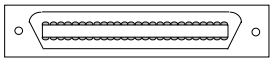
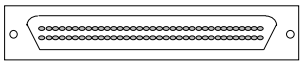
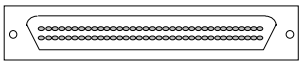
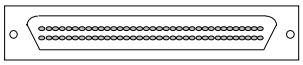
4.2.5 SCSI cable connectors

Table 4.2.3 Cable side connector

Connector name	Number of pins	Manufacturer's model name	Interface specification
Half pitch pin-type connector	68	AMP Connector : 749111-6 Cover : 750752-1	Wide SCSI Single-ended Differential Low Voltage Differential

Select the SCSI interface cable after making sure of the shape of the connector on the host computerized shown in Table 4.2.4.

Table 4.2.4 SCSI Cable-Connector Forms

No.	Model(*1) (DF-F500-)	Cable length (Number of pins)	SCSI cable connector shape (*1)		Remarks
			Host computer side	INTERFACE BOARD side	
1	K350L K550L K650L	5 m 1.5 m 3 m (50 pins)	 50-pin type /latch-locked	 68-pin type /screw-locked	
2	K450L K750L K850L	5 m 1.5 m 3 m (50 pins)	 50-bellows type / latch-locked	 68-pin type /screw-locked	
3	K068L K168L K268L K568L	1.5 m 3 m 5 m 20 m (68 pins)	 68-bellows type / latch-locked	 68-pin type /screw-locked	
4	K068M K168M K268M K368M K468M	1.5 m 3 m 5 m 15 m 10 m (68 pins)	 68-mini bellows type / screw-locked	 68-pin type /screw-locked	
5	K068S K168S K268S K368S K468S K568S	1.5 m 5 m 3 m 10 m 15 m 0.5 m (68 pins)	 68-pin type /screw-locked	 68-pin type /screw-locked	

*1 : Make sure of a form of a component on the SCSI board side.

4.2.6 Pin arrangements of connectors

(1) Differential

Table 4.2.5 SCSI Connector Pin Arrangement (Differential)

Pin No.	Signal name	Signal name	Pin No.
01	+ DB12	- DB12	35
02	+ DB13	- DB13	36
03	+ DB14	- DB14	37
04	+ DB15	- DB15	38
05	+ DBP1	- DBP1	39
06	GND	GND	40
07	+ DB0	- DB0	41
08	+ DB1	- DB1	42
09	+ DB2	- DB2	43
10	+ DB3	- DB3	44
11	+ DB4	- DB4	45
12	+ DB5	- DB5	46
13	+ DB6	- DB6	47
14	+ DB7	- DB7	48
15	+ DBP	- DBP	49
16	DIFFSENS	GND	50
17	TERMPWR(*1, 2)	TERMPWR(*1, 2)	51
18	TERMPWR(*1)	TERMPWR(*1)	52
19	OPEN	OPEN	53
20	+ ATN	- ATN	54
21	GND	GND	55
22	+ BSY	- BSY	56
23	+ ACK	- ACK	57
24	+ RST	- RST	58
25	+ MSG	- MSG	59
26	+ SEL	- SEL	60
27	+ C/D	- C/D	61
28	+ REQ	- REQ	62
29	+ I/O	- I/O	63
30	GND	GND	64
31	+ DB8	- DB8	65
32	+ DB9	- DB9	66
33	+ DB10	- DB10	67
34	+ DB11	- DB11	68

*1 : When TERMPWR is not to be used, select OPEN (not used).

*2 : When connecting pins 06 to 30 and 40 to 64 to a Narrow SCSI device, do not connect pins 17 and 51.

(2) Single-ended (Wide SCSI)

Table 4.2.6 SCSI Connector Pin Arrangement (Single-ended)

Pin No.	Signal name	Signal name	Pin No.
01	GND	- DB12	35
02	GND	- DB13	36
03	GND	- DB14	37
04	GND	- DB15	38
05	GND	- DBP1	39
06	GND	- DB0	40
07	GND	- DB1	41
08	GND	- DB2	42
09	GND	- DB3	43
10	GND	- DB4	44
11	GND	- DB5	45
12	GND	- DB6	46
13	GND	- DB7	47
14	GND	- DBP	48
15	GND	GND	49
16	GND	GND	50
17	TERMPWR(*1, 2)	TERMPWR(*1, 2)	51
18	TERMPWR(*1)	TERMPWR(*1)	52
19	OPEN	OPEN	53
20	GND	GND	54
21	GND	- ATN	55
22	GND	GND	56
23	GND	- BSY	57
24	GND	- ACK	58
25	GND	- RST	59
26	GND	- MSG	60
27	GND	- SEL	61
28	GND	- C/D	62
29	GND	- REQ	63
30	GND	- I/O	64
31	GND	- DB8	65
32	GND	- DB9	66
33	GND	- DB10	67
34	GND	- DB11	68

*1 : When TERMPWR is not to be used, select OPEN (not used).

*2 : When connecting pins 06 to 30 and 40 to 64 to a Narrow SCSI device, do not connect pins 17 and 51.

(3) Ultra 2 (LVD)

Table 4.2.7 SCSI Connector Pin Arrangement (Ultra 2)

Pin No.	Signal name	Signal name	Pin No.
01	+ DB12	- DB12	35
02	+ DB13	- DB13	36
03	+ DB14	- DB14	37
04	+ DB15	- DB15	38
05	+ DBP1	- DBP1	39
06	+ DB0	- DB0	40
07	+ DB1	- DB1	41
08	+ DB2	- DB2	42
09	+ DB3	- DB3	43
10	+ DB4	- DB4	44
11	+ DB5	- DB5	45
12	+ DB6	- DB6	46
13	+ DB7	- DB7	47
14	+ DBP	- DBP	48
15	GND	GND	49
16	DIFFSENS	GND	50
17	TERMPWR	TERMPWR	51
18	TERMPWR	TERMPWR	52
19	OPEN	OPEN	53
20	GND	GND	54
21	+ ATN	- ATN	55
22	GND	GND	56
23	+ BSY	- BSY	57
24	+ ACK	- ACK	58
25	+ RST	- RST	59
26	+ MSG	- MSG	60
27	+ SEL	- SEL	61
28	+ C/D	- C/D	62
29	+ REQ	- REQ	63
30	+ I/O	- I/O	64
31	+ DB8	- DB8	65
32	+ DB9	- DB9	66
33	+ DB10	- DB10	67
34	+ DB11	- DB11	68

4.2.7 SCSI bus signals

The initiator and the target are connected via the SCSI-2 bus interface (ANSI standard X3T9.2/ 86-109, REV10E). Figure 4.2.4 shows the Wide SCSI bus signal conductors. Table 4.2.8 shows meaning of each signal.

Wide SCSI bus signal

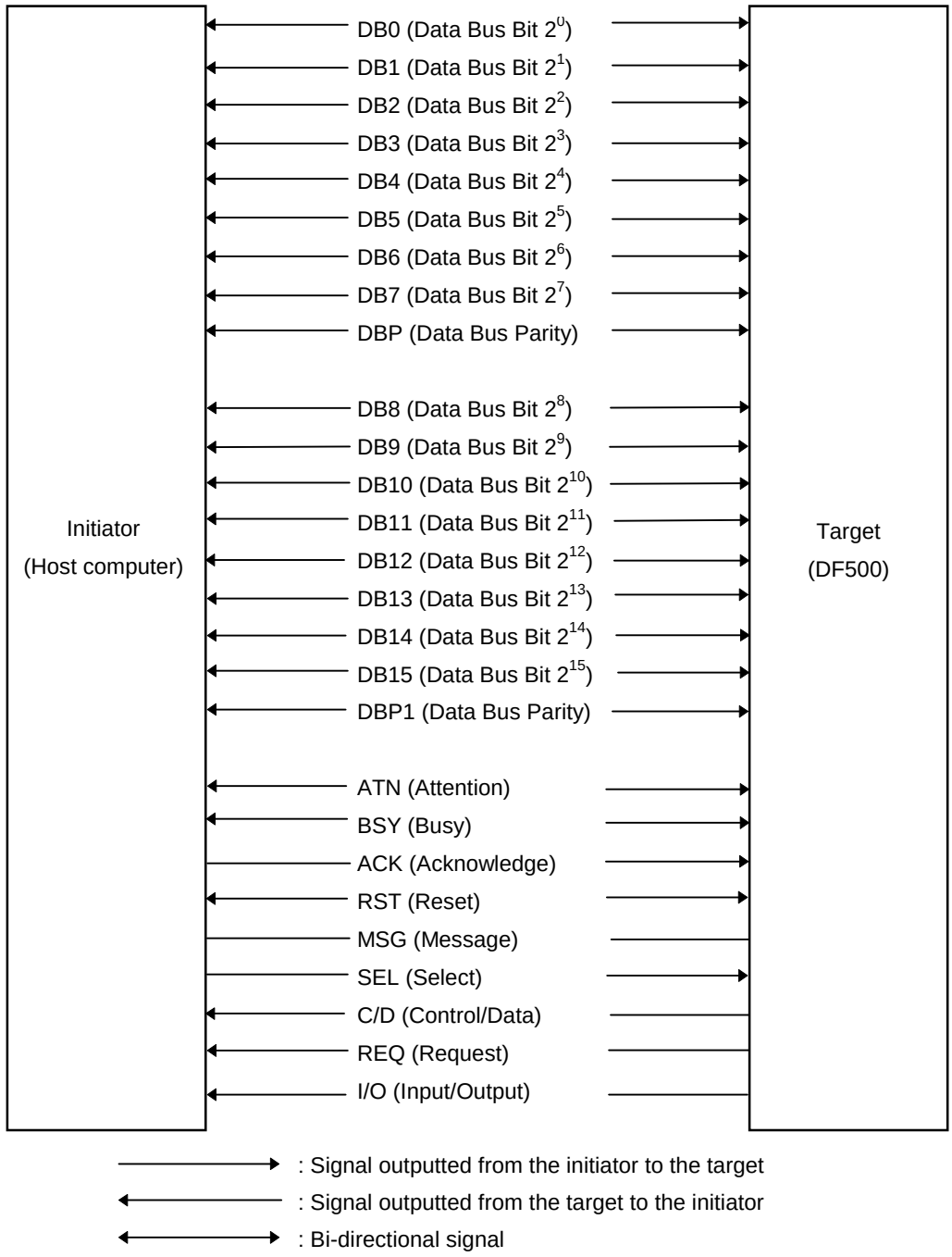


Figure 4.2.4 Wide SCSI Bus Signal Conductors

Table 4.2.8 Meanings of SCSI Bus Signals

Classification	Signal name	Description
Signal controlled by the target	I/O (Input/Output)	• Shows information flow direction on the data bus. I/O=1: From the target to the initiator I/O=0: From the initiator to the target • Differentiates the target from initiator. I/O=1: Re-selection (i.e. the target re-connects the initiator.) I/O=0: Selection (i.e. the initiator selects the target.)
	C/D (Control/Data)	• Shows the type of information on the data bus. C/D=1: Command, status, or message C/D=0: Data
	MSG (Message)	• When MSG=1, the SCSI bus is in the message phase.
Signal controlled by the initiator and target	BSY (Busy)	• When BSY=1, the SCSI bus is in use.
	SEL (Select)	• Selection control signal for selection/re-selection.
Handshake signal between the initiator and target	REQ (Request)	• Used for information transfer on the data bus along with ACK. • The target sets REQ=1 for each data byte for data transfer with the initiator.
	ACK (Acknowledge)	• Used for information transfer on the data bus along with REQ. • When data sending/receiving is ready, the initiator sets ACK=1 in response to REQ. • To complete handshaking, the initiator should set ACK=0 in response to REQ=0.
Signal controlled by the initiator	RST (Reset)	• Target resetting signal. When RST=1, the target is initialized.
	ATN (Attention)	• If ATN=1, the initiator has a message to be sent to the target.
Data bus signal	DB15 ~ DB0 (Data Bus Bit2^{15}) | (Data Bus Bit2^{0})	(Wide SCSI bus) • 8-bit data bus • Becomes SCSI ID bit used to determine the priority in arbitration. ID bit priority order is (<MSB> DB7 to DB0, DB15 to DB8 = <LSB>).
	DBP, DBP1 (Data Bus Parity)	(Wide SCSI Bus) • Data bus parity bit • Odd parity

4.2.8 Bus phases

The SCSI bus states are classified into eight phases according to operations of the initiator and target shown below:

(1) Bus free phase
The SCSI bus is free and the initiator can start a new operation or the target can re-connect the initiator.
In the bus free phase, all signals on the SCSI bus are "0".

(2) Arbitration phase
In this phase, the initiator or target acquires the right to use the SCSI bus.

(3) Selection phase
In this phase, the initiator selects the target.

(4) Re-selection phase
In this phase, the target re-selects the initiator.

(5) Command phase
In this phase, the target receives a command from the initiator via the data bus.

(6) Data transfer phase
In this phase, data transfer with the initiator via the data bus is performed.
This phase is skipped when the command is not accompanied by data transfer.

(7) Status phase
In this phase, the status byte after command execution is transferred from the target to the initiator via the data bus.

(8) Message phase
In this phase, message bytes are transferred from the target to the initiator or from the initiator to the target via the data bus.

By following the above eight phase (steps) for a command, a series of operations such as command receiving, execution, and completion report are executed.

For information transfer phases (i.e. command, data transfer, status, and message phases), the target informs the initiator of which phase is currently in progress with a combination of three signals : I/O, C/D, and MSG.

Table 4.2.9 shows the correspondence between the signal combinations and phases.

Table 4.2.9 Information Transfer Phases

Signal name			Phase
MSG	C/D	I/O	
0	0	0	• Data transfer phase (Data is sent from the initiator to the target.)
0	0	1	• Data transfer phase (Data is sent from the target to the initiator.)
0	1	0	• Command phase (A command is received from the initiator.)
0	1	1	• Status phase (A status is sent to the initiator.)
1	0	0	• Unused
1	0	1	• Unused
1	1	0	• Message phase (A message is sent from the initiator to the target.)
1	1	1	• Message phase A message is sent from the target to the initiator.)

A typical phase transition is shown in Figure 4.2.5.

Solid lines show normal sequence.

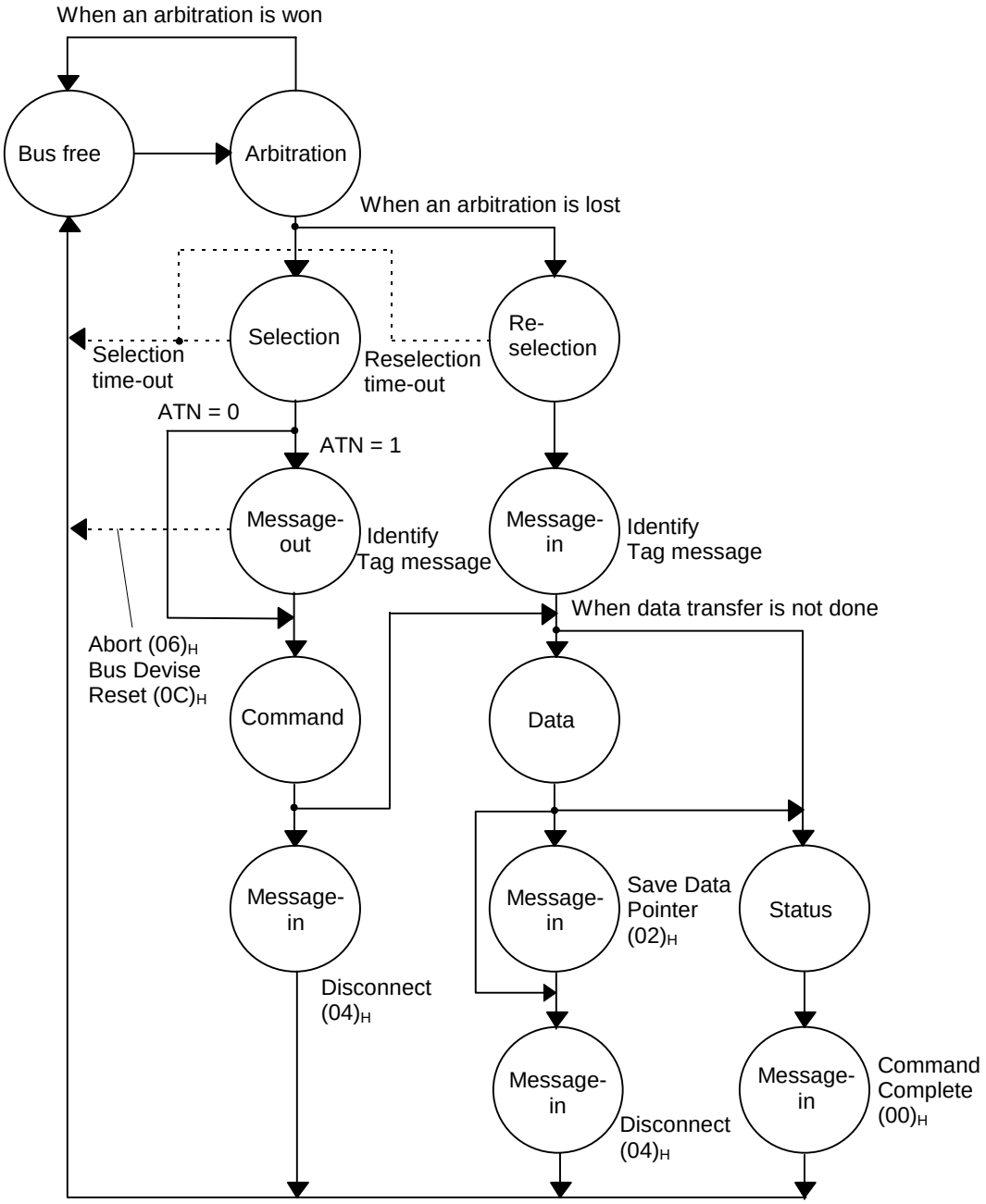


Figure 4.2.5 Phase Transition (in the System Having Arbitration)

- The convention on the Wide Bus transfer and synchronous transfer is implemented in the message after the selection when necessary.
- After resetting, any phase goes to the bus free phase.
- For details of messages, refer to "Hitachi Disk Array Subsystem SCSI Interface Specifications".

4.2.9 Outline of software of supported commands

The controller supports the commands in groups 0 to 2, 5, and 7 shown in Table 4.2.10.

Table 4.2.10 Supported Commands

Group name	Operation code	Command name
Group 0	00_H	TEST UNIT READY
	01_H	REZERO UNIT
	03_H	REQUEST SENSE
	04_H	FORMAT UNIT
	07_H	REASSIGN BLOCKS
	08_H	READ
	$0A_H$	WRITE
	$0B_H$	SEEK
	12_H	INQUIRY
	15_H	MODE SELECT(6)
	16_H	RESERVE
	17_H	RELEASE
	$1A_H$	MODE SENSE(6)
	$1B_H$	START/STOP UNIT
	$1C_H$	RECEIVE DIAGNOSTIC RESULTS
	$1D_H$	SEND DIAGNOSTIC
Group 1	25_H	READ CAPACITY
	28_H	READ (EXTEND)
	$2A_H$	WRITE (EXTEND)
	$2B_H$	SEEK (EXTEND)
	$2E_H$	WRITE AND VERIFY
	$2F_H$	VERIFY
	35_H	SYNCHRONIZE CACHE
	37_H	READ DEFECT DATA
	$3B_H$	WRITE BUFFER
	$3C_H$	READ BUFFER
Group 2	55_H	MODE SELECT (10)
	56_H	RESERVE(10)
	57_H	RELEASE(10)
	$5A_H$	MODE SENSE (10)
Group 5	$A0_H$	REPORT LUNS
Group 7	$E4_H$	FORCED RESERVE
	$E8_H$	READ WITH SKIP MASK
	EA_H	WRITE WITH SKIP MASK

Table 4.2.11 lists the commands for direct access devices defined in the ANSI's SCSI standard (SCSI-2) but not supported by the controller.

Table 4.2.11 List of Unsupported Commands

Operation code	Command name (in alphabetical order)	Remarks
40_H	CHANGE DEFINITION	
39_H	COMPARE	
18_H	COPY	
$3A_H$	COPY AND VERIFY	
36_H	LOCK-UNLOCK-CACHE	
$4C_H$	LOG SELECT	
$4D_H$	LOG SENSE	
34_H	PRE-FETCH	
$1E_H$	PREVENT-ALLOW MEDIUM REMOVAL	
$3E_H$	READ LONG	
31_H	SEARCH DATA EQUAL	
30_H	SEARCH DATA HIGH	
32_H	SEARCH DATA LOW	
33_H	SET LIMITS	
$3F_H$	WRITE LONG	
41_H	WRITE SAME	

4.2.10 Messages

Table 4.2.12 lists messages supported by the controller.

Table 4.2.12 Message Codes

Code	Description	Direction(*1)		Remarks
00_H	COMMAND COMPLETE	In		
01_H	EXTENDED MESSAGE	In	Out	
02_H	SAVE DATA POINTER	In		
03_H	RESTORE POINTERS	In		
04_H	DISCONNECT	In		
05_H	INITIATOR DETECTED ERROR		Out	
06_H	ABORT		Out	
07_H	MESSAGE REJECT	In	Out	
08_H	NO OPERATION		Out	
09_H	MESSAGE PARITY ERROR		Out	
$0A_H$	LINKED COMMAND COMPLETE	In		
$0B_H$	LINKED COMMAND COMPLETE (WITH FLAG)	In		
$0C_H$	BUS DEVICE RESET		Out	
$0D_H$	ABORT TAG		Out	
$0E_H$	CLEAR QUEUE		Out	
$0F_H$ - $1F_H$	Reserved Code			
20_H	SIMPLE QUEUE TAG	In	Out	2 bytes message
21_H	HEAD OF QUEUE TAG		Out	2 bytes message
22_H	ORDERED QUEUE TAG		Out	2 bytes message
23_H	IGNORE WIDE RESIDUE	In		2 bytes message
24_H - $7F_H$	Reserved Code			
80_H - FF_H	IDENTIFY	In	Out	

*1 : In : Controller to host computer
Out : Host computer to controller

4.2.11 Status's

Status bytes are defined as shown in Tables 4.2.13 and 4.2.14. It the status byte is reported from the controller to a host computer in the Status phase when each command is completed.
However, this operation is not performed when the command is cleared by the ABORT message, ABORT TAG message, CLEAR QUEUE message, BUS DEVICE RESET message, or RESET status (including POWER ON RESET).

Table 4.2.13 Status Byte

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved 0	Reserved 0	Status Byte Code					Reserved 0

Table 4.2.14 Status Byte Codes

Bit					Status
5	4	3	2	1	
0	0	0	0	0	GOOD
0	0	0	0	1	CHECK CONDITION
0	0	1	0	0	BUSY
0	1	0	0	0	INTERMEDIATE/GOOD
0	1	1	0	0	RESERVATION CONFLICT
1	0	1	0	0	QUEUE FULL

Status byte codes are defined as follows:

GOOD:

This status indicates that the controller has completed the command execution successfully.

CHECK CONDITION:

This status indicates that the command execution has terminated abnormally owing to an error, exception, or abnormal state resulting in setting of the sense data.
The host computer can acquire the detailed information on the error by issuing the REQUEST SENSE command after this status is reported.
After the CHECK CONDITION status is returned to a host computer and before the REQUEST SENSE command is issued, activation from another host computer may result in the BUSY status. Therefore, the REQUEST SENSE command(‡1) must be issued.

BUSY:

This status indicates that the controller is busy.
The controller reports this status when it cannot accept a command from a host computer.
In this case, retry the command issue after a while.

INTERMEDIATE/GOOD:

This status indicates that each command execution (excluding the last one) in the link has completed successfully.
If this status is not reported, the link command chain is disconnected.

RESERVATION CONFLICT:

This status is reported when the host computer attempts to access the logical unit reserved by another host computer. However, this status is not reported for the INQUIRY, REQUEST, SENSE, RELEASE (6), RELEASE (16), and REPORT LUNS command. (Each command is updated with the current reservation not changed.)

QUEUE FULL:

This status indicates that the command queue is full and the command from the host computer cannot be accepted. In this case, retry the command issue after a while.

*1 : If a command ends with the CHECK CONDITION status, be sure to issue the REQUEST SENSE command without a tag. The REQUEST SENSE command with a tag may result in incorrect reporting of the error.

Chapter 5 RS232C Cables

5.1 Pin Arrangement of Connector

The RS232C cable connector to be used on the subsystem side is shown in the Figure 5.1.1 below.
For pin numbers and corresponding signals, see the Table 5.1.1 below.

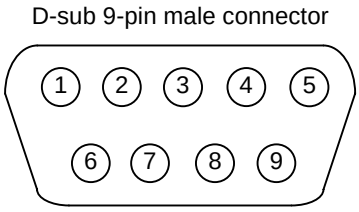


Figure 5.1.1 Pin Arrangement of R232C Cable Connector

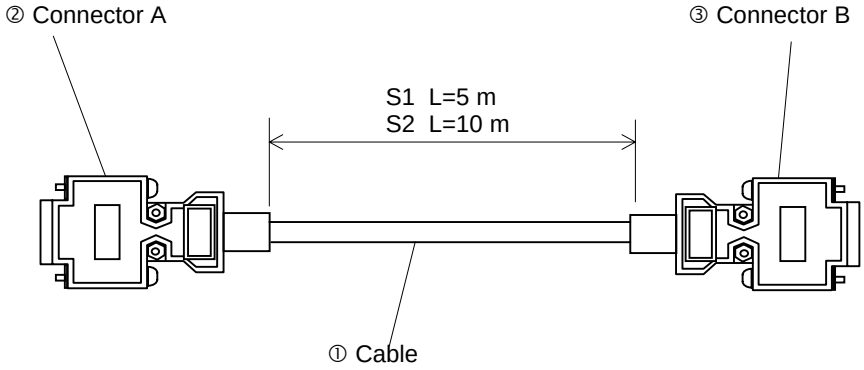
Table 5.1.1 Pin and Signal Specification of R232C Connector

Pin No.	Signal name and description
1	—
2	RxD : Received Data
3	TxD : Transmitter Data
4	DTR : Data Terminal Ready
5	GND : Signal Ground
6	DSR : Data Set Ready
7	RTS : Request to Send
8	CTS : Clear to Send
9	—

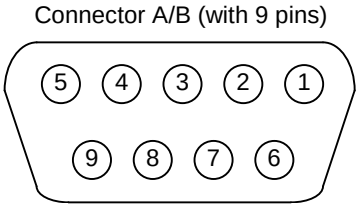
5.2 S1 and S2

(1) Cable

Cable name	Part No.	Name	Quantity	Part name	
				Part specification/model	Manufacturer
RS232C cable (S1/S2)	1	Cable	—	UL20276 #28×8C	Furukawa Denko
	2	Connector A	1	17JE-13090-02 (D8C)	Daiichi Denshi
	3	Connector B	1	17JE-13090-02 (D8C)	Kogyo



(2) Pin arrangement and cabling of connectors

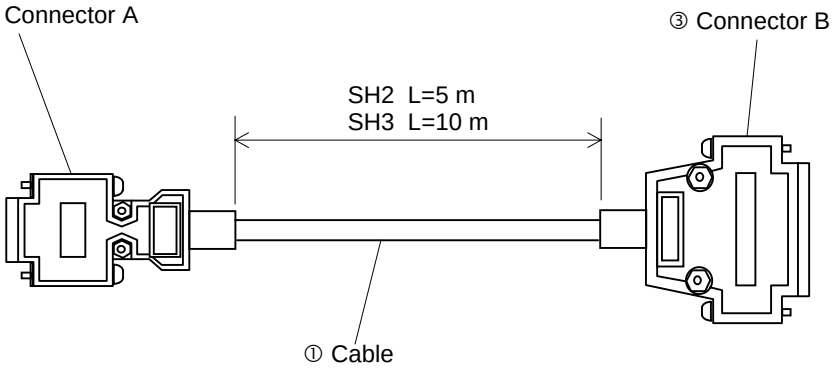


Connector A	Pin No. (among 9 pins)	—	2	3	4	5	6	7	8	—
Connector B	Pin No. (among 9 pins)	—	3	2	6	5	4	8	7	—

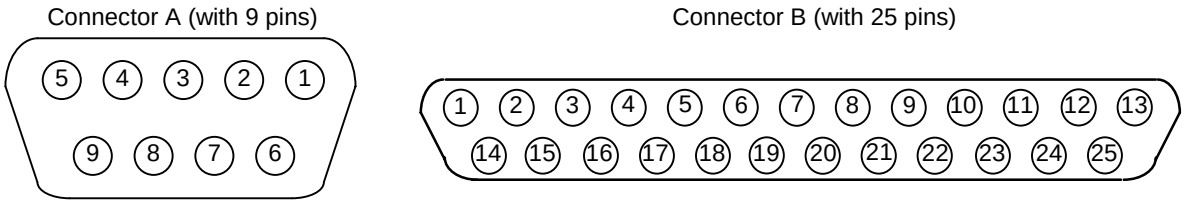
5.3 SH2 and SH3

(1) Cable

Cable name	Part No.	Name	Quantity	Part name	
				Part specification/model	Manufacturer
RS232C cable (SH2/SH3)	1	Cable	—	UL20276 #28×8C	Furukawa Denko
	2	Connector A	1	17JE-13090-02 (D8C)	Daiichi Denshi Kogyo
	3	Connector B	1	17JE-23250-02 (D8C)	



(2) Pin arrangement and cabling of connectors

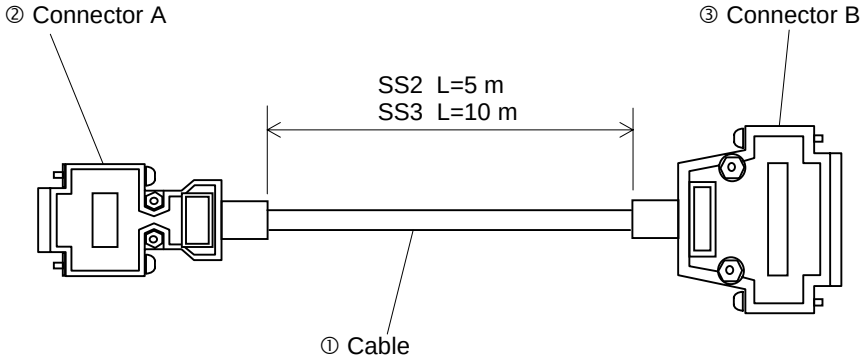


Connector A	Pin No. (among 9 pins)	—	2	3	4	5	6	7	8	9
Connector B	Pin No. (among 25 pins)	—	3	2	20	7	6	4	5	22

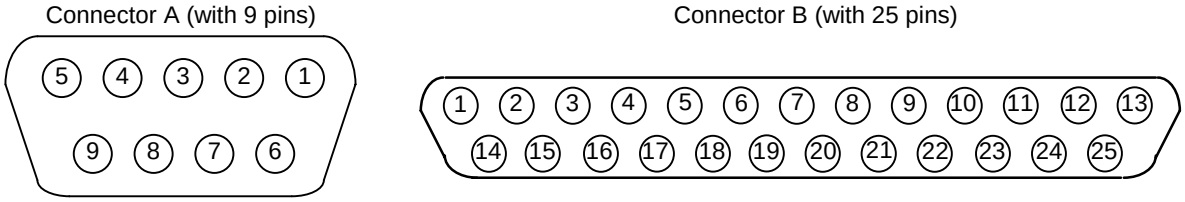
5.4 SS2 and SS3

(1) Cable

Cable name	Part No.	Name	Quantity	Part name	
				Part specification/model	Manufacturer
RS232C cable (SS2, SS3)	1	Cable	—	UL20276 #28×8C	Furukawa Denko
	2	Connector A	1	17JE-13090-02 (D8C)	Daiichi Denshi Kogyo
	3	Connector B	1	17JE-23250-02 (D8C)	



(2) Pin arrangement and cabling of connector

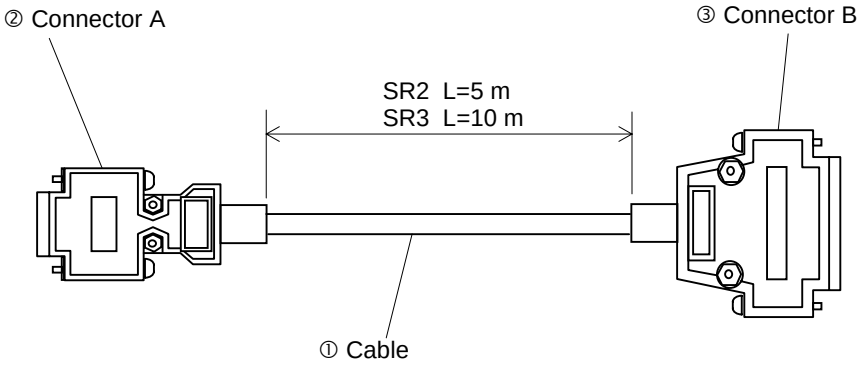


Connector A	Pin No. (among 9 pins)	1	2	3	4	5	6	7	8	—
Connector B	Pin No. (among 25 pins)	4, 5	2	3	6	7	20	8	8	—

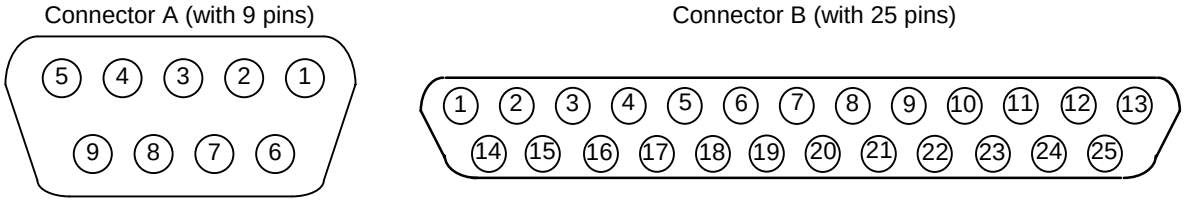
5.5 SR2 and SR3

(1) Cable

Cable name	Part No.	Name	Quantity	Part name	
				Part specification/model	Manufacturer
RS232C cable (SR2, SR3)	1	Cable	—	UL20276 #28×8C	Furukawa Denko
	2	Connector A	1	17JE-13090-02 (D8C)	Daiichi Denshi
	3	Connector B	1	17JE-23250-02 (D8C)	Kogyo



(2) Pin arrangement and cabling of connectors

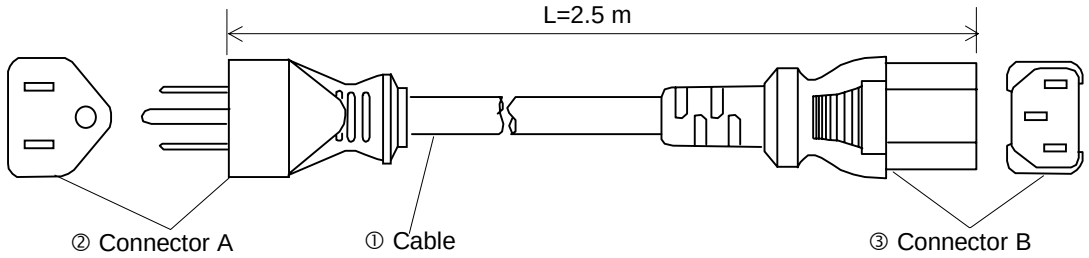


Connector A	Pin No. (among 9 pins)	1	2	3	4	5	6	7	8	—
Connector B	Pin No. (among 25 pins)	4, 5	2	3	6	7	20	8	8	—

Chapter 6 Power Cables

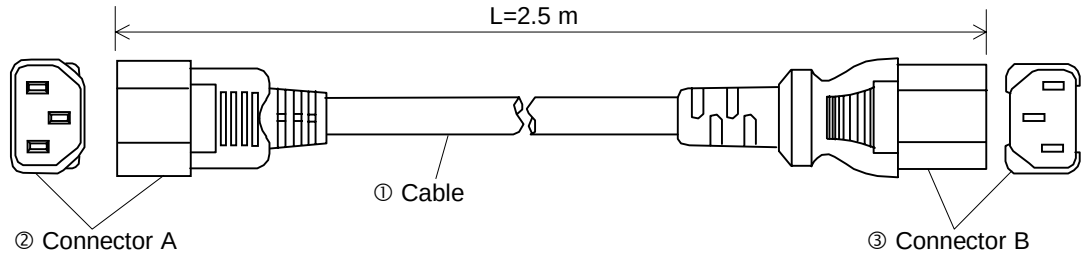
6.1 J1F

Cable name	Part No.	Name	Quantity	Model	Applicable safety standard / rating
DF-F500-J1F Power cable	1	Cable	—	PVC code	UL and CSA
	2	Connector A	1	NEMA Standard 5-15P	For AC125 V (13 A)
	3	Connector B	1	EN60320-C13	For standard use



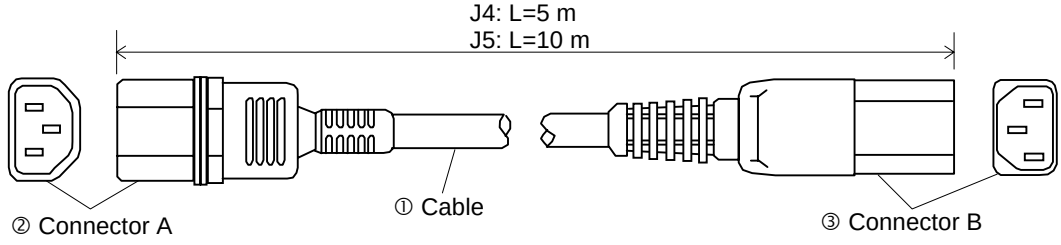
6.2 J2F

Cable name	Part No.	Name	Quantity	Model	Applicable safety standard / rating
DF-F500-J2F Power cable	1	Cable	—	PVC code	UL and CSA
	2	Connector A	1	EN60324-C14	AC250 V(10 A)
	3	Connector B	1	EN60324-C13	For rack frame



6.3 J4 and J5

Cable name	Part No.	Name	Quantity	Model	Applicable safety standard / rating
DF-F500-J4	1	Cable	—	CENELEC	VDE
DF-F500-J5	2	Connector A	1	EN60320-C14	AC250 V(10 A)
Power cable	3	Connector B	1	EN60320-C13	For rack frame



Appendix

Appendix A List of Storage Capacities Corresponding to RAID Levels and Configurations

Appendix A.1-1 RAID 0 and RAID 1 with 8.7 G bytes Disk Drives

The maximum disk capacity of each configuration in the case where a combination of the one RK and the one to nine RKAs is configured in RAID 0 or RAID 1 is shown below. The upper and lower values in each cell show number of mounted Disk drives and disk capacity respectively. No spare disk is included.

Appendix A.1-1 List of Capacities Corresponding to RAID 0 and RAID 1 (8.7 G bytes)

Disk capacity			8.7 G bytes										
Component unit			Detail of component unit										
			RK		RKA								
Range			1		1	2	3	4	5	6	7	8	9
Total range of Disk drives			Min.	10 (Max.)	20	30	40	50	60	70	80	90	100
RAID level	0	2D	2 17.4	10 87.1	20 174.2	30 261.3	40 348.5	50 435.6	60 522.7	70 609.8	80 697.0	90 784.1	100 871.2
		3D	3 26.1	9 78.4	18 156.8	30 261.3	39 339.7	48 418.2	60 522.7	69 601.1	78 679.5	90 784.1	99 862.5
		4D	4 34.8	8 69.7	20 174.2	28 243.9	40 348.5	48 418.2	60 522.7	68 592.4	80 697.0	88 766.7	100 871.2
		5D	5 43.5	10 87.1	20 174.2	30 261.3	40 348.5	50 435.6	60 522.7	70 609.8	80 697.0	90 784.1	100 871.2
		6D	6 52.2	6 52.2	18 156.8	30 261.3	36 313.6	48 418.2	60 522.7	66 575.0	78 679.5	90 784.1	96 836.4
		7D	7 60.9	7 60.9	14 121.9	28 243.9	35 304.9	49 426.9	56 487.9	70 609.8	77 670.8	84 731.8	98 853.8
		8D	8 69.7	8 69.7	16 139.4	24 209.1	40 348.5	48 418.2	56 487.9	64 557.6	80 697.0	88 766.7	96 836.4
		9D	9 78.4	9 78.4	18 156.8	27 235.2	36 313.6	45 392.0	54 470.4	63 548.8	72 627.3	90 705.6	99 862.5
		10D	10 87.1	10 87.1	20 174.2	30 261.3	40 348.5	50 435.6	60 522.7	70 609.8	80 697.0	90 784.1	100 871.2
		11D	-	-	11 95.8	22 191.6	33 287.5	44 383.3	55 479.1	66 575.0	77 670.8	88 766.7	99 862.5
		12D	-	-	12 104.5	24 209.1	36 313.6	48 418.2	60 522.7	60 522.7	72 627.3	84 731.8	96 836.4
		13D	-	-	13 113.2	26 226.5	39 339.7	39 339.7	52 453.0	65 566.3	78 679.5	78 679.5	91 792.8
		14D	-	-	14 121.9	28 243.9	28 243.9	42 365.9	56 487.9	70 609.8	70 609.8	84 731.8	98 853.8
		15D	-	-	15 130.6	30 261.3	30 261.3	45 392.0	60 522.7	60 522.7	75 653.4	90 784.1	90 784.1
		16D	-	-	16 139.4	16 139.4	32 278.8	48 418.2	48 418.2	64 557.6	80 697.0	80 697.0	96 836.4
	1	1D+1P	2 8.7	10 43.5	20 87.1	30 130.6	40 174.2	50 217.8	60 261.3	70 304.9	80 348.5	90 392.1	100 435.6

Appendix A.1-2 RAID 5 with 8.7 G bytes Disk drives

The maximum disk capacity of each configuration in the case where a combination of the one RK and the one to nine RKAs is configured in RAID 5 is shown below.
The upper and lower values in each cell show number of mounted Disk drives and disk capacity respectively. No spare disk is included.

Appendix A.1-2 List of Capacities Corresponding to RAID 5 (8.7 G bytes)

Disk capacity			8.7 G bytes										
Component unit			Detail of component unit										
			RK		RKA								
Range			1		1	2	3	4	5	6	7	8	9
Total range of Disk drives			Minimun	10 (Max.)	20	30	40	50	60	70	80	90	100
RAID level	5	2D+1P	3 17.4	9 52.2	18 104.5	30 174.2	39 226.5	48 278.8	60 348.5	69 400.7	78 453.0	90 522.7	99 575.0
		3D+1P	4 26.1	8 52.2	20 130.6	28 182.9	40 261.2	48 313.6	60 392.0	68 444.3	80 522.7	88 575.0	100 653.4
		4D+1P	5 34.8	10 69.7	20 139.4	30 209.1	40 278.8	50 348.5	60 418.2	70 487.9	80 557.6	90 627.3	100 697.0
		5D+1P	6 43.5	6 43.5	18 130.6	30 217.8	36 261.3	48 348.5	60 435.6	66 479.1	78 566.3	90 653.4	96 697.0
		6D+1P	7 52.2	7 52.2	14 104.5	28 209.1	35 261.3	49 365.9	56 418.2	70 522.7	77 575.0	84 627.3	98 731.8
		7D+1P	8 60.9	8 60.9	16 121.9	24 182.9	40 304.9	48 365.9	56 426.9	64 487.9	80 609.8	88 670.8	96 731.8
		8D+1P	9 69.7	9 69.7	18 139.4	27 209.0	36 278.8	45 348.5	54 418.2	63 487.9	72 557.6	90 627.2	99 766.7
		9D+1P	10 78.4	10 78.4	20 156.8	30 235.2	40 313.6	50 392.0	60 470.4	70 548.8	80 627.3	90 705.7	100 784.1
		10D+1P	-	-	11 87.1	22 174.2	33 261.3	44 348.5	55 435.6	66 522.7	77 609.8	88 697.0	99 784.1
		11D+1P	-	-	12 95.8	24 191.6	36 287.5	48 383.3	60 479.1	60 479.1	72 575.0	84 670.8	96 766.7
		12D+1P	-	-	13 104.5	26 209.1	39 313.6	39 313.6	52 418.2	65 522.7	65 522.7	78 627.3	91 731.8
		13D+1P	-	-	14 113.2	28 226.5	28 226.5	42 339.7	56 453.0	70 566.3	70 566.3	84 679.5	98 792.8
		14D+1P	-	-	15 121.9	30 243.9	30 243.9	45 365.9	60 487.9	60 487.9	75 609.8	90 731.8	90 731.8
		15D+1P	-	-	16 130.6	16 130.6	32 261.3	48 392.0	48 392.0	64 522.7	80 653.4	80 653.4	96 784.1

Appendix A.1-3 RAID 0+1 with 8.7 G bytes Disk drives

The maximum disk capacity of each configuration in the case where a combination of the one RK and the one to nine RKAs is configured in RAID 0+1 is shown below.
The upper and lower values in each cell show number of mounted Disk drives and disk capacity respectively. No spare disk is included.

Appendix A.1-3 List of Capacities Corresponding to RAID 0+1 (8.7 G bytes)

Disk capacity			8.7 G bytes										
Component unit			Detail of component unit										
			RK		RKA								
Range			1		1	2	3	4	5	6	7	8	9
Total range of Disk drives			Min.	10 (Max.)	20	30	40	50	60	70	80	90	100
RAID level	0+1	2D+2P	2 8.7	10 43.5	20 87.1	30 130.6	40 174.2	50 217.8	60 261.3	70 304.9	80 348.5	90 392.0	100 435.6
		3D+3P	6 26.1	6 26.1	18 78.4	30 130.6	36 156.8	48 209.1	60 261.3	66 287.5	78 339.7	90 392.0	96 418.2
		4D+4P	8 34.8	8 34.8	16 69.7	24 104.5	40 174.2	48 209.1	56 243.9	64 278.8	80 348.5	88 383.3	96 418.2
		5D+5P	10 43.5	10 43.5	20 87.1	30 130.6	40 174.2	50 217.8	60 261.3	70 304.9	80 348.5	90 392.0	100 435.6
		6D+6P	-	-	12 52.2	24 104.5	36 156.8	48 209.1	60 261.3	60 261.3	72 313.6	84 365.9	96 418.2
		7D+7P	-	-	14 60.9	28 121.9	28 121.9	42 182.9	56 243.9	70 304.9	70 304.9	84 365.9	98 426.9
		8D+8P	-	-	16 69.7	16 69.7	32 139.4	48 209.1	48 209.1	64 278.8	80 348.5	80 348.5	96 418.2

Appendix A.2-1 RAID 0 and RAID 1 with 17.8 G bytes Disk drives

The maximum disk capacity of each configuration in the case where a combination of the one RK and the one to nine RKAs is configured in RAID 0 or RAID 1 is shown below. The upper and lower values in each cell show number of mounted Disk drives and disk capacity respectively. No spare disk is included.

Appendix A.2-1 List of Capacities Corresponding to RAID 0 and RAID 1 (17.8 G bytes)

Disk capacity			17.8 G bytes												
Component unit			Detail of component unit												
			RK		RKA									RKL	
Range			1		1	2	3	4	5	6	7	8	9	1	
Total range of Disk drives			Min.	10 (Max.)	20	30	40	50	60	70	80	90	100	Min.	12 (Max.)
RAID level	0	2D	2 35.5	10 177.9	20 355.9	30 533.8	40 711.8	50 899.7	60 1067.7	70 1245.6	80 1423.6	90 1601.5	100 1779.5	2 35.5	12 213.5
		3D	3 53.3	9 160.1	18 320.3	30 533.8	39 694.0	48 854.1	60 1067.7	69 1227.8	78 1388.0	90 1601.5	99 1761.7	3 53.3	12 213.5
		4D	4 71.1	8 142.3	20 355.9	28 498.2	40 711.8	48 854.1	60 1067.7	68 1210.0	80 1423.6	88 1565.9	100 1789.5	4 71.1	12 213.5
		5D	5 88.9	10 177.9	20 355.9	30 533.8	40 711.8	50 899.7	60 1067.7	70 1245.6	80 1423.6	90 1601.5	100 1789.5	5 88.9	10 177.9
		6D	6 106.7	6 106.7	18 320.3	30 533.8	36 640.6	48 854.1	60 1067.7	66 1174.4	78 1388.0	90 1601.5	96 1708.3	6 106.7	12 213.5
		7D	7 124.5	7 124.5	14 249.1	28 498.2	35 622.8	49 871.9	56 996.5	70 1245.6	77 1370.2	84 1494.7	98 1743.9	7 124.5	7 124.5
		8D	8 142.3	8 142.3	16 284.7	24 427.0	40 711.8	48 854.1	56 996.5	64 1138.8	80 1423.6	88 1565.9	96 1708.3	8 142.3	8 142.3
		9D	9 160.1	9 160.1	18 320.3	27 480.4	36 640.6	45 800.7	54 960.9	63 1121.0	72 1281.2	81 1441.5	99 1761.7	9 160.1	9 160.1
		10D	10 177.9	10 177.9	20 355.9	30 533.8	40 711.8	50 899.7	60 1067.7	70 1245.6	80 1423.6	90 1601.5	100 1779.5	10 177.9	10 177.9
		11D	-	-	11 195.7	22 391.4	33 587.2	44 782.9	55 978.7	66 1174.4	77 1370.2	88 1565.9	99 1761.7	11 195.7	11 195.7
		12D	-	-	12 213.5	24 427.0	36 640.6	48 854.1	60 1067.7	60 1067.7	72 1281.2	84 1494.7	96 1708.3	12 213.5	12 213.5
		13D	-	-	13 231.3	26 284.6	39 694.0	39 694.0	52 925.3	65 1156.6	78 1388.0	78 1388.0	91 1619.3	-	-
		14D	-	-	14 249.1	28 498.2	28 498.2	42 747.3	56 996.5	70 1245.6	70 1245.6	84 1494.7	98 1743.9	-	-
		15D	-	-	15 266.9	30 533.8	30 533.8	45 800.7	60 1067.7	60 1067.7	75 1334.6	90 1601.5	90 1601.5	-	-
		16D	-	-	16 284.7	16 284.7	32 569.4	48 854.1	48 854.1	64 1138.8	80 1423.6	80 1423.6	96 1708.3	-	-
	1	1D +1P	2 17.7	10 88.9	20 177.9	30 266.9	40 355.9	50 444.8	60 533.8	70 622.8	80 711.8	90 800.7	100 889.7	2 17.7	12 106.7

Appendix A.2-2 RAID 5 with 17.8 G bytes Disk drives

The maximum disk capacity of each configuration in the case where a combination of the one RK and the one to nine RKAs is configured in RAID 5 is shown below.
The upper and lower values in each cell show number of mounted Disk drives and disk capacity respectively. No spare disk is included.

Appendix A.2-1 List of Capacities Corresponding to RAID 5 (17.8 G bytes)

Disk capacity			17.8 G bytes												
Component unit			Detail of component unit												
			RK		RKA									RKL	
Range			1		1	2	3	4	5	6	7	8	9	1	
Total range of Disk drives			Min.	10 (Max.)	20	30	40	50	60	70	80	90	100	Min.	12 (Max.)
RAID level	5	2D +1P	3 35.5	9 106.7	18 213.5	30 355.9	39 462.6	48 569.4	60 711.8	69 818.5	78 925.3	90 1067.7	99 1174.7	3 35.5	12 142.3
		3D +1P	4 53.3	8 106.7	20 266.9	28 373.6	40 533.8	48 640.6	60 800.7	68 907.5	80 1067.7	88 1174.4	100 1334.6	4 53.3	12 160.1
		4D +1P	5 71.1	10 142.3	20 284.7	30 427.0	40 569.4	50 711.8	60 854.1	70 996.5	80 1138.8	90 1281.2	100 1423.6	5 71.1	10 142.3
		5D +1P	6 88.9	6 88.9	18 266.9	30 444.8	36 533.8	48 711.8	60 899.7	66 978.7	78 1156.6	90 1334.6	96 1423.6	6 88.9	12 177.9
		6D +1P	7 106.7	7 106.7	14 213.5	28 427.0	35 533.8	49 747.3	56 854.1	70 1067.7	77 1174.4	84 1281.2	98 1494.7	7 106.7	7 106.7
		7D +1P	8 124.5	8 124.5	16 249.1	24 373.6	40 622.8	48 747.3	56 871.9	64 996.5	80 1245.6	88 1370.2	96 1494.7	8 124.5	8 124.5
		8D +1P	9 142.3	9 142.3	18 284.7	27 427.0	36 569.4	45 711.8	54 854.1	63 996.5	72 1138.8	90 1281.2	99 1565.9	9 142.3	9 142.3
		9D +1P	10 160.1	10 160.1	20 320.3	30 480.4	40 640.6	50 800.7	60 960.9	70 1121.0	80 1281.2	90 1441.4	100 1601.5	10 160.1	10 160.1
		10D +1P	- -		11 177.9	22 355.9	33 533.8	44 711.8	55 899.7	66 1067.7	77 1245.6	88 1423.6	99 1601.5	11 177.9	11 177.9
		11D +1P	- -		12 195.7	24 391.4	36 587.2	48 782.9	60 978.7	60 978.7	72 1174.4	84 1370.2	96 1565.9	12 195.7	12 195.7
		12D +1P	- -		13 213.5	26 427.0	39 640.6	39 640.6	52 854.4	65 1067.7	78 1281.2	78 1281.2	91 1494.7	-	-
		13D +1P	- -		14 231.3	28 462.6	28 462.6	42 694.0	56 925.3	70 1156.6	70 1156.6	84 1388.0	98 1619.3	-	-
		14D +1P	- -		15 249.1	30 498.2	30 498.2	45 747.3	60 996.5	60 996.5	75 1245.6	90 1494.7	90 1494.7	-	-
		15D +1P			16 266.9	16 266.9	32 533.8	48 800.7	48 800.7	64 067.8	80 1334.6	80 1334.6	96 1601.5	-	-

Appendix A.2-3 RAID 0+1 with 17.8 G bytes Disk drives

The maximum disk capacity of each configuration in the case where a combination of the one RK and the one to nine RKAs is configured in RAID 0 +1 is shown below.
The upper and lower values in each cell show number of mounted Disk drives and disk capacity respectively. No spare disk is included.

Appendix A.2-3 List of Capacities Corresponding to RAID 0+1 (17.8 G bytes)

Disk capacity			17.8 G bytes												
Component unit			Detail of component unit												
			RK		RKA									RKL	
Range			1		1	2	3	4	5	6	7	8	9	1	
Total range of Disk drives			Min.	10 (Max.)	20	30	40	50	60	70	80	90	100	Min.	12 (Max.)
RAID level	0+1	2D +2P	4 35.5	8 71.1	20 177.9	28 249.1	40 355.9	48 427.0	60 533.8	68 605.0	80 711.8	88 782.9	100 899.7	4 35.5	12 106.7
		3D +3P	6 53.3	6 53.3	18 160.1	30 266.9	36 320.3	48 427.0	60 533.8	66 587.2	78 694.0	90 800.7	96 854.1	6 53.3	12 106.7
		4D +4P	8 71.1	8 71.1	16 142.3	24 213.5	40 355.9	48 427.0	56 498.2	64 569.4	80 711.8	88 782.9	96 854.1	8 71.1	8 71.1
		5D +5P	10 88.9	10 88.9	20 177.9	30 266.9	40 355.9	50 444.8	60 533.8	70 622.8	80 711.8	90 800.7	100 889.7	10 88.9	10 88.9
		6D +6P	- -	- -	12 106.7	24 213.5	36 320.3	48 427.0	60 533.8	60 533.8	72 640.6	84 747.3	96 854.1	12 106.7	12 106.7
		7D +7P	- -	- -	14 124.5	28 249.1	28 249.1	42 373.6	56 498.2	70 622.8	70 622.8	84 747.3	98 871.9	- -	- -
		8D +8P	- -	- -	16 142.3	16 142.3	32 284.7	48 427.0	48 427.0	64 569.4	80 711.8	80 711.8	96 854.1	- -	- -

Appendix A.3-1 RAID 0 and RAID 1 with 35.6 G bytes Disk drives

The maximum disk capacity of each configuration in the case where a combination of the one RK and the one to nine RKAs is configured in RAID 0 or RAID 1 is shown below. The upper and lower values in each cell show number of mounted Disk drives and disk capacity respectively. No spare disk is included.

Appendix A.3-1 List of Capacities Corresponding to RAID 0 and RAID 1 (35.6 G bytes)

Disk capacity			35.6 G bytes												
Component unit			Detail of component unit												
			RK		RKA									RKL	
Range			1		1	2	3	4	5	6	7	8	9	1	
Total range of Disk drives			Min.	10 (Max.)	20	30	40	50	60	70	80	90	100	Min.	12 (Max.)
RAID level	0	2D	2 71.3	10 356.8	20 713.6	30 1070.4	40 1427.2	50 1784.0	60 2140.8	70 2497.6	80 2854.4	90 3211.1	100 3568.0	2 71.3	12 428.1
		3D	3 107.0	9 321.1	18 642.2	30 1070.4	39 1391.5	48 1712.6	60 2140.8	69 2461.9	78 2783.1	90 3211.2	99 3532.4	3 107.0	12 428.1
		4D	4 142.7	8 285.4	20 713.6	28 999.0	40 1427.2	48 1712.6	60 2140.8	68 2426.3	80 2854.4	88 3139.9	100 35680.0	4 142.7	12 428.1
		5D	5 178.4	10 356.8	20 713.6	30 1070.4	40 1427.2	50 1784.0	60 2140.8	70 2497.6	80 2854.4	90 3211.2	100 3568.0	5 178.4	10 356.8
		6D	6 214.0	6 214.0	18 642.2	30 1070.4	36 1284.5	48 1712.6	60 2140.8	66 2354.9	78 2783.1	90 3211.2	96 3425.3	6 214.0	12 428.1
		7D	7 249.7	7 249.7	14 499.5	28 999.0	35 1248.8	49 1748.3	56 1998.1	70 2497.6	77 2747.4	84 2997.1	98 3496.7	7 249.7	7 249.7
		8D	8 285.4	8 285.4	16 570.8	24 856.3	40 1427.2	48 1712.6	56 1998.1	64 2283.5	80 2854.4	88 3139.9	96 3425.3	8 285.4	8 285.4
		9D	9 321.1	9 321.1	18 642.2	27 963.3	36 1284.5	45 1605.6	54 1926.7	63 2247.8	72 2569.0	90 3211.2	99 3532.4	9 321.1	9 321.1
		10D	10 356.8	10 356.8	20 713.6	30 1070.4	40 1427.2	50 1784.0	60 2140.8	70 2497.6	80 2854.4	90 3211.2	100 3568.0	10 356.8	10 356.8
		11D	-	-	11 392.4	22 784.9	33 1177.4	44 1569.9	55 1962.4	66 2354.9	77 2747.4	88 3139.9	99 3532.4	11 392.4	11 392.4
		12D	-	-	12 428.1	24 856.3	36 1284.5	48 1712.6	60 2140.8	60 2140.8	72 2569.0	84 2997.1	96 3425.3	12 428.1	12 428.1
		13D	-	-	13 463.8	26 927.7	39 1391.5	39 1391.5	52 1855.4	65 2319.2	78 2783.1	78 2783.1	91 3246.9	-	-
		14D	-	-	14 499.5	28 999.0	28 999.0	42 1498.5	56 1998.1	70 2497.6	70 2497.6	84 2997.1	98 3496.7	-	-
		15D	-	-	15 535.2	30 1070.4	30 1070.4	45 1605.6	60 2140.8	60 2140.8	75 2676.0	90 3211.1	90 3211.1	-	-
		16D	-	-	16 570.8	16 570.8	32 1141.7	48 1712.6	48 1712.6	64 2283.5	80 2854.4	80 2854.4	96 3425.3	-	-
	1	1D +1P	2 35.6	10 178.4	20 356.8	30 535.2	40 713.6	50 892.0	60 1070.4	70 1248.8	80 1427.2	90 1605.6	100 1784.0	2 35.6	12 214.0

Appendix A.3-2 RAID 5 with 35.6 G bytes Disk drives

The maximum disk capacity of each configuration in the case where a combination of the one RK and the one to nine RKAs is configured in RAID 5 is shown below.
The upper and lower values in each cell show number of mounted Disk drives and disk capacity respectively. No spare disk is included.

Appendix A.3-2 List of Capacities Corresponding to RAID 5 (35.6 G bytes)

Disk capacity			35.6 G bytes												
Component unit			Detail of component unit												
			RK		RKA									RKL	
Range			1		1	2	3	4	5	6	7	8	9	1	
Total range of Disk drives			Min.	10 (Max.)	20	30	40	50	60	70	80	90	100	Min.	12 (Max.)
RAID level	5	2D +1P	3 71.3	9 214.0	18 428.1	30 713.6	39 927.7	48 1141.7	60 1427.2	69 1641.3	78 1855.4	90 2140.3	99 2354.9	3 71.3	12 285.4
		3D +1P	4 107.0	8 214.0	20 535.2	28 749.2	40 1070.4	48 1284.5	60 1605.6	68 1819.7	80 2140.8	88 2354.9	100 2676.0	4 107.0	12 321.1
		4D +1P	5 142.7	10 285.4	20 570.8	30 856.3	40 1141.7	50 1427.2	60 1712.6	70 1998.1	80 2283.5	90 2569.0	100 2854.4	5 142.7	10 285.4
		5D +1P	6 178.4	6 178.4	18 535.2	30 892.0	36 1071.4	48 1427.2	60 1784.0	66 1962.4	78 2319.2	90 2676.0	96 2854.4	6 178.4	12 356.8
		6D +1P	7 214.0	7 214.0	14 428.1	28 856.3	35 1070.4	49 1498.5	56 1712.6	70 2140.8	77 2354.9	84 2569.0	98 2997.1	7 214.0	7 214.0
		7D +1P	8 249.7	8 249.7	16 499.5	24 749.2	40 1248.8	48 1498.5	56 1748.3	64 1998.1	80 2497.6	88 2747.4	96 2997.1	8 249.7	8 249.7
		8D +1P	9 285.4	9 285.4	18 570.8	27 856.3	36 1141.7	45 1427.2	54 1712.6	63 1998.1	72 2283.5	81 2569.0	99 3139.9	9 285.4	9 285.4
		9D +1P	10 321.1	10 321.1	20 642.2	30 963.3	40 1284.5	50 1605.6	60 1926.7	70 2247.8	80 2569.0	90 2890.1	100 3211.2	10 321.1	10 321.1
		10D+ 1P	-	-	11 356.8	22 713.6	33 1070.4	44 1427.2	55 1784.0	66 2140.8	77 2497.6	88 2854.4	99 3211.2	11 356.8	11 356.8
		11D +1P	-	-	12 392.4	24 784.9	36 1177.4	48 1569.9	60 1962.4	60 1962.4	72 2354.9	84 2747.4	96 3139.9	12 392.4	12 392.4
		12D +1P	-	-	13 428.1	26 856.3	39 1284.5	39 1284.5	52 1712.6	65 2140.8	78 2569.0	78 2569.0	91 2997.1	-	-
		13D +1P	-	-	14 463.8	28 927.7	28 927.7	42 1391.5	56 1855.4	70 2319.2	70 2319.2	84 2783.1	98 3246.9	-	-
		14D +1P	-	-	15 499.5	30 999.0	30 999.0	45 1498.5	60 1998.1	60 1998.1	75 2497.6	90 2997.1	90 2997.1	-	-
		15D +1P	-	-	16 535.2	16 535.2	32 1070.4	48 1605.6	48 1605.6	64 2140.8	80 2676.0	80 2676.0	96 3211.2	-	-

Appendix A.3-3 RAID 0+1 with 35.6 G bytes Disk drives

The maximum disk capacity of each configuration in the case where a combination of the one RK and the one to nine RKAs is configured in RAID 0 +1 is shown below.
The upper and lower values in each cell show number of mounted Disk drives and disk capacity respectively. No spare disk is included.

Appendix A.3-3 List of Capacities Corresponding to RAID 0+1 (35.6 G bytes)

Disk capacity			35.6 G bytes												
Component unit			Detail of component unit												
			RK		RKA									RKL	
Range			1		1	2	3	4	5	6	7	8	9	1	
Total range of Disk drives			Min.	10 (Max.)	20	30	40	50	60	70	80	90	100	Min.	12 (Max.)
RAID level	0+1	2D +2P	4 71.3	8 142.7	20 356.8	28 499.5	40 713.6	48 856.3	60 1070.4	68 1213.1	80 1427.2	88 1569.9	100 1784.0	4 71.3	12 214.0
		3D +3P	6 107.0	6 107.0	18 321.1	30 535.2	36 642.2	48 856.3	60 1070.4	66 1177.4	78 1391.5	90 1605.6	96 1712.6	6 107.0	12 214.0
		4D +4P	8 142.7	8 142.7	16 285.4	24 428.1	40 713.6	48 856.3	56 999.0	64 1141.7	80 1427.2	88 1569.9	96 1712.6	8 142.7	8 142.7
		5D +5P	10 178.4	10 178.4	20 356.8	30 535.2	40 713.6	50 892.0	60 1070.4	70 1248.8	80 1427.2	90 1605.6	100 1784.0	10 178.4	10 178.4
		6D +6P	- -	- -	12 214.0	24 428.1	36 642.2	48 856.3	60 1070.4	60 1070.4	72 1284.5	84 1498.5	96 1712.6	12 214.0	12 214.0
		7D +7P	- -	- -	14 249.7	28 499.5	28 499.5	42 749.2	56 999.0	70 1248.8	70 1248.8	84 1498.5	98 1748.3	- -	- -
		8D +8P	- -	- -	16 285.4	16 285.4	32 570.8	48 856.3	48 856.3	64 1141.7	80 1427.2	80 1427.2	96 1712.6	- -	- -

Appendix A.4-1 RAID 0 and RAID 1 with 71.6 G bytes Disk drives

The maximum disk capacity of each configuration in the case where a combination of the one RK and the one to nine RKAs is configured in RAID 0 or RAID 1 is shown below. The upper and lower values in each cell show number of mounted Disk drives and disk capacity respectively. No spare disk is included.

Appendix A.4-1 List of Capacities Corresponding to RAID 0 and RAID 1 (71.6 G bytes)

Disk capacity			71.6 G bytes												
Component unit			Detail of component unit												
			RK		RKA									RKL	
Range			1		1	2	3	4	5	6	7	8	9	1	
Total range of Disk drives			Min.	10 (Max.)	20	30	40	50	60	70	80	90	100	Min.	12 (Max.)
RAID level	0	2D	2 143.2	10 716.3	20 1432.7	30 2149.0	40 2865.4	50 3581.7	60 4298.1	70 5014.4	80 5730.8	90 6447.1	100 7163.5	2 143.2	12 859.6
		3D	3 214.9	9 644.7	18 1289.4	30 2149.0	39 2793.7	48 3438.4	60 4298.1	69 4942.8	78 5587.5	90 6447.1	99 7091.8	3 214.9	12 859.6
		4D	4 286.5	8 573.0	20 1432.7	28 2005.7	40 2865.4	48 3438.4	60 4298.1	68 4871.1	80 5730.8	88 6303.8	100 7163.5	4 286.5	12 859.6
		5D	5 358.1	10 716.3	20 1432.7	30 2149.0	40 2865.4	50 3581.7	60 4298.1	70 5014.4	80 5730.8	90 6447.1	100 7163.5	5 358.1	10 716.3
		6D	6 429.8	6 429.8	18 1289.4	30 2149.0	36 2578.8	48 3438.4	60 4298.1	66 4727.9	78 5587.5	90 6447.1	96 6876.9	6 429.8	12 859.6
		7D	7 501.4	7 501.4	14 1002.8	28 2005.7	35 2507.2	49 3510.1	56 4011.5	70 5014.4	77 5515.8	84 6017.3	98 7020.2	7 501.4	7 501.4
		8D	8 573.0	8 573.0	16 1146.1	24 1719.2	40 2865.4	48 3438.4	56 4011.5	64 4584.6	80 5730.8	88 6303.8	96 6876.9	8 573.0	8 573.0
		9D	9 644.7	9 644.7	18 1289.4	27 1934.1	36 2578.8	45 3223.5	54 3868.2	63 4513.0	72 5157.7	90 6447.1	99 7091.8	9 644.7	9 644.7
		10D	10 716.3	10 716.3	20 1432.7	30 2149.0	40 2865.4	50 3581.7	60 4298.1	70 5014.4	80 5730.8	90 6447.1	100 7163.5	10 716.3	10 716.3
		11D	-	-	11 787.9	22 1575.9	33 2363.9	44 3151.9	55 3939.9	66 4727.9	77 5515.8	88 6303.8	99 7091.8	11 787.9	11 787.9
		12D	-	-	12 859.6	24 1719.2	36 2578.8	48 3438.4	60 4298.1	60 4298.1	72 5157.7	84 6017.3	96 6876.9	12 859.6	12 859.6
		13D	-	-	13 931.2	26 1862.5	39 2793.7	39 2793.7	52 3725.0	65 4656.2	78 5587.5	78 5587.5	91 6518.7	-	-
		14D	-	-	14 1002.8	28 2005.7	28 2005.7	42 3008.6	56 4011.5	70 5014.4	70 5014.4	84 6017.3	98 7020.3	-	-
		15D	-	-	15 1074.5	30 2149.0	30 2149.0	45 3223.5	60 4298.1	60 4298.1	75 5372.6	90 6447.1	90 6447.1	-	-
		16D	-	-	16 1146.1	16 1146.1	32 2292.3	48 3438.4	48 3438.4	64 4584.6	80 5730.8	80 5730.8	96 6876.9	-	-
	1	1D +1P	2 71.6	10 358.1	20 716.3	30 1074.5	40 1432.7	50 1790.8	60 2149.0	70 2507.2	80 2865.4	90 3223.5	100 3581.7	2 71.6	12 429.8

Appendix A.4-2 RAID 5 with 71.6 G bytes Disk drives

The maximum disk capacity of each configuration in the case where a combination of the one RK and the one to nine RKAs is configured in RAID 5 is shown below.
The upper and lower values in each cell show number of mounted Disk drives and disk capacity respectively. No spare disk is included.

Appendix A.4-2 List of Capacities Corresponding to RAID 5 (71.6 G bytes)

Disk capacity			71.6 G bytes												
Component unit			Detail of component unit												
			RK		RKA									RKL	
Range			1		1	2	3	4	5	6	7	8	9	1	
Total range of Disk drives			Min.	10 (Max.)	20	30	40	50	60	70	80	90	100	Min.	12 (Max.)
RAID level	5	2D +1P	3 143.2	9 429.8	18 859.6	30 1432.7	39 1862.5	48 2292.3	60 2865.4	69 3295.2	78 3725.0	90 4298.1	99 4727.9	3 143.2	12 573.0
		3D +1P	4 214.9	8 429.8	20 1074.5	28 1504.3	40 2149.0	48 2578.8	60 3223.5	68 3653.3	80 4298.1	88 4727.9	100 5372.6	4 214.9	12 644.7
		4D +1P	5 286.5	10 573.0	20 1146.1	30 1719.2	40 2292.3	50 2865.4	60 3438.4	70 4011.5	80 4584.6	90 5157.7	100 5730.8	5 286.5	10 573.0
		5D +1P	6 358.1	6 358.1	18 1074.5	30 1790.8	36 2149.0	48 2865.4	60 3581.7	66 3939.9	78 4656.2	90 5372.6	96 5730.8	6 358.1	12 716.3
		6D +1P	7 429.8	7 429.8	14 859.6	28 1719.2	35 2149.0	49 3008.6	56 3438.4	70 4298.1	77 4727.9	84 5157.7	98 6017.3	7 429.8	7 429.8
		7D +1P	8 501.4	8 501.4	16 1002.8	24 1504.3	40 2507.2	48 3008.6	56 3510.1	64 4011.5	80 5014.4	88 5515.8	96 6017.3	8 501.4	8 501.4
		8D +1P	9 573.0	9 573.0	18 1146.1	27 1719.2	36 2292.3	45 2865.4	54 3438.4	63 4011.5	72 4584.6	90 5157.7	99 6303.8	9 573.0	9 573.0
		9D +1P	10 644.7	10 644.7	20 1289.4	30 1934.1	40 2578.8	50 3223.5	60 3868.2	70 4513.0	80 5157.7	90 5802.4	100 6447.1	10 644.7	10 644.7
		10D +1P	- -	- -	11 716.3	22 1432.7	33 2149.0	44 2865.4	55 3581.7	66 4298.1	77 5014.4	88 5730.8	99 6447.1	11 716.3	11 716.3
		11D +1P	- -	- -	12 787.9	24 1575.9	36 2363.9	48 3151.9	60 3939.9	60 3939.9	72 4727.9	84 5515.8	96 6303.8	12 787.9	12 787.9
		12D +1P	- -	- -	13 859.6	26 1719.2	39 2578.8	39 2578.8	52 3438.4	65 4298.1	78 5157.7	78 5157.7	91 6017.3	- -	- -
		13D +1P	- -	- -	14 931.2	28 1862.5	28 1861.6	42 2793.7	56 3725.0	70 4656.2	70 4656.2	84 5587.5	98 6518.7	- -	- -
		14D +1P	- -	- -	15 1002.8	30 2005.7	30 2005.7	45 3008.6	60 4011.5	60 4011.5	75 5014.4	90 6017.3	90 6017.3	- -	- -
		15D +1P	- -	- -	16 1074.5	16 1074.5	32 2149.0	48 3223.5	48 3223.5	64 4298.1	80 5372.6	80 5372.6	96 6447.1	- -	- -

Appendix A.4-3 RAID 0+1 with 71.6 G bytes Disk drives

The maximum disk capacity of each configuration in the case where a combination of the one RK and the one to nine RKAs is configured in RAID 0 +1 is shown below.
The upper and lower values in each cell show number of mounted Disk drives and disk capacity respectively. No spare disk is included.

Appendix A.4-3 List of Capacities Corresponding to RAID 0+1 (71.6 G bytes)

Disk capacity			71.6 G bytes												
Component unit			Detail of component unit												
			RK		RKA									RKL	
Range			1		1	2	3	4	5	6	7	8	9	1	
Total range of Disk drives			Min.	10 (Max.)	20	30	40	50	60	70	80	90	100	Min.	12 (Max.)
RAID level	0+1	2D +2P	4 143.2	8 286.5	20 716.3	28 1002.8	40 1432.7	48 1719.2	60 2149.0	68 2435.5	80 2865.4	88 3151.9	100 3581.7	4 143.2	12 429.8
		3D +3P	6 214.9	6 214.9	18 644.7	30 1074.5	36 1289.4	48 1719.2	60 2149.0	66 2363.9	78 2793.7	90 3223.5	96 3438.4	6 214.9	12 429.8
		4D +4P	8 286.5	8 286.5	16 573.0	24 859.6	40 1432.7	48 1719.2	56 2005.7	64 2292.3	80 2865.4	88 3151.9	96 3438.4	8 286.5	8 286.5
		5D +5P	10 358.1	10 358.1	20 716.3	30 1074.5	40 1432.7	50 1790.8	60 2149.0	70 2507.2	80 2865.4	90 3223.5	100 3581.7	10 358.1	10 358.1
		6D +6P	- -	- -	12 429.8	24 859.6	36 1289.4	48 1719.2	60 2149.0	60 2149.0	72 2578.8	84 3008.6	96 3438.4	12 429.8	12 429.8
		7D +7P	- -	- -	14 501.4	28 1002.8	28 1002.8	42 1504.3	56 2005.7	70 2507.2	70 2507.2	84 3008.6	98 3510.1	- -	- -
		8D +8P	- -	- -	16 573.0	16 573.0	32 1146.1	48 1719.2	48 1719.2	64 2292.3	80 2865.4	80 2865.4	96 3438.4	- -	- -

Glossary

Cache backup :

Because a cache memory uses DRAM, information stored in it is lost when the subsystem power is shut off. To provide against unexpected power failure, the subsystem has an setup to maintain data in the cache memory by batteries. Cache backup is a state in which the data is protected by the batteries.

Canister :

A mechanical part for mounting disk drives in order to allow the Disk drives to be installed/ removed in/from the subsystem easily.

EIA : Electronic Industries Alliance

EIA standard 1 EIA unit = 44.45 mm

FC-AL : Fibre Channel Arbitrated Loop

Fibre Channel HBA : Figre Channel Host bus Adapter

Fibre Channel HUB :

An apparatus to connect and relay Fibre Channel cables each connected to a Fibre Channel device in order to form an arbitrated loop of the Fibre Channel.

FC-SW : Fibre Channel-SWitch Topology

GBIC : GigaBit Interface Converter

Host computer :

A computer which manages devices. In the case of the disk array, a computer which makes the disk array store data is applicable to the term.

Hot replacement :

To replace an installed part with the subsystem power on. Usually, the major part is duplicated so that when one of the parts fails, the subsystem function is maintained by another part.

Mirror disk :

A slave disk on which the same data as that on the master disk, which is used to read/write data, is written in the RAID 1 configuration. When a failure occurs in the master Disk drive, reading/writing is done from/on the mirror disk.

MTBF : Mean Time Between Failure

MTBDL : Mean Time Between Data Lost

LVD : Low Voltage Differential

Parity disk :

When configuring RAID 5, one disk drive in a RAID group is designated as the parity disk and the other disk drives as data disks. On the parity disk, parity data calculated from those of data disks is stored. Even when one of the Disk drives in a RAID group fails, the subsystem can be used with its data not damaged by virtue of the parity data.

PDB : Power Distribution Box

PDU : Power Distribution Unit

Rack frame:

A frame on which electronic equipment are mounted like a bookshelf using rails, etc. Most of them have a width of 19 inches, and called 19-inch rack frame. Height of the equipment to be mounted is regulated by the EIA standard (1 EIA unit = 44.45 mm).
The rack frame has screw holes to fasten equipment with bolts, etc.

RAID : Redundant Array of Independent (Inexpensive) Disks

The RAID technology, which was proposed by a research group in the University of California at Berkeley in 1987, is to realize high-speed, large capacity, and highly reliable storage device by scattering accesses using several disk drives. RAID levels proposed by the University of California are classified into six levels, that is, RAID 0 to RAID 5, and they are selected according to user's demand taking their costs and speeds in consideration.

Remote maintenance function (SNMP) :

SNMP agent support function reports an occurrence of a failure to the workstation for monitoring the network via the SNMP of the open platform.
It also reports the operating condition, such as numbers of command reception and cache hits, of the disk array subsystem.
It enables the command executing condition, which corresponds to the type of access from host computers, to be referred to, and such information aids performance tune-up of the subsystem.
To use the SNMP agent support function, LAN facility and a workstation in which SNMP Manager is installed are required.

SNNP : Simple Network Management Protocol

Spare disk :

A Disk drive installed separately from disk drives used for usual reading and writing.
When one of the latter Disk drives fails, the subsystem keeps in service as before by copying data stored in the failed Disk drive to the spare disk.

UPS : Uninterrupted Power Supply

Write cache :

When data is written from a host computer onto a disk array subsystem, it is not written directly on the Disk drive but written on a cache memory. In this way, the disk array subsystem can return a writing completion report promptly. This writing method using a cache memory is called write cache.

Write through mode :

A method to write data directly on a Disk drive without using the write cache.

DF500

Disk Array Subsystem

Specifications

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