

THEORY OF OPERATION SECTION

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1. RAID Architecture Overview

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

1.1 Outline of RAID Systems

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

The research group called the disk array RAID (Redundant Array of Inexpensive Disks: A storage system that has redundancy by employing multiple inexpensive and small disk drives), classified the RAID systems into five levels, that is, RAID 1 to RAID 5, and added RAID 0 and RAID 6 later. Since the DKC810I storage system supports RAID 1, RAID 5, and RAID 6, the method, advantage, and disadvantage of each of them are explained below.

Table 1.1-1 Outline of RAID Systems

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

THEORY01-20

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

THEORY01-30

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

1.2 Comparison of RAID levels

(1) Space efficiency

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

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

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

THEORY01-50

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

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

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

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

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

(3) Reliability

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

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

2. Hardware Specifications

2.1 General

DKC810I is a high performance and large capacity storage system at the high-end that follows the architecture of the DKC710I and has improved Hi-Star Net Architecture and speeded up microprocessor.

DKC810I has single DKC model and twin DKC model.

DKC810I contains the configuration from a single rack to six racks, and the racks contain the configuration from a diskless configuration to a maximum of 2,304 disk drives installed, to meet customer's needs.

DKC810I supports the single-phase AC power supply equipment that enables to connect both the mainframe and the open system.

Single Rack configuration

Six Racks configuration

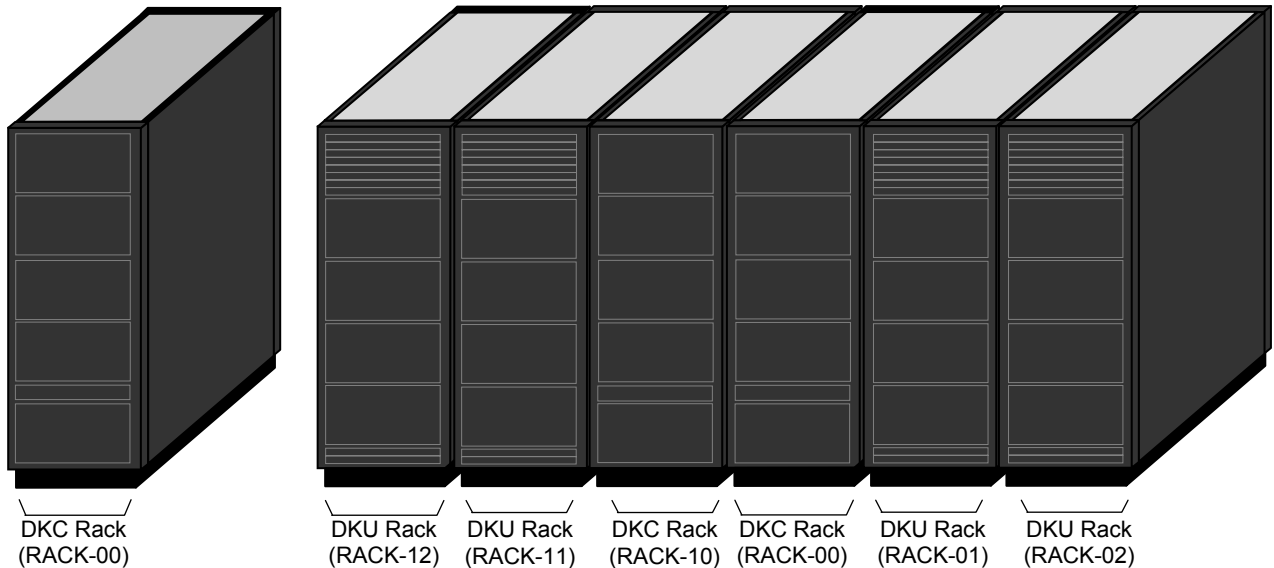


Fig. 2.1-1 Storage System

2.1.1 Features

(1) Scalability

DKC810I provides variations of the storage system configuration according to the kinds and the numbers of selected options: channel adapter, cache memory, disk drive, flash drive (SSD) and flash module drive (FMD).

- Number of installed channel options: 1 to 12 sets
- Capacity of cache memory: 32GB to 2,048GB
- Number of drives: Up to 2,304 (2.5-inch HDD), 1,152 (3.5-inch HDD), 384 (2.5-inch SSD) or 192 (FMD)

(2) High-performance

- DKC810I supports three kinds of high-speed disk drives at the speed of 7.2kmin^{-1} , 10kmin^{-1} and 15kmin^{-1}
- DKC810I supports flash drives (SSD) and Flash Module Drive (FMD) with ultra high-speed response.
- DKC810I realizes high-speed data transfer between DKA and drives at a rate of 6Gbps with the SAS interface.
- DKC810I uses the 8-core processor (twice the number of cores that the processor of DKC710I has) on MP board, doubling the processing ability.

(3) Large Capacity

- DKC810I supports disk drive with capacities of 300GB, 600GB, 900GB, 1.2TB, 3TB and 4TB.
- DKC810I supports flash drive with capacities of 400GB and 800GB.
- DKC810I supports Flash Module Drive (FMD) with capacities of 1.6TB and 3.2TB.
- DKC810I controls up to 65,280 logical volumes and up to 2,304 disk drives, and provides a physical disk capacity of approximately 4,511TB per storage system.

(4) Flash Module Drive (FMD)

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

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

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

(5) Connectivity

DKC810I supports OS's for various UNIX servers, PC servers, and mainframes, so that it conforms to heterogeneous system environment in which those various OS's coexist.

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

Table 2.1.1-1 Support OS Type

Mainframe		Open system	
Maker	OS	Maker	OS
Hitachi	VOS3/US, VOS3/LS	HP	OpenVMS
IBM	z/OS, z/VSE, z/VM, z/TPF		HP-UX
	LINUX on System z	Sun	Solaris
		IBM	AIX 5L
		Microsoft	Windows
		SUSE	SUSE Linux
		Red Hat	Red Hat Linux
		VMware	VMware

Host interfaces supported by the DKC810I are shown below. They can mix within the storage system.

- Mainframe: fibre channel (FICON)
- Open system: fibre channel

(6) High reliability

- DKC810I supports RAID6 (6D+2P/14D+2P), RAID5 (3D+1P/7D+1P), and RAID1 (2D+2D/4D+4D).
- Main components are implemented with a duplex or redundant configuration, so even when single point of the component failure has occurred, the storage system can continue the operation.

(7) Non-disruptive Service and Upgrade

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

2.2 Architecture

2.2.1 Outline

The DKC810I consists of Controller Chassis (DKC) with various control boards and Drive Chassis (DKU) with drives. The DKC and the DKU are installed in a 19-inch rack. The maximum configuration of the storage system is a 6-rack configuration that consists of 2 DKC and 12 DKU.

There are 3 kinds of Drive Chassis as follows:

- SFF Drive Chassis: Up to 192 2.5-inch HDDs/SSDs can be installed.
- LFF Drive Chassis: Up to 96 3.5-inch HDDs can be installed.
- FMD Chassis: Up to 48 FMDs (Flash Module Drive) can be installed.

A Controller Chassis can connect a maximum of 6 SFF/LFF Drive Chassis and control up to 1,152 (2.5-inch HDD) / 576 (3.5-inch HDD) / 192 (2.5-inch SSD) drives. And a Controller Chassis can connect a maximum of 2 FMD Chassis and control up to 96 Flash Module Drives. The SFF Drive Chassis, the LFF Drive Chassis and the FMD Chassis can be mixed in the storage system.

The size of each chassis is as follows: The Controller Chassis is 10U high, the SFF Drive Chassis is 16U high, the LFF Drive Chassis is 16U high, and the FMD Chassis is 8U high.

The outline of components of the DKC810I storage system is shown below.

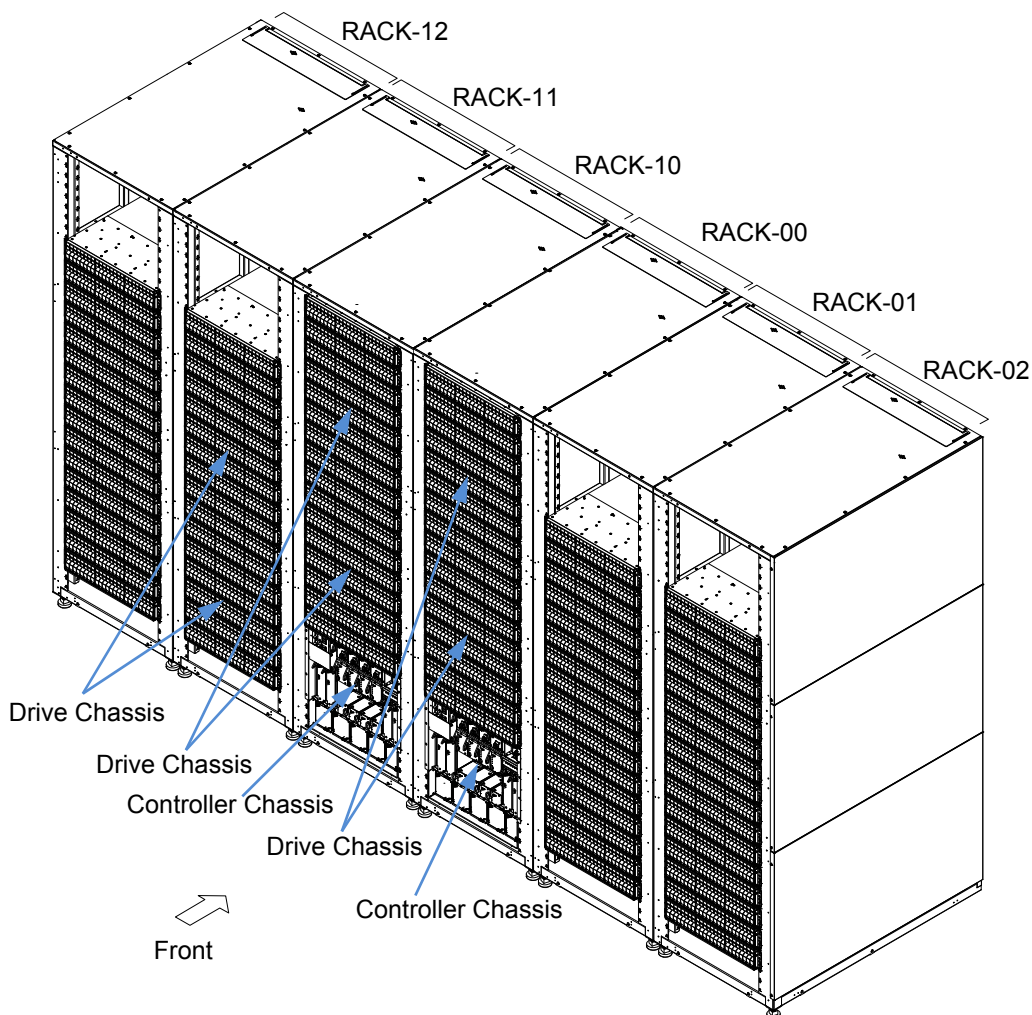


Fig. 2.2.1-1 DKC810I Outline

2.2.2 Hardware Architecture

(1) Controller Chassis (DKC)

The Controller Chassis (DKC) consists of Channel Adapter (CHA), Disk Adapter (DKA), Cache Path Control Adapter (CPEX), Cache Backup Module Kit (BKM), Processor Blades (MPB), Service Processor (SVP), Cooling Fan and AC-DC Power Supply that supplies the power to the components. The batteries and the cache flash memories are installed in the Cache Backup Module Kit to prevent data loss by the occurrence of power outage or the like.

The storage system continues to operate when a single point of failure occurred, by adopting a duplexed configuration for each control board (CHA, DKA, CPEX, BKM and MPB) and the AC-DC Power Supply, and a redundant configuration for the AC-DC Power Supply and the Cooling Fan. The addition and the replacement of the components and the upgrading of the microcode can be processed while the storage system is in operation.

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

(2) Drive Chassis (DKU)

Three types of Drive Chassis are available: SFF Drive Chassis for 2.5-inch drives, LFF Drive Chassis for 3.5-inch drives and FMD Chassis for Flash Module Drives (FMD).

The SFF Drive Chassis is a chassis to install the disk drives and the flash drives, and consists of SSW boards and the AC-DC power supplies equipped with built-in cooling fans.

The LFF Drive Chassis is a chassis to install the disk drives, and consists of SSW boards and the AC-DC Power Supplies equipped with built-in cooling fans.

The FMD Chassis is a chassis to install Flash Module Drives, and consists of SSW boards and the AC-DC Power Supplies equipped with built-in cooling fans.

The duplex configuration is adopted in SSW and AC-DC Power Supply, and moreover, the redundant configuration is adopted in AC-DC Power Supply. All the components can be replaced and added while the storage system is in operation.

A maximum of 192 drives can be installed in the SFF Drive Chassis and a maximum of 96 drives can be installed in the LFF Drive Chassis. Up to 48 drives can be installed in the FMD Chassis.

(3) Power Supply

The AC input method of DKC810I adopts the duplex and the redundant configurations as well as the conventional products, and continues to operate when a failure occurs in either of the power systems.

(4) Data Path

The access performance to cache memory is determined by the number of installed Cache Path Control Adapter (CPEX).

Table 2.2.2-1 Data Path Bandwidth Performance

CPEX	DKC-0		DKC-1		Data Path Bandwidth
	CPEX-0	CPEX-1	CPEX-2	CPEX-3	
1 set	✓	—	—	—	192GB/s
2 sets	✓	✓	—	—	384GB/s
	✓	—	✓	—	384GB/s
4 sets	✓	✓	✓	✓	768GB/s

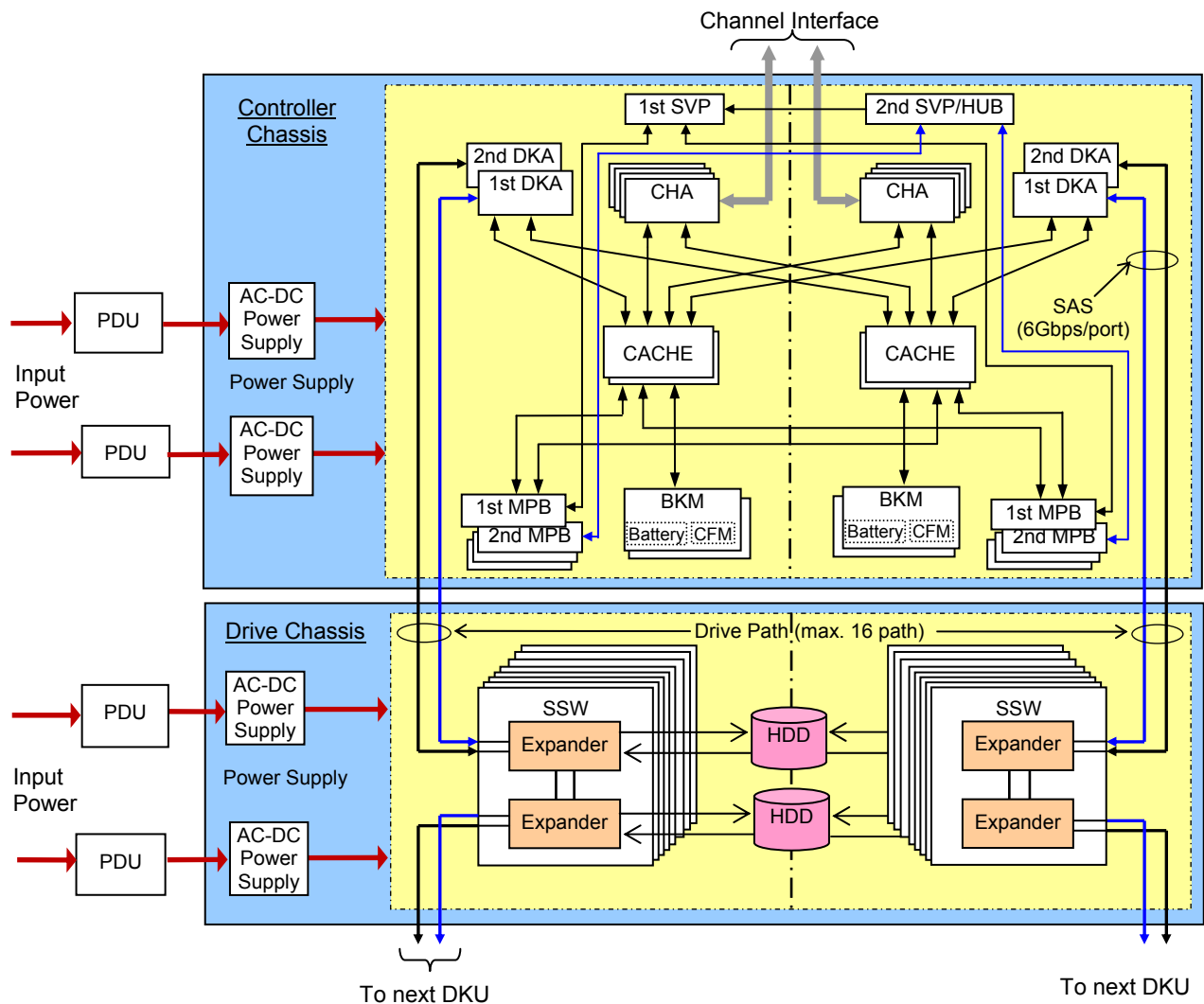


Fig. 2.2.2-1 DKC810I Hardware Architecture Outlines

(5) Drive Path

(a) When using 2.5-inch HDD

DKC controls 1,152 HDDs with 8 paths for the standard model, and with 16 paths for the high performance model. A maximum of 6 SFF Drive Chassis (DKC-F810I-SBX) can be controlled by a single DKC.

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

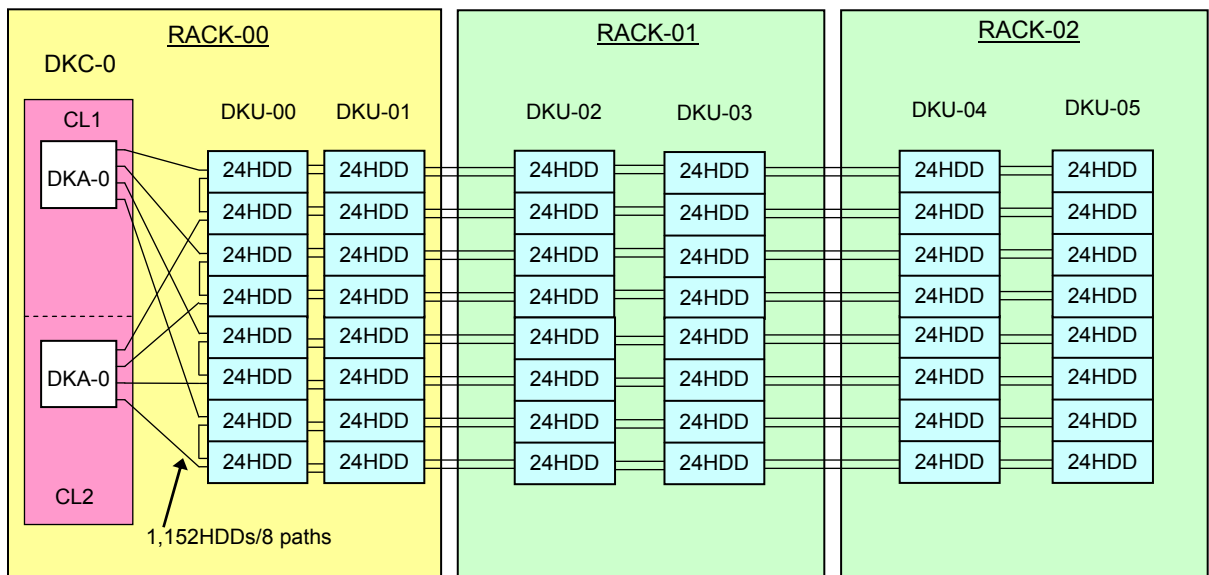


Fig. 2.2.2-2 Drive Path Connection Outlines of 2.5-inch Standard Model

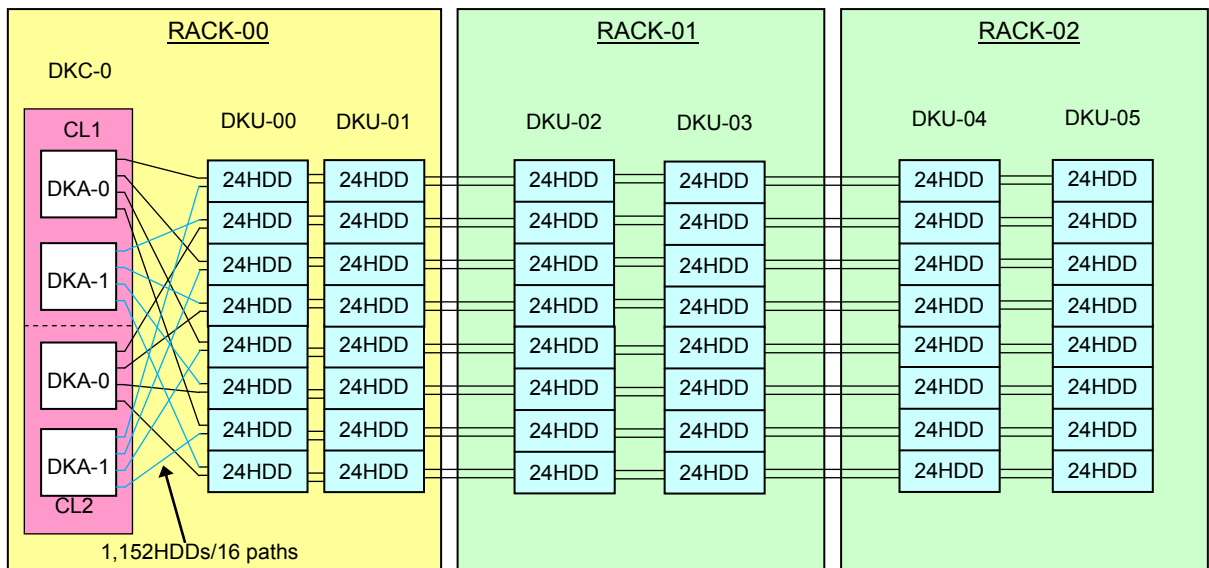


Fig. 2.2.2-3 Drive Path Connection Outlines of 2.5-inch High-Performance Model

(b) When using 3.5-inch HDD

DKC controls 576 HDDs with 8 paths for the standard model, and with 16 paths for the high performance model. A maximum of 6 LFF Drive Chassis (DKC-F810I-UBX) can be controlled by a single DKC.

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

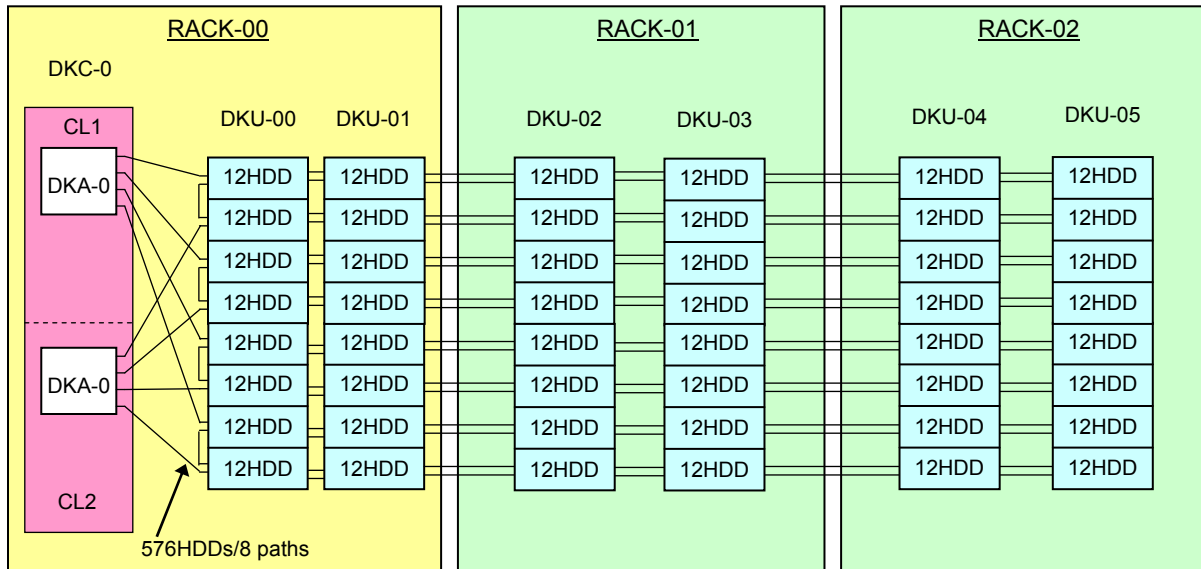


Fig. 2.2.2-4 Drive Path Connection Outlines of 3.5-inch Standard Model

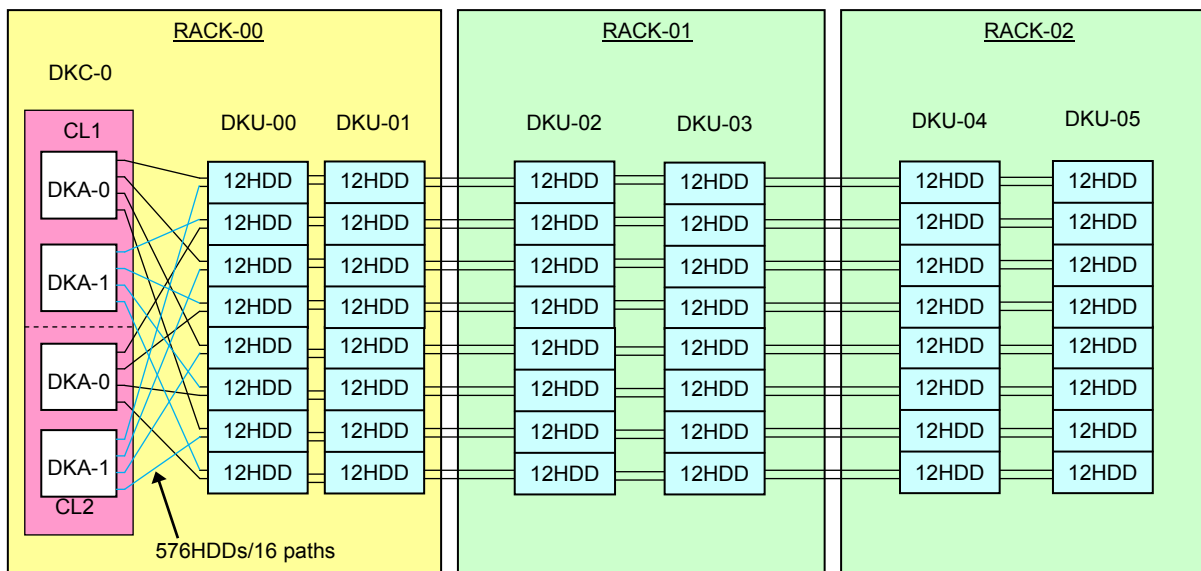


Fig. 2.2.2-5 Drive Path Connection Outlines of 3.5-inch High-Performance Model

(c) When using FMD

DKC controls 96 FMDs with 8 paths for the standard model, and with 16 paths for the high performance model. A maximum of 2 FMD Chassis (DKC-F810I-FBX) can be controlled by a single DKC.

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

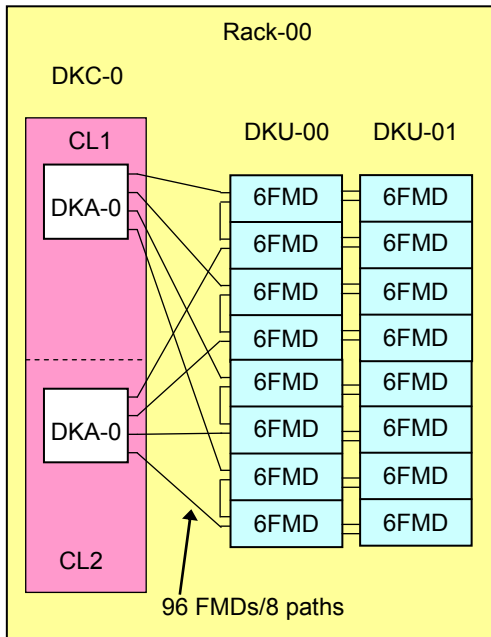


Fig. 2.2.2-6 Drive Path Connection Outlines of FMD Standard Model

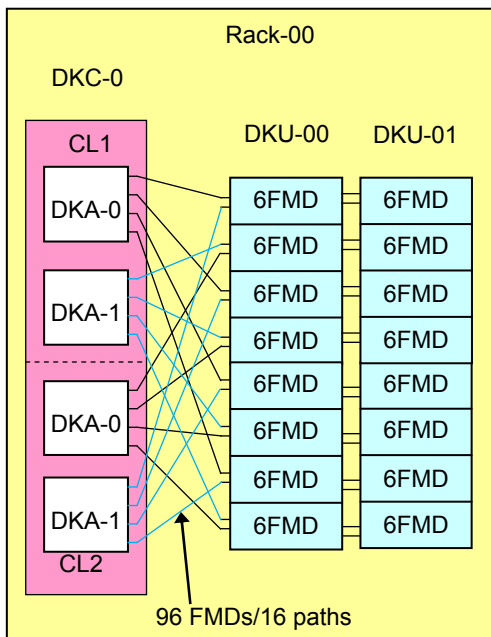


Fig. 2.2.2-7 Drive Path Connection Outlines of FMD High-Performance Model

2.2.3 Hardware Component

(1) Channel Adapter (CHA)

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

DKC810I supports two kinds of CHAs for the mainframe and for the open system.

Table 2.2.3-1 Mainframe Connection CHA Specifications

	Mainframe Fibre 8Gbps	
	Shortwave	Longwave
Model number	DKC-F810I-16MS8	DKC-F810I-16ML8
Host interface	FICON	FICON
Data transfer rate (MB/s)	200/400/800	200/400/800
Number of options installed (): DKA slot used	1/2/3/4/5/6/7/8 (9/10/11)	1/2/3/4/5/6/7/8 (9/10/11)
Number of ports per Option	16	16
Number of ports per storage system (): DKA slot used	16/32/48/64/80/96/112/128 (144/160/176)	
Maximum cable length	500m/380m/150m (*1)	10km

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

Table 2.2.3-2 Open System Connection CHA Specifications

	Fibre 8Gbps		Fibre 16Gbps	
	16port		8port	
Model number	DKC-F810I-16FC8 (*2)		DKC-F810I-8FC16 (*3)	
Host interface	FCP		FCP	
Data transfer rate	200/400/800 MB/s		400/800/1600 MB/s	
Number of options installed (): DKA slot used	1/2/3/4/5/6/7/8 (9/10/11/12)		1/2/3/4/5/6/7/8 (9/10/11/12)	
Number of ports per Option	16		8	
Number of ports per storage system (): DKA slot used	16/32/48/64/80/96/112/128 (144/160/176/192)		8/16/24/32/40/48/56/64 (72/80/88/96)	
Maximum cable length	Shortwave	500m/380m/150m (*1)	380m/150m/100m (*1)	
	Longwave	10km	10km	

- *1: Indicates when 50/125μm laser optimized multi-mode fiber cable (OM3) is used. When using other cable types, it is limited to the length shown in Table 2.2.3-3.
- *2: The CHA for the fibre channel connection can conform to either Shortwave or Longwave by selecting a transceiver installed on each port. However, DKC-F810I-1PL8 (SFP for 8Gbps Longwave) must be installed for the Longwave, because the Shortwave transceiver is included in the CHA as a standard.
- *3: The CHA for the fibre channel connection can conform to either Shortwave or Longwave by selecting a transceiver installed on each port. However, DKC-F810I-1PL16 (SFP for 16Gbps Longwave) must be installed for the Longwave, because the Shortwave transceiver is included in the CHA as a standard.

Table 2.2.3-3 Maximum cable length (Shortwave)

Data Transfer Rate	Maximum cable length			
	OM1 (62.5/125μm multi-mode fiber)	OM2 (50/125μm multi-mode fiber)	OM3 (50/125μm laser optimized multi-mode fiber)	OM4 (50/125μm laser optimized multi-mode fiber)
200MB/s	150m	300m	500m	—
400MB/s	70m	150m	380m	400m
800MB/s	21m	50m	150m	190m
1600MB/s	15m	35m	100m	125m

(2) Disk Adapter (DKA)

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

DKC-F810I-ESCA supports data encryption function.

DKC-F810I-SCA and DKC-F810I-ESCA cannot be mixed in the same storage system.

Table 2.2.3-4 Disk Adapter Specifications

Model Number	DKC-F810I-SCA	DKC-F810I-ESCA
PCB Name	WP820-A	WP820-B
Number of PCB	2	2
Maximum Number of Options per Storage System	4	4
Performance of SAS Port	6Gbps	6Gbps
Number of SAS Port per PCB	4	4
Data encryption function	Not Support	Support
Maximum Number of Drive Paths per Storage System	32	32
Maximum number of Drives per SAS Port (Under the 2.5-inch HDD Standard Model)	288	288

(3) Processor Blades (MPB)

The Processor Blades consist of 2 boards that include the DIMMs and the processor with the chip set, and control the CHA, the DKA, the PCI-Express interface, the local memory, and communication between the SVPs by Ethernet.

Table 2.2.3-5 Processor Blades Specifications

Model Number	DKC-F810I-MP	
PCB Name	WP850-A (*1)	WP850-B (*1)
Number of PCB	2	2
Maximum Number of Options per Storage System	8	8
Performance of Processor	2.1GHz	2.1GHz
Processor Type	Xeon E5-2450 (Eight-core)	Xeon E5-2450 v2 (Eight-core)
Number of Processor per PCB	1	1
Local Memory Capacity per PCB	16GB (8GB DIMM × 2)	16GB (8GB DIMM × 2)

*1: WP850-A and WP850-B are compatible and can be used together.

(4) Cache Memory Module (CM-DIMM)

Two types of Cache Memory Module are available for DKC810I.

Table 2.2.3-6 Cache Memory Module Specifications

Model Number	Capacity	Component	Memory Chip Type
DKC-F810I-CM16G	16GB	16GB-DIMM × 1	4Gbit DRAM × 2RANK
DKC-F810I-CM32G	32GB	32GB-DIMM × 1	4Gbit DRAM × 4RANK

(5) Cache Path Control Adapter (CPEX)

The PCI-Express Switch Adapter (ESW) and Cache Memory Adapter (CPC) of DKC710I, which are separate PCBs, have been integrated into the Cache Path Control Adapter (CPEX) of DKC810I.

The Cache Path Control Adapter consists of 2 boards to install the cache memory (CM-DIMM). Each board has 8 CM-DIMM slots.

The CPEX connects between MPB, CHA, DKA and BKM by using PCI-Express path and distributes data (data routing function), and sends hot-line signals to the MPB.

A minimum of two CM-DIMMs must be installed in a set of CPEX. The maximum cache memory capacity of 256GB (DKC-F810I-CM16G × 16) or 512GB (DKC-F810I-CM32G × 16) can be installed in a set of CPEX.

The DKC-F810I-CM16G and the DKC-F810I-CM32G cannot be mixed in a set of CPEX.

Table 2.2.3-7 Cache Memory Capacity per CPEX

Number of Cache Path Control Adapter	Cache Memory Capacity (GB)	
	DKC-F810I-CM16G are used	DKC-F810I-CM32G are used
1 set	32 to 256	64 to 512
2 sets	64 to 512	128 to 1,024
4 sets	128 to 1,024	256 to 2,048

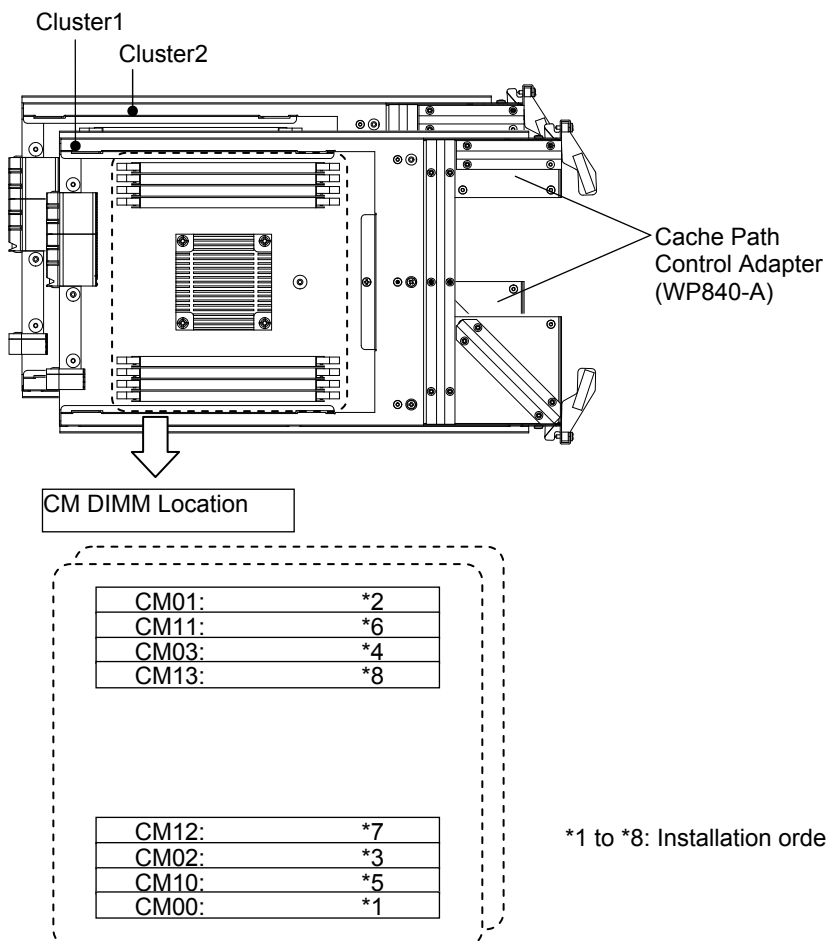


Fig. 2.2.3-1 Top of Cache Path Control Adapter (DKC-F810I-CPEX)

(6) Cache Flash Memory (CFM)

The Cache Flash Memory is memory to back up cache memory data when a power failure occurs and is installed in the Cache Backup Module Kit (DKC-F810I-BKMS/BKML). The required capacity of the Cache Flash Memory is determined depending on the cache memory capacity installed in the Cache Path Control Adapter (CPEX).

Table 2.2.3-8 Cache Flash Memory Specifications

Model Number	Capacity	Installation Requirements
DKC-F810I-BMM128	128GB	Two DKC-F810I-BMM128 are required for 256GB or less cache memory data backup.
DKC-F810I-BMM256	256GB	Two DKC-F810I-BMM256 are required for 512GB or less cache memory data backup.

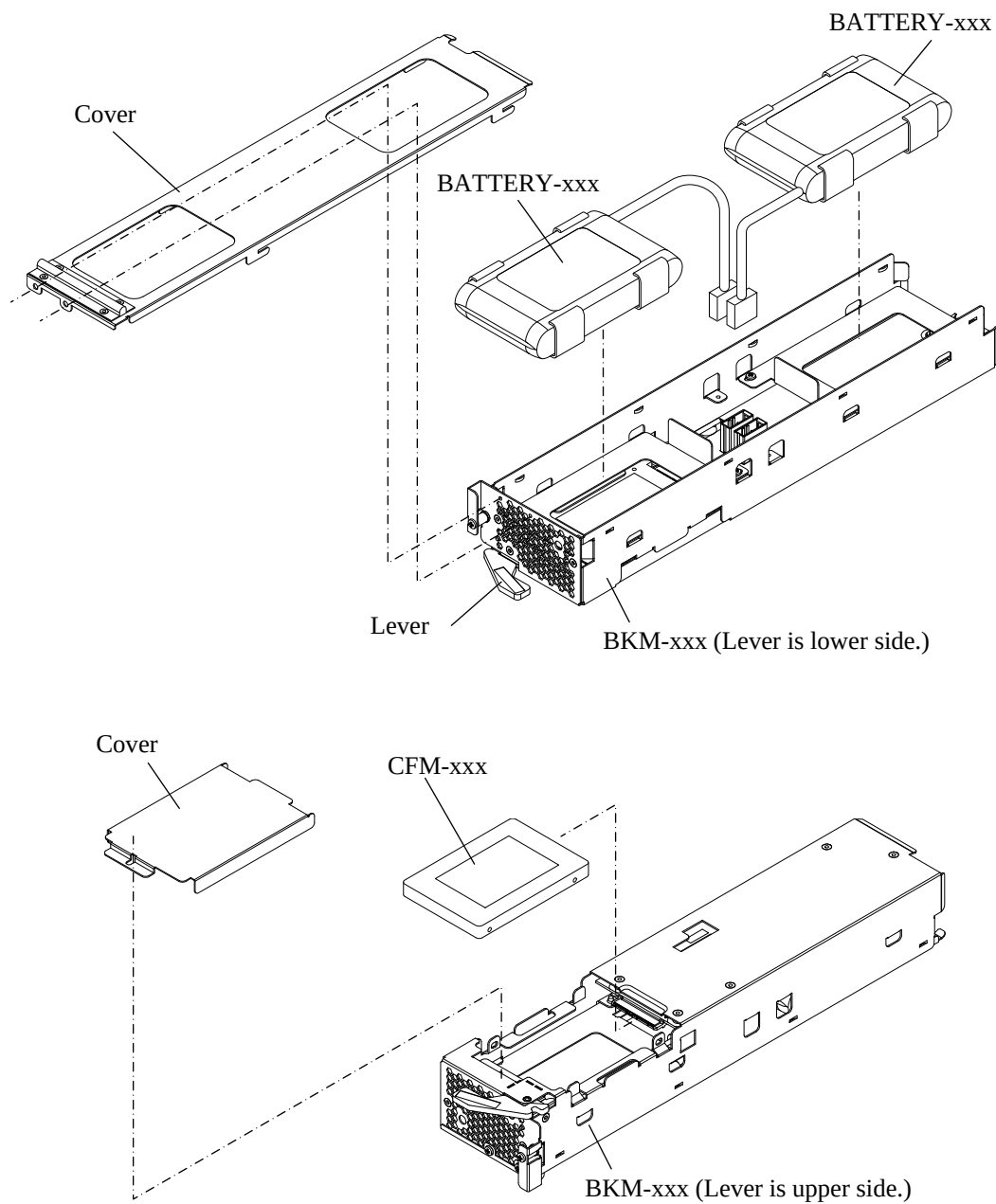
(7) Cache Backup Module Kit (BKM)

The Cache Backup Module Kit is a kit to back up cache memory data when a power failure occurs and consists of 2 boxes with batteries and a control board. The Cache Flash Memory (CFM) corresponding to cache memory capacity installed in the Cache Path Control Adapter is required to install.

Two types of BKM are available. One is the DKC-F810I-BKMS for backing up cache memory data with a capacity of 256GB or less, and the other is the DKC-F810I-BKML for backing up cache memory data with a capacity of 512GB or less.

Table 2.2.3-9 Cache Backup Module Kit Specifications

Model Number	Battery Type	CM Backup Capacity	CFM to Install
DKC-F810I-BKMS	Ni-MH	256GB or less	DKC-F810I-BMM128 × 2
DKC-F810I-BKML	Ni-MH	256GB or less	DKC-F810I-BMM128 × 2
		512GB or less	DKC-F810I-BMM256 × 2



NOTE: xxx: BKM No.
(1BA, 1BB, 1BC, 1BD, 2BA, 2BB, 2BC, 2BD)

Fig. 2.2.3-2 Components of Cache Backup Module Kit

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

The disk drive, the flash drive, and the flash module drive supported by DKC810I are shown below.

Table 2.2.3-10 Drive Support List

Group	I/F	Canister Type	Drive Type (inch)	Transfer Rate (Gbps)	Revolution Speed (min^{-1}) / Flash Memory Technology	Capacity
Disk Drive	SAS	SFF	2.5	6	10,000	600GB, 900GB, 1.2TB
		SFF	2.5	6	15,000	300GB
		LFF	3.5	6	7,200	3TB, 4TB
		LFF	2.5	6	10,000	600GB
Flash Drive	SAS	SFF	2.5	6	MLC	400GB, 800GB
		LFF	2.5	6	MLC	400GB
Flash Module Drive	SAS	—	—	6	MLC	1.6TB, 3.2TB

Table 2.2.3-11 3.5 inch Disk Drive Specifications (1/2)

Item ^{*2}		3TB / 7.2k min^{-1}		
Disk Drive Model Name	Seagate	S2E-H3R0SS		
	HGST	—		
Capacity/HDD		2937.11GB		
Number of heads		8		
Number of disks		4		
Seek Time (ms) (Read/Write)	Average ^{*1}	7.8/8.5		
Average latency time (ms)		4.16		
Revolution speed (min^{-1})		7,200		
Interface data transfer rate (Gbps)		6		
Internal data transfer rate (MB/s)		Max 276		

Table 2.2.3-11 3.5 inch Disk Drive Specifications (2/2)

Item ^{*2}		4TB / 7.2kmin ⁻¹			
Disk Drive Model Name	Seagate	—	S2E-H4R0SS		
	HGST	R2E-H4R0SS	—		
Capacity/HDD		3916.14	3916.14		
Number of heads		10	10		
Number of disks		5	5		
Seek Time (ms) (Read/Write)	Average ^{*1}	8.2/8.2	7.8/8.5		
Average latency time (ms)		4.2	4.16		
Revolution speed (min ⁻¹)		7,200	7,200		
Interface data transfer rate (Gbps)		6	6		
Internal data transfer rate (MB/s)		103 to 203	Max 276		

*1: Not including controller overhead

*2: min⁻¹ = rpm

Table 2.2.3-12 2.5 inch Disk Drive Specifications (1/2)

Item ^{*2}		300GB / 15kmin ⁻¹	600GB / 10kmin ⁻¹		
Disk Drive Model Name	Seagate	S5C-K300SS	—	S5E-J600SS	
	HGST	—	R5D-J600SS	—	
Capacity/HDD		288.20GB	576.39GB	576.39GB	
Number of heads		4	4	4	
Number of disks		2	2	2	
Seek Time (ms) (Read/Write)	Average ^{*1}	2.7/3.1	3.8/4.2	3.6/4.1	
Average latency time (ms)		2.0	3.0	2.9	
Revolution speed (min ⁻¹)		15,000	10,000	10,000	
Interface data transfer rate (Gbps)		6	6	6	
Internal data transfer rate (MB/s)		194.3 to 283.4	164.9 to 279	180 to 293.8	

*1: Not including controller overhead

*2: min⁻¹ = rpm

Table 2.2.3-12 2.5 inch Disk Drive Specifications (2/2)

Item ^{*2}		900GB / 10kmin ⁻¹		1.2TB / 10kmin ⁻¹	
Disk Drive Model Name	Seagate	—	S5E-J900SS	—	S5F-J1R2SS
	HGST	R5D-J900SS	—	R5E-J1R2SS	—
Capacity/HDD		864.64GB	864.64GB	1152.79GB	1152.79GB
Number of heads		6	6	8	8
Number of disks		3	3	4	4
Seek Time (ms) (Read/Write)	Average ^{*1}	3.9/4.2	3.6/4.1	4.6/5.0	3.7/4.3
Average latency time (ms)		3.0	2.9	3.0	3.0
Revolution speed (min ⁻¹)		10,000	10,000	10,000	10,000
Interface data transfer rate (Gbps)		6	6	6	6
Internal data transfer rate (MB/s)		164.9 to 279	180 to 293.8	161.1 to 279	180 to 293.8

*1: Not including controller overhead

*2: min⁻¹ = rpm

Table 2.2.3-13 2.5 inch Flash Drive Specifications

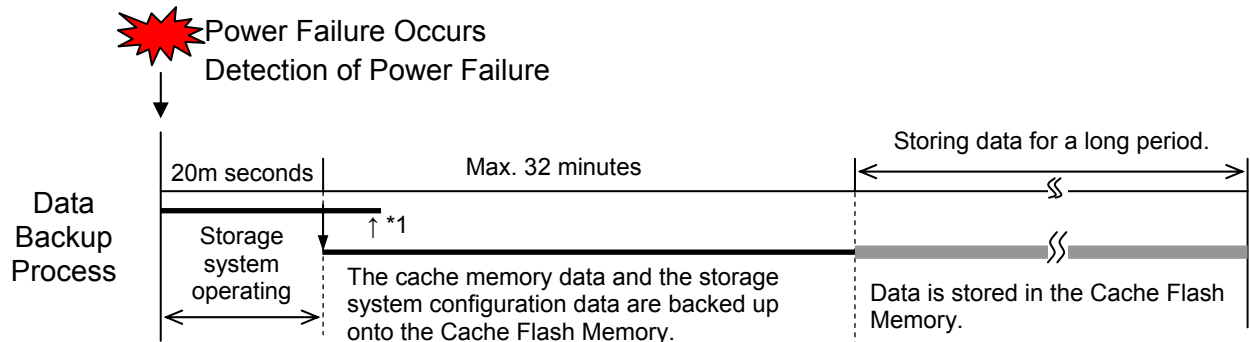
Item		SFF 400GB		SFF 800GB	
Flash Drive Model Name	Toshiba	B5A-M400SS	—	B5A-M800SS	—
	HGST	—	R5C-M400SS	—	R5C-M800SS
Form Factor		2.5 inch	2.5 inch	2.5 inch	2.5 inch
Capacity		393.85GB	393.85GB	787.69GB	787.69GB
Flash memory technology		MLC	MLC	MLC	MLC
Interface data transfer rate (Gbps)		6	6	6	6

Table 2.2.3-14 Flash Module Drive Specifications

Item	1.6TB	3.2TB		
Flash Module Drive Model Name	HAA-P1R6SS	HAB-P3R2SS		
Form Factor	—	—		
Capacity	1759.21GB	3518.43GB		
Flash memory technology	MLC	MLC		
Interface data transfer rate (Gbps)	6	6		

(9) Battery

The batteries for the data saving are installed on Cache Backup Module Kit (BKM) in DKC810I. When the power failure continues more than 20 milliseconds, the storage system uses power from the batteries to back up the cache memory data and the storage system configuration data onto the Cache Flash Memory. Ni-MH batteries are installed in the Cache Backup Module Kit for Small Memory (DKC-F810I-BKMS) for 256GB or less cache memory backup and are also installed in the Cache Backup Module Kit for Large Memory (DKC-F810I-BKML) for 512GB or less cache memory backup.



*1: The data backup continues even if power is restored during the data backup.

Fig. 2.2.3-3 Data Backup Process

(9)-1 Relation between Battery Charge Level and System Start up Action

No.	Power Status	Battery Charge Level	System Start up Action
1	PS ON	<Case1> The battery charge level of some CPEX is below 25% in both the clusters.	The system does not start up until the battery charge level of all the CPEX becomes 25% or more in either or both of the clusters. (It takes a maximum of 85 minutes (*2).) (*1)
2		<Case2> The battery charge level of some CPEX is below 50% in both the clusters. (In the case other than Case1)	SIM (*3) that shows the lack of battery charge is reported and the system starts up. I/O is executed by the pseudo through operation until the battery charge level of all the CPEX becomes 50% or more in either or both of the clusters. (It takes a maximum of 50 minutes (*2).)
3		<Case3> Other than Case1, 2. The battery charge level of all the CPEX is 50% or more in either or both of the clusters.	The system starts up normally. If the condition changed from Case2 to Case3 during start up, SIM (*3) that shows the completion of battery charge is reported.

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

*2: Battery charge time: 4.5 hours to charge from 0% to 100%.

*3: The following SIMs are reported when battery charge is insufficient.

Cache write through operation start SIM = FE020X

Cache write through operation completion SIM = FE010X

(9)-2 Relation between Power Status and SM/CM Data Backup Methods

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

(9)-3 Action When CFM Error Occurs

No.	DKC Status	Description of Error	Action When Error Occurs
1	In operation	CFM error or data comparing error was detected at the time of CFM health check (*1).	CMBK warning SIMRC = FFFB0X is generated.
2	Planned power off or power outage	CFM error was detected, and moreover, retry failed four times during data storing. Data storing error is managed in a per module group (MG) basis and is classified into data storing error only in the MG concerned and data storing error in all the MG depending on the location of the failed memory.	(1) DKC power off process is executed. (2) Blockage occurs in Cache area, CPEX, or MG in CPEX depending on the location of the failed memory. For details, see THEORY03-07-40 .
3	When powered on -1 (In the case that data storing was successfully done in No.2)	CFM error or protection code (*2) error occurred during data restoring.	(1) Blockage occurs in Cache area, CPEX, or MG in CPEX depending on the location of the failed memory. (2) If the failed memory is in the CPEX in Basic location (CACHE-1CA, CACHE-2CA), the CACHE concerned becomes blocked. If the failed memory is in the CPEX other than in Basic Location, the CACHE concerned is volatilized and the system starts up. (If data in the CPEX in the other cluster can be restored, the data in the CACHE concerned is not lost)
4	When powered on -2 (In the case that data storing failed in No.2)	—	(1) Blockage occurs in Cache area, CPEX, or MG in CPEX depending on the location of data storing error. (2) Same as No.3 (2).

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

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

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

Example: Cache data in the CACHE-1CA is not stored in CFM which is installed in another CPEX other than the CACHE-1CA.
Similarly, CFM data in the CACHE-1CA is not restored to cache memory in another CPEX other than the CACHE-1CA.

(10) Service Processor (SVP)

The Service Processor (SVP) mainly performs a setting and a modification of the storage system configuration, a device availability statistical information acquisition, and maintenance. When the 2nd SVP is installed and the SVP is duplicated, the primary SVP that is installed as standard equipment becomes the activated SVP, and the secondary SVP becomes the hot standby SVP with activated Windows. When the primary SVP fails, the hot standby SVP is switched automatically into operation with approximately 3 minutes of switching time. In the event of a SVP failure, employing the duplicate SVP configuration can prevent the outage of the failure monitoring function or the like of the storage system.

Table 2.2.3-15 SVP Specifications

Item		Specifications
OS		Windows 7
CPU		Intel Celeron P4505 1.86GHz
Internal Memory		4GB
Keyboard		— (*1)
Display		— (*1)
Disk Drive		300GB (3.5-inch HDD)
LAN		On-Board 10Base-T / 100Base-TX / 1000Base-T × 2 Port
HUB		On-Board 10Base-T / 100Base-TX / 1000Base-T × 19 Port
Device	FDD	None
	DVD Drive	None
Serial Port		RS232C
USB		Version 2 × 4 ports
PC Card Slot		None

*1: The Maintenance PC(Console PC) with exact specification must be prepared and connects with SVP, to implement the installation or maintenance of the storage system, because the exclusive SVP for DKC810I has neither a display nor a keyboard. A power supply for the Maintenance PC(Console PC) also must be prepared near the SVP.

Table 2.2.3-16 Specification of Maintenance PC(Console PC)

Item	Specifications
OS	Windows Vista / Windows 7 / Windows 8
Disk Drive	Available hard disk space: 500MB or more
Display	1024 × 768 (XGA) or higher-resolution 1280 × 1024 (SXGA) Recommendation
DVD Drive	Need
LAN	Ethernet 1000Base-T / 10Base-T / 100Base-T
USB	Need

(11) Drive Chassis

Three types of Drive Chassis are available for DKC810I: SFF Drive Chassis for 2.5-inch disk drives and flash drives, LFF Drive Chassis for 3.5-inch disk drives, and FMD Chassis for Flash Module Drives (FMD). In the same drive chassis, 2.5-inch drives, 3.5-inch drives and Flash Module Drives cannot be mixed.

Up to 192 drives can be installed in the SFF Drive Chassis. Up to 96 drives can be installed in the LFF Drive Chassis. Up to 48 drives can be installed in the FMD Chassis. DKC810I-CBXA/DKC-F810I-CBXB can control SFF Drive Chassis, LFF Drive Chassis and FMD Chassis at the same time.

SFF Drive Chassis

Front								Rear			
7-23	6-23	5-23	4-23	3-23	2-23	1-23	0-23	SSW007-1	DKUPS007-1	SSW007-2	DKUPS007-2
7-22	6-22	5-22	4-22	3-22	2-22	1-22	0-22				
7-21	6-21	5-21	4-21	3-21	2-21	1-21	0-21				
7-20	6-20	5-20	4-20	3-20	2-20	1-20	0-20				
7-19	6-19	5-19	4-19	3-19	2-19	1-19	0-19				
7-18	6-18	5-18	4-18	3-18	2-18	1-18	0-18				
7-17	6-17	5-17	4-17	3-17	2-17	1-17	0-17				
7-16	6-16	5-16	4-16	3-16	2-16	1-16	0-16				
7-15	6-15	5-15	4-15	3-15	2-15	1-15	0-15				
7-14	6-14	5-14	4-14	3-14	2-14	1-14	0-14				
7-13	6-13	5-13	4-13	3-13	2-13	1-13	0-13				
7-12	6-12	5-12	4-12	3-12	2-12	1-12	0-12				
7-11	6-11	5-11	4-11	3-11	2-11	1-11	0-11				
7-10	6-10	5-10	4-10	3-10	2-10	1-10	0-10				
7-09	6-09	5-09	4-09	3-09	2-09	1-09	0-09				
7-08	6-08	5-08	4-08	3-08	2-08	1-08	0-08				
7-07	6-07	5-07	4-07	3-07	2-07	1-07	0-07				
7-06	6-06	5-06	4-06	3-06	2-06	1-06	0-06				
7-05	6-05	5-05	4-05	3-05	2-05	1-05	0-05				
7-04	6-04	5-04	4-04	3-04	2-04	1-04	0-04				
7-03	6-03	5-03	4-03	3-03	2-03	1-03	0-03				
7-02	6-02	5-02	4-02	3-02	2-02	1-02	0-02				
7-01	6-01	5-01	4-01	3-01	2-01	1-01	0-01				
7-00	6-00	5-00	4-00	3-00	2-00	1-00	0-00				

Fig. 2.2.3-4 Structures of SFF Drive Chassis

LFF Drive Chassis

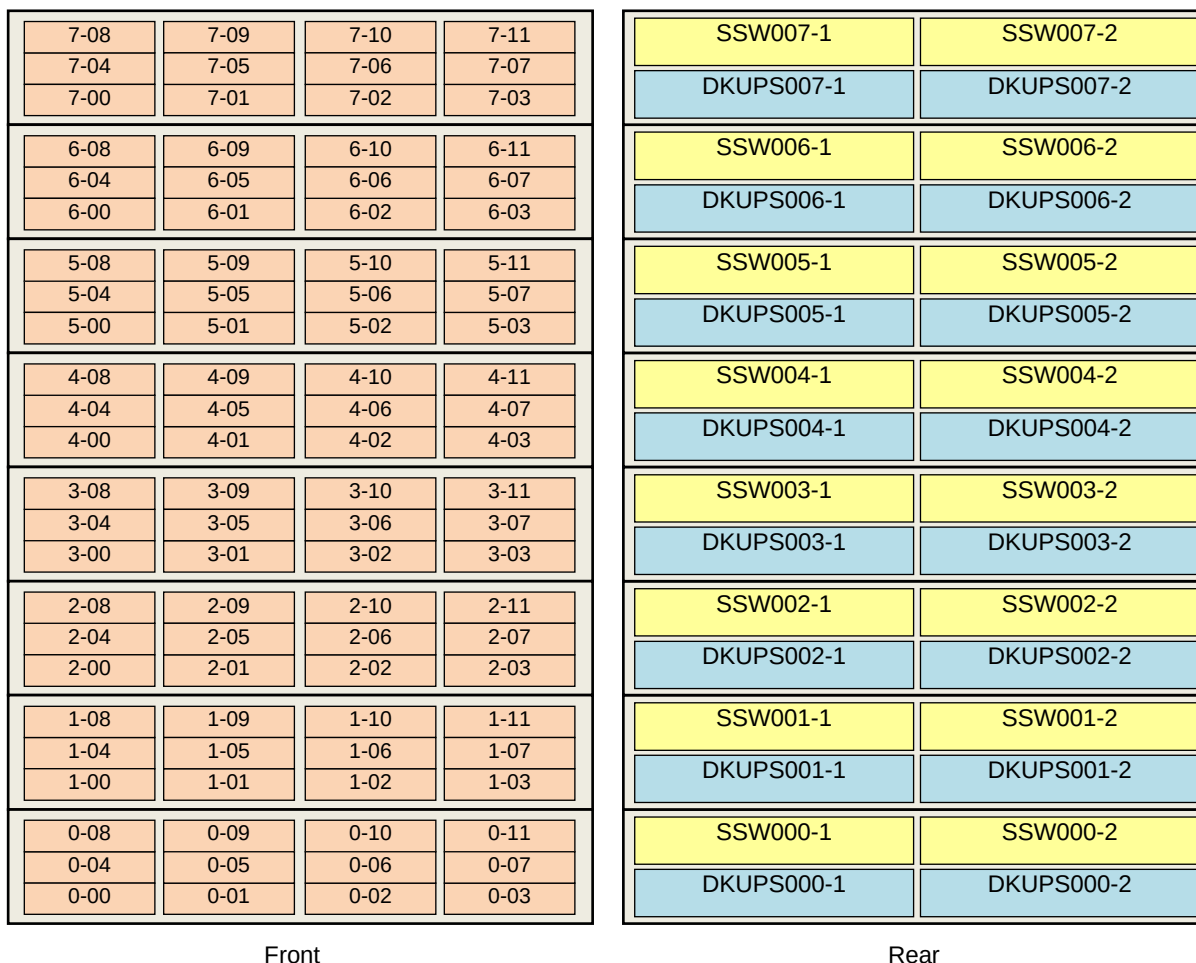


Fig. 2.2.3-5 Structures of LFF Drive Chassis

Flash Module Drive Chassis

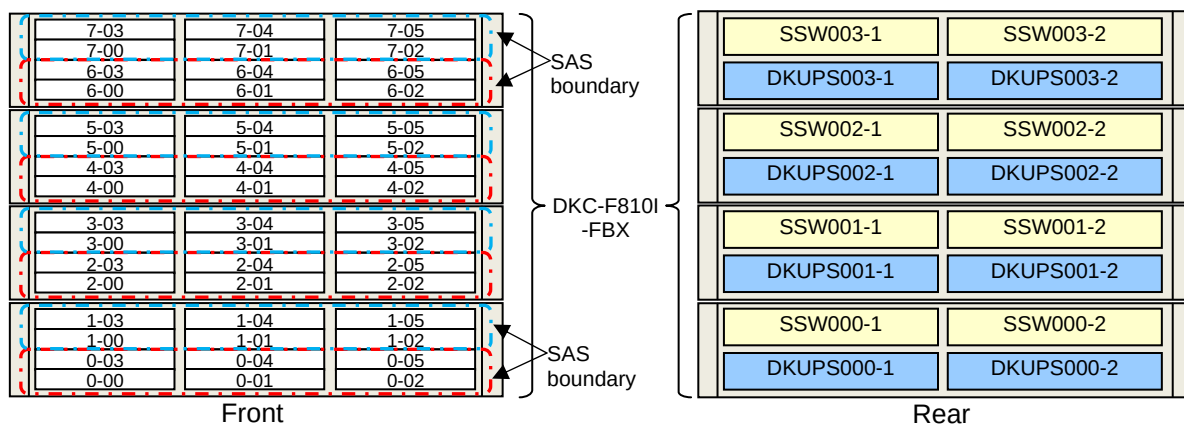


Fig. 2.2.3-6 Structures of Flash Module Drive Chassis

(12) FMD

FMD has 27.75Wh Li-ion battery in it.

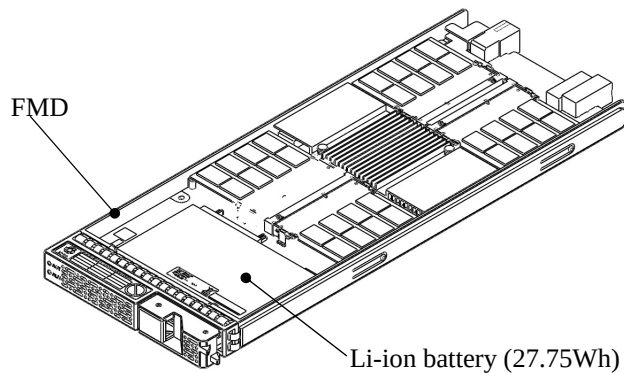


Fig. 2.2.3-7 Location of Li-ion Battery

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

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

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

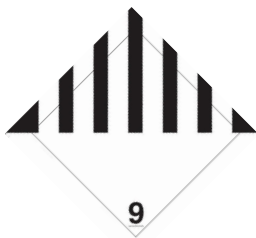


Fig. 2.2.3-8 DG Mark label

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



Fig. 2.2.3-9 Battery label

THEORY02-02-270

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

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

2.3 Storage system Specifications

Storage system specifications are shown in the following table.

Table 2.3-1 Storage system specifications

Item			Specifications
System	Number of Disk Drives	Minimum	4 (disk-in model) / 0 (diskless model)
		Maximum	2,304 (2.5-inch HDD) 1,152 (3.5-inch HDD)
	Maximum Number of Flash Drives (SSD)		384 ^{*6}
	Maximum Number of Flash Module Drives (FMD)		192
	RAID Level		RAID6/RAID5/RAID1
	RAID Group Configuration	RAID6	6D+2P, 14D+2P
		RAID5	3D+1P, 7D+1P
		RAID1	2D+2D, 4D+4D
	Maximum Number of Spare Drives		96 ^{*1}
	Maximum Number of Volumes		65,280
	Maximum Storage System Capacity (Physical Capacity)		2,656TB (1.2TB 2.5-inch HDD used) 4,511TB (4TB 3.5-inch HDD used)
Internal Path	Architecture		Hierarchical Star Net
	Maximum Bandwidth	Data Path	768GB/s
		Control Path	128GB/s
Memory	Cache Memory Capacity		32GB to 2,048GB
	Cache Flash Memory Capacity		256GB to 2,048GB
Device I/F	DKC-DKU Interface		SAS/Dual Port
	Data Transfer Rate		Max. 6Gbps
	Maximum Number of Drive per SAS I/F (Under the 2.5-inch HDD Standard Model)		288
	Maximum Number of DKA		4
Channel I/F	Support Channel Type	Mainframe	2/4/8Gbps Fibre channel: 16MS8/16ML8
		Open System	2/4/8Gbps Fibre Short Wavelength ^{*2} : 16FC8 4/8/16Gbps Fibre Short Wavelength ^{*3} : 8FC16
	Data Transfer Rate	MF Fibre Channel	200 / 400 / 800 MB/s
		Fibre Channel	200 / 400 / 800 / 1600MB/s
	Maximum Number of CHA		12
Power	AC Input	Single Phase	60Hz : 200V to 240V 50Hz : 200V to 240V
Acoustic Level ^{*4}	Operating	CBXA/CBXB	58dB (24°C or less) / 60dB (32°C)
		SBX/UBX/FBX	61dB (24°C or less) / 64dB (32°C)
	Standby ^{*5}	CBXA/CBXB	58dB (24°C or less) / 60dB (32°C)
		SBX/UBX/FBX	61dB (24°C or less) / 64dB (32°C)

(To be continued)

(Continued from the preceding page)

Item			Specifications
Dimension	W × D × H (mm)	Single Rack	610 × 1,115 × 2,006
		Six Rack	3,610 × 1,115 × 2,006
Non Stop Maintenance	Control PCB		Support
	Cache Memory Module		Support
	Cache Flash Memory		Support
	Power Supply, Fan		Support
	Microcode		Support
	Drive (HDD, SSD, FMD)		Support

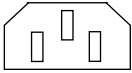
- *1: Available as spare or data disks.
- *2: By the replacing SFP transceiver of the fibre port on the CHA to the DKC-F810I-1PL8, the port can be used for the Longwave.
- *3: By the replacing SFP transceiver of the fibre port on the CHA to the DKC-F810I-1PL16, the port can be used for the Longwave.
- *4: Measurement Condition: The point 1m far from floor and surface of the product.
- *5: Even if Storage system is in a power-off state, the cooling fan continues to rotate in a standby mode.
- *6: Not includes the spare drive.

2.4 Power Specifications

2.4.1 Storage system Power Specifications

DKC810I input power specifications are shown as each power supply.

Table 2.4.1-1 Input Power Specifications

Item	Input Power	Input Current ^{*1}	Steady Current ^{*2}	Leakage Current	Inrush Current			Power Cord Plug Type
					1st (0-p)	2nd (0-p)	1st (0-p) Time (-25%)	
DKC PS	1-phase, AC200V to AC240V	7.18A	3.59A	0.28mA	20A	15A	80ms	IEC60320 C14 
UBX PS		2.07A	1.04A	1.75mA	25A	20A	150ms	
SBX PS		2.61A	1.31A	1.75mA	25A	20A	150ms	
FBX PS		2.83A	1.42A	0.28mA	20A	10A	80ms	

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

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

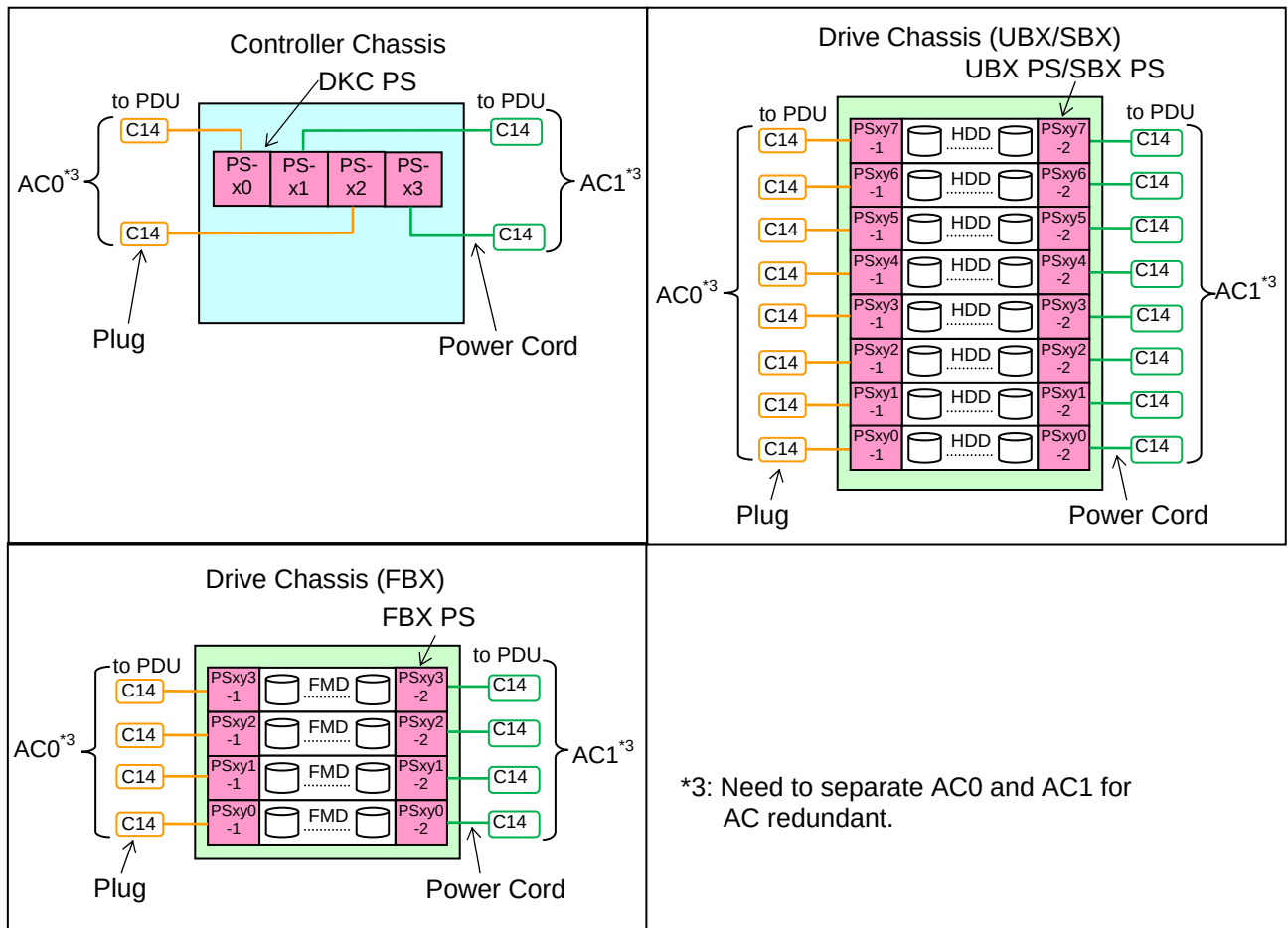
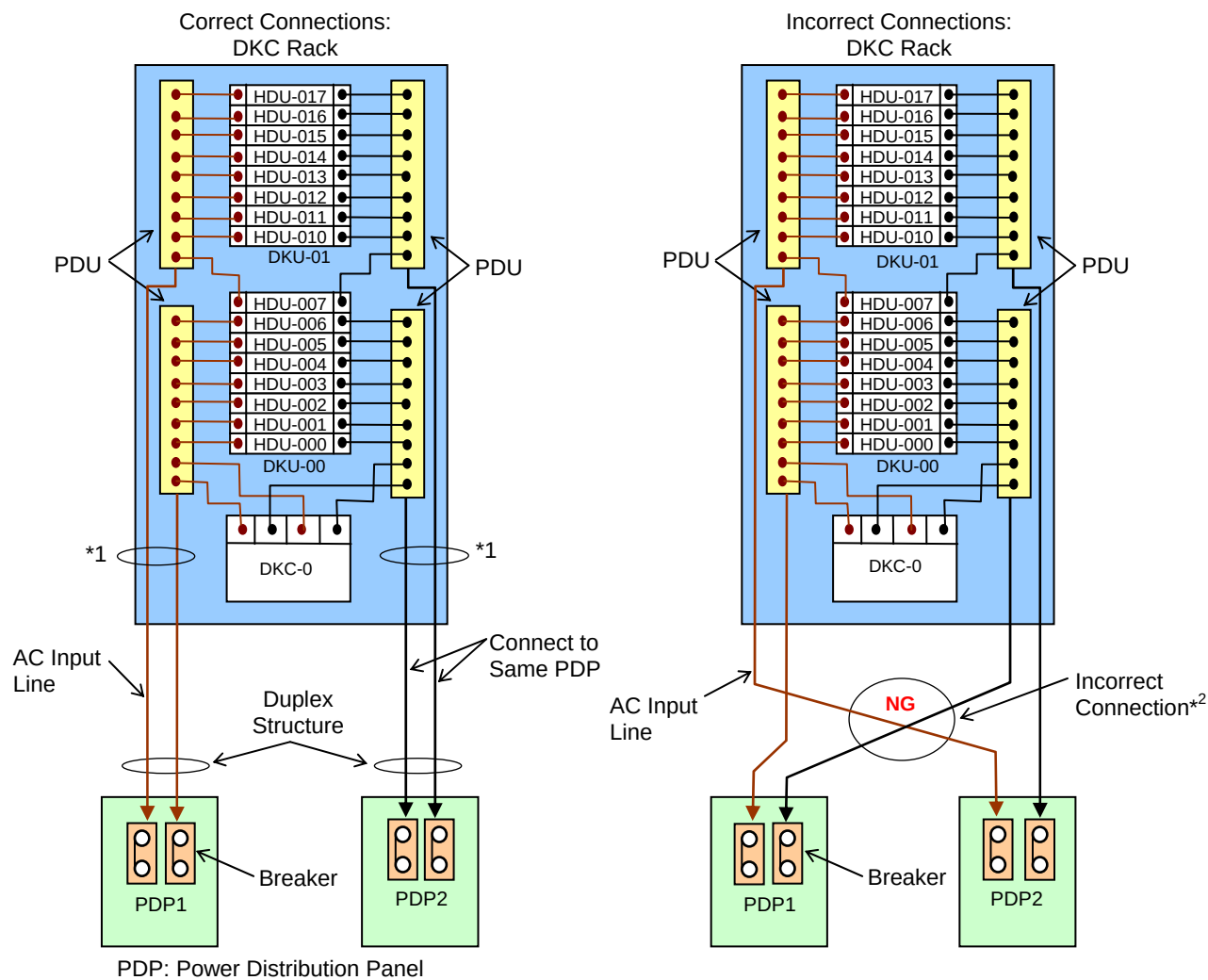


Fig. 2.4.1-1 Power Supply Locations

2.4.2 Notes of Power Supply

(1) Power Connection

The AC power input for the DKC810I has the duplex PDU structure. This duplex structure enables the entire rack to remain powered on if AC power is removed from one of the two PDP (Power Distribution Panel).



***1:** When connected correctly, two of the four PDUs can supply power to the DKC rack.

*2: When connected incorrectly, two PDUs cannot supply power to the DKC rack, which causes a system failure.

Fig. 2.4.2-1 Direct Power Connection

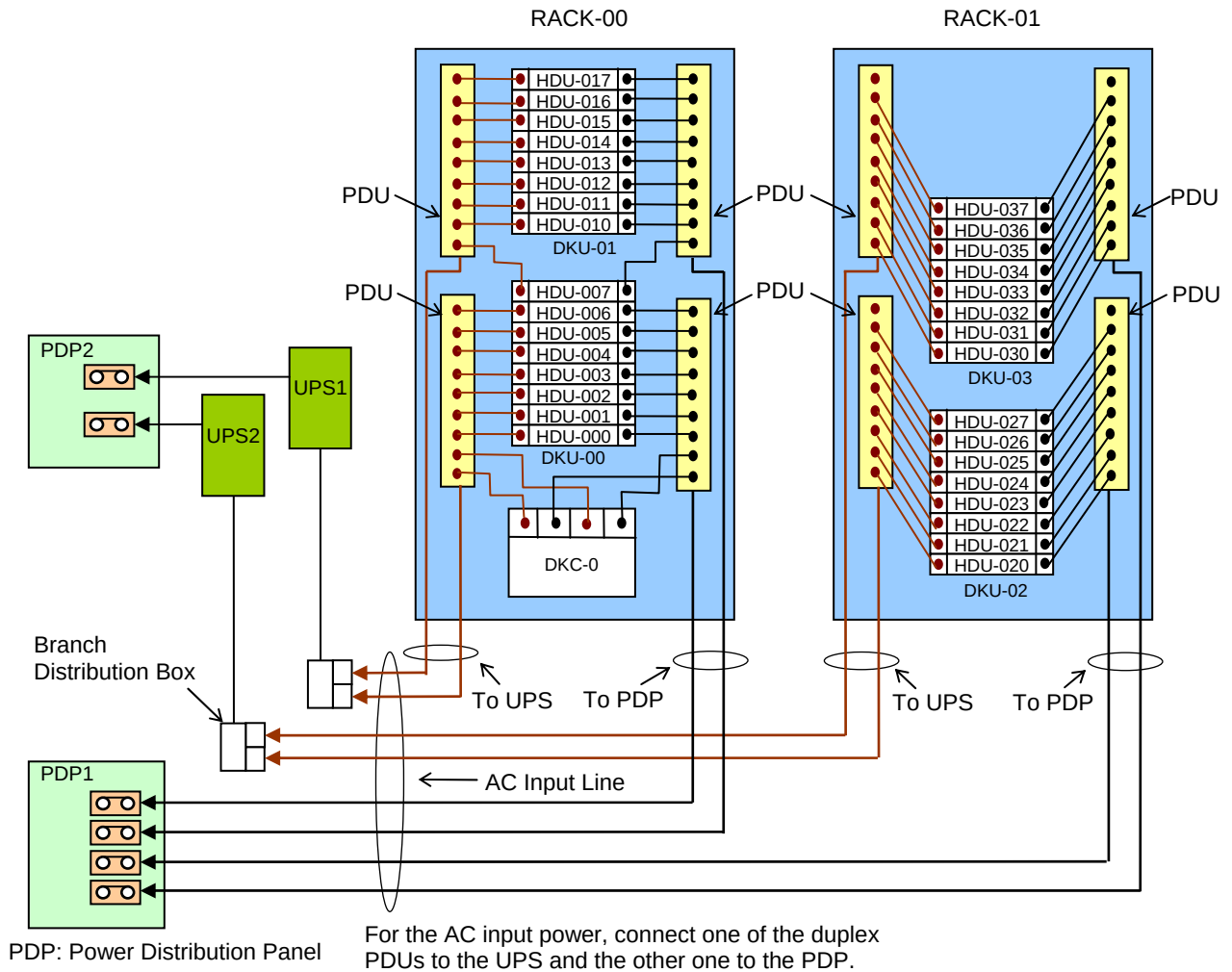


Fig. 2.4.2-2 Power Connection via UPS

2.5 Environmental Specifications

The environmental specifications are shown in the following table.

Item	Condition		
	Operating (*1)	Non-operation (*2)	Shipping & Storage (*3)
Temperature (°C)	16 to 32	-10 to 43 -10 to 35 (*10)	-25 to 60
Relative Humidity (%) (*4)	20 to 80	8 to 90	5 to 95
Max. Wet Bulb (°C)	26	27	29
Temperature Deviation (°C/hour)	10	10	20
Vibration (*5)	5 to 10Hz: 0.25mm 10 to 300Hz: 0.49m/s ²	5 to 10Hz: 2.5mm 10 to 70Hz: 4.9m/s ² 70 to 99Hz: 0.05mm 99 to 300Hz: 9.8m/s ²	Sine Vibration: 4.9m/s ² , 5min. At the resonant frequency with the highest displacement found between 3 to 100Hz (*6)
			Random Vibration: 0.147m ² /s ³ , 30min, 5 to 100Hz (*7)
Earthquake resistance (m/s ²)	up to 2.5 (*11)	—	—
Shock	—	78.4m/s ² , 15ms	Horizontal: Incline Impact 1.22m/s (*8)
			Vertical: Rotational Edge 0.15m (*9)
Altitude	-60 to 3,000m		—
Noise Level (*12)	80dB or less (requisite) 70dB or less (recommended)	—	—

- *1: The requirements for operating condition should be satisfied before the storage system is powered on. Maximum temperature of 32°C should be strictly satisfied at air inlet portion. The recommended operational room temperature is 21°C to 24°C.
- *2: Non-operating condition includes both packing and unpacking conditions unless otherwise specified.
- *3: For shipping and storage, the product should be packed with factory packing.
- *4: No condensation in and around the drive should be observed under any conditions.
- *5: The vibration specifications apply to all three axes.
- *6: See ASTM D999-01 The Methods for Vibration Testing of Shipping Containers.
- *7: See ASTM D4728-01 Test Method for Random Vibration Testing of Shipping Containers.
- *8: See ASTM D5277-92 Test Method for Performing Programmed Horizontal Impacts Using an Inclined Impact Tester.
- *9: See ASTM D6055-96 Test Methods for Mechanical Handling of Unitized Loads and Large Shipping Cases and Crates.
- *10: When FMDs (DKC-F810I-1R6FM/3R2FM) are installed.
- *11: Time is 5 seconds or less in case of the testing with device resonance point (6 to 7Hz).
- *12: Noise exceeding the specified level may cause an error in the storage system.
 - Be sure to place the system at 6 or more meters distance from a noise source such as an emergency bell.
 - For example, the noise level of an emergency bell that generates noise of 93dB will be :
 - Approximately 80dB at 6 meters distance from the emergency bell.
 - Approximately 70dB at 15 meters distance from the emergency bell.

3. Internal Operation

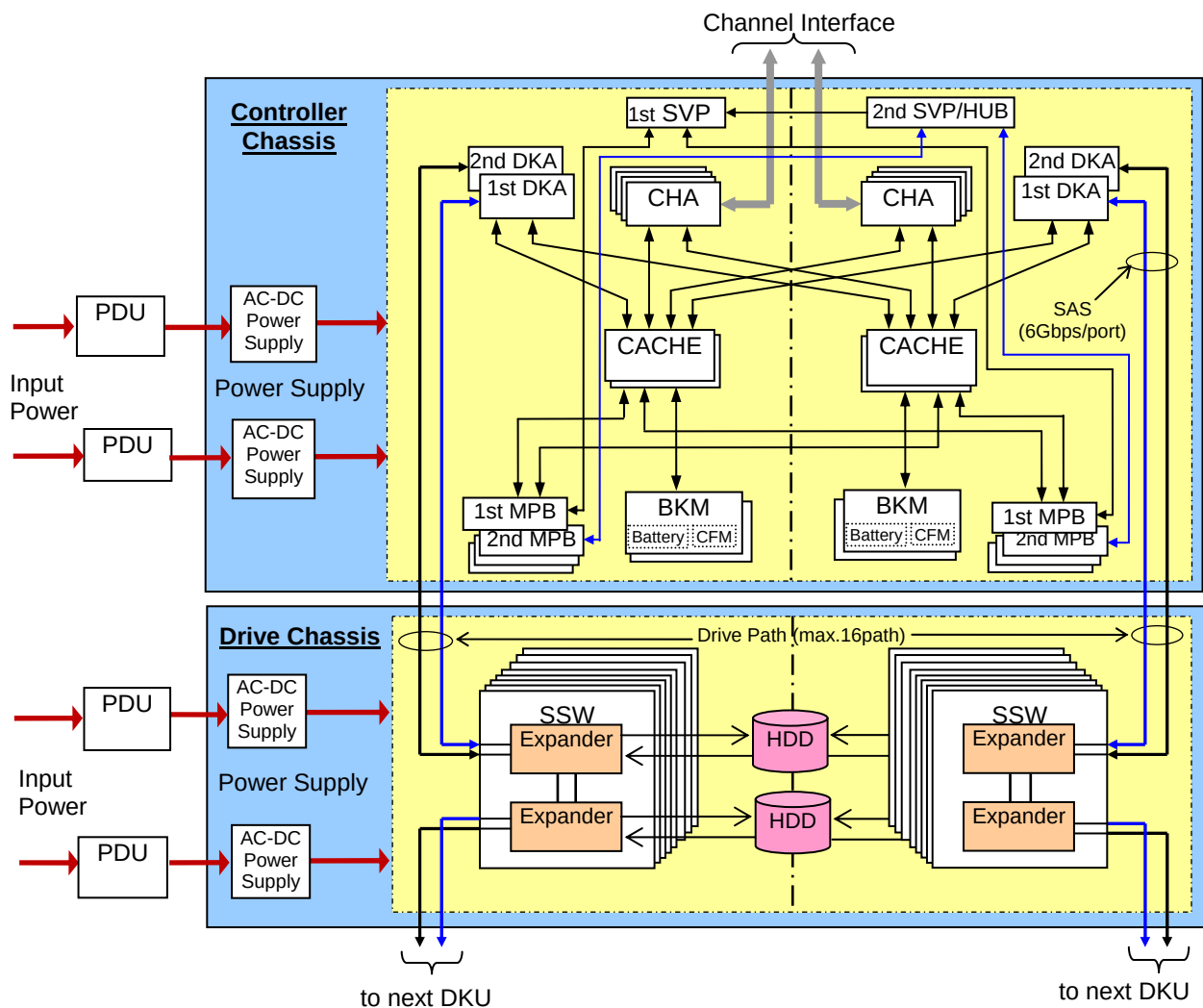
3.1 Hardware Block Diagram

DKC810I consists of Controller Chassis (DKC) and Drive Chassis (DKU).

Controller Chassis (DKC) consists of channel adapter (CHA), disk adapter (DKA), cache path control adapter (CPC), processor blade (MPB), backup module (BKM), service processor (SVP), cooling fan and AC-DC power supply that supplies power to the components.

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

A hardware block diagram of storage system is shown below.



3.2 Software Organization

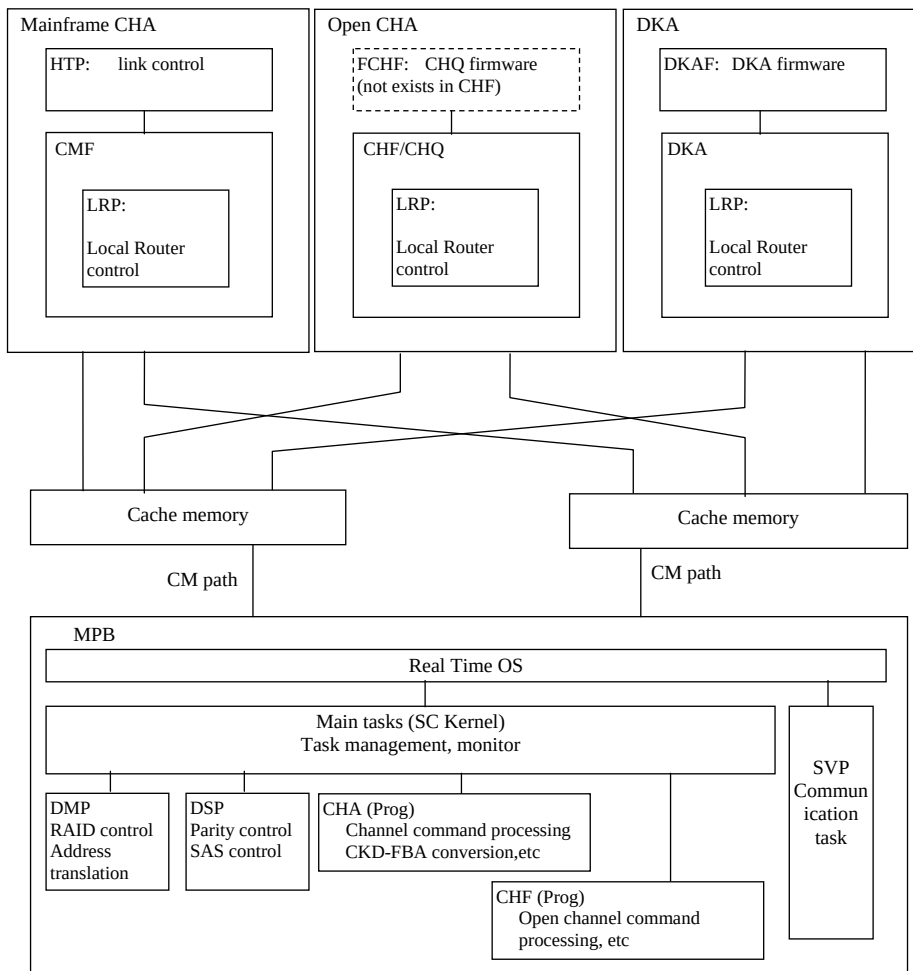


Fig. 3.2-1 Software Organization

Real Time OS:

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

Main tasks:

Made up of DKC control tasks (M/F CHA Prog., OPEN CHA Prog, DMP, DSP) etc., and they switch the control tasks by making use of the main task's task switching facility.

SVP communication task:

Controls the communication with the SVP.

HTP (Hyper Transfer Program):

Controls the FICON channel links.

LRP (Local Router Program):

Controls the allocation of commands (which received from the host and to be issued to the drive) to MPs.

M/F CHF (Prog):

Is a channel command control layer that processes mainframe commands and controls cache and data transfer operations. M/F CHF Prog. is recognized by the logical volume number and logical block number.

OPEN CHA (Prog):

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

DMP (Disk Master Program):

RAID control functions. DMP is a program to control RAID by cache-control and conversion between physical and logical addresses. DMP is recognized by the logical volume number and logical block number.

DSP (Disk Slave Program):

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

Cache memory:

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

Cache PATH (Cache Memory Access Path):

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

3.3 Operations Performed when Drive Errors Occur

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

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

Fig. 3.3-1 shows the outline of data read processing in case a drive error occurs.

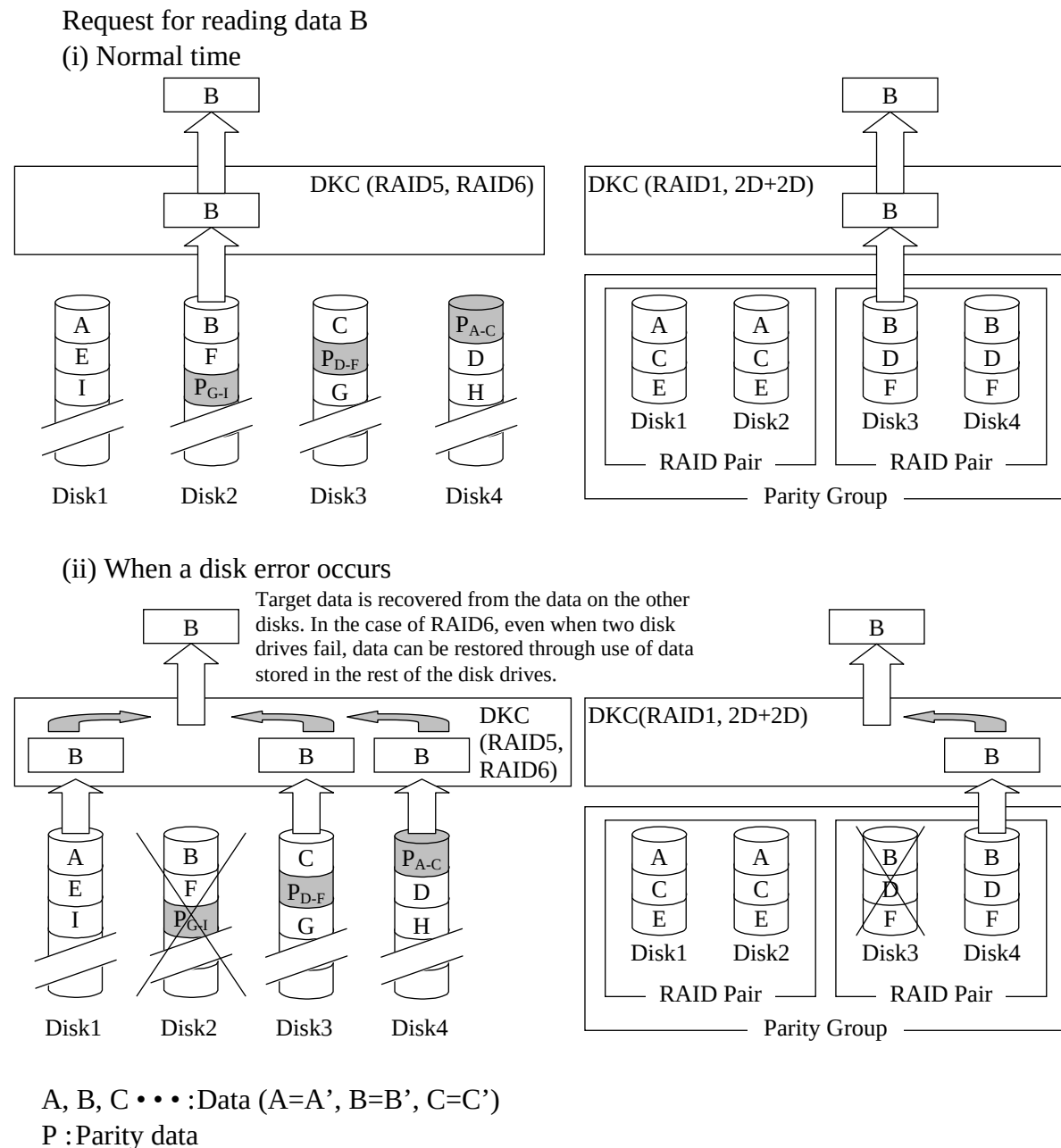


Fig. 3.3-1 Outline of Data Read Processing

(2) Data integrity feature and drive errors

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

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

1. Dynamic sparing

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

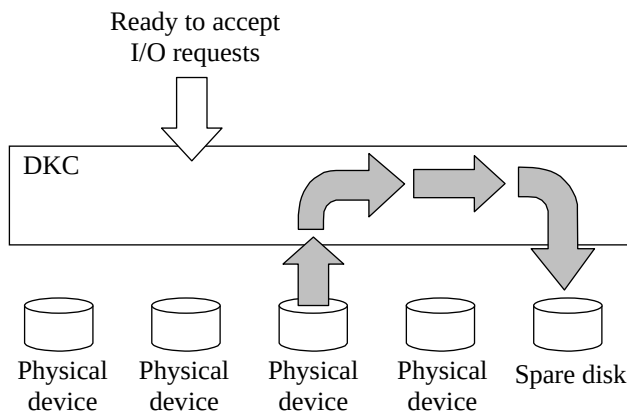


Fig. 3.3-2 Outline of the Dynamic Sparing Function

2. Correction copy

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

In the case of RAID6, the correction copy can be made to up to two disk drives in a parity group.

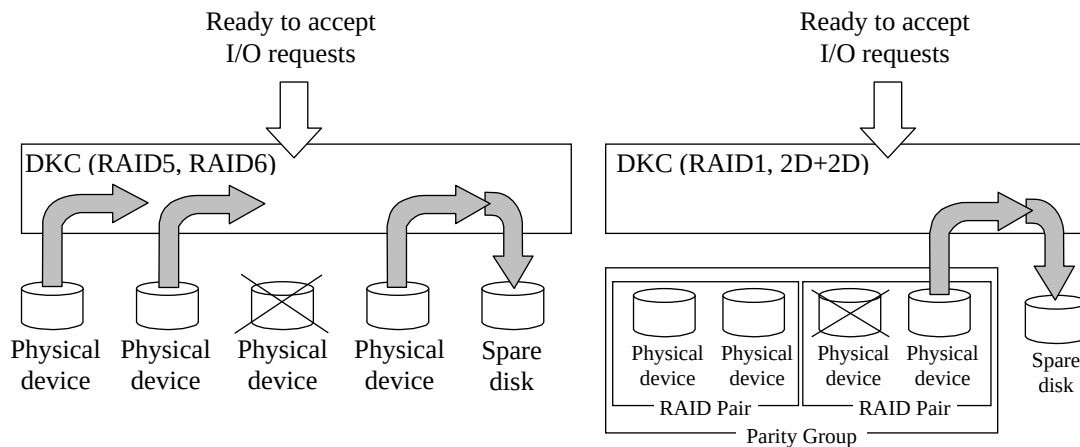


Fig. 3.3-3 Outline of the Correction Copy Function

3. Allowable number of copying operations

Table 3.3-1 Allowable number of copying operations

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

3.4 65280 logical addresses

The mainframe host connection interface specification are outlined in Tables 3.4-1 and 3.4-2.

Table 3.4-1 List of Allowable Maximum Values of Mainframe Host Connection Interface Items on the DKC Side

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

Table 3.4-2 Allowable Range of Mainframe Host Connection Interface Items on DKC Side

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

*1: Number of CUs connectable to the one FICON channel (CHPID) is 64 or 255.

In the case of 2107 emulation, the CU addresses in the interface with a host are 00 to FE for the FICON channel.

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

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

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

XP7 cannot assign from 0x0001 to 0x0003. Because, XP7 is using them for internally. If you will set SSID for mainframe, please follow mainframe to hand range of SSID.

Detailed numbers of logical paths of the main frame fibre and serial channels are shown in Table 3.4-3.

Table 3.4-3 List of Numbers of Connectable Logical Paths

Item	Fibre channel
Number of channel ports	16 to 192
Max. number of logical paths per CU	2048
Max. number of logical paths per port	65536 ^{*5} /261120 ^{*4} ^{*5}
Max. number of logical paths per channel adapter	65536/261120 ^{*4}
Max. number of logical paths per system	131072/522240 ^{*4}

*4: In case of 2107 emulation.

*5: The maximum number of paths for connection to a host per fibre channel port is 1024 (1024 host paths × 255 CUs = 261120 logical paths for 2107 emulation.).

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The SAID values at 2107 emulation are shown in Table 3.4-4 and Table 3.4-5.

NOTE: SAID values required for CESTPATH command are shown in [THEORY03-08-70](#), Table 3.8.1-2.

Table 3.4-4 SAID values (CL1)

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

Table 3.4-5 SAID values (CL2)

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

3.5 LDEV Formatting

3.5.1 High-Speed Format and Low-Speed Format

3.5.1.1 Outlines

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

Table 3.5.1.1-1

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

*1: The HDD type of DKR5x-yzzzSS/DKS5x-yzzzSS has the LDEV formatting function.

x : generation (A-Z)
y : rpm (H: 7,200 / J: 10,000 / K: 15,000)
zzz : capacity (GB or TB)

*2: Low-speed format is executed to Flash drive or encrypted ECC.

3.5.1.2 Estimation of LDEV Formatting Time

Estimation of the high-speed LDEV-FMT and the low-speed LDEV-FMT formatting times are indicated in section (1) (a) and (1) (b). Measurement Condition is indicated as follows.

<Measurement condition>

- Standard model (the number of DKA is one pair)
- When LDEV format is executed, the host I/O is not being processed.
- LDEV format is executed to only a ECC.
- The number of MPPK is one pair.
- The number of LDEV definition is system default value.
- Emulation types are OPEN-V and 3390-M.

(1) Hard Disk Drive

(a) High speed LDEV formatting

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

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

Formatting time is indicated as follows.

Table 3.5.1.2-1

HDD Capacity/Rotation Speed	Formatting Time		Time Out Value (*1)
	OPEN-V	3390-M	
4.0TB/7.2krpm	600 min	620 min	1060 min
3.0TB/7.2krpm	460 min	480 min	840 min
1.2TB/10krpm	140 min	150 min	270 min
900GB/10krpm	130 min	140 min	210 min
600GB/10krpm	85 min	90 min	170 min
300GB/15krpm	45 min	50 min	80 min

(b) Low speed LDEV formatting

The format time of DKxxx-JxxxSS/KxxxSS/HxxxSS is indicated as follows.

Rough formatting time per 1TB/1PG without host I/O is indicated as follows (be include Encrypt RAID Group) (*2).

Table 3.5.1.2-2 15krpm

RAID Level		Formatting Time (*3)	
		OPEN-V	3390-M
RAID1	2D+2D	90 min	90 min
RAID5	3D+1P	70 min	70 min
	7D+1P	30 min	35 min
RAID6	6D+2P	35 min	40 min
	14D+2P	15 min	20 min

Table 3.5.1.2-3 10krpm

RAID Level		Formatting Time (*3)	
		OPEN-V	3390-M
RAID1	2D+2D	110 min	140 min
RAID5	3D+1P	70 min	90 min
	7D+1P	30 min	40 min
RAID6	6D+2P	40 min	45 min
	14D+2P	20 min	20 min

Table 3.5.1.2-4 7.2krpm

RAID Level		Formatting Time (*3)	
		OPEN-V	3390-M
RAID1	2D+2D	150 min	200 min
RAID5	3D+1P	70 min	120 min
	7D+1P	40 min	50 min
RAID6	6D+2P	45 min	60 min
	14D+2P	25 min	25 min

(2) Flash Drive

SSD doesn't have the self LDEV formatting function.

LDEV formatting is performed by slow LDEV formatting only.

Rough formatting time per 1TB/1PG without host I/O is indicated as follows (be include Encrypt RAID Group) (*2).

Table 3.5.1.2-5

RAID Level		Formatting Time (*3)	
		OPEN-V	3390-M
RAID1	2D+2D	25 min	25 min
RAID5	3D+1P	20 min	15 min
	7D+1P	15 min	10 min
RAID6	6D+2P	20 min	10 min
	14D+2P	10 min	10 min

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

(3) NFxxx-PxRxSS

(a) High speed LDEV formatting

The format time of NFxxx-PxxxSS doesn't depend on number of ECC, and be decided by capacity and the rotational speed of HDD.

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

Formatting time is indicated as follows.

Table 3.5.1.2-6

Drive Capacity	Formatting Time		Time Out Value (*1)
	OPEN-V	3390-M	
1.6TB	35 min	40 min	120 min
3.2TB	70 min	80 min	190 min

(b) Low speed LDEV formatting

The format time of NFxxx-PxxxSS is indicated as follows.

Rough formatting time per 1TB/1PG without host I/O is indicated as follows (be include Encrypt RAID Group) (*2).

Table 3.5.1.2-7

RAID Level		Formatting Time (*3)	
		OPEN-V	3390-M
RAID1	2D+2D	20 min	10 min
RAID5	3D+1P	10 min	5 min
	7D+1P	10 min	5 min
RAID6	6D+2P	10 min	5 min
	14D+2P	5 min	5 min

- *1: The progress rate on SVP is displays as “99%” during the “Formatting Time” and the “Time Out Value”.
Because drive executes the formatting, and the progress rate to the total capacity is not understood, the ratio at the elapsed time from the format beginning to the Formatting time required is displayed.
- *2: If there is an I/O operation, the minimum formatting time is over 6 times as long as the discrete value, depending on the I/O load.
- *3: The format time varies according to the generation of the drive in standard time distance.

NOTE:

- If the drive types and configurations mentioned in above (1), (2) coexist, the format time required matches the one of the drive type whose standard time required is the longest.
As a result, the time required to start using the logical volumes is longer than the case of adding drive one by one.
Therefore, when adding drives in the cases of above (1), (2), it is recommended to start the operation one by one from the drive type whose standard time required is the shortest.
- If the emulation type of LDEV is for Mainframe, Fibre CHA for mainframe is necessary.
- If the emulation type of LDEV is for OPEN, Fibre CHA for OPEN is necessary.

3.5.2 Quick Format

3.5.2.1 Outlines

Quick Format provides a function on executing a format that you can use volumes without waiting for the completion of the format by performing the format in the background. The supported specifications are shown below.

Table 3.5.2.1-1 Quick Format Specifications

Item No.	Item	Contents
1	Supported HDD type	Supported All HDD type support
2	Emulation type	All emulation types
3	Number of parity groups	The number of parity groups that Quick Format is possible at the same time is up to 72. The number of volumes is not limited if it is within 72 parity groups. In the case of four concatenations, the number of parity groups is four. In the case of two concatenations, the number of parity groups is two.
4	Combination with various P.P.	It is operable in combination with all P.P.
5	Execution opportunity	When performing a format from SVP or Web Console, you can select either Quick Format or the normal format.
6	Additional start in execution	When a Quick format has been executed, additional Quick format can be performed within a total of 72 parity groups including the executing parity groups.
7	Preparation for Quick Format	Management information is created first when executing a Quick Format. I/O access cannot be executed in this period as well as in a normal format. In the case of OPEN volume, it takes up to about one minute for one parity group, and up to about 36 minutes in the case of 72 parity groups for the preparation. In the case of M/F volume, it takes the time shown in Table 3.5.2.3-1 in addition to the time described above.

(To be continued)

(Continued from the preceding page)

Item No.	Item	Contents
8	Blocking and restoring a volume	- When a volume during Quick Format execution is blocked for maintenance, the status of the volume (during Quick Format execution) is stored in the storage system. When the volume is restored afterwards, the volume status becomes "Normal (Quick Format)". - When all of the volumes during Quick Format in the parity group are blocked, the number of parity groups that are during Quick Format displayed in the 'Logical Device' window of Storage Navigator and 'Maintenance' window of SVP decreases equally to the number of the blocked parity groups. However, the number of parity groups that can additionally execute Quick Format will not increase. The number of parity groups that can additionally execute Quick Format can be calculated with the following calculating formula; $72 - X - Y$. (Legend) X: The number of parity groups during Quick Format execution displayed in the window. Y: The number of parity groups with all of the volumes in the parity group blocked during Quick Format execution.
9	Operation at the time of PS OFF/ON	After PS ON, Quick Format restarts.
10	Restrictions	- Quick Format cannot be executed to the journal volume of Universal Replicator, external volume, and virtual volume. - Volume Migration and Quick Restore of ShadowImage cannot be executed to a volume during Quick Format. - Prestaging of Cache Residency Manager cannot be executed to a volume during Quick Format. Prestaging to be performed after Quick Format.

3.5.2.2 Data security of volumes during Quick Format

The Quick Format control table is kept on SM. This model prevents losing the Quick Format control table and secures the data on the volume during a quick format by making backups of the SM on SSD.

3.5.2.3 Control information format time of M/F VOL

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

Table 3.5.2.3-1 Control Information Format Time of M/F VOL (Per 1K Volume)

Emulation type	Format time (minute)
3390-A	133
3390-M	34
3390-MA/MB/MC	28
3390-L	18
3390-LA/LB/LC	14
3390-9	9
3390-9A/9B/9C	5
Others	3

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

3.5.2.4 Quick Format time

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

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

Table 3.5.2.4-1 Quick Format Time

Drive capacity	Format time
300GB	4h
400GB	6h
600GB	8h
800GB	11h
900GB	12h
1.2TB	16h
1.6TB	24h
3.0TB	40h
3.2TB	48h
4.0TB	53h

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

3.5.2.5 Performance during Quick Format

Quick Format executes a format in the background while executing I/O from HOST. Therefore, it may influence the HOST performance. The following table shows the proportion of the performance influence. (Note that these are estimated time and may vary depending on the conditions.)

Table 3.5.2.5-1 Performance during Quick Format

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

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

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

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

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

3.5.2.6 Combination with other maintenance

Table 3.5.2.6-1 Combination with Other Maintenance

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

3.5.2.7 SIM when Quick Format finished

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

When all Quick Format which is executed through SVP is finished, SIM = 0x410100 is output. In the case Quick Format is executed through Storage Navigator while Quick Format also has been executed through SVP, the SIM above is output when all Quick Format including what executed through Storage Navigator is finished, and the opposite is also true.

3.6 Ownership Management

3.6.1 Confirmation and Definitions of requests and issues

Table 3.6.1-1 Confirmation and Definitions of requests and issues

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

3.6.1.1 Request #1

Request

Maximize system performance by using MPB effectively.

Issue

Way to allocate resources to balance load of each MPB.

How to realize

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

Case

(A) Define Configuration & Install

Target resource: LDEV

Setting IF: SVP

(B) Ownership management resources are installed

Target resources: LDEV/External VOL/JNLG

Setting IF: SVP/Storage Navigator/CLI/RMLib

3.6.1.2 Request #2

Request

Maximize system performance by using MPB effectively.

Issue

Way to move resources to balance load of each MPB.

How to realize

User directly requests to move resources.

Case

Performance tuning

Target resources: LDEV/External VOL/JNLG

Setting IF: Storage Navigator/CLI/RMLib

3.6.1.3 Request #3

Request

Troubleshoot in case of problems related to ownership.

Issue

Way to move resources required for solving problems.

How to realize

Maintenance personnel directly requests to move resources.

Case

Troubleshoot

Target resources: LDEV/External VOL/JNLG

Setting IF: Storage Navigator/CLI/RMLib

3.6.1.4 Request #4

Request

Confirm resources allocated to each MPB.

Issue

Way to reference resources allocated to each MPB.

How to realize

User directly request to reference resources.

Case

(A) Before ownership management resources are installed

Target resources: LDEV/External VOL/JNLG

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

(B) Performance tuning

Target resources: LDEV/External VOL/JNLG

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

(C) Troubleshoot

Target resources: LDEV/External VOL/JNLG

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

3.6.1.5 Request #5

Request

Maintain performance for resources allocated to specific MPB.

Issue

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

How to realize

Resources are not allocated/ moved automatically to the MPB that user specified.

Case

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

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

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

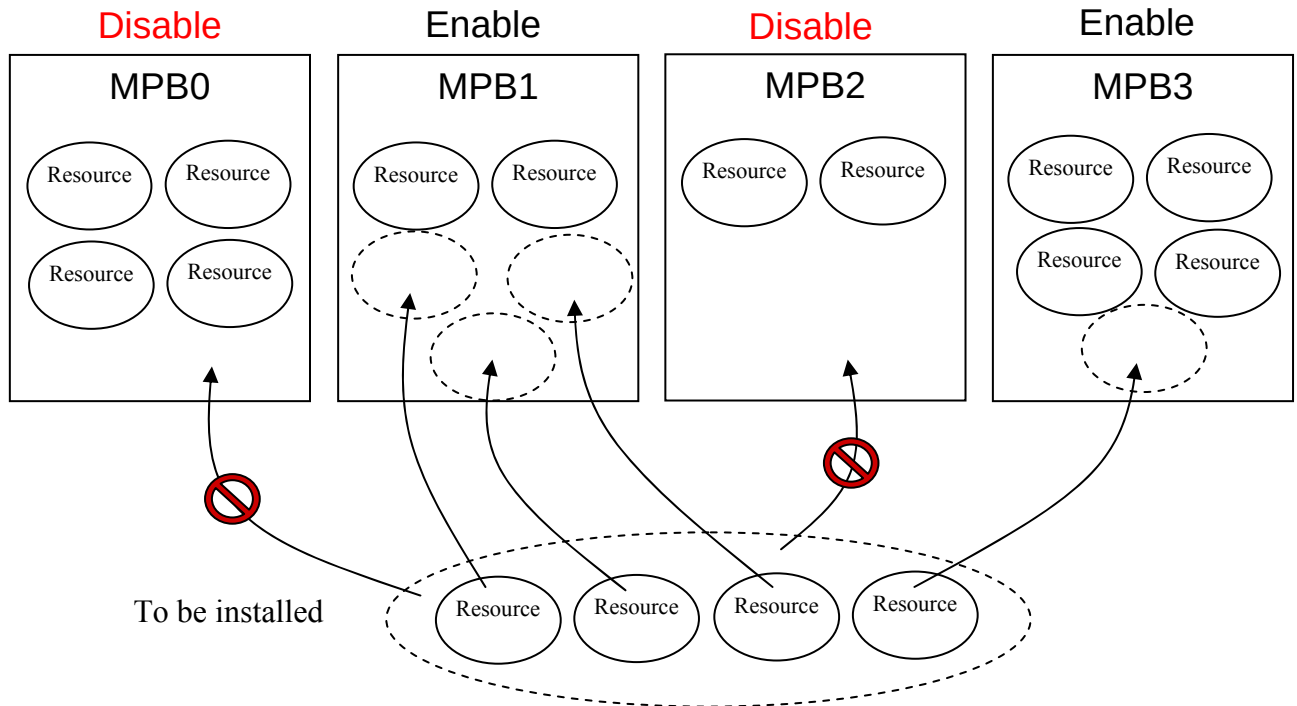
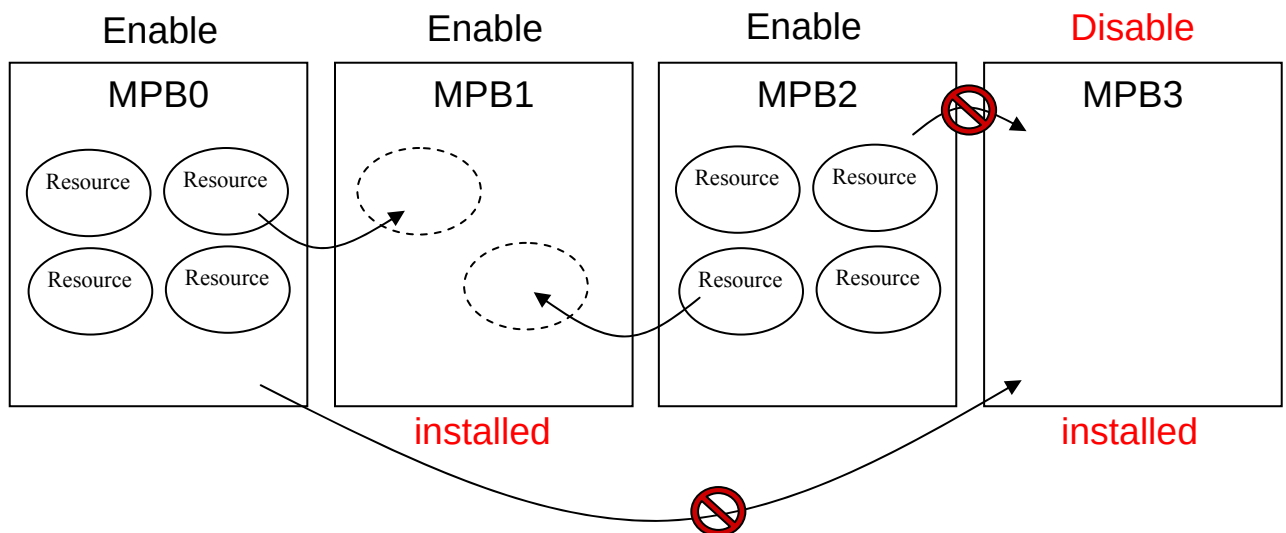


Fig. 3.6.1.5-1 Request #5 (A)

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



Example) After MPB installation completes, allocate resources to MPB3.

Fig. 3.6.1.5-2 Request #5 (B)

3.6.1.6 Process flow

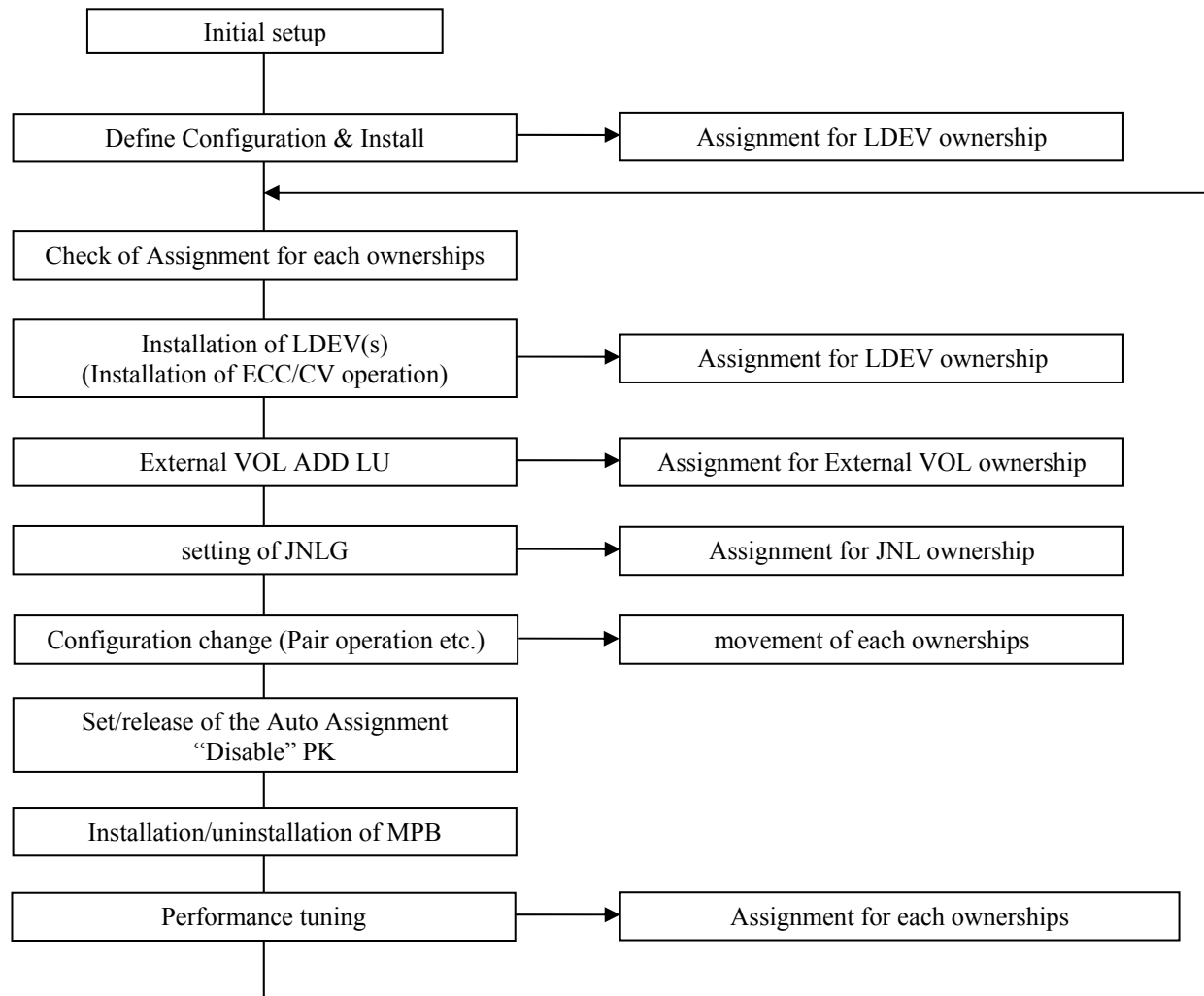


Fig. 3.6.1.6-1 Process flow

3.6.2 Resource allocation Policy

- (1) Both User-specific and automatic allocation are based on the same policy: allocate resources to each MPB equally.

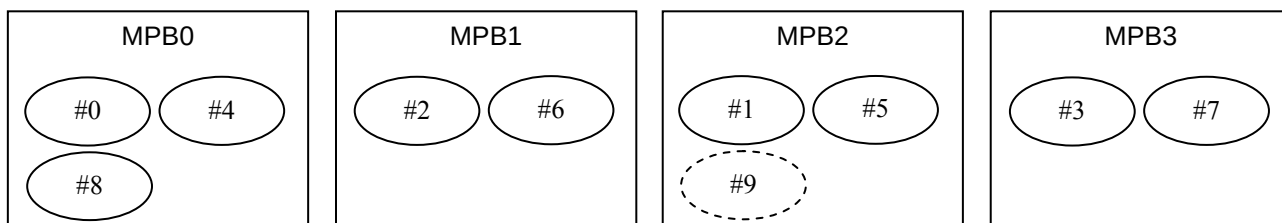


Fig. 3.6.2-1 Resource allocation Policy (1)

- (2) Additionally, in the user-specific allocation, the weight of each device to be considered.

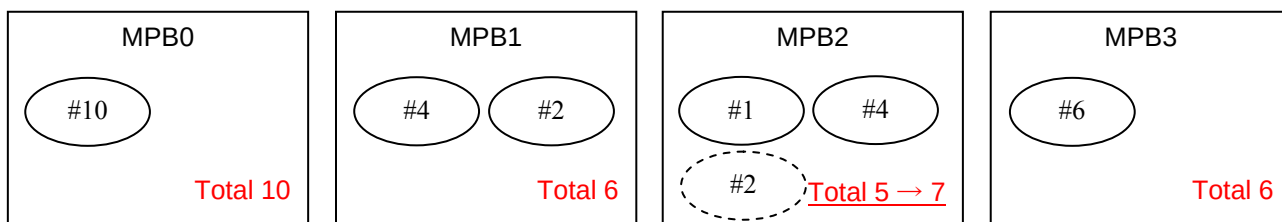


Fig. 3.6.2-2 Resource allocation Policy (2)

However, in the automatic allocation, the weight of each device will not be considered.

3.6.2.1 Automatic allocation

Allocate resources to each MPB equally independently in each type.

Table 3.6.2.1-1 Automatic allocation

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

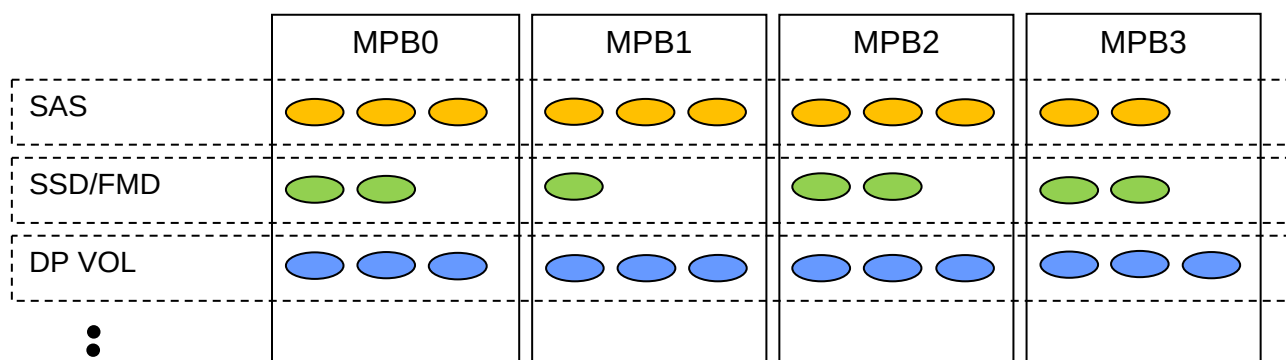


Fig. 3.6.2.1-1 Automatic allocation

3.6.2.1.1 Automatic allocation (SAS)

Unit: ECC Gr.

Leveling: LDEV num.

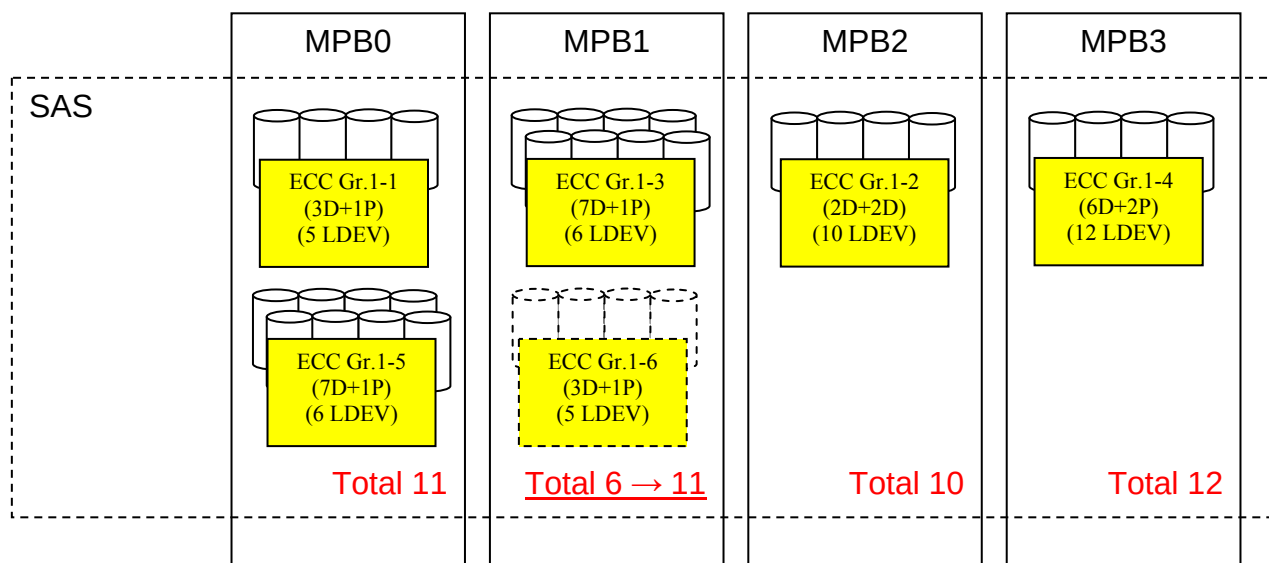


Fig. 3.6.2.1.1-1 Automatic allocation (SAS)

3.6.2.1.2 Automatic allocation (SSD, FMD/DP VOL)

Unit: ECC Gr.

Leveling: LDEV num.

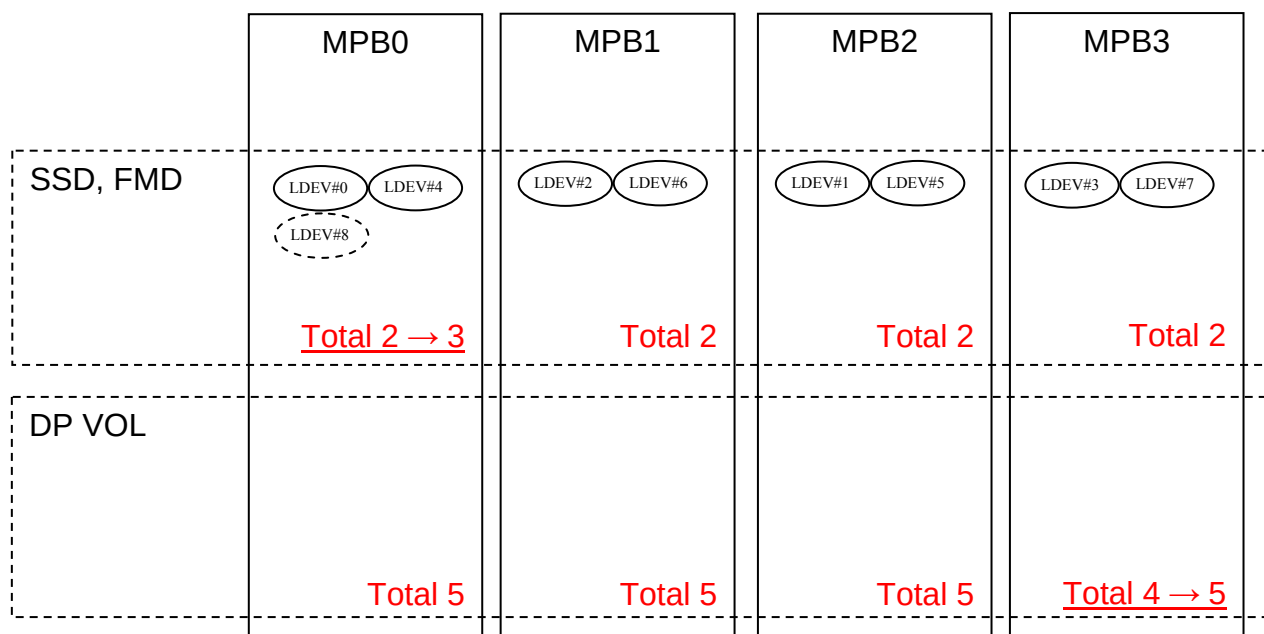


Fig. 3.6.2.1.2-1 Automatic allocation (SSD, FMD/DP VOL)

3.6.2.1.3 Automatic allocation (Ext. VOL)

Unit: Ext. VOL

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

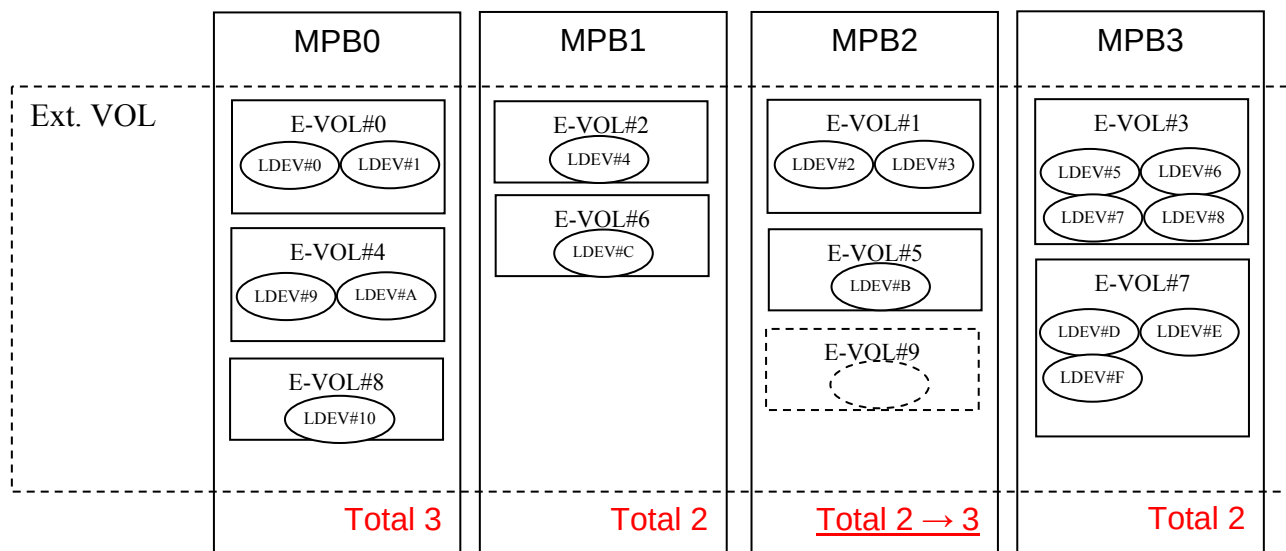


Fig. 3.6.2.1.3-1 Automatic allocation (Ext. VOL)

3.6.2.1.4 Automatic allocation (JNLG)

Unit: JNLG

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

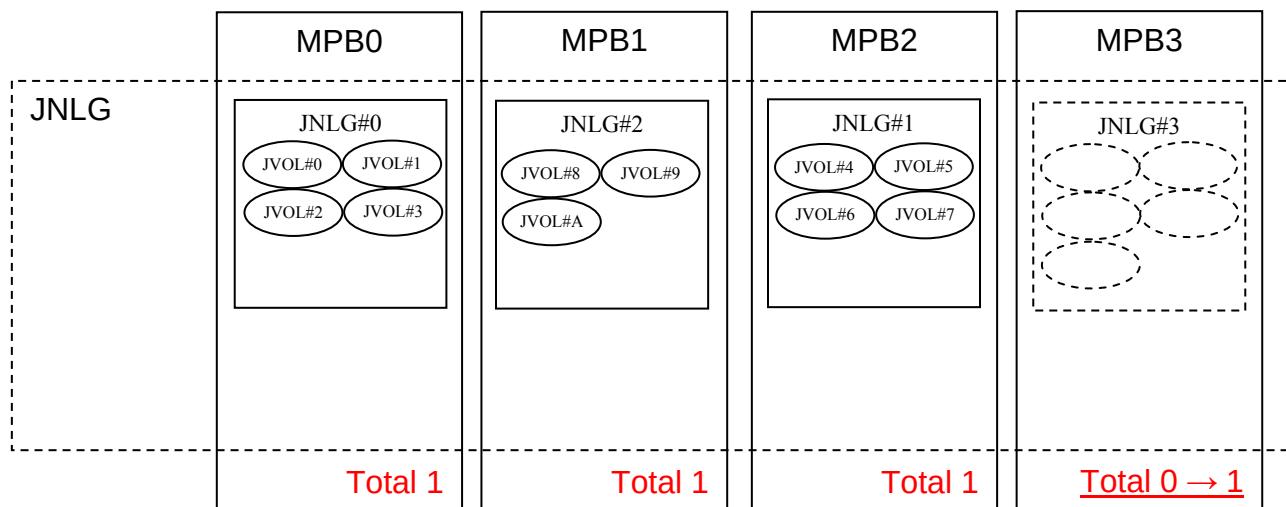


Fig. 3.6.2.1.4-1 Automatic allocation (JNLG)

3.6.3 MPB block

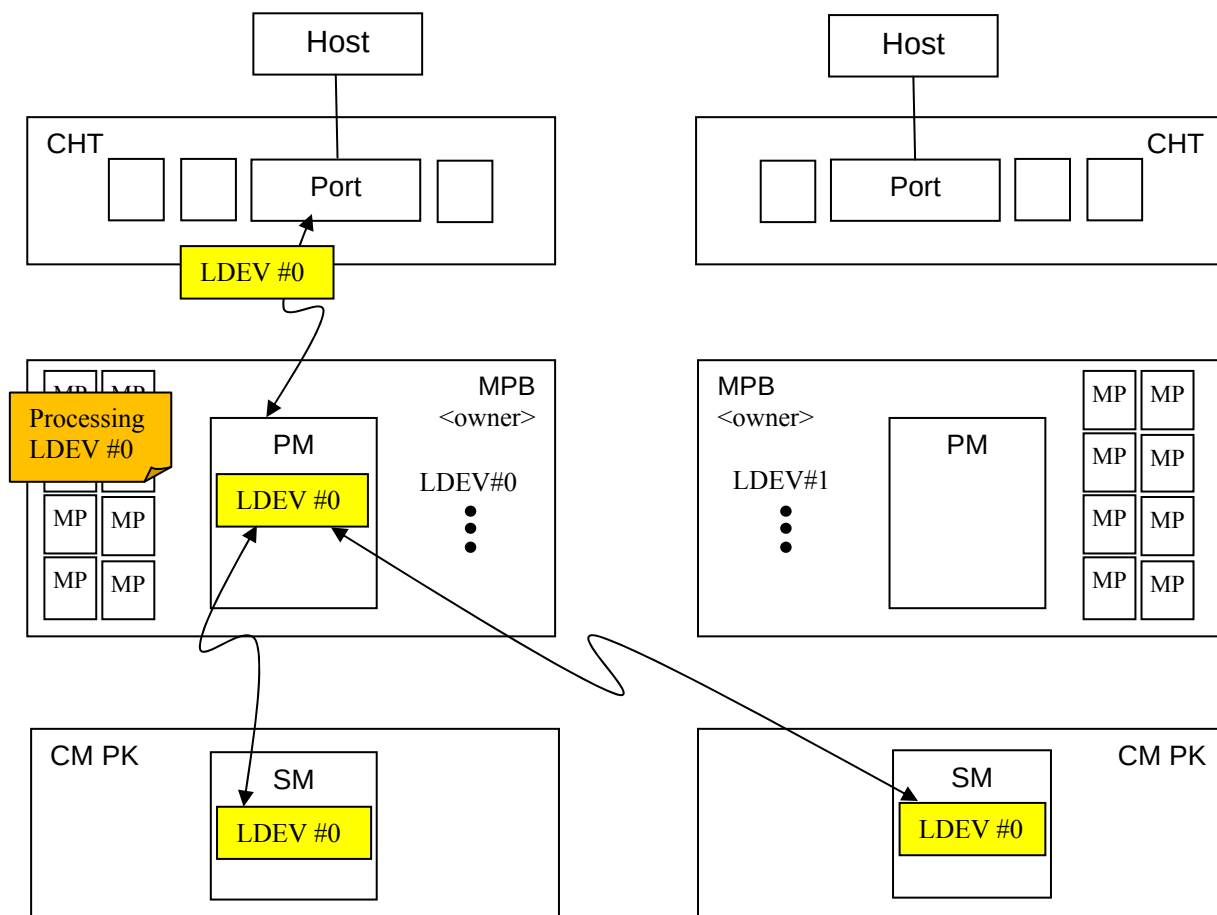


Fig. 3.6.3-1 MPB block

3.6.3.1 MPB block for maintenance

Step1. Start moving the ownership.

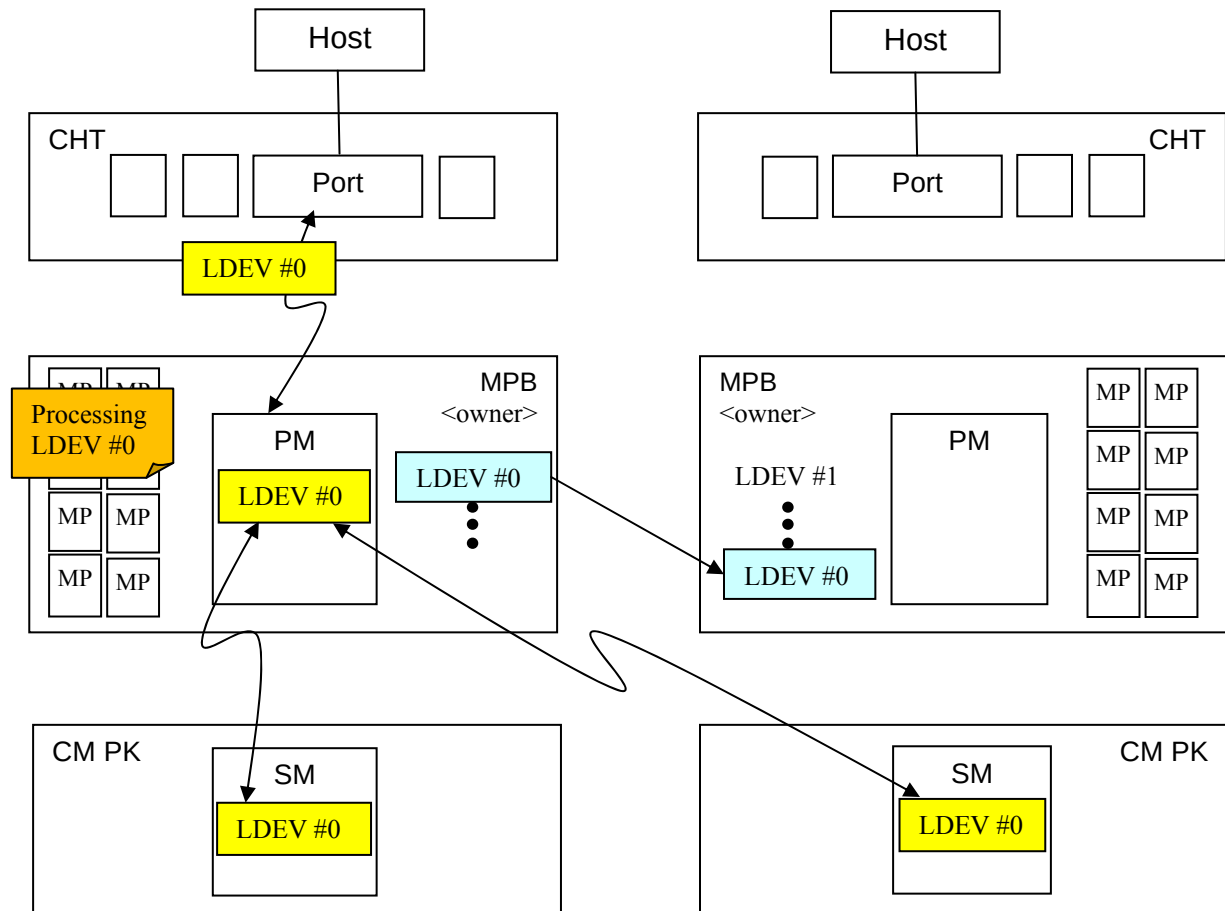


Fig. 3.6.3.1-1 MPB block for maintenance (1)

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

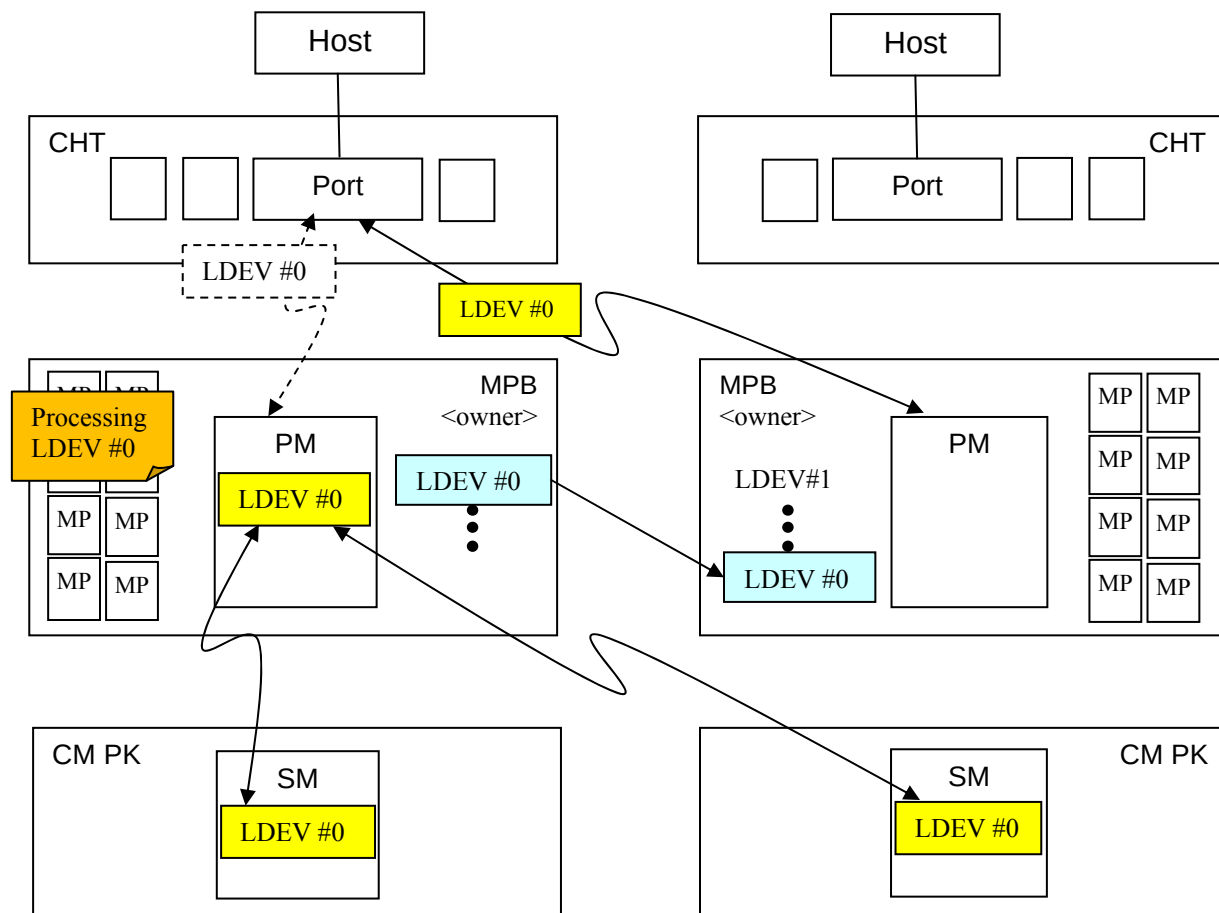


Fig. 3.6.3.1-2 MPB block for maintenance (2)

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

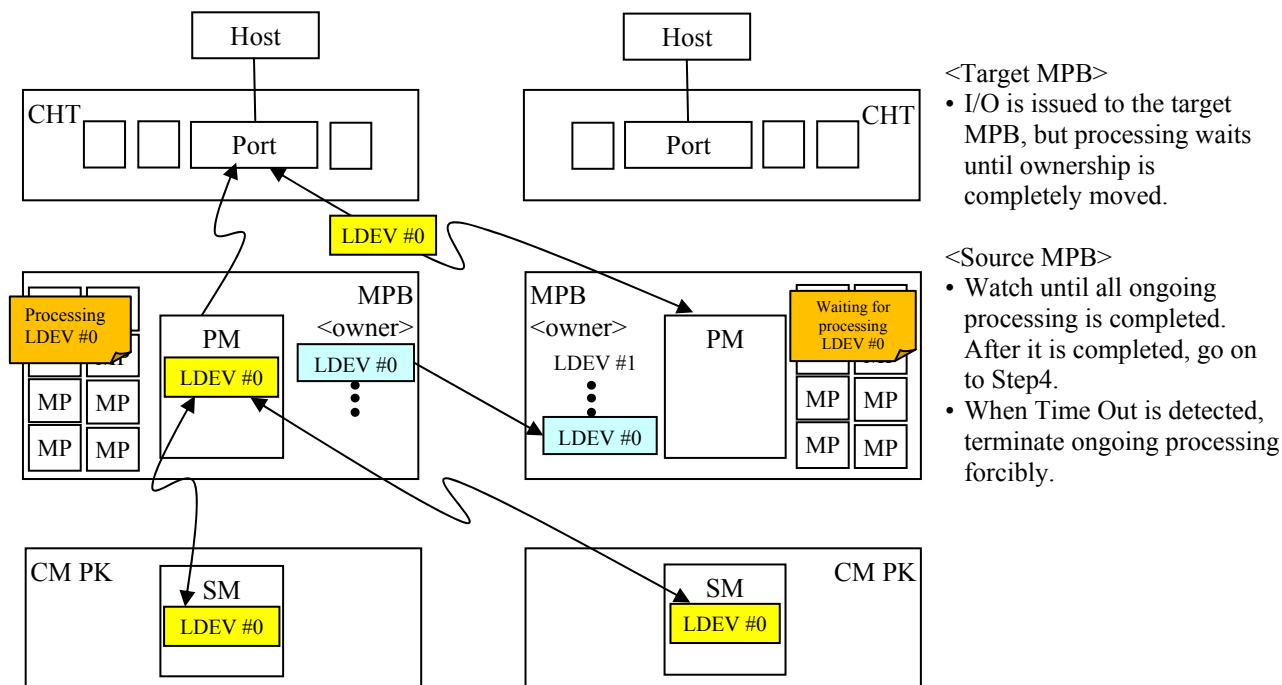


Fig. 3.6.3.1-3 MPB block for maintenance (3)

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

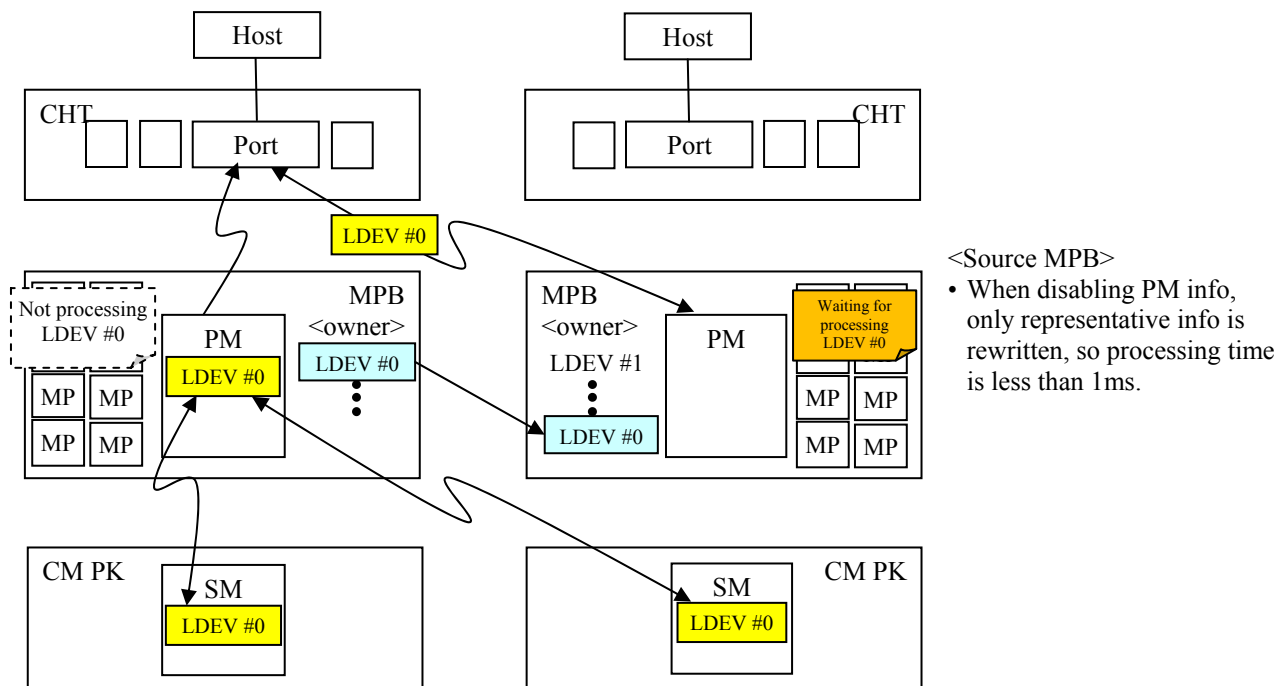


Fig. 3.6.3.1-4 MPB block for maintenance (4)

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

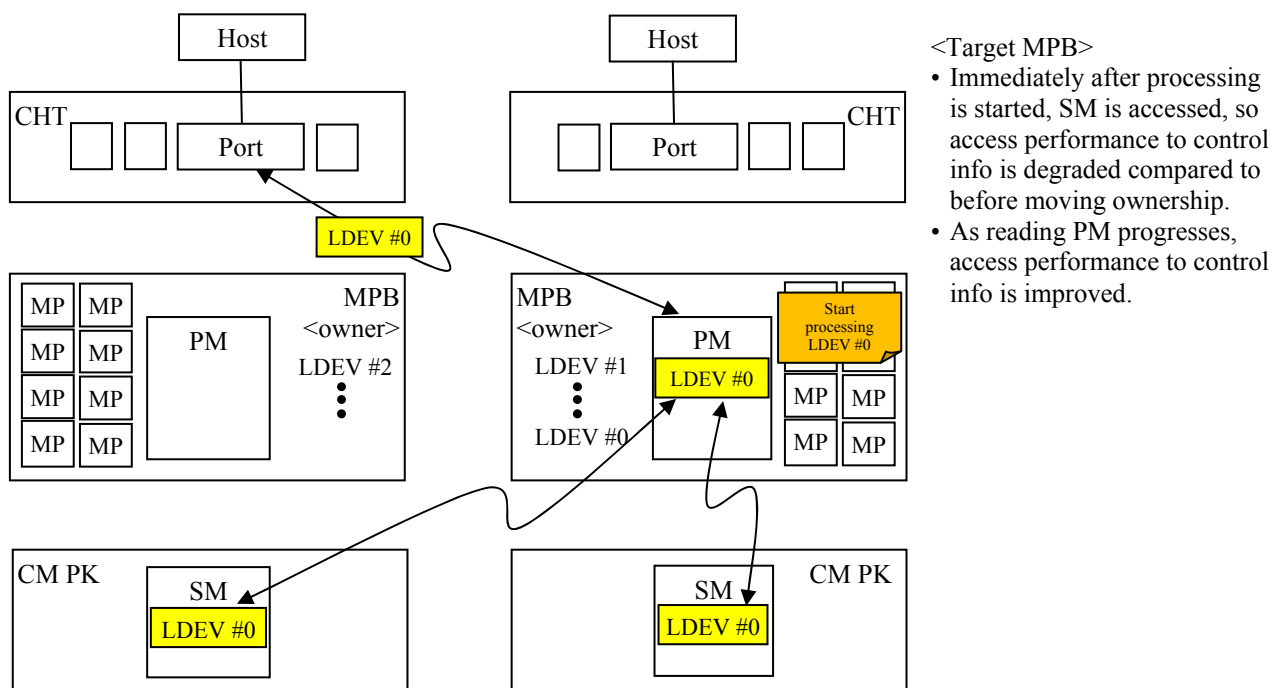


Fig. 3.6.3.1-5 MPB block for maintenance (5)

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

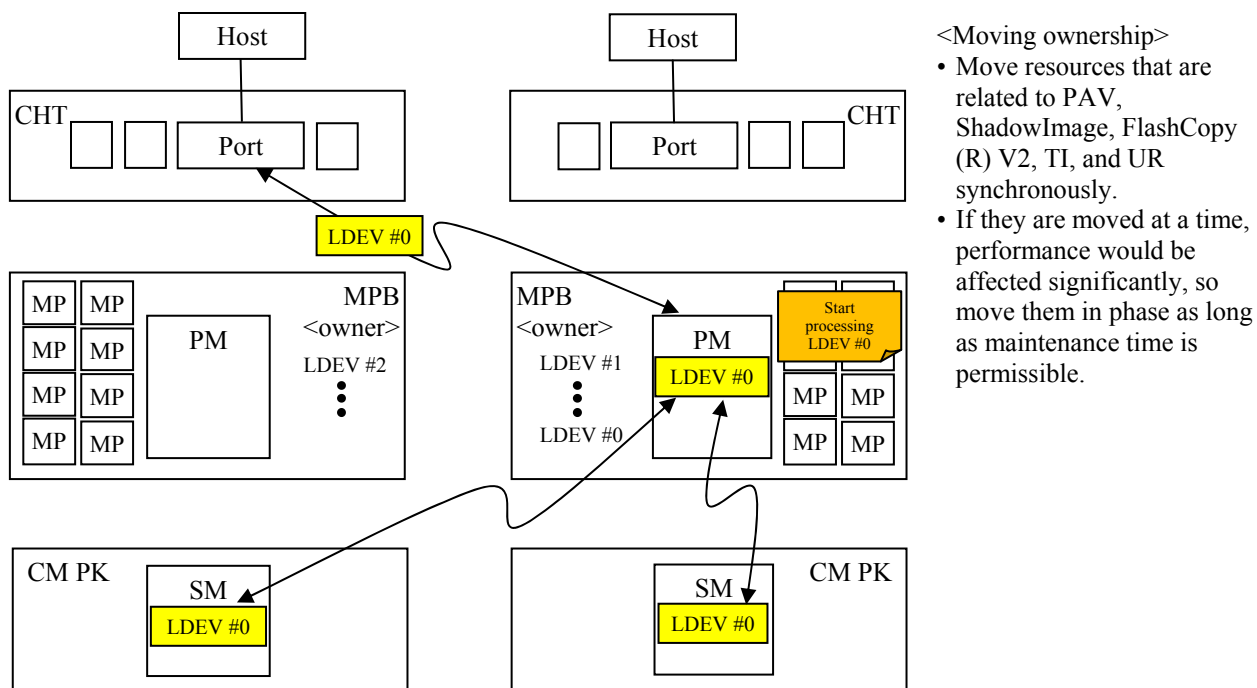


Fig. 3.6.3.1-6 MPB block for maintenance (6)

3.6.3.2 MPB blocked due to failure

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

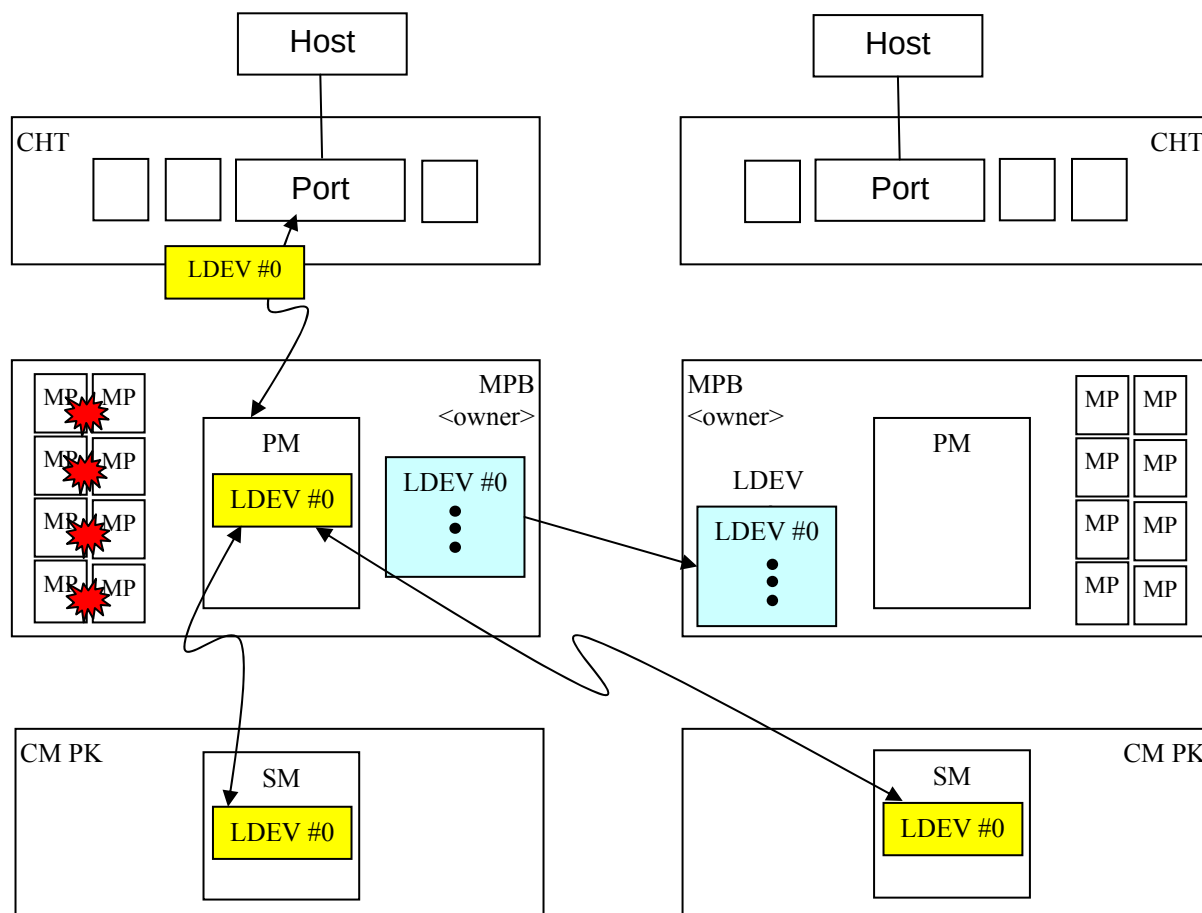


Fig. 3.6.3.2-1 MPB blocked due to failure (1)

Step2. Switch MPB, to which I/O is distributed, to the target MPB that takes over the ownership.

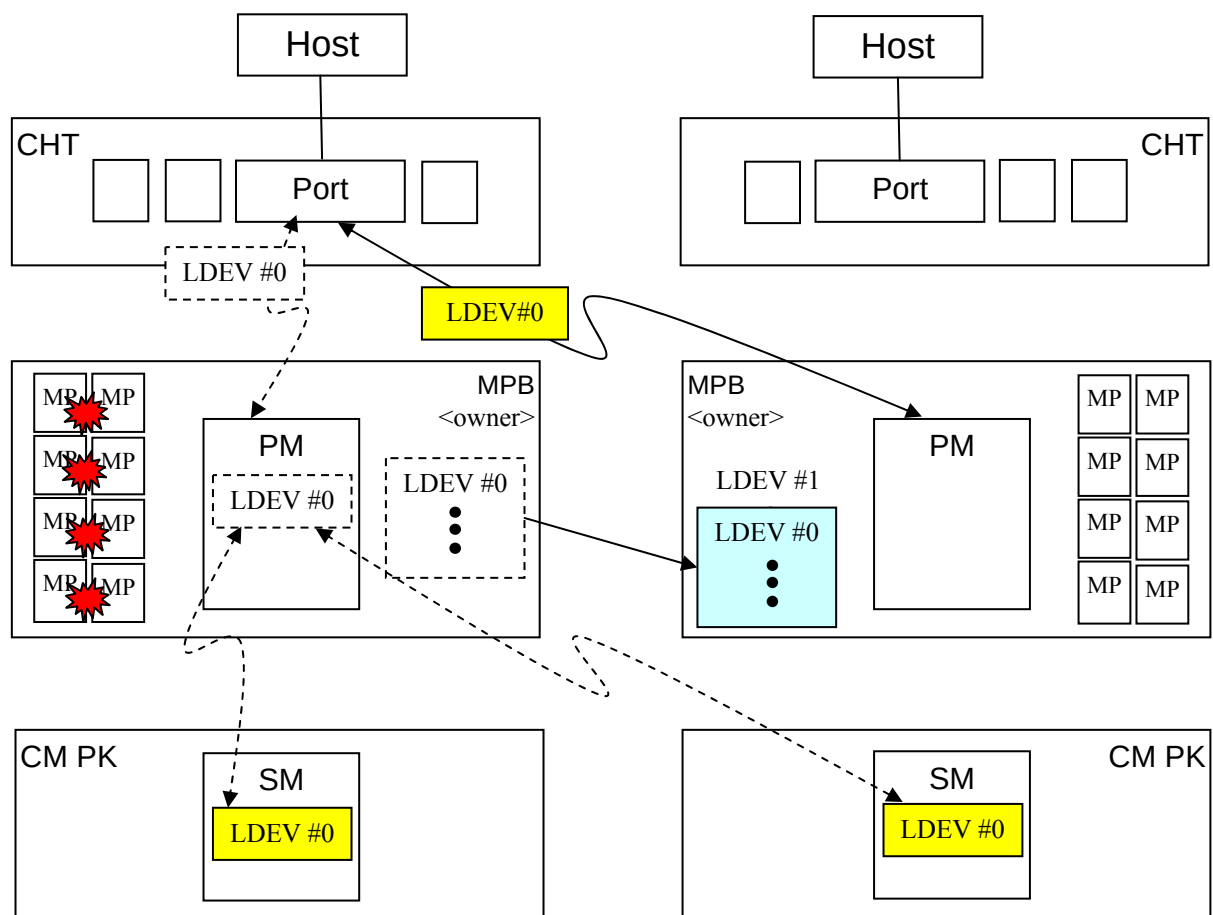


Fig. 3.6.3.2-2 MPB blocked due to failure (2)

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

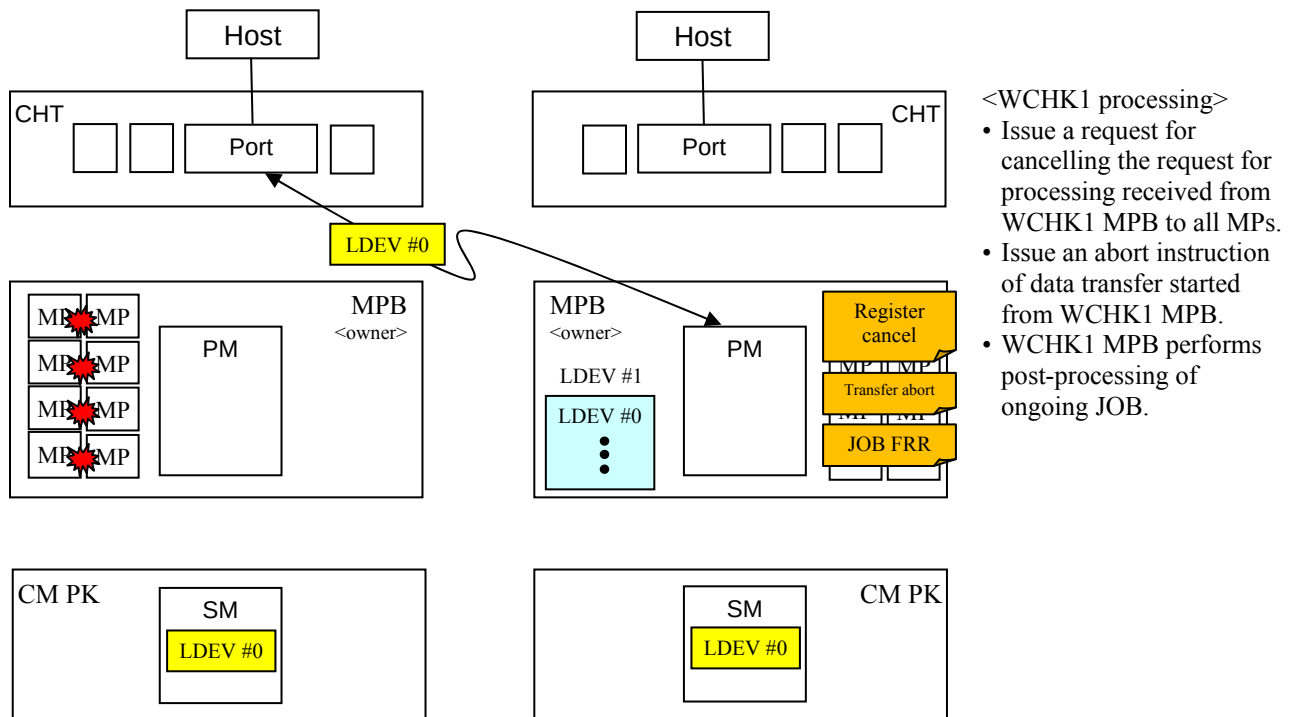


Fig. 3.6.3.2-3 MPB blocked due to failure (3)

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

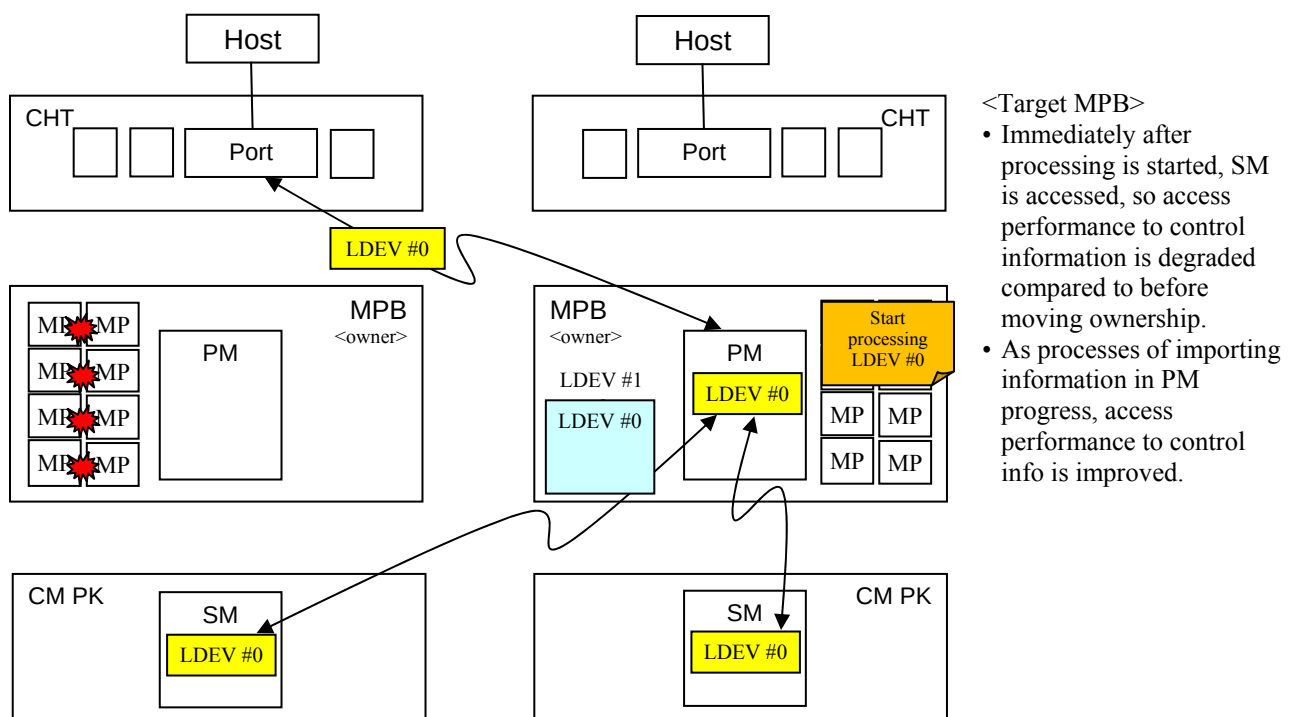


Fig. 3.6.3.2-4 MPB blocked due to failure (4)

3.7 Cache Architecture

3.7.1 Overall

3.7.1.1 Physical installation of Cache PK/DIMM

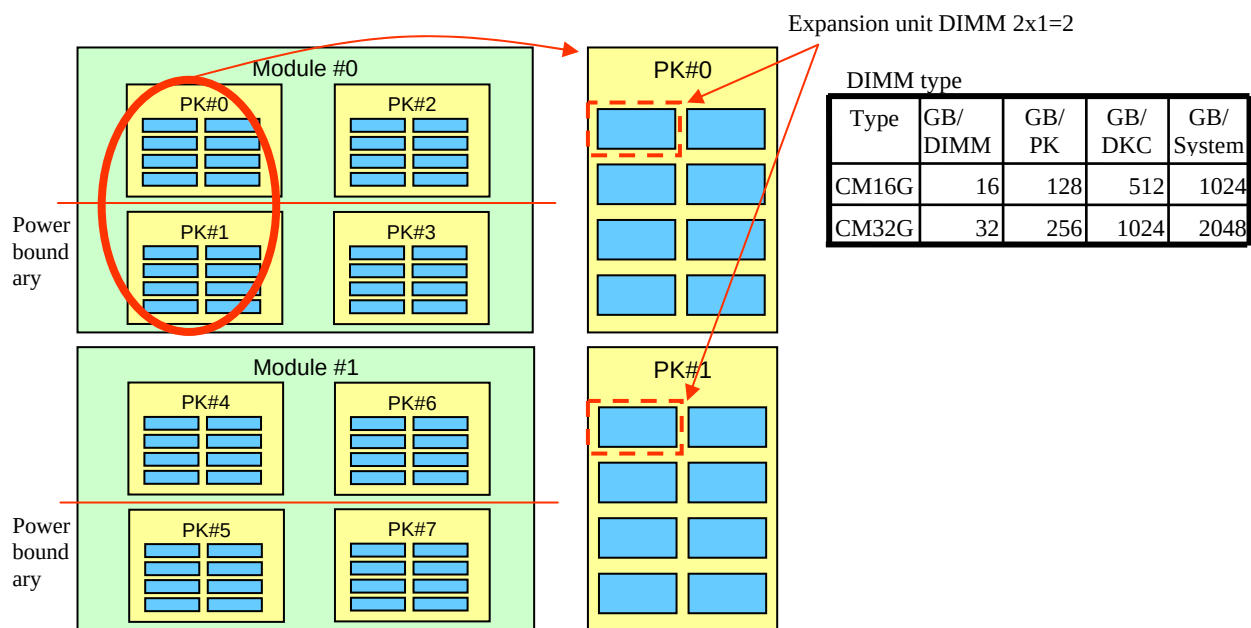


Fig. 3.7.1.1-1 Physical installation of Cache PK/DIMM

3.7.1.2 Consolidated Cache DIR and user data in PK

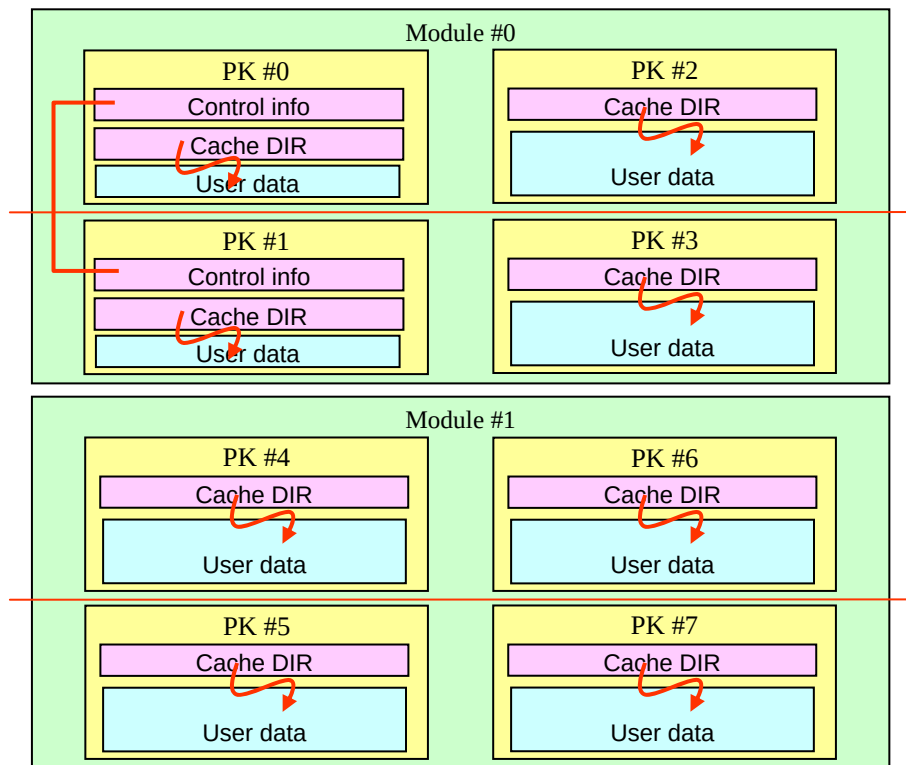


Fig. 3.7.1.2-1 Consolidated Cache DIR and user data in PK

3.7.1.3 Usage of SSD on BKM

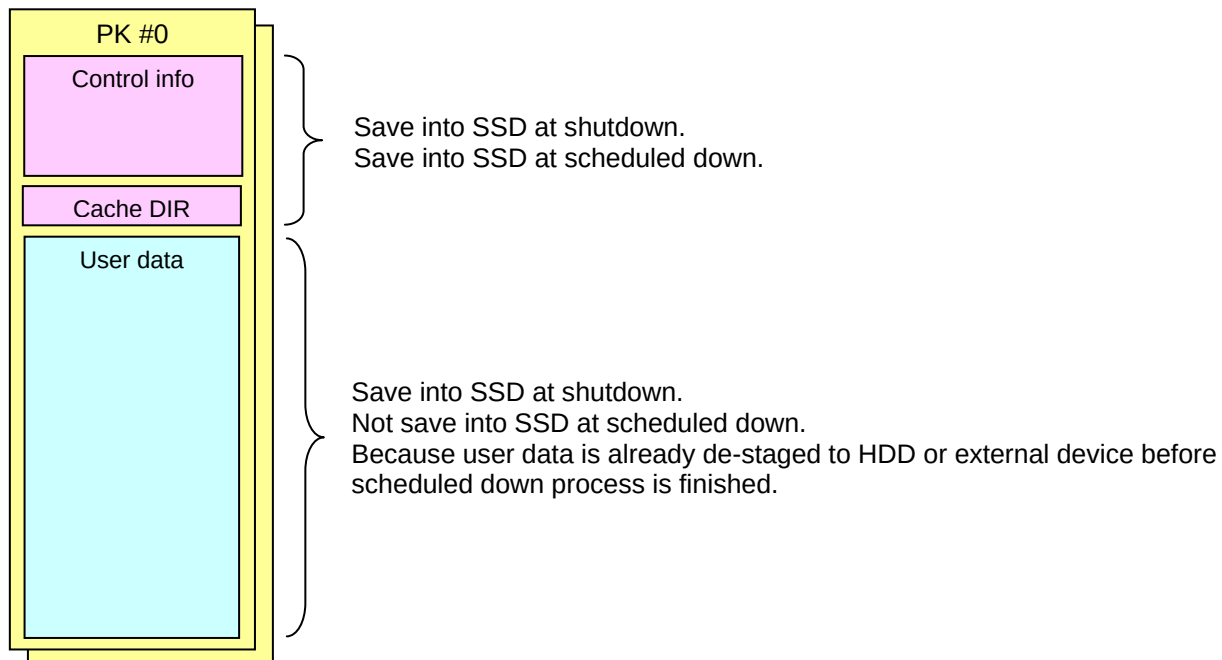


Fig. 3.7.1.3-1 Usage of SSD on BKM

3.7.2 Maintenance/Failure Blockade Specification

3.7.2.1 Blockade Unit

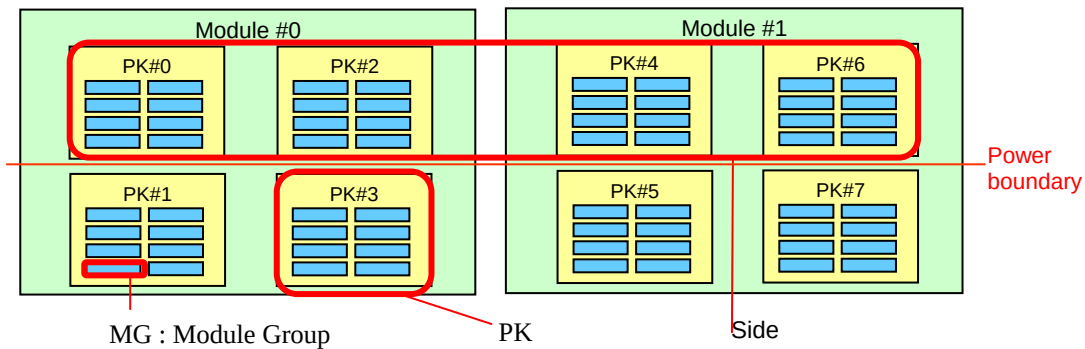


Fig. 3.7.2.1-1 Blockade Unit

3.7.2.2 PK Blockade

A PK blockade occurs in the following cases of (1) to (4).

(1) Cache Replacement

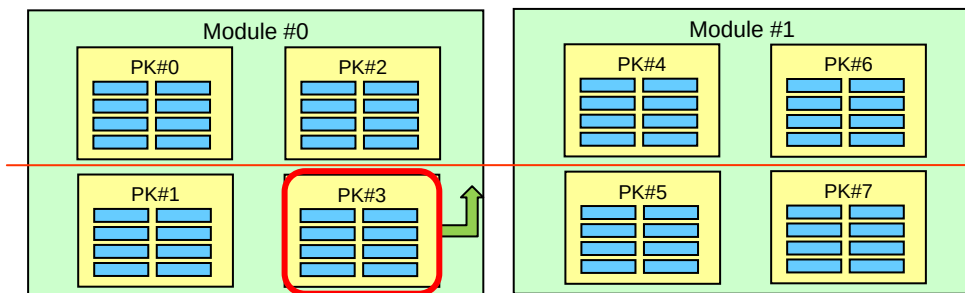


Fig. 3.7.2.2-1 PK Blockade (1)

(2) Cache Replacement

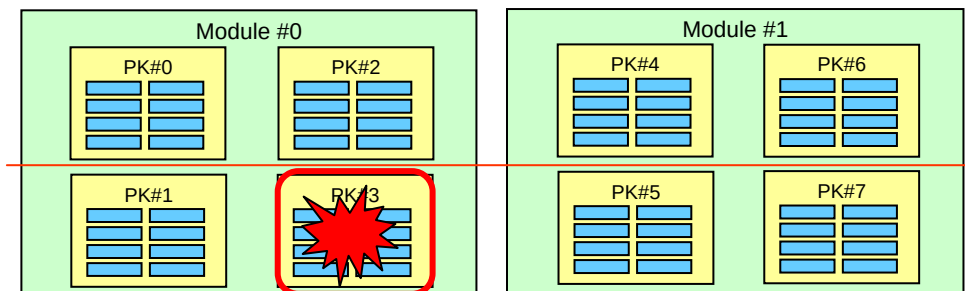


Fig. 3.7.2.2-2 PK Blockade (2)

- (3) 75% or more MGs on the cache PK are in failure

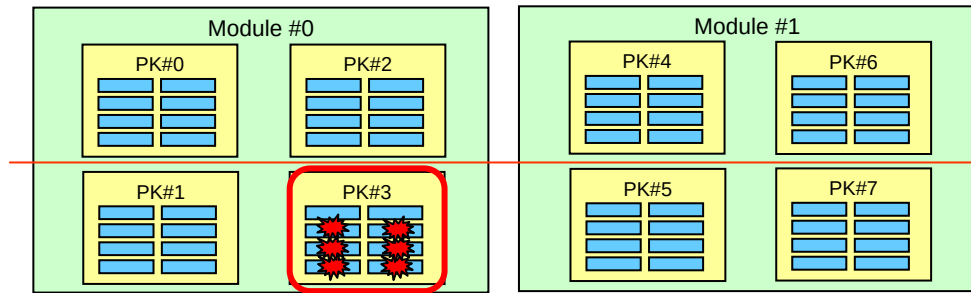


Fig. 3.7.2.2-3 PK Blockade (3)

- (4) MG#0 storing PK common information in the cache DIR is in failure

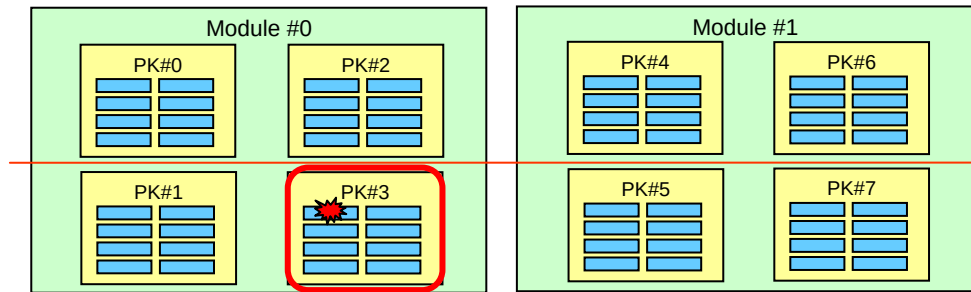


Fig. 3.7.2.2-4 PK Blockade (4)

3.7.2.3 Side Blockade

A side blockade occurs in the following cases of (1) and (2).

- (1) 75% or more PKs on the side are in failure

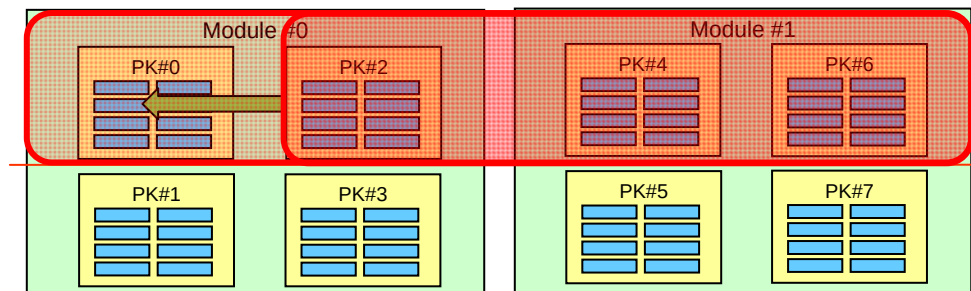


Fig. 3.7.2.3-1 Side Blockade (1)

- (2) ALL PKs storing GRPP information in the cache DIR on the side are blocked

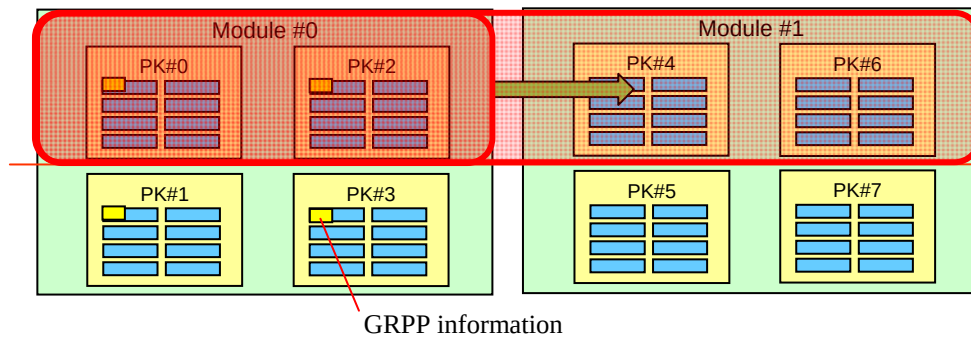


Fig. 3.7.2.3-2 Side Blockade (2)

3.7.2.4 SM Side Blockade (Logical)

A SM side (logical information) blockade occurs in the following cases of (1) and (2).

- (1) One or more MGs storing configuration information on the side are in failure

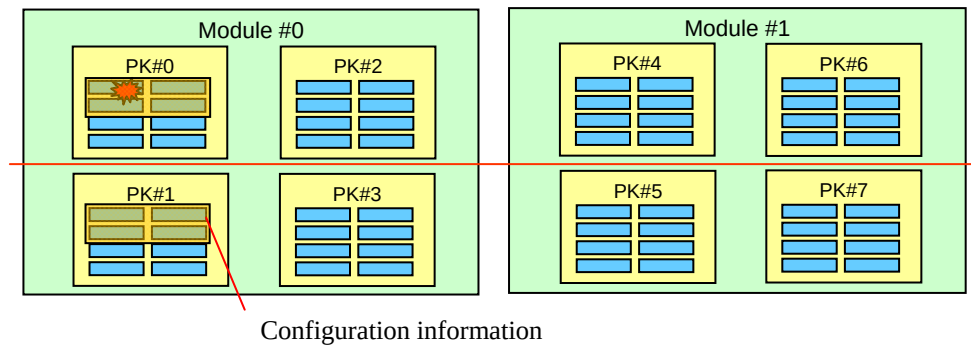


Fig. 3.7.2.4-1 SM Side Blockade (1)

- (2) A cache including MGs storing configuration information on the side is replaced

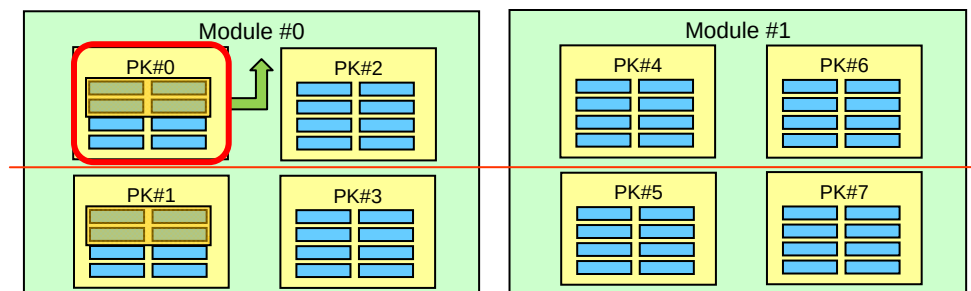


Fig. 3.7.2.4-2 SM Side Blockade (2)

3.7.3 Reduction of chance for Write Through

In DKC810I, conditions leading to Write Through at cache maintenance are reduced and the impact that cache maintenance gives to host I/O performance is drastically mitigated.

Table 3.7.3-1 shows Write Through time of DKC810I.

Table 3.7.3-1 Specifications of Write Through time (1)

<DKC810I> Four CM PK

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

*1: See table 3.7.3-2.

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

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

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

Table 3.7.3-2 Specifications of Write Through time (2)

		Blocked to Max. 2min	to Max. 4hr	Max. 4hr or longer
DKC810I CM PK Failure	Write Hit	Write Through		
	Write Miss			
DKC810I CM PK Maintenance	Write Hit	Write Through		
	Write Miss			

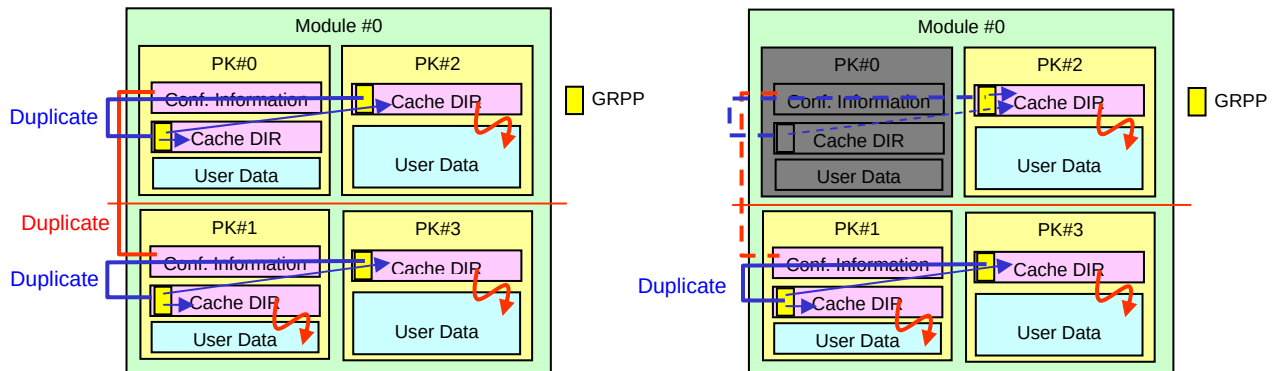


Fig. 3.7.3-1 Reduction of chance for Write Through (1)

In DKC810I, Cache DIR and User Data are stored in the same CM PK, so even when any one of PK is blocked, two CM sides remain. Managing GRPP, the upper Index of Cache DIR, in 2PKs per side makes possible to search Cache DIR during Cache PK failure/maintenance.

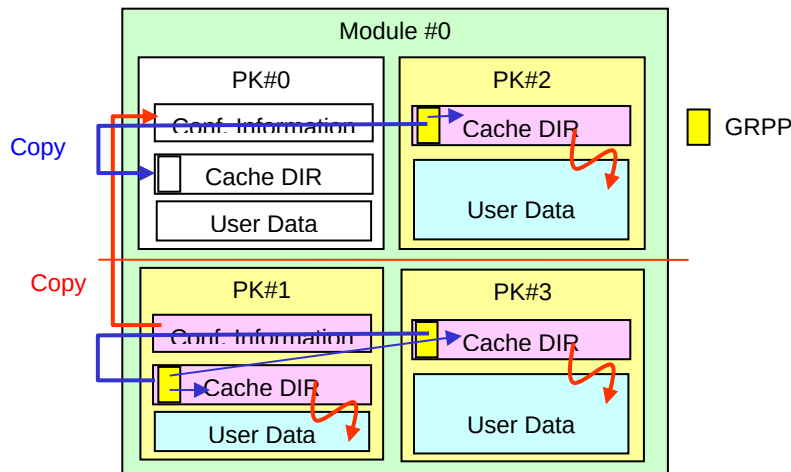


Fig. 3.7.3-2 Reduction of chance for Write Through (2)

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

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

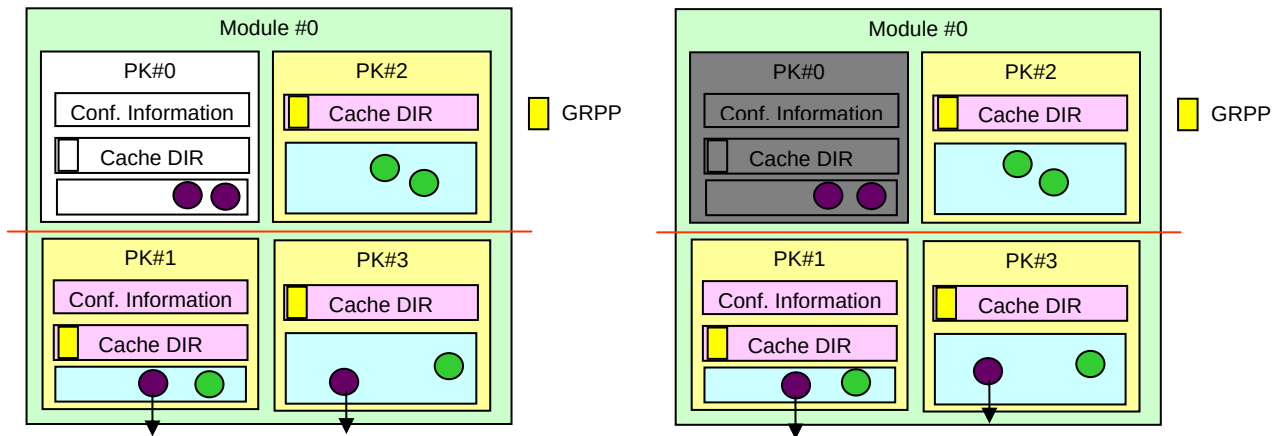


Fig. 3.7.3-3 Reduction of chance for Write Through (3)

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

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

- PK #0 is blocked due to a failure
 - Write after the completion of cache DIR re-establishment following failure blockade can reserve two sides of CM (Write Through is not required).
 - Write Pending Data in the PK blocked due to a failure is single (no longer duplicated) and forcibly destaged asynchronously.

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

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

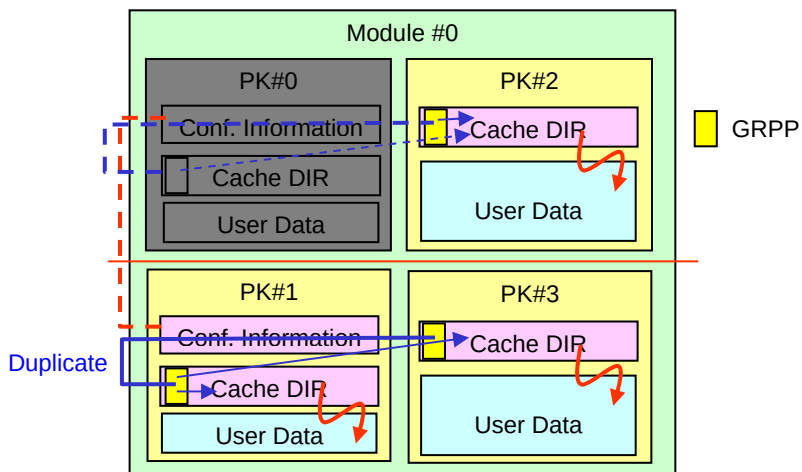


Fig. 3.7.3-4 Reduction of chance for Write Through (4)

Data guarantee of single Configuration Information (Storage system is stopped)

Table 3.7.3-3 Data guarantee of single Configuration Information (Storage system is stopped)

Case	DKC810I
Power failure	Recover configuration information from SSD on PK #1. Recover WP from SSD on CPK #1, #2, #3.
PK #1 failure (LSI failure, memory failure, SSD failure etc.)	Recover configuration information from SVP. Recover WP from configuration information recovered from SVP and SSD on CPK #2, #3.

3.7.4 Cache Control

3.7.4.1 Cache DIR PM read and PM/SM write

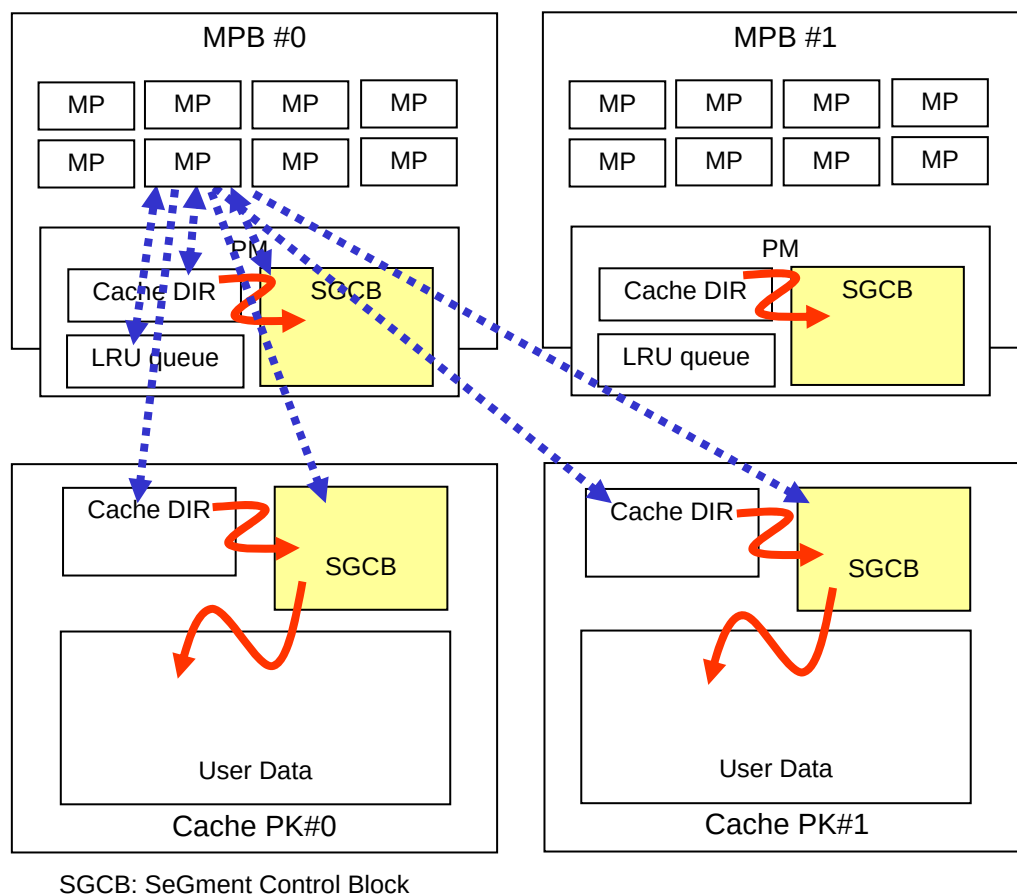


Fig. 3.7.4.1-1 Cache DIR PM read and PM/SM write

3.7.4.2 Cache Segment Control Image

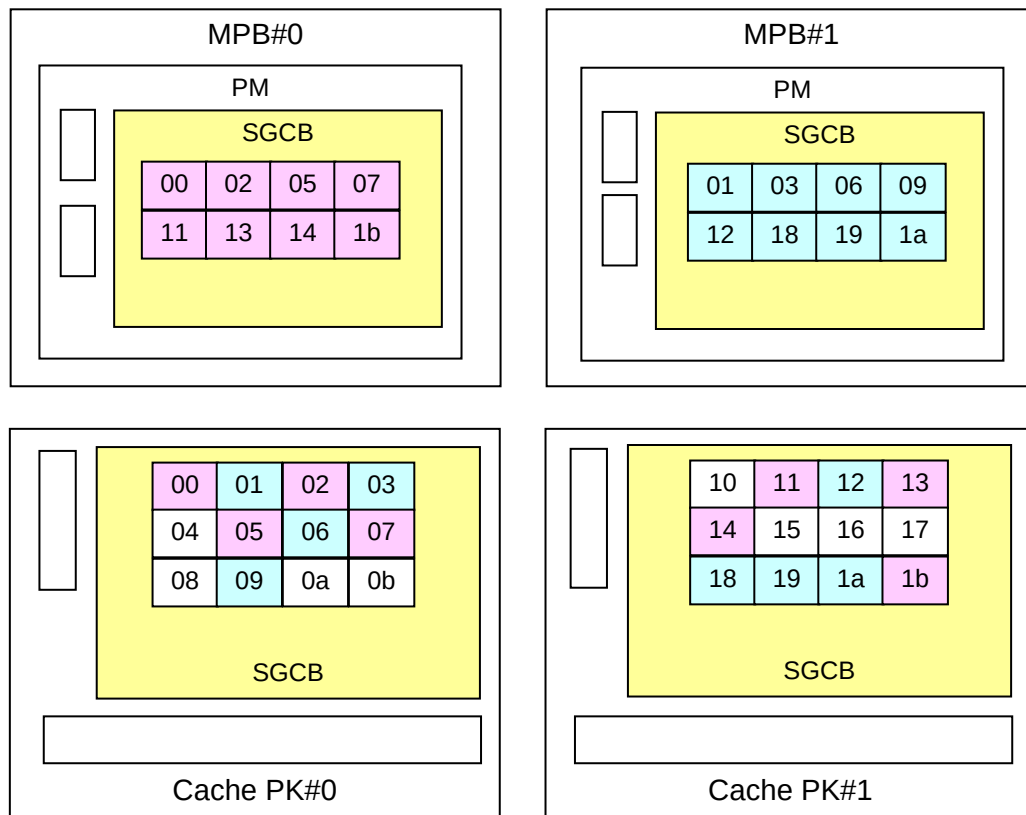


Fig. 3.7.4.2-1 Cache Segment Control Image

3.7.4.3 Initial Setting (Cache Volatile)

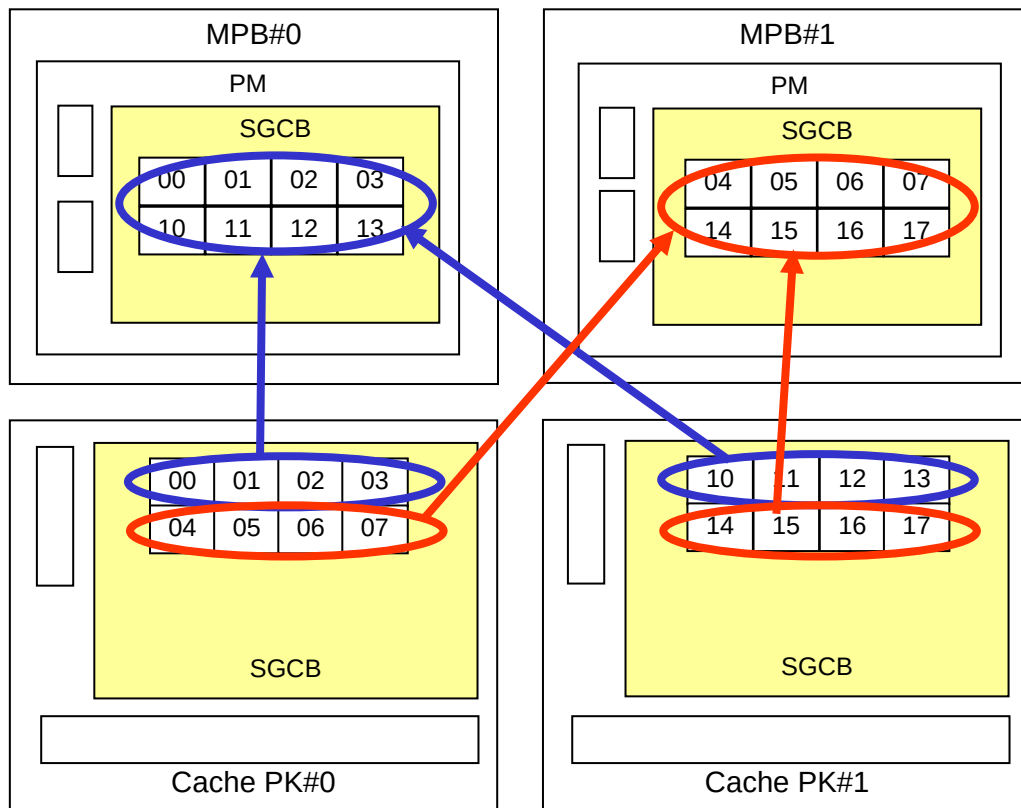


Fig. 3.7.4.3-1 Initial Setting (Cache Volatile)

3.7.4.4 Cache Replace

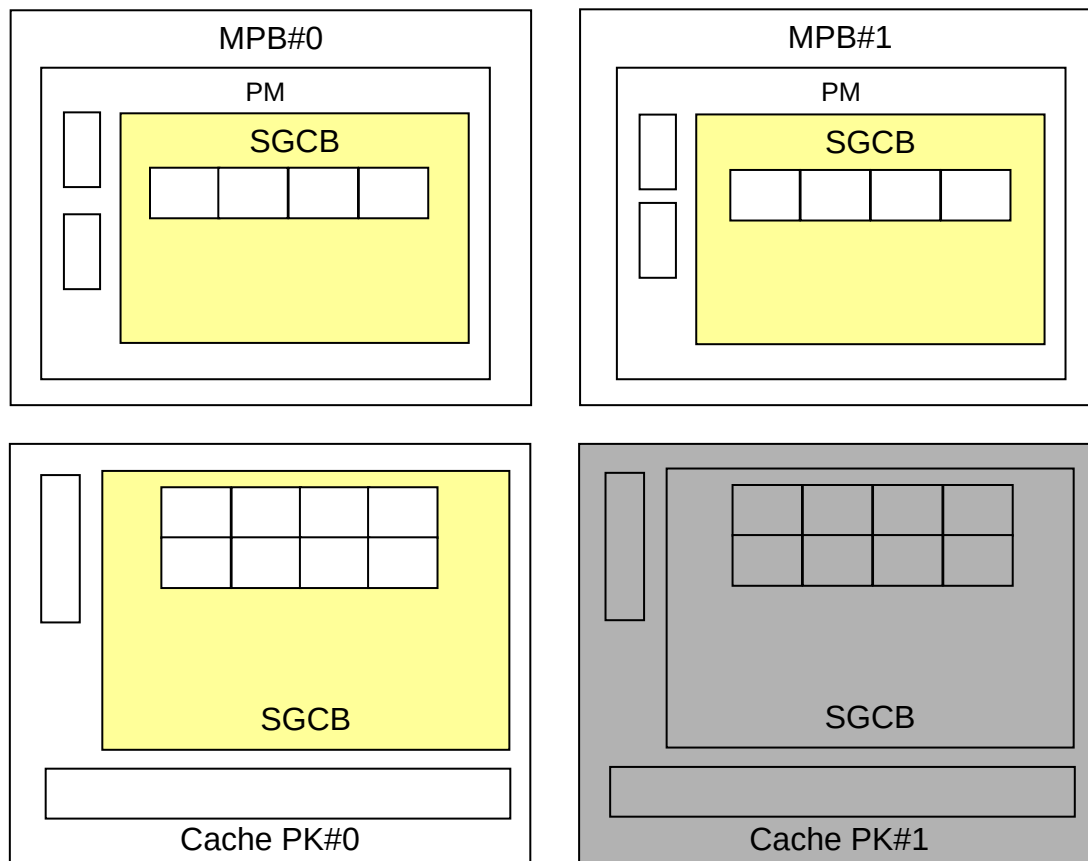


Fig. 3.7.4.4-1 Cache Replace (1)

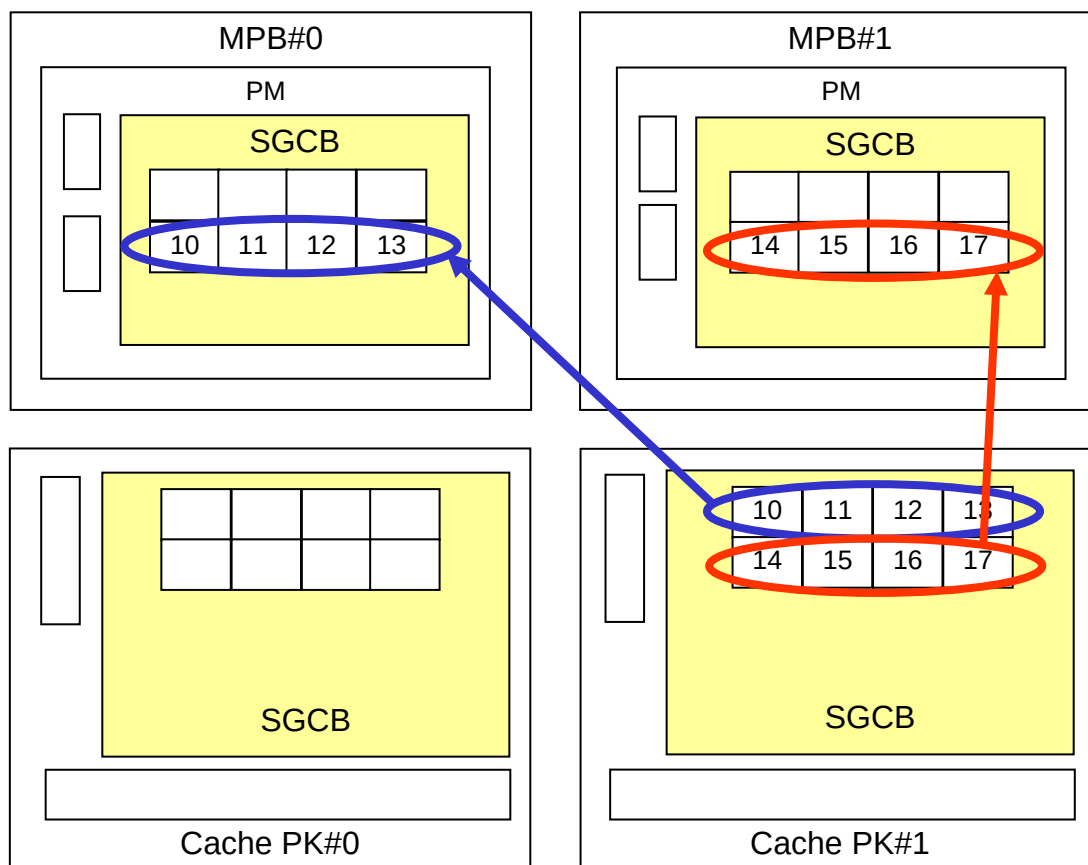


Fig. 3.7.4.4-2 Cache Replace (2)

3.7.4.5 Cache Installation

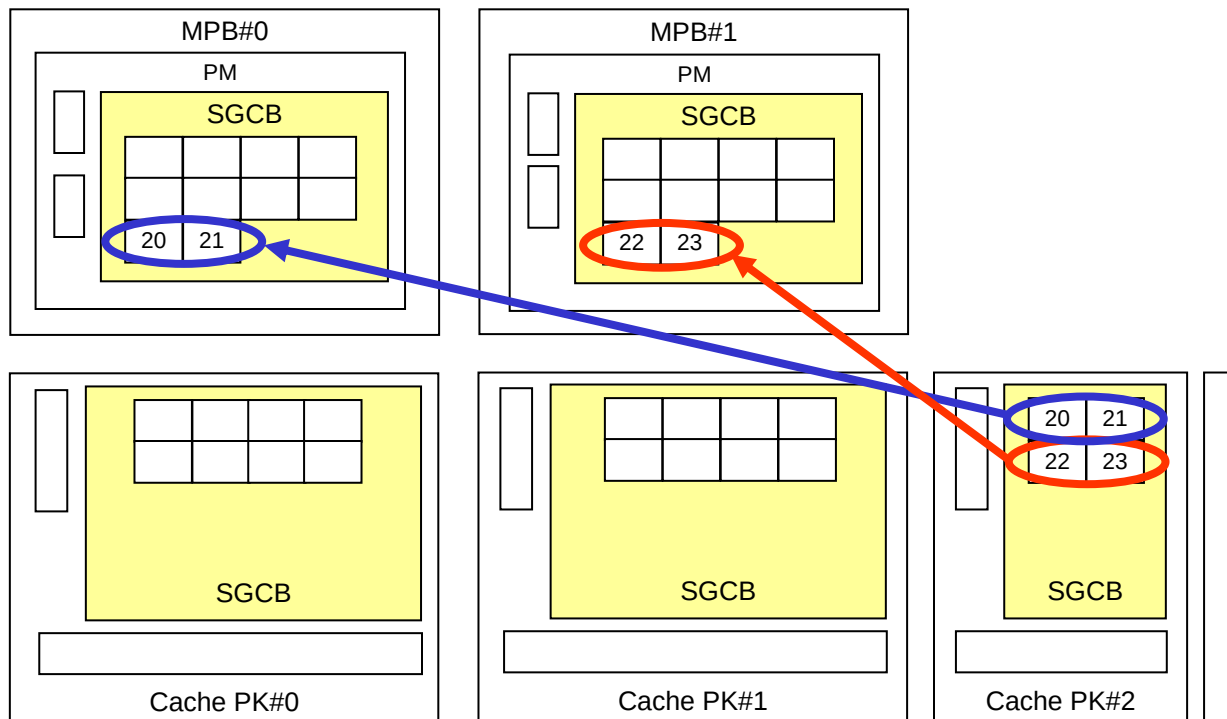


Fig. 3.7.4.5-1 Cache Installation (1)

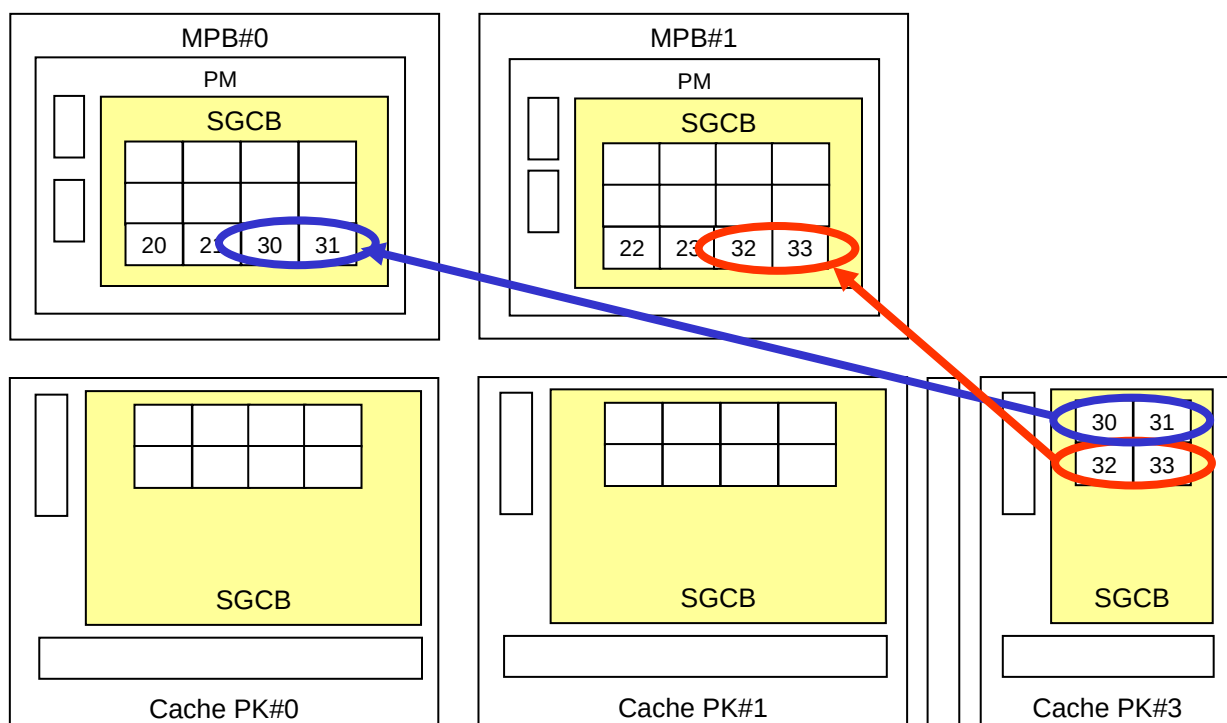


Fig. 3.7.4.5-2 Cache Installation (2)

3.7.4.6 Ownership movement

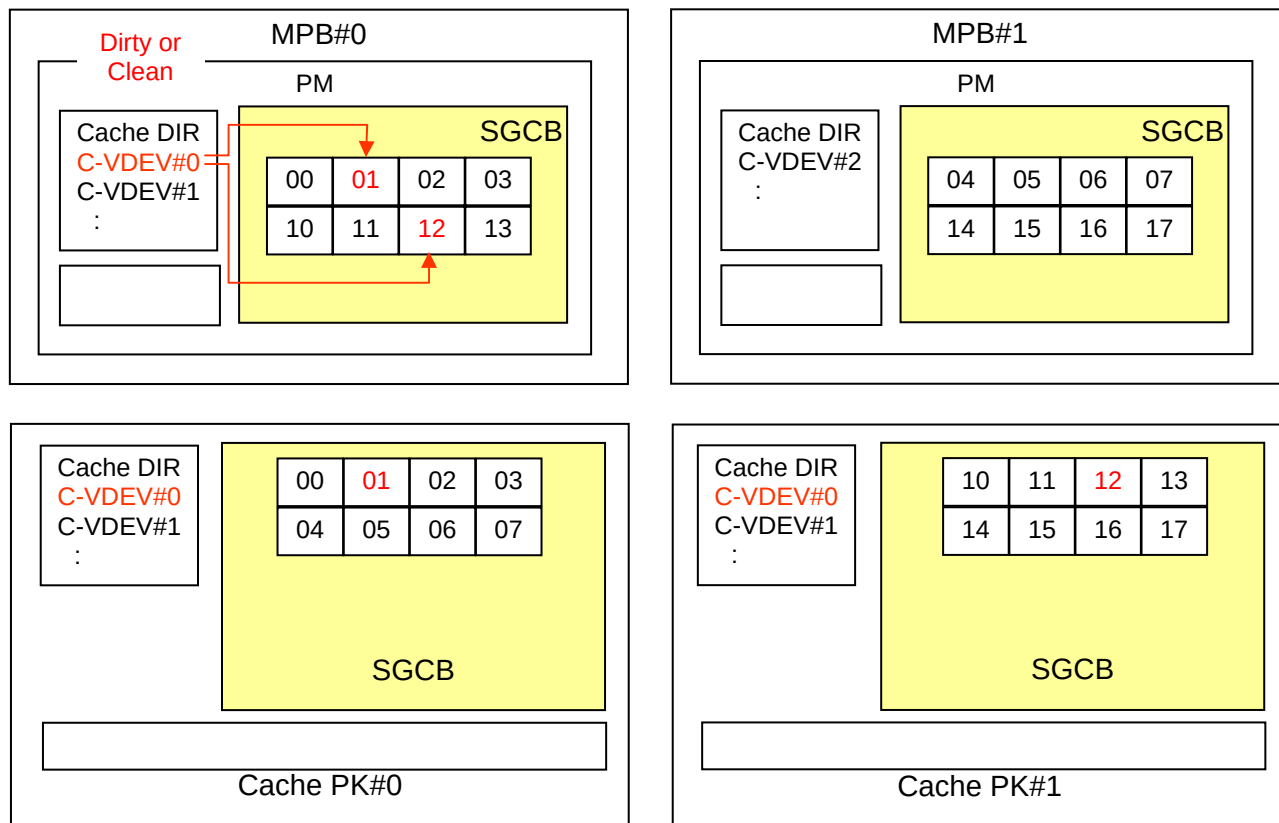


Fig. 3.7.4.6-1 Ownership movement (1)

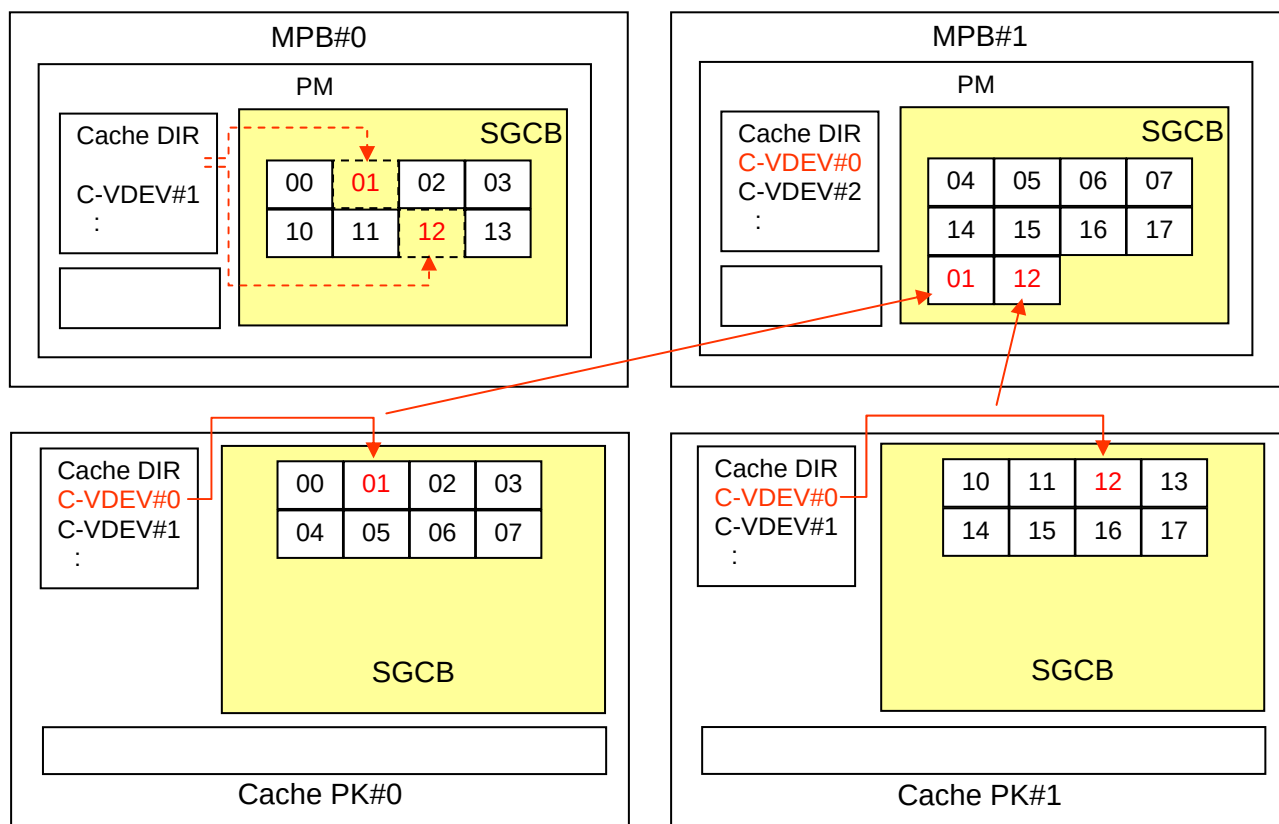


Fig. 3.7.4.6-2 Ownership movement (2)

3.7.4.7 Cache Workload balance

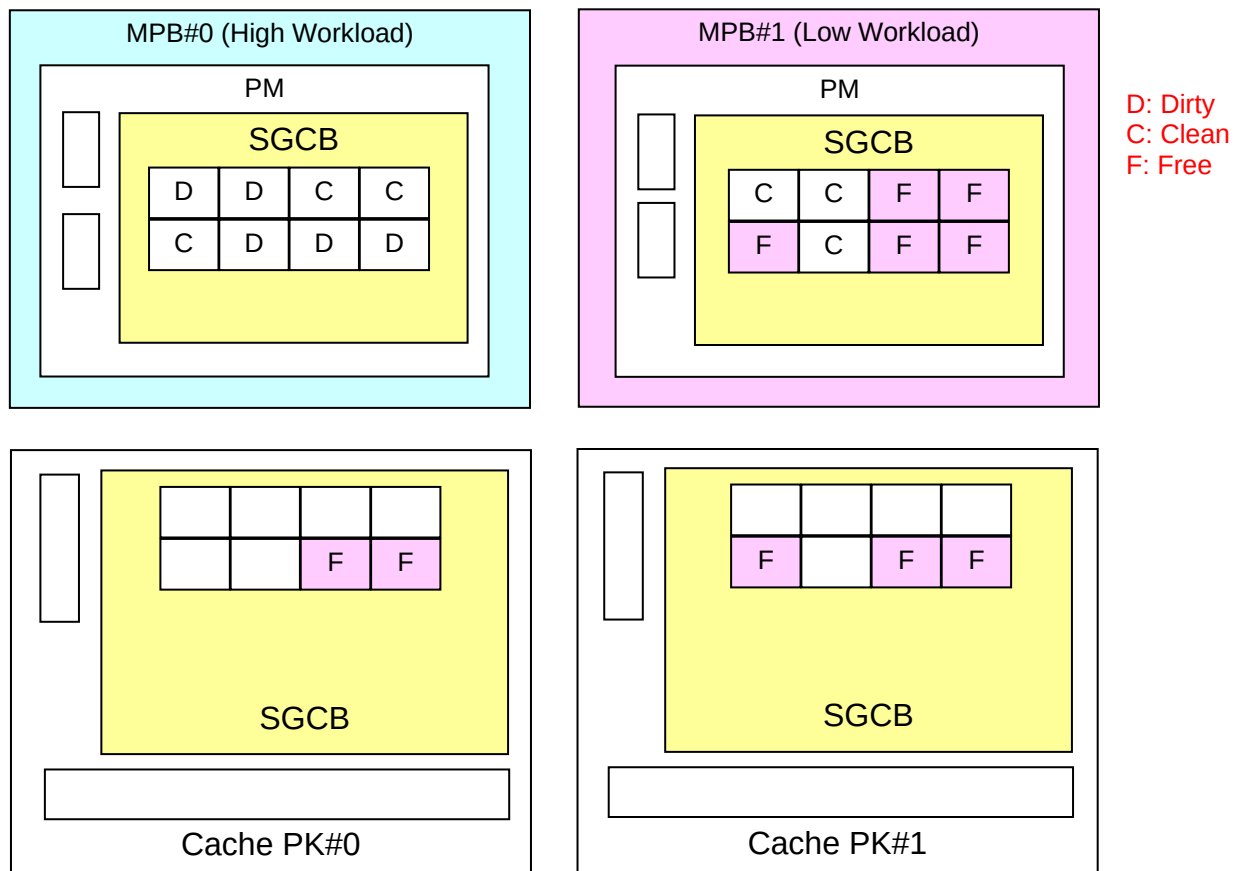


Fig. 3.7.4.7-1 Cache Workload balance (1)

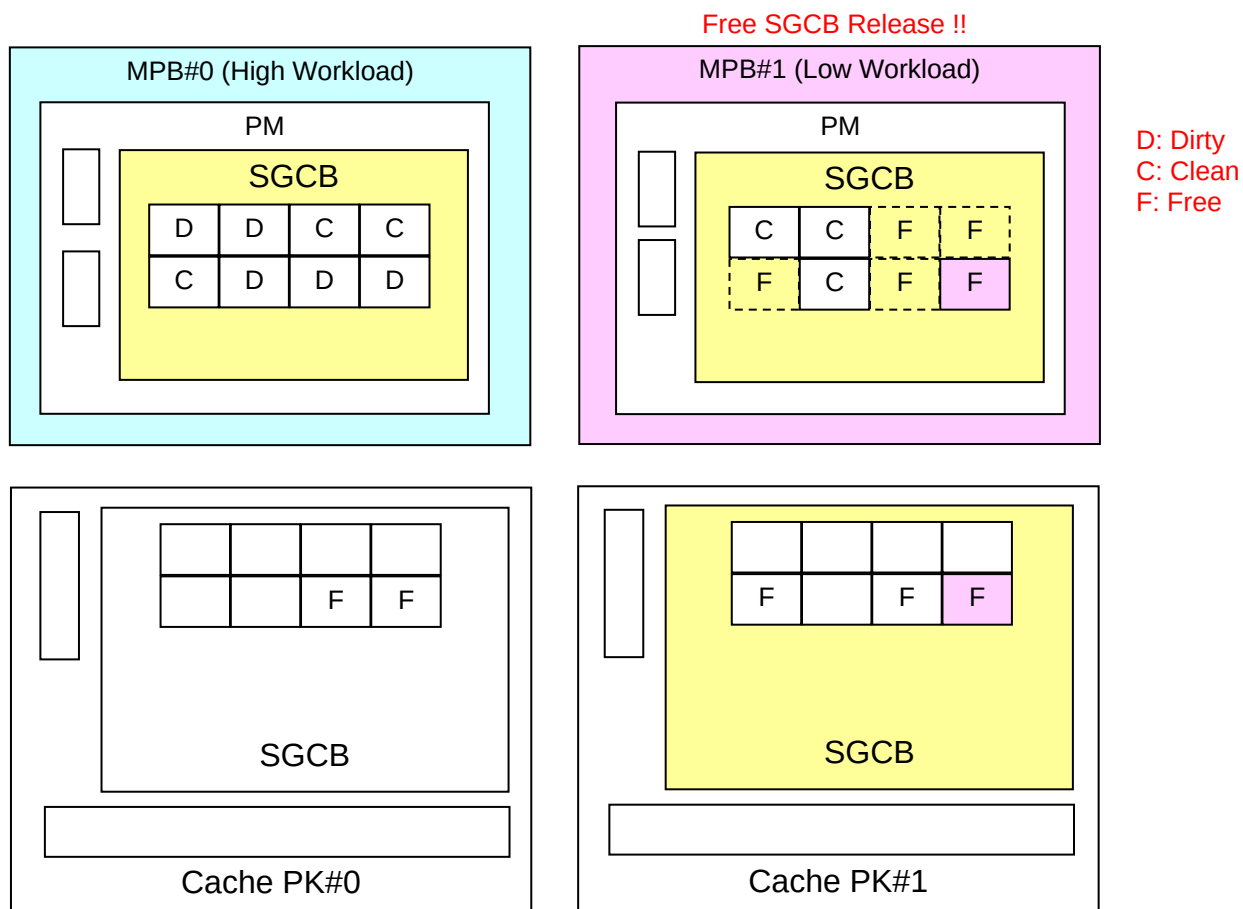


Fig. 3.7.4.7-2 Cache Workload balance (2)

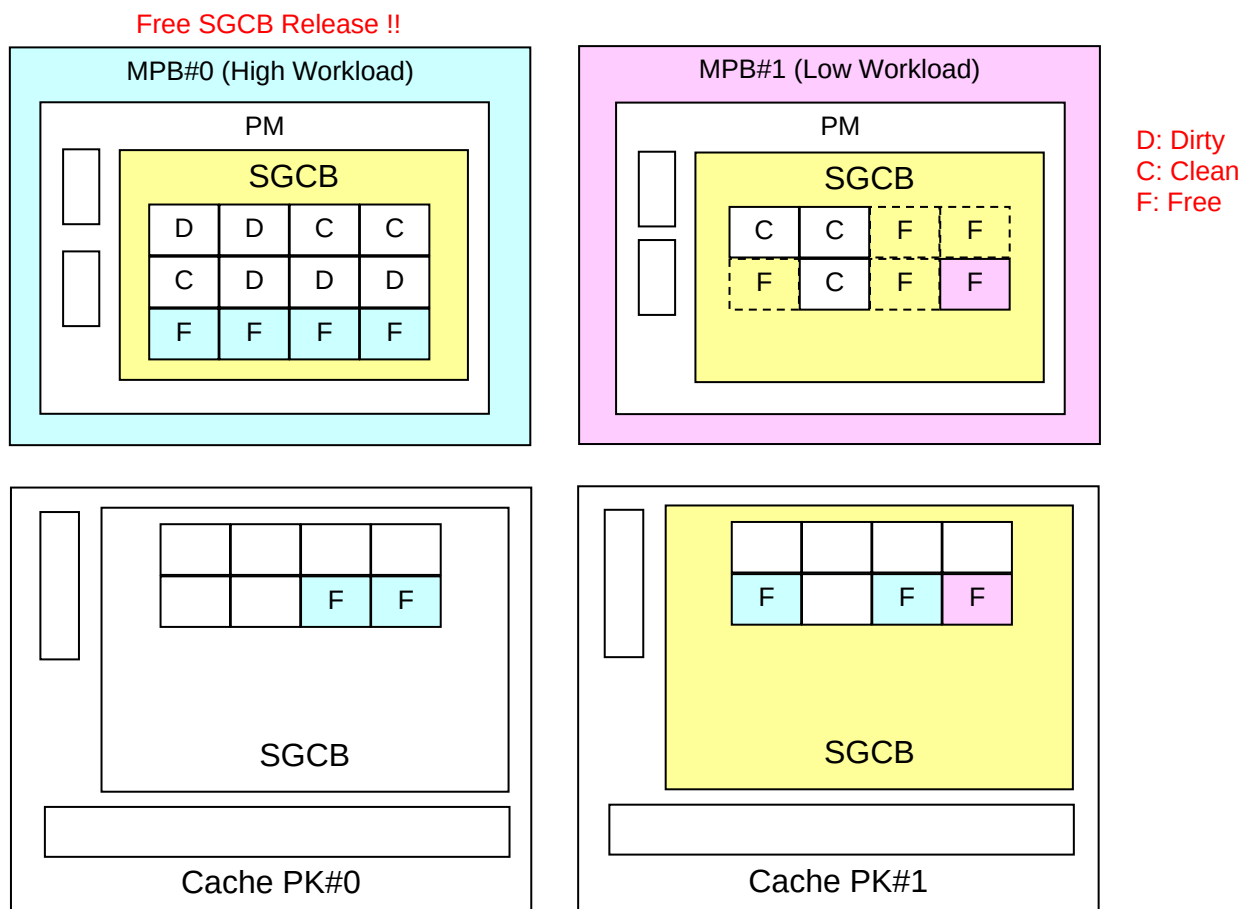


Fig. 3.7.4.7-3 Cache Workload balance (3)

3.7.4.8 MPB Replace

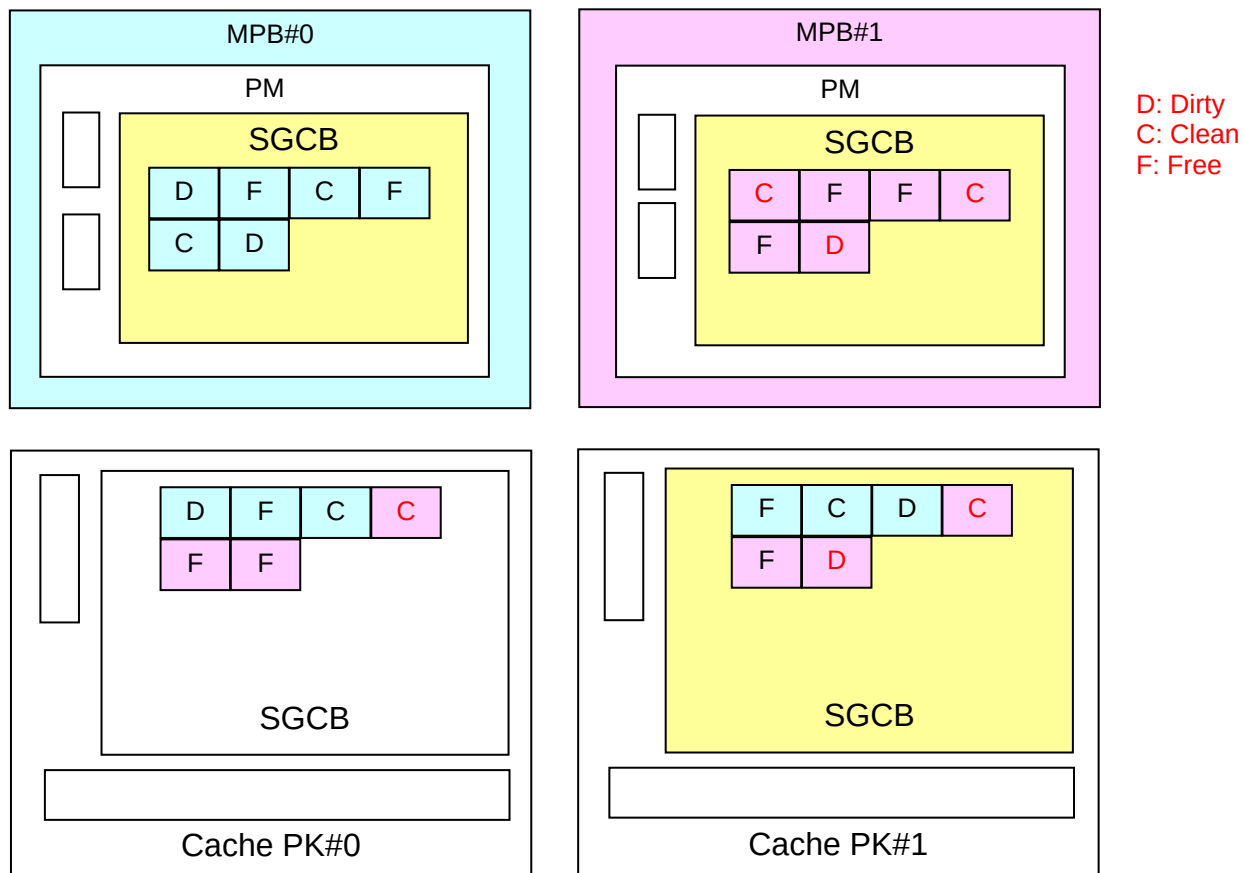


Fig. 3.7.4.8-1 MPB Replace (1)

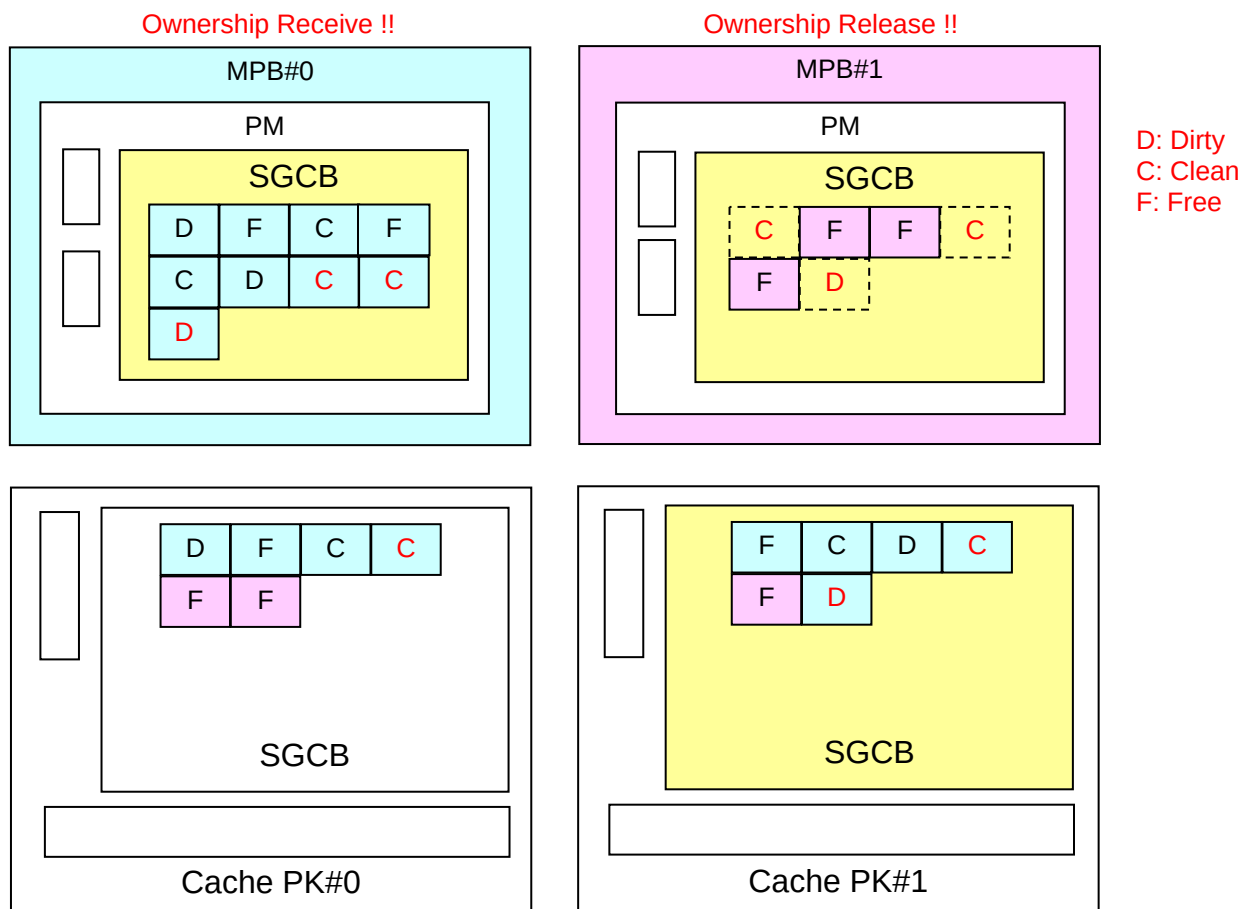


Fig. 3.7.4.8-2 MPB Replace (2)

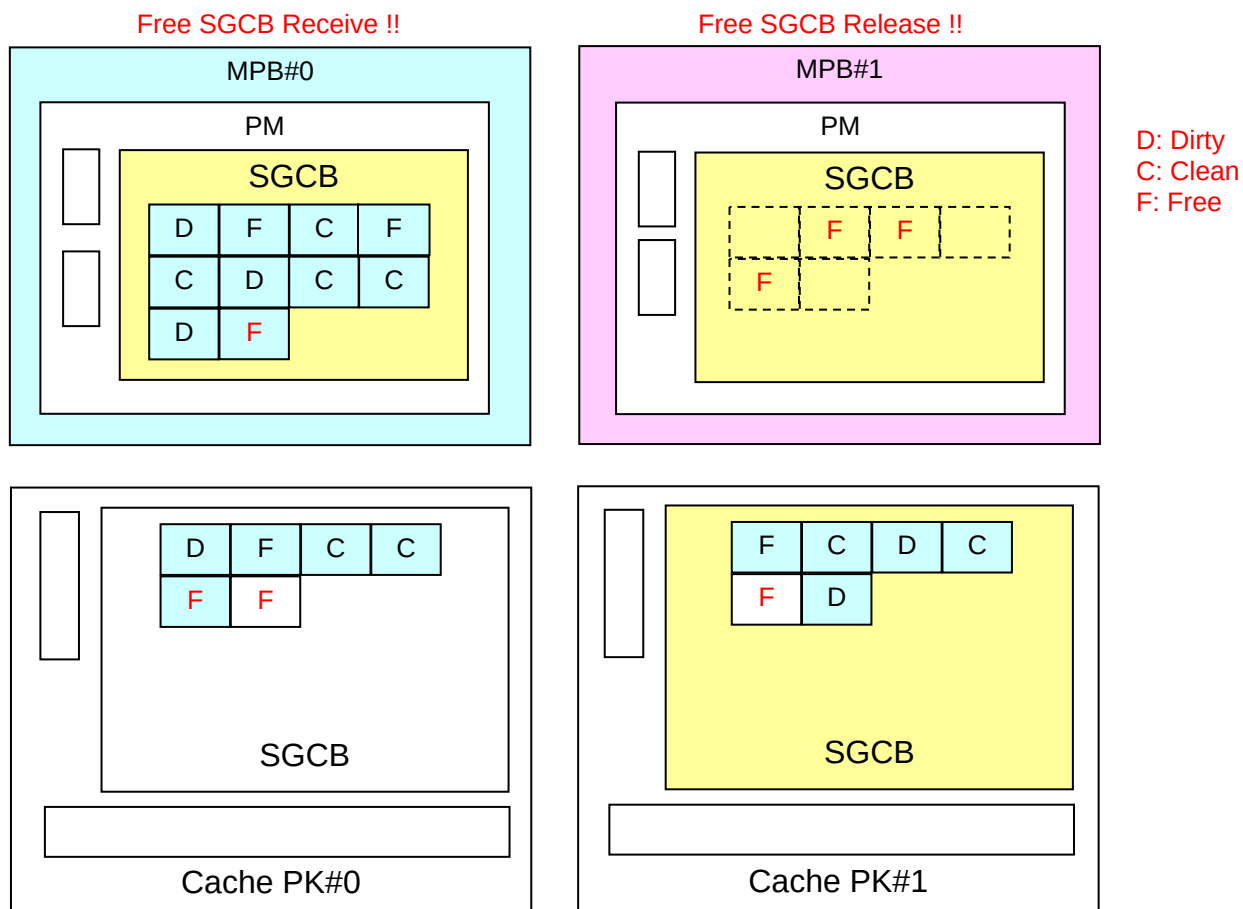


Fig. 3.7.4.8-3 MPB Replace (3)

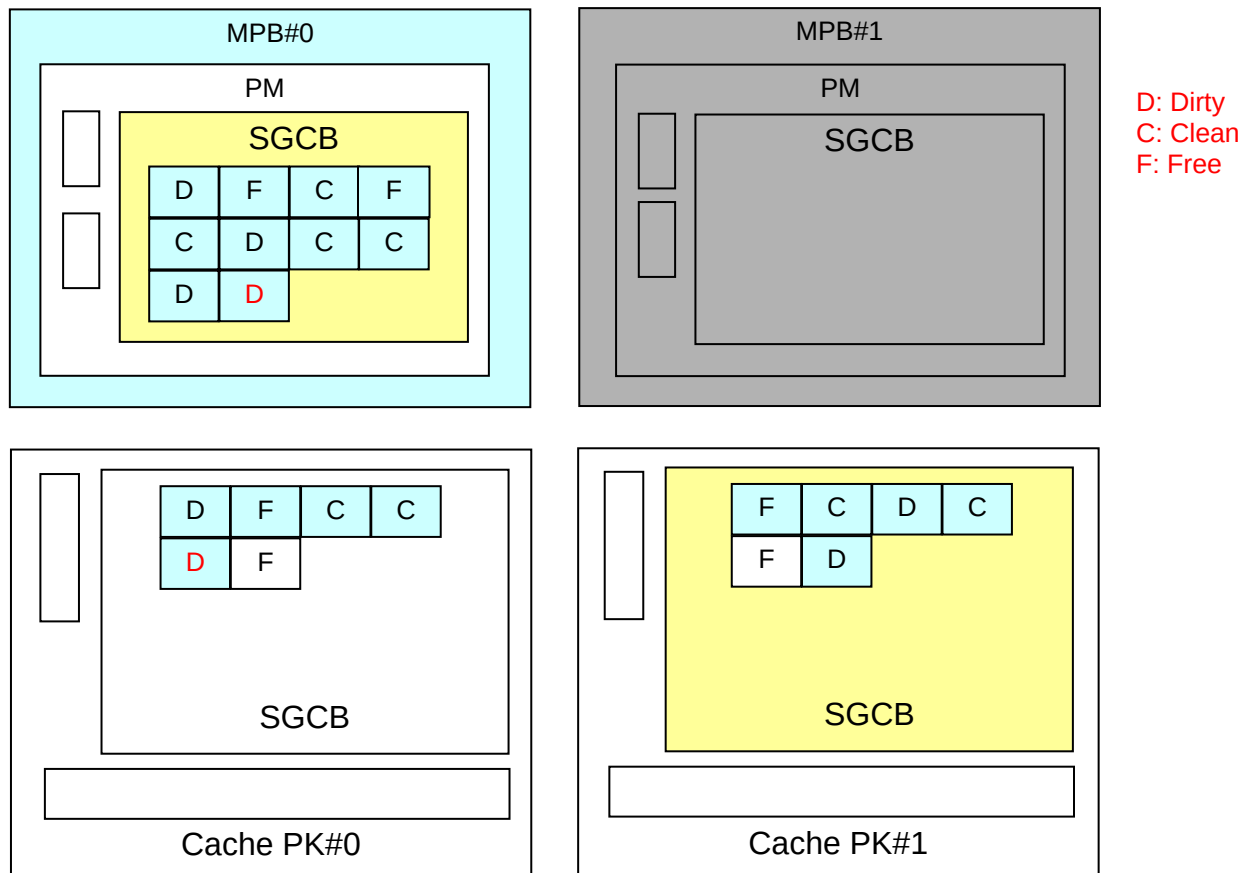


Fig. 3.7.4.8-4 MPB Replace (4)

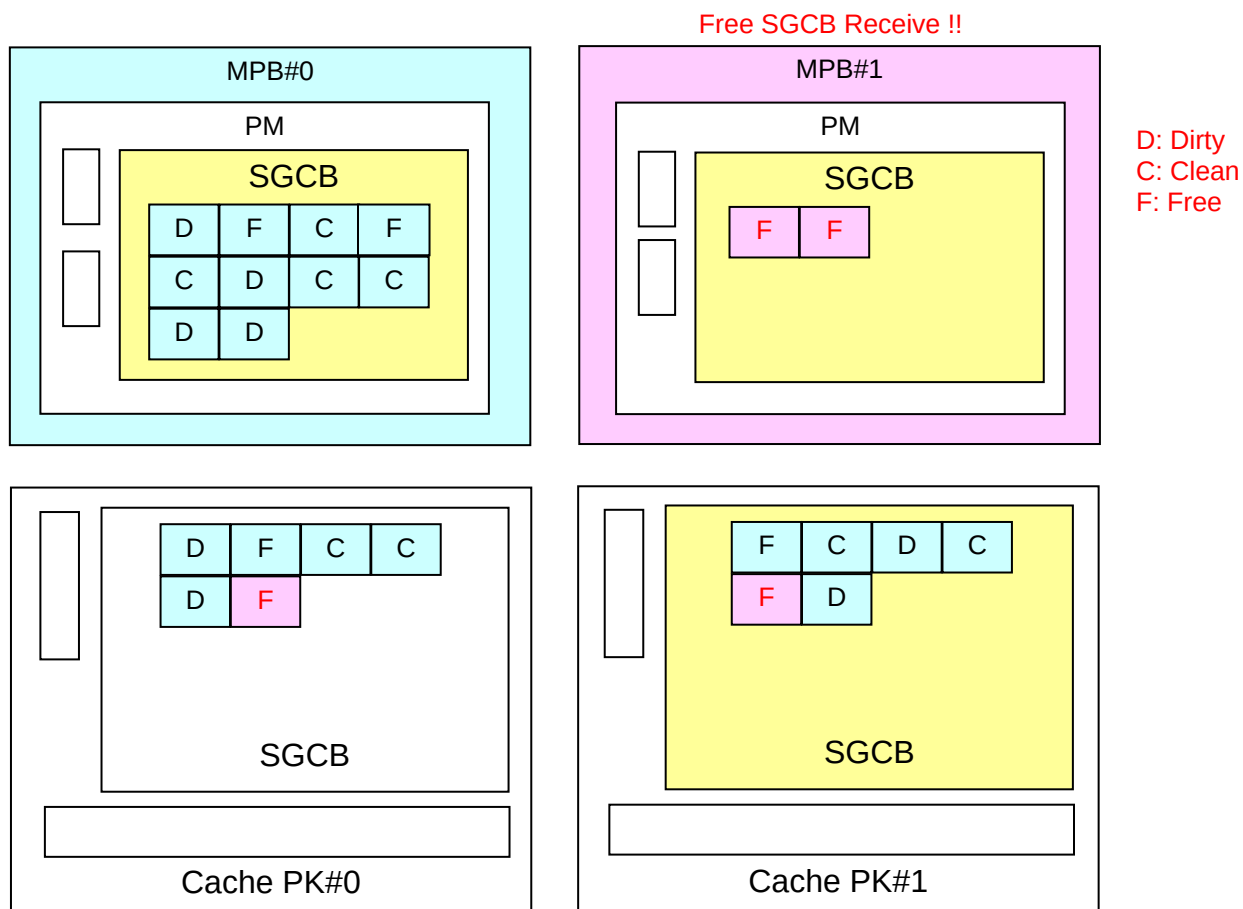


Fig. 3.7.4.8-5 MPB Replace (5)

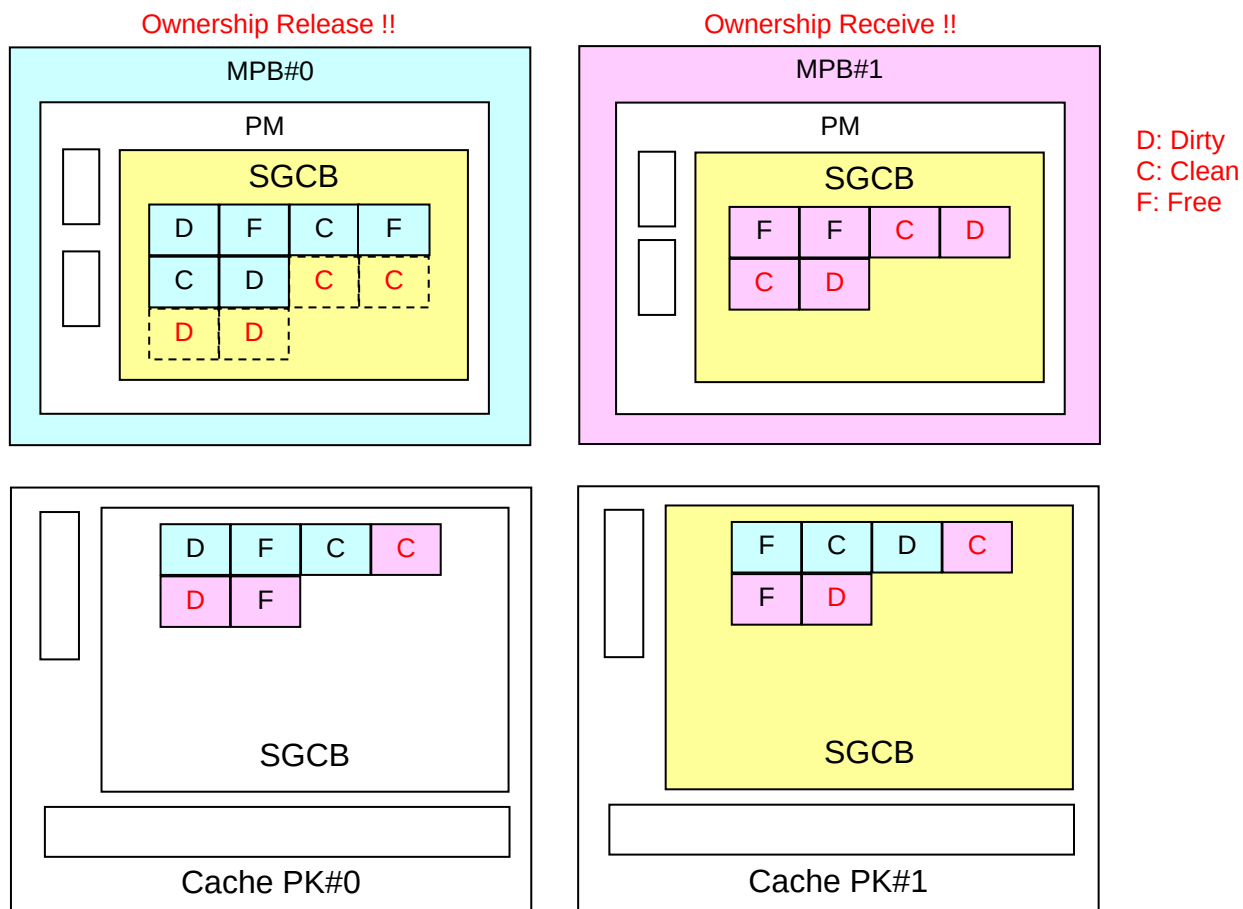


Fig. 3.7.4.8-6 MPB Replace (6)

3.7.4.9 Queue/Counter Control

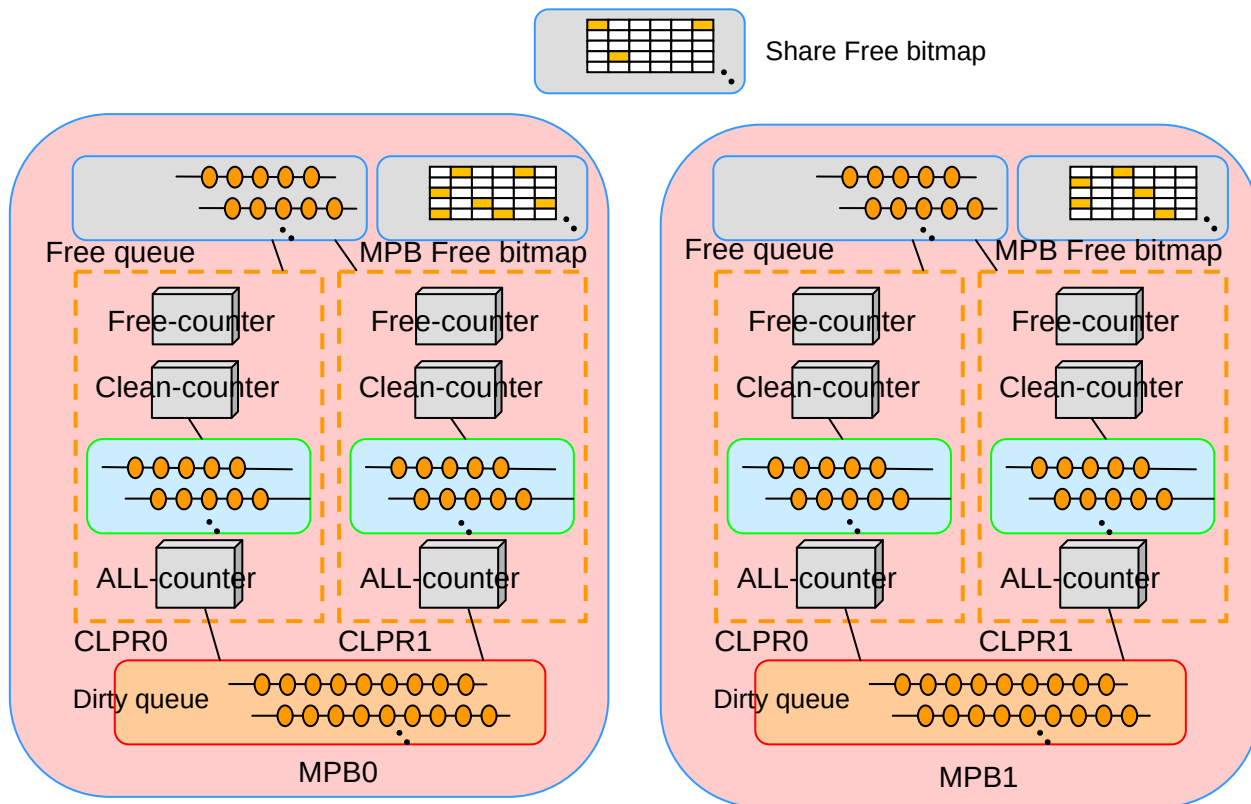


Fig. 3.7.4.9-1 Queue/Counter Control (1)

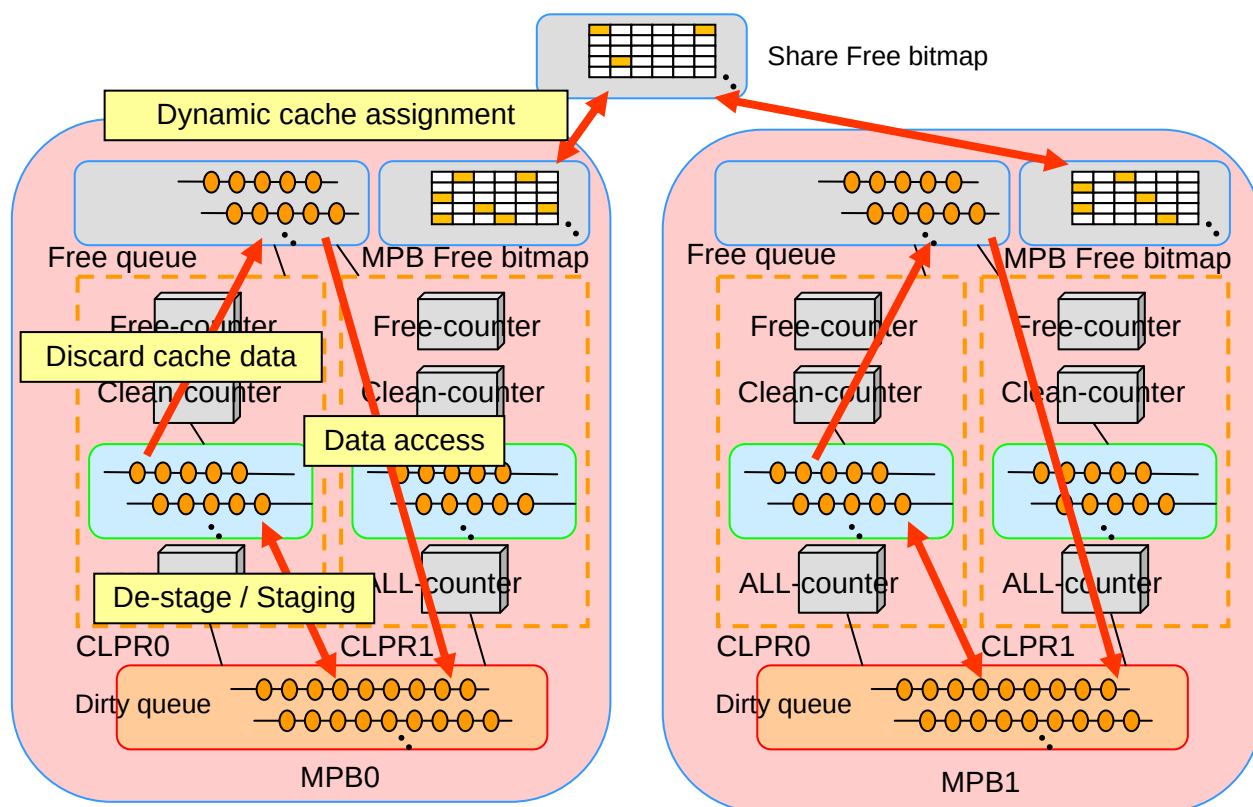


Fig. 3.7.4.9-2 Queue/Counter Control (2)

3.8 TrueCopy for Mainframe

3.8.1 TrueCopy for Mainframe Components

(1) TrueCopy for Mainframe Components

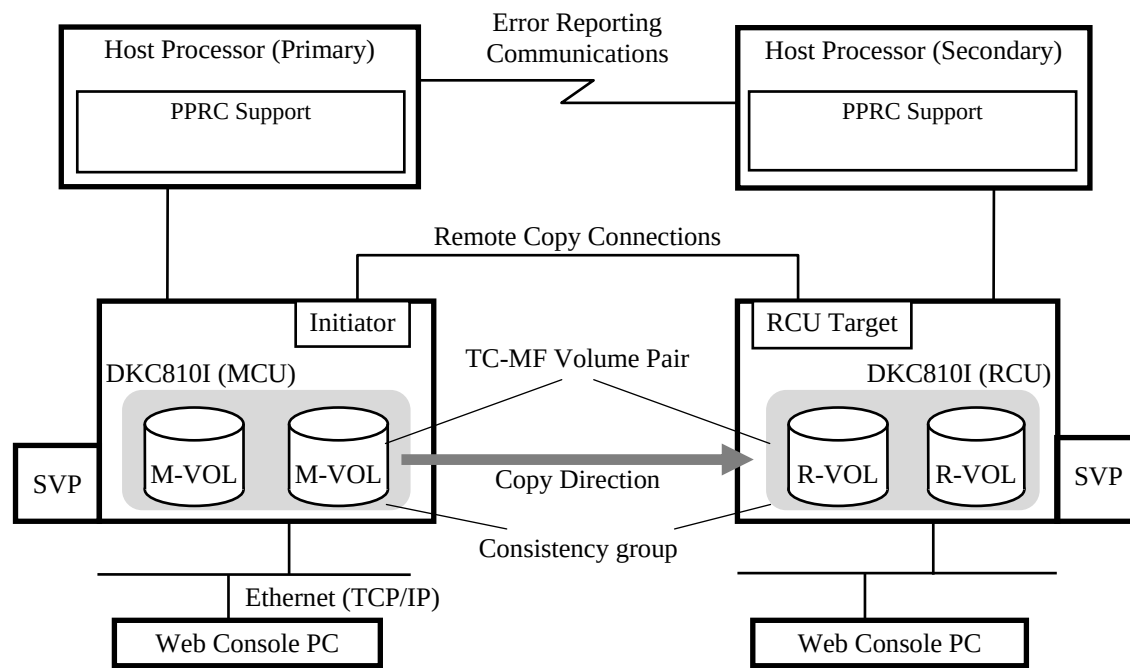


Fig. 3.8.1-1 TrueCopy for Mainframe Components for Fibre-Channel Interface Connection

(a) TrueCopy for Mainframe Volume Pair

An **TrueCopy for Mainframe volume pair** consists of two logical volumes, an M-VOL and an R-VOL, in different DKC810I storage system.

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

An **R-VOL** (remote volume) is a secondary or a mirrored volume. Under control of the DKC810I storage systems, contents of an M-VOL and updates from host processors are copied to an R-VOL. Read or write I/O operations from host processors to R-VOLs are rejected.

NOTE: R-VOL Read Only function

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

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

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

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

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

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

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

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

The M-VOLs of the TrueCopy for Mainframe volume pairs and the R-VOLs of other TrueCopy for Mainframe volume pairs can be intermixed in one DKC810I storage system.

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

(b) MCU and RCU

An **MCU** (main disk control unit) and an **RCU** (remote disk control unit) are disk control units in the DKC810I storage systems to which the M-VOLs and the R-VOLs are connected respectively.

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

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

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

(c) Remote Copy Connections

There Fibre channel interface of connection form.

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

(d) SVP and Web Console

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

A **Web Console** is a personal computer compatible with the PC/AT. It should be connected to DKC810I storage systems with an Ethernet network (TCP/IP). Several DKC810I storage systems can be connected with one Ethernet network.

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

(e) Error Reporting Communications

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

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

(f) PPRC Support

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

(g) Initiator Port

An **Initiator Port** (remote control port) is a Fibre Channel interface port to which an RCU is connected. Any Fibre Channel interface port of the DKC810I storage systems can be configured as an Initiator Port.

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

(h) RCU Target Port

An **RCU Target Port** (remote control port) is a Fibre Channel interface port to which an MCU is connected. Any Fibre Channel interface port of the DKC810I storage systems can be configured as an RCU Target Port.

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

TrueCopy for Mainframe operations from an SVP or a Web Console and the corresponding TSO commands are shown in Table 3.8.1-1. Before using TSO commands or DSF commands for PPRC, the serial interface ports to which the RCU(s) will be connected must be set to the Initiator mode. Table 3.8.1-2 shows the value of the SAID (system adapter ID) parameters required for CESTPATH command. For full description on TSO commands or DSF commands for PPRC, refer to the appropriate manuals published by IBM corporation.

Table 3.8.1-1 TrueCopy for Mainframe operations and corresponding TSO commands for PPRC

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

NOTE: Required Parameters

(How to setup LINK PARAMETER for CESTPATH command)

LINK PARAMETER

a	a	a	a	b	b	c	c

aaaa: SAID (refer to Table 3.8.1-2)

bb : destination address

cc : CUI# of RCU

Table 3.8.1-2 SAID (system adapter ID) required for CESTPATH command (1/2)

DKC-0

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

Table 3.8.1-2 SAID (system adapter ID) required for CESTPATH command (2/2)

DKC-1

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

- (i) DKC emulation type = 2107

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

3.8.2 TrueCopy for Mainframe Software Requirements

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

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

3.8.3 TrueCopy for Mainframe Hardware Requirements

(1) TrueCopy for Mainframe Supported models

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

- Emulation type of an MCU and RCU can be different.
- Emulation type of an M-VOL and R-VOL must be same.
- CVS/DCR is able to define on the M-VOL and R-VOL.
- The 2107 DKC emulation supports only 3390 DKU emulation.
- The R-VOL must have the same track sizes, and the same or larger volume capacities, as the M-VOL. (*1)
- When T-VOL of ShadowImage for Mainframe is established as M-VOL of TrueCopy for Mainframe, the T-VOL must be “Split” state. If not so, an equipment check error will occur in establishing TrueCopy for Mainframe pair.

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

① State of the storage system when executing the TrueCopy for Mainframe

All M-VOL data including the VTOC is physically copied by executing the TrueCopy for Mainframe. Accordingly, the R-VOL is recognized as having the same capacity as that of the M-VOL in the TrueCopy for Mainframe execution.

② Expansion of the VTOC (*2)

It is needed to expand the VTOC to make the R-VOL simplex and be accessed as having the normal capacity by the host. The VTOC is expanded by issuing the ICKDSF REFORMAT (REFVTOC) command.

*2: The system environment is required to support the REFVTOC parameter. This parameter can be executed only by the ICKDSF which supports the PPRC function.

(2) Web Station PC Requirements

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

(3) Distance between MCU and RCU

(a) Fibre channel interface connection

You must connect MCU and RCU with Optical Fibre cable.

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

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

Channel Extender Connects MCU and RCU with no distance restriction.

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

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

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

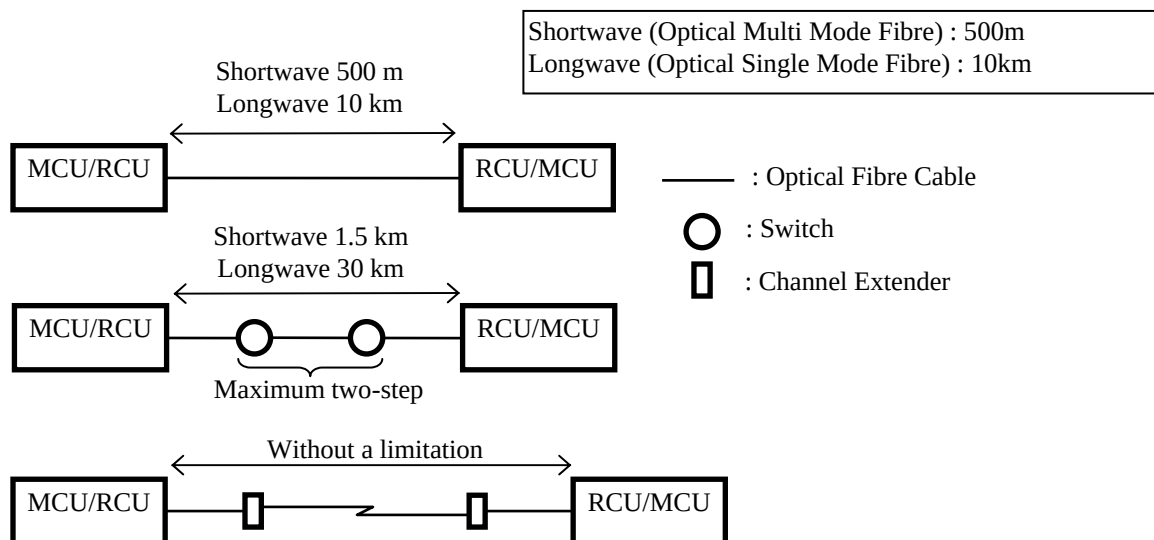


Fig. 3.8.3-1 Distance between Storage systems of Fibre channel interface connection

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

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

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

Appendix A: TrueCopy for Mainframe Installation check list

Table 3.8.3-1 TrueCopy for Mainframe Installation Check List

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

3.8.4 TrueCopy for Mainframe Theory of Operations

(1) TrueCopy for Mainframe Copy Activities

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

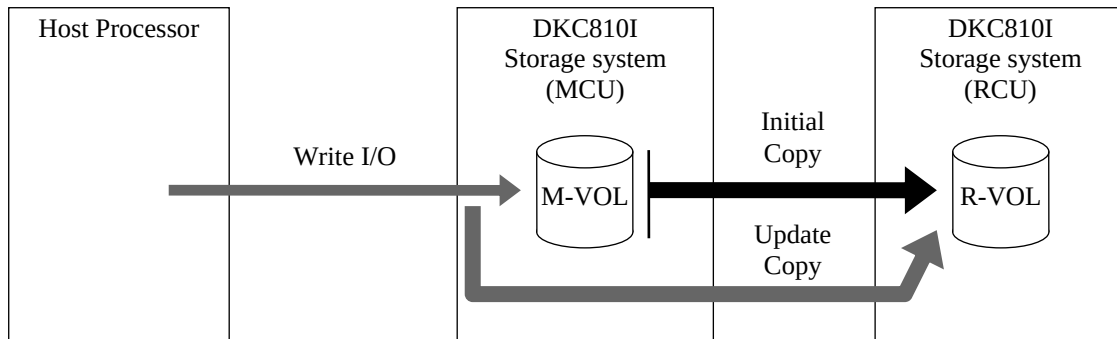


Fig. 3.8.4-1 TrueCopy for Mainframe Copy Activities

(a) Initial Copy

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

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

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

(b) Controlling Initial Copy

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

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

(c) Update Copy

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

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

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

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

(d) Update Copy for Cache Fast Write Data

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

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

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

In order to reduce overhead by the copy activities, TC-MF uses a special write command which is allowed only for copy activities between the DKC810I storage systems. The single write command transfers control parameters and an FBA formatted data which includes consecutive updated records in a track.

(2) TrueCopy for Mainframe Read I/O Operations

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

(3) TrueCopy for Mainframe Volume Pair Status

All volumes in a DKC810I storage system are in one of the states shown in Table 3.8.4-1.

Status of the M-VOLs or the R-VOLs are kept by the MCU and the RCU respectively. The MCU is responsible to keep status of the R-VOLs identical to status of the M-VOLs.

However, in the case of communication failure between the MCU and the RCU, they could be different.

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

Table 3.8.4-1 TrueCopy for Mainframe Volume Status

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

Table 3.8.4-2 TrueCopy for Mainframe Volume Status - Sub-status of Suspended Volume

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

3.8.5 TrueCopy for Mainframe Control Operations

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

(1) Add RCU Operation

(a) Fibre channel interface connection

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

Port Type	Fibre: Fiber channel interface is used for the connection of MCU and RCU.
Controller ID	But, set it up with '05' when RCU is DKC610I, and set it up with '06' when RCU is DKC710I. Default is '07' fixed.
RIO MIH Time	A data transfer complete waiting time to RCU from MCU. Usual: 15[Sec]. Avail. range: 10[Sec] ~ 100[Sec]
MCU Port	An Initiator port of the DKC810I storage system which setup a logic pass. You must setup a Fibre Channel interface port in Initiator port before this operation.
RCU Port	The Fibre Channel interface port of the place of the connection. You must specify a RCU target port.

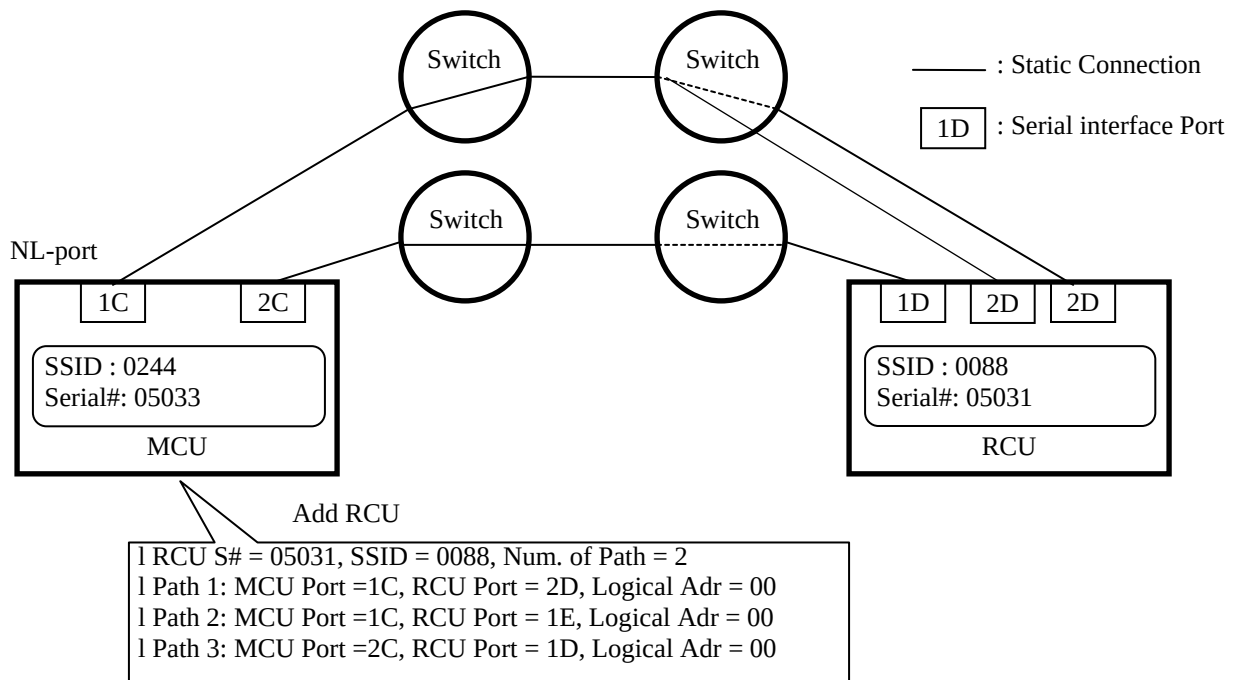


Fig. 3.8.5-1 Add RCU Operation

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

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

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

(2) Edit Path Operation

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

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

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

(3) RCU Option Operation

An RCU Option operation modifies the Remote Copy options described in “3.8.5(1) Add RCU operation”.

(4) Delete RCU Operation

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

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

(5) RCU Status Operation

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

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

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

(6) Add Pair Operation

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

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

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

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

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

(7) Delete Pair Operation

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

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

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

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

(8) Suspend Pair Operation

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

The option parameters for this operation are as follows:

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

(9) Pair Option Operation

A Pair Option operation modifies the Remote Copy option parameters which has been applied to the selected Remote Copy volume pair. Refer to “3.8.5(6) Add Pair Operation” for the option parameters.

(10) Pair Status Operation

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

Pair Synchronized	The value indicates the percent completion of the initial copy operation. This value is always 100% after the initial copy operation is complete. For a volume being queued, “Queuing” is displayed.
Pair Status	It indicates the status of the M-VOL or the R-VOL. Definition of the volume states is described in “3.8.4(3) TrueCopy for Mainframe Volume Pair Status”.
Last Update	Indicates the time stamp when the volume pair status has been updated. Note that the time stamp value is obtained from an internal clock in the DKC810I storage system.
Pair Established	It indicates the time stamp when the volume pair has been established by an Add Pair operation. Note that the time stamp value is obtained from an internal clock in the DKC810I storage system.

(11) Resume Pair Operation

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

“Out-of-Sync Cylinders” are recorded in the form of cylinder-bit-map allocated in SM (shared memory) of the DKC810I. If the MCU is powered off and the cylinder-bit-map is not retained due to the battery being discharged, the MCU resumes the initial copy as follows:

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

(12) Port Operation

(a) Fibre channel interface connection

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

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

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

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

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

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

(13) Remote Copy function Switch Operation

The Specification of a present function switches is displayed.

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

Number of function switches is 64.

This function is only SVP operation.

The function allocated in each switch is as follows.

00 ~ 06: Reserved.

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

08 ~10: Reserved.

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

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

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

13: Unused.

14: Reserved.

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

16: Reserved.

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

<The path failure threshold values>

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

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

19: Unused.

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

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

<The threshold value of RIO response time delay>

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

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

<Blockade of path less than minimum path>

Switch #43	Blockade of path
OFF	Not blocked
ON	blocked

- 44 ~ 63: Unused.

NOTE: Function switch 15, 17, 18, 20, 33, 41, 42, 43 are common in TC/TC-MF/GAD.
When configured, the configuration is effective in all functions of TC/TC-MF/GAD.

(14) Connection composition

Connection composition examples are shown below:

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

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

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

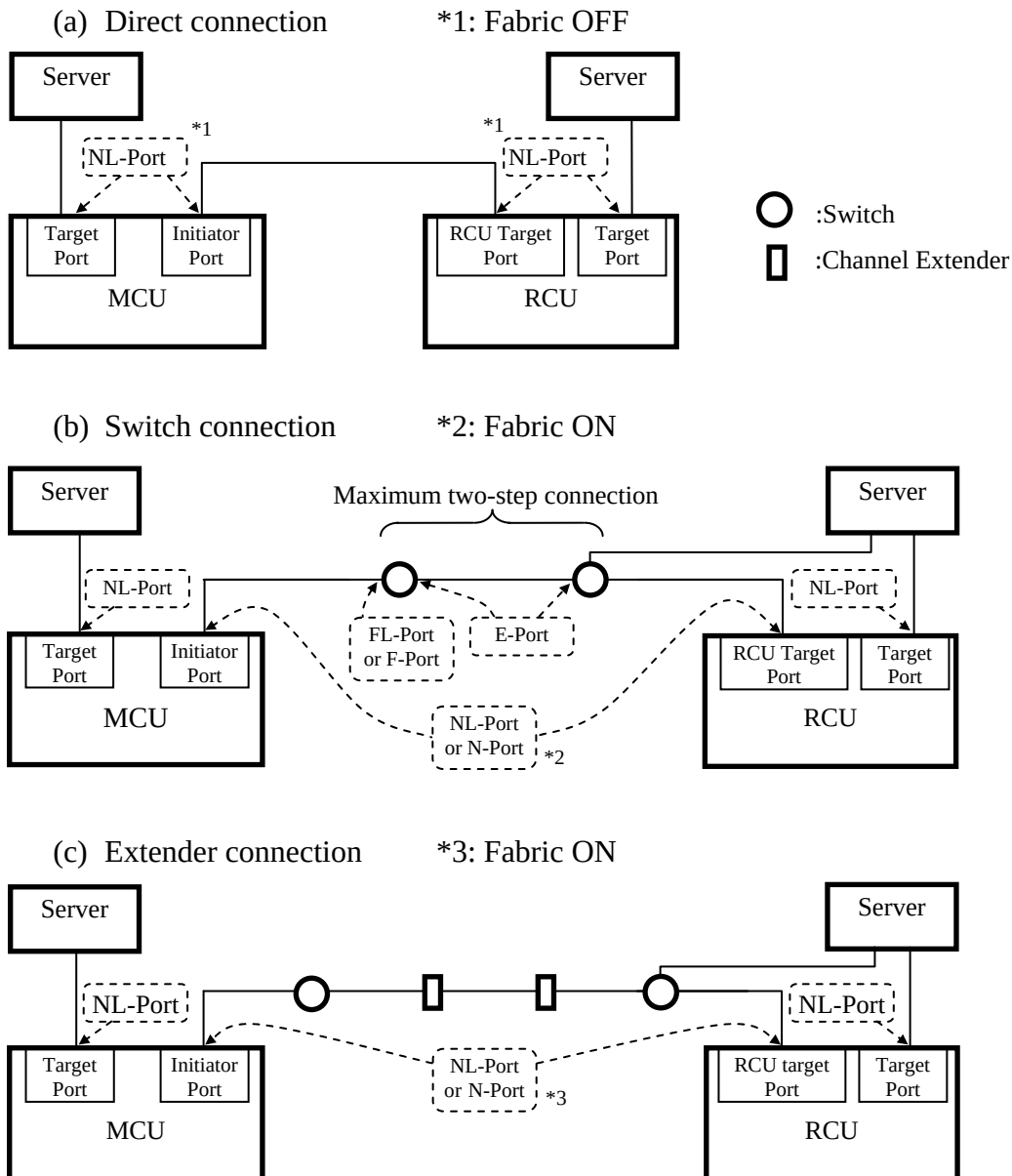


Fig. 3.8.5-2 Connection composition examples

3.8.6 Managing TrueCopy for Mainframe Environment

(1) Setting Up TrueCopy for Mainframe Volume Pairs

(a) Sequence of Operations

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

Table 3.8.6-1 Operations to Setup TrueCopy for Mainframe Volume Pairs

Step		Operation	
		SVP *	Others
1	Set appropriate Fibre interface ports to the Initiator mode.	Port	
2	Establish logical paths between the DKC810I TC-MF storage systems	Add RCU	Before this step, remote copy connections must be established between DKC810I storage systems.
3	Ensure that the R-VOLs are offline from host processors		If necessary, perform the following system command. <In case of MVS system> • VARY OFFLINE <In case of VM system> • VARY OFFLINE from guest OS • VARY PATH OFFLINE from VM
4	Establish TC-MF volume pairs.	Add Pair	

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

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

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

(b) Considering TrueCopy for Mainframe Parameters

Setting of the “fence level” parameter to the Add Pair operation and the “PPRC supported by host” and “Service SIM of Remote Copy” option to the Add RCU operation depends on your disaster recovery planning. Refer to “3.8.7(1) Preparing for Disaster Recovery” for these parameters.

Setting of the “CFW data” and “DFW to R-VOL” parameters to the Add Pair operation and the “minimum paths” parameter to the Add RCU operation depends on your performance requirement to the DKC810I storage system at the primary site. Refer to “3.8.5(6) Add Pair operation” and “3.8.5(1) Add RCU operation” for these parameters.

Setting of the “maximum initial copy activities” parameter to the Add RCU operation and the “priority” and the “initial copy pace” parameters can control performance effect from the initial copy activities. Refer to “3.8.6(1)(c) Controlling Initial Copy Activities” for more detailed description.

Refer to “3.8.5(1) Add RCU operation” and “3.8.5(6) Add Pair operation” for other parameters.

(c) Controlling Initial Copy Activities

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

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

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

Example

Conditions:

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

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

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

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

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

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

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

Refer to “3.8.5(8) Suspend Pair Operation” and “3.8.5(6) Add Pair Operation” for more detailed description.

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

(a) Cutting Power to TrueCopy for Mainframe component

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

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

Refer to “3.8.6(2) Suspending and Resuming the TC-MF Volume Pairs” for the operations to suspend and resume the TC-MF volume pairs.

(b) Power Control Interface at the Secondary Site

In the secondary site, It is not recommended to use the power control interface which remotely cuts the power to the RCU or the Switch/Extender on the remote copy connections in order to avoid the situation described in “3.8.6(3)(a) Cutting Power to TrueCopy for Mainframe components”.

(c) Power-on-sequence

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

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

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

(4) Executing ICKDSF to TrueCopy for Mainframe Volume Pairs

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

Refer to “3.8.6(2) Suspending and Resuming the TrueCopy for Mainframe Volume Pairs” for the operations to suspend and resume the TC-MF volume pairs.

3.8.7 TrueCopy for Mainframe Error Recovery

(1) Preparing for Disaster Recovery

(a) Considering Fence Level Parameter

Table 3.8.7-1 shows how the fence level parameter of the Add Pair operation has an effect on the write I/O operations to the M-VOL after the TC-MF volume pair has been suspended. You should select one of the fence level considering the “degree of the currency” of the R-VOL required by your disaster recovery planning. The SVP or Web Console, which is connected to either the MCU or the RCU, can display the fence level parameter which has been set to the TC-MF volume pairs.

Table 3.8.7-1 Effect of the Fence Level Parameter

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

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

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

1) Fence Level = “Data”

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

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

Most of the database system supports duplexing the critical files, for example log files of DB2, for its file recovering capability. It is recommended to locate the duplexed files on the volumes in the physically separated DKC810I storage systems, and establish TC-MF volume pairs for each volumes by using physically separated remote copy connections.

NOTE1: If the failure has occurred before completing the initial copy, the R-VOL cannot be used for disaster recovery because the data of the R-VOL is not fully consistent yet. You can become aware of this situation with referring status of the R-VOL in your disaster recovery procedures. Refer to “3.8.7(2)(b) Analyzing the Currency of R-VOLs” for more detailed description.

NOTE2: Only the difference between the TC-MF volume pair must be the last update from the host processor. TC-MF is a synchronous remote copy. The MCU reports a “unit check” if it detects the failure on the write I/O operation including the update copy to the R-VOL. Therefore, the operating system and the application program does not regard the last (failed) I/O operation as successfully completed.

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

2) Fence Level = Never

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

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

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

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

3) Fence Level = Status

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

(b) Transferring the Sense Information through Error Reporting Communications

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

The sense information can be selected out of:

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

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

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

(c) File Recovery Procedures Depending on Installations

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

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

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

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

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

(d) CSUSPEND/QUIESCE for IBM PPRC

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

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

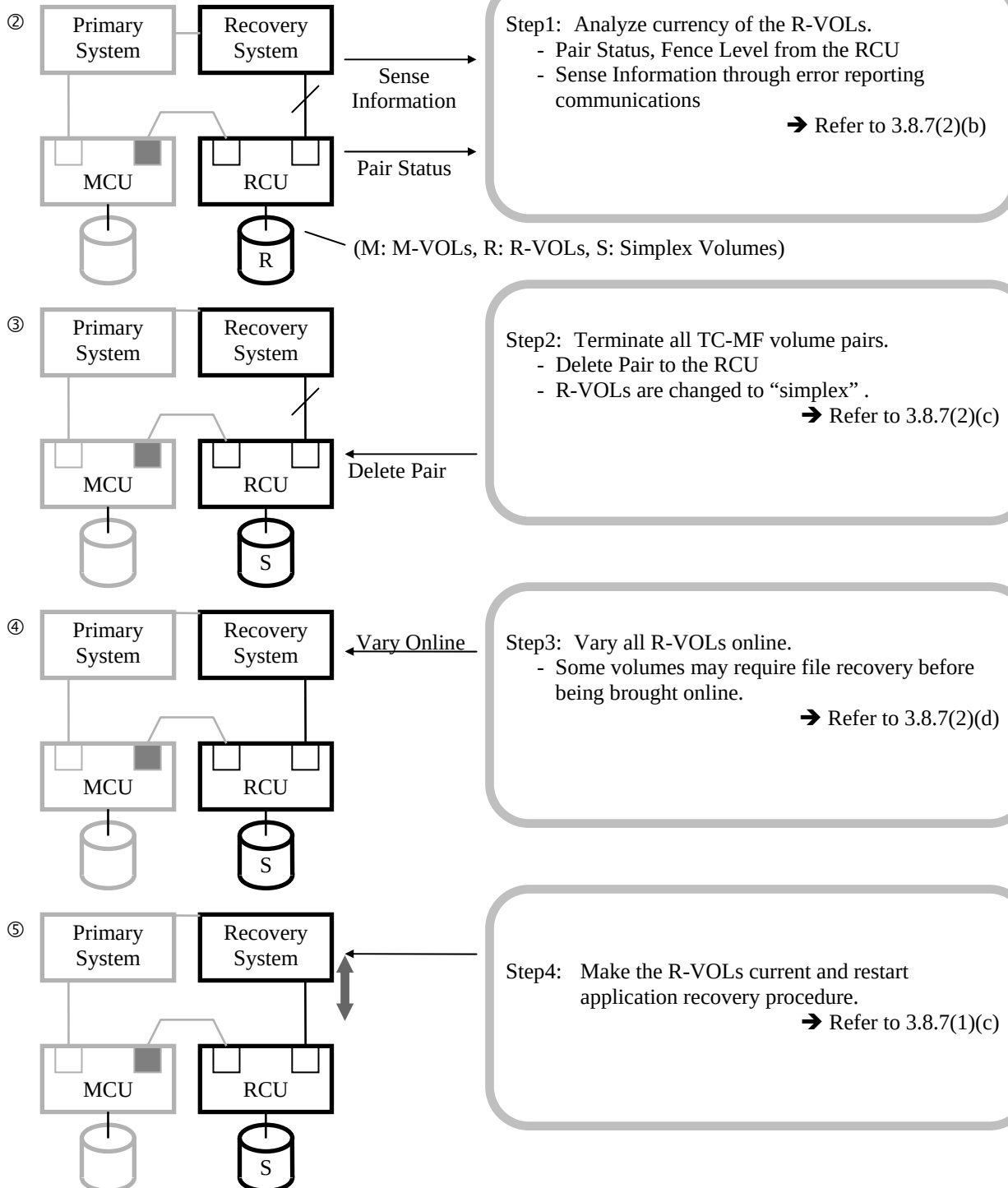
(e) All SIM of the TrueCopy for Mainframe clear option

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

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

(a) Summary

① Primary system and MCU becomes inoperable due to disaster.



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

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

Table 3.8.7-2 Currency of the R-VOLs

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

Table 3.8.7-2 shows how to analyze the currency of the R-VOLs referring the status of the R-VOLs and the fence level parameter which have been specified when establishing the TC-MF volume pairs.

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

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

The meaning of the results or further actions shown in each column of Table 3.8.7-2 are as follows:

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

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

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

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

Suspected

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

2) Further Analysis by Referring to Other Information

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

- The sense information through the error reporting communications. If the sense information which denote the suspension of this volume is found, you can return to Table 3.8.7-2 with assumption of the “suspended” state.
- The status of the M-VOL obtained from the MCU, if possible. You should return to Table 3.8.7-2 with assumption of the same status as the M-VOL and fence level of “Status”.
- The other related files, for example DB2 log files, which have been confirmed to be current.

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

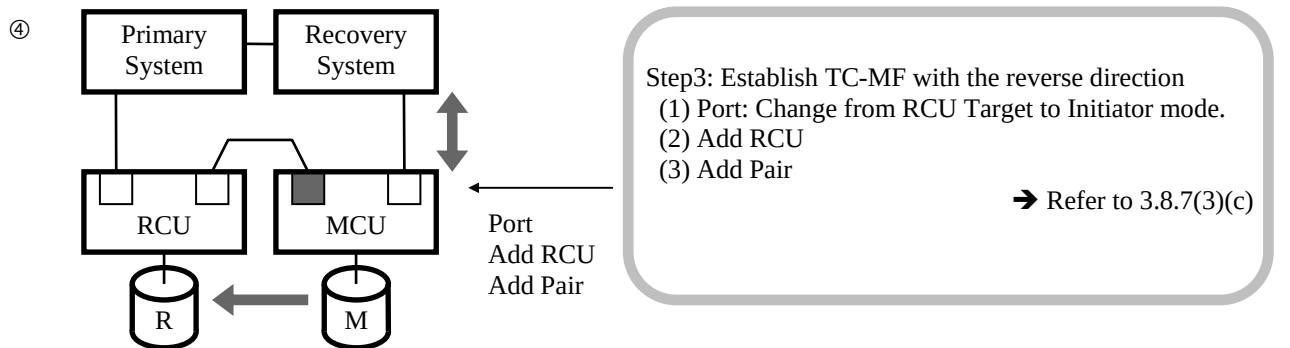
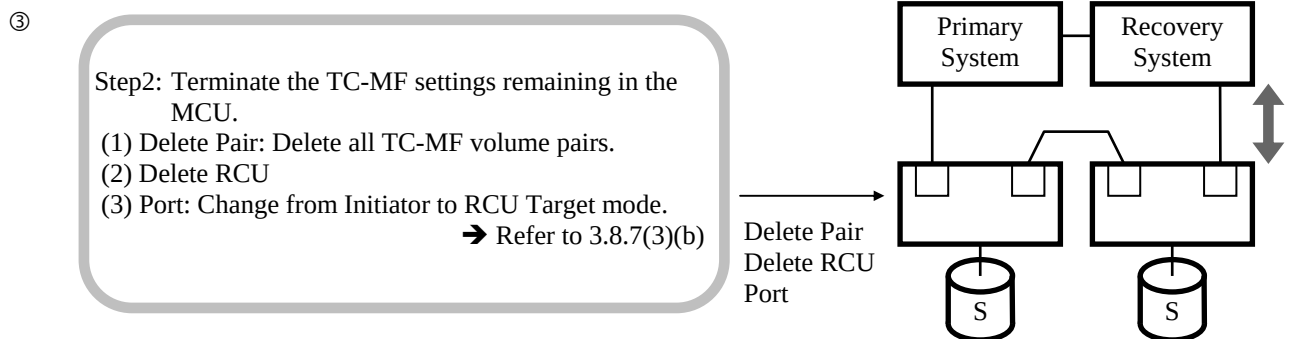
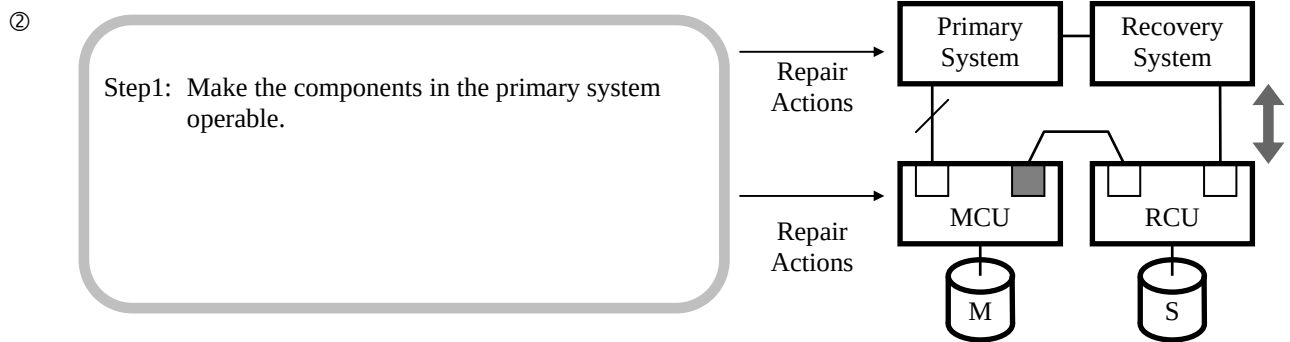
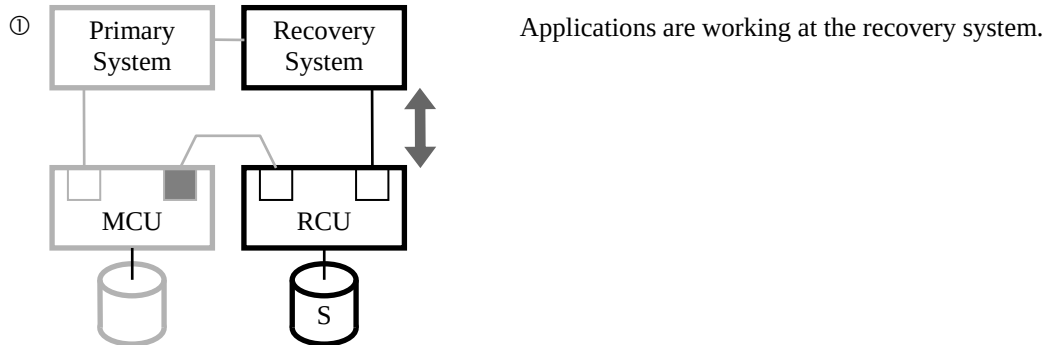
The “Delete Pair” operation to the RCU terminates the specified TC-MF volume pairs. These R-VOLs will be changed to “simplex” state. Specified “Delete Pair by Force” option and “Delete All Pairs” option the all volume pairs in the same serial number of the MCU and the same CU image of the MCU should be deleted. Refer to “3.8.5(7) Delete Pair Operation”.

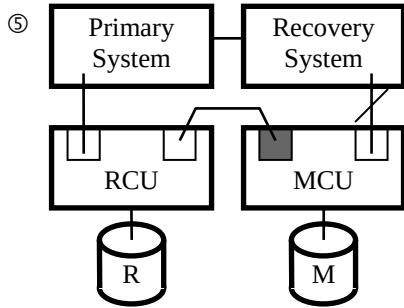
(d) Vary all R-VOLs online (Step 3)

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

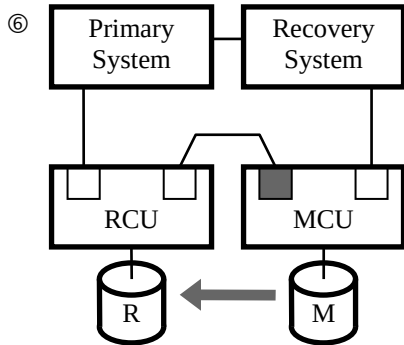
(3) Disaster Recovery Procedures - Returning to the Primary Site

(a) Summary

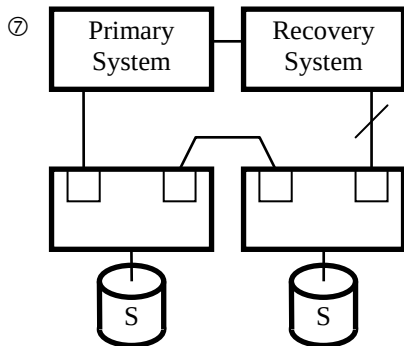




Step4: Halt related applications and vary all M-VOLs offline from the recovery system.



Step5: Confirm all TC-MF volume pairs become "duplex" state.



Step6: Terminate all TC-MF settings.

(1) Delete Pair: Delete all TC-MF volume pairs.

(2) Delete RCU

(3) Port: Change from Initiator to RCU Target mode.

→ Refer to 3.8.7(3)(d)

⑧

Step7: Establish TC-MF pair with the original direction and start applications.

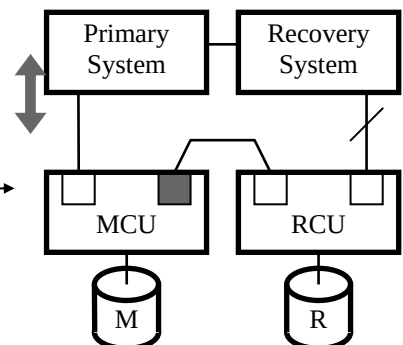
(1) Port: Change from RCU Target to Initiator mode.

(2) Add RCU

(3) Add Pair

→ Refer to 3.8.7(3)(e)

Port
Add RCU
Add Pair



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

After the DKC810I storage system becomes operable, the remaining registration of the TC-MF volume pairs and the RCU should be deleted by performing the Delete Pair operation and Delete RCU operation respectively.

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

Note that the status of M-VOLs may be “Suspended (Delete Pair to RCU)” because of Delete Pair operation issued to the RCU in step 2 of “3.8.7(2) Disaster Recovery Procedures - Switching to the Recovery System”. It is normal condition in this situation.

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

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

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

The TC-MF volume pair should be established with the reverse direction to synchronize the original M-VOLs with the original R-VOLs. The procedures for this step are same as those described in “3.8.6(1) Setting Up TC-MF Volume Pairs”. Note that the DKC810I storage systems in the original primary site and the recovery site are treated as the RCUs/R-VOLs and the MCUs/M-VOLs respectively.

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

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

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

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

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

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

The TC-MF volume pair should be established with the original direction to synchronize the original M-VOLs with the original R-VOLs. The procedures for this step are same as those described in “3.8.6(1) Setting Up TC-MF Volume Pairs”.

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

3.9 ShadowImage for Mainframe & ShadowImage

3.9.1 Overview

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

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

(1) Main object

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

(2) Function Outline

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

Table 3.9.1-1 Outline of ShadowImage for Mainframe & ShadowImage

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

(To be continued)

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

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

(Continued from the preceding page)

No.	Items	Specification
11	Cooperation with TrueCopy	SI : Supported The master volume of SI can be an M-VOL or R-VOL of TC. • TC volumes are shared with Universal Replicator volumes can't be SI pair volumes.
	Cooperation with TrueCopy (only for ShadowImage)	Supported • The M-VOL or R-VOL of TC can be a primary volume of SI. • The secondary volume of SI-MF can be an M-VOL of TC. • TC volumes are shared with Universal Replicator volumes can be SI pair volumes.
12	Cooperation with Volume Migration	Supported • When SI-MF/SI pair which is combined with Volume Migration is split, the migration of Volume Migration is canceled.
13	Cooperation with Universal Replicator (only for ShadowImage)	Supported • Universal Replicator volumes (primary / secondary) can be a primary volume of SI. • The secondary volume of SI can be Universal Replicator volumes (primary / secondary). • The journal volume of Universal Replicator can't be a primary or secondary volume of SI. • Universal Replicator volumes are shared with TC volumes can be SI pair volumes.

(To be continued)

(Continued from the preceding page)

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

(To be continued)

(Continued from the preceding page)

No.	Items	Specification
18	Consistency group pair-split (ShadowImage/ShadowImage for Mainframe) performed through RAID Manager	This is a function for SI/SI-MF pairs in a consistency group that creates the primary volume data onto the secondary volume at the execution time of the Pairsplit command through Command Control Interface (CCI) software from the UNIX[®]/PC server host to the 9900V storage system. NOTE: For further information on Command Control Interface, refer to “Hitachi Command Control Interface User and Reference Guide”. An SI/SI-MF consistency group is a user-defined set of SI/SI-MF volume pairs used for this function. Users can define a consistency group for this function through CCI on the UNIX[®]/PC server host. SI/SI-MF consistency groups correspond to the groups registered in the CCI configuration definition file. SI/SI-MF consistency groups have the following restrictions: • You can configure up to 128 SI/SI-MF consistency groups in a storage system. • A number (0 to 7F) is assigned to each consistency group. You can specify a consistency group number when you create SI pairs. If you do not specify a number, then the 9900V storage system assigns a number automatically. • You can define up to 8,192 SI pairs in a consistency group. • SI pair and SI-MF pair cannot coexist in one consistency group. • SI/SI-MF consistency groups need to be configured through CCI software. However, to confirm SI/SI-MF consistency group numbers for each pair, you can also use Storage Navigator.

(To be continued)

(Continued from the preceding page)

No.	Items	Specification									
19	Consistency group pair-split (ShadowImage for Mainframe) performed through Business Continuity Manager or PPRC	To use this function, Business Continuity Manager or PPRC is required. This function performs one of the copy operations shown in the following table using Business Continuity Manager or PPRC for multiple SI-MF pairs that belong to the same consistency group. User needs to configure consistency groups for this function through Storage Navigator before creating a pair. Table: Consistency group pair-split performed through Business Continuity Manager or PPRC <table> <tr> <th>Copy</th><th>Business Continuity Manager</th><th>PPRC</th></tr> <tr> <td>Create the primary volume data at the specified time onto the secondary volume</td><td>Possible</td><td>Impossible</td></tr> <tr> <td>Create the primary volume data at the execution time of a Split operation onto the secondary volume</td><td>Possible</td><td>Impossible</td></tr> </table> Possible : Operation can be performed Impossible : Operation cannot be performed - You can configure up to 128 SI/SI-MF consistency groups in a storage system. - A number (0 to 7F) is assigned to each consistency group. - You can specify a consistency group number when you create SI pairs. - To confirm SI-MF consistency group numbers for each pair, you can use Storage Navigator, PPRC command, or Business Continuity Manager. - You can define up to 8,192 SI pairs in a consistency group. - SI pair and SI-MF pair cannot coexist in one consistency group.	Copy	Business Continuity Manager	PPRC	Create the primary volume data at the specified time onto the secondary volume	Possible	Impossible	Create the primary volume data at the execution time of a Split operation onto the secondary volume	Possible	Impossible
Copy	Business Continuity Manager	PPRC									
Create the primary volume data at the specified time onto the secondary volume	Possible	Impossible									
Create the primary volume data at the execution time of a Split operation onto the secondary volume	Possible	Impossible									
20	The maximum number of pairs	The maximum number of pairs is as follows. The maximum number of pairs is the sum of the numbers of pairs of the SI-MF, SI and Volume Migration.									

(1) Calculating Maximum Number of Pairs

When you create ShadowImage pairs, resources called differential tables, pair tables will be required. The number of available differential tables, pair tables in one storage system depends on whether the additional shared memory is installed or not. There are several patterns of additional shared memory for differential tables, pair tables, and you can choose any pattern you like. Table 3.9.1-2 shows the pattern of additional shared memory.

Table 3.9.1-2 Additional Shared Memory for Differential Tables, Pair Tables

Additional Shared Memory for Business Copy	Number of Differential Tables	Number of Pair Tables	Number of System Volumes
Base (No additional shared memory)	57,600	8,192	16,384
Extension	419,200	32,768	65,536

NOTE:

- To install additional shared memory for differential tables, please call the Support Center.
- Even if you install additional shared memory for differential tables, pair tables, the maximum number of pairs is half of the total number of volumes in the storage system (see Table 3.9.1-2). For example, in case of “Base (No additional shared memory)” in Table 3.9.1-2, when P-VOLs and S-VOLs are in a one-to-one relationship, you can create up to 8,192 pairs. However, note that in case of “Extension”, the maximum number of pairs is 32,768 regardless of the total number of volumes in the storage system.

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

The following program products use differential tables

- ShadowImage for z/OS
- Volume Migration

The following program products use pair tables

- ShadowImage for z/OS
- Volume Migration

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

For information about how to calculate the number of differential tables and pair tables that are required for ShadowImage for z/OS, refer to “Hitachi ShadowImage for Mainframe User Guide”. Also, refer to “Volume Migration Use Guide” to calculate the number of differential tables and pair tables that are required for Volume Migration.

Assuming that only ShadowImage uses differential tables, pair tables, this section describes how to calculate the number of differential tables, 1 pair table required for one ShadowImage pair, and the conditions you need to consider when calculating the number of ShadowImage pairs that can be created.

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

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

When you create a ShadowImage pair, the number of required differential tables, 1 pair table will change according to the emulation type of the volumes. To calculate the number of differential tables, pair tables required for a pair according to the emulation type, use the expression in Table 3.9.1-3.

Table 3.9.1-3 The Total Number of the Differential Tables Per Pair

Emulation Type	Expression
OPEN-3	Total number of the differential tables per pair = $((X) \div 48 + (Y) \times 15) \div (Z)$ (X): The capacity of the volume. (KB) (*1) (Y): The number of the control cylinders. (See Table 3.9.1.1-4) (Z): 20,448 (The number of the slots that can be managed by a differential table)
OPEN-8	
OPEN-9	Note that you should round up the number to the nearest whole number. For example, if the emulation type of a volume is OPEN-3, and when provided that the number of the cylinders of the divided volume is 2,403,360 KB ((X) in the expression above), the calculation of the total number of the differential tables is as follows. $(2,403,360 \div 48 + 8 \times 15) \div 20,448 = 2.4545...$ When you round up 2.4545 to the nearest whole number, it becomes 3. Therefore, the total number of the differential tables for one pair is 3 when emulation type is OPEN-3. In addition, 1 pair tables per 36 differential tables is used. The number of pair tables used for above-mentioned OPEN-3 becomes 1.
OPEN-E	
OPEN-L	
OPEN-V	Total number of the differential tables per pair = $((X) \div 256) \div (Z)$ (X): The capacity of the volume. (KB) (Z): 20,448 (The number of the slots that can be managed by a differential table) Note that you should round up the number to the nearest whole number. For example, if the emulation type of a volume is OPEN-V, and when provided that the number of the cylinders of the divided volume is 3,019,898,880 KB ((X) in the expression above), the calculation of the total number of the differential tables is as follows. $(3,019,898,880 \div 256) \div 20,448 = 576.9014...$ When you round up 576.9014 to the nearest whole number, it becomes 577. Therefore, the total number of the differential tables for one pair is 577 when emulation type is OPEN-V. In addition, 1 pair tables per 36 differential tables is used. The number of pair tables used for above- mentioned OPEN-V becomes 17. The emulation type of the case to use the two or more pair tables with the open system is only OPEN-V.

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

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

Table 3.9.1-4 The Number of the Control Cylinders According to the Emulation Types

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

(1-2) Conditions for the Number of ShadowImage Pairs that can be Created

This section describes how to calculate the number of ShadowImage pairs.

You can use the following equation to find out whether the desired number of ShadowImage pairs can be created.

NOTICE: You need to meet the inequation below:

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

and

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

- (α) : The required number of differential tables per pair.

(α) changes according to the emulation type. For information about how to calculate (α) , see Table 3.9.1-3.

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

If an additional shared memory for differential tables is not installed, (β) is 57,600. If an additional shared memory for differential tables is installed, see Table 3.9.1-2.

- (γ) : The required number of pair tables per pair.

Value of (γ) changes according to the (α) . For information about how to calculate (γ) , see Table 3.9.1-3.

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

If an additional shared memory for pair tables is not installed, (δ) is 8,192. If an additional shared memory for pair tables is installed, see Table 3.9.1-2.

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

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

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

$$3 \times 10 + 577 \times 20 = 11,570 \leq 57,600$$

and

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

Since 11,570 is smaller than 57,600, you can see that 10 pairs of OPEN-3 volumes and 20 pairs of OPEN-L volumes can be created.

(2) Calculating Maximum Number of Pairs

When you create SIz pairs, resources called differential tables, pair tables will be required. The number of available differential tables, pair tables in one storage system depends on whether the additional shared memory is installed or not. There are several patterns of additional shared memory for differential tables, pair tables, and you can choose any pattern you like. Table 3.9.1-5 shows the pattern of additional shared memory.

Table 3.9.1-5 Additional Shared Memory for Differential Tables, Pair Tables

Additional Shared Memory for Business Copy	Number of Differential Tables	Number of Pair Tables	Number of System Volumes
Base (No additional shared memory)	57,600	8,192	16,384
Extension	419,200	32,768	65,536

NOTE:

- To install additional shared memory for differential tables, please call the Support Center.
- Even if you install additional shared memory for differential tables and pair tables, the maximum number of pairs is half of the total number of volumes in the storage system (see Table 3.9.1-5). For example, in case of “Base (No additional shared memory)” in Table 3.9.1-5, when S-VOLs and T-VOLs are in a one-to-one relationship, you can create up to 8,192 pairs. However, note that in case of “Extension”, the maximum number of pairs is 32,768 regardless of the total number of volumes in the storage system.

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

The following program products use differential tables

- ShadowImage
- Volume Migration

The following program products use pair tables

- ShadowImage
- Volume Migration

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

For information about how to calculate the number of differential tables and pair tables that are required for ShadowImage, refer to “Hitachi ShadowImage (R) User Guide”.

Also, refer to “Volume Migration Use Guide” to calculate the number of differential tables and pair tables that are required for Volume Migration.

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

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

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

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

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

(Y): The number of the control cylinders. (See Table 3.9.1-6)

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

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

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

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

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

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

Table 3.9.1-6 The Number of the Control Cylinders According to the Emulation Types (1/2)

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

Table 3.9.1-6 The Number of the Control Cylinders According to the Emulation Types (2/2)

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

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

This value is used to calculate the number of differential table for a pair of ShadowImage for Mainframe.

If you intend to create pairs with volumes of different emulation types, the maximum number of pairs you can create will depend on the following conditions.

NOTE: For details about the calculation of the total number of the differential tables, pair tables per a pair, see the expression described just before Table 3.9.1-6.

The maximum number of pairs that you can create is the largest number that meets the inequation below :

$$\Sigma (\alpha) \leq (\beta)$$

and

$$\Sigma (\gamma) \leq (\delta)$$

$\Sigma (\alpha)$ stands for the total number of differential tables per pair (see Table 3.9.1-6), and (β) stands for the number of differential tables available in the storage system.

$\Sigma (\gamma)$ stands for the total number of pair tables per pair (see Table 3.9.1-6), and (δ) stands for the number of pair tables available in the storage system.

(β) is 57,600 when an additional shared memory for differential tables is not installed. If an additional shared memory for differential tables is installed, see Table 3.9.1-5 for (β) .

(δ) is 57,600 when an additional shared memory for pair tables is not installed. If an additional shared memory for pair tables is installed, see Table 3.9.1-5 for (δ) .

For example, if you are to create 10 pairs of 3390-3 volumes and 20 pairs of 3390-L volumes in a storage system that is not installed with an additional shared memory for differential tables, pair tables, the following equation would be used to calculate $\Sigma (\alpha)$, $\Sigma (\gamma)$:

$$(3 \times 10) + (24 \times 20) = 510.$$

and

$$(1 \times 10) + (1 \times 20) = 30$$

Since 510 is smaller than 57,600, it meets the equation, $\Sigma (\alpha) \leq (\beta)$, thus ensuring you that 10 pairs of 3390-3 volumes and 20 pairs of 3390-L volumes can be created.

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In case of ShadowImage for Mainframe/ShadowImage volume is selected for Volume Migration volume

	P-VOL	S-VOL	RootVOL	NodeVOL	LeafVOL
Source VOL	Possible (*1)	Possible	Possible (*1)	Possible (*2)	Command Reject
Target VOL	Command Reject	Command Reject	Command Reject	Command Reject	Command Reject

*1: It is impossible if ShadowImage for Mainframe/ShadowImage P-VOL or RootVOL already has 3 pairs.

*2: It is impossible if ShadowImage for Mainframe/ShadowImage NodeVOL is already paired with 2 LeafVOLs.

In case of Volume Migration volume is selected for ShadowImage for Mainframe/ShadowImage volume

	Source VOL	Target VOL
P-VOL	Command Reject	Command Reject
S-VOL	Command Reject	Command Reject
RootVOL	Command Reject	Command Reject
NodeVOL	Command Reject	Command Reject
LeafVOL	Command Reject	Command Reject

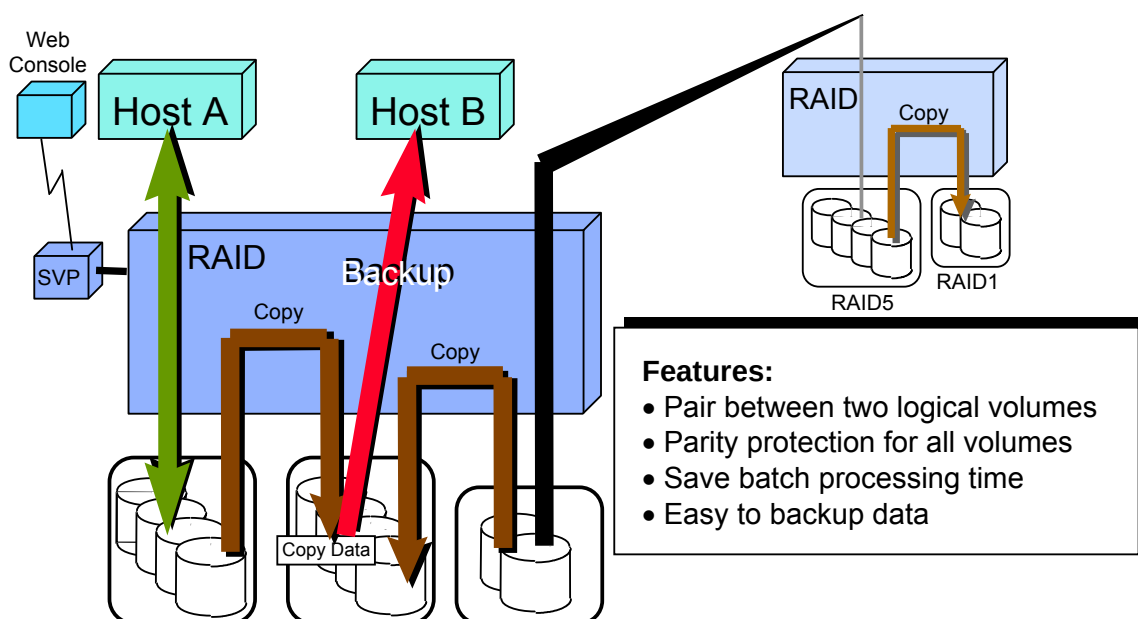
If you want to add pair of ShadowImage for Mainframe/ShadowImage, you need to cancel Volume Migration migration.

⚠ CAUTION

Copy process is done asynchronously with HOST I/O according to differential bit map. Differential bit map is recorded on shared memory. So if shared memory is lost by offline micro exchange or volatile PS-ON etc., DKC lost differential bit map. In these cases DKC treat as whole volume area has differential data, so copy process will take longer time than usual. And if the pair is SPLIT-PEND status, the pair become SUSPEND status because lost of differential bit map.

Primary volumes and secondary volumes of SI-MF/SI pairs should be placed on many RAID groups separately. And SI-MF/SI pairs which are operated at the same time should be placed in other RAID groups. SI-MF/SI pairs which are concentrated at very few RAID groups may influence HOST I/O performance.

If DKC is busy, increase Cache, DKA and RAID groups. And secondary volumes of SI-MF/SI pairs should be placed in the increased RAID groups. SI-MF/SI pairs in very busy DKC may influence HOST I/O performance.



3.9.2 Construction of ShadowImage for Mainframe & ShadowImage

- ShadowImage for Mainframe & ShadowImage can be controlled from SVP, Web Console and HOST.
- DKA with LA exchange has to exist in the storage system.

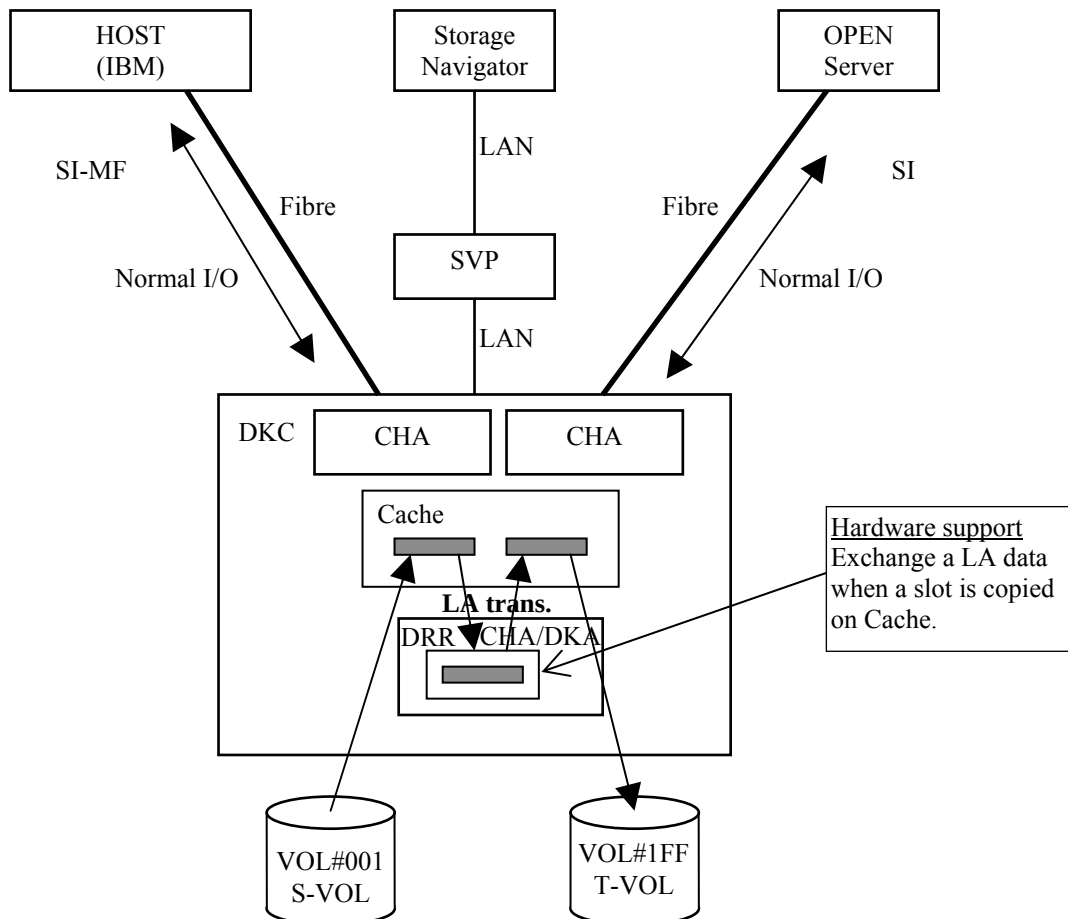


Fig. 3.9.2-1 Construction of ShadowImage for Mainframe & ShadowImage

3.9.3 Status transition

Table 3.9.3-1 Status of ShadowImage for Mainframe & ShadowImage

No.	Status	Definition
1	Simplex	There is no pair with the volume.
2	Pending	In the copy job status from the master volume to the destination volume for duplex status.
3	Duplex	The copy from master to destination is finished. The destination volume cannot be accessed from HOST.
4	Split Pending	In the copy job status of the differential data from the master volume.
5	Split	The pair is split. The destination volume can be accessed from HOST. In this status, the position of write data from the HOST is recorded on a bitmap to reduce the copy time on RESYNC.
6	Resync	In the copy job status of the differential data from master to destination.
7	Suspend	There is an error with the pair. After a running copy job was stopped by the SVP operation, the pair status is "suspend".

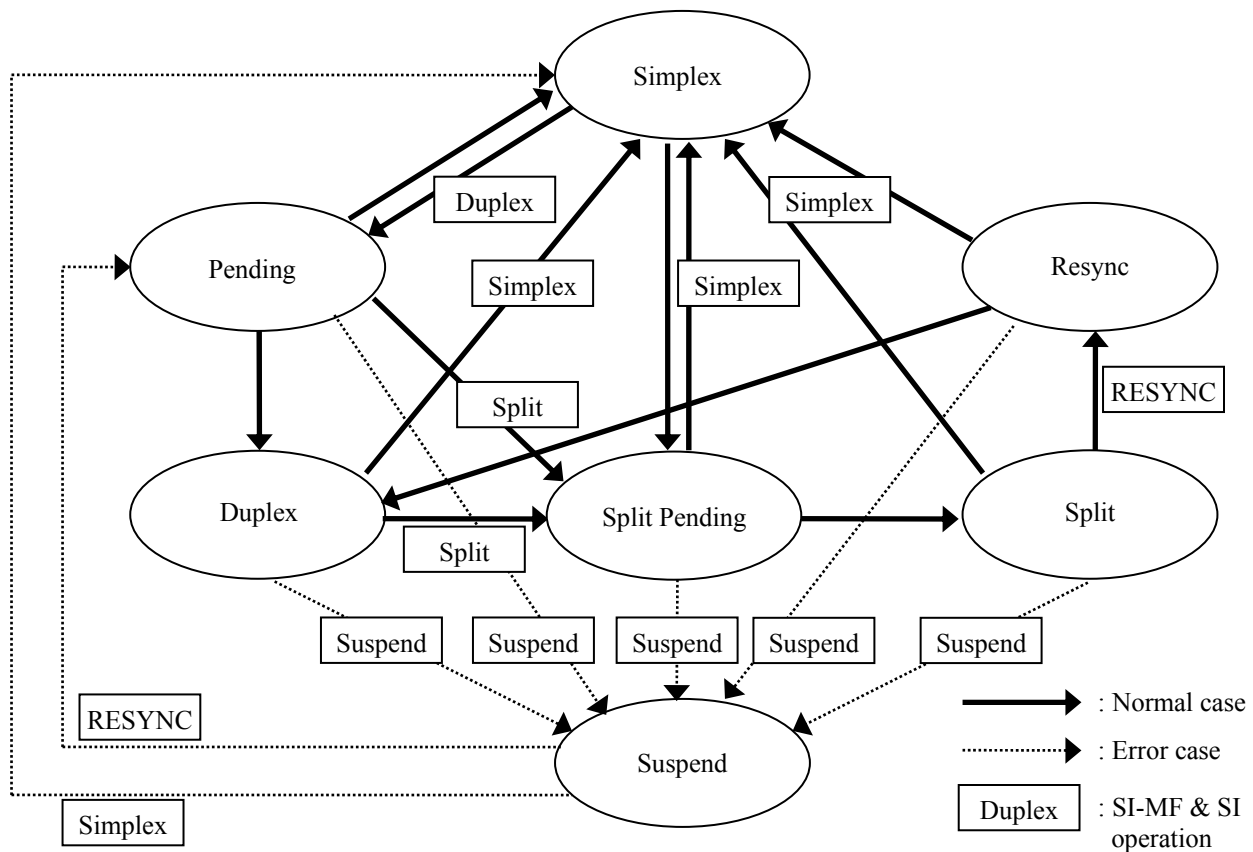


Fig. 3.9.3-1 State transition of ShadowImage

3.9.4 Interface

(1) Outline

ShadowImage for Mainframe & ShadowImage support a command set to control ShadowImage for Mainframe & ShadowImage functions.

This command set is a common interface in a storage system. So the commands from different HOSTs are translated to the ShadowImage for Mainframe & ShadowImage command at each command process.

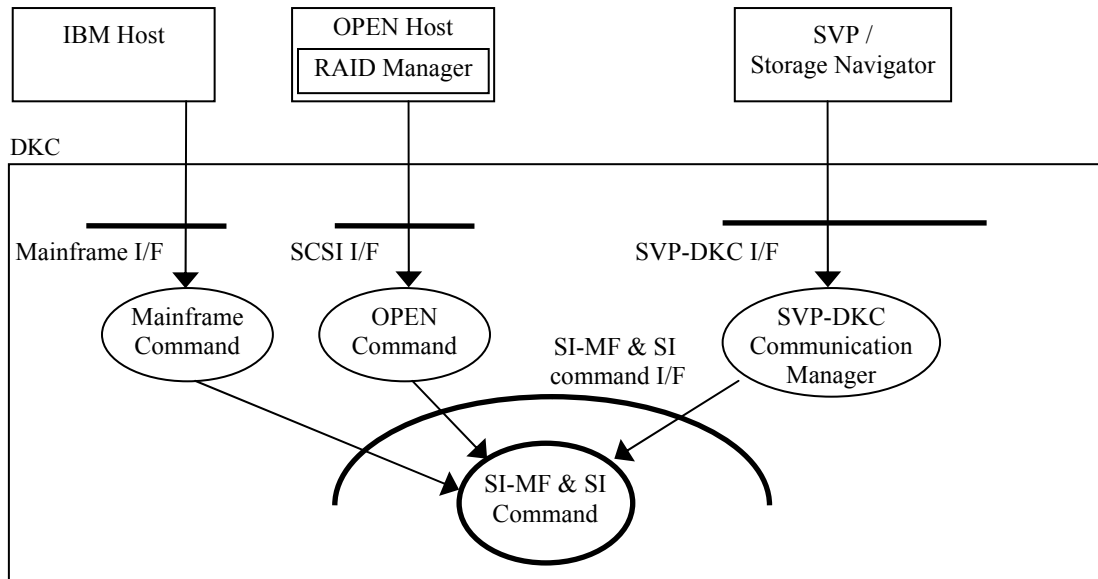


Fig. 3.9.4-1 Outline of ShadowImage for Mainframe & ShadowImage I/F

NOTE: It is necessary to define Command Device before using RAID Manager with In-Band on OPEN HOST.

Do not define Command Device on a heavy-load path.

It is unnecessary to define Command Device before using RAID Manager with Out-of-Band on OPEN HOST.

(2) ShadowImage for Mainframe & ShadowImage operation

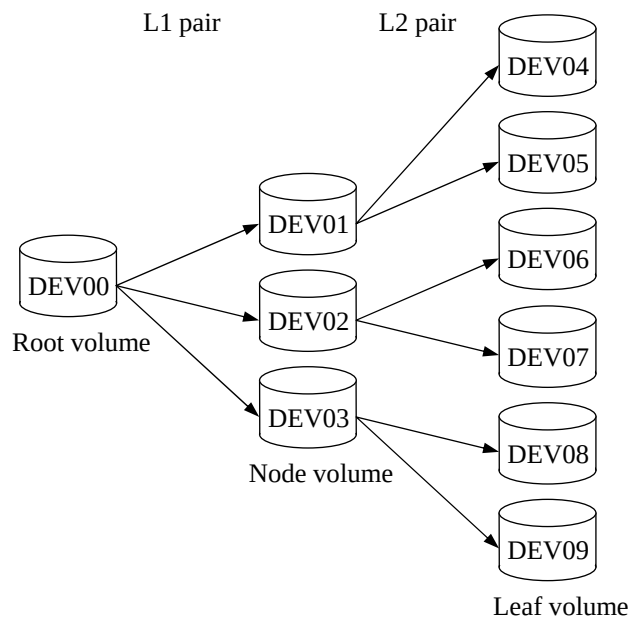
Table 3.9.4-1 ShadowImage for Mainframe & ShadowImage operation

No.	Command	Operation
1	Duplex	Creates a pair and start initial copy
2	Split	Splits the pair
3	RESYNC	Resumes the pair and start differential copy
4	Simplex	Deletes the pair
5	Suspend	Suspends the pair action
6	Status Check	Requires the status information

3.9.5 Cascade function

Cascade function makes a pair with an existed Target volume as a new Source volume. See the figure below.

This function is available for ShadowImage only.



No.	Content	Specification
1	Pair structure	A Target volume of L1 pair (=Node volume) can be a Source volume of L2 pair.
2	Number of copies	Root : Node = 1 : 3 Node : Leaf = 1 : 2 Root : (Node + Leaf) = 1 : 9
3	Split pair condition	L2 pair is able to execute split pair request only when the L1 pair is in the split status.
4	Delete pair condition	- No conditions. - When L1 pair is deleted, L2 pair becomes L1 pair.
5	Combination with TrueCopy	Possible. However, Node volume and Leaf volume are treated as a target volume.
6	Combination with Volume Migration	Possible. However, Leaf volume cannot be moved.
7	Combination with global-active device	Possible. However, Node volume and Leaf volume are treated as a target volume.

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- Name of volume type
 - Source volume of the first pair : Root Volume
 - Target volume of the first pair : Node Volume
 - Source volume of the 2nd pair : Node Volume
 - Target volume of the 2nd pair : Leaf Volume
- Name of pair
 - The first pair (A pair of root volume is source volume) : L1 pair
 - The second pair (A pair of node volume is source volume) : L2 pair
- Name of pair chain
 - A chain of L1 pair and L2 pair with a node volume: stream

3.9.6 Reverse-RESYNC

(1) Reverse-RESYNC Function/Quick Restore Function

The Reverse-RESYNC function is an extension of the RESYNC function of the ShadowImage. The Quick Restore function is a similar function with Reverse-RESYNC, but it speeds up the operation.

When a pair in the Split status is requested to perform the Reverse-RESYNC, the differential data between the target volume and the source volume is copied to the source volume from the target volume.

When a pair in the Split status is requested to perform the Quick Restore, a volume map in DKC is changed to swap contents of Source volume and Target volume without copying the Source volume data to the Target volume. The Source volume and the Target volume are resynchronized when update copy operations are performed for pairs in the Duplex status.

Note on RAID Level and DCR swap:

The Quick Restore operation changes locations of the data for primary volumes and secondary volumes and location of DCR of ShadowImage for Mainframe/ShadowImage pairs. Therefore, the operation may change RAID levels and HDD types of the volumes. For example, if the primary volume is RAID1 and the secondary volume is RAID5, Quick Restore operation changes the primary volume to RAID5 and the secondary to RAID1. RAID6 volume is also similar.

If you want to go back to the previous state, follow the actions below:

- step1 : Stop HOST I/O to the pair
- step2 : Split the pair
- step3 : Perform Quick Restore for the pair
- step4 : Restart HOST I/O to the pair

Due to the replacement of DCR setting locations, you must operate 1 or 2 shown below.

1. Set the same DCR location for Source volume and Target volume.
2. Reset the DCR settings of Source volume and Target volume before Quick Restore, and set DCR of Source volume and Target volume after the pair transits to the Duplex status by Quick Restore.

Unless you perform the operation above, I/O performance to the same data may be down for the change of the locations of cache-resident area after Quick Restore.

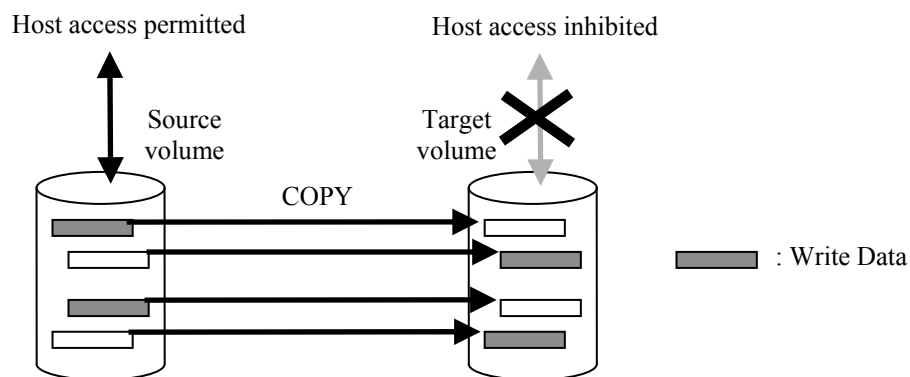


Fig. 3.9.6-1 Normal RESYNC Process

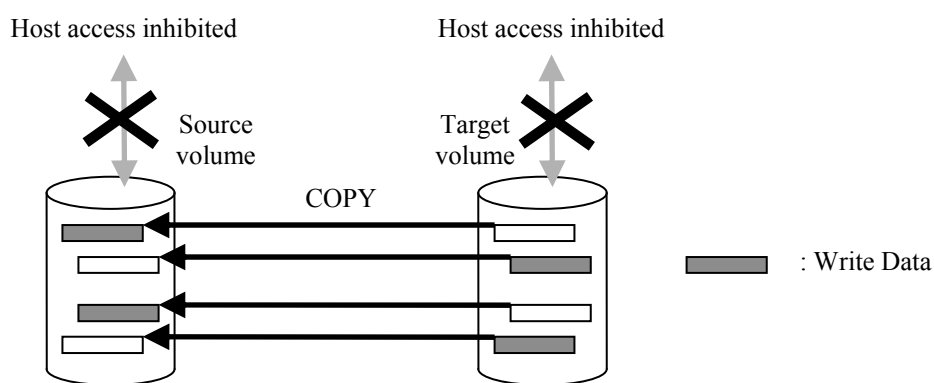


Fig. 3.9.6-2 Reverse RESYNC Process

(2) Specifications

No.	Item	Description
1	RESYNC copy pattern	- The data of the target volume is copied to the source volume. - The copy pattern can be selected by specifying a unit of operation. Specified operation unit : SVP/RMC: In units of pair operation at a time RAID manager: In units of command
2	Copy range	In the case of the Reverse-Copy and Quick Restore in the Split status, a range for merging the writing into the source and target volumes.
3	Copy format	Same format as that of a copy in the Duplex status.
4	Applicable LDEV type	- SI-MF : 3390-3/9/L/M/A, Emulation types and CVSs of them - SI : OPEN-3/8/9/E/L/V, emulation types and CVSs (except OPEN-L emulation type)
5	Host access during copying	(1) In the case of the main frame volume - Source volume: Reading and writing disabled - Target volume: Reading and writing disabled (2) In the case of the open volume - Source volume: Writing disabled - Target volume: Reading and writing disabled Note: The reason why the source volume is not disabled to read is to make the volume recognizable by the host and it does not mean that the data is assured.
6	Specification method	SVP/Storage Navigator: Add a specification for the RESYNC pattern onto the Pair Resync screen.
7	Conditions of command reception	- The pair concerned is in the Split status. - Another pair sharing the source volume is in the Suspend or Split status. → If this condition is not satisfied, the CMD RJT takes place. - When the Reverse-Resync or Quick Restore is being executed by another pair which is sharing the source volume, it is impossible to change the pair status of the pair concerned. (However, the pair deletion and pair suspension requests are excluded.) - The source volume of the pair concerned has no pair of the TC-MF/TC/GAD or in the Suspend status. (See Item No.14, 16 in this table.)
8	Status display during copying	- SVP/Storage Navigator SI-MF : RESYNC -R SI : COPY (RS-R) The display of the attribute, source or target, is not changed. - RAID manager Pair status display: RCPY The display of the attribute, source or target, is not changed.

(To be continued)

(Continued from the preceding page)

No.	Item	Description
9	Condition after normal end of the copy operation	- The pair concerned enters the Duplex status. - The conditions of the host access after the status transition are shown below. (1) Mainframe volume - Source volume: Reading and writing enabled - Target volume: Reading and writing disabled (2) Open volume - Source volume: Reading and writing enabled - Target volume: Writing disabled
10	Impacts on another pair	In another pair sharing the source volume, the part actually copied becomes the difference after executing this function. Example: Pair of the other target volumes in the 1:3 configuration
11	Operation when the copying terminates abnormally	(1) The pair concerned enters the Suspend status. (2) The source volume of the pair concerned is enabled to read and write. → Data is not assured. The target volume of the pair concerned is disabled to read nor write in the case of the Main frame volume and disabled to write in the case of the open volume. (3) The status of a pair sharing the source volume is not changed.
12	Operation when a suspension request is received during copying	Same as above
13	Relation to the cascade function	The Reverse-RESYNC and Quick Restore cannot be executed for the L2 pair.

(To be continued)

(Continued from the preceding page)

No.	Item	Description
14	Relation to the TrueCopy for Mainframe/TrueCopy	• In the case where “M-volume of the TC-MF/TC” = “Source volume of the ShadowImage” “Pair status of the TC-MF/TC” = “Suspend” → The Reserve-Resync and Quick Restore can be executed. “Pair status of the TC-MF/TC” ≠ “Suspend” → The Reserve-Resync and Quick Restore cannot be executed. (Command Reject) • In the case where “R-volume of the TC-MF/TC” = “Source volume of the ShadowImage” “Pair status of the TC-MF/TC” = “Suspend” → The Reserve-Resync and Quick Restore can be executed. “Pair status of the TC-MF/TC” ≠ “Suspend” → The Reserve-Resync and Quick Restore cannot be executed. (Command Reject) • In the case where “Target volume of the ShadowImage” = “M-VOL of the TC-MF/TC” “Pair status of the TC-MF/TC” = “Suspend” → The Reserve-Resync and Quick Restore can be executed. “Pair status of the TC-MF/TC” ≠ “Suspend” → The Reserve-Resync and Quick Restore cannot be executed. (Command Reject) • A pair of the TC-MF/TC cannot be created with the volume of the ShadowImage executing the Reserve-Resync or Quick Restore. (Command Reject) These specifications do not depend on using external Volumes.

(To be continued)

(Continued from the preceding page)

No.	Item	Description
15	Relation to the Universal Replicator / Universal Replicator for Mainframe	• In the case where “Primary volume of the Universal Replicator / Universal Replicator for Mainframe” = “Source volume of the ShadowImage” “Pair status of the Universal Replicator / Universal Replicator for Mainframe” = “Suspend” → The Reserve-Resync and Quick Restore can be executed. “Pair status of the Universal Replicator / Universal Replicator for Mainframe” ≠ “Suspend” → The Reserve-Resync and Quick Restore cannot be executed. (Command Reject) • In the case where “Secondary volume of the Universal Replicator / Universal Replicator for Mainframe” = “Source volume of the ShadowImage” “Pair status of the Universal Replicator / Universal Replicator for Mainframe” = “Suspend” → The Reserve-Resync and Quick Restore can be executed. “Pair status of the Universal Replicator / Universal Replicator for Mainframe” ≠ “Suspend” → The Reserve-Resync and Quick Restore cannot be executed. (Command Reject) These specifications do not depend on using external Volumes.
16	Relation to the global-active device	• In the case where “P-volume of the global-active device” = “Source volume of the ShadowImage” “P-volume of the global-active device” = “PSUS(Local) / PSUE(Local)” → The Reserve-Resync can be executed. Quick Restore cannot be executed (Command Reject). “P-volume of the global-active device” ≠ “PSUS(Local) / PSUE(Local)” → The Reserve-Resync and Quick Restore cannot be executed. (Command Reject) • In the case where “S-volume of the global-active device” = “Source volume of the ShadowImage” “S-volume of the global-active device” = “SSWS(Local)” → The Reserve-Resync can be executed. Quick Restore cannot be executed (Command Reject). “S-volume of the global-active device” ≠ “SSWS(Local)” → The Reserve-Resync and Quick Restore cannot be executed. (Command Reject)

(3) Action to be taken when the pair is suspended during the Reverse-RESYNC

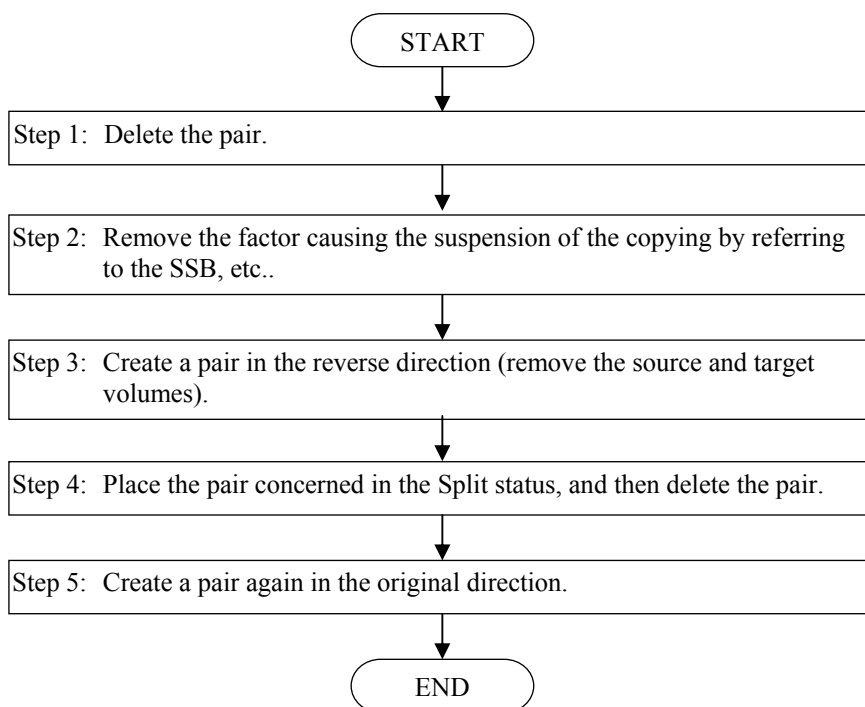
The recovery procedure to be used when the pair executing the Reverse-RESYNC is suspended owing to some problem or is explicitly transferred to the Suspend status by a command from the SVP/Web Console/RAID manager is explained below.

(a) Case 1: A case where the Suspend status can be recovered without recovering the LDEV concerned

This is equivalent to a case where the pair encounters an event that copying cannot be continued owing to a detection of pinned data or a staging time-out.

Or, it is equivalent to a case where the pair is explicitly transferred to the Suspend status by a command.

<<Recovery procedure>>



- (b) Case 2: A case where the Suspend status cannot be recovered unless the LDEV concerned is recovered

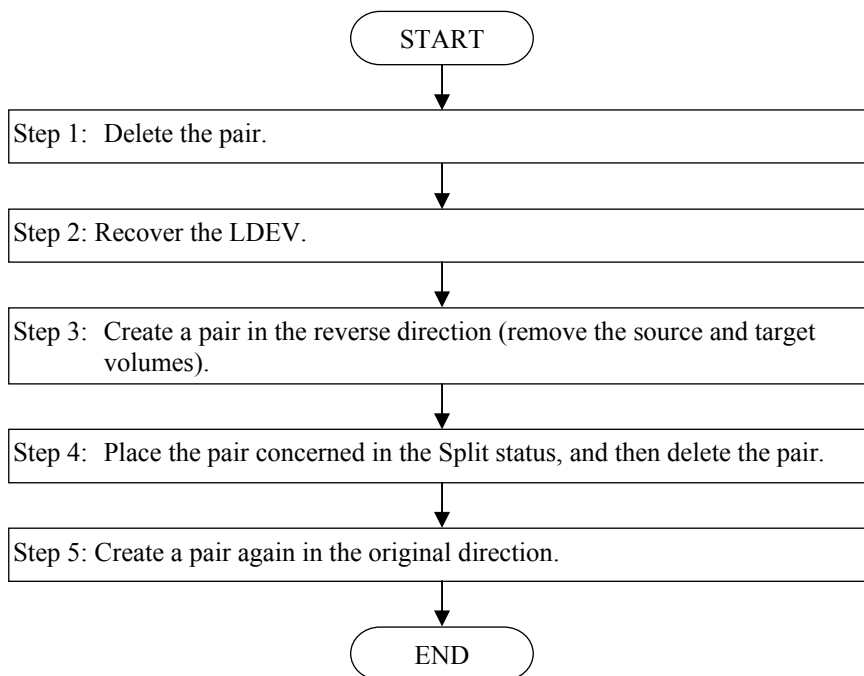
This is equivalent to a case that the LDEV is blocked.

To recover the blockade of the LDEV, an LDEV formatting or LDEV recovery is required. Both of them cannot be executed in the state that the ShadowImage pair is created. (A guard works against it.) Therefore, delete the pair once, recover the LDEV, and then create the pair once again.

However, in the pending state, caution must be taken because the data of the source volume is copied to the target volume if the pair is simply created again. Recover the blockade following the procedure below.

The following procedure is applicable just to a restoration of the source volume using the target volume. The following procedure does not include a procedure for directly restoring the source volume when the target volume is blocked.

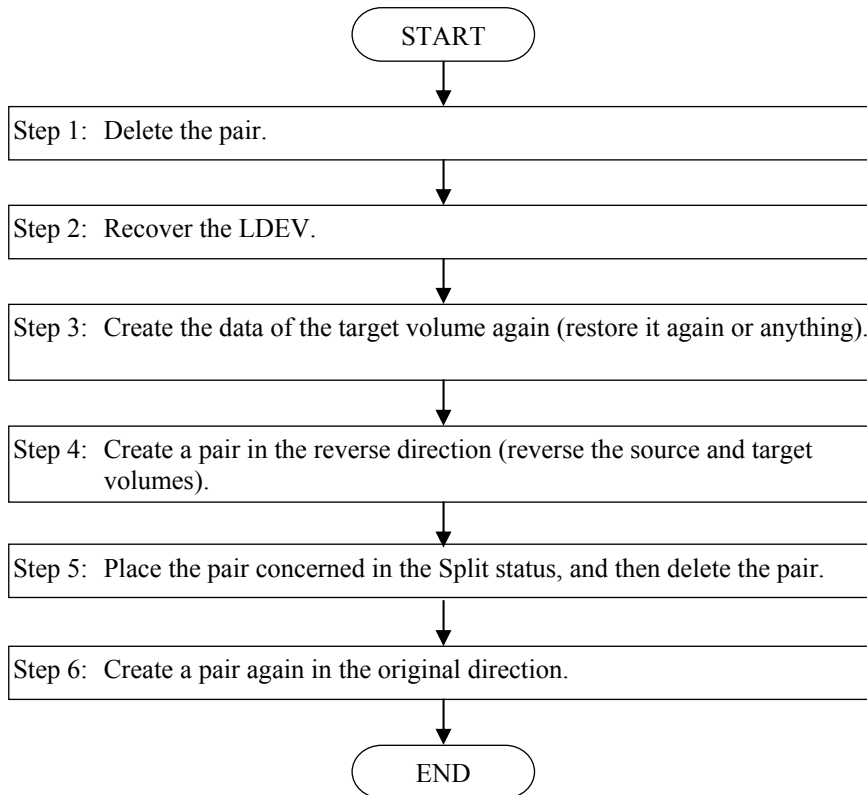
- Case 2-1: A case where the source volume is blocked
<<Recovery procedure>>



- Case 2-2: A case where the target volume is blocked

A recovery procedure for restoring data of the target volume is added because the copy source of the Reverse-RESYNC cannot be accessed.

<<Recovery procedure>>



3.9.7 FlashCopy (R) Option function

FlashCopy (R) Option function requires the shared memory. For more details, please refer to the section of “6.1 Required CM Capacity” ([INST06-10](#)).

(1) FlashCopy (R) Option functions

FlashCopy (R) provides a function to copy data in high-speed.

FlashCopy (R) forms a pair by copying data of a copy source (source volume) virtually or physically to a copy destination (target volume).

A pair formed by means of FlashCopy (R) is called a “relationship.” Once a relationship of FlashCopy (R) is established, a host can execute a reading/writing from/to target data that is a virtual or physical copy of source volume data.

When making a copy of each data set, a relationship of only the specified data set (an extent of the CCHH). This extent of data to be copied is called an “extent.” The minimum unit of the extent is a track.

(2) Use of FlashCopy (R) Option together with the other function

A FlashCopy (R) pair can be formed using an ShadowImage for Mainframe volume in the Simplex status. Besides the pair can be formed also using a P-VOL in the Split or Duplex status as a copy source.

Table 3.9.7-1 Possibility of Volume Sharing by FlashCopy (R) and Other Copy Solutions

	Possibility of coexistence with FlashCopy (R)	
	FlashCopy (R) S-VOL	FlashCopy (R) T-VOL
ShadowImage S-VOL	Possible	Impossible
ShadowImage T-VOL	Impossible	Impossible
XRC PVOL	Possible	Impossible
XRC SVOL	Impossible	Impossible
TC-MF M-VOL	Possible	Possible
TC-MF R-VOL	Possible	Impossible
UR-MF PVOL	Possible	Possible
UR-MF SVOL	Impossible	Impossible
CC S-VOL	Possible	Impossible
CC T-VOL	Impossible	Impossible
Volume Migration	Impossible	Impossible

NOTE: Even if a volume can be shared by FlashCopy (R) and another copy solution, there may be a case where restrictions are placed on the pair status. For details of the restriction, refer to the chapter on simultaneous use with other program products in “Hitachi Compatible FlashCopy (R) User Guide”.

3.9.8 Micro-program Exchange

(1) Off-line Micro-program Exchange

- (a) The existence of relationship of FlashCopy (R) option is checked on the Compatible FlashCopy (R) Information screen on Storage Navigator. Refer to the chapter on information display in “Hitachi Compatible FlashCopy (R) User Guide”.
 - (a)-1: In the case of existing no relationship of FlashCopy (R) option. go to (b).
 - (a)-2: In the case of existing relationship.
 - Request to delete all relationship to user. However, notify user of information no longer being guaranteed T-VOL by deleting the relationship under copy.
- (b) If the Thin Image Option is installed, notify the users that data on S-VOL will be invalid.
- (c) Perform micro-program exchange operation.
- (d) If required, establish the relationship of FlashCopy (R) option again.
- (e) If the Thin Image Option is installed, restore the pool-VOL.

NOTE1: If step 1 above is not performed, all relationship of FlashCopy (R) option is deleted forcibly .

If T-VOL is external volume, the storage system might stand up with normal T-VOL, without blocked T-VOL.

In this case, the data of T-VOL isn't guaranteed, so you need operate either following one.

- Dataset of T-VOL is deleted
- Initialization of volume is performed

NOTE2: Request user to delete all relationship of FlashCopy (R) option beforehand at the time of performing off-line micro exchange.

NOTE3: When performing Offline Micro-Exchange, ask the user to stop using Thin Image, i.e.;

- Remove all Thin Image pairs
- Disband all Pool Groups

THEORY03-09-370**3.9.9 Notes on powering off**

When performing a powering off, take notice of the following.

Item	Note	Reason
1	(ShadowImage) Take care that the time required for the copying becomes longer. Make a schedule taking the copying time into consideration.	If data in the shared memory has volatilized when the next powering on is performed, the following phenomena occur. - When the pair is in the Pending or Resync status, the data, from which a copying has been completed before the powering off, is also treated as data to be copied again. - Even if no I/O has been issued, the rate of data identity does not reach 100% when the pair status is changed to Duplex. - The data that has become the one to be copied again is copied to the secondary volume after the pair status is changed to Duplex. - When the pair is in the Duplex status, the data, from which a copying has been completed before the powering off, is also treated as data to be copied again. - The rate of data identity will be 0%. - The copying of the data, which has become the one to be copied again, is performed in the state in which the pair is in the Duplex status. - When the pair is in the Split status, the whole volume will be a differential between the two volumes. - The rate of data identity will be 0%. - Data of the whole volume is copied when a resynchronization is performed.
2	(ShadowImage) As to a pair in the Split transitional status (SP-Pend, V-Split), complete the copying of it and put it in the Split status.	If data in the shared memory has volatilized when the next powering on is performed, the following phenomenon occurs. When the pair is Split transitional status (SP-Pend, V-Split), it is changed to Suspend.
3	(FlashCopy (R) Option function) Perform a powering off of the storage system after the copying is completed.	If data in the shared memory has volatilized when the next powering on is performed, the following phenomena occur. - The relationship is dissolved. - The secondary volume is detached. If T-VOL is external volume, the storage system might stand up with normal T-VOL, without blocked T-VOL. In this case, the data of T-VOL isn't guaranteed, so you need operate either following one. - Dataset of T-VOL is deleted - Initialization of volume is performed
4	(ShadowImage consistency group pair-split) Perform PS OFF when by split operation by consistency group pair-split, after change status of all pairs belonging to consistency group is completed. (ShadowImage for Mainframe consistency group pair-split) Perform PS OFF when by pair operation of copy group specification, or split operation by split time registration, after change status of all pairs belonging to consistency group is completed.	Pair by which change status is not carried out even if it carries out PS ON may occur.

3.9.10 Thin Image option

(1) Thin Image function

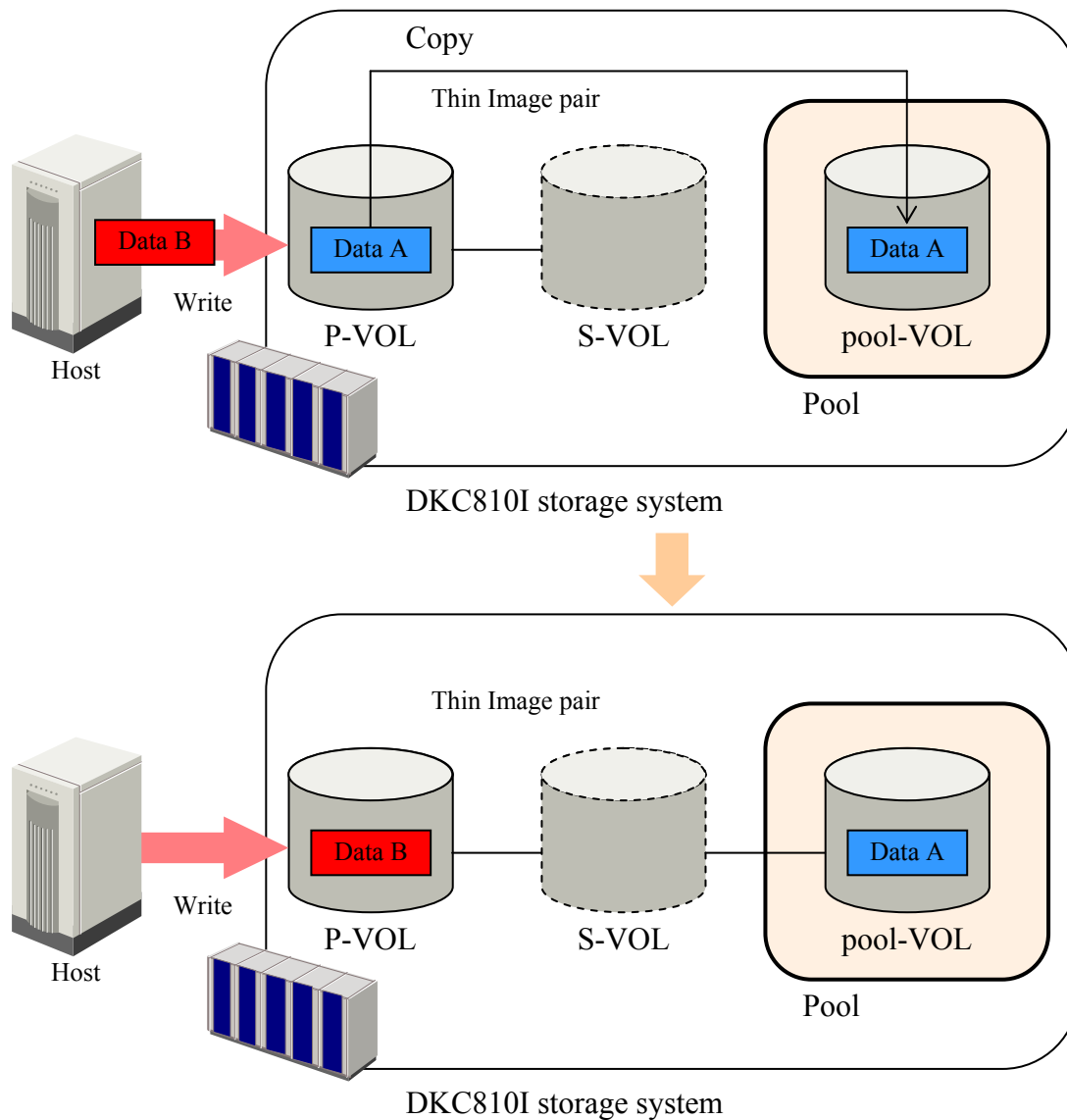
It is a product to copy and manage the data in the storage system as well as the ShadowImage function. The Thin Image forms the pair of which the logical volume is made as the primary volume (hereafter, indicated as P-VOL), and the virtual volume (hereafter, indicated as V-VOL) is made as the secondary volume (hereafter, indicated as S-VOL).

Because the S-VOL of the Thin Image pair is the V-VOL with no reality, the S-VOL does not actually consume the capacity of the storage system.

As for the Thin Image pair, only the part to be updated is copied to the pool-VOL among the data of the P-VOL. Therefore, the capacity used by the entire storage system can be reduced.

It is possible to access the S-VOL of the Thin Image pair. In this case, the data of the P-VOL is referred to via the S-VOL. Therefore, the load concentrates on the parity group of the P-VOL.

Also, if the P-VOL becomes a failure, it cannot access the S-VOL.



(2) pool-VOL

A pool is an area to store the snapshot data acquired by the Thin Image.

The pool consists of multiple pool-VOLs, and the snapshot data is actually stored in the pool-VOLs.

When the amount of the pool in use exceeds the capacity of the pool as a result of writing the data on the volume of the Thin Image pair, the Thin Image pair becomes PSUE (failure status) and cannot acquire further snapshot data.

3.10 TPF

3.10.1 An outline of TPF

TPF stands for Transaction Processing Facility.

TPF is one of operating systems (OS) for mainframes mainly used for airline customer reservation systems.

To correspond to TPF, DKC must support logical exclusive lock facility and extended cache facility.

The former is a function which is called MPLF (Multi-Path Lock Facility) and the latter is a function which is called RC (Record Cache).

A DKC which corresponds to TPF implements a special version of microprogram which supports the MPLF and RC functions of TPF feature (RPQ#8B0178), described in the following IBM public manuals:

- (a) IBM3990 Transaction Processing Facility support RPQs (GA32-0134-03)
- (b) IBM3990 Storage Control Reference for Model 6 (GA32-0274-03)

(1) An outline of MPLF

This facility provides a means, using a DKC, to control concurrent usage of resources in host systems via use of logical locks. A logical lock may be defined for the control of a shared resource, where the sharing of that resource must be controlled. Each shared resource has its own name called Lock Name. Every Lock Name controls multiple lock states (2 to 16).

The following figure shows the outline of I/O sequence which uses MPLF.

DKC recognizes up to 16 MPLF users. In this figure, user A and user B are shown. These users may belong to the same HOST or different HOSTs. Each user must indicate MPLP (Multi-Path Lock Partition) to use MPLF. MPLP is a means of logically subdividing the MPLs (Multi-Path Locks) for a user set. The maximum number of MPLP is four. Each MPLP has numbered from 1 to 4. The process to get permission to use MPLF is called CONNECT.

The connected user executes the SET LOCK STATE process using Lock Name. The MPL corresponding to specified Lock Name is assigned to the user. This assignment is canceled by the UNLOCK process. HOSTs can share the DASD without contradiction by using this MPLF.

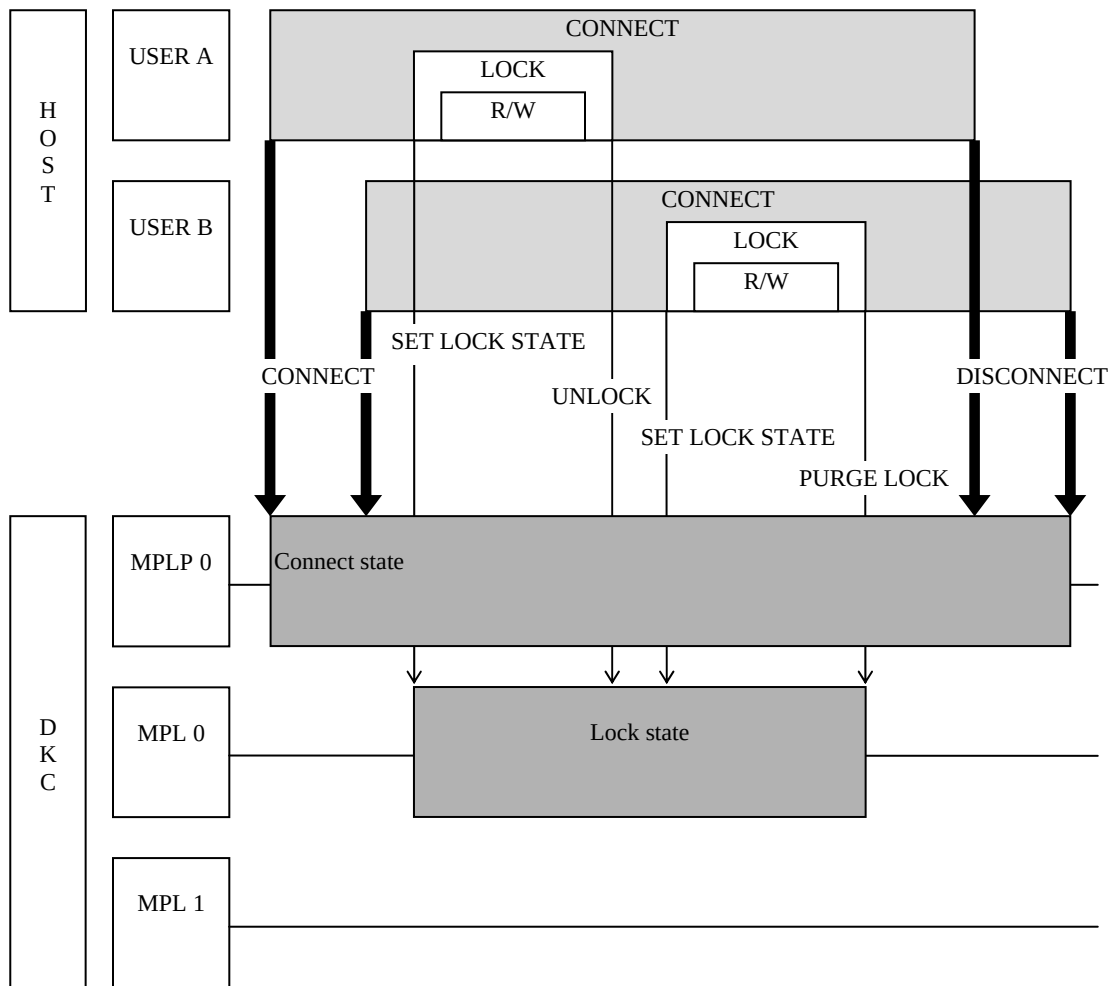


Fig. 3.10.1-1 An outline of MPLF

(2) An outline of RC

RC has the following two features:

- (a) Record Mode Chain
- (b) Record Caching

The following explains these features.

(a) Record Mode Chain

Record Mode Chain consists of the following 4 command chains:

- 1) Mainline Processing (Read)
- 2) Mainline Processing (Write)
- 3) Capture
- 4) Restore

To execute Record Mode Chain, a storage system must be initialized for Record Caching, and Record Mode must be allowed for the addressed device. Under these conditions, Record Mode Chain works when Record Mode Chain is indicated in the Extended Global Attributes of Define Extent command. Otherwise, the chain is processed in a standard mode.

A Mainline Processing chain consists of a Define Extent command, a Locate Record command, and a single Read Data or Write Update Data command.

A Capture chain consists of a Define Extent command followed by a Seek command and multiple Read Count, Key, and Data commands.

A Restore chain consists of a Define Extent command, a Locate Record command, and multiple Write Update Data commands.

(b) Record Caching

Record Caching is a naming contract with Track Caching used in a standard model. At the completion of first initialization, all caches are allocated to Track Slot as a standard model. Record Cache will be allocated if Set Cache Allocation Parameters Order is issued.

3.10.2 TPF Support Requirement

(1) OS

TPF Ver.4.1./zTPF VER.1.1

(2) Hardware

The following table shows the storage system hardware specifications for TPF support.

Table 3.10.2-1 TPF Support Hardware Specification

Item	Description
Number of MODs	Max. 16,384/box
Number of LCUs/Box	Max. 64
Number of SSIDs/LCU	1
Cache/SM capacity	(Refer to INST06-10)
RAID level	6, 5 or 1
Emulation type	
(1) LCU	2107
(2) Device	3390-3/9/L/M
Number or Multi-Path Locks	16,384/LCU (assigned to only 16LCUs) 4,096/LCU (assigned to 64LCUs)
Option features:	
(1) CVS	Available
(2) DCR	Available
(3) TC-MF	Available *2
(4) UR	Available *2
(5) SI-MF	Available
(6) VM	Available *1
(7) Cross-OS File Exchange	(Not Available)

*1: VM supports only a monitor function.

*2: It is available for only offline volume.

3.10.3 TPF trouble shooting method

Basically TPF environment and MVS (as a standard operation system) are same in trouble shooting.

A example order is below:

- (a) Collect system error information by Syslog...etc.
- (b) Collect DKC error information by SVP dump operation.
- (c) Send the above data to T.S.D.

3.10.4 The differences of DASD-TPF (MPLF) vs DASD-MVS

(1) Data-exclusive method by MPLF function

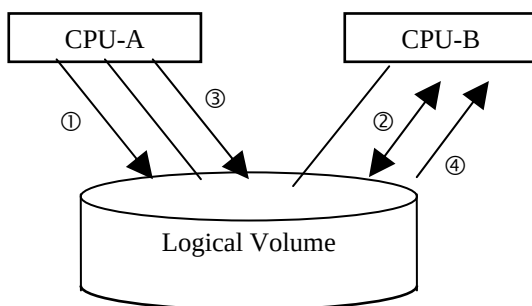
MVS environments

- (a) Logical volume (Device) is the unit of data-exclusive between several CPUs.
- (b) “Device” is owned by one CPU during CPU processing (accessing), and “Device-busy” status is reported to another CPU’s accesses.
- (c) “Device-end” status is used to notify the waiting CPUs when the device becomes free.

TPF environments

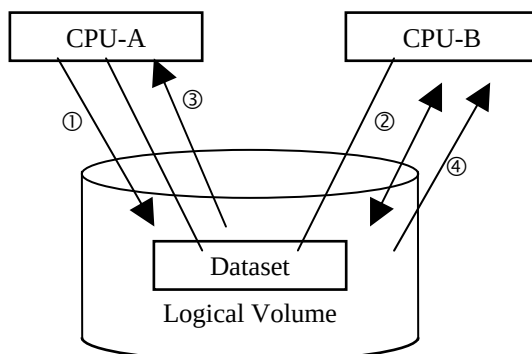
- (a) Logical “Lock” is used for this purpose, instead of logical volume (device) of MVS.
- (b) Most Read/Write CCWs have a unique: Prefix-CCW (Set Lock) to own the target lock.
And only when the request-lock is granted to, its CCW continues the following Read/Write processes.
DSB=“4C” is for granted / DSB=“0C” is for NOT-granted (wait).
- (c) “Attention” status is used to notify the waiting CPUs when the lock becomes free.
- (d) The relationship between Lock and Dataset is completely free.
Usually TPF users (customers) have their own definitions.

MVS environments



- ① Reserve/Read&Write Access by CPU-A (Successful).
- ② CPU-B's trial is rejected by Device-busy (Failed).
- ③ Terminate its process and release the volume.
- ④ Free (Device-end) will be sent. CPU-B can use this volume.

TPF environments



- ① Set Lock/Read&Write process *1 by CPU-A (Successful).
- ② CPU-B's trial is rejected by Not-granted (failed).
- ③ Terminate with Unlock, by CPU-A.
- ④ Free (Attention) will be sent. *2. CPU-B can use this Dataset.

*1: Typical CCW chain:

- Set lock State (x27/order(x30));
- Read Storage system Data (x3E);
- TIC (to be continued if granted)
- (ordinary CCW chain)

*2: This report's path/Address is usually different from above ②.

Fig. 3.10.4-1 Environments of DASD-TPF and DASD-MVS

(2) No path-group

MVS environments

- (a) Each CPU establishes the Path-group on every DASD Online-device, using all the connected paths.
- (b) Channel and DASD (Control Unit) rotate the I/O service path to meet each occasion within this group.
- (c) “Device-end” status can be reported through any-path of this group.

TPF environments

- (a) TPF OS/CPU does not establish this Path-Group, even if the configuration has multiple-paths for DASD.
- (b) But the Channel rotates the I/O request-path, within the connected paths. (Like old MVS way)
- (c) “Attention” report is restricted to one “Connect-Path” which has been defined during IPL (Vary-online) procedure.

(3) Connect Path/Device

- (a) TPF system issues “Connect order” to define :
 - Lock tables on each DASD control-unit.
 - Report path & Device for Attention interrupt.
- (b) This order is code (x33) of Perform Storage system Function (x27) command.
- (c) This order is issued during the IPL process of each CPU.
- (d) CPU (channel) only has the capability to change this path and device definition.

Table 3.10.4-1 Order-list of Perform Storage system Function (x27) command

Order	Meaning	Function
x10	Commit	RC
x11	Discard	
x18	Prepare for Read Storage system Data	
x19	Destage Modified Tracks	
x1B	Set Special Intercept Condition	
x20	Set Cache Allocation Parameters	
x21	Suspend/Resume Function	
x22	Prepare to Read Lock Data	MPLF
x30	Set Lock State	
x31	Purge Lock	
x32	Unlock	
x33	Connect	
x34	Disconnect	

For details, please see the following IBM RPQ manual;

“IBM 3990 Transaction Processing Facility Support RPQs” (GA32-0134-03)

(4) Channel Re-drive function

MVS environments

- (a) In general, the Channel selects the most proper path (in the Path-group) for each I/O request.
- (b) In MVS environments, there is not this kind of function.

TPF environments

- (a) In TPF environments, to keep a fast I/O response and I/O request-order (fast-in, fast-out), this kind of special function has been introduced. (This is our conjecture.)
- (b) By the channel-monitor data, once I/O request is rejected with Control-unit busy by DASD, Sub-channel repeats a reconnect-trial to DASD (with some short interval) until (1) the sub-channel gets into DASD or (2) it reaches the trial-count threshold. (In this case, the I/O request is registered to some waiting Queue in the channel.)
- (c) And once the I/O request is accepted by DASD control-unit, next Control-unit judges this would be accepted or not using "Lock" status.

(5) Fixed Record-size

Dataset structure in DASD

In general, TPF software makes the following logical structure in DASDs.

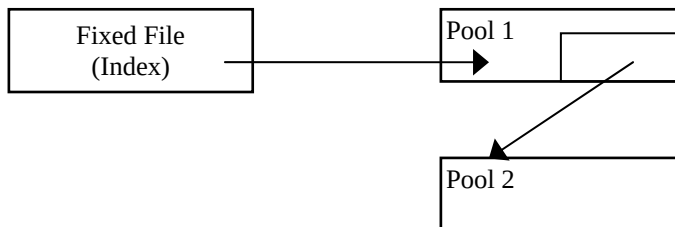


Fig. 3.10.4-2 Logical structure in DASDs

Table 3.10.4-2 Pool records Classification

Logical (usable) size	Physical size
381 Bytes	384 Bytes
1,055 Bytes	1,056 Bytes
4,095 Bytes	4,096 Bytes

Only three lengths exist for pool records.

Table 3.10.4-3 More detailed classification

381 Record	1,055 Record	4,095 Record
SLT (Small, Long Term)	LLT (Large, Long Term)	4LT (4KB, Long Term)
SST (Small, Short Term)	LST (Large, Short Term)	4ST (4KB, Short Term)
SDP (Small, Long Term, Duplicated)	LDP (Large, Long Term, Duplicated)	4DP (4KB, Long Term, Duplicated)

(6) Prime/Dupe MODs pairs

- (a) To improve Data-integrity of DASD, TPF system often makes the Data-duplications on different two DASD storage systems.
- (b) The following figure shows one example of these pairs.
Prime MOD (module)s and Dupe MODs are always located on each side of storage system (spread to all storage systems).

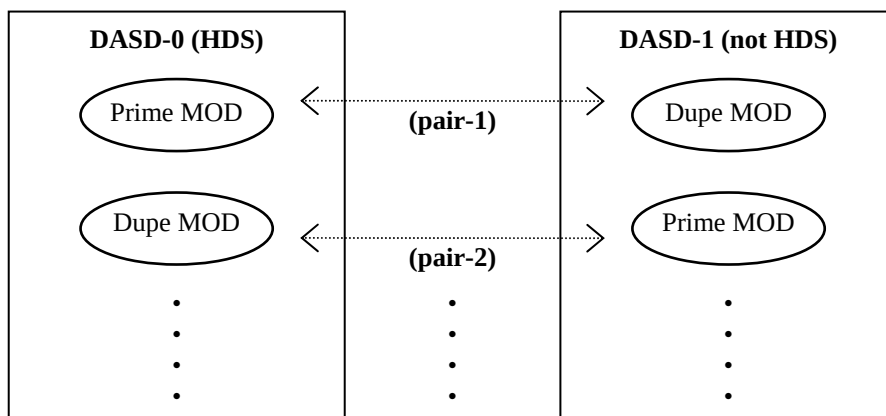


Fig. 3.10.4-3 Prime/Dupe MODs pairs

(7) Data Copy procedures

The Copy procedures are taken for the following purposes:

- (a) To make a pair (To copy data from Prime MOD to Dupe).
- (b) To recover the failed data (To copy the remaining data to the re-init MOD).

There are two ways to make a pair.

- (a) AFC (All File Copy)
 - (b) AMOD copy
- (a): In this copy process, the destination-drive of the copy keeps “Offline” status, and just after the completion of this copy, the source-drive becomes “Offline” and the destination-drive changes to “Online”. From the view-point of TPF software, there is only one MOD, independent of copy process.
 - (b): In this copy process, both source-drive and destination-drive stay “Online”. TPF software can distinguish both drives, even in the copy process.

3.10.5 Notices for TrueCopy for Mainframe-option setting

<SVP operation>

(1) RCU Option

We strongly recommend you to select “No” in the “PPRC support by host” column of the “RCU Option” window.

We strongly recommend you to select the “Not Report” in the “Service SIM of Remote Copy” column of the “RCU Option” window.

(2) Add Pair

We strongly recommend you to select the “Copy to R-VOL” in the “CFW Data” column of the “Add Pair” window.

(3) Suspend Pair

We strongly recommend you to select the “Disable” in the “SSB(F/M=FB)” column of the “Suspend Pair” window.

<Host (TPF-OS) consideration>

In MVS-OS world, DKC with TC-MF expects (requires) Customers to extend I/O Patrol Timer to prevent many MIHs from reporting.

Also in TPF-OS world, same consideration is required, so please discuss with your Customer to find the opportunity to extend “Stalled Module Queue” timer over 5 seconds.

3.11 Volume Migration

3.11.1 Volume Migration Overview

This document describes the function of Volume Migration that is one of program products.

A storage system can be constructed by several types of physical drives and three types of RAID levels (RAID1, RAID5 and RAID6).

This combination of the type of physical drive and the type of RAID level provides a system that cost and performance are optimized to user environment. However, it is difficult to get information about actual operation of physical drives in the RAID system unlike other storage systems.

- (1) Volume Migration provides solutions of the problem and supports decision of users to determine system construction as described below.
 - (a) Load balancing of system resources
Unbalance of utilization of system resources makes performance worse. Volume Migration supports decision of optimized allocation of logical volumes to physical drives.
 - (b) Migration of logical volumes optimized to access patterns to physical drives
For instance, RAID5/RAID6 are suitable to sequential access, and RAID1 of high performance drive is suitable to random access that is required small response time. Volume Migration shows types of access pattern to physical drives clearly, and supports migration of logical volumes to suit the access pattern.
- (2) Volume Migration consists of following subfunction to achieve above purposes.
 - (a) Volume moving (migration) function moves logical volumes to specified parity groups.

3.11.2 Hardware requirements

Addition of SM capacity setting may be needed if SM capacity setting in the DKC is not enough.
Please refer to INSTALLATION SECTION.

3.11.3 Software requirements

The Program Product, Performance Monitor is required.

3.11.4 Volume moving (migration) function

Volume moving (migration) function moves data in logical volume (source volume) to physical location of another logical volume (destination volume). Users specify the volumes in Volume Migration utility window.

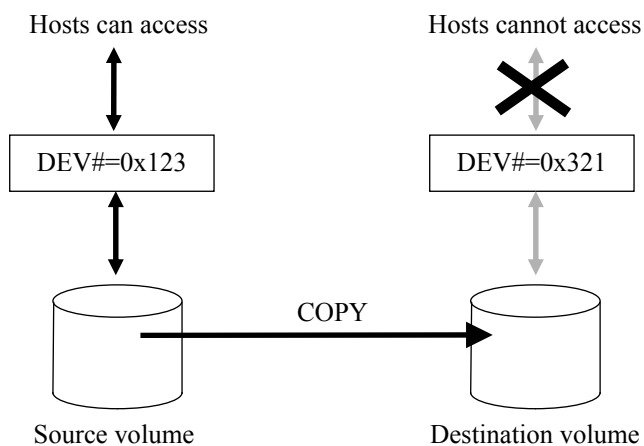


Fig. 3.11.4-1 Before moving

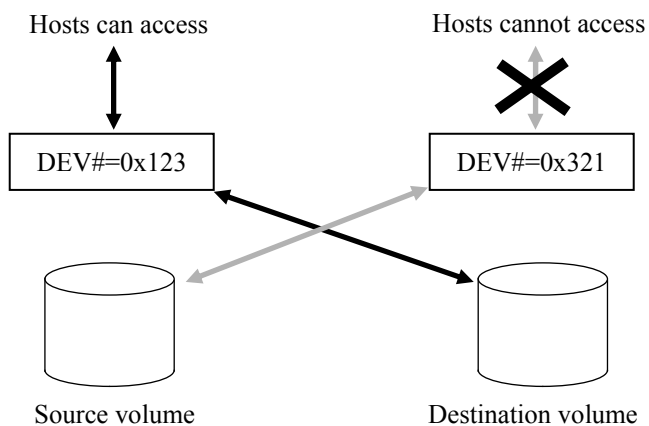


Fig. 3.11.4-2 After moving

(1) Volume moving function Overview

(a) Source volumes:

The following volumes cannot be used as source volumes:

- Volumes which are set as command devices (devices reserved for use by the host)
- Volumes which are used by XRC
- Volumes which are used by Concurrent Copy (CC)
- Volumes which have FlashAccess (also called DCR) data stored in cache
- Volumes which are in an abnormal or inaccessible condition (e.g., pinned track, fenced)
- Journal Volumes which are used by Universal Replicator
- Volumes on which CCI is performing volume migration operation
- Volumes that form a Thin Image pair
- Virtual volumes and pool volumes
- Volume executing Quick Format
- Global-active device volumes
- Quorum disk

If the status of volumes that form TrueCopy for Mainframe pairs is suspended or duplex, the volumes can be used as source volumes. If you delete an TrueCopy for Mainframe pair from an MCU, the status of the M-VOL and the R-VOL changes to simplex so that the volumes can be used as source volumes. If you delete an TrueCopy for Mainframe pair from an RCU, the status of the M-VOL changes to suspended and the status of the R-VOL changes to simplex so that the volumes can be used as source volumes.

If the status of volumes that forms TrueCopy pairs is PSUS or PSUE or PAIR, the volumes can be used as source volumes. If not, the volumes cannot be used as source volumes. If you delete an TrueCopy pair from an MCU, the status of the P-VOL and the S-VOL changes to SMPL so that the volumes can be used as source volumes. If you delete an TrueCopy pair from an RCU, the status of the P-VOL changes to PSUS and the status of the S-VOL changes to SMPL, so that the volumes can be used as source volumes.

— Dynamic Provisioning / Dynamic Provisioning for Mainframe Volume

If the Dynamic Provisioning / Dynamic Provisioning for Mainframe Volume are used as source volumes, the Dynamic Provisioning / Dynamic Provisioning for Mainframe Volume that associates same pool volume as source volumes can't be specified as target volumes.

The Dynamic Provisioning / Dynamic Provisioning for Mainframe V-VOL whose capacity is being expanded cannot be used as the source volume for volume migration. After DP V-VOL expansion is completed, the V-VOL can be used as the source volume for migration. In this case, make sure that the capacity of the target volume must be the same as that of the expanded source volume.

— Volumes which configure the Universal Replicator for Mainframe pairs

If the status of the volumes is Pending duplex or Duplex, they cannot be source volumes. Also, if the volumes which configure the Universal Replicator for Mainframe pairs are used as source volumes, external volumes cannot be specified as target volumes.

When Delta Resync is set in 3D Multi Target Configuration (See Fig. 3.11.4-3), P-VOL and S-VOL of a pair of Universal Replicator for Mainframe and for Delta Resync can be set as a source volume. However, the status of each pair in 3D Multi Target Configuration is required to be as the following table.

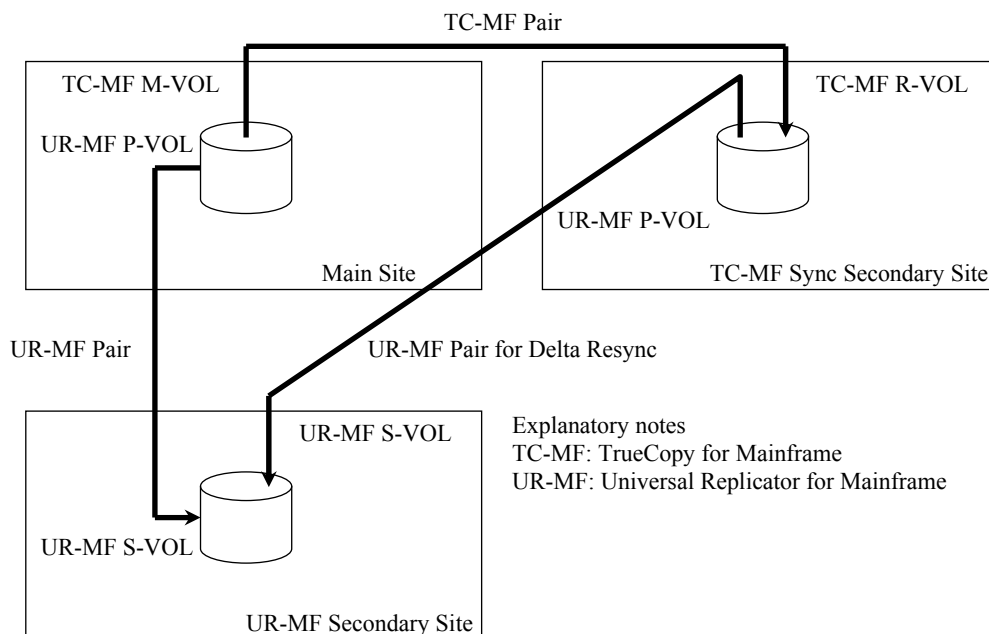


Fig. 3.11.4-3 3D Multi Target Configuration (Universal Replicator for Mainframe)

Table 3.11.4-1 The Status of Each Pair when P-VOL of UR-MF Pair for Delta Resync is Set as a Source Volume

Pair	Pair Status
TC-MF Pair	SUSPEND
UR-MF Pair	Random Pair Status
UR-MF Pair for Delta Resync	HOLD or HLDE

Table 3.11.4-2 The Status of Each Pair when S-VOL of UR-MF Pair for Delta Resync is Set as a Source Volume

Pair	Pair Status
TC-MF Pair	Random Pair Status
UR-MF Pair	SUSPEND
UR-MF Pair for Delta Resync	HOLD or HLDE

- Volumes which configure the Universal Replicator pairs

If the status of the volumes is COPY or PAIR, they cannot be source volumes.

Also, if the volumes which configure the Universal Replicator pairs are used as source volumes, external volumes cannot be specified as target volumes.

When Delta Resync is set in 3D Multi Target Configuration (See Fig. 3.11.4-4), P-VOL and S-VOL of a pair of Universal Replicator and for Delta Resync can be set as a source volume. However, the status of each pair in 3D Multi Target Configuration is required to be as the following table.

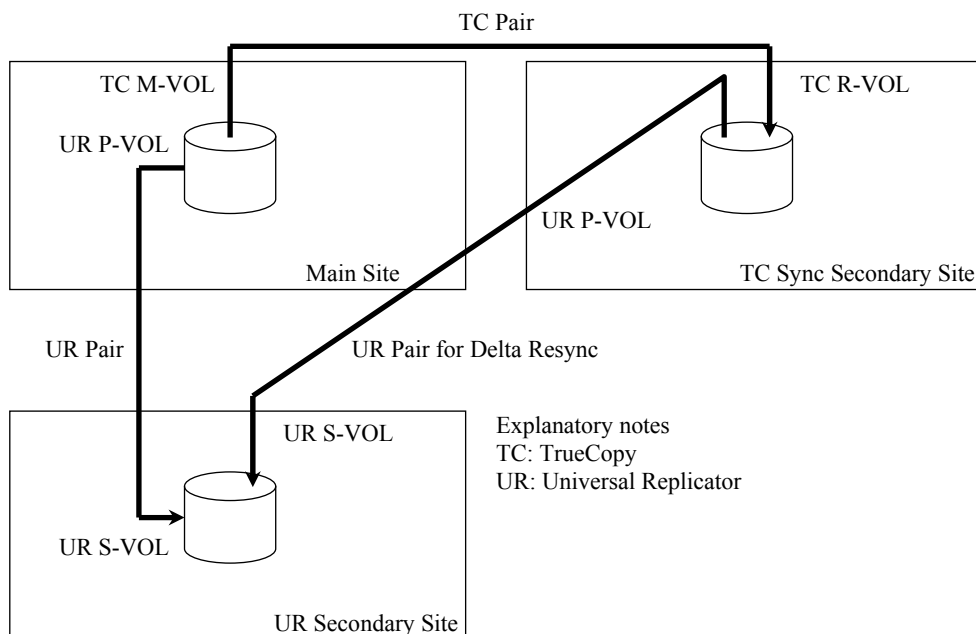


Fig. 3.11.4-4 3D Multi Target Configuration (Universal Replicator)

Table 3.11.4-3 The Status of Each Pair when P-VOL of UR Pair for Delta Resync is Set as a Source Volume

Pair	Pair Status
TC Pair	PSUS
UR Pair	Random Pair Status
UR Pair for Delta Resync	HOLD or HLDE

Table 3.11.4-4 The Status of Each Pair when S-VOL of UR Pair for Delta Resync is Set as a Source Volume

Pair	Pair Status
TC Pair	Random Pair Status
UR Pair	PSUS
UR Pair for Delta Resync	HOLD or HLDE

For volumes that form an ShadowImage for Mainframe pair or an ShadowImage pair, it depends on the status or configuration of the pair whether the volumes can be used as source volumes, as explained below:

- If the status of the pair is not SP-Pend/V-Split, the volumes can be used as source volumes. If the status of the pair is SP-Pend/V-Split, the volumes cannot be used as source volumes.
- The table below explains whether volumes that do not form a cascade pair can be used as source volumes:

Table 3.11.4-5 Whether volumes that do not form a cascade pair can be used as source volumes

If the pair is configured as follows	Can P-VOLs be used as source volumes?	Can S-VOLs be used as source volumes?
If the ratio of P-VOLs to S-VOLs is 1:1	Yes	Yes
If the ratio of P-VOLs to S-VOLs is 1:2	Yes	Yes
If the ratio of P-VOLs to S-VOLs is 1:3	No	Yes

- The table below explains whether volumes that form a cascade pair can be used as source volumes:

Table 3.11.4-6 Whether volumes that form a cascade pair can be used as source volumes

If the pair is configured as follows	Can P-VOLs be used as source volumes?	Can S-VOLs be used as source volumes?
If the pair is an L1 pair and the ratio of P-VOLs to S-VOLs is 1:1	Yes	Yes
If the pair is an L1 pair and the ratio of P-VOLs to S-VOLs is 1:2	Yes	Yes
If the pair is an L1 pair and the ratio of P-VOLs to S-VOLs is 1:3	No	Yes
If the pair is an L2 pair and the ratio of P-VOLs to S-VOLs is 1:1	Yes	No
If the pair is an L2 pair and the ratio of P-VOLs to S-VOLs is 1:2	No	No

NOTE: If any of the following operations is performed on a source volume, the volume migration process stops:

- XRC operation
- CC operation
- TrueCopy for Mainframe/TrueCopy operation that changes the volume status to something other than suspended
- ShadowImage (ShadowImage for Mainframe/ShadowImage) operation that changes the volume status to SP-Pend/V-Split.
- Universal Replicator for Mainframe operation or Universal Replicator operation which seems to make the volumes the status of COPY

(b) Target volumes:

Target volumes must be reserved prior to migration. The Volume Migration Web Console software allows you to reserve volumes as Volume Migration target volumes.

Hosts cannot access Volume Migration-reserved volumes.

The following volumes cannot be used as target volumes:

- Volumes which are set as command devices (devices reserved for use by the host)
- Volumes which are assigned to Hitachi ShadowImage (ShadowImage for Mainframe/ShadowImage) or Hitachi Remote Copy (TrueCopy for Mainframe/TrueCopy) pairs
- Volumes which are used by XRC
- Volumes which are used by Concurrent Copy (CC)
- Volumes which are reserved for ShadowImage operations
- Volumes which have FlashAccess (also called DCR) data stored in cache
- Volumes which are in an abnormal or inaccessible condition (e.g., pinned track, fenced)
- Onlined volume
- Volumes which are used by Universal Replicator (Primary Data Volume, Secondary Data Volume and Journal Volume)
- Volumes which are set as Read Only or Protect from Volume Retention Manager
- Volumes which are set as T-VOL/R-VOL Disabled from Volume Security
- Volumes which are set as Read Only, Protect or S-VOL Disable from Data Retention Utility
- Volumes on which CCI is performing volume migration operation
- Volumes that form a Thin Image pair
- Virtual volumes and pool volumes
- Volume executing Quick Format
- The Dynamic Provisioning/Dynamic Provisioning for Mainframe V-VOL whose capacity is being expanded

(c) Specifying Volumes:

Source volumes and Target volumes are specified by LDEV number.

An open volume is also specified by one LDEV number.

(d) Moving of multi volumes:

Moving of volumes can be performed by repeating instruction about each volume.

In using Volume Migration for manual volume migration, the number of migration plans that can be executed concurrently might be restricted. The number of migration plans that can be executed concurrently depends on the following conditions.

- How much shared memory is available for differential tables:
You may use 57,600 differential tables if no additional shared memory for differential tables is installed.
You may use 419,200 differential tables if additional shared memory for differential tables is installed.
- How much shared memory is available for pair tables:
You may use 8,192 pair tables if no additional shared memory for differential tables is installed.
You may use 32,768 pair tables if additional shared memory for differential tables is installed.
To install additional shared memory for differential tables, please call the Support Center.
- The emulation type and capacity of each volume to be migrated:
The number of differential tables, pair tables needed to migrate one volume differs depending on the emulation type and size of the volume. For the number of differential tables, pair tables needed for migrating a mainframe volume, see section (i). For the number of differential tables, pair tables needed for migrating an open-system volume, see section (ii).

You can estimate the maximum number of migration plans that can be executed concurrently by applying the above conditions into the following equation:

NOTICE: $\Sigma (\alpha) \leq (\beta)$
and
 $\Sigma (\gamma) \leq (\delta)$

$\Sigma (\alpha)$ stands for the total number of differential tables needed for migrating all volumes (β) stands for the number of differential tables available in the DKC810I storage system.

$\Sigma (\gamma)$ stands for the total number of pair tables needed for migrating all volumes (δ) stands for the number of pair tables available in the DKC810I storage system.

For example, if you want to create 20 migration plans of OPEN-3 volumes (size of a volume is 2,403,360 kilobytes), the number of the required differential tables is 3, the number of the required pair tables is 1 that can be found by the calculation described in section (ii). When you apply this number to the equation, it will be as follows:

$$[(3 \times 20) = 60] \leq 57,600$$

and

$$[(1 \times 20) = 20] \leq 8,192$$

Since this equation is true, you can create all the migration plans that you wish to create.

In this section, we mentioned the calculation of the maximum number of migration plans when only Volume Migration is running. However, in fact, the total number of differential tables used by ShadowImage, ShadowImage for z/OS (R), and Volume Migration should be within the value of (β), and the total number of pair tables used by ShadowImage, ShadowImage for z/OS (R), Volume Migration should be within the value of (δ). For details on how to calculate the number of differential tables, pair tables used by the programs other than Volume Migration, please refer to the following manuals:

- For ShadowImage, please refer to “Hitachi ShadowImage (R) User Guide”.
- For ShadowImage for z/OS (R), please refer to “Hitachi ShadowImage for Mainframe User Guide”.

(i) Calculating Differential Tables, Pair Tables Required for Mainframe Volume Migration

When you migrate mainframe volumes, use the following expression to calculate the total number of the required differential tables, pair tables per migration plan.

NOTICE: Total number of the differential tables per migration plan
$$= ((X) + (Y)) \times 15 \div (Z)$$

(X): The number of the cylinders of the volume to be migrated. *

(Y): The number of the control cylinders. (See Table 3.11.4-7)

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

*: If the volume is divided by the VLL function, this value means the number of the cylinders of the divided volume.

Note that you should round up the number to the nearest whole number.

For example, in case of a volume which emulation type is 3390-3, and when provided that the number of the cylinders of the volume is 3,390 ((X) in the expression above), the calculation of the total number of the differential table is as follows.

$$(3,339 + 6) \times 15 \div (20,448) = 2.453785211$$

When you round up 2.453785211 to the nearest whole number, it becomes 3.

Therefore, the total number of the differential table for one migration plan is 3 when emulation type is 3390-3.

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

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

Table 3.11.4-7 The Number of the Control Cylinders According to the Emulation Types

Emulation Type	Number of the Control Cylinders
3390-3	6
3390-3A	6
3390-3B	6
3390-3C	6
3390-9	25
3390-9A	25
3390-9B	25
3390-9C	25
3390-L	23
3390-LA	23
3390-LB	23
3390-M	53
3390-MA	53
3390-MB	53
3390-MC	53
3390-LC	23
3390-A	53 (*1)

*1: This value is different from an actual number of control cylinders in 3390-A.
This value is used to calculate the number of differential table for a pair of Volume Migration.

(ii) Calculating Differential Tables, Pair Tables Required for Open-System Volume Migration

When you migrate open-system volumes, use the expression in Table 3.11.4-8 to calculate the total number of the required differential tables, pair tables per migration plan.

Table 3.11.4-8 The Total Number of the Differential Tables Per Migration Plan

Emulation Type	Expression
OPEN-3	Total number of the differential tables per migration plan = $((X) \div 48 + (Y) \times 15) \div (Z)$ (X): The capacity of the volume to be migrated. (kilobyte) (*1) (Y): The number of the control cylinders. (See Table 3.11.4-9) (Z): The number of the slots that can be managed by a differential table. (20,448)
OPEN-8	
OPEN-9	
OPEN-E	Note that you should round up the number to the nearest whole number. For example, if the emulation type of a volume is OPEN-3, and when provided that the number of the cylinders of the volume is 2,403,360 kilobytes ((X) in the expression above), the calculation of the total number of the differential tables is as follows. $(2,403,360 \div 48 + 8 \times 15) \div 20,448 = 2.454518779$ When you round up 2.454518779 to the nearest whole number, it becomes 3. Therefore, the total number of the differential tables for one migration plan is 3 when emulation type is OPEN-3. In addition, 1 pair tables per 36 differential tables is used. The number of pair tables used for above-mentioned OPEN-3 becomes 1.
OPEN-L	
OPEN-V	Total number of the differential tables per migration plan = $((X) \div 256) \div (Z)$ (X): The capacity of the volume to be migrated. (kilobyte) (*1) (Z): The number of the slots that can be managed by a differential table. (20,448) Note that you should round up the number to the nearest whole number. For example, if the emulation type of a volume is OPEN-V, and when provided that the number of the cylinders of the volume is 3,019,898,880 kilobytes ((X) in the expression above), the calculation of the total number of the differential tables is as follows. $(3,019,898,880 \div 256) \div 20,448 = 576.9014085$ When you round up 576.9014085 to the nearest whole number, it becomes 577. Therefore, the total number of the differential tables for one migration plan is 577 when emulation type is OPEN V. In addition, 1 pair tables per 36 differential tables is used. The number of pair tables used for above- mentioned OPEN-V becomes 17. The emulation type of the case to use the two or more pair tables with the open system is only OPEN-V.

*1: If the volume is divided by the VLL function, this value means the capacity of the divided volume. Note that if the emulation type is OPEN-L, the VLL function is unavailable.

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

Table 3.11.4-9 The Number of the Control Cylinders According to the Emulation Types

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

(e) Abort moving:

Users can direct to abort the instructed moving before completion.

With aborting, the data in the destination volume is not guaranteed.

Users can direct to abort by each LDEV.

(f) Notice when the DKC is maintenance:

Volume migration may be failed if you start the following action:

(i) Replace Cache/HDD

(ii) Install/deinstall Cache/HDD

(iii) Change of SM capacity setting

(2) Conditions for moving

Data moving is performed when all conditions about source volume and destination volume described below are satisfied.

(a) Both of the volumes have same emulation type.

(b) Both of the volumes have same size.

(c) There is no PIN data in the source volume.

(d) Both of the volumes are not blockade.

(e) Both of the volumes in same DKC.

(f) The volumes are not instructed to move already and not waiting to move.

(g) The volumes are not combination of CVS Volume and Normal Volume.

(3) Viewing History

Users can see the history of volume moving (migration).

3.11.5 Decision of volume moving (migration)

Volume Migration supports decision of users about storage system performance tuning by logical volume moving (migration). This section describes usage and points to notice about monitor function.

(1) Inspecting utilization of system resources

First of all, using monitoring function, a user investigates MP utilization, Startnet utilization, DRR utilization, RAID group utilization. a user investigates whether there exists overloaded resources, or imbalance of resource utilization. Then the user tunes resource utilization in the manner described in the following clause.

NOTE: Due to average system resource utilization, there will be such a case as a portion of system performance will be negatively effective although total performance of a system will be improved. For example, if there exists RAID groups A and B of utilization 20% and 90% respectively, and if the utilization will become 55% and 55% if a logical volume residing in parity group B moves parity group A. Then response time of I/Os to parity group A will be increased while response time of I/Os and throughput to parity group B will be improved.

(2) Tuning Starnet utilization

Since Starnet are common resources in DKC710I, migration of logical volumes does not improve system performance. The user should consider migration the data to other DKC.

(3) Tuning MP utilization

Migration of logical volumes does not improve MP performance. Therefore if MPs are overloaded on an average, the user should consider installation of new MPs. And if the utilization of MPs are imbalance, the user should consider that channel paths connecting to a CHA, which includes overloaded MPs, is reconfigured into the connection to another CHA which includes MPs of lower utilization.

(4) Tuning DRR utilization

If utilization of DRRs is in high average, the user should consider installing new DKAs and HDDs or migration logical volumes of RAID5/6 to RAID1 or migration the data to other DKC. After installation of DKAs and HDDs, logical volumes which had high traffic of write access (especially of sequential write access) should be migrated to a parity group in newly installed HDDs. The estimate function cannot simulate the DRR utilization.

(5) Tuning RAID group utilization

If parity groups are in high utilization, the user should consider installing new HDDs. After installation of HDDs, logical volume which had high traffic of I/Os should be migrated to a parity group in newly installed HDDs by reference RAID group utilization on a logical volume.

If utilization of each parity group is imbalanced, the user should consider migration of logical volumes from the current parity group showing high utilization to the one showing lower utilization.

These methods should be applied with a view to large improvement. There would be least improvement in a case of slight difference of utilization of each parity group, or if DRRs or DKPs are already comparatively highly utilized.

If a number of the condition are right, the user should decide to do considering each examination items.

When errors exist in the system, utilization of system resource can increase or be unbalanced

3.12 Data Assurance at a Time When a Power Failure Occurs

Refer to “2.2.3 (9) Battery” ([THEORY02-02-180](#)) for the operation to be done when a power failure occurs.

3.13 PAV

3.13.1 Overview

3.13.1.1 Overview of PAV

PAV (Parallel Access Volume) enables a host computer to issue multiple I/O requests in parallel to a device in the storage system. Usually, when a host computer issues one I/O request to a device, the host computer is unable to issue another I/O request to that device. However, PAV enables you to assign one or more aliases to a single device so that the host computer is able to issue multiple I/O requests. In this way, PAV provides the host computer with substantially faster access to data in the storage system.

When assigning an alias to a device, you choose one of unused LDEVs (logical devices or logical volumes) in the disk storage system and specify the LDEV's address. The specified address is used as the alias address. You can choose multiple LDEVs to use as aliases.

Throughout this manual, the term “base device” or “base volume” refers to a device to which aliases will be assigned. Also, the term “alias device” or “alias volume” refers to an alias.

PAV operates in either of the following ways: static PAV and dynamic PAV. These are described next:

■ Static PAV

When static PAV is used, the number of aliases for each base device does not change by load fluctuations in I/O requests. As explained later, when dynamic PAV is used, the number of aliases for a base device is likely to increase as the number of I/O requests to the device increases; this means the number of aliases for other base devices may decrease. However, when static PAV is used, the number of aliases remains as specified by the Web Console user or SVP operation user.

Before you assign aliases to base devices, you should consider whether I/O requests will converge on some of the base devices. We recommend that you assign more aliases to the base devices where I/O requests are expected to converge, and assign less aliases to the base devices where the I/O request load would be low.

The following figure gives an example of static PAV. In this figure, each of the three base devices (numbered 10, 11, and 12, respectively) has two aliases assigned. I/O requests converge on the base device #10, but the number of aliases for each base device remains unchanged.

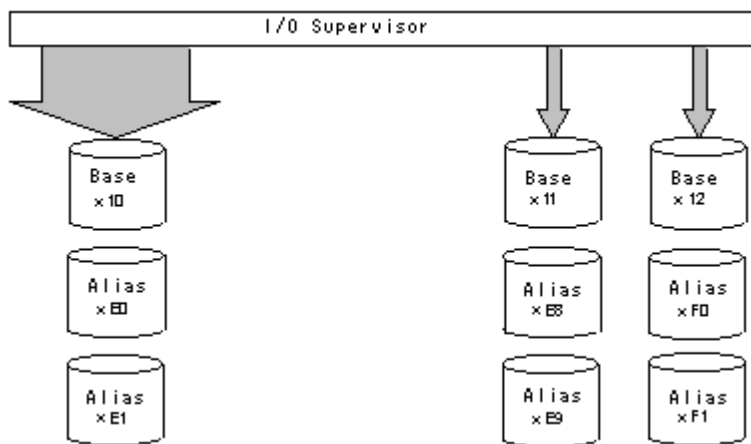


Fig. 3.13.1.1-1 Static PAV

■ Dynamic PAV

When dynamic PAV is used, the number of aliases of a base device may change by load fluctuations in I/O requests. If I/O requests converge on one base device, the number of aliases of the base device may increase, whereas the number of aliases of other base devices on which the I/O request load is low may decrease. Dynamic PAV can balance workloads on base devices and optimize the speed for accessing data in the storage system.

The following figure gives an example of dynamic PAV. In this example, each of the three base devices (#10, #11, and #12) was originally assigned two aliases. As I/O requests converge on #10, the number of aliases for #10 increases to four. For the base devices #11 and #12, the number of aliases decreases to one.

Dynamic PAV requires the Workload Manager (WLM), a special function provided by the operating system on the host computer. For details, see sections 3.13.2.1 and 3.13.2.2.

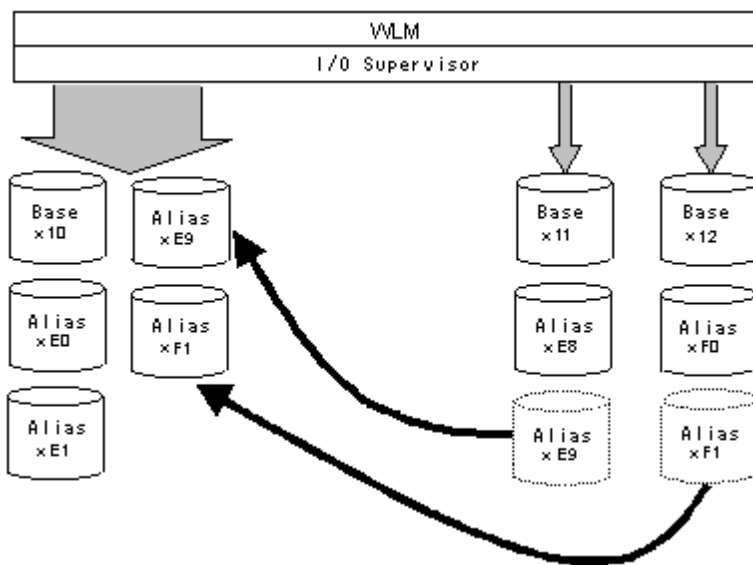


Fig. 3.13.1.1-2 Dynamic PAV

3.13.1.2 How to Obtain Optimum Results from PAV

To obtain good results from PAV, you should be aware of the following:

- The best results can be obtained if the number of aliases is “Number of available channel paths minus 1”. If the number of aliases is specified this way, I/O operations can use all the channel paths, and thus the best results can be obtained.
- PAV may not produce good results when many channel paths are used. If all the channel paths are used, no good results can be expected.
- PAV lets you assign unused devices for use as aliases. If you assign most of the unused devices for use as aliases, only a small amount of free devices are available. It is recommended that you think about adding more disks in the future when you determine the number of aliases to be assigned.

If we assume that there are 256 devices and we assign the same number of alias devices to each base devices, the number of base devices and alias devices is calculated as explained in Table 3.13.1.2-1. The recommended ratio of base devices to alias devices is 1:3.

If you can expect the types of jobs to be passed to base devices, or if you can expect how many accesses should be made to each base device, you should determine the number of aliases for each base device so that it meets the requirements for each base device.

Table 3.13.1.2-1 The ratio of base devices to aliases

Ratio (base devices : alias devices)	The number of base devices	The number of alias devices
1:3 (recommended)	64	192
1:1	128	128

- Good results cannot be expected on devices that are always shared and used by multiple host computers.
- If dynamic PAV can be used in all the systems, good results can be expected if you assign 8 to 16 aliases to each CU (control unit).

3.13.2 Preparing for PAV Operations

3.13.2.1 System Requirements

To be able to run, PAV requires the following operating systems to be installed on the host computer:

- For static PAV
 - OS/390 V1R3 (DFSMS/DSF 1.3) with Program Temporary Fix (PTF) or later
 - VM/ESA 2.4.0 or later
- For dynamic PAV
 - OS/390 V2R7 (DFSMS/DSF 1.5) with PTF or later
 - z/VM5.2 with PTF or later
- For Hyper PAV
 - z/OS 1.8 or later
 - z/OS 1.6 with PTF or later
 - z/VM5.3 or later

NOTE: When you use z/VM, it is a premise to use z/OS as a guest OS on z/VM.

NOTE: To perform operations with PAV, you must have administrator access privileges.
Users who do not have administrator access privileges can only view PAV information.
The following restrictions apply when using PAV.

Table 3.13.2.1-1 Restrictions that apply when using PAV

No.	Item	Specifications
1	DKC emulation type	I-2107
2	DKU emulation type	3390-3, 3390-9, 3390-L, 3390-M, 3390-A
3	Number of aliases that can be assigned to a single base device	Up to 255
4	Alias device numbers that can be used	When you set an alias of a base device, the alias device number you can use is a device number of unused devices which is on the same CU (Control Unit) with the base device. A device on the different CU cannot be used as an alias. When you set aliases for base devices, you must be aware that the alias devices and the base devices must belong to the same CU.
5	Device functions that can concurrently be used with PAV	• Customized Volume Size (CVS) • Dynamic Cache Residence (DCR) • Volume Security
6	Device functions that cannot concurrently be used with PAV	• Cross-OS File Exchange – Do not intermingle a device used by Cross-OS File Exchange in CU (Control Unit) including a device performed by PAV. – Do not change DKU emulation type of a device performed by PAV to a DKU emulation type to use by Cross-OS File Exchange.
7	Copy functions that can concurrently be used with PAV	• TrueCopy for Mainframe – Do not mix DKC emulation type 2107 and the other DKC emulation types in one chassis. If mixed, an MIH message may be reported to the other emulation side host. • Concurrent Copy (CC) / XRC – No restrictions on DKC emulation types. • ShadowImage for Mainframe / Volume Migration – No restrictions on DKC emulation types.

3.13.2.2 Preparations at the Host Computer

This section briefly describes arrangements that should be made at the host computer. For detailed information, see the documentation for MVS.

3.13.2.2.1 Generation Definition of Base Devices and Alias Addresses

The address mapping between base devices and the corresponding alias devices must be defined at generation.

The address mapping between base devices and alias devices at the host computer should match the corresponding address mapping at the DKC side. If it does not match, a serious failure might occur during data processing.

The following gives an example of mapping between base devices and aliases devices:

(A)	x 00-x1F:Base	(B)	x 00-x3F:Base	(C)	x 00-x7F:Alias	(D)	x 00-x3F:Alias
	x 20-xFF:Alias		x 40-x7F:Alias		x 80-xFF:Base		x 40-x7F:Base
			x 80-xBF:Base				x 80-xBF:Alias
			x C0-xFF:Alias				x C0-xFF:Base

NOTE: The recommended ratio of base devices to aliases is 1:3, if each base device is assumed to be assigned the same number of aliases.

3.13.2.2.2 Setting the WLM Operation Mode

If you want to use dynamic PAV, you must set the WLM (Workload Manager) operation mode to goal mode. WLM manages workloads on MVS and can use two operation modes, which include goal mode. In goal mode, WLM manages the system to fulfill the performance goal that was specified when installing the system.

You should be aware that static PAV is used instead of dynamic PAV if compatibility mode is used instead of goal mode.

For details and how to set the WLM operation modes, see the documentation for MVS.

3.14 Hyper PAV

3.14.1 Overview of Hyper PAV

Hyper PAV was evolved from static PAV and dynamic PAV.

If you use Hyper PAV, alias devices that were assigned to a base device are shared with all base devices in the same CU. Thereby, alias devices do not need to be shifted by dynamic PAV.

Moreover, you can use more devices for a base device than when you use PAV because you can reduce devices to be assigned as alias devices.

You can specify the type of PAV (PAV or Hyper PAV) to use for each host computer. Therefore, an alias device may accept I/O requests that are issued from both PAV and Hyper PAV.

NOTE: When you use z/VM, it is a premise to use z/OS as a guest OS on z/VM.

3.14.2 Hyper PAV function setting procedure

This section describes the procedures for installing and uninstalling Hyper PAV. The procedure depends on whether Hyper PAV is used from z/OS or from z/OS used as a guest OS on z/VM. The following subsections describe each procedure.

This appendix also describes the point to be checked when you change the setting to enable or disable Hyper PAV on the host computer and when you restart DKC810I while using Hyper PAV.

NOTE: When you use Hyper PAV on z/VM, DKC810I has to be defined as a support device of z/VM.

■ Conventions used in this section

This section uses the following symbols and typefaces to explain each command operation:

italics

Indicates the type of the input value. You can input an arbitrary value.

- (hyphen)

Specifies the range to enable the setting (for example, 8101-81FF).

3.14.2.1 Installing Hyper PAV

3.14.2.1.1 Using Hyper PAV from z/OS

To install Hyper PAV when you use Hyper PAV from z/OS:

1. Upgrade the host software to support Hyper PAV, that is, z/OS 1.8 or later, or z/OS 1.6 with PTF or later.
2. Install the PAV software.
3. Install the Compatible Hyper PAV software.
4. Assign aliases.
If it is a new installation and you have already assigned aliases to base volumes for Hyper PAV, skip this step.
5. On the host computer, enable Hyper PAV.
6. Issue the DEVSERV QPAV command from the host to make sure that the displayed aliases are those assigned for Hyper PAV.

■ Aliases for Hyper PAV are not displayed by the DEVSERV QPAV command.

Execute either of the following operations, and then issue the DEVSERV QPAV command and check the display again.

- If the host accesses only the corresponding DKC810I, disable Hyper PAV on the host computer, and then enable Hyper PAV again.
- If the host accesses other storage systems that use Hyper PAV, issue the following commands from the host to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2, OFFLINE
CF CHP(channel-path1 - channel-path2), OFFLINE
CF CHP(channel-path1 - channel-path2), ONLINE
V base-device-number1 - base-device-number2, ONLINE
```

■ Cross-OS File Exchange is used on the host computer.

After performing the installation of Hyper PAV as mentioned above, issue the following commands to all Cross-OS File Exchange volumes.

```
V Cross-OS-File-Exchange-volume-number1 - Cross-OS-File-Exchange-volume-number2, OFFLINE
V Cross-OS-File-Exchange-volume-number1 - Cross-OS-File-Exchange-volume-number2, ONLINE
```

3.14.2.1.2 Using Hyper PAV from z/OS Used as a Guest OS on z/VM

To install Hyper PAV when you use Hyper PAV from z/OS that is used as a guest OS on z/VM:

1. Upgrade the host software to support Hyper PAV.
z/VM: z/VM 5.3 or later
z/OS (guest OS): 1.8 or later, or z/OS 1.6 with PTF or later
2. Install the PAV software.
3. Install the Compatible Hyper PAV software.
4. Assign aliases.
If your installation is a new DKC810I, and you have already assigned aliases to the base volumes for Hyper PAV, skip this step.
5. On z/VM, enable Hyper PAV.
6. On z/OS which is used as a guest OS on z/VM, enable Hyper PAV.
7. Issue the QUERY PAV command from z/VM, and make sure that the displayed aliases are those assigned for Hyper PAV.
8. Issue the DEVSERV QPAV command from z/OS, and make sure that the displayed aliases are those assigned for Hyper PAV.

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- Aliases for Hyper PAV are not displayed by the DEVSERV QPAV command issued from z/OS or QUERY PAV command issued from z/VM.

Execute either of the following operations, and then issue the command and check the display again.

- If the host accesses only the corresponding DKC810I, disable Hyper PAV on the host computer, and then enable Hyper PAV again.
 - If the host accesses other storage systems that use Hyper PAV, execute the following procedure.
- a) Issue the following command from z/OS which is used as a guest OS on z/VM to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2,OFFLINE
```

- b) Issue the following commands from z/VM to all base devices and alias devices used for Hyper PAV in the corresponding CU.

```
DET alias-device-number1 - alias-device-number2
DET base-device-number1 - base-device-number2
VARY OFFLINE alias-device-number1 - alias-device-number2
VARY OFFLINE base-device-number1 - base-device-number2
VARY OFFLINE CHPID channel-path1
VARY OFFLINE CHPID channel-path2
:
VARY ONLINE CHPID channel-path1
VARY ONLINE CHPID channel-path2
:
VARY ONLINE base-device-number1 - base-device-number2
VARY ONLINE alias-device-number1 - alias-device-number2
ATT base-device-number1 - base-device-number2*
ATT alias-device-number1 - alias-device-number2*
```

- c) Issue the following command from z/OS to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2,ONLINE
```

- d) Issue the following command from z/OS to all channel paths configured on the corresponding CU. The command has to be issued for each channel path.

```
V PATH(base-device-number1 - base-device-number2, channel-path),ONLINE
```

3.14.2.2 Restarting the DKC810I While Using Hyper PAV

3.14.2.2.1 Using Hyper PAV from z/OS

When you restart a DKC810I storage system while using Hyper PAV, issue the DEVSERV QPAV command from the host after restarting the DKC810I. Make sure that the aliases displayed as the ones assigned for Hyper PAV. If these aliases cannot be displayed as for Hyper PAV, issue the following commands from the host to all base devices in the corresponding CU, and then check again.

```
V base-device-number1 - base-device-number2,OFFLINE
CF CHP(channel-path1 - channel-path2),OFFLINE
CF CHP(channel-path1 - channel-path2),ONLINE
V base-device-number1 - base-device-number2,ONLINE
```

3.14.2.2.2 Using Hyper PAV from z/OS which is Used as a Guest OS on z/VM

When you restart a DKC810I storage system while using Hyper PAV, issue the DEVSERV QPAV command from z/OS, and the QUERY PAV command from z/VM, after restarting the DKC810I. Make sure that the aliases displayed as the ones assigned for Hyper PAV. If these aliases cannot be displayed as for Hyper PAV, execute the following procedure and then check again.

1. Issue the following command from z/OS which is used as a guest OS on z/VM to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2,OFFLINE
```

2. Issue the following commands from z/VM to all base devices and alias devices used for Hyper PAV in the corresponding CU.

```
DET alias-device-number1 - alias-device-number2
DET base-device-number1 - base-device-number2
VARY OFFLINE alias-device-number1 - alias-device-number2
VARY OFFLINE base-device-number1 - base-device-number2
VARY OFFLINE CHPID channel-path1
VARY OFFLINE CHPID channel-path2
:
VARY ONLINE CHPID channel-path1
VARY ONLINE CHPID channel-path2
:
VARY ONLINE base-device-number1 - base-device-number2
VARY ONLINE alias-device-number1 - alias-device-number2
ATT base-device-number1 - base-device-number2*
ATT alias-device-number1 - alias-device-number2*
```

3. Issue the following command from z/OS to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2,ONLINE
```

4. Issue the following command from z/OS to all channel paths set on the corresponding CU. The command has to be issued to each channel path.

```
V PATH(base-device-number1 - base-device-number2, channel-path),ONLINE
```

3.14.2.3 Changing the Hyper PAV Setting on z/OS While Using Hyper PAV

If you change the setting to enable or disable Hyper PAV on z/OS while using Hyper PAV, and if you use Cross-OS File Exchange on z/OS computer, issue the following commands to all Cross-OS File Exchange volumes after you enable or disable Hyper PAV on the host computer.

```
V Cross-OS-File-Exchange-volume-number1 - Cross-OS-File-Exchange-volume-number2, OFFLINE
V Cross-OS-File-Exchange-volume-number1 - Cross-OS-File-Exchange-volume-number2, ONLINE
```

3.14.2.4 Uninstalling Hyper PAV

3.14.2.4.1 Using Hyper PAV from z/OS

To uninstall Hyper PAV when you use Hyper PAV from z/OS:

1. On the host computer, disable Hyper PAV.
2. Uninstall the Compatible Hyper PAV software.
For information on uninstall of Storage Navigator software, please refer to “Hitachi Command Suite User Guide” or “Hitachi Virtual Storage Platform G1000 Mainframe System Administrator Guide”.
3. Execute the **DEVSERV (DS)** command as shown below from the host to a device per CU:
DS QD,xxx,VALIDATE (xxx = device number)
4. Issue the DEVSERV QPAV command and make sure that the displayed aliases are those assigned for Hyper PAV.

- Hyper PAV and Cross-OS File Exchange are still used on the other storage systems which are accessed from the corresponding host:

Execute the following procedure to uninstall Hyper PAV only from the target DKC810I.

1. Issue the following commands to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2,OFFLINE
CF CHP(channel-path1 - channel-path2),OFFLINE
```

2. Uninstall the Compatible Hyper PAV software.
For information on uninstall of Storage Navigator software, please refer to “Hitachi Command Suite User Guide” or “Hitachi Virtual Storage Platform G1000 Mainframe System Administrator Guide”.

3. Issue the following commands to all base devices in the corresponding CU.

```
CF CHP(channel-path1 - channel-path2),ONLINE
V base-device-number1 - base-device-number2,ONLINE
```

4. Issue the DEVSERV QPAV command and check whether the aliases assigned for Hyper PAV are displayed.

- Aliases for Hyper PAV are still displayed by the DEVSERV QPAV command.

Execute either of the following operations, and then issue the command and check the display again.

- If the host accesses only the corresponding DKC810I, enable Hyper PAV on the host computer, and then disable Hyper PAV again.
- If the host accesses other storage systems that use Hyper PAV, execute the following commands to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2,OFFLINE
CF CHP(channel-path1 - channel-path2),OFFLINE
CF CHP(channel-path1 - channel-path2),ONLINE
V base-device-number1 - base-device-number2,ONLINE
```

3.14.2.4.2 Using Hyper PAV from z/OS which is Guest OS on z/VM

To uninstall Hyper PAV when you use Hyper PAV from z/OS that is used as a guest OS on z/VM:

1. On the host computer, disable Hyper PAV.
2. Uninstall the Hyper PAV software.
For information on uninstall of Storage Navigator software, please refer to “Hitachi Command Suite User Guide” or “Hitachi Virtual Storage Platform G1000 Mainframe System Administrator Guide”.
3. Execute the **DEVSERV (DS)** command as shown below from z/OS which is used as a guest OS on z/VM to an arbitrary device per CU:
DS QD,xxx,VALIDATE (xxx = device number)
4. Issue the QUERY PAV command from z/VM to check whether the aliases assigned for Hyper PAV are displayed.
5. Issue the DEVSERV QPAV command from z/OS to check whether the aliases assigned for Hyper PAV are displayed.

- Aliases for Hyper PAV are still displayed by the DEVSERV QPAV command issued from z/OS or QUERY PAV command issued from z/VM.

Execute either of the following operations, and then issue DEVSERV QPAV command or QUERY PAV command and check the display again.

- If the host accesses only the corresponding DKC810I, enable Hyper PAV on the host computer, and then disable Hyper PAV again.
- If the host accesses other storage systems that use Hyper PAV, execute the following procedure.

- a) Issue the following command from z/OS which is guest OS on z/VM to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2,OFFLINE
```

- b) Issue the following commands from z/VM to all base devices and alias devices used for Hyper PAV in the corresponding CU.

```
DET alias-device-number1 - alias-device-number2
DET base-device-number1 - base-device-number2
VARY OFFLINE alias-device-number1 - alias-device-number2
VARY OFFLINE base-device-number1 - base-device-number2
VARY OFFLINE CHPID channel-path1
VARY OFFLINE CHPID channel-path2
:
VARY ONLINE CHPID channel-path1
VARY ONLINE CHPID channel-path2
:
VARY ONLINE base-device-number1 - base-device-number2
VARY ONLINE alias-device-number1 - alias-device-number2
ATT base-device-number1 - base-device-number2*
ATT alias-device-number1 - alias-device-number2*
```

- c) Issue the following command from z/OS to all base devices in the corresponding CU.

```
V base-device-number1 - base-device-number2,ONLINE
```

- d) Issue the following command from z/OS to all channel paths configured on the corresponding CU. The command has to be issued to each channel path.

```
V PATH(base-device-number1 - base-device-number2, channel-path),ONLINE
```


3.15 FICON

3.15.1 Introduction

FICON is a new mainframe architecture based on FC-SB-2/FC-SB-3/FC-SB-4/FC-SB-5 protocol which is Fiber channel physical layer protocol (FC-PH) to which the mainframe protocol is mapped.

The specification of FICON is below.

- Full duplex data transfer
- Multiple concurrent I/O operations on channel
- High bandwidth data transfer (200MB/s, 400MB/s, 800MB/s)
- Interlock reduction between disk controller and channel
- Pipelined CCW execution
- High Performance FICON (HPF) function

3.15.2 FICON specification

Table 3.15.2-1 shows the specification of FICON support DKC.

Table 3.15.2-1 FICON support DKC specification

Items		Contents
Support DKC emulation type		I-2107
Range of CU address (*3)		0 to FE
Number of logical volumes (*4)		1 to 65280
Number of connectable channel port		16 to 80 (*1) 16 to 176 (*2)
Maximum number of logical paths per CU		2048
Maximum number of logical paths per port (*5)		261120
Maximum number of logical paths per CHA		261120
Maximum number of logical paths per storage system		522240
Support fiber channel	Bandwidth	2Gbps/4Gbps/8Gbps
	Cable and connector	LC-Duplex
	Mode	Single Mode Fibre/Multi Mode Fibre

*1: In case of the one module component.

*2: In case of the two module components.

*3: When the number of CUs per FICON channel (CHPID) exceeds the limitation, there is a possibility that HOST OS IPL fails.

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

*5: The maximum number of connectable hosts per FICON port is 1024.
(1024 host paths × 255 CUs = 261120 logical paths for 2107-900 emulation.)

3.15.3 Configuration

(1) Topology

The pattern of connection between FICON and channel are such as below.

- Point to point connection
- Switched point to point connection
- Non cascading connection
- Cascading connection

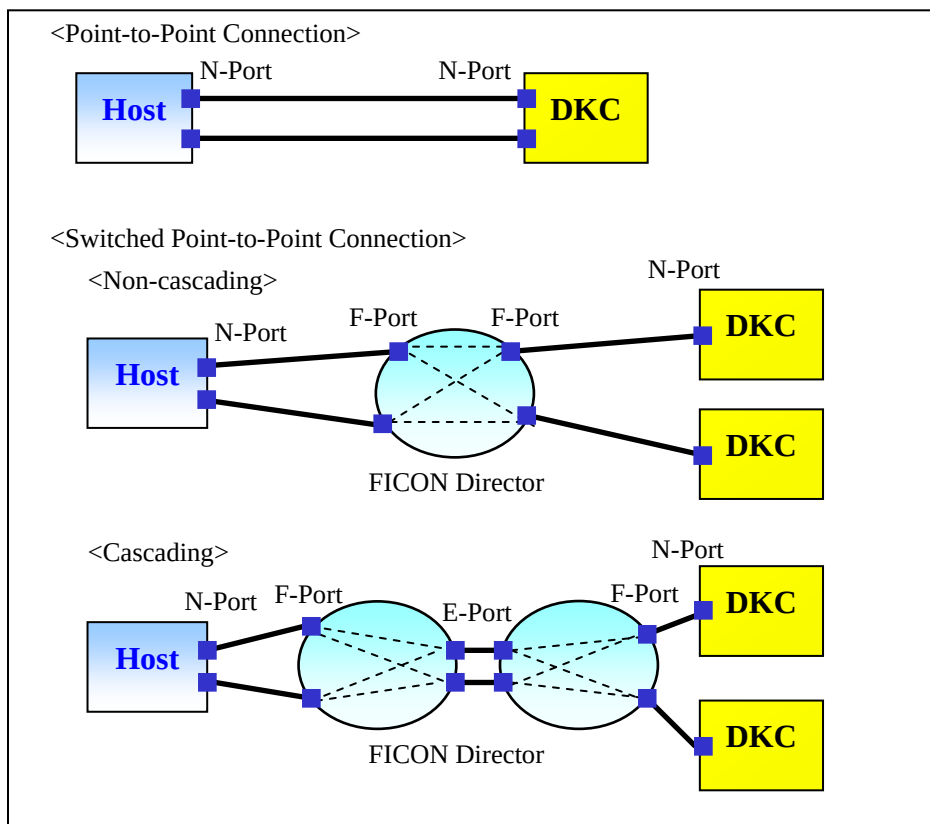


Fig. 3.15.3-1 FICON Topology

3.15.4 The operation procedure

(1) Notice about Speed Auto Negotiation

A stable physical environment (fully mated connectors, no cable flexing, no transient noise sources, etc.) is expected on Speed Auto Negotiation. Otherwise, Speed Auto Negotiation may settle to not the fastest speed but an optimum speed.

To change into the fastest speed, check that the physical environment is stable, and then either of the following operation is required.

Confirm the Link speed from the 'Physical path status' window of DKC after executing each operation.

- DKC PS OFF/ON
- Dummy replace the package including the FICON ports
- Remove and insert the FICON cable which is connected to the FICON port in DKC (*1)
- Block and Unblock the associated outbound switch/director port (*1) (*2)

*1: Execute this after deleting the logical paths from the host with the "CHPID OFFLINE" operation. If this operation is not executed, Incident log may be reported.

*2: Alternate method using switch/director configuration.

<Operating procedure from switch control window (Example: in the EFCM)>

- (a) Block the associated outbound switch/director port to the CHA interface that is currently "Negotiated" to not the fastest speed (Example: 1Gb/s).
- (b) Change the port speed setting from "Negotiate mode" to "Fastest speed fix mode (Example: 2Gb/s mode)", then from "Fastest speed fix mode (Example: 2Gb/s mode)" back to "Negotiate mode" in the switch/director port configuration window.
- (c) Unblock the switch/director port.
- (d) Confirm that an "Online" and "Fastest speed (Example: 2Gb/s)" link is established without errors on the switch/director port status window.

(2) Configuring Alternate paths

In mainframe systems, the concept of alternate paths is available for the purpose of avoiding system down.

We recommend you to configure alternate paths based on the following priorities.

The supported mainframe fibre package is as follows.

- Mainframe fibre 16 port adapter

The internal structure and characteristics of each package are as shown in Table 3.15.4-1.

Table 3.15.4-1 Internal structures and characteristics of Mainframe packages

Item	Mainframe fibre 16 port adapter
Internal structure	
Characteristics	• Can access all processor through CACHE from 1Port (↔) • 1HTP controls 2Port • 4HTP/LR8/PCB

HTP : Processor used for controlling FIBARC/FICON protocols

BRG : HSN-PCI bridge

HSN : Unique protocol interface

Port 1A/3A/5A/7A/1B/3B/5B/7B : Port IDs in Cluster 1/BASIC slot

The mainframe fibre 16 port adapter can access all processors from the 16 ports. Regardless of the locations of the used ports and the number of ports, it is always possible to perform processing by using all processors. HTP, however, is shared by two ports. If you use ports of different HTPs (for example, Port 1A and 1B in the figure), the throughput performance of one path is better than using ports of the same HTP (for example, Port 1A and 3A).

In addition to the package structure described above, power redundancy is provided using the cluster configurations.

Considering the structures and performance, we recommend you to set paths based on the following priorities when configuring alternate paths.

Priority 1: Set paths to modules/clusters

Priority 2: Set paths to packages

Priority 3: Set paths to HTPs

(3) Notes on High Performance FICON (HPF)

To use the High Performance FICON (HPF), “Mainframe Fibre Channel Adapter” and “High Performance FICON (R) of the PP License” is required.

Do not install High Performance FICON (HPF) to a DKC which Mainframe Fibre Channel Adapter is not setup.

Do not remove all of the Mainframe Fibre Channel Adapters when High Performance FICON (HPF) is installed.

3.16 Universal Volume Manager (UVM)

3.16.1 Overview

Universal Volume Manager is a program product that realizes the virtualization of the storage system. Universal Volume Manager enables you to operate multiple storage systems including DKC810I storage system as if they are all in one storage system. As Universal Volume Manager realizes the virtualization of the storage system, the system administrator can manage the different kinds of multiple storage systems as one storage system.

Once you connect the DKC810I storage system and another kind of storage system using Universal Volume Manager, the system administrator can also manage another storage system using DKC810I Storage Navigator. For example, the system administrator can set the path from a host computer to the volume of DF800 storage system using LUN Management of DKC810I.

In addition to the function of Universal Volume Manager, the ShadowImage function enables you to easily make a backup copy of data stored in the DKC810I storage system to another storage system. It is also easy to restore the backed up copy of data to DKC810I storage system.

In this manual, the source DKC810I storage system is called “local storage system”, and the connected storage system is called “external storage system”. The volume managed in the local storage system is called “internal volume”, and the volume in the external storage system is called “external volume”.

Features of Universal Volume Manager are as follows:

By mapping an external volume as an internal volume using Universal Volume Manager, it becomes possible to operate the external volume using DKC810I Storage Navigator as if it is a volume in the DKC810I storage system.

“Mapping” means assigning the CU:LDEV numbers of the internal volumes to the external volumes. By assigning the numbers of the internal volumes to the external volumes, the system administrator will be able to operate not only internal volumes of DKC810I storage system but also external volumes using DKC810I Storage Navigator.

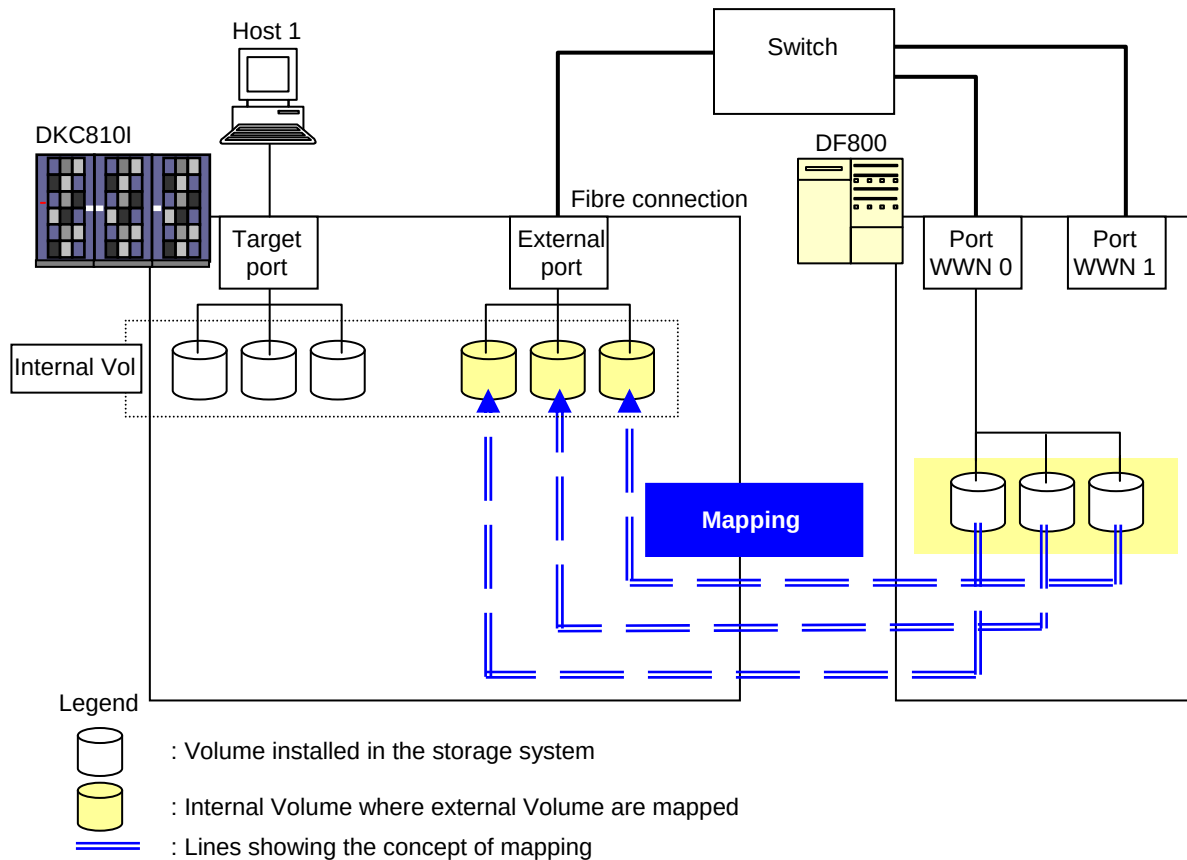


Figure 3.16.1-1

Figure 3.16.1-1 shows the idea of connection between a DKC810I storage system and an external storage system which are connected by the Universal Volume Manager function. In Figure 3.16.1-1, the DKC810I storage system is connected to the external storage system through an external port via a switch using the Fibre-channel interface. The external port is a kind of port attribute, which is used for Universal Volume Manager. In Figure 3.16.1-1, the external volumes are mapped as DKC810I volumes.

3.16.2 Procedure of using external volumes

- (1) Prepare in the external storage system a volume to be used for UVM.
- (2) Change the port attribute to External.
- (3) Connect the external storage system to the port changed to the external.
- (4) Search for the external storage system from the UVM operation panel (Discovery).
- (5) Map an external volume.
 - (a) Register to an external volume group
 - (b) Select the cache mode
- (6) Format the volume (MF volume only).
- (7) Define the host path (Open volume only).
- (8) Other settings.

3.16.2.1 Prepare in the external storage system a volume to be used for UVM

Prepare a volume to be used for UVM in the external storage system to be connected to the DKC810I.

NOTE: The volume in the external storage system should be about 38 MB (77,760 blocks) to 60 TB (128,849,018,880 blocks). If the capacity of the external volume is 60 TB or larger, you can use up to 60 TB of the volume.

If one mapped external volume is used as one internal volume, the external volume size must be less than 128,849,011,200 blocks or smaller.

3.16.2.2 Change the port attribute to External

The port used for Universal Volume Manager needs to be set as the “external” port. When the external storage system is connected to the external port of the local storage system, you can view the information of the external storage system from the DKC810I Storage Navigator computer. The external storage system cannot be connected to the ports other than the external ports.

In order to set the port attribute to external, you need to release the paths set to the port. The attribute of the port where the paths are set cannot be changed to external. Before starting the Universal Volume Manager operations, you need to know the ports whose attributes can be changed to external.

NOTE: The ports whose attributes are set for remote copy software (eg., RCU target, initiator) or the other features cannot be used as external ports for Universal Volume Manager. Change the port attribute to external if the port attribute is set to other than external.

3.16.2.3 Connect the external storage system to the external port

Insert a Fibre cable into external port from the external storage system.

3.16.2.4 Search for the external storage system from the UVM operation panel (Discovery)

Search for the external storage system from the UVM operation panel (LU Operation tab) in the Storage Navigator.

You cannot use the external volume from the DKC810I by just discovering the external storage system. You need to perform the Add LU operation (mapping) shown in the next section.

3.16.2.5 Map an external volume

When you connect the external storage system to the external port, volumes in the external storage system (external volumes) can be mapped as volumes in the local storage system (internal volumes). Confirm which volumes in which external storage system you need to map as internal volumes.

Only one external volume can be mapped as one internal volume. The maximum number of external volumes, which can be mapped, is 4096 per port.

When the external volume is more than 60 TB (128,849,018,880 blocks), you can access the data stored in the field up to 60 TB. If one mapped external volume is used as one internal volume, the external volume size must be less than 128,849,011,200 blocks or smaller.

You cannot access the data that is stored in the field over 60 TB. The external volumes of about 38 MB (77,760 blocks) or smaller cannot be mapped. When you want to set the OPEN-V emulation type, about 47 MB (96,000 blocks) or smaller external volume cannot be mapped.

(1) Register to an external volume group

When you map an external volume as an internal volume, you need to register the external volume to an external volume group.

The user can classify the external volumes, which is set by Universal Volume Manager, into the groups according to the use. The group is called external volume group (ExG). For instance, you can register multiple volumes in one external storage system to one external volume group. Or, even though the data you want to manage in a lump is stored in volumes in the different external storage systems, you can register the volumes in one external volume group and manage them in block.

You need to assign numbers from 1 to 16384 to external LU groups. A maximum of 16384 external volume groups can be created. A maximum number of volumes, which can be registered in one external group, is 4096.

(2) Select the external volume attribute

When you map an external volume as an internal volume, you set the attributes of the external volume. The attributes of an external volume can be set using Add LU panel of Universal Volume Manager.

(a) I/O cache mode (Cache mode: Disable or Enable)

You can set whether to use the cache or not for processing I/O requests from the host. If you select Enable, the host I/O once goes to the cache and then to the volume. If you select Disable, the host I/O comes directly to the volume not coming through the cache.

(3) Emulation type

You can set the emulation type of the mapped volume.

3.16.2.6 Format volume (MF volume only)

If you set the MF emulation type (3390-x) for the external volume which is mapped as an internal volume, you need to format the LDEV before using the volume.

Use the VLL feature to format the LDEV.

3.16.2.7 Define the host path (Open volume only)

If you set the Open emulation type (Open-x) for the external volume which is mapped as an internal volume, define a path between the host and the internal storage system. Use the LUNM feature to define a path.

3.16.2.8 Other settings

(1) Define alternate path to the external volume

When you map an external volume as an internal volume, the path(s) will be set from the internal volume to the external volume. When two paths, which can be set, from the two different clusters to the external volume exist, the two paths are set at the time of the mapping. When two settable paths do not exist, one path is set at the time of the mapping.

You can setup to eight paths to the external volume including the automatically set paths.

Among the paths to the external volume, a path that is given the highest priority is called a primary path. Paths other than the primary path are also called alternative paths.

When the external volume is mapped as the internal volume using Universal Volume Manager, the host I/O operations to the external volume are enabled normally using the path set in the mapping operation. However, the path is automatically switched to the alternate path when the path set in mapping operation cannot be used due to, for instance, maintenance operation in the storage system, or a failure in the channel processor. Because the path is switched to the alternate path, you can continue performing the I/O operation to the external volume that is mapped by Universal Volume Manager as usual even though an error occurred in the original path.

If the alternate path is not set, host I/O, is aborted when a maintenance operation is performed for the storage system or a trouble such as a failure in the channel processor occurs.

It is recommended to set the alternate paths for safer operation.

To set the alternate path, use the path setting function of Universal Volume Manager.

Figure 3.16.2.8-1 illustrates an example of setting an alternate path. In Figure 3.16.2.8-1, external storage system ports, “WWN A” and “WWN B”, are connected to “CL1-A” and “CL2-A” respectively which are set to the external ports in the DKC810I storage system. As shown in Figure 3.16.2.8-1 (“CL1” port and “CL2” port are specified as alternate paths), you need to specify ports in different clusters in the DKC810I storage system as alternate paths.

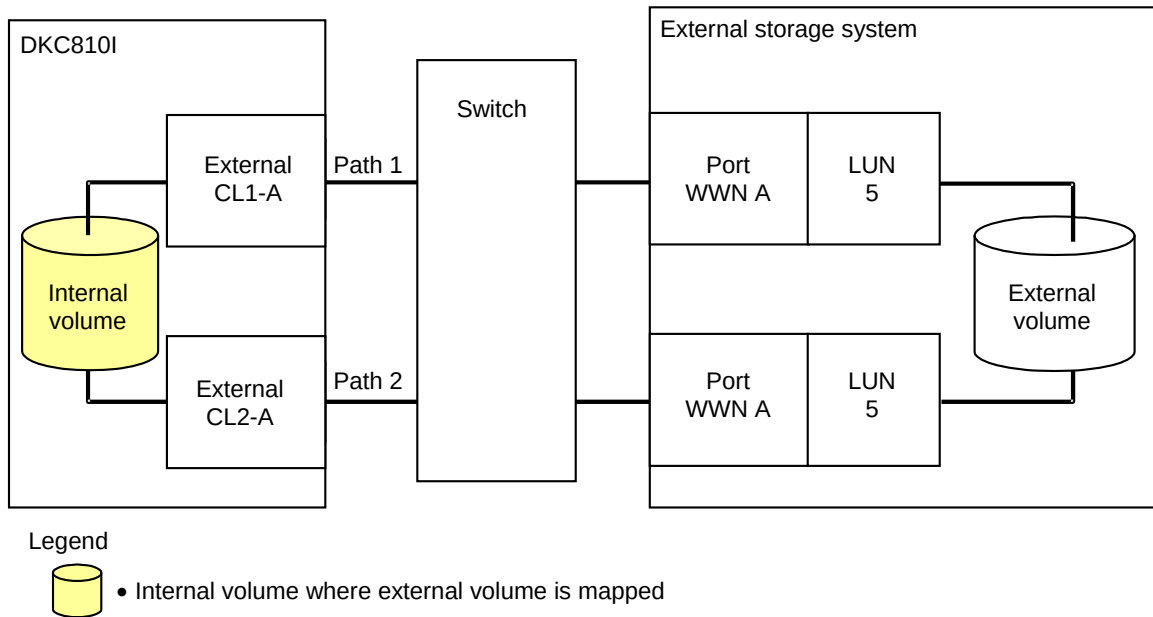


Figure 3.16.2.8-1

Figure 3.16.2.8-2 also illustrates an example of setting an alternate path. In Figure 3.16.2.8-2, two ports are specified in the DKC810I storage system, and connected to the ports in the external storage system via the switch. In this case, two ports of different clusters are specified in the DKC810I storage system. Therefore, the setting of the alternate path is enabled.

In Figure 3.16.2.8-3, two paths are also set between the internal volume and the external volume. However, one port is specified in the DKC810I storage system, and two ports are specified in the external storage systems via the switch. Since two ports of different clusters need to be set in the DKC810I storage system for alternate path settings in Universal Volume Manager, we do not recommend the setting shown in Figure 3.16.2.8-3.

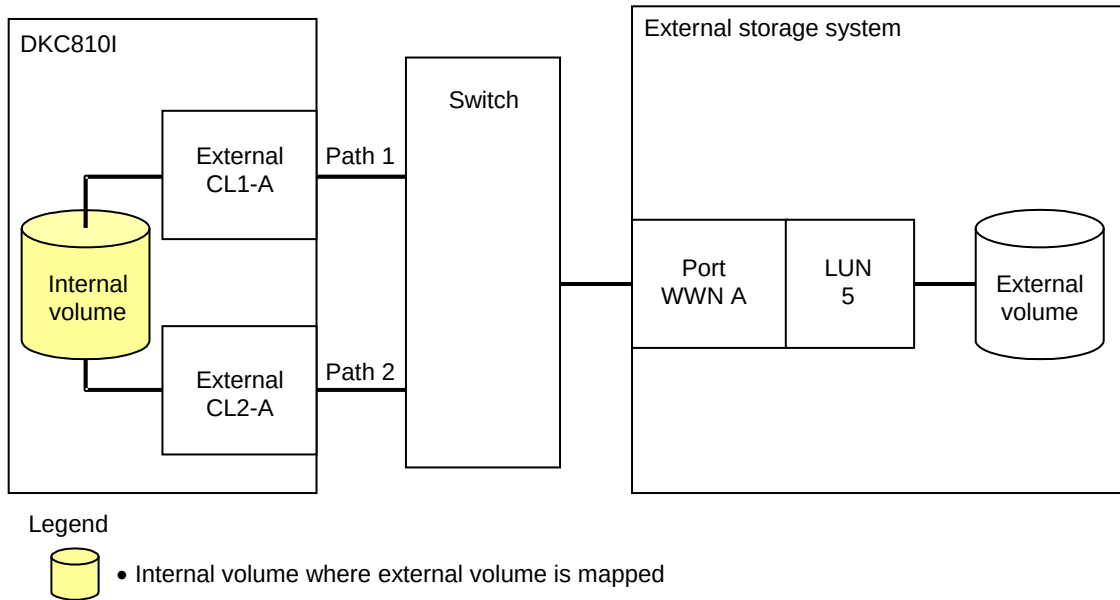


Figure 3.16.2.8-2

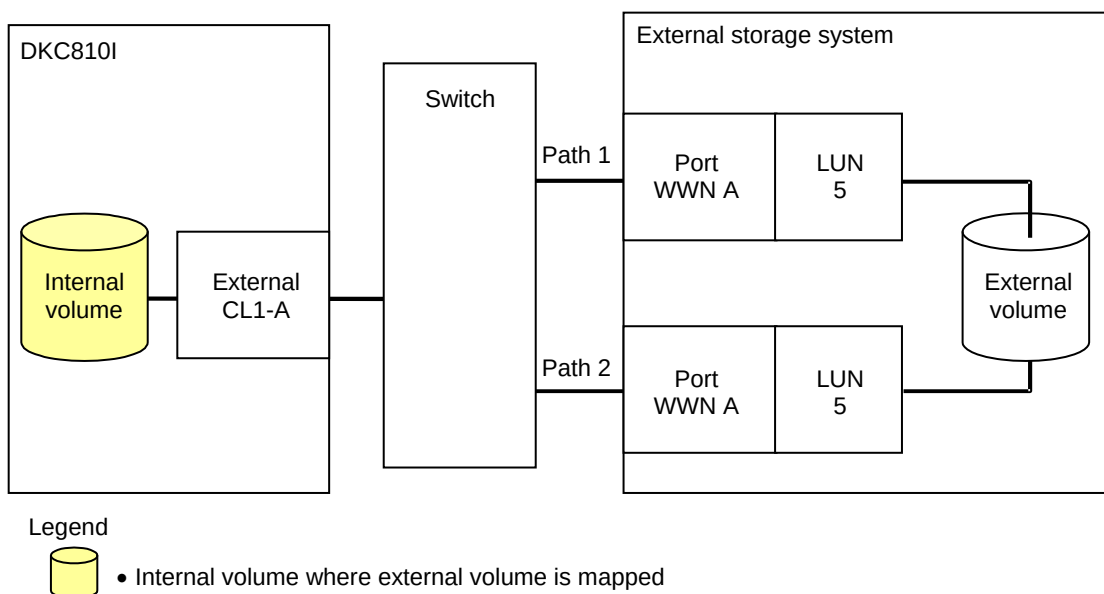


Figure 3.16.2.8-3

3.17 Universal Replicator

This Chapter explains Universal Replicator (hereafter referred to as UR).

3.17.1 UR Components

UR operations involve the DKC810I storage systems at the primary and secondary sites, the physical communications paths between these storage systems, and the DKC810I UR Web Console software. UR copies the original online data at the primary site to the offline backup volumes at the secondary site via the dedicated fibre-channel remote copy connections using a journal volume. You can operate the UR software with the user-friendly GUI environment using the DKC810I UR Web Console software.

NOTE: Host failover software is required for effective disaster recovery with UR.

Figure 3.17.1-1 shows the UR components and their functions:

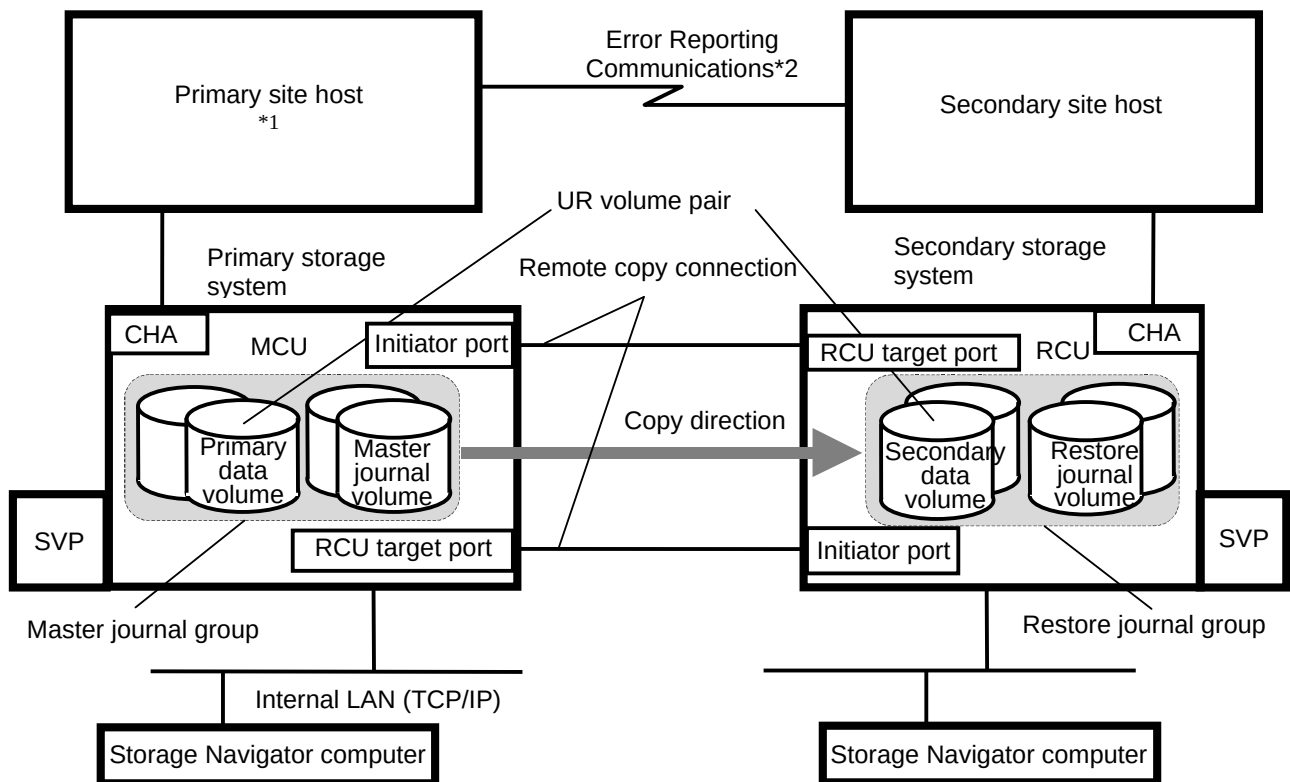


Figure 3.17.1-1 UR components

*1: URz requires the installation of the host I/O time stamping function on the primary site host.

*2: Error reporting communications (ERC) feature is essential for URz to recover the data lost in a disaster.

Table 3.17.1-2 shows the plural secondary storage systems connection configuration of UR. By connecting one primary storage system with more than one secondary storage system, you can create a volume pair that has a one-to-one relationship for each journal group.

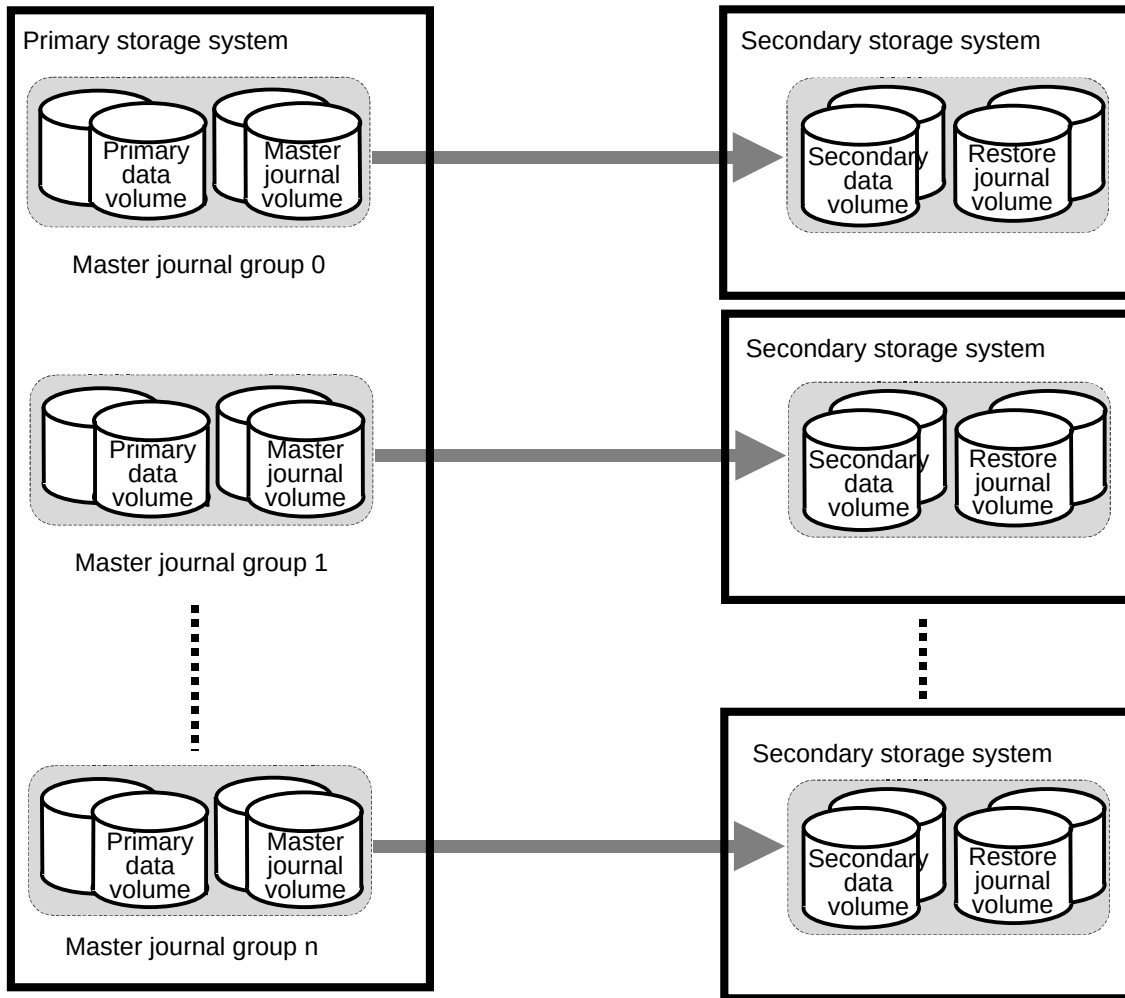


Figure 3.17.1-2 Connection Configuration of Plural Secondary Storage systems

This UR components describes:

- DKC810I RAID storage system (see section 3.17.1.1)
- Main and remote control units (primary storage systems and secondary storage systems) (see section 3.17.1.2)
- Journal group (see section 3.17.1.3)
- Data volume pair (see section 3.17.1.4)
- Journal volume (see section 3.17.1.5)
- Remote copy connections (see section 3.17.1.6)
- Initiator ports and RCU target ports (see section 3.17.1.7)
- DKC810I UR Web Console software (see section 3.17.1.8)
- Host I/O time stamping function (see section 3.17.1.9)
- Error reporting communications (ERC) (see section 3.17.1.10)

3.17.1.1 DKC810I Storage systems

UR operations involve the DKC810I storage systems at the primary and secondary sites. The primary storage system consists of the main control unit (primary storage system) and SVP. The secondary storage system consists of the remote control unit (secondary storage system) and SVP.

3.17.1.2 Main and Remote Control Units (Primary Storage systems and Secondary Storage systems)

The main control unit (primary storage system) and remote control unit (secondary storage system) control UR operations:

- The primary storage system is the control unit in the primary storage system which controls the primary data volume of the UR pairs and master journal volume. The Storage Navigator Web Console PC must be LAN-attached to the primary storage system. The primary storage system communicates with the secondary storage system via the dedicated remote copy connections. The primary storage system controls the host I/O operations to the UR primary data volume and the journal obtain operation of the master journal volume as well as the UR initial copy and update copy operations between the primary data volumes and the secondary data volumes.
- The secondary storage system is the control unit in the secondary storage system which controls the secondary data volume of the UR pairs and restore journal volume. The secondary storage system controls copying of journals and restoring of journals to secondary data volumes. The secondary storage system assists in managing the UR pair status and configuration (e.g., rejects write I/Os to the UR secondary data volumes). The secondary storage system issues the read journal command to the primary storage system and executes copying of journals. The secondary Storage Navigator PC should be connected to the secondary storage systems at the secondary site on a separate LAN. The secondary storage systems should also be attached to a host system to allow sense information to be reported in case of a problem with a secondary data volume or secondary storage system and to provide disaster recovery capabilities.

3.17.1.3 Journal Group

Journal group consists of two or more data volumes and journal volumes. It is a feature that allows you to sort multiple data volumes and journal volumes into collective units to tailor UR to meet your unique business needs. The journal group in the primary storage system is referred to as the master journal group. The journal group in the secondary storage system is referred to as the restore journal group. The data volumes in the master journal group are also called the primary data volumes. The journal volumes in the master journal group are called the master journal volumes. The data volumes in the restore journal group are similarly called the secondary data volumes. The journal volumes in the restore journal group are called the restore journal volumes. The data update sequence from the host is managed per the journal group. The data update sequence consistency between the master and restore journal groups to be paired is maintained and ensured. The master and restore journal groups are managed according to the journal group number. The journal numbers of master and restore journal groups that are paired can be different. One data volume and one journal volume can belong to only one journal group.

3.17.1.4 Data Volume Pair

UR performs remote copy operations for data volume pairs created by the user. Each UR pair consists of one primary data volume and one secondary data volume which can be located in different storage systems. The UR primary data volumes are the primary volumes (LDEVs) which contain the original data, and the UR secondary data volumes are the secondary volumes (LDEVs) which contain the backup or duplicate data. During normal UR operations, the primary data volume remains available to all hosts at all times for read and write I/O operations. During normal UR operations, the secondary storage system rejects all host-requested write I/Os for the secondary data volume. The secondary data volume write enable option allows write access to a secondary data volume while the pair is split and uses the secondary data volume and primary data volume track maps to resynchronize the pair (see section 3.17.2.4).

3.17.1.5 Journal Volume

When UR is used, updates to primary data volumes can be stored in other volumes, which are called journal volumes. The updates (which is sometimes referred to as update data) that will be stored in journal volumes are called journal data.

Because journal data will be stored in journal volumes, you can perform and manage highly reliable remote copy operations without suspension of remote copy operations. For example:

- Even if a communication path between the primary storage system and the secondary storage system fails temporarily, remote copy operations can continue after the communication path is recovered.
- If data transfer from hosts to the primary storage system is temporarily faster than data transfer between the primary storage system and the secondary storage system, remote copy operations between the primary storage system and the secondary storage system can continue. Because journal volumes can contain a lot more update data than the cache memory can contain, remote copy operations can continue if data transfer from hosts to the primary storage system is faster for a relatively long period of time than data transfer between the primary storage system and the secondary storage system.

(1) The Number of Journal Volumes

One journal group can contain one journal volume. However, during journal volume maintenance, one journal group can contain two journal volumes.

In this case, a volume which has been registered first is used as the journal volume, and secondary registered volume is registered as the spare journal volume to be used at the time of maintenance. If you deleted the volume which has been registered first, the spare journal volume will be the primary journal volume automatically to be used as the journal volume.

Note that the spare journal volume will be the unregistered state after the above stated operation.

(2) Specifications of Journal Volumes

■ Volumes and their capacity:

Volume which can be registered in the journal is only the Dynamic Provisioning virtual volume of the OPEN-V emulation type.

Journal volumes in the same journal group can be of different capacity. A master journal volume and the corresponding restore journal volume can be of different capacity.

A journal volume consists of two areas: one area is used for storing journal data, and the other area is used for storing metadata for remote copy.

■ RAID configuration:

Journal volumes support all RAID configurations that are supported by DKC810I. Journal volumes also support all physical volumes that are supported by DKC810I.

(3) Restrictions on Journal Volumes

■ Registering journal volumes:

NOTE: You must register journal volumes in a journal group before you create a data volume pair for the first time in the journal group.

You can add journal volumes under any of the following conditions:

- When the journal group does not contain data volumes (i.e., before you create a data volume pair for the first time in the journal group, or after all data volume pairs are deleted)
- When processing for changing the status of a data volume pair (for example, deletion or suspension of a data volume pair) is not in progress

NOTE: If a path is defined from a host to a volume, you cannot register the volume as a journal volume.

You can use Storage Navigator computers to register journal volumes.

If you add a journal volume when a remote copy operation is in progress (i.e., when at least one data volume pair exists for data copying), the metadata area of the journal volume (see (4)) will be unused and only the journal data area will be used. To make the metadata area usable, you need to split (suspend) all the data volume pairs in the journal group and then restore (resynchronize) the pairs.

Adding journal volumes during a remote copy operation will not decrease the metadata usage rate if the metadata usage rate is high.

Adding journal volumes during a remote copy operation may not change the journal data usage rate until the journal volumes are used. To check the journal data usage rate, use the Usage Monitor panel.

■ Deleting journal volumes:

You can delete journal volumes under any of the following conditions:

- When the journal group does not contain data volumes (i.e., before you create a data volume pair for the first time in the journal group, or after all data volume pairs are deleted)
- When all data volume pairs in the journal group are suspended.

You can use Storage Navigator computers to delete journal volumes.

■ Access from hosts to journal volumes:

If a path is defined from a host to a volume, you cannot register the volume as a journal volume.

You cannot define paths from hosts to journal volumes. This means that hosts cannot read from and write to journal volumes.

(4) Journal Volume Areas

The journal volume consists of the metadata area and the journal data area. The ratio of metadata area to journal data area is common in the journal volumes within the journal group.

In the metadata area, the metadata that manages the journal data is stored. For further information on the metadata area, see Table 3.17.3.1-1. The journal data that the metadata manages is stored in the journal data area.

3.17.1.6 Remote Copy Connections

The remote copy connections are the physical paths used by the primary storage systems to communicate with the secondary storage systems. Remote copy connections enable communication between the primary and secondary storage systems. The primary storage systems and secondary storage systems are connected via fibre-channel interface cables. You must establish paths from the primary to the secondary storage system, and also from the secondary to the primary storage system. Up to eight paths can be established in both of these directions.

When fibre-channel interface (optical multimode shortwave) connections are used, two switches are required for distances greater than 0.5 km (1,640 feet), and distances up to 1.5 km (4,920 feet, 0.93 miles) are supported. If the distance between the primary and secondary sites is greater than 1.5 km, the optical single mode longwave interface connections are required. When fibre-channel interface (single-mode longwave) connections are used, two switches are required for distances greater than 10 km (6.2 miles), and distances up to 30 km (18.6 miles) are supported.

3.17.1.7 Initiator Ports and RCU Target Ports

The initiator port and the RCU target port are required at both the primary storage system and secondary storage system. The initiator port at the primary storage system is connected to the RCU target port at the secondary storage system via the fibre channel interface. The initiator port at the secondary storage system is connected to the RCU target port at the primary storage system. The initiator port at the secondary storage system issues a “read journal” command to the primary storage system, and then the RCU target port at the primary storage system sends journal data to the secondary storage system in response to the “read journal” command.

Any fibre-channel interface port of the DKC810I can be configured as an initiator port. The initiator ports cannot communicate with the host processor channels. The host channel paths must be connected to the fibre-channel interface port other than the initiator port.

3.17.1.8 UR Web Console Software

DKC810I Storage Navigator Java applet program product includes UR for the DKC810I storage system. The DKC810I Storage Navigator software communicates with the SVP of each DKC810I storage system via defined TCP/IP connections.

The Storage Navigator PC at the primary site must be attached to the primary storage system. You should also attach a Storage Navigator PC at the secondary site to all secondary storage systems. Having a Storage Navigator PC at the secondary site enables you to change the UR parameter of the secondary storage system and access the UR secondary data volume (e.g. for the maintenance of media). If you need to perform UR operations in the reverse direction from the secondary site to the primary site (e.g., disaster recovery), the DKC810I UR software simplifies and expedites this process.

3.17.1.9 Host I/O Time-Stamping Function (URz Only)

If you plan to establish URz journal groups, the I/O time-stamping function must be installed on the host processor at the primary site. The I/O time-stamp, which is provided by MVS DFSMSdfp, is the same time-stamp that is used by IBM® XRC pairs. The I/O time-stamping function should also be installed on the host processor at the secondary site, so that time-stamps can be used when copying data in the reverse direction.

NOTE: If the system at the primary and/or secondary site consists of several CPU complexes, a SYSPLEX timer is required to provide a common time reference for the I/O time-stamping function.

3.17.1.10 Error Reporting Communications (ERC) (URz Only)

Error reporting communications (ERC), which transfers information between host processors at the primary and secondary sites, is a critical component of any disaster recovery effort. You can configure ERC using channel-to-channel communications, NetView technology, or other interconnect technologies, depending on your installation requirements and standards. Neither URz nor the URz Web Console software provides ERC between the primary and secondary sites.

When URz is used as a data migration tool, ERC is recommended but is not required. When URz is used as a disaster recovery tool, ERC is required to ensure effective disaster recovery operations. When a URz pair is suspended due to an error condition, the primary storage system generates sense information which results in an IEA491E system console message. This information should be transferred to the primary site via the ERC for effective disaster detection and recovery.

3.17.2 Remote Copy Operations

Figure 3.17.2-1 illustrates the two types of UR remote copy operations: initial copy and update copy.

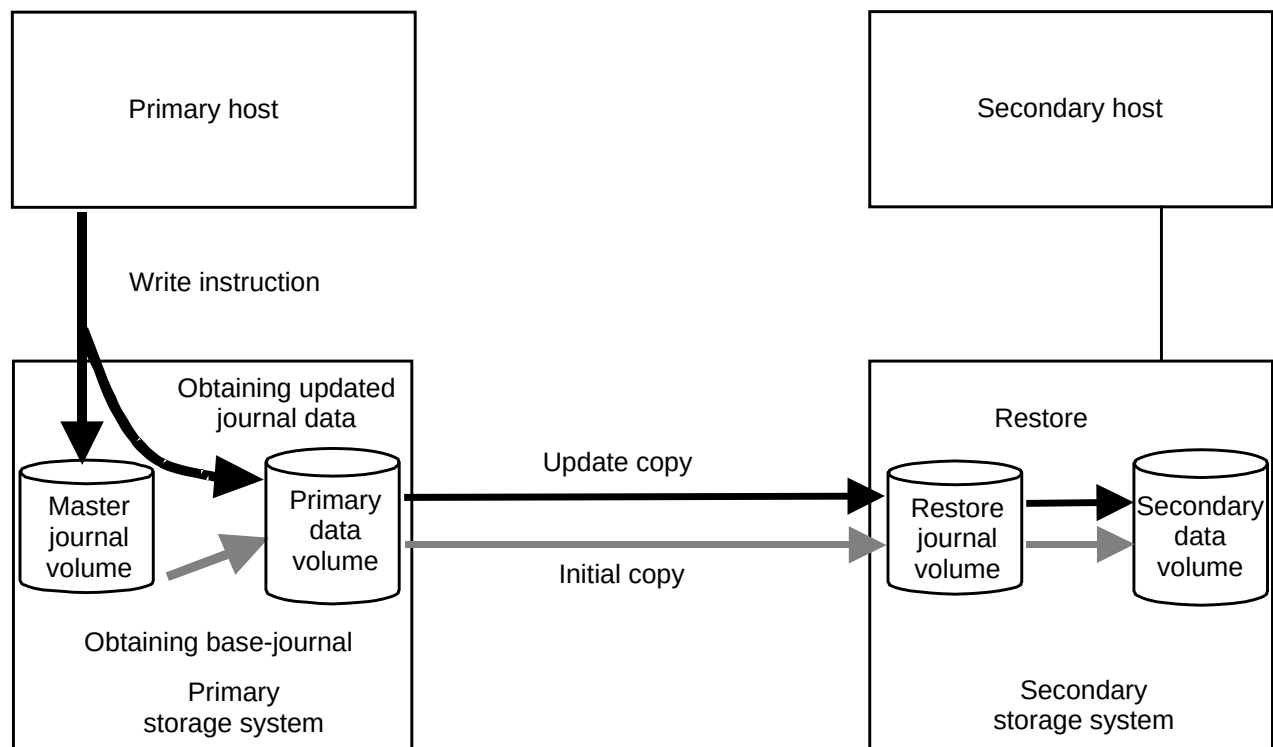


Figure 3.17.2-1 Remote copy operations

This section describes the following topics that are related to remote copy operations with UR:

- Initial copy operation (see section 3.17.2.1)
- Update copy operation (see section 3.17.2.2)
- Read and write I/O operations for UR volumes (see section 3.17.2.3)
- Secondary data volume write option (see section 3.17.2.4)
- Secondary data volume read option (see section 3.17.2.5)
- Difference management (see section 3.17.2.6)

3.17.2.1 Initial Copy Operation

Initial copy operations synchronize data in the primary data volume and data in the secondary data volume. Initial copy operations are performed independently from host I/Os. Initial copy operations are performed when you create a data volume pair or when you resynchronize a suspended pair. The initial copy operation copies the base-journal data that is obtained from the primary data volume at the primary storage system to the secondary storage system, and then restores the base-journal to the secondary data volume.

If the journal-obtain operation starts at the primary data volume, the primary storage system obtains all data of the primary data volume as the base-journal data, in sequence. The base-journal contains a replica of the entire data volume or a replica of updates to the data volume. The base-journal will be copied from the primary storage system to the secondary storage system after the secondary storage system issues a read-journal command. After a base-journal is copied to the secondary storage system, the base-journal will be stored in a restore journal volume in a restore journal group where the secondary data volume belongs. After that, the data in the restore journal volume will be restored to the secondary data volume, so that the data in the secondary data volume synchronizes with the data in the primary data volume.

The base-journal data is stored in the entire data volume or the area for the difference. The area for the difference is used when the difference resynchronization operation is performed. The journal data for the entire data volume is created when the data volume pair is created. The difference journal data is obtained when the pair status of the data volume changes from the Suspending status to the Pair resync status. Merging the difference bitmaps that are recorded on both primary and secondary data volumes enables you to obtain the journal data for only difference. When a data volume pair is suspended, the status of data that is updated from the host to the primary and secondary data volumes is recorded to the difference bitmap.

The base-journal data of primary storage system is stored to the secondary storage system journal volume according to the read command from the secondary storage system. After that, the base-journal data is restored from the journal volume to the secondary data volume. The initial copy operation will finish when all base-journals are restored.

NOTE: If you manipulate volumes (not journal groups) to create or resynchronize two or more data volume pairs within the same journal group, the base journal of one of the pairs will be stored in the restore journal volume, and then the base journal of another pair will be stored in the restore journal volume. Therefore, the operation for restoring the latter base journal will be delayed.

NOTE: You can specify None as the copy mode for initial copy operations. If the None mode is selected, initial copy operations will not be performed. The None mode must be used at your responsibility only when you are sure that data in the primary data volume is completely the same as data in the secondary data volumes.

3.17.2.2 Update Copy Operation

When a host performs a write I/O operation to a primary data volume of a data volume pair, an update copy operation will be performed. During an update copy operation, the update data that is written to the primary data volume is obtained as an update journal. The update journal will be copied to the secondary storage system, and then restored to the secondary data volume.

The primary storage system obtains update data that the host writes to the primary data volume as update journals. Update journals will be stored in journal volumes in the journal group that the primary data volume belongs to. When the secondary storage system issues “read journal” commands, update journals will be copied from the primary storage system to the secondary storage system asynchronously with completion of write I/Os by the host. Update journals that are copied to the secondary storage system will be stored in journal volumes in the journal group that the secondary data volume belongs to. The secondary storage system will restore the update journals to the secondary data volumes in the order write I/Os are made, so that the secondary data volumes will be updated just like the primary data volumes are updated.

3.17.2.3 Read and Write I/O Operations During UR Volumes

When a primary storage system receives a read I/O for a UR primary data volume, the primary storage system performs the read from the primary data volume. If the read fails, the redundancy provided by RAID-1 or RAID-5 technology recovers the failure. The primary storage system does not read the UR secondary data volume for recovery.

When a primary storage system receives a write I/O for the primary data volume with PAIR status, the primary storage system performs the update copy operation, as well as writing to the primary data volume.

The primary storage system completes the primary data volume write operations independently of the update copy operations at the secondary data volume. The secondary storage system updates the data in the secondary data volume according to the write sequence number of journal data. This will maintain the data consistency between the primary and secondary data volumes. If the primary data volume write operation fails, the primary storage system reports a unit check and does not create the journal data for this operation. If the update copy operation fails, the secondary storage system suspends either the affected pair or all UR pairs in the journal group, depending on the type of failure. When the suspended UR pair or journal group is resumed (Pair resync), the primary storage system and secondary storage system negotiate the resynchronization of the pair(s).

During normal UR operations, the secondary storage system does not allow UR secondary data volumes to be online (mounted), and therefore hosts cannot read from and write to secondary data volumes. The UR secondary data volume write enable option allows write access to a secondary data volume while the pair is split (see section 3.17.2.4). The secondary data volume write option can only be enabled when you split the pair (Pair split) from the primary storage system.

3.17.2.4 Secondary Data Volume Write Option

For additional flexibility, UR provides a secondary data volume write option (S-VOL. Write) which enables write I/O to the secondary data volume of a split UR pair. The secondary data volume write option can be selected by the user during the Suspend Pair operation and applies only to the selected pair(s). The secondary data volume write option can be accessed only when you are connected to the primary storage system. When you resync a split UR pair which has the secondary data volume write option enabled, the secondary storage system sends the secondary data volume track bitmap to the primary storage system, and the primary storage system merges the primary data volume and secondary data volume bitmaps to determine which tracks are out-of sync. This ensures proper resynchronization of the pair.

3.17.2.5 Secondary Data Volume Read Option (URz Only)

For additional flexibility, URz offers a special secondary data volume read option. The Hitachi representative enables the secondary data volume read option on the secondary storage system (mode 20). The secondary data volume read option allows you to read a URz secondary data volume only while the pair is suspended, that is, without having to delete the pair. The secondary storage system will allow you to change only the VOLSER of the suspended secondary data volume, so that the secondary data volume can be online to the same host as the primary data volume while the pair is suspended. All other write I/Os will be rejected by the secondary storage system. The primary storage system copies the VOLSER of the primary data volume back onto the secondary data volume when the pair is resumed. When the secondary data volume read option is not enabled and/or the pair is not suspended, the secondary storage system rejects all read and write I/Os to a URz secondary data volume.

3.17.2.6 Difference Management

The differential data (updated by write I/Os during split or suspension) between the primary data volume and the secondary data volume is stored in each track bitmap. When a split/suspended pair is resumed (Resume Pair), the primary storage system merges the primary data volume and secondary data volume bitmaps, and the differential data is copied to the secondary data volume.

3.17.3 Journal Processing

The UR journal data contains the primary data volume updates and the metadata information (associated control information), which enables the secondary storage system to maintain update consistency of the UR secondary data volumes. UR journal processing includes:

- Creating and storing journals at the primary storage system (see section 3.17.3.1)
- Copying journals to the secondary storage system (see section 3.17.3.2)
- Storing journals at the secondary storage system (see section 3.17.3.3)
- Selecting and restoring journals at the secondary storage system (see section 3.17.3.4)
- Types of journals (see section 3.17.3.5)

3.17.3.1 Creating and Storing Journals at the Primary Storage system

When a primary storage system performs an update (host-requested write I/O) on a UR primary data volume, the primary storage system creates a journal data to be transferred to secondary storage system. The journal data will be stored into the cache at first, and then into the journal volume.

Metadata information will be attached to journal data (see Table 3.17.3.1-1). When base-journal is obtained, only metadata information is created and stored in UR cache or the journal volume.

Table 3.17.3.1-1 Metadata Information

Type	Description
Journal type	Type of journal (e.g., base-journal or update journal)
LDEV No. (data)	The number of primary data volume that stores the original data
Original data storing position	The primary data volume slot number, and the start and end of sub-block number (data length)
LDEV No. (journal)	The volume number of master journal volume that stores the journal data
Journal data storing position	The slot number of master journal volume, and the start sub-block number
Journal sequence number	The sequence number that is assigned when the journal is obtained
Timestamp	The time when the journal data is obtained

The journal sequence number indicates the primary data volume write sequence that the primary storage system has created for each journal group. The journal data is transferred to the secondary storage system asynchronously with the host I/O. The secondary storage system updates the secondary data volume in the same order as the primary data volume according to the sequence number information in the journal.

3.17.3.2 Copying Journals to the Secondary Storage system

When a primary storage system receives a read journal command from a secondary storage system, the primary storage system sends the journal data to the secondary storage system. The secondary storage system's initiator ports act as host processor channels and issue special I/O operations, called remote I/Os (RIOs), to the primary storage system. The RIO transfers the journal data in FBA format using a single channel command. The primary storage system can send several journal data using a single RIO, even if their sequence numbers are not contiguous. Therefore, the journal data are usually sent to the secondary storage system in a different order than the journal data were created at the primary storage system. The secondary storage system ensures that the journal data are applied to the secondary data volume in the correct sequence. This method of remote I/O provides the most efficient use of primary storage system-to-secondary storage system link resources.

3.17.3.3 Storing Journal at the Secondary Storage system

A secondary storage system receives the journal data that is transferred from a primary storage system according to the read journal command. The journal data will be stored into the cache at first, and then into the journal volume.

NOTE: The primary storage system does not remove the target journal data from its master journal volume until it receives the sequence numbers of restored journal which is give to the read journal command from the secondary storage system. This is true even if the primary storage system and secondary storage system are connected via a channel extender product.

3.17.3.4 Selecting and Restoring Journal at the Secondary Storage system

The secondary storage system selects journal data to be promoted to formal data (or “restored”) as follows:

1. The secondary storage system gives the number as the management information to distinguish the journal data arrival to the sequence number that is assigned to the journal data from the primary storage system. If the number is 1, the journal data arrived at the secondary storage system. If the number is 0, the journal data has not arrived yet. The secondary storage system determines whether the journal data should be settled or not according to this number. If the journal data has not arrived yet, the secondary storage system waits for the journal data.
2. When the top of queue in the journal group indicates the journal data arrival, the secondary storage system selects the journal data which has the lowest sequence number, and then settles this journal data.
3. The secondary storage system repeats steps 1. and 2. to select and settle the journal data.

Figure 3.17.3.4-1 illustrates the journal data selection and settling at the secondary storage system. This diagram shows that journal data S1 arrives at the secondary storage system because the management information indicates 1. The secondary storage system selects journal data S1 to be settled, because S1 is the lowest sequence number. When S1 is removed from the queue of sequence numbers, journal data S2 becomes the top entry, but it has not arrived yet. The management information of journal data S2 is 0. The secondary storage system waits journal data S2. When journal data S2 arrives, the secondary storage system selects S2 as the next journal data to be settled. The journal data selected by the secondary storage system is marked as “host-dirty” and treated as formal data.

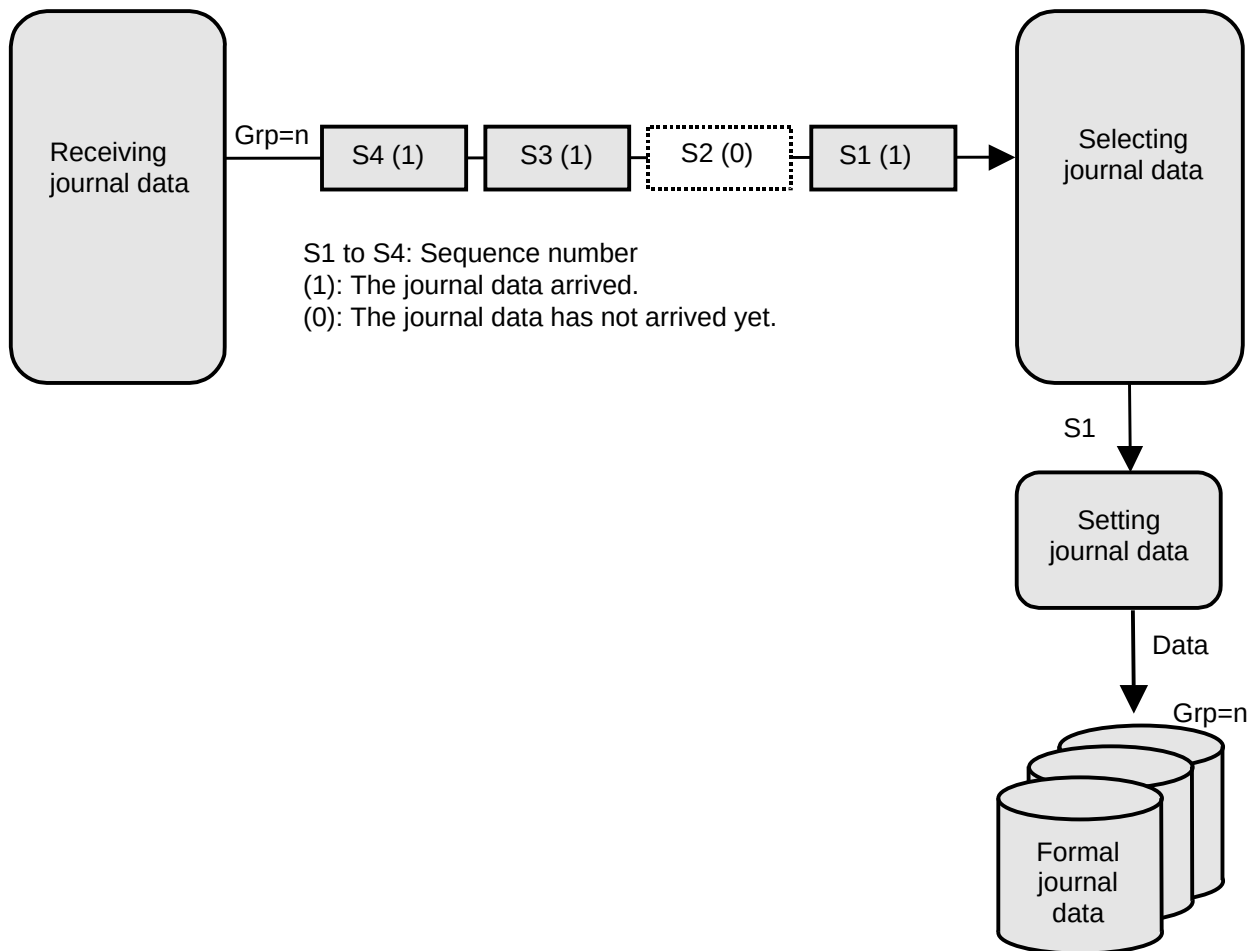


Figure 3.17.3.4-1 Selecting and Settling Journal at the Secondary Storage system

The secondary storage system settles and restores the journal data to the secondary data volume as follows:

- Journal data stored in the cache
The journal data is copied to the corresponding cached track and promoted to formal data.
- Journal data stored in the restore journal volume
The journal data is read from the restore journal volume to cache. The journal data that is read to cache is copied to the existing cache track and promoted to formal data. After that, the space for the restore journal volume is released.

3.17.4 UR operation

3.17.4.1 Pair operation

The following figure illustrates an UR pair configuration. In the configuration, UR pairs belong to the journal group. Each journal group and UR pair have an attribute and status. Each attribute and status is described in the following subsections.

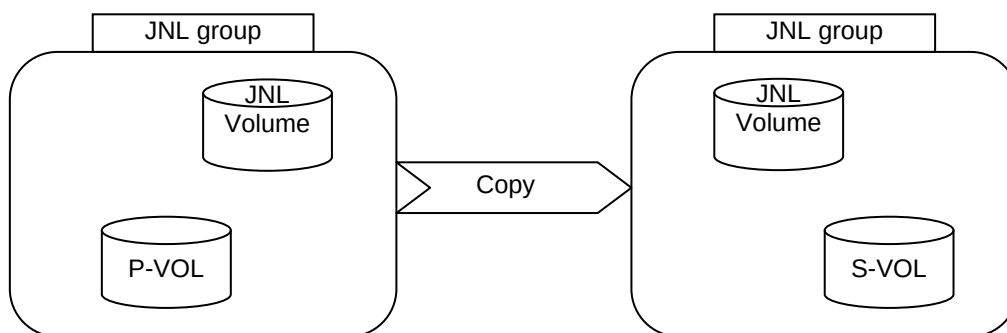


Figure 3.17.4.1-1 Relationship between pairs and journal groups

(1) Journal group

Prior to pair creation, the journal volume needs to be registered, and the journal group needs to be defined. You can delete journal groups that are not in use. To define journal groups, you need to register journal volumes. On the other hand, to delete journal groups, you need to delete all journal volumes.

Table 3.17.4.1-1 Journal group attributes

#	Journal group attribute	Meaning
1	Initial	No UR pair is set in the journal group to which journal volumes are registered.
2	Master	The journal group to which the logical volume storing the original data (P-VOL) belongs. The attribute of the journal group in Master is called “M journal”.
3	Restore	The journal group to which the logical volume storing the duplicated data (S-VOL) belongs. The attribute of the journal group in Restore is called “R journal”.

Table 3.17.4.1-2 Journal group status

#	Journal group status	Meaning
1	–	UR pairs are not set in the target group
2	Active	Base/update copy is in progress in the target group
3	Halting	The target group is being suspended, or being deleted
4	Stopping	The target group is being suspended, or being deleted
5	Stop	The target group is suspended. (All UR pairs in the target group are suspended)

Table 3.17.4.1-3 Journal group operations

#	Operation	Specified attribute	Description
1	Register journal volume	MJNL/RJNL	✓ Register a logical volume, to which no path is defined, as a JNL volume. ✓ Can register the additional volume to the existing journal group only when the UR remote copy is stopped (Journal group status is STOP). ✓ When the journal group state is ACTIVE, the journal volume can be registered. (However, only the journal area increases, and after the journal group suspend and resync, the meta data area increases). ✓ Can register UR pair to the journal group to which the journal volume is registered.
2	Delete journal volume	MJNL/RJNL	✓ Delete the logical volume registered as a journal volume from the journal volume. ✓ Can delete it only when UR remote copy is stopped (Journal group status is STOP or the group attribute is Initial) if there are two or more journal volumes in the target journal group. ✓ Can delete it only when the target group does not have any UR pair (Group attribute is Initial) if the number of journal volumes in the target journal group is one ✓ No UR pair can be registered to such a journal group from which all journal volumes are deleted.

(2) UR pairs

UR performs a remote copy operation for the logical volume pair set by the user. Based on pair operations, pair attributes and pair statuses are added to the logical volumes. You can perform the following remote copy operations for UR pairs. The figure below illustrates how the UR pair status changes due to each operation.

Table 3.17.4.1-4 Pair attributes

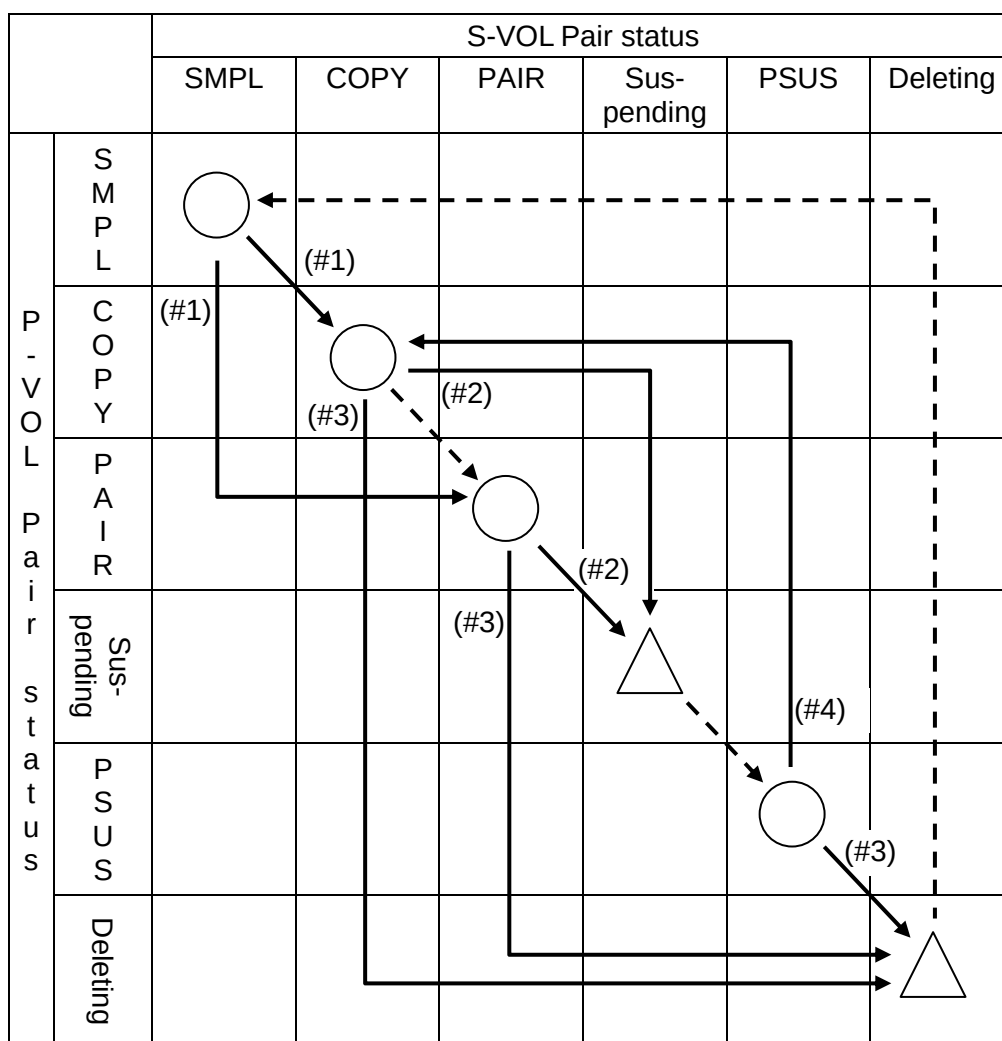
#	Pair attribute	Description
1	SMPL	Target volume is not assigned to an UR pair.
2	P-VOL	Primary volume. Data volume to which the original data is stored.
3	S-VOL	Secondary volume. Data volume to which backup or duplicated data is stored.

Table 3.17.4.1-5 Pair status

#	Pair status	Description
1	SMPL	Target volume is not assigned to an UR pair.
2	COPY	Base copy is in progress and data of the P-VOL and S-VOL of the UR pair do not match completely. When their data match, the status changes to PAIR.
3	PAIR	Base copy is completed, and data of the P-VOL and S-VOL match completely.
4	PSUS/SSUS	Copy operation is suspended in the UR pair.
5	PSUE	An error is detected in the DKC, and the copy in the UR pair is stopped (Suspended).
6	PFUL	The journal usage in the journal volume exceeded the threshold. The copy operation is continued.
7	PFUS	The capacity of the stored journal exceeded the journal volume capacity, and the copy operation is suspended in DKC.
8	SSWS	Data can be written to the S-VOL in which Takeover is in progress.
9	Suspending	The status of the UR pair is being changed to Suspend.
10	Deleting	The UR pair is deleted, and the status is being changed to SMPL.

Table 3.17.4.1-6 Pair operations

#	Operation	Specified attribute	Description
1	Pair create	MJNL	Register the logical volume to which a path is defined as an UR pair. There are two types of copy instruction, "All copy" and "NO copy". "All copy" performs a base copy, and "NO copy" does not perform a base copy.
2	Pair suspend	MJNL/RJNL	Change the status of the UR pair, which is performing the base/update copy, to the suspend status.
3	Pair delete	MJNL/RJNL	Delete the already registered UR pair.
4	Pair resync	MJNL/RJNL	Change the pair status of the UR, in which the copy operation is suspended, to the pair resume status. (RJNL can be specified only when swapping is specified)
5	Takeover	RJNL	Swap MJNL and RJNL (reverse the source and the target) and resync the pair.



(#x) : Correspond to the pair operation # in Table 3.17.4.1-6.

△ : Status transition is in progress. DKC internal processing is in progress.

○ : Normal status. Status is changed to this when operation completes.

——→ : Status transition due to pair operation

-----→ : Status transition in DKC

Figure 3.17.4.1-2 Pair attributes

(3) Pair create

Logical volume to which a path is defined is registered to the target journal group as an UR pair (data volume). The specification of a data volume and UR pair in a journal group is as follows.

Table 3.17.4.1-7 Pair create

#	Item	Mainframe	Open platform
1	Pair create timing	✓ Can register the pair only when the specified journal group exists, and no Suspending/Deleting pair is included in that journal group.	✓ Can register the pair only when the specified journal group exists, and no Suspending/Deleting pair is included in that journal group.

● Pair create option

When creating a pair, you can set a pair create option. The following table shows the options and applications that can be specified.

Table 3.17.4.1-8 Pair create options

#	Option	Feature overview	OP	MF	RM	BC
1	Copy type	You can choose to or not to perform a base copy. The following copy types are available. ✓ All copy: Perform base copy when creating a pair. ✓ No copy: Not perform base copy when creating a pair.	○	○	○	○
2	Priority	Specify which pair you want to perform a base copy first when creating multiple pairs at a time. ✓ Setting: 1-255	○	○	—	—
3	Error level	Set error levels. You can choose either of the following levels. ✓ Group: Even if an error which affects only the specified volume occurs, all pairs in the journal group will suspend due to the error. ✓ Volume: When an error which affects only the specified volume occurs, only that pair suspends due to the error. However, when an error which affects the entire journal group occurs, all pairs in the journal group are suspended.	○	○	—	○
4	S-VOL ONLINE Check	Check whether S-VOL is ONLINE or not, and if it is ONLINE, you cannot create a pair. You can choose either of the following. ✓ No Check: Create a pair without checking whether S-VOL is ONLINE ✓ S-VOL ONLINE: Check if S-VOL is ONLINE.	—	—	—	○
5	CFW data	Choose whether MCU copies the CFW data to S-VOL. You can choose either of the following. ✓ Copy to S-VOL: MCU copies the CFW data to S-VOL. ✓ P-VOL only: MCU does not copy the CFW data to S-VOL.	—	○	—	—

Legend) OP: Instruction from Storage Navigator (OPEN), MF: Instruction from Storage Navigator (MF)
RM: Instruction from RAID Manager, BC: Instruction from BC Manager

(4) Pair suspend

The copy operation of an UR pair is stopped, and the pair status is changed to PSUS. When all UR pairs in a journal group are suspended, the status of the journal group is changed to STOP. The specifications of the suspend operation are as follows.

- ✓ This operation is performed when the target volume is in the COPY/PAIR status and all volumes in the journal group are in the status other than Suspending/Deleting status.
- ✓ The pair suspend operation can be performed from P-VOL/S-VOL. The processing of the suspend operation is the same for both P-VOL/S-VOL instructions.
- ✓ When you perform the pair suspend operation, you can specify the Pend Update and the suspend range. The table below shows the relationships of Pend Update and the suspend range.

Table 3.17.4.1-9 Pair suspend

#	Pend Update	Feature overview	Volume	Group
1	Flush	✓ When the suspend operation is received, the pending data in MCU/RCU is reflected. ✓ When the operation is performed while the host I/O is being processed, the contents of the P-VOL and S-VOL are not the same. (In the operation after the host I/O is stopped, the contents of the P-VOL and S-VOL are the same)	○	○
2	Purge	✓ When the suspend operation is received, the difference of the pending data in MCU/RCU is recorded to the differential bitmaps. (Since the data is not reflected, the contents of the P-VOL and S-VOL are not the same) ✓ The status can be changed to Suspend in a short time.	—	○

● Pair suspend option

When you perform a pair suspend operation, you can specify a pair suspend option. The following table shows the options and applications you can specify.

Table 3.17.4.1-10 Pair suspend option

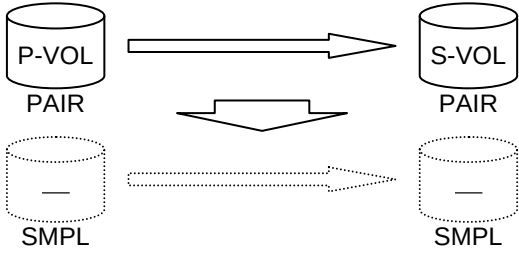
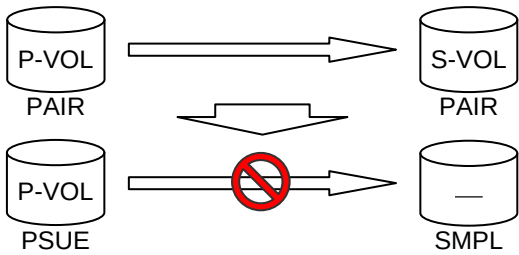
#	Option	Feature overview	OP	MF	RM	BC
1	Pend Update	You can choose a Pend Update type when performing a pair suspend. (Note that only Flush is available for RAID Manager) ✓ Flush: The Pend data is processed in the Flush mode. ✓ Purge: The Pend data is processed in the Purge mode.	○	○	○	○
2	Range	You can specify the suspend range. (However, when the Purge mode is selected in Pend Update, only “Group” can be selected) ✓ Volume: Only the specified UR pairs are suspended. ✓ Group: All pairs in the specified journal group are suspended.	○	○	○	○
3	S-VOL write	You can choose to perform Write/Read to the S-VOL when performing a pair suspend. ✓ Disable: Cannot Read/Write data to the suspended S-VOL. ✓ Enable: Can Read/Write data to the suspended S-VOL.	○	○	○	○

(5) Pair delete

The UR pair is deleted, and the pair volumes are restored to non-UR logical volumes. When all UR pairs in the target journal group are deleted, the attribute of the journal group is changed to Initial. The following table shows the specifications of the pair delete operation.

- ✓ This operation is performed when the target volume is in the normal status (COPY/PAIR/PSUS(PSUE)) and all volumes in the journal group are in the status other than Suspending/Deleting.
- ✓ If you perform the pair delete operation for an UR pair after stopping the host I/O, the data in the P-VOL and that in the S-VOL are the same. (When this operation is performed while the host I/O is in progress, the data are not the same.)
- ✓ The pair delete operation can be performed from P-VOL/S-VOL. Note that the feature depends on the specified volume attribute. The following table shows the specified volume attributes and the features.

Table 3.17.4.1-11 Pair delete

#	Specified volume	Feature overview
1	P-VOL specified	✓ The statuses of both P-VOL and S-VOL are changed to SMPL, and the UR pair will be deleted. 
2	S-VOL specified	✓ Only the status of S-VOL changes to SMPL, and the P-VOL status is not changed. If the P-VOL is in the COPY/PAIR status, the pair will be suspended due to a failure (PSUE). When the operation is performed to the suspended pair, the P-VOL status is not changed.  ✓ The UR pair of only the P-VOL after the pair delete operation cannot be resynchronized. Therefore, you need to delete the pair using the P-VOL specified pair delete operation.

● Pair delete option

When you perform a pair delete operation, you can specify a pair delete option. The following table shows the options and applications you can specify.

Table 3.17.4.1-12 Pair delete option

#	Option	Feature overview	OP	MF	RM	BC
1	Range	You can specify the following pair delete range. ✓ Volume: Only the specified UR pairs are deleted. ✓ Group: All pairs in the specified journal group are deleted.	○	○	○	○
2	Specified volume attribute	You can specify the attribute of the volume to which the pair delete is performed. P-VOL specified: Normal pair delete operation is performed. S-VOL specified: Pair is deleted only in S-VOL.	○	○	○	○
3	ForceDelete	You can specify ForceDelete which deletes pairs regardless of the pair status. The overview of the ForceDelete feature is as follows. ✓ ForceDelete deletes only the pairs in the specified volume without recognizing the status of the paired volume. Therefore, the operations in the target (paired) volume is not guaranteed. ✓ Only “Group” range is available. (Note that only “Volume” range is available for SMPL volumes) ✓ After the ForceDelete operation, the data in P-VOL and that in S-VOL are not the same.	○	○	—	—

(6) Pair resync (Pair resume)

The copy operation of the suspended UR pair is resumed. When a copy operation of one pair is resumed in the journal group in which the copy operation is stopped (STOP), the journal group status will be changed to Active. The specifications of pair resync operation are as follows.

- ✓ This operation is performed when the target UR pair is in the PSUS/PSUE status and the journal group to which the target UR belongs does not contain UR pair in the Suspending/Deleting status. However, this operation cannot be performed to the P-VOL which is paired with the S-VOL in the SSWS status.
- ✓ The operations can be specified in P-VOL. However, the Swap instruction can be specified in S-VOL optionally.

● Pair resync option

When you perform a pair resync operation, you can specify a pair resync option. In addition, when the range of the operation is “volume”, you can change the pair create option for the target volume. The following table shows the options and applications you can specify.

Table 3.17.4.1-13 Pair resync option

#	Option	Feature overview	OP	MF	RM	BC
1	Range	You can specify the following pair resync range. ✓ Volume: Only the specified UR pairs are resynchronized. ✓ Group: All pairs in the specified journal group are resynchronized.	○	○	○	○
2	Priority	To resynchronize multiple pairs at a time, set the priority of the base copy operation. ✓ Range: 1-255	○	○	—	—
3	Error level	Set the error level in the case of a failure. (Enabled only when the range “volume”) ✓ Group: Even if a failure affects only the specified volume, all pairs in the journal group will be suspended due to the failure. ✓ Volume: When a failure affects only the specified volume, only the pair will be suspended due to the failure. However, when a failure affects the entire journal group, all pairs in the journal group will be suspended due to the failure.	○	○	—	○
4	Swap	This option is specified in the S-VOL, the volumes are swapped (S-VOL→P-VOL/P-VOL→S-VOL). The differential data is resynchronized from the swapped P-VOL to S-VOL. See “3.17.4.1 (7) Takeover” for the swapping feature.	—	—	○	○

(7) Takeover (Reverse Resync)

Takeover swaps P-VOL and S-VOL (switch the source and the target) and resynchronizes the pair. The specifications of the Takeover operation are as follows.

- ✓ Only RAID Manager can perform this operation.
- ✓ This operation is performed to S-VOL. It can be performed even if the P-VOL (i.e. DKC in the MCU) is lost due to disaster etc.
- ✓ This operation is performed when the pair status of the S-VOL is PAIR or PSUS/SSWS and when the target RCU does not contain UR pairs in the Suspending/Deleting or COPY status. The following table shows when the Takeover command is issued.

Table 3.17.4.1-14 Takeover

#	Pair status	Feature overview
1	PAIR	(1) When a Takeover command is issued to the RCU, the Flush suspend is performed for the specified group. When it is issued, the S-VOL status changes to SSWS, and it becomes a volume that can be read/written. (2) After the pair is suspended, a pair resync swap is performed to swap the P-VOL and the S-VOL, and an initial copy operation is performed.
2	PSUS/PSUE	(1) When a Takeover command is issued to RCU, the Flush suspend is not performed for the specified group. Only the S-VOL status is changed to SSWS. (2) After the suspend operation completes, a pair resync swap is performed to swap the P-VOL and the S-VOL, and an initial copy operation is performed.

(8) JNL group status and display of pair status by RAID Manager

We summarize the relationship between display of JNL group status and display of pair status regarding RAID Manager(RM) compared with JAVA display as the following.

① Operation suspend

#	JAVA Pair status	RM Pair status	RM (M-JNL) JNLGroup status	RM (R-JNL) JNLGroup status	Remarks
1	SMPL	SMPL	—	—	—
2	COPY/PAIR	COPY/PAIR	PJNN	SJNN	—
3	Suspending				—
4	PSUS	PSUS/SSUS	PJSN	SJSN	—

② JNL utilization threshold over (JNL utilization is over 80% (but...not failure))

#	JAVA Pair status	RM Pair status	RM (M-JNL) JNLGroup status	RM (R-JNL) JNLGroup status	Remarks
1	SMPL	SMPL	—	—	—
2	COPY/PAIR	PFUL	PJNF	SJNF	—
3	Suspending	—	—	—	Pair status will not change to “Suspend”.
4	PSUS	PSUS/SSUS	—	—	Same as above

③ Failure suspend (except for JNL puncture)

#	JAVA Pair status	RM Pair status	RM (M-JNL) JNLGroup status	RM (R-JNL) JNLGroup status	Remarks
1	SMPL	SMPL	—	—	—
2	COPY/PAIR	COPY/PAIR	PJNN	SJNN	—
3	Suspending	PSUE	PJSE	SJSE	—
4	PSUE	PSUE			—

④ JNL puncture suspend

#	JAVA Pair status	RM Pair status	RM (M-JNL) JNLGroup status	RM (R-JNL) JNLGroup status	Remarks
1	SMPL	SMPL	—	—	—
2	COPY/PAIR	COPY/PAIR	PJNN	SJNN	—
3	Suspending	PFUS	PJSF	SJSF	—
4	PSUS	PFUS			—

3.17.4.2 USAGE/HISTORY

(1) USAGE

This feature enables you to view the UR information (Frequency of I/O for UR pair, transfer rate of journals between MCU/RCU, usage of journals in MCU/RCU etc.) using SVP and Web Console. The specifications are as follows.

Table 3.17.4.2-1 USAGE specification

#	Item	Specification etc.
1	Sampling interval	1-15 min. (1 min.)
2	Samplings	1440
3	Unit of sampling/display	• For each LU • For each JNL group • For each system
4	Sampling item	See Table 3.17.4.2-2
5	Others	You can save the monitor data in the text format using the Export Tool of Performance Monitor.

Table 3.17.4.2-2 Sampled items

#		Category	Statistics	Description
1	M C U	Host I/O	Write Record Count	The number of Write I/Os per second
2			Write Transfer Rate	The amount of data that are written per second (KB/sec.)
3		Initial copy	Initial copy HIT rate	Initial copy hit rate (%)
4			Average Transfer Rate	The average transfer rate for initial copy operations (KB/sec.)
5	M C U	Async copy	M-JNL Asynchronous RIO count	Number of async RIOs per second in MCU
6			M-JNL Total Number of Journal	The number of journals at MCU
7			M-JNL Average Transfer Rate	The average transfer rate for journals at MCU (KB/sec.)
8			M-JNL Average RIO Response	The remote I/O process time at MCU (milliseconds)
9	R C U	Async copy	R-JNL Asynchronous RIO count	The number of asynchronous remote I/Os per second at the RCU
10			R-JNL Total Number of Journal	The number of journals at the RCU
11			R-JNL Average Transfer Rate	The average transfer rate for journals at RCU (KB/sec.)
12			R-JNL Average RIO Response	The remote I/O process time at RCU (milliseconds)
13	M C U	Journal group	Data Used Rate	Data usage rate for journals at MCU (%)
14			Meta Data Used Rate	Metadata usage rate for journals at MCU (%)
15	R C U	Journal group	Data Used Rate	Data usage rate for journals at RCU (%)
16			Meta Data Used Rate	Metadata usage rate for journals at RCU (%)

(2) HISTORY

This feature enables you to view the history of operations for data volume pairs (Operations performed in the past) using SVP and Web Console. The specifications are as follows.

Table 3.17.4.2-3 HISTORY specifications

#	Item	Spec etc.
1	Displayed info	Date and time of the operation, contents of the operation (See #3, Journal group number, Mirror ID, Data volume, Target volume)
2	Samplings	524288, or for one week
3	Operation	• Pair create • Pair delete • Pair recovery • Pair split etc.
4	Others	The snapshot function enables you to save operation history to a text file.

3.17.4.3 Option

The following table shows UR settings. For pair settings, see 3.17.4.1. The following system option and journal group options are supported.

Table 3.17.4.3-1 List of options

#	Affected	Setting	Description	Supported version
1	System	Max number of initial copy VOLs	✓ Number of volumes to which initial copy operations are performed at a time. The setting value is 1-128. ✓ Default is 64.	
2	Journal group	Inflow Control	✓ Indicates whether to restrict inflow of update I/Os to the P-VOL (whether to delay a response to the hosts). ✓ If you select “Yes”, the inflow control is performed according to the condition of #3.	
3		Data Overflow Watch	✓ Indicates the time (in seconds) for monitoring whether metadata and journal data are of journal volume are full. ✓ When either of the areas becomes full, the target group will be suspended due to a failure after this specified time. ✓ The setting value is 0-600 sec.	
4		Use of Cache	✓ If you select “USE”, journal data will be stored into the cache and don't destage journal volumes in the restore journal group as long as the cache memory is not filled. The JNL restore performance improves.	

(To be continued)

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(Continued from the preceding page)

#	Affected	Setting	Description	Supported version
5	Mirror	Copy pace	✓ Initial copy pace (speed). ✓ The setting value is “Low”, “Medium” or “High”.	
6		Speed of Line	✓ JNL copy performance pace (speed). ✓ The setting value is “256Mbps”, “100Mbps” or “50Mbps”.	
7		Unit of Path Watch time	✓ Unit of Path Watch time (#8) ✓ The setting value is “minute”, “hour” or “day”.	
8		Path Watch time	✓ Time for monitoring a path from the time it is blocked until it is suspended due to a failure. ✓ The setting value is 1 min - 30 days. ✓ You can specify whether to forward the Path Watch time value of the master journal group to the restore journal group. If the Path Watch time value is forwarded from the master journal group to the restore journal group, the two journal groups will have the same Path Watch time value.	
9		Forward Path Watch time	✓ If you select “Yes”, the Path Watch time (#8) value of the master journal group will be forwarded to the restore journal group.	
10		Delta resync Failure	✓ Specify the processing that takes place when delta resync operation cannot be performed. ✓ If “Copy of all” is specified, the whole data in primary data volume is copied to secondary data volume when delta resync operation cannot be performed.	

Table 3.17.4.3-2 Link failure monitoring mode

Mode	Feature digest	Feature overview
448	Mode for suspending the pair immediately after UR path is disconnected	Turn this mode ON when you want to suspend the pair due to a failure immediately after a communication failure is detected between UR M-R. This mode runs only when Mode 449 is OFF. ON: In MCU, the pair is suspended due to a failure immediately after the RDJNL from RCU is stopped. In RCU, the pair is suspended due to a failure immediately after the RDJNL fails. OFF: In MCU, the pair is suspended due to a failure when the RDJNL from RCU is stopped for a certain period of time. In RCU, the pair is suspended due to a failure when the RDJNL fails for a certain period of time.
449	Mode for prohibiting UR path watch	Turn this mode ON when you want to prevent communication failures between UR M-R from being detected. On is default. ON: In MCU, the RDJNL stop check from RCU is prevented. In RCU, the RDJNL failure monitoring is prevented. OFF: Communication failures between M-R are detected.

3.17.5 Maintenance features and procedure

3.17.5.1 Maintenance

The following table shows limitations/impact on the maintenance operations regarding the UR operations. Other limitations/impact refer to “2.8 Availability of Installation and De-installation” of INSTALLATION SECTION ([INST02-260](#)).

Table 3.17.5.1-1 Limitations/restrictions on maintenance

#	Item	Limitation/impact	Note
1	CM replacement/ change of SM capacity setting in MCU	Pair in the initial copy status will suspend due to a failure.	
2	Microprogram exchange in RCU	The pair may be suspended in MCU due to a failure. (Cause: Link failure, journal full)	Alternate paths are set between MCU and RCU. If microprogram is not replaced using these alternate paths at a time, the pair will not be suspended due to a link failure.
3	CHT replacement in MCU/RCU	The pair may be suspended in MCU/RCU due to a failure. (Cause: Link failure, journal full)	Alternate paths are set between MCU and RCU. If microprogram is not replaced using these alternate paths at a time, the pair will not be suspended due to a link failure.

3.17.5.2 PS OFF/ON Process

Before you power off/on (PS OFF/ON) the DKC, we recommend that you suspend all pairs (all JNL groups) by specifying Flush in advance as shown below. When you stop the host I/O and suspend (Flush) the pairs in advance, the contents of P-VOL and S-VOL match. Consequently, the operation can be continued using the S-VOL data in R-DKC even if you fail to power on the M-DKC for some reason. The recommended procedure is as follows.

- (1) Stop the host I/O.
- (2) Issue the suspend (Flush) request for M-JNL, and change the statuses of both M-JNL and R-JNL to suspend.
- (3) Power off the M-DKC.
- (4) Power off the R-DKC.
- (5) Power on the R-DKC.
- (6) Power on the M-DKC.
- (7) Resynchronize the pair upon the pair resync request.
- (8) Resume the host I/O.

If you do not perform the procedure above, operations are performed as follows. The numbers in the table below show the target of PS OFF/ON, and the order of PS OFF/ON. “-” shows that it is not the target of PS OFF/ON.

Table 3.17.5.2-1 PS OFF/ON

	Part and Order of PS OFF/ON				Operation
	M-DKC		R-DKC		
	OFF	ON	OFF	ON	
Case 1	1	2	–	–	[PS OFF/ON only M-DKC] No problem.
Case 2	–	–	1	2	[PS OFF/ON only R-DKC] Pair may be suspended due to a failure in MCU. As a result, R-JNL detects the failure suspension when PS ON is performed, and the pair may be also suspended. Such a failure suspension is caused because the M-JNL is full or the read journal is stopped.
Case 3	1	3	2	4	[PS OFF/ON both M-DKC and R-DKC] PS ON the M-DKC first. If it takes time until R-DKC PS ON (4) after M-DKC PS ON (3), the same phenomenon as Case 2 will occur.
Case 4	1	4	2	3	[PS OFF/ON both M-DKC and R-DKC] The procedure is the recommended one, except that host I/O stop and pair suspension are excluded. When PS ON is performed, the pair status before PS OFF is maintained.
Case 5	2	3	1	4	[PS OFF/ON both M-DKC and R-DKC] PS OFF R-DKC first. If it takes time until M-DKC PS OFF (2) after R-DKC PS OFF (1), the same phenomenon as Case 2 will occur. If it takes time until R-DKC PS ON(4) after M-DKC PS ON (3), the same phenomenon as Case 2 will occur.
Case 6	2	4	1	3	[PS OFF/ON both M-DKC and R-DKC] If it takes time until M-DKC PS OFF (2) after R-DKC PS OFF (1), the same phenomenon as Case 2 will occur.

3.17.5.3 Power failure

When a power failure occurs, UR pairs will be in the following status.

Table 3.17.5.3-1 Power failures

#	Item	Pair in PS ON	Recovery
1	SM/CM non-volatile	Suspended due to a failure	Resynchronize to the target group
2	SM/CM volatile	Journal group information and pair information will be lost.	Register journal group and pair

3.17.6 Cautions on software

3.17.6.1 Error recovery

The following subsections describes failure detection, error report, and recovery in UR. When a failure occurs in UR, Group or Volume (according to the error level setting) will be suspended.

(1) Error report

The following table shows the error report in the case of a failure.

Table 3.17.6.1-1 Error report

Item	Type	SSB(F/M)	SIM
Path	Link failure	—	0x2180-XX
Pair	Failure suspend	F/M = 0xFB Not reported to host	Serious SIM Not reported to host

(2) Failure detection and recovery

Failure detection and recovery in MCU are described in the following table.

Table 3.17.6.1-2 Failure detection and recovery

Part	Description	Error	Recovery
Path failure	Link failure of MCU->RCU	SIM = 0x2180	Recover the link
	Link failure of MCU<-RCU	When Read JNL is stopped for a certain period of time, the target Volume/Group is suspended, and F/M = 0xFB, SIM is generated. (see Table 3.17.4.3-1 and Table 3.17.4.3-2.)	Recover the link Resync after the failure recovered
Data volume failure	PDEV failure	Target Volume/Group is suspended F/M = 0xFB, SIM Update I/O is managed as differential data	Resync after the failure recovered
Journal failure	PDEV failure	Target Group is suspended F/M = 0xFB, SIM Update I/O is managed as differential data	Resync after the failure recovered
Journal full	Metadata area or journal data area of JNL volume is not sufficient for a certain period of time	Target Group is suspended F/M = 0xFB, SIM Update I/O is managed as differential data	Resync after the failure recovered

(3) Failure detection in RCU

Failure detection and recovery in RCU are described in the following table.

Table 3.17.6.1-3 Failure detection in RCU

Part	Description	Error	Recovery
Path failure	Link failure of MCU<-RCU	SIM = 0x2180 When Read JNL is stopped for a certain period of time, the target Volume/Group is suspended, and F/M = 0xFB, SIM is generated. (see Table 3.17.4.3-1 and Table 3.17.4.3-2.)	Recover the link Resync after the failure recovered
Data volume failure	PDEV failure	Target Volume/Group is suspended F/M = 0xFB, SIM	Resync after the failure recovered
Journal failure	PDEV failure	Target Group is suspended F/M = 0xFB, SIM	Resync after the failure recovered

3.17.7 Disaster Recovery Operations

3.17.7.1 Preparation for Disaster Recovery

The type of disaster and the status of the UR volume pairs will determine the best approach for disaster recovery. Unfortunately, some disasters are not so “orderly” and involve intermittent or gradual failures occurring over a longer period of time. The user should anticipate and plan for all types of failures and disasters.

The major steps in preparing for disaster recovery are:

1. Identify the journal groups and data volumes that contain important files and data (e.g., DB2 log files, master catalogs, key user catalogs, and system control datasets) for disaster recovery.
2. Install the Storage Navigator PC and UR hardware and software, and establish Universal Replicator operations for the journal groups and data volumes identified in step (1).
3. Establish file and database recovery procedures. These procedures should already be established for recovering data volumes that become inaccessible due to some failure.
4. Install and configure the host failover software between the primary and secondary sites.
5. Install and configure error reporting communications (ERC) between the primary and secondary sites. (only in URz.)

3.17.7.2 Sense information is transferred between sites (URz only)

When the primary storage system (or secondary storage system for URz) suspends a URz pair due to an error condition, the primary storage system or secondary storage system sends sense information with unit check status to the appropriate host(s). This sense information is used during disaster recovery. You must transfer the sense information to the secondary site via the error reporting communications (ERC).

3.17.7.3 File and Database Recovery Procedures

When the primary or secondary storage system suspends a UR pair due to a disaster, the secondary data volume may contain in-process data. A data set could be open, or transactions may not have completed. Therefore, you need to establish file recovery procedures. These procedures should be the same as those used for recovering data volume that becomes inaccessible due to control unit failure.

UR does not provide any procedure for detecting and retrieving lost updates. To detect and recreate lost updates, you must check other current information (e.g., database log file) that was active at the primary site when the disaster occurred. Since this detection/retrieval process can take a while, your disaster recovery scenario should be designed so that detection/retrieval of lost updates is performed after the application has been started at the secondary site.

You should prepare for file and database recovery by using:

- Files for file recovery (e.g., database log files which have been verified as current).
- The sense information with system time stamp which will be transferred via ERC. (only in URz.)

3.17.7.4 Switching Operations to the Secondary Site

If a disaster or failure occurs at the primary site, the first disaster recovery activity is to use Business Continuity Manager to switch your operations to the remote backup site.

The basic procedures for switching operations to the remote backup site are:

1. Check whether the restore journal group includes a secondary data volume whose pair status is Pending duplex or Suspend (equivalent to SUSPOP in Business Continuity Manager).
If such a pair exists, consistency in the secondary data volume is dubious, and recovery with guaranteed consistency is impossible. In this case, if you want to use the secondary data volume, you must delete the pair.
2. If such a pair does not exist, use Business Continuity Manager to execute the YKSUSPND REVERSE option on the restore journal group (YKSUSPND is a command for splitting a pair).
If an error occurs, consistency in the secondary data volume is dubious, and recovery with guaranteed consistency is impossible. In this case, if you want to use the secondary data volume, you must delete the pair.
3. If no error occurs in step 2, wait until the splitting finishes. When the splitting finishes, the secondary data volume becomes usable with maintained consistency.
4. When the splitting finishes, use Business Continuity Manager to execute the YKRESYNC REVERSE option on the restore journal group (YKRESYNC is a command for restoring a pair). This option attempts to restore the pair and reverse the primary/secondary relationship.
5. Check whether there is a pair whose pair status of the restore journal group is Suspend (equivalent to SWAPPING in Business Continuity Manager).
If such a pair does not exist, the pair is successfully restored and the copy direction is reversed, and then copying of data from the secondary site to the primary site will start.

If the YKSUSPND command finishes successfully and the splitting ends successfully, you can resume business tasks (i.e., you can start business applications) by using secondary data volumes in the secondary site. Also, if the primary storage system, the secondary storage system, and remote copy connections are free from failure and fully operational, the restoring of the pair will finish successfully, and then copying of data from the secondary site to the primary site will start.

3.17.7.5 Transferring Operations Back to the Primary Site

Once the disaster recovery procedure is finished and your business applications are running at the secondary site, the next activity is to restore the primary site and make arrangements for copying data from the secondary site back to the primary site. The following procedure explains how to use Business Continuity Manager to copy data from the secondary site to the primary site:

1. Restore the primary storage system and remote copy connections, and make sure that all UR components are fully operational.
2. At the primary site, locate primary data volumes whose pair status is Pending duplex or Duplex, and then locate corresponding secondary data volumes whose pair status is Suspend, which is equivalent to SWAPPING in Business Continuity Manager terminology. If such volume pairs are found, issue a request for splitting the pairs to the primary data volumes.
3. At the primary site, locate primary data volumes whose pair status is not Simplex, and then locate corresponding secondary data volumes whose pair status is Simplex. If such volume pairs are found, issue a request for deleting the pairs to the primary data volumes.
4. At the primary site, locate data volume pairs whose pair status is Simplex, and then use Business Continuity Manager to execute YKRECOVER on the secondary data volume (YKRECOVER is a command for deleting a pair).
5. Execute the YKRESYNC REVERSE option on secondary data volumes whose pair status is Suspend, which is equivalent to SWAPPING in Business Continuity Manager terminology (YKRESYNC is the Business Continuity Manager command for resynchronizing pair). This reverses primary data volumes and secondary data volumes to resynchronize pairs.
6. Create pairs, specifying secondary data volumes whose pair status is Simplex as primary data volumes. This creates pairs in which primary data volumes and secondary data volumes are reversed.
7. Verify that pair status of all secondary data volumes (which were originally primary data volumes) changes from Pending Duplex to Duplex. If the pair status is changed to Duplex, initial copy operations are finished and consistency is maintained.

The above procedure enables copying of data from the secondary site to the primary site. Data in the secondary site will be reflected on the primary site.

3.17.7.6 Resuming Normal Operations at the Primary Site

Once the UR volume pairs have been established in the reverse direction, you are ready to resume normal operations at the primary site. The following procedure explains how to resume normal operations at the primary site by using Business Continuity Manager. Remember that the UR terminology is now reversed: the original primary data volumes are now secondary data volumes, and the original secondary data volumes are now primary data volumes.

1. At the primary and secondary sites, make sure that all UR components are fully operational and are free from failures.
2. Make sure that pair status of primary and secondary data volumes in all UR pairs is “Duplex”. This indicates that the UR initial copy operations are complete and consistency is maintained.
3. Stop the applications at the secondary site.
4. Issue a request for splitting pairs to master journal groups (which were originally restore journal groups); please use the Business Continuity Manager to execute the YKSUSPND FLUSH S-VOL PERMIT option on the master journal group (which was originally the restore journal group); YKSUSPND is a command for splitting pairs. If an error occurs when splitting pairs, please remove the error cause and go back to Step 1 after resuming your business task at the secondary site.
5. If no error occurs in step 4, wait until suspension finishes. After suspension finishes, check whether there is a secondary data volume (which is originally a primary data volume) whose pair status is other than Suspend (equivalent to SUSPOP with Business Continuity Manager). If such a pair exists, please remove the error cause and go back to Step 1 after resuming your business task at the secondary site.
6. If there is no secondary data volume (which is originally a primary data volume) whose pair status is other than Suspend (equivalent to SUSPOP with Business Continuity Manager), data in primary data volumes are the same as data in secondary data volumes, and the secondary data volume (which are originally primary data volumes) are usable. Please resume applications at the primary site.
7. Execute the YKSUSPND FORWARD command on the restore journal group (which were originally master journal group); YKSUSPND is a Business Continuity Manager command and REVERSE is an option. Wait until suspension completes.
8. After suspension completes, execute the Business Continuity Manager YKRESYNC FORWARD command on the restore journal group (which were originally master journal group). This reverses primary data volumes and secondary data volumes to resynchronize pairs and restores copy direction to its original direction.

3.18 CVS and DCR Option function

3.18.1 Customized Volume Size (CVS) Option

3.18.1.1 Outline

As regards the main frame host, the multiplicity of an I/O request is restricted to one per volume because UCBs are mutually exclusive.

Therefore, when two or more files to which I/Os are applied frequently exist in the same volume, a contention for the logical volume occurs. If this occurs, the files mentioned above are stored separately in different logical volumes and an action is taken to avoid contention for access. (Or means to prevent I/Os from generation is required.)

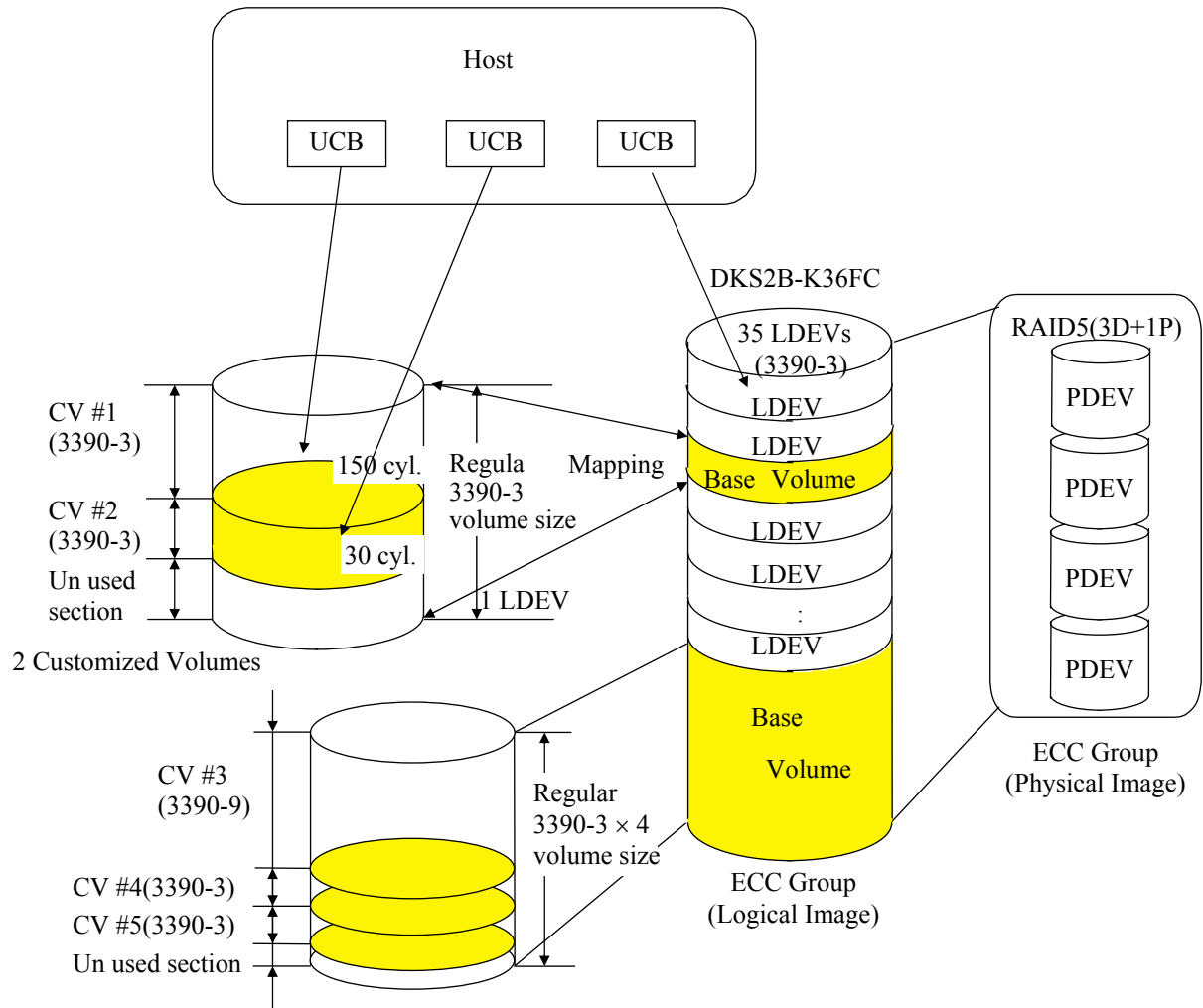
However, the work for adjusting the file arrangement giving consideration to the accessing characteristic of the file will be a burden on users of the DKC and it is not welcomed by them.

To solve this problem, the Customized Volume Size (CVS) option is provided. (Hereinafter, it is abbreviated to CVS.)

The CVS provides a function for freely defining the logical volume size. By doing this, even in a storage system with the same capacity, the number of volumes can be increased easily. As a result, a file with a high I/O frequency can be easily allocated to an independent volume. That is to say, the trouble to consider a combination of stored files in a volume can be saved.

3.18.1.2 Features

- The contention for UCB in the mainframe host can be avoided, and the waiting time (IOSQ time) from the IO starting command of the OS to the IO issuance by the UCB can be reduced.
- The capacity of the ECC group can be fully used.
- By combining with the Dynamic Cache Residence (DCR) option, high performance equivalent to that of a semiconductor storage device can be realized.



3.18.1.3 Specifications

The CVS option consists of a function to provide variable capacity volumes and a function to provide free arrangement of volumes on the ECC group.

(a) Function to provide variable capacity volumes

This function can create the capacity volume as required by the users.

(b) Emulation type intermix on the ECC group

As regard the DKC810I, the logical volume type in the ECC group is restricted to the same type only. However, the CVS option enables the different emulation types of volumes to coexist in one ECC group.

Table 3.18.1.3-1 CVS Specifications

Parameter	Mainframe system	Open system	
Track format	3390	OPEN-3, OPEN-8, OPEN-9, OPEN-E	OPEN-V
Emulation type	3390-3, 3390-3A, 3390-3B, 3390-3C, 3390-9, 3390-9A, 3390-9B, 3390-9C, 3390-L, 3390-LA, 3390-LB, 3390-LC, 3390-M, 3390-MA, 3390-MB, 3390-MC, 3390-A	OPEN-3, OPEN-8, OPEN-9, OPEN-E	OPEN-V
Ability to intermix emulation type	Depends on the track geometry	Depends on the track geometry	Depends on the track geometry
Maximum number of volumes (normal and CVS) per VDEV	2,048 for RAID5 (7D+1P), RAID6 (6D+2P) or RAID6 (14D+2P) 1,024 for other RAID levels	2,048 for RAID5 (7D+1P), RAID6 (6D+2P) or RAID6 (14D+2P) 1,024 for other RAID levels	2,048 for RAID5 (7D+1P), RAID6 (6D+2P) or RAID6 (14D+2P) 1,024 for other RAID levels
Maximum number of volumes (normal and CVS) per storage system	65,280	65,280	65,280
Minimum size for one CVS Volume	User cylinder (+ Control cylinders) (See Table 3.18.1.3-2 about control cylinders)	36,000 KB (+ Control cylinders)	48,000KB (+ 50 cylinders)
Maximum size for one CVS Volume	User cylinder (+ Control cylinders) (See Table 3.18.1.3-2 about control cylinders)	See Table 3.18.1.3-3	See Table 3.18.1.3-3
Size increment	1 user cylinder	1 MB	1 MB (1 user cylinder)
Disk location for CVS Volume	Anywhere	Anywhere	Anywhere

- NOTE:
- When you specify more than 65520 cylinders as 3390-A, the cylinder number is revised to the multiple of 1113 cylinders. (for example: When you specify 65521 cylinders, it becomes 65667 cylinders ($=1,113 \text{ cylinder} \times 59$))
 - When you specify 3390-V, the size is revised to about 38MB (44.8 cylinders) multiples. Lower than few marks cut it off and display the number of the cylinders. (For example: When you specify 10000 cylinders, it becomes 10035 cylinders ($=44.8 \text{ cylinder} \times 224=10,035.2 \text{ cylinder}$)).
 - Capacity of more than 8GB is necessary to register 3390-V with a pool of Dynamic Provisioning for Mainframe/Thin Provisioning for Mainframe. When you make 3390-V, you should specify capacity of more than 9633 cylinders.

NOTE1:**(1) Mainframe volume**

The number of physical cylinders in an ECC group depends on the emulation type.

Where (A) is a specified value through SVP/Web Console, (B) is a value defined from the emulation type as shown in the table below.

The range of (C) could be from 0 to 47 or 0 to 55 depending on the result of (A) + (B).

i: 3390-A

Physical mapping onto an ECC group (tracks) =

$$\uparrow \text{User logical cylinders (A)} \div 1113 \uparrow \times 1120 \times 15$$

ii: Other than 3390-A (except HMDE volume and 3390-V)

Physical mapping onto an ECC group (tracks) =

$$\uparrow \{ \uparrow (\text{User logical cylinders (A)} + \text{additional control cylinders (B)}) \div 1113 \uparrow \times 7 \times 15 + (\text{User logical cylinders (A)} + \text{additional control cylinders (B)}) \times 15 \} \div 672 \uparrow \times 672$$

iii: 3390-V

Physical mapping onto an ECC group (tracks) =

$$\uparrow (\text{User logical cylinders (A)} \times 15) \div 672 \uparrow \times 672$$

iv: HMDE volume (3390-3A, 3B, 3C, and so on)

Physical mapping onto an ECC group (tracks) =

$$\text{User logical cylinders (A)} \times 15 + \text{additional control cylinder (B)} \times 15 + \text{adjustment (C)}$$

$$\therefore 1 \text{ cylinder} = 15 \text{ tracks}$$

i) RAID5 (3D + 1P)

$$((C) = \uparrow \frac{((A) + (B)) \times 15}{24} \uparrow \times 24 - ((A) + (B)) \times 15$$

ii) RAID5 (7D + 1P)

$$((C) = \uparrow \frac{((A) + (B)) \times 15}{56} \uparrow \times 56 - ((A) + (B)) \times 15$$

iii) RAID1

$$((C) = \uparrow \frac{((A) + (B)) \times 15}{16} \uparrow \times 16 - ((A) + (B)) \times 15$$

iv) RAID6 (6D + 2P)

$$((C) = \uparrow \frac{((A) + (B)) \times 15}{48} \uparrow \times 48 - ((A) + (B)) \times 15$$

v) RAID6 (14D + 2P)

$$((C) = \uparrow \frac{((A) + (B)) \times 15}{112} \uparrow \times 112 - ((A) + (B)) \times 15$$

∴ $\uparrow \uparrow$ means round up to the next integer.

e.g. $\uparrow 3.96 \uparrow = 4$

(2) Open volume

You can set the data by Mbytes or Logical Blocks. You can also set by Cylinders in case of OPEN-V. And the Program will assign the actual value as the following expression. The maximum OPEN-V capacity depends on that of VDEV size.

Except for OPEN-V

$X = (\text{your setting size}) \times 1024 \div 720$ (if there is remainder, add 1 to X.)

$Y = (X \times 96 \times 15 \times 512) \div 1024 \div 1024$

OPEN-V

$X = (\text{your setting size}) \times 16 \div 15$ (if there is remainder, add 1 to X.)

$Y = (X \times 128 \times 15 \times 512) \div 1024 \div 1024$

NOTE: X is a value of converting capacity into number of cylinders. Y is a value of converting value into number of mega bytes.

In case of open volume, physical mapping onto ECC group(track) is also calculated by the expression of (1).

In case of set by Logical Blocks, the value is assigned as actual size directly.

Table 3.18.1.3-2 CV capacity by Emulation types (for Mainframe System)

Emulation type	Minimum CV capacity (Cyl)	Maximum CV capacity (Cyl)	Number of control cylinder (Cyl)
3390-3	1	3,339	6
3390-3A	1	3,339	6
3390-3B	1	3,339	6
3390-3C	1	3,339	6
3390-9	1	10,017	25
3390-9A	1	10,017	25
3390-9B	1	10,017	25
3390-9C	1	10,017	25
3390-L	1	32,760	23
3390-LA	1	32,760	23
3390-LB	1	32,760	23
3390-LC	1	32,760	23
3390-M	1	65,520	53
3390-MA	1	65,520	53
3390-MB	1	65,520	53
3390-MC	1	65,520	53
3390-A	1	262,668	7 per 1113 cylinder
3390-V	1	837,760 (Internal volume) 1,117,760 (External volume)	0

Table 3.18.1.3-3 CV capacity by Emulation types (for Open System)

Emulation type	Minimum CV capacity (Cyl)	Maximum CV capacity (Cyl)	Number of control cylinder (Cyl)
OPEN-V	48,000KB	Internal volume: 3,221,159,680KB (2.99TB) External volume: 4,294,967,296KB (4TB)	0KB (0Cyl)
OPEN-3	36,000KB (50Cyl)	2,403,360KB	5,760KB (8Cyl)
OPEN-8	36,000KB (50Cyl)	7,175,520KB	19,440KB (27Cyl)
OPEN-9	36,000KB (50Cyl)	7,211,520KB	19,440KB (27Cyl)
OPEN-E	36,000KB (50Cyl)	14,226,480KB	13,680KB (19Cyl)

NOTE: CVS functions are not applicable to OPEN-L volumes.

NOTICE: When you set Cross-OS File Exchange volumes to customized volumes and reset them to the normal volume again, these volumes could not be set as Cross-OS File Exchange volumes. Please refer to the following table.

Emulation Types for Cross-OS File Exchange volumes	Emulation types after changing from Customized volume to normal volume
3390-3A	3390-3
3390-3B	
3390-3C	

If you want to reset these volumes as Cross-OS File Exchange, please call technical support division to set them to Cross-OS File Exchange volumes by SVP.

3.18.1.4 Maintenance functions

Features of the maintenance functions of the CVS option is that they allow execution of not only the conventional maintenance operations instructed by the SVP but also the maintenance operations instructed from the Storage Navigator. (See Item No. 2 to 5 in Table 3.18.1.4-1.)

Unlike the conventional LDEV addition or reduction, the operation for the ECC group is made unnecessary, so that the volumes can be operated from the Storage Navigator.

Table 3.18.1.4-1 Maintenance Function List

Item No.	Maintenance function	CE	User	Remarks
1	Concurrent addition or deletion of CVs at the time of addition or reinstallation of ECC group	✓	—	Same as the conventional addition or reinstallation of LDEVs
2	Addition of CVs only	✓	✓	Addition of CVs in the free area
3	Conversion of normal volumes to CV	✓	✓	
4	Conversion of CV to normal volumes	✓	✓	
5	Deletion of CVs only	✓	✓	Only the optional CVs are deleted and incorporated into the free area. No deinstallation of ECC group is involved.

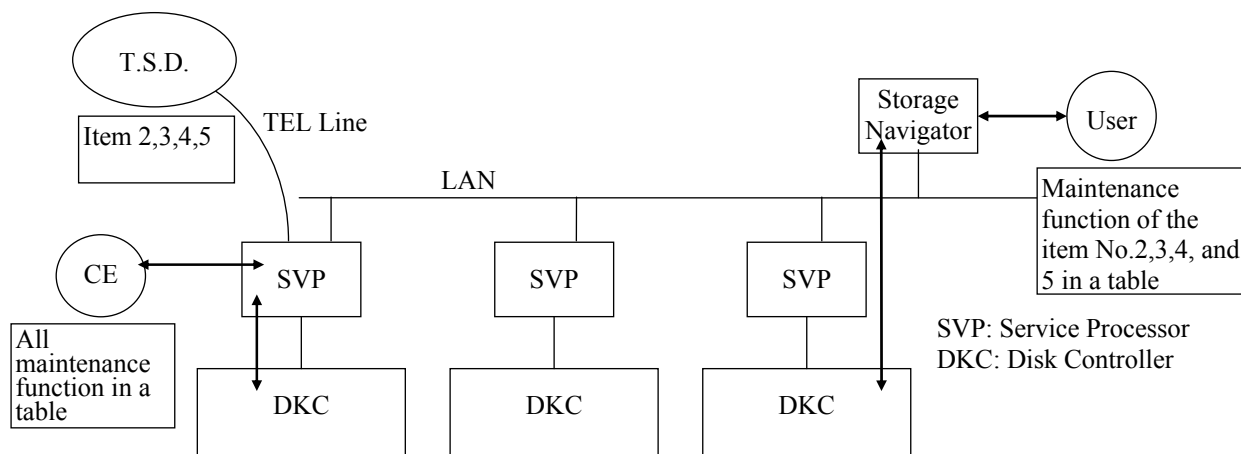


Fig. 3.18.1.4-1 Maintenance Execution Route when CVS Is Used

3.18.2 Dynamic Cache Residence (DCR) Option

3.18.2.1 Outline

Because cache capacity is usually smaller than the total HDD capacity in RAID storage system, cache cannot keep all data at the same time which is stored whole HDDs in the storage system. Cache management controls cache extent so as to allocate more capacity to more frequently accessed data to embed this gap by LRU algorithm.

By this control, data with a low access frequency is hard to remain in the cache, de-staged into HDDs, therefore the more frequent accesses to physical HDDs occur, decrease the access performance and unpredictable response time appears.

The DCR option provides a function for making data being resident on the cache and realize high access performance.

DCR is a function to make the specified data resident in the specific Cache area in DKC. This will enable the host to always execute Cache hit of the specified data and access it at high speed.

3.18.2.2 Features

- Feature of the DCR consist of two modes, one is called “PRIOrity mode (hereinafter, it is abbreviated to PRIO)” and the other “BIND mode (hereinafter, it is abbreviate to BIND)”. PRIO is a basic mode (100% Read Hit) of this feature, which fits typical user needs and BIND is supplementary for special customer (100% Read/Write Hit. Replace SSD) needs.
- To use the DCR, addition of the cache memory is required for the service as a “DCR cache”.
- DCR supports PreStaging function. The PreStaging is a function which read data on Logical Volume onto cache by receiving Storage Navigator or SVP instructions. The PreStaging request is included in the DCR setting operations.

3.18.2.2.1 PRIO

[Processing]

- When a read command to the data which is assigned as DCR extent is issued and first meet “miss” in cache, the data is staged into cache by usual staging mechanism.

The data remains in the DCR cache permanently for future access to guarantee read-hit performance even after data is transferred to the host, regardless usually cache LRU management. If a write command is issued to the data remaining in the cache in the way above, the data is updated with an out-of-DCR cache segment provided for write data duplication, and the data is de-staged into the HDD. Then the cache segment for write data duplication is returned to the out-of-DCR cache segment group.

In this case, new data is left in the cache extent together with old data.

[Performance impact]

- Theoretically, because above de-staging into HDD is processed by usual asynchronous de-staging mechanism, succeeding host access has a possibility to meet the same cache slot collision by locking both the host access and asynchronous de-staging process. However in that case, by minimizing the collision time implemented in micro-code, performance impact will be negligible for usual customer jobs.
- In the case the storage system cache becomes overloaded, a performance degradation occurs because the non-DCR cache segment must be used for the data assurance during a period between write data reception and de-staging operation completion.

NOTE: When the operation of deleting the resident cache-data is performed during host I/O execution, the host I/O execution conflict with the procedure in which the data is transferred to disk drives (de-staging) may happen. It may cause the response performance degradation.

To avoid the response performance degradation, please limit the total capacity of data released by one operation.

- If the Host timeout period is more than 11 seconds, the amount of acceptable releasing cache is limited to 3Gbyte or less.
 - OPEN system: The amount of acceptable releasing cache is limited to 3Gbyte or less.
 - Mainframe system: The number of acceptable releasing cylinders is limited to 3000 or less.
- If the Host timeout period is less than 10 seconds, it is limited to 1Gbyte or less.
 - OPEN system: The amount of acceptable releasing cache is limited to 1Gbyte or less.
 - Mainframe system: The number of acceptable releasing cylinders is limited to 1000 or less.

NOTE: If the setting or the release of the DCR extent is performed to a lot of LDEVs when there is I/O from Host, the response performance degradation of HOST I/O may occur.

To avoid the response performance degradation, limit the number of LDEVs to be set or released by one operation to 1.

[Maximum DCR capacity]

- Addition of the “DCR cache” is required for the DCR, and a number of disk tracks equivalent to the capacity of the added “DCR cache” is the maximum number definable for the DCR.

Besides, STR recommends to keep the standard cache capacity for the non-DCR portion as a minimum out-of-DCR cache, to avoid considerable performance degradation for original data because of the newly installed DCR (Standard Cache capacity is decided by the storage system capacity).

To keep this rule, when the customer want to install DCR feature for the storage system, he needs to install additional cache capacity as a DCR area is taken out of pre-defined standard cache capacity.

Table 3.18.2.2.1-1 indicates the additional cache capacity as a DCR area out of pre-defined standard cache capacity.

The additional cache capacity requires out-of-DCR cache capacity.

Table 3.18.2.2.1-1 is the relationship between number of using extents and additional cache capacity.

Table 3.18.2.2.1-1 Necessary addition of cache memory

	Number of Priority Mode extents			
	1 ~ 4096	4097 ~ 8192	8193 ~ 12288	12289 ~ 16384
Additional Standard cache memory capacity	16GB	16GB	32GB	32GB

Caution

A required cache capacity in PRIO mode:

standard cache capacity + DCR cache capacity + the above cache capacity

A required cache capacity in BIND mode:

standard cache capacity + DCR cache capacity

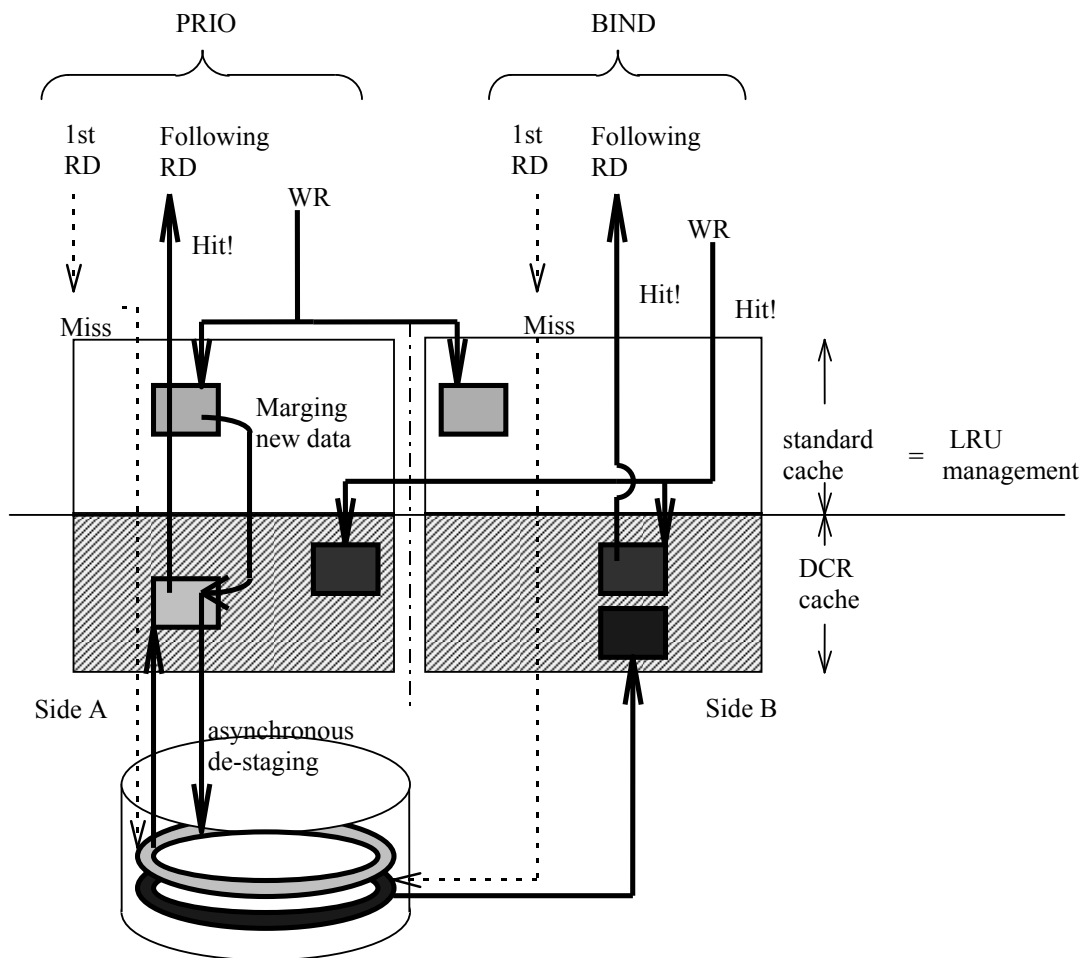


Fig. 3.18.2.2.1-1 Processing for DCR Extent

3.18.2.2.2 BIND

[Processing]

- As described above, there is a possibility that a responding performance degradation occurs in the PRIO mode because of a collide slot lock between the host access and asynchronous de-staging process or a waiting for the cache segment to be empty caused by an overload of the storage system cache.

This is a negligibly small impact on the performance in the typical user environment, however, in some environments, if any, in which the performance is very critical and the maximum response time must be assured, the above factors to degrade the response may be the issues.

[Performance impact]

- In BIND, the difference for PRIO, not only read data but also being all write data for the assigned DCR extent are resident in cache, no de-stage process occurred by any write command. Thus, by protecting any asynchronous de-stage process for the DCR data, read operation become a perfectly hit process.
- However, as a compensation for the perfect hit performance, the cache to be used is three times larger than that of in the PRIO mode.

NOTE: When the operation of deleting the resident cache-data is performed during host I/O execution, the host I/O execution conflict with the procedure in which the data is transferred to disk drives (de-staging) may happen. It may cause the response performance degradation.

To avoid the response performance degradation, please limit the total capacity of data released by one operation.

- If the Host timeout period is more than 11 seconds, the amount of acceptable releasing cache is limited to 3Gbyte or less.
 - OPEN system: The amount of acceptable releasing cache is limited to 3Gbyte or less.
 - Mainframe system: The number of acceptable releasing cylinders is limited to 3000 or less.
- If the Host timeout period is less than 10 seconds, it is limited to 1Gbyte or less.
 - OPEN system: The amount of acceptable releasing cache is limited to 1Gbyte or less.
 - Mainframe system: The number of acceptable releasing cylinders is limited to 1000 or less.

NOTE: If the setting or the release of the DCR extent is performed to a lot of LDEVs when there is I/O from Host, the response performance degradation of HOST I/O may occur.
To avoid the response performance degradation, limit the number of LDEVs to be set or released by one operation to 1.

[Maximum DCR capacity]

- User data can be set to 1/3 of the cache capacity for BIND.

3.18.2.2.3 Assignment of DCR extent and guard logic

- BIND/PRIO modes can be assigned for each DCR extent individually.
For example, the user want to assign 1GB cache for PRIO and 256MB cache for BIND, DKC allocate the extents in additional cache area by 1GB for PRIO and 256MB times 3 equals 0.75GB for BIND. Total 1.75GB cache should be additionally installed. The user can assign repeatedly many DCR extents with choosing each mode for each extent. Say, 1GB for PRIO + 512MB for PRIO + 256MB for BIND + 128MB for BIND comes to 2.6GB total DCR area necessary. The real capacity of cache needs adjusting to the cache unit to be added.
- SVP micro-code accepts many extents allocated for DCR. A minimum of 4GB must remain unallocated to DCR.
In other words, DKC checks that the remaining cache capacity after DCR allocation is over 4GB, if the addition of DCR breaks the remaining 4GB boundary, the SVP rejects the allocation of DCR extents with an error message.
- From that point, the user theoretically can assign all cache capacity except 4GB for DCR regardless of their configurations, STR strongly recommend the user should keep standard cache capacity out of DCR dependant on the configuration according to the manuals. Guard boundary by SVP is only 4GB for all configurations.
- For the outline and the setting operation procedure of the DCR cache, see page [THEORY03-18-240](#).

3.18.2.2.4 DCR PreStaging

- The processor reports SIMs when the PreStaging abnormal end.
(following Table)

Error		REF CODE			SIM	Level	Host report	Remarks
		22	23	13	28			
DCR status	PreStaging abnormal end	48	21	xx	FE	Service	No	xx: abnormal end reason code

x'E1', x'10' : No DCR PP
 x'E2', x'20' : Storage system busy
 x'E4', x'40' : Staging time over
 x'E5', x'50' : Cache or SM blockade
 x'E6', x'60' : LDEV warning
 x'E7', x'70' : Staging failure
 x'E8', x'80' : P/S OFF
 x'E9', x'90' : PreStaging canceled
 x'EA', x'a0' : Cache over loaded
 x'EB', x'b0' : Some MP's blockade

- In the case the storage system cache becomes overloaded, a resulting performance degradation occurs during a PreStaging execution. We strongly recommend issuing a PreStaging request to stage data onto cache at the timing of normal load, or SIM REF CODE = 4821a0 may be reported resulting in failure.
- DKC rejects PreStaging requests during PreStaging execution. Please retry PreStaging requests after PreStaging termination.

If you specify the DCR setting on the volume during the quick formatting, do not use the prestaging function. If you want to use the prestaging function after the quick formatting processing completes, first you need to release the setting and then specify the DCR setting again, with the prestaging setting enabled this time. For information about the quick formatting, see the “Provisioning for Open Systems User Guide” or “Provisioning Mainframe Systems User Guide”.

3.18.2.3 Specifications

Table 3.18.2.3-1 Specifications of the Function

Item No.	Item	Description
1	Maximum number of areas to be made resident	For the PRIO and BIND modes together: 4096 areas/logical volume 16384 areas/storage system
2	Unit of area specified to be resident	Mainframe : 1 track, Open : 96 logical blocks*2 (512 logical blocks in case of OPEN-V)
3	Minimum/Maximum size of extent	1 track/logical volume size
4	Online change of resident area	Allowable (from the SVP and Web Console)
5	Addition of cache capacity	Mandatory (Program Product: Charged with cache)
6	Maximum usable cache capacity*1 as DCR	Capacity of the cache memory added as the DCR cache. The “standard cache capacity” must be ensured by the rule.

*1: Convert as follows:

For the 3390 emulation: 1 track = 66KB

For the OPEN-3/8/9/E/L emulation: 1 track (96 logical block) = 66KB

For the OPEN-V emulation: 1 track (512 logical block) = 264KB

*2: In the case of open volume, the DCR program recognizes logical blocks in 96 block increments (512 block increments for OPEN-V).

- If DCR function is used for OPEN-3, OPEN-8, OPEN-9, OPEN-E, OPEN-L or OPEN-V, whole volume should be specified for DCR.
It is because file of open system does not correspond to RAID track structure.

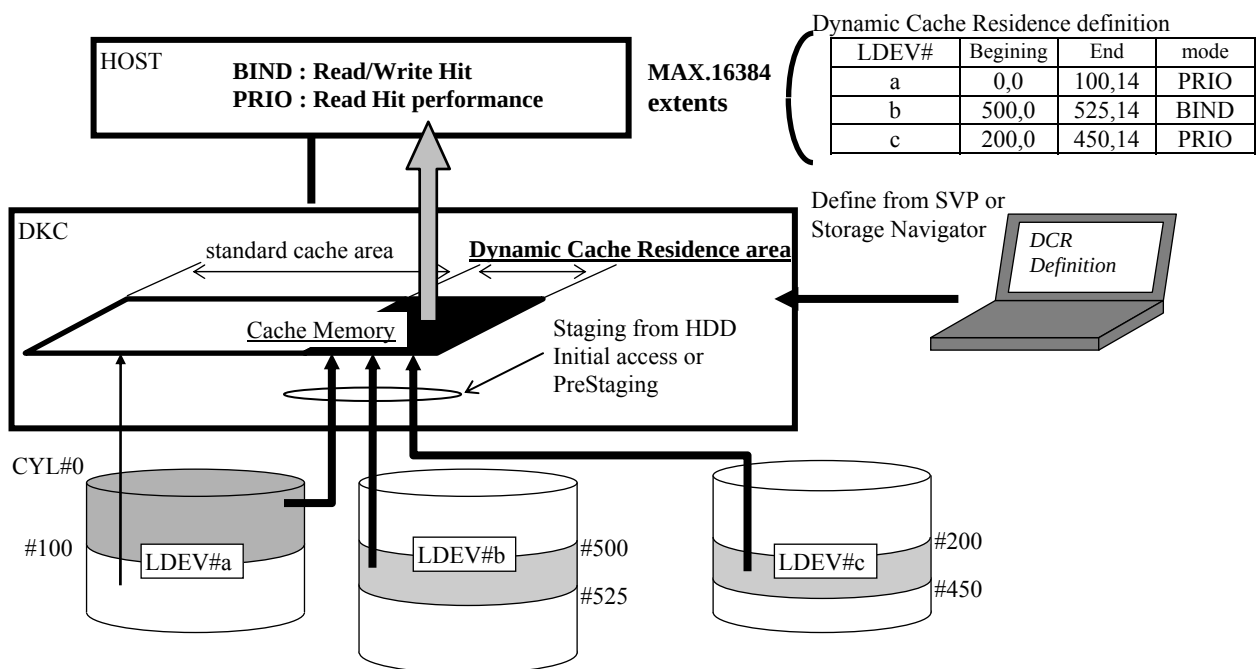


Fig. 3.18.2.3-1 Conceptual Diagram of DCR

3.18.2.4 Maintenance functions

The characteristic of the maintenance function of the DCR option is that the maintenance operation is possible from not only the SVP instruction but also Storage Navigator. (Refer to Table 3.18.2.4-1.)

Table 3.18.2.4-1 Maintenance Function List

Item No.	Maintenance operation	T.S.D.	CE	User	Description
1	Addition of the DCR area	—	✓	✓	- Adds the DCR area. - Unit of the area to be specified by the SVP is a track.
2	Deletion of the DCR area	—	✓	✓	Deletes the continuous DCR area.
3	Change of the DCR area	—	✓	✓	Changes the DCR area size.
4	Status display of the DCR area	—	✓	✓	Displays the specifications of the DCR area.
5	Addition and de-installation of the DCR cache	—	✓	—	Because insertion and pulling off of the cache module into/from the DKC is required
6	Indication of DCR PreStaging	—	✓	✓	Indicates the DCR PreStaging.

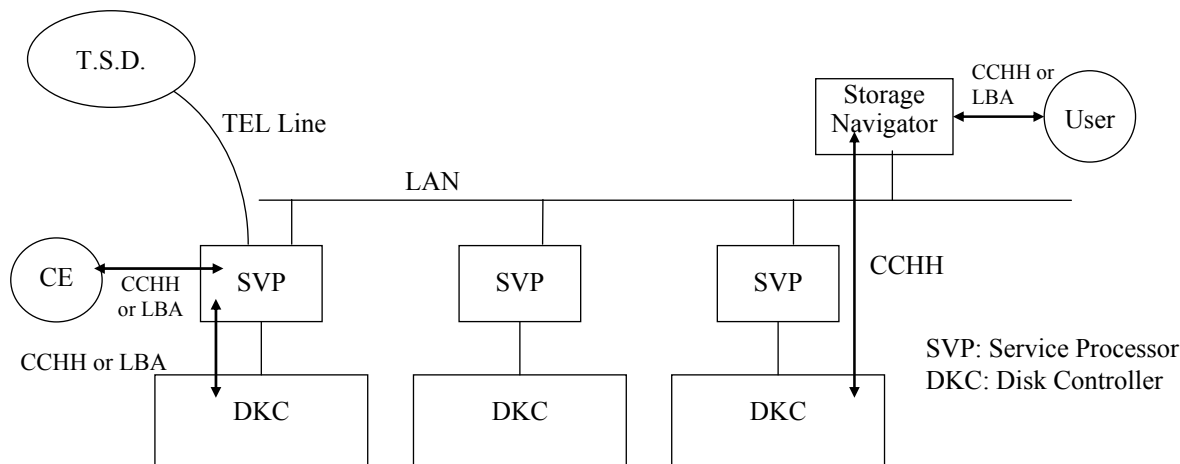


Fig. 3.18.2.4-1 Maintenance Execution Route when DCR Is Used

3.18.2.5 Notes on maintenance when DCR is used

When performing the following maintenance, it is attended with a temporary regression of the cache memory or shared memory. Since this regression disables retention of the cache capacity required for the DCR, the DCR function is automatically suppressed for a while until the maintenance is completed.

A service person is required to obtain an approval of a user before starting the maintenance because there is a high possibility that the DCR function suppression may result in a degradation of responding performance.

- (1) Cache replacement
- (2) Addition and de-installation of the cache (including addition and de-installation of the DCR cache)
- (3) Addition of the ECC Gr. and LDEV requiring addition of the SM because of the addition of the CU
- (4) Addition and de-installation of the SM
- (5) Cluster maintenance

We recommend that CE or Customer should execute the following action after DKC power supply restoration or equipment restoration, when the DKC power supply is down by power failure or mistake during “DCR area” release.

(Because it is a high possibility that the action may result in a degradation of responding performance, CE should execute the following action on a customer’s authority.)

Action : (1) CE or Customer should release all DCR areas in a DCR area released Volume.
(2) CE or Customer should setup again all DCR areas with the exception of the released DCR area in the DCR area released Volume.

Reason : When DKC power is off during “DCR area” release, it is possible that DKC left a release DCR data on Cache.

DKC does not faulty operation by leaving “released DCR data” use a excessive cache memory.

We recommend that CE or Customer should execute the above-mentioned action after DKC restoration, because DKC perfectly execute the “DCR area” release process.

3.18.2.6 Effects of DKC failures on DCR

The DCR function is automatically suppressed when any of the following failures occurs. The suppression continues until the regressed operation owing to the maintenance is canceled in the cases of Items (1) to (3) or continues until an automatic recovery of the shared memory by the microprogram is terminated normally in the case of Item (4).

- (1) Cache failure
- (2) Shared memory failure
- (3) One-side cluster down
- (4) One-side shared memory blockade (SIMRC = FFEE)

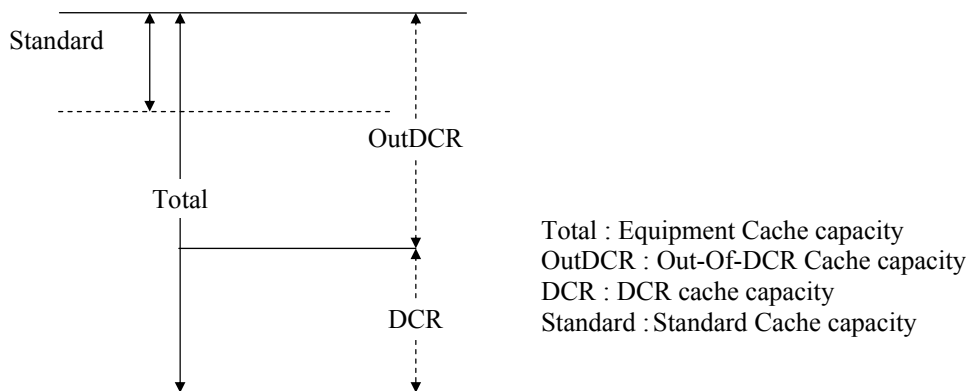
3.18.2.7 Automatic cancellation of DCR

The DCR setting of a volume to be de-installed by the functions of Deletion of CVs (LDEV), Conversion of CV to normal volume, and Conversion of normal volume to CV is automatically canceled as a part of the de-installation processing by the SVP microprogram.

3.18.2.8 Explanation of DCR cache and procedure for setting operation

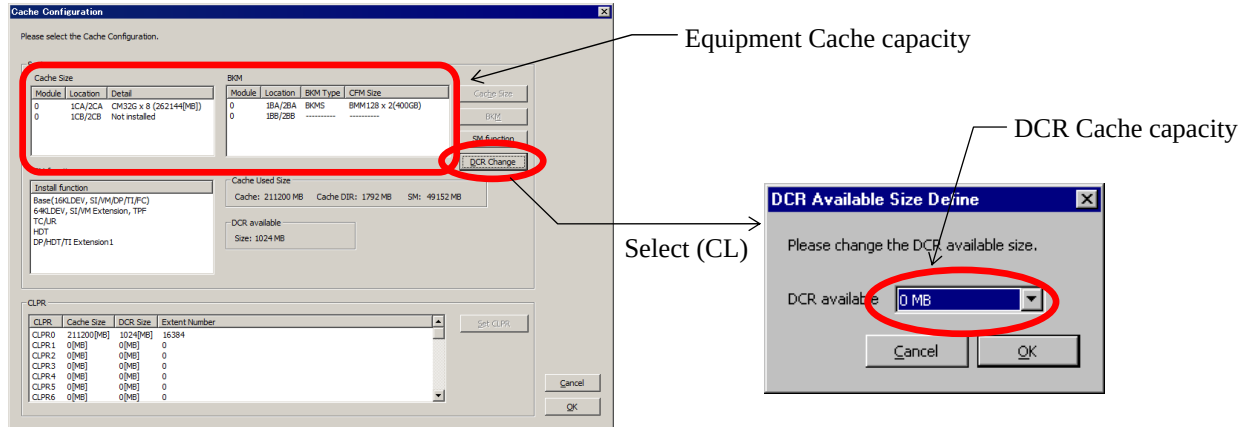
3.18.2.8.1 Explanation

- A cache module must be defined and installed for the DCR before using the DCR.
- The DCR extent can be set only for the defined “DCR cache capacity.”
- The “out-of-DCR cache capacity” must be retained more than “standard cache capacity” which is defined in accordance with the disk capacity in order to assure the performance in the non-DCR area.
- Therefore, DCR extent definition more than “DCR cache capacity” is rejected according to the SVP guarding logic. Also, the “DCR cache capacity” definition lower than the minimum “standard cache capacity” ($2\text{GB} \times 2$) is also rejected.



3.18.2.8.2 Setting operation procedure

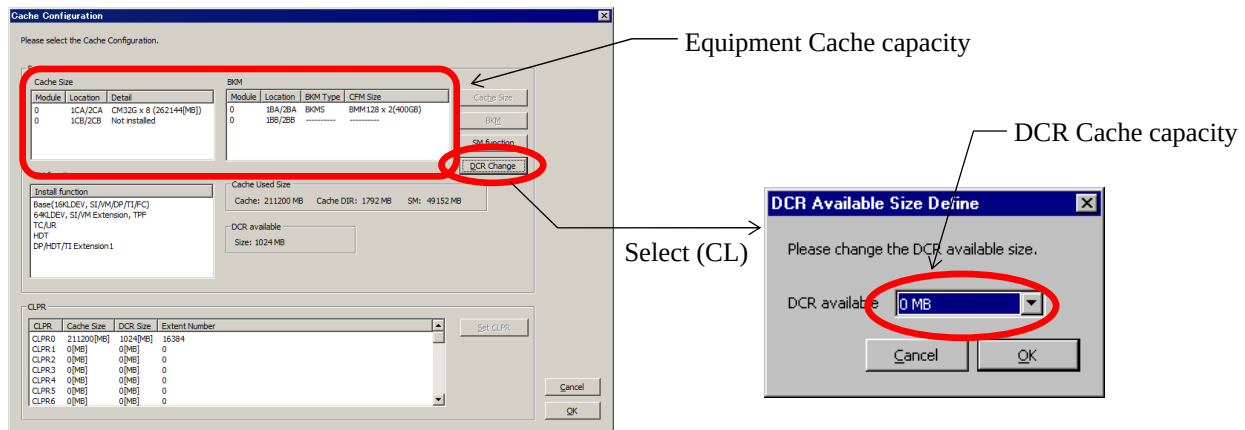
- (1) Setting DCR cache capacity in Define Config & Install sequence
Set the DCR cache capacity in the equipment cache capacity.



NOTE: Set the DCR cache capacity so that it is less than the “equipment cache capacity minus standard cache capacity.”

(2) Adding operation of DCR cache capacity in cache addition sequence

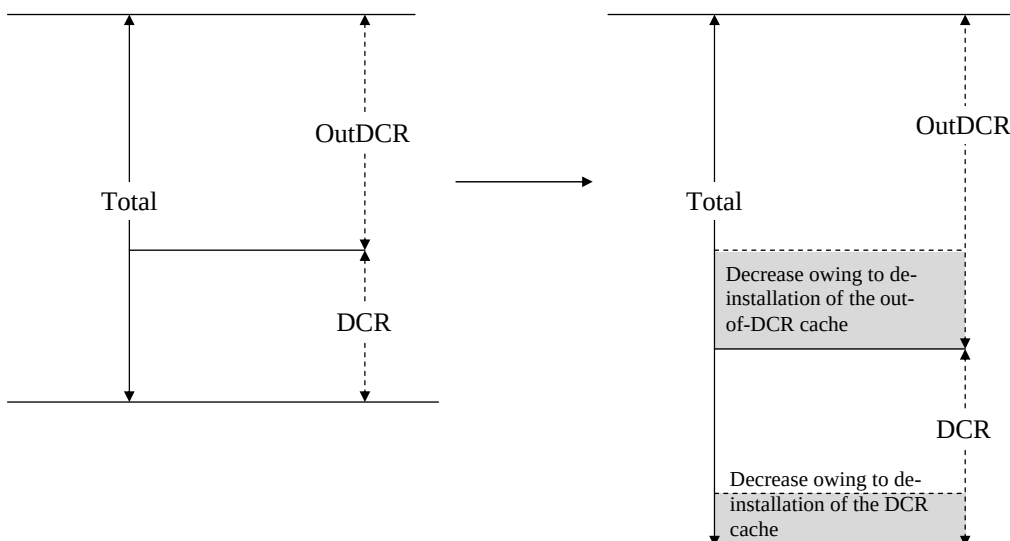
When adding the cache, set the DCR cache capacity in the equipment cache capacity after the addition.



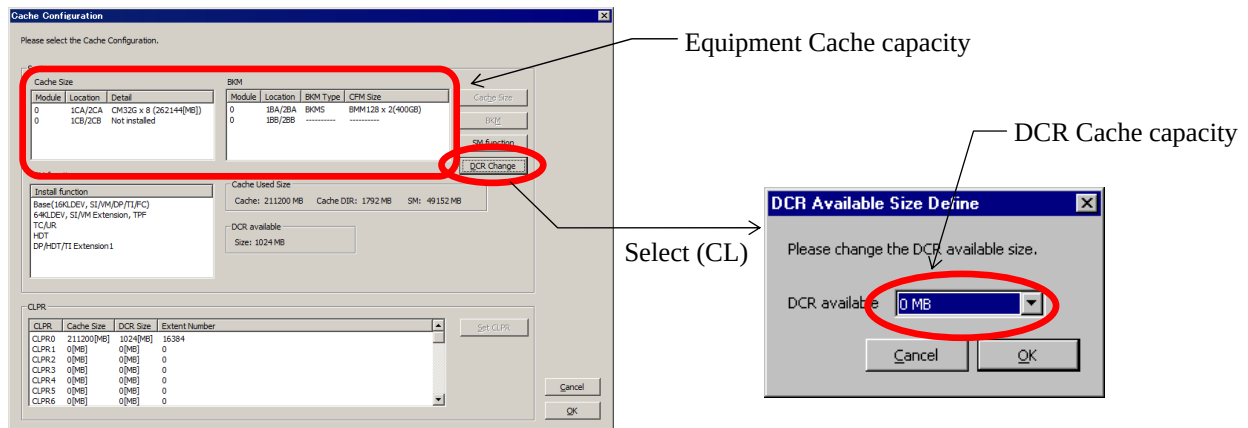
For example, to change a status with the cache of $2.0 \text{ GB} \times 2$ installed and $256 \text{ MB} \times 2$ of it set to the DCR cache to a status with the cache of $4.0 \text{ GB} \times 2$ installed and $512 \text{ MB} \times 2$ of it set to the DCR cache by adding the cache of $2.0 \text{ GB} \times 2$,

- ① Set the equipment cache capacity to $4.0 \text{ GB} \times 2$ in the “Cache Configuration” dialog box, and
- ② Press the “Change...” button to open the “DCR Available Size” dialog box and set the DCR cache capacity to $512 \text{ MB} \times 2$.

The DCR cache capacity can be setup to the cache capacity to be added. In the above example, the DCR cache capacity can be setup to $768 \text{ MB} \times 2$ by adding $512 \text{ MB} \times 2$.



When de-installing the cache, set a capacity to be left as the DCR cache in the equipment cache capacity.



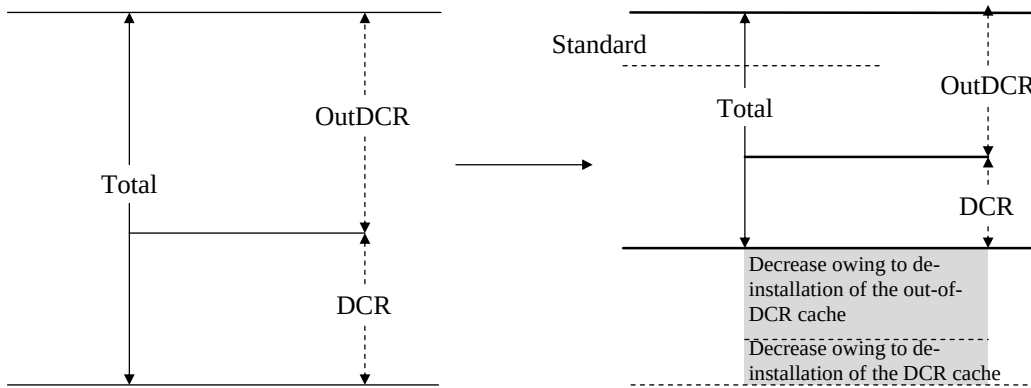
For example, to change a status with the cache of 4.0 GB $\times$ 2 installed and 512 MB $\times$ 2 of it set to the DCR cache to a status with the cache of 2.0 GB $\times$ 2 installed and 256 MB $\times$ 2 of it set to the DCR cache by de-installing the cache of 2.0 GB $\times$ 2,

- ① Set the equipment cache capacity to 2.0 GB $\times$ 2 in the “Cache Configuration” dialog box, and
- ② Press the “Change...” button to open the “DCR Available Size” dialog box and set the DCR cache capacity to 256 MB $\times$ 2.

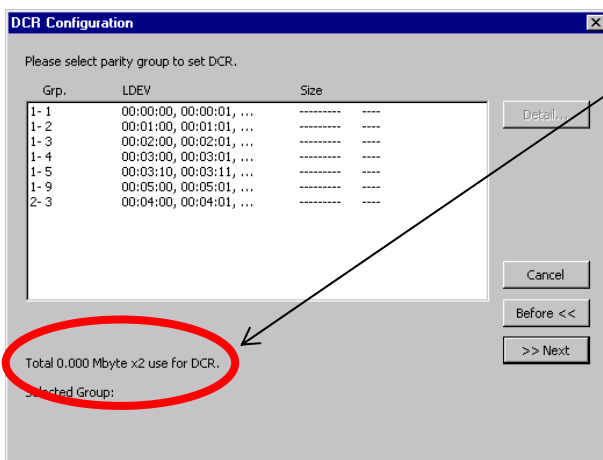
The maximum decreasable capacity of the DCR cache is equal to the capacity of the installed cache to be de-installed. The maximum decreasable capacity of the DCR cache capacity in the above example is 2.0 GB $\times$ 2. As a result, the DCR cache capacity after the de-installation becomes 0 MB $\times$ 2.

NOTE:

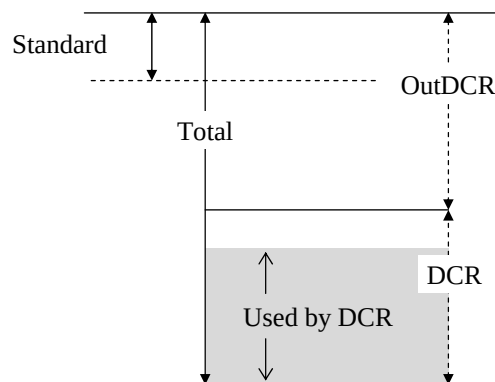
- In the case in which the de-installation of the DCR cache causes the capacity used by the DCR actually defined as the DCR extent to be above the DCR cache capacity, the cache de-installing process is suspended by the SVP guarding logic. Before executing the DCR cache de-installation, cancel the DCR setting to decrease the actual capacity used by the DCR.
- It is required to avoid de-installation of the out-of-DCR cache which causes its capacity to be below the standard cache capacity.



- The “cache capacity used by the DCR” actually used as the DCR extent is displayed on the ‘DCR Configuration’ screen in [SVP]-[Install]-[Refer Configuration] for confirmation.



Cache capacity used by the DCR



3.18.2.8.3 Notes at the time of operation

From a cash manager utility, while carrying out DCR setup / release, please do not perform DCR operation (a display is included) of SVP/Web Console simultaneously.

When the Volume is in quick formatting, please do not set and release DCR from Cache Manager Utility until the operation is completed. For information about the quick formatting, see “Provisioning Guide for Open Systems” “Provisioning Guide for Mainframe Systems”.

3.19 Caution of flash drive and flash module drive chassis installation

For caution of flash drive and flash module drive chassis installation, refer to [INST01-670](#).

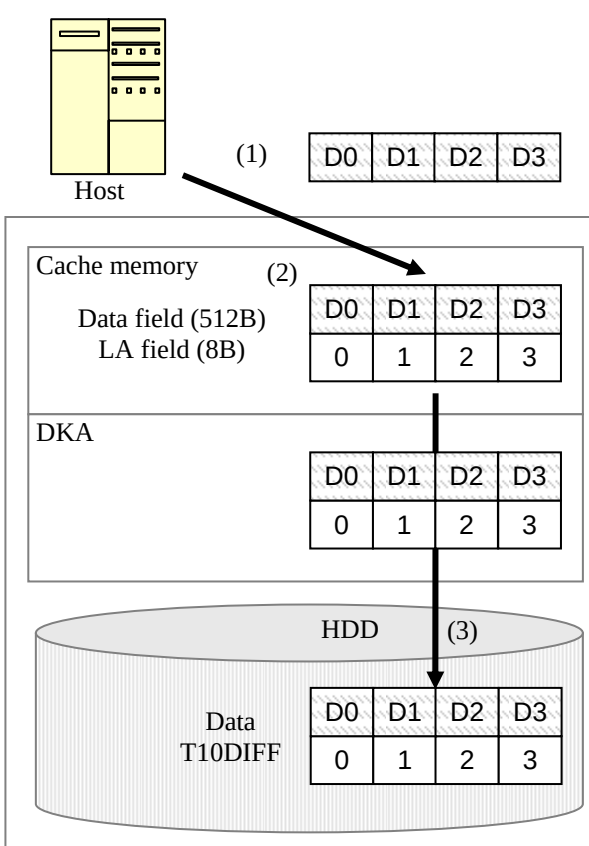
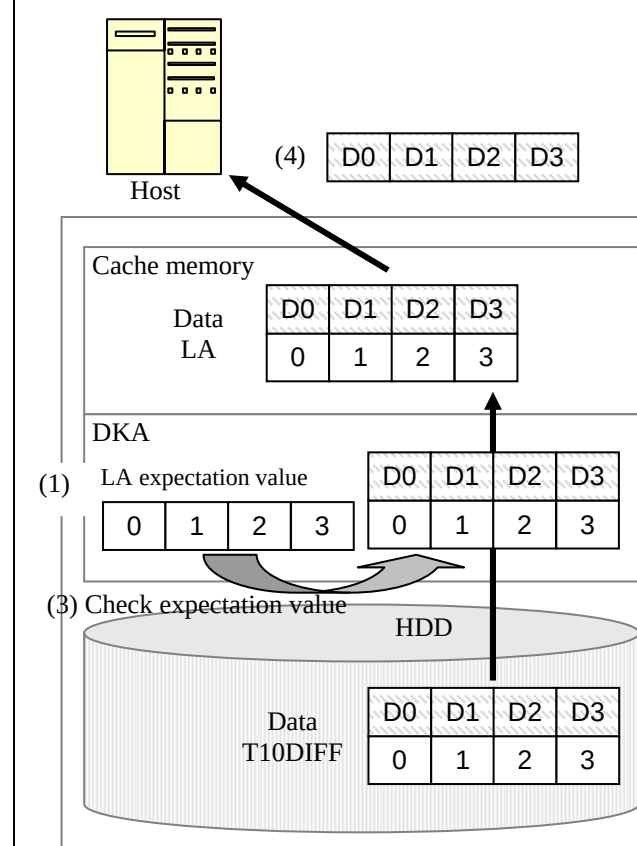
3.20 Data guarantee

DKC810I makes unique reliability improvements and performs unique preventive maintenance.

3.20.1 Data check using LA (Logical Address) (LA check)

When data is transferred, the LA value of the target BLK (LA expectation value) and the LA value of the actual transferred data (Read LA value) are compared to guarantee data. This data guarantee is called “LA check”. With the LA check, it is possible to check whether data is read from the correct BLK location.

Table 3.20.1-1 LA check method

Write	Read
 (1) Host sends data D0 D1 D2 D3. (2) Cache memory stores data in the Data field (512B) and LA field (8B). The LA field contains values 0, 1, 2, 3. (3) DKA stores data on HDD. The HDD stores data in the Data T10DIFF field.	 (4) Host requests data D0 D1 D2 D3. (1) DKA calculates the LA expectation value based on the logical address of the BLK to read. The LA expectation value is 0, 1, 2, 3. (2) Perform read from HDD. (3) Check that the LA expectation value and the T10DIFF value of the read data are consistent. (when the wrong target LBA was read, it can be detected because the values will be inconsistent. In that case, a correction read is performed to restore the data.) (4) CHA transfers data to Host by removing the LA field.
(1) Receive Write request from Host. (2) CHA stores data on cache and adds the LA value and, at the same time, adds an LA value, which is a check code, to each BLK. (LA value is calculated based on the logical address of each BLK) (3) DKA stores data on HDD.	(1) DKA calculates the LA expectation value based on the logical address of the BLK to read. (2) Perform read from HDD. (3) Check that the LA expectation value and the T10DIFF value of the read data are consistent. (when the wrong target LBA was read, it can be detected because the values will be inconsistent. In that case, a correction read is performed to restore the data.) (4) CHA transfers data to Host by removing the LA field.

3.21 Open platform

3.21.1 GENERAL

3.21.1.1 Product Outline and Features

The open platform optional feature can assign a partial or full of disk volume area of the DKC storage system for the Mainframe and Open system hosts by installing Fibre channel adapter (CHF) packages to the disk controller (hereinafter called DKC). This function enables a use of high reliable and high performance storage system realized by the DKC for an open platform or Fibre system environment. This also provides the customers with a flexible and optimized system construction capability for their system expansion and migration. In Open system environment, Fibre Channel (FC) can be used as a channel interface.

3.21.1.1.1 Fibre attachment option (FC)

Some of the major features of this Fibre attachment option are listed below.

(1) Fibre interface connectivity

Fibre channel interface can be mounted as one controller. This enables multiplatform system users to share the high reliable and high performance resource realized by the DKC storage system.

The SCSI interface is complied with ANSI SCSI-3, a standard interface for various peripheral devices for open systems. Thus, the DKC can be easily connected to various open-market Fibre host systems (e.g. Workstation servers and PC servers).

DKC810I can be connected to open system via Fibre interface by installing Fibre Adapter (DKC810I-8FC16/16FC8).

Fibre connectivity is provided as channel option of DKC810I.

Fibre Adapter can be installed in any CHA location of DKC810I and can be co-exist with any other channel adapters.

(2) Fast and concurrent data transmission

Data can be read and written at a maximum speed of 8 Gbps with use of Fibre interface.

All of the Fibre ports can transfer data concurrently too.

(3) All Fibre configuration (only for FC)

All Fibre configuration is also allowed either with one CHF pair or two, three or full of 12 CHF pairs configuration.

These will provide more flexible use of the storage system for open system environment.

(4) Cross-OS File Exchange support (only for FC)

By installing Cross-OS File Exchange mto optional feature, data in the mainframe volumes can be read from open systems and written into the open system volumes. Another way, by installing Cross-OS File Exchange otm optional feature, data can be transferred from open system to mainframe.

This enables faster data transmission of data base files between mainframe and open systems than currently used means such as network transfer.

The Cross-OS File Exchange mto/otm feature is available through Fibre adapters.

(5) Customer assets guarantee (Upgrading paths)

The Fibre attachment options allow on-site upgrading of already installed channel-type DKC systems owned by customers.

(6) High performance

The DKC has two independent areas of nonvolatile cache memory and this mechanism also applies to the Fibre attachment option. Thus, compared with a conventional disk array controller used for open systems and not having a cache, this storage system has the following outstanding characteristics:

- ① Cache data management by LRU control
- ② Adoption of DFW (DASD Fast Write)
- ③ Write data duplexing
- ④ Nonvolatile cache

(7) High availability

The DKC is fault-tolerant against even single point of failure in its components and can successively read and write data without stopping the system. This concept is also taken over to the Fibre attachment option, which ensures fault-tolerance against even single point of failure in its components, except the CHF. Fault-tolerance against CHF and Fibre cable failures depends on the multi-path configuration support of the host system too.

(8) High data reliability

The Fibre attachment option automatically creates a guarantee code of a unique eight byte data, adds it to host data, and writes it onto the disk as data. The data guarantee code is checked automatically on the internal data bus of the DKC to prevent data errors due to array-specific data distribution or integration control. Thus, the reliability of the data improves.

(9) TrueCopy Support

TrueCopy is a function to realize the duplication of open system data by connecting the two DKC810I storage systems or inside parts of a single DKC810I using the Fibre.

This function enables the construction of a backup system against disasters by means of the duplication of data including those of the host system or the two volumes containing identical data to be used for different purposes.

(10) Global-active device (GAD)

GAD is a function to create a volume pair and to store the same data in two storage systems. Both volume of a GAD pair can be used for I/O from servers.

GAD can achieve the following purposes.

- ① Continuous server I/O (at failure occurrence in the storage system)
- ② Failover/Failback without operating the storage system
- ③ Relocation of server virtual machines without operating the storage system

3.21.1.2 Terminology

- (1) Arbitrated Loop
A configuration that allows multiple ports to be connected serially.
- (2) CHA
CHannel Aapter. A hardware package to connect with a channel interface.
- (3) CHF
CHannel adapter for Fibre. A hardware package to connect with Fibre interface.
- (4) Command descriptor block (CDB)
A command block in SCSI interface used to send requests from the initiator to a target.
- (5) DKA
DisK Aapter. A hardware package which controls disk drives within a DKC.
- (6) DKC
DisK Controller. A disk controller unit consisting of CHA, CHF, DKA, Cache and other components except DKU.
- (7) DKU
DisK Unit. Disk drives units.
- (8) Fabric
The entity which interconnects various N-Ports attached to it and is capable of routing frames.
- (9) FAL
File Access Library: A program package and provided as a program product for Cross-OS File Exchange.
- (10) FCU
File Conversion Utility: A program package and provided together with FAL for Cross-OS File Exchange.
- (11) HA configuration
High Availability configuration

(12) Initiator

The OPEN device (usually, a host computer) that requests another OPEN device to operate.

(13) Logical unit (LU)

The logical unit of division of the storage system data area accessible from SCSI interface.

(14) Logical unit number (LUN)

Identifier for a logical unit. LUN0-2048 can be assigned.

(15) Logical volume or logical device (LDEV)

The disk pack image, formed on an array disk, that is compatible with that of a 3390-3 in terms of cylinder and track quantities and the track capacity.

(16) Point-to-Point

A configuration that allows two ports to be connected serially.

(17) Open device

Collectively refers to the host computer, peripheral control units, and intelligent peripherals that are connected to Fibre channel.

(18) Target

An Open device (usually, the DKC) that operates at the request of the initiator.

(19) VENDOR UNIQUE or VU

A manufacturer- or device-unique definable bit, byte, field, or code value.

(20) Initiator Port

A port-type used for MCU port of TrueCopy function, or MCU/RCU port of Universal Replicator/global-active device function.

(21) RCU Target Port

A port-type used for RCU port of TrueCopy function, or MCU/RCU port of Universal Replicator/global-active device function.

This port allows LOGIN of host computers and MCUs/RCUs.

(22) Target port

A port-type which is different from “Initiator Port” and “RCU Target Port”.

This port is a normal target port which is used without configuration of TrueCopy/Universal Replicator/global-active device.

This “Target port” allows LOGIN of host computers. It does not allow LOGIN of MCUs.

(23) External Port

Port attribute set when using it as initiator of Universal Volume Manager function.

3.21.1.3 Notice about maintenance operations

There are some notices about Fibre maintenance operations.

- (1) Before LUN path configuration is changed, Fibre I/O on the related Fibre port must be stopped.
- (2) Before Fibre channel adapter or LDEV is de-installed, the related LUN path must be de-installed.
- (3) Before Fibre channel adapter is replaced, the related Fibre I/O must be stopped.
- (4) When Fibre-Topology information is changed, pull out a Fibre cable between the port and SWITCH and put it back again. Before a change of Fibre-Topology information, pull out Fibre cable and put it back after completing the change.

3.21.2 Interface Specification

3.21.2.1 Fibre Physical Interface Specification

The physical interface specification supported for Fibre Channel (FC) is shown in Table 3.21.2.1-1 to 3.21.2.1-3.

Table 3.21.2.1-1 Fibre Physical specification

No.	Item		Specification	Remark
1	Host interface	Physical interface	Fibre Channel	FC-PH, FC-AL
		Logical interface	SCSI-3	FCP, FC-PLDA
			Fibre	FC-AL
2	Data Transfer Rate	Optic Fibre cable	2, 4, 8 Gbps/ 4, 8, 16 Gbps	16FC8, 8FC16
3	Cable Length	Optic single mode Fibre	10 km	Longwave laser
		Optic multi mode Fibre	150 m/300 m/500 m	Shortwave laser
4	Connector Type		LC: 16FC8/8FC16	—
5	Topology		NL-Port (FC-AL) (*1) F-Port FL-Port (*1)	—
6	Service class		3	—
7	Protocol		FCP	—
8	Transfer code		8B/10B translate	—
9	Number of hosts		255/Path	—
10	Number of host groups		255/Path	—
11	Maximum number of LUs		2048/Path	—
12	PORT/PCB	16FC8	8 Port	—
		8FC16	4 Port	—
13	Maximum number of PORTs		192 Port	All PCB are the 16FC8

*1: As for NL-Port (FC-AL) connection and FL-Port connection in DKC-F810I-8FC16, 8Gbps is the upper limit in accordance with the Fibre standard.

Table 3.21.2.1-2 Port name of Module #0

Cluster	Name	Location	Port Name	Cluster	Name	Location	Port Name
CLS1	CHA1PC (BASIC)	1PC	1A	CLS2	CHA2PC (BASIC)	2PC	2A
			3A				4A
			5A (*1)				6A (*1)
			7A (*1)				8A (*1)
			1B				2B
			3B				4B
			5B (*1)				6B (*1)
			7B (*1)				8B (*1)
	CHA1PD (ADD1)	1PD	1C		CHA2PD (ADD1)	2PD	2C
			3C				4C
			5C (*1)				6C (*1)
			7C (*1)				8C (*1)
			1D				2D
			3D				4D
			5D (*1)				6D (*1)
			7D (*1)				8D (*1)
	CHA1PE (ADD2)	1PE	1E		CHA2PE (ADD2)	2PE	2E
			3E				4E
			5E (*1)				6E (*1)
			7E (*1)				8E (*1)
			1F				2F
			3F				4F
			5F (*1)				6F (*1)
			7F (*1)				8F (*1)
	CHA1PF (ADD3)	1PF	1G		CHA2PF (ADD3)	2PF	2G
			3G				4G
			5G (*1)				6G (*1)
			7G (*1)				8G (*1)
			1H				2H
			3H				4H
			5H (*1)				6H (*1)
			7H (*1)				8H (*1)
	CHA1PA (DKA BASIC)	1PA	9A		CHA2PA (DKA BASIC)	2PA	AA
			BA				CA
			DA (*1)				EA (*1)
			FA (*1)				GA (*1)
			9B				AB
			BB				CB
			DB (*1)				EB (*1)
			FB (*1)				GB (*1)
	CHA1PB (DKA ADD1)	1PB	9C		CHA2PB (DKA ADD1)	2PB	AC
			BC				CC
			DC (*1)				EC (*1)
			FC (*1)				GC (*1)
			9D				AD
			BD				CD
			DD (*1)				ED (*1)
			FD (*1)				GD (*1)

*1: The port location doesn't exist on 8FC16.

Table 3.21.2.1-3 Port name of Module #1

Cluster	Name	Location	Port Name	Cluster	Name	Location	Port Name
CLS1	CHA1PJ (ADD4)	1PJ	1J	CLS2	CHA2PJ (ADD4)	2PJ	2J
			3J				4J
			5J (*1)				6J (*1)
			7J (*1)				8J (*1)
			1K				2K
			3K				4K
			5K (*1)				6K (*1)
			7K (*1)				8K (*1)
	CHA1PK (ADD5)	1PK	1L		CHA2PK (ADD5)	2PK	2L
			3L				4L
			5L (*1)				6L (*1)
			7L (*1)				8L (*1)
			1M				2M
			3M				4M
			5M (*1)				6M (*1)
			7M (*1)				8M (*1)
	CHA1PL (ADD6)	1PL	1N		CHA2PL (ADD6)	2PL	2N
			3N				4N
			5N (*1)				6N (*1)
			7N (*1)				8N (*1)
			1P				2P
			3P				4P
			5P (*1)				6P (*1)
			7P (*1)				8P (*1)
	CHA1PM (ADD7)	1PM	1Q		CHA2PM (ADD7)	2PM	2Q
			3Q				4Q
			5Q (*1)				6Q (*1)
			7Q (*1)				8Q (*1)
			1R				2R
			3R				4R
			5R (*1)				6R (*1)
			7R (*1)				8R (*1)
	CHA1PG (DKA ADD2)	1PG	9J		CHA2PG (DKA ADD2)	2PG	AJ
			BJ				CJ
			DJ (*1)				EJ (*1)
			FJ (*1)				GJ (*1)
			9K				AK
			BK				CK
			DK (*1)				EK (*1)
			FK (*1)				GK (*1)
	CHA1PH (DKA ADD3)	1PH	9L		CHA2PH (DKA ADD3)	2PH	AL
			BL				CL
			DL (*1)				EL (*1)
			FL (*1)				GL (*1)
			9M				AM
			BM				CM
			DM (*1)				EM (*1)
			FM (*1)				GM (*1)

*1: The port location doesn't exist on 8FC16.

3.21.3 CONFIGURATION

3.21.3.1 System Configurations

3.21.3.1.1 Multiplatform Configuration

The DKC can be connected to a target device through the Fibre channel interface (FC) and can exchange data with the open host. The DKC can also be connected to the mainframe channel host system simultaneously. The possible system configurations with the Fibre attachment are shown below.

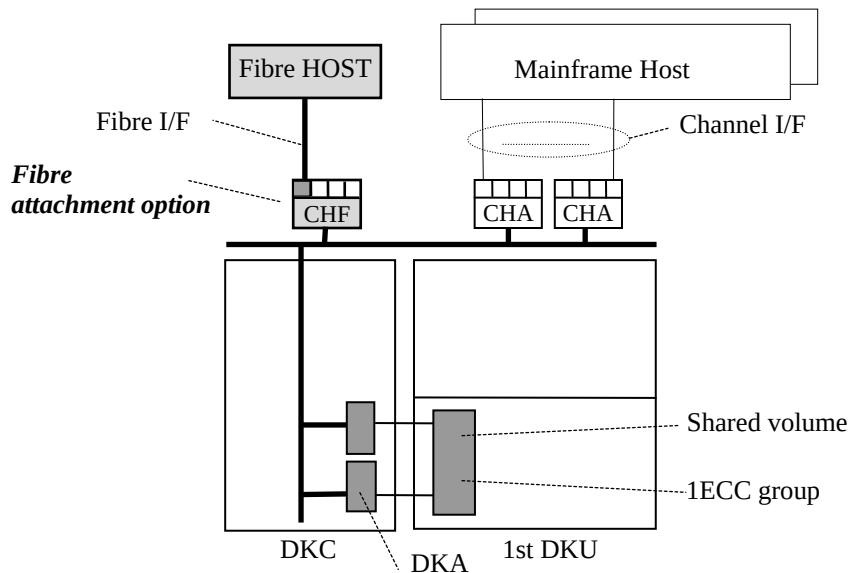


Fig. 3.21.3.1.1-1 multiplatform configuration example

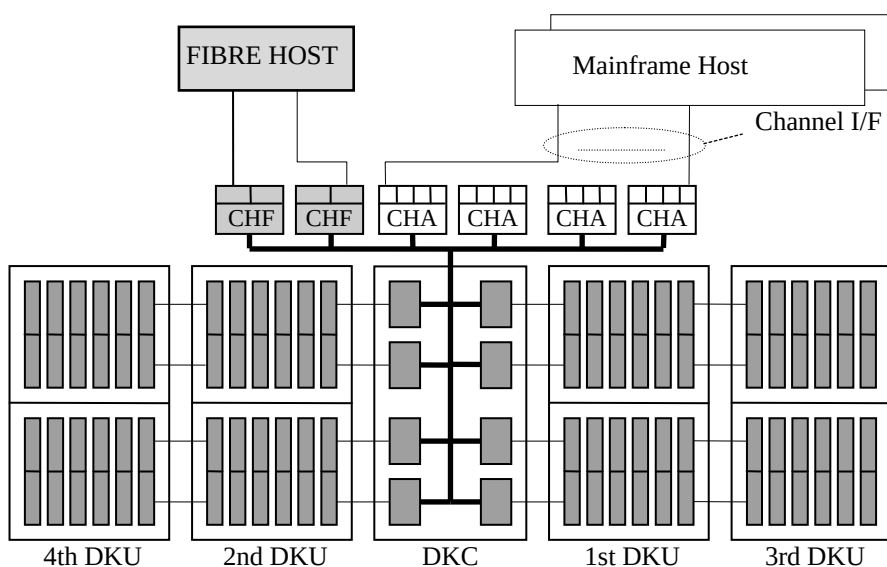


Fig. 3.21.3.1.1-2 multiplatform configuration example

3.21.3.1.2 All Fibre Configuration

The DKC can configure the All Fibre configuration, in which only CHF's are used. The possible system configurations for the All Fibre configuration are shown below.

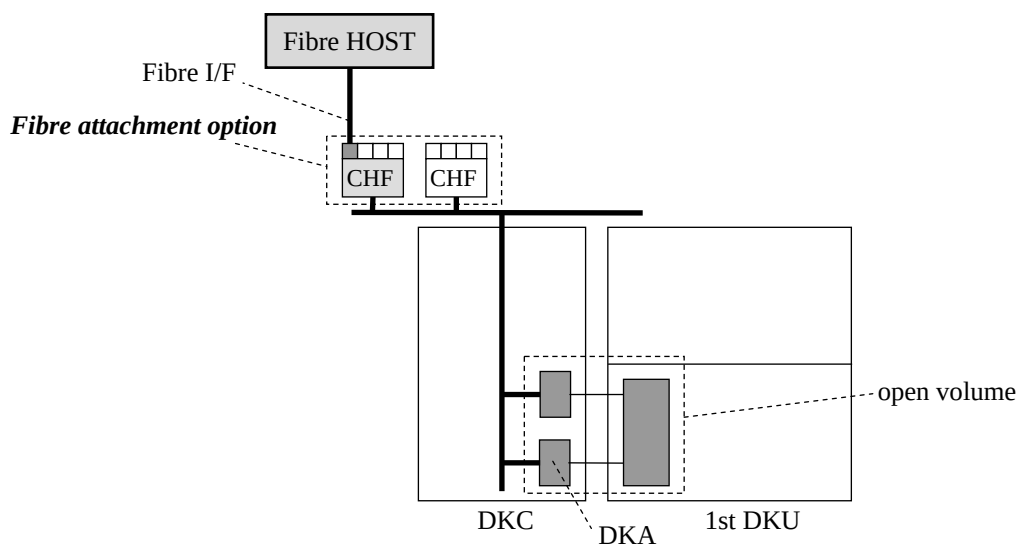


Fig. 3.21.3.1.2-1 Minimum system configuration for All Fibre

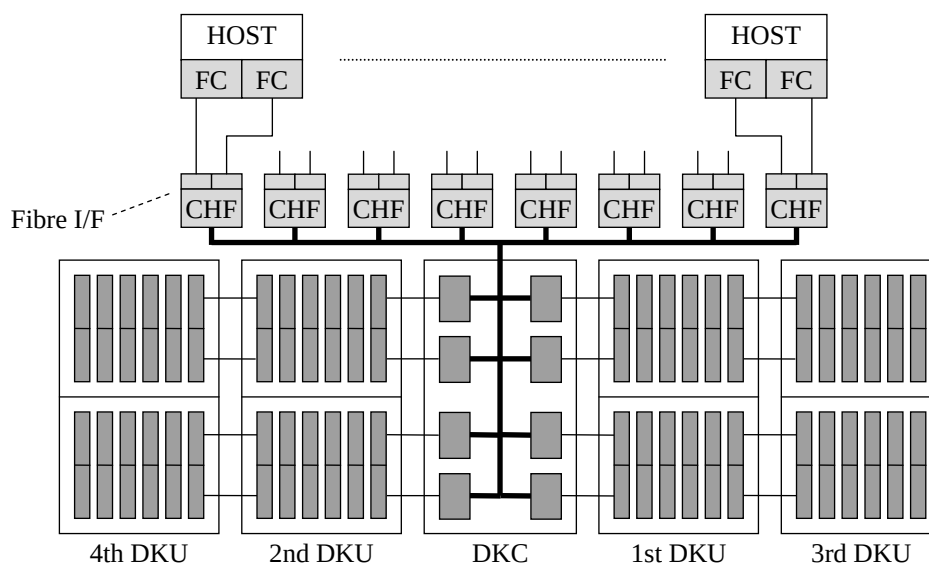


Fig. 3.21.3.1.2-2 Maximum system configuration example for All Fibre

3.21.3.2 Channel Configuration

3.21.3.2.1 Fibre Channel Configuration

The Fibre channel adapter (CHF) PCBs must be used in sets of two. Up to 24 PCBs of the CHA and/or CHF can be installed in the DKC in total.

In the All Fibre configuration, it is possible to assign the CHF PCB to every one of the 24 PCBs. Each CHF PCB has 4 (8FC16) or 8 (16FC8) Fibre channel ports.

Examples of channel configurations are shown in Table 3.21.3.2.1-1.

Table 3.21.3.2.1-1 Example of available channel configuration

No.	Basic	Addition 1	Addition 2	Addition 22	Addition 23	Remark
1	CHA	CHF	—	—	—	Minimum multiplatform
2	CHF	—	—	—	—	Minimum All Fibre
3	CHF	CHF	CHF	CHF	CHF	Maximum All Fibre

CHF: Fibre adapter, CHA: FICON, —: empty

Table 3.21.3.2.1-2 Channel Configuration

No.	Premise	Additional 3	Additional 2	Additional 1	Basic	Remark
1	3	CHF	—	—	—	CHA+DKA SLOT
2	3	CHF	CHF	CHF	CHF	CHA+DKA SLOT

3.21.3.3 Fibre Addressing

When the topology is AL_PA, each Fibre channel port is assigned an unique Port-ID number within the range from 1 to EF.

An addressing from the Fibre host to the Fibre volume in the DKC can be uniquely defined with a nexus between them. The nexus through the Initiator (host) ID, the Target (CHF port) ID, and LUN (Logical Unit Number) defines the addressing and access path. The maximum number of LUNs that can be assigned to one port is 2048.

The addressing configuration is shown in the Fig. 3.21.3.3.3-1.

3.21.3.3.1 Number of Hosts

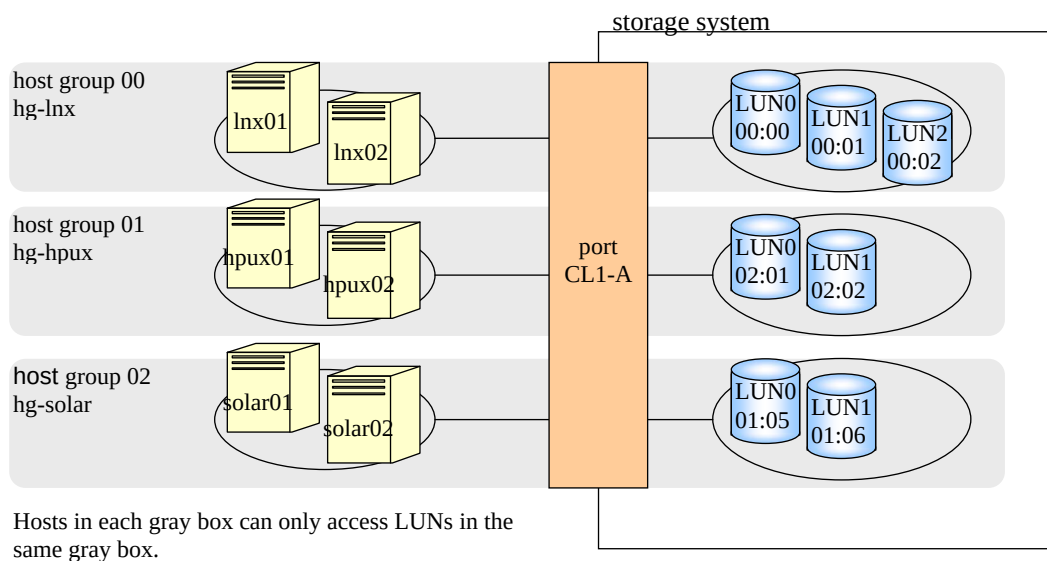
For Fibre channel, the number of connectable hosts (Initiator) is limited to 256 per Fibre port. (FC)

For MCU port such as TrueCopy function, this limitation is as follows:

The number of MCU connections is limited to 16 per RCU Target port. (only for FC)

3.21.3.3.2 Number of Host Groups

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



3.21.3.3.3 LUN (Logical Unit Number)

LUNs can be assigned from 0 to 2047 to each Fibre Port.

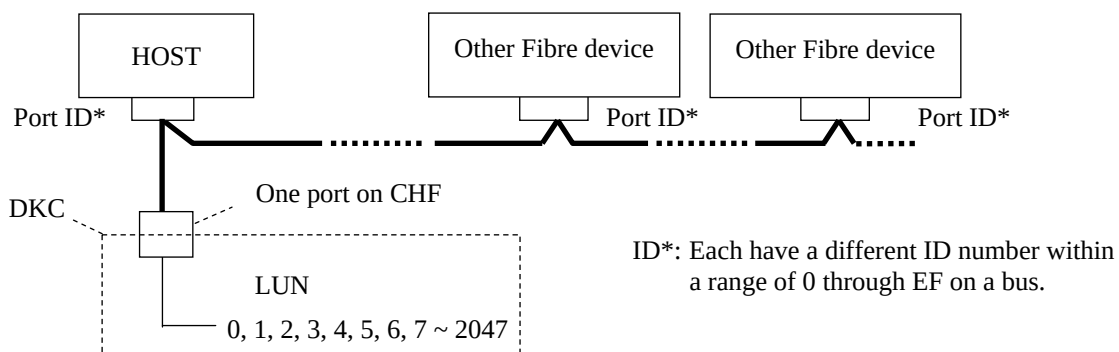


Fig. 3.21.3.3.3-1 Fibre addressing configuration from Host

3.21.3.3.4 PORT INFORMATION

A PORT address and the Topology can be set as PORT INFORMATION. The value of PORT address is EF and can be changed by user. Topology information is selected from “Fabric”, “FC-AL” or “Point to point”.

THEORY03-21-160**3.21.3.4 Logical Unit****3.21.3.4.1 Logical Unit Specification**

The specifications of Logical Units supported and accessible from Open system hosts are defined in the Table 3.21.3.4.1-1.

Table 3.21.3.4.1-1 LU specification (1/2)

No	Item		Specification			
1	Volume name		OPEN-3	OPEN-8	OPEN-9	OPEN-E
2	Volume attribute		- OPEN volume	- OPEN volume	- OPEN volume	- SCSI volume
3	Access right	Fibre host	Read/Write	Read/Write	Read/Write	Read/Write
		M/F host	Read/Write	Read/Write	Read/Write	—
4	Logical Unit (LU) size	G byte (10 ⁹)	2.4 GB	7.3 GB	7.3 GB	14.5 GB
		G byte (1,024 ³)	2.29 GB	6.84 GB	6.87 GB	13.56 GB
5	Block size		512 Bytes	512 Bytes	512 Bytes	512 Bytes
6	# of blocks		4,806,720	14,351,040	14,423,040	28,452,960
7	LDEV emulation name		OPEN-3	OPEN-8	OPEN-9	OPEN-E
8	LDEV size : LU size		1 : 1	1 : 1	1 : 1	1 : 1

Table 3.21.3.4.1-1 LU specification (2/2)

No	Item		Specification				
1	Volume name		OPEN-L	OPEN-V (*1) (*2)	3390-3A	3390-3B	3390-3C
2	Volume attribute		- SCSI volume	- SCSI volume	- M/F volume - Cross-OS File Exchange volume	- M/F volume - Cross-OS File Exchange volume	- M/F volume - Cross-OS File Exchange volume
3	Access right	Fibre host	Read/Write	Read/Write	Read/Write (need Cross-OS File Exchange otm/mto option)	Read only (need Cross-OS File Exchange mto option)	Read/Write (need Cross-OS File Exchange otm/mto option)
		M/F host	—	—	Read/Write	Read/Write	Read only
4	Logical Unit (LU) size	G byte (10 ⁹)	36.4 GB	(*1)	—	—	—
		G byte (1,024 ³)	33.94 GB	(*1)	—	—	—
5	Block size		512 Bytes	512 Bytes	512 Bytes	512 Bytes	512 Bytes
6	# of blocks		71,192,160	(*1)	5,825,520	5,822,040	5,825,520
7	LDEV emulation name		OPEN-L	OPEN-V	3390-3A	3390-3B	3390-3C
8	LDEV size : LU size		1 : 1	1 : 1	1 : 1	1 : 1	1 : 1

*1: OPEN-V is CVS basis. The default capacity of OPEN-V is nearly equals to the size of the parity group. So it depends on RAID level and DKU (HDD).

The capacity is limited by 2.812TB (1024⁴), 3.019TB (10¹²) or 6,039,797,248 blocks logically.

*2: “0” is added to the emulation type of the V-VOLs (e.g. OPEN-0V).

When you create a Thin Image pair, specify the volume whose emulation type is displayed with “0” like OPEN-0V as the S-VOL.

3.21.3.4.2 Logical Unit Mapping of Fibre

Each volume name, such as OPEN-3, OPEN-8, OPEN-9, 3390-3A, 3390-3B, 3390-3C, is also used as an emulation type name to be specified for each ECC group. When the emulation type is defined on an ECC group, Logical volumes (LDEVs) are automatically allocated to the ECC group from the specified LDEV#. After creating LDEVs, each LUN of Fibre port will be mapped on any location of LDEV within DKC. This setting is performed by SVP operation or Web Console operation (option).

This flexible LU and LDEV mapping scheme enables the same logical volume to be set to multiple paths so that the host system can configure a shared volume configuration such as a High Availability (HA) configuration. In the shared volume environment, however, some lock mechanism need to be provided by the host systems.

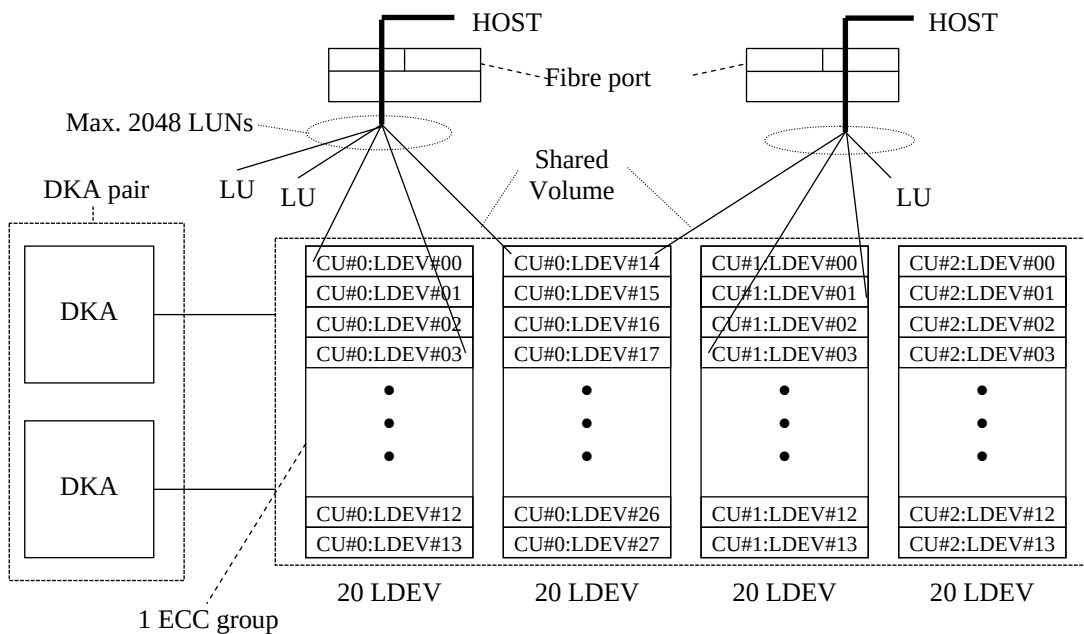


Fig. 3.21.3.4.2-1 LDEV and LU mapping for Fibre volume

3.21.3.4.3 LUN Security

(1) Outline

This function enables you to use storages and servers in the SAN environment by using a switch on a Fibre connection to connect to a secured environment in which several types of servers are segregated.

The MCU (initiator) port such as TrueCopy does not support this function.

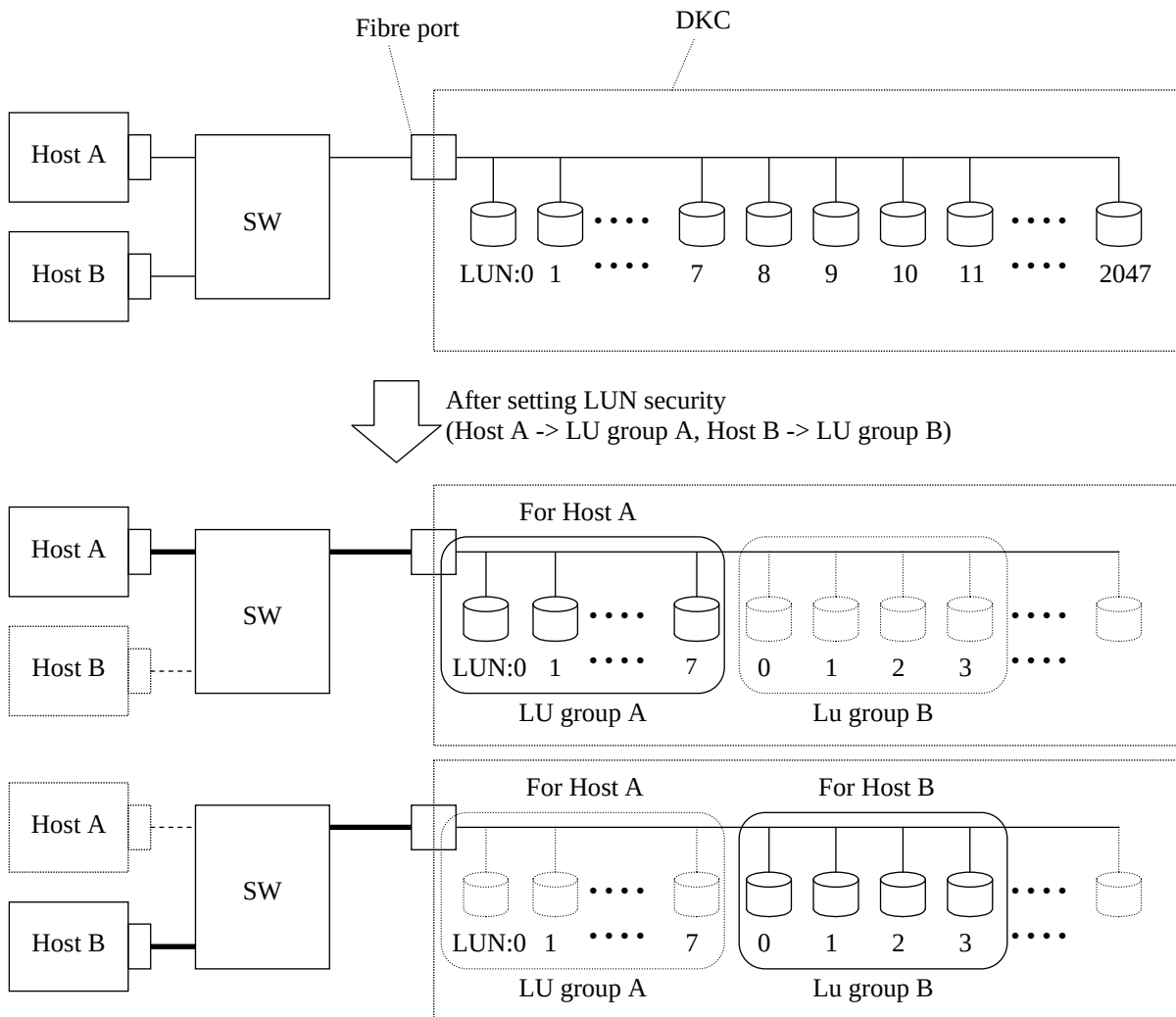


Fig. 3.21.3.4.3-1 LUN Security

3.21.3.5 Volume Specification

3.21.3.5.1 Volume Specification

For Volume Specification, refer to “E.1 Emulation Type List” ([THEORY-E-10](#)).

3.21.3.5.2 Intermix Specification

Refer to “3.25 Inter Mix of Drives and Emulation types” of [THEORY03-25-10](#) about Intermix Specification.

3.21.3.5.3 Cross-OS File Exchange volume intermix within ECC group

- (1) Four emulation types of volume can coexist within one ECC group about each groups below.
 - ① 3390-3A, -3B, -3C, -3 (or 3390-3A, -3B, -3C)
 - ② 3390-9A, -9B, -9C, -9
 - ③ 3390-LA, -LB, -LC, -L
- (2) The type can be changed for each one volume within an ECC group.
- (3) The type can be changed by the emulation type change function of the SVP.
- (4) The emulation type change function allows any change of types among 3A, 3B, 3C and 3.
- (5) At “define configuration and install” or installation of disk drives, device definition and LDEV-FMT are performed in units of ECC group with any type of 3A, 3B, 3C and 3. Afterwards the type is changed for each one volume if necessary.
When the type change is completed, all volumes are initialized (a VTOC is created for volumes) from the mainframe system.
- (6) After the type change, the previous data is not assured.
After the type change, all volumes must be initialized (a VTOC must be created) from the mainframe system.

3.21.3.6 Open Volume Setting

3.21.3.6.1 Setting of open volume space

The procedure of open volume setting is performed either by using the SVP or Storage Navigator function (optional feature).

3.21.3.6.2 LUN setting

- LUN setting:

- Select the CHF, Fibre port and the LUN, and select the CU# and LDEV# to be assigned to the LUN.
- Repeat the above procedure as needed.

The MCU port (Initiator port) such as TrueCopy function does not support this setting.

NOTE1: It is possible to refer to the contents which is already set on the SVP display.

NOTE2: The above setting can be done during on-line.

NOTE3: Duplicated access paths' setting from the different hosts to the same LDEV is allowed. This will provide a means to share the same volume among host computers. It is, however, the host responsibility to manage an exclusive control on the shared volume.

Refer to the INSTALLATION SECTION for more detailed procedures.

3.21.3.7 Host mode setting

It is necessary to set Host Mode by using SVP if you want to change a host system.
The meanings of each mode are follows.

*****HDS RAID Controller Models*****

MODE 00 : Standard mode (Linux)
 MODE 01 : VMWare host mode
 MODE 03 : HP-UX host mode
 MODE 05 : OpenVMS host mode
 MODE 07 : Tru64 host mode
 MODE 09 : Solaris host mode
 MODE 0A : NetWare host mode
 MODE 0C : Windows host mode
 MODE 0F : AIX host mode
 MODE 21 : VMWare host mode
 MODE 2C : Windows host mode
 MODE 4C : UVM connection host mode *1
 others : Reserved

*****HP RAID Controller Models*****

MODE 00 : Standard mode (Linux)
 MODE 01 : VMWare host mode
 MODE 05 : OpenVMS host mode
 MODE 07 : Tru64 host mode
 MODE 08 : HP-UX host mode
 MODE 09 : Solaris host mode
 MODE 0A : NetWare host mode
 MODE 0C : Windows host mode, NonStop OS
 MODE 0F : AIX host mode
 MODE 21 : VMWare host mode
 MODE 2C : Windows host mode, NonStop OS
 MODE 4C : UVM connection host mode *1
 others : Reserved

There is no functional difference between MODE0C and 2C, and MODE01 and 21.

It is recommended to set MODE2C or 21 as Host Mode when creating a new connection. However, if MODE0C or 01 has been used due to a migration from the old model, etc., it is possible to keep using it.

Set the HOST MODE OPTION if required.

See “5.3.1.4 LUN Management” ([INST05-03-450 to INST05-03-880](#)). Also see the operational manual for more detailed information about the alternate link and HA software.

*1: If setting this mode to ON when DKC810I is being used as an External Storage, the data of the MF-VOL (Multi-platform VOL emulation only) in the DKC810I can be succeeded.

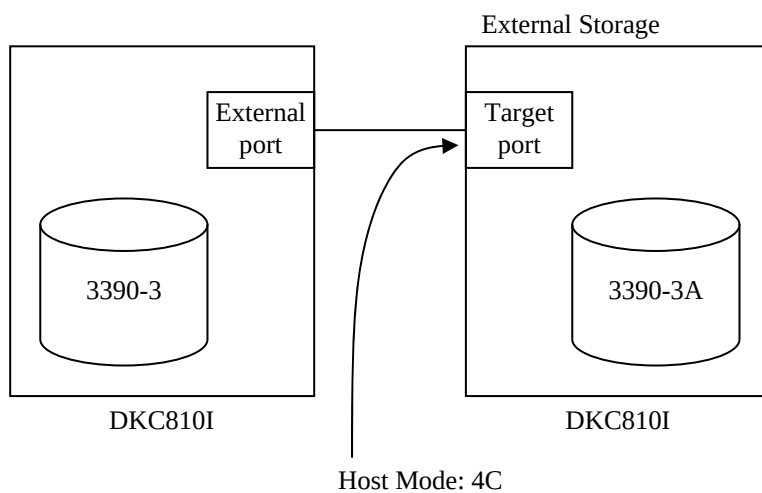


Fig. 3.21.3.7-1 Typical system configuration in MODE 4C

3.21.4 Control Function

3.21.4.1 Cache Usage

The DKC has two independent areas of non-volatile cache memory for the mainframe volumes. This mechanism also commonly applies to the OPEN volumes without any distinction. Thus, the high reliability and high performance realized by the following features can be commonly applied to the OPEN volumes.

① Cache data management by LRU control

Data that has been read out is stored into the cache and managed under LRU control. For upright transaction processing, therefore, a high cache hit ratio can be expected, which results in improvement on the system throughput by reducing the data write time.

② Adoption of DFW (DASD Fast Write)

In the normal write command, completion of the writing is reported to the host as the data is transferred to the cache. Data writing to disk is asynchronous with host access. The host, therefore, can execute the next process without waiting for the end of data writing to disk.

③ Write data duplexing

The same write data is stored into the two areas of a cache provided in the DKC. Thus, loss of DFW data can be avoided even one failure occurs in the cache.

④ Nonvolatile cache

The cache in the DKC is non-volatile by battery backup. Once data has been written into the cache, its non-volatility will maintain the data, even if a power interruption occurs. Under a standard system configuration having a fully charged battery pack, data is guaranteed for at least 48 hours.

3.21.4.2 SCSI Command Multi-processing

3.21.4.2.1 Command Tag Queuing

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

The MCU port (Initiator port) such as TrueCopy function cannot support this function because it does not support a connection with a host computer.

3.21.4.2.2 Concurrent data transfer

Four Fibre ports on a CHF can perform the host I/Os and data transfer with maximum 8 Gbps transfer concurrently.

This is also applied among different CHFs.

The MCU port (Initiator port) such as TrueCopy function cannot support this function because it does not support a connection with a host computer.

THEORY03-21-260**3.21.5 SCSI Commands****3.21.5.1 Fibre**

The DASD commands defined under the SCSI-3 standards and those supported by the DKC are listed in Table 3.21.5.1-1.

Table 3.21.5.1-1 SCSI-3 DASD commands and DKC-supported commands

Group	Op Code	Name of Command	Type	○:Supported	Remarks
0 (00 _H -1F _H)	00 _H	Test Unit Ready	CTL/SNS	○	
	01 _H	Rezero Unit	CTL/SNS	Nop	
	03 _H	Request Sense	CTL/SNS	○	
	04 _H	Format Unit	DIAG	Nop	
	07 _H	Reassign Blocks	DIAG	○	For RAID5, Nop
	08 _H	Read (6)	RD/WR	○	
	0A _H	Write (6)	RD/WR	○	
	0B _H	Seek (6)	CTL/SNS	Nop	
	12 _H	Inquiry	CTL/SNS	○	
	15 _H	Mode Select (6)	CTL/SNS	○	
	16 _H	Reserve	CTL/SNS	○	
	17 _H	Release	CTL/SNS	○	
	18 _H	Copy	—	—	
	1A _H	Mode Sense (6)	CTL/SNS	○	
	1B _H	Start/Stop Unit	CTL/SNS	Nop	
	1C _H	Receive Diagnostic Results	DIAG	—	
	1D _H	Send Diagnostic	DIAG	Nop	Supported only for self-test.
	1E _H	Prevent Allow Medium Removal	—	—	
	1F _H	Reserved code	—	—	
	Other	Vendor-unique	—	—	
1 (20 _H -3F _H)	25 _H	Read Capacity (10)	CTL/SNS	○	
	28 _H	Read (10)	RD/WR	○	
	2A _H	Write (10)	RD/WR	○	
	2B _H	Seek (10)	CTL/SNS	Nop	
	2E _H	Write And Verify (10)	RD/WR	○	DKC8101 only supports Write.
	2F _H	Verify (10)	RD/WR	Nop	
	30 _H	Search Data High	—	—	
	31 _H	Search Data Equal	—	—	
	32 _H	Search Data Low	—	—	
	33 _H	Set Limits (10)	—	—	
	34 _H	Pre-Fetch (10)	—	—	
	35 _H	Synchronize Cache (10)	CTL/SNS	Nop	
	36 _H	Lock-Unlock Cache (10)	—	—	
	37 _H	Read Defect Data (10)	DIAG	○	No defect is always reported.
	38 _H	Reserved code	—	—	
	39 _H	Compare	—	—	

Table 3.21.5.1-1 SCSI-3 DASD commands and DKC-supported commands (Continued)

Group	Op Code	Name of Command	Type	O:Supported	Remarks
1 (20 _H -3F _H)	3A _H	Copy And Verify	—	—	
	3B _H	Write Buffer	DIAG	○	
	3C _H	Read Buffer	DIAG	○	
	3D _H	Reserved code	—	—	
	3E _H	Read Long	—	—	
	3F _H	Write Long	—	—	
	Other	Vendor-unique	—	—	
2 (40 _H -5F _H)	40 _H	Change Definition	—	—	
	41 _H	Write Same	—	—	
	42 _H	Unmap	CTL/SNS	○	
	4C _H	Log Select	—	—	
	4D _H	Log Sense	—	—	
	50 _H	XD Write (10)	—	—	
	51 _H	XP Write (10)	—	—	
	52 _H	XD Read (10)	—	—	
	53 _H	XD Write Read (10)	—	—	
	55 _H	Mode Select (10)	CTL/SNS	○	
	56 _H	Reserve (10)	CTL/SNS	○	
	57 _H	Release (10)	CTL/SNS	○	
	5A _H	Mode Sense (10)	CTL/SNS	○	
	5E _H	Persistent Reserve IN	CTL/SNS	○	
	5F _H	Persistent Reserve OUT	CTL/SNS	○	
	Other	Reserved code	—	—	
3 (60 _H -7F _H)	7F _H /0001	Rebuild (32)	—	—	
	7F _H /0002	Regenerate (32)	—	—	
	7F _H /0003	XD Read (32)	—	—	
	7F _H /0004	XD Write (32)	—	—	
	7F _H /0005	XD Write Extend (32)	—	—	
	7F _H /0006	XD Write (32)	—	—	
	7F _H /0007	XD Write Read (32)	—	—	
	7F _H /0008	XD Write Extend (64)	—	—	
	Other	Reserved code	—	—	
4 (80 _H -9F _H)	80 _H	XD Write Extend (16)	—	—	
	81 _H	Rebuild (16)	—	—	
	82 _H	Regenerate (16)	—	—	
	83 _H	Extended Copy	CTL/SNS	○	
	84 _H	Receive Copy Result	CTL/SNS	○	
	85 _H	Access Control IN	—	—	
	86 _H	Access Control OUT	—	—	
	88 _H	Read (16)	RD/WR	○	
	89 _H	Compare and Write	RD/WR	○	
	8A _H	Write (16)	RD/WR	○	
	8C _H	Read Attributes	—	—	
	8D _H	Write Attributes	—	—	

Table 3.21.5.1-1 SCSI-3 DASD commands and DKC-supported commands (Continued)

Group	Op Code	Name of Command	Type	O:Supported	Remarks
4 (80 _H -9F _H)	8E _H	Write And Verify (16)	RD/WR	○	
	8F _H	Verify (16)	RD/WR	Nop	
	90 _H	Pre-Fetch (16)	—	—	
	91 _H	Synchronized Cache (16)	CTL/SNS	Nop	
	92 _H	Lock-Unlock Cache (16)	—	—	
	93 _H	Write Same (16)	CTL/SNS	○	
	9E/10 _H	Read Capacity (16)	CTL/SNS	○	
	9E/12 _H	Get LBA Status	CTL/SNS	○	
	Other	Vendor-unique	—	—	
5 (A0 _H -BF _H)	A0 _H	Report LUN	CTL/SNS	○	
	A3 _H /xx _H	Maintenance IN	CTL/SNS	—	
	A3 _H /05 _H	Report Device Identifier	CTL/SNS	○	
	A3 _H /0A _H	Report Target Port Groups	CTL/SNS	—	
	A3 _H /0B _H	Report Aliases	CTL/SNS	—	
	A3 _H /0C _H	Report Supported Operation Codes	CTL/SNS	—	
	A3 _H /0D _H	Report Supported Task Management Functions	CTL/SNS	—	
	A3 _H /0E _H	Report Priority	CTL/SNS	—	
	A3 _H /0F _H	Report Timestamp	CTL/SNS	—	
	A4 _H /XX _H	Maintenance OUT	CTL/SNS	—	
	A4 _H /06 _H	Set Device Identifier	CTL/SNS	—	
	A4 _H /0A _H	Set Target Port Groups	CTL/SNS	○	
	A4 _H /0B _H	Change Aliases	CTL/SNS	—	
	A4 _H /0E _H	Set Priority	CTL/SNS	—	
	A4 _H /0F _H	Set Timestamp	CTL/SNS	—	
	A7 _H	Move Medium Attached	—	—	
	A8 _H	Read (12)	RD/WR	○	
	AA _H	Write (12)	RD/WR	○	
	AE _H	Write And Verify (12)	RD/WR	○	Only Write supported.
	AF _H	Verify (12)	RD/WR	Nop	
	B3 _H	Set Limits (12)	—	—	
	B4 _H	Read Element Status Attached	—	—	
	B7 _H	Read Defect Data (12)	CTL/SNS	○	No defect is always reported.
	BA _H	Redundancy Group IN	—	—	
	BB _H	Redundancy Group OUT	—	—	
	BC _H	Spare IN	—	—	
	BD _H	Spare OUT	—	—	
	BE _H	Volume Set IN	—	—	
	BF _H	Volume Set OUT	—	—	
	Other	Reserved code	—	—	

Table 3.21.5.1-1 SCSI-3 DASD commands and DKC-supported commands (Continued)

Group	Op Code	Name of Command	Type	O:Supported	Remarks
6 (C0 _H -DF _H)	C0 _H ~D0 _H	Vendor-unique	—	—	
7 (E0 _H -FF _H)	E8 _H	Read With Skip Mask (IBM-unique)	CTL/SNS	—	
	EA _H	Write With Skip Mask (IBM-unique)	CTL/SNS	—	
	Other	Vendor-unique	—	—	

3.21.6 Cross-OS File Exchange

3.21.6.1 Overview

The Cross-OS File Exchange optional feature provides a function to enable the SAM files of the mainframe to be accessed by the open system host by executing the File Access Library (FAL) program or File Conversion Utility (FCU) program installed in the open system host. Accessible frame files are limited to the SAM files only.

The FCU program has code conversion function between EBCDIC and ASCII.

The FAL has disclosed API and users can incorporate the FAL program directly into a user program.

This optional feature is supplied as a program product (P.P.) that consists of the following programs:

- (1) File Access Library program (FAL)
 - C language functions and a Header file for incorporation into a user program
- (2) File Conversion Utility program (FCU)
 - An execution-format utility program that contains the access library

The program product is supplied separately for each platform of the open system. Table 3.21.6.1-1 lists platforms supported for using the Cross-OS File Exchange.

Table 3.21.6.1-1 Platforms supported

#	Platform supported	OS	Window System
1	SUN	Solaris	Motif 1.2
2	HP	HP-UX, Tru64	Motif 1.2
3	IBM	AIX	Motif 1.2
4	(Not specified)	Windows	MFC
5	(Not specified)	Linux	MFC

3.21.6.2 Installation

(1) Installation of P.P.

For the method of installing the P.P. (containing FAL and FCU) and its detailed specifications, refer to the manual attached to the P.P.

(2) Cross-OS File Exchange volume setting

Volumes whose emulation type is 3390-3A, 3390-3B, 3390-3C, 3390-9A, 3390-9B, 3390-9C, 3390-LA, 3390-LB, 3390-LC, 3390-MA, 3390-MB and 3390-MC can be used for the Cross-OS File Exchange operations. In addition to being accessible as 3390-3/9/L/M type volumes from the mainframe host in the same manner as before, the 3390-3B/9B/LB/MB type volumes permit read-only access from the open system host.

The 3390-3A/9A/LA/MA type volumes can be accessible as 3390-3/9/L/M from the mainframe host and permit a read/write access from the open system host. The 3390-3C/9C/LC/MC can be read only accessible as 3390-3/9/L/M from mainframe host and permit a read/write access from the open system host. The 3390-3C/9C/LC/MC permit creating and updating of VTOC.

Table 3.21.6.2-1 Cross-OS File Exchange volume specifications

#	Volume attribute	Emulation Type	Access right		Remarks
			Mainframe	Open system	
1	Mainframe volume	3390-3A/9A/LA/MA	R/W	R/W	Cross-OS File Exchange volume
2		3390-3B/9B/LB/MB	R/W	R	Cross-OS File Exchange volume
3		3390-3C/9C/LC/MC	R	R/W	Cross-OS File Exchange volume
4	Open volume	OPEN-3	(Backup/Restore)	R/W	Cross-OS File Exchange volume
5		OPEN-E		R/W	Cross-OS File Exchange volume
6		OPEN-9	(Backup/Restore)	R/W	Cross-OS File Exchange volume
7		OPEN-L		R/W	Cross-OS File Exchange volume
8		OPEN-8	(Backup/Restore)	R/W	Cross-OS File Exchange volume
9		OPEN-V		R/W	Cross-OS File Exchange volume

The 3390-3A, 3390-3B, 3390-3C, 3390-9A, 3390-9B, 3390-9C, 3390-LA, 3390-LB, 3390-LC, 3390-MA, 3390-MB and 3390-MC type Cross-OS File Exchange volumes can be set during initial installation or LDEV addition. To use volumes used by the mainframe and/or OPEN as the Cross-OS File Exchange volumes, they must be set as the Cross-OS File Exchange volumes by removing the corresponding ECC group once and then adding them again. This procedure is the same as the ordinary one for setting emulation type of another drive.

The drive emulation type can be changed between 3390-3, 3390-3A, 3390-3B and 3390-3C by change emulation operation. The drive emulation type can be changed between 3390-9, 3390-9A, 3390-9B and 3390-9C by change emulation operation. The drive emulation type can be changed between 3390-L, 3390-LA, 3390-LB and 3390-LC by change emulation operation. The drive emulation type can be changed between 3390-M, 3390-MA, 3390-MB and 3390-MC by change emulation operation.

(3) Setting from the open system host

- To access the Cross-OS File Exchange volumes from the open system host, it is necessary to define the connection to the open system host and to set an OPEN path. The method of defining the OPEN path for the open system host is the same as that of the ordinary OPEN path definition with the SVP.
- Refer to the manual attached to the P.P. for the method of setting the open system host to enable it to access the Cross-OS File Exchange volumes. This setting operation requires labeling of the Cross-OS File Exchange volumes, for example.

3.21.6.3 Notes on Use

A like the ordinary mainframe volumes, the 3390-3B, 3390-3A, 3390-9B, 3390-9A, 3390-LB, 3390-LA, 3390-MB and 3390-MA type Cross-OS File Exchange volumes can be accessed from the mainframe. The 3390-3C, 3390-9C, 3390-LC and 3390-MC type Cross-OS File Exchange volumes can be read only accessed any area except VTOC area from the mainframe.

If the OPEN path are not defined for 3390-3A/B, 3390-9A/B, 3390-LA/B or 3390-MA/B, the volume cannot be accessed from the open system host.

Sun/Solaris cannot use 3390-MA, 3390-MB and 3390-MC.

3.21.7 HA Software Linkage Configuration in a Cluster Server Environment

When this storage system is linked to High-Availability software (HA software) which implements dual-system operation for improved total system fault-tolerance and availability, the open system side can also achieve higher reliability on the system scale.

3.21.7.1 Example of System Configurations

(1) Hot-standby system configuration

The HA software minimizes system down time in the event of hardware or software failures and allows processing to be restarted or continued. The basic system takes a hot-standby (asymmetric) configuration, in which, as shown in the figure below, two hosts (an active host and a standby host) are connected via a monitoring communication line. In the hot-standby configuration, a complete dual system can be built by connecting the Fibre cables of the active and standby hosts to different CHF Fibre ports.

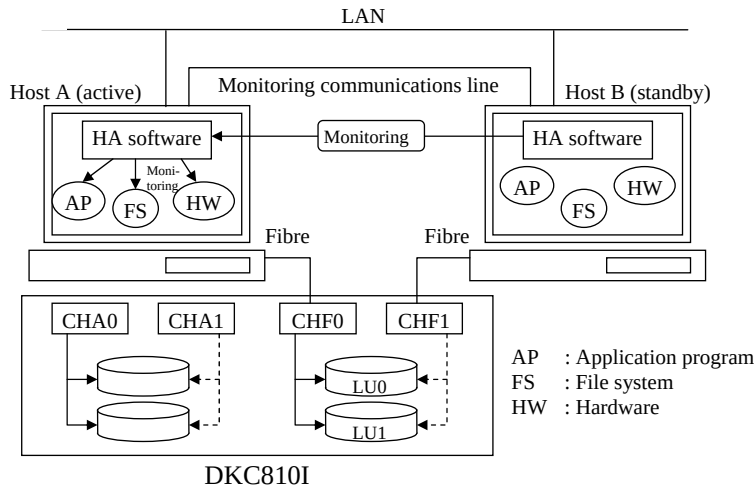


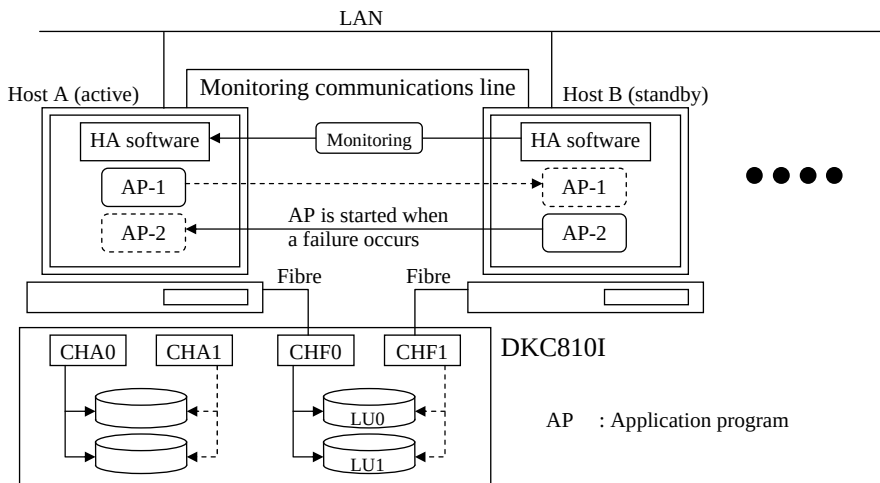
Fig. 3.21.7.1-1 Hot-standby configuration

- The HA software under the hot-standby configuration operates in the following sequence:
 - a. The HA software within the active host monitors the operational status of own system by using a monitoring agent and sends the results to the standby host through the monitoring communication line (this process is referred to as “heart beat transmission”). The HA software within the standby host monitors the operational status of the active host based on the received information.
 - b. If an error message is received from the active host or no message is received, the HA software of the standby host judges that a failure has occurred in the active host. As a result, it transfers management of the IP addresses, disks, and other common resources, to the standby host (this process is referred to as “fail-over”).
 - c. The HA software starts the application program concerned within the standby host to take over the processing on behalf of the active host.

- Use of the HA software allows a processing request from a client to be taken over. In the case of some specific application programs, however, it appears to the client as if the host that was processing the task has been rebooted due to the host switching. To ensure continued processing, therefore, a login to the application program within the host or sending of the processing request may need to be executed once again.

(2) Mutual standby system configuration

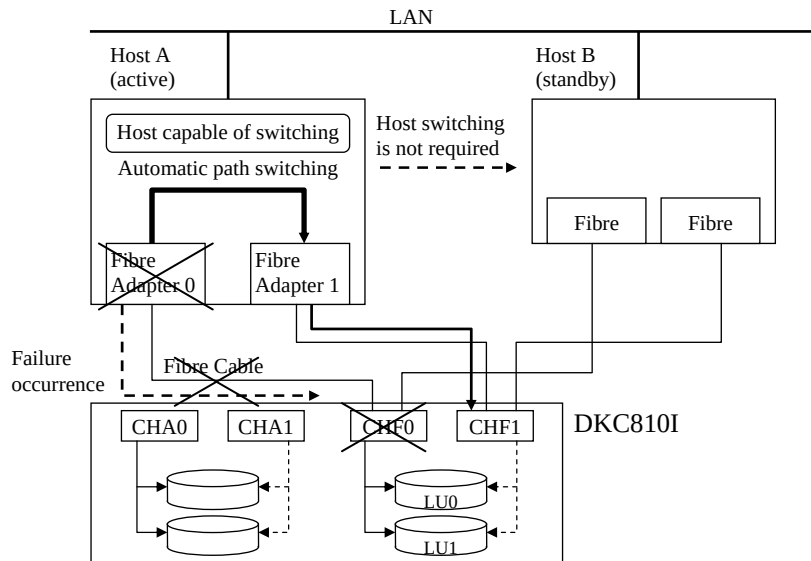
In addition to the hot-standby configuration described above, the mutual standby (symmetric) configuration can be used to allow two or more hosts to monitor each other. Since this storage system has eight Fibre ports, it can, in particular, be applied to a large-scale cluster environment in which more than two hosts exist.



- In the mutual standby configuration, since both hosts operate as the active hosts, no resources exist that become unnecessary during normal processing. On the other hand, however, during a backup operation the disadvantages are caused that performance deteriorated and that the software configuration becomes complex.

3.21.7.2 Configuration Using Host Path Switching Function

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



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

3.21.8 TrueCopy

3.21.8.1 Overview

The Hitachi Open Remote Copy function can remotely duplicate data (volumes) under the control of the storage system by directly connecting the two DKC810s. A backup system against disasters can be constructed by installing one of the two DKC810s at the main site and the other at the recovery site and configuring the HA cluster on the server side by means of the HA (High Availability) software.

This function also enables the two volumes containing identical data to be used for different purposes by duplicating data (volumes) within the same DKC810I or between the two DKC810s and separating the volumes in a primary-and-secondary relation at any time.

An online database can be backed up or batch programs can be executed while the database is being accessed. There are TrueCopy and Universal Replicator (UR) for TrueCopy.

The TrueCopy makes various settings and it controls operations by means of the RAID manager, which runs on the open system. The RAID manager provides various commands for user applications to control the TrueCopy functions. Creation of a user shell script using these commands enables the TrueCopy control being interlocked with server's fail-over executed by the HA software.

There is Fibre channel interface of connection form between CUs.

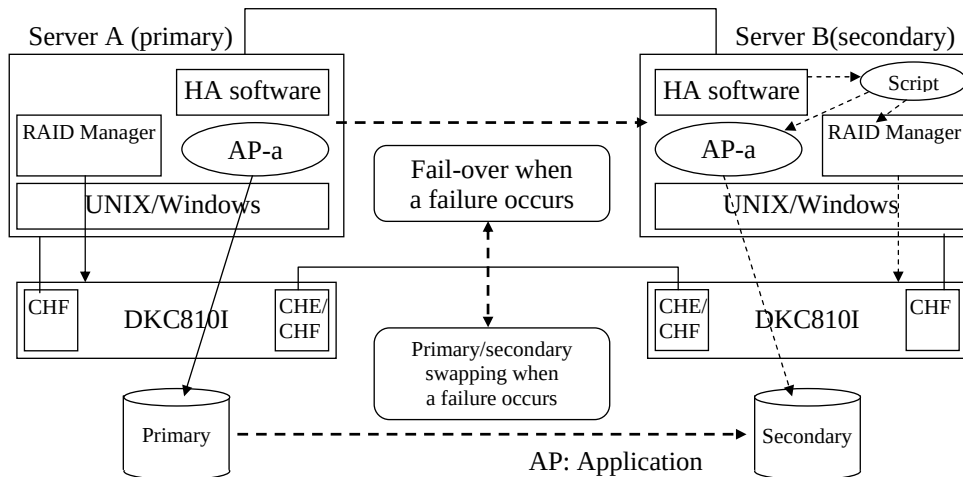


Fig. 3.21.8.1-1 Outline of TrueCopy Function and Example of Application to HA Configuration (Hot Standby Configuration)

3.21.8.2 Basic TrueCopy Specifications

Basic TrueCopy specifications are shown below.

Table 3.21.8.2-1 Basic Specifications of TrueCopy

No.	Item	Description	Remarks
1	Host interface on open system side	Fibre Channel	Conforming to base platform function. Connection configuration using FCoE is not supported.
2	Supporting OS platform	Conforming to base platform function.	
3	Connection between the CUs	Fibre Channel	Connection configuration using FCoE is not supported.
4	Means for setting a paired LU	RAID Manager	
		Storage Navigator	
		Web Console	
5	Number of LUs capable of the duplicated writing	Maximum 65280 pairs	Depending on emulation type
6	LU size capable of the duplicated writing (The paired VOL must be the same DEV type.)	All basic emulation types (include OPEN-V *1)	Maximum 4TB
		CVS Virtual Volume	
7	Duplicated writing mode	Synchronized (Sync)	
8	Combination of the CUs	One-to-one correspondence N-to-one correspondence one-to-N correspondence	
9	Fence level	Data, Status, Never	Supports a function equivalent to the TC-MF.
10	Multiple DKC support	Yes	For CU#0 through CU#FE, TrueCopy pairs can be created.

*1: Since OPEN-V is based on CVS, the capacity changes with RAID-level or DKU (HDD) type. Please refer to “3.21.3.4.1 Logical Unit Specification” for details.

(1) Means for setting a paired LU:

The following three means are provided:

- RAID Manager
- Web Console
- Storage Navigator

Not only the pairing but also a series of pair state changes are possible by using these three means. However, the user can use two means only: the command instruction from the RAID Manager and the instruction from the Web Console.

(2) LU size capable of the duplicated writing:

All emulation types' volumes are replicable.

(Condition: The primary volume and the secondary volume must have the same emulation type.)

The volumes to be specified as the primary and secondary volumes must be the same size.

(3) Fence level:

The TrueCopy, alike the TrueCopy for Mainframe, supports three types of fence level: Data, Status, and Never.

- (4) Control of the TrueCopy for Mainframe pairs and the TrueCopy pairs mixture:
Control of the mixture of the TrueCopy for Mainframe pairs and the TrueCopy pairs is possible within the one DKC.
- S-VOL (secondary VOL) access:
 - ① An RD access to the secondary VOL is permitted to accept the RD command issued to the disk label when the secondary server is started.
 - ② In order to support the DataPlex function, write access to the secondary VOL is permitted on condition that the pair is being suspended.
Using the RAID Manager or SVP, you can indicate the permission of write operation to S-VOL. After this indication, if the server performs any write operation to S-VOL, in Pair Resync (Resume) operation all tracks on P-VOL will be copied to S-VOL.
If using SVP, the permission of write operation to S-VOL is executed by setting “S-VOL write Enable” on Suspend Pair display in the indication of S-VOL Suspend on MCU.
Also, you can confirm using RAID manager or SVP whether “S-VOL write Enable” on S-VOL is permitted or not.

◆ Restrictions:

(1) Command device:

- ① The TrueCopy provides users with a command to enable a state change and status display of the TrueCopy pair from the server.
- ② Assign a special LUN called a command device so that the DKC810I can receive this pair state change and pair status display commands.
- ③ Users cannot use the command device. A command device with a capacity of 2.4GB within the storage system cannot be used (when the OPEN3 is assigned as a command device).
If you install the micro version supporting CVS function for Open volume, you can specify CVS volume as command device. In this case, the minimum capacity of command device is 35MB.
- ④ Use Web Console to specify the command device.

(2) Flashing updated data in the server:

When the TrueCopy is used as a DataPlex function, split the primary/secondary paired VOL. A Sync command or the like must be issued before splitting it and a file system buffer must be flashed when acquiring a backup from the secondary VOL.
Thus, the latest backup can be acquired.

(3) P-VOL (primary VOL) access:

Pair suspend operation (pairsplit-P option) from RAID Manager can be executed to TrueCopy pair volumes.

3.21.8.3 Basic UR Specifications

Basic UR specifications are shown below.

Table 3.21.8.3-1 Basic Specifications of UR

No.	Item	Description	Remarks
1	Host interface on open system side	Fibre Channel	Conforming to base platform function. Connection configuration using FCoE is not supported.
2	Supporting OS platform	Conforming to base platform function.	
3	Connection between the CUs	Fibre Channel	Connection configuration using FCoE is not supported.
4	Means for setting the Journal volume	Storage Navigator	
		RAID Manager	
		Web Console	
5	Number of setting Journal volumes in a Journal Group	64 volumes	
6	LU type for setting the Journal volume	OPEN-V	
		Virtual Volume	
7	Means for setting a paired LU	RAID Manager	
		Storage Navigator	
		Web Console	
8	Number of LUs capable of the duplicated writing	Maximum 65280 pairs (*1)	
9	LU size capable of the duplicated writing (The paired VOL must be the same DEV type.)	OPEN-V (*2)	Maximum 4TB
		CVS Virtual Volume	
10	Duplicated writing mode	Asynchronized (Async)	
11	Combination of the CUs	One-to-one correspondence	
12	Multiple DKC support	Yes	For CU#0 through CU#FE, UR pairs can be created.

*1: The number of maximum pairs varies depending on the volume size of each pair.
Refer to “Hitachi Universal Replicator User Guide” for the number of maximum pairs.

*2: Since OPEN-V is based on CVS, the capacity changes with RAID-level or DKU (HDD) type.
Refer to “3.21.3.4.1 Logical Unit Specification” for details.

(1) Means for setting a paired LU:

The following three means are provided:

- RAID Manager/UR
- Web Console
- Storage Navigator

Not only the pairing but also a series of pair state changes are possible by using these three means. However, the user can use two means only: the command instruction from the RAID Manager/UR and the instruction from the Web Console.

(2) LU size capable of the duplicated writing:

The replicable volume is only OPEN-V.

(Condition: The primary volume and the secondary volume must have the same emulation type.)

The volumes to be specified as the primary and secondary volumes must be the same size.

(3) Copy Mode:

UR: The copy operation and the host I/O can be performed asynchronously, but it must to ensure the update sequence consistency of Write progress across multiple primary volumes (The data written late cannot be copied earlier.). In addition, when a failure occurs, the function (for multiple pairs) having multiple pairs blocked while keeping the update sequence consistency is available. In this way, the group composed of pairs, which are the control objects, is called Consistency Group.

(4) Means for setting the Journal Volume:

The following two means are provided.

- Web Console
- RAID Manager
- Storage Navigator

Not only setting Journal volumes but also Journal Group options are possible to be changed by using these two means. However, the user can use only instruction from the Web Console.

◆ Restrictions:

(1) Command device:

- ① The UR provides users with a command to enable a state change and status display of the UR pair from the server.
- ② Assign a special LUN called a command device so that the DKC810I can receive this pair state change and pair status display commands.
- ③ Users cannot use the command device. A command device with a capacity of 2.4GB within the storage system cannot be used. If you install the micro version supporting CVS function for Open volume, you can specify CVS volume as command device. In this case, the minimum capacity of command device is 35MB.
- ④ Use Web Console to specify the command device.

(2) Flashing updated data in the server:

When the UR is used as a DataPlex function, split the primary/secondary paired VOL. A Sync command or the like must be issued before splitting it and a file system buffer must be flashed when acquiring a backup from the secondary VOL. Thus, the latest backup can be acquired.

(3) S-VOL (secondary VOL) access:

- ① An RD access to the secondary VOL is permitted to accept the RD command issued to the disk label when the secondary server is started.
- ② In order to support the DataPlex function, write access to the secondary VOL is permitted on condition that the pair is being suspended.
Using the RAID Manager/UR or SVP, you can indicate the permission of write operation to S-VOL. After this indication, if the server performs any write operation to S-VOL, in Pair Resync (Resume) operation all tracks on P-VOL will be copied to S-VOL. If using SVP, the permission of write operation to S-VOL is executed by setting “S-VOL write Enable” on Suspend Pair display in the indication of S-VOL Suspend on MCU.
Also, when using RAID Manager/UR or SVP, confirm whether “S-VOL write Enable” on S-VOL is permitted or not.

3.21.9 LUN installation

3.21.9.1 Overview

LUN installation feature makes it enable to add LUNs to DKC810I Fibre ports while I/Os are still running.

Some host operations are required before the added volumes are recognized and become usable from the host operating systems.

MCU (Initiator port) such as TrueCopy function or External port does not support LUN installation.

3.21.9.2 Specifications

(1) General

- (a) LUN installation feature supports Fibre interface.
- (b) LUN installation is supported.
- (c) LUN installation can be executed by SVP or by Web Console.
- (d) Some operating systems require reboot operation to recognize the newly added volumes.
- (e) When new LDEVs should be installed for LUN installation, install the LDEVs by SVP first. Then add LUNs by LUN installation from SVP or Web Console.
- (f) MCU (Initiator port) such as TrueCopy function or External port does not support LUN installation.

(2) Platform support

Host Platforms supported for LUN installation are shown in Table 3.21.9.2-1.

Table 3.21.9.2-1 Platform support level

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

3.21.9.3 Operations

(1) Operations

Step 1: Execute LUN installation from SVP or from JAVA = “Web Console”.

Step 2: Check whether or not the initiator platform of the Fibre port supports LUN recognition with Table 3.21.9.3-1.

Support (A) -> Execute LUN recognition procedures in Table 3.21.9.3-1

Not support (B) -> Reboot host and execute normal install procedure.

(2) Host operations

Host operations for LUN recognition are shown in Table 3.21.9.3-1.

Table 3.21.9.3-1 LUN recognition procedures outline for each platform

Platform	LUN recognition procedures
HP-UX	(1) ioscan (check device added after IPL) (2) insf (create device files)
Solaris	(1) /usr/sbin/drvconfig (2) /usr/sbin/devlinks (3) /usr/sbin/disks (4) /usr/ucb/ucblinks
AIX	(1) Devices-Install/Configure Devices Added After IPL By SMIT
Windows	Automatically detected

3.21.10 LUN de-installation

3.21.10.1 Overview

LUN de-installation feature makes it enable to delete LUNs to DKC810I Fibre ports while I/Os are still running.

MCU (Initiator port) such as TrueCopy function or External port does not support Online LUN de-installation.

3.21.10.2 Specifications

(1) General

- (a) LUN de-installation feature supports Fibre interface.
- (b) LUN de-installation can be used only for the ports on which LUNs are already existing.
- (c) LUN de-installation can be executed by SVP or by “Web Console”.
- (d) When LUNs should be de-installed for LUN de-installation, stop Host I/O of concerned LUNs.
- (e) If necessary , execute backup of concerned LUNs.
- (f) De-install concerned LUNs from HOST.
- (g) In case of AIX, release the reserve of concerned LUNs.
- (h) In case of HP-UX do not delete LUN=0 under existing target ID.
- (i) MCU (Initiator port) such as TrueCopy function or External port does not support Online LUN de-installation.

NOTE: If LUN de-installation is done without stopping Host I/O, or releasing the reserve, it would fail. Then stop HOST I/O or release the reserve of concerned LUNs and try again. If LUN de-installation would fail after stopping Host I/O or releasing the reserve, there is a possibility that the health check command from HOST is issued. At that time, wait about three minutes and try again.

(2) Platform support

Host platforms supported for LUN de-installation are shown in Table 3.21.10.2-1.

Table 3.21.10.2-1 Support platform

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

(example) ○: support, ×: not support

3.21.10.3 Operations

(1) Operations

Step 1: Confirm whether or not the initiator platform of the FIBRE port supports LUN de-installation with Table 3.21.10.2-1.

Support :Go to Step 2.

Not support :Go to Step 3.

Step 2: If HOST MODE of the port is not 00 or 04 or 07 use, go to Step 4.

Step 3: Stop Host I/O of concerned LUNs.

Step 4: If necessary, execute backup of concerned LUNs.

Step 5: De-install concerned LUNs form HOST.

Step 6: In case AIX, release the reserve of concerned LUNs.

If not, go to Step 7.

Step:7 Execute LUN de-installation from SVP or from Remote “Web Console”.

(2) Host operations

Host operations for LUN de-installation procedures are shown in Table 3.21.10.3-1.

Table 3.21.10.3-1 LUN de-installation procedures outline for each platform

Platform	LUN de-installation procedures
HP-UX	mount point:/01, volume group name:vg01 (1) umount /01 (umount) (2) vgchange -a n vg01 (deactive volume groups) (3) vgexport /dev/vg01 (export volume groups)
Solaris	mount point:/01 (1) umount /01 (unmout)
AIX	mount point:/01, volume group name:vg01, device file name:hdisk1 (1) umount /01 (umount) (2) rmfs -r" /01 (delete file systems) (3) varyoffvg vg01 (vary off) (4) exportvg vg01 (export volume groups) (5) rmdev -I 'hdisk1' '-d' (delete devime files)

3.21.11 Prioritized Port Control (PPC)

3.21.11.1 Overview

The Prioritized Port Control (PPC) feature allows you to use the DKC for both production and development. The assumed system configuration for using the Prioritized Port Control option consists of a single DKC that is connected to multiple production servers and development servers. Using the Prioritized Port Control function under this system configuration allows you to optimize the performance of the development servers without adversely affecting the performance of the production servers.

MCU port (Initiator port) such as Fibre Remote Copy function does not support Prioritized Port Control (PPC).

The Prioritized Port Control option has two different control targets: fibre port and open-systems host's World Wide Name (WWN). The fibre ports used on production servers are called prioritized ports, and the fibre ports used on development servers are called non-prioritized ports. Similarly, the WWNs used on production servers are called prioritized WWNs, and the WWNs used on development servers are called non-prioritized WWNs.

NOTE: The Prioritized Port Control option cannot be used simultaneously for both the ports and WWNs for the same DKC. Up to 176 ports or 2048 WWNs can be controlled for each DKC.

The Prioritized Port Control option monitors I/O rate and transfer rate of the fibre ports or WWNs. The monitored data (I/O rate and transfer rate) is called the performance data, and it can be displayed in graphs. You can use the performance data to estimate the threshold and upper limit for the ports or WWNs, and optimize the total performance of the DKC.

■ Prioritized Ports and WWNs

The fibre ports or WWNs used on production servers are called prioritized ports or prioritized WWNs, respectively. Prioritized ports or WWNs can have threshold control set, but are not subject to upper limit control. Threshold control allows the maximum workload of the development server to be set according to the workload of the production server, rather than at an absolute level. To do this, the user specifies whether the current workload of the production server is high or low, so that the value of the threshold control is indexed accordingly.

■ Non-Prioritized Ports and WWNs

The fibre ports or WWNs used on development servers are called non-prioritized ports or prioritized WWNs, respectively. Non-prioritized ports or WWNs are subject to upper limit control, but not threshold control. Upper limit control makes it possible to set the I/O of the non-prioritized port or WWN within a range that does not affect the performance of the prioritized port or WWN.

3.21.11.2 Overview of Monitoring

■ Monitoring Function

Monitoring allows you to collect performance data, so that you can set optimum upper limit and threshold controls. When monitoring the ports, you can collect data on the maximum, minimum and average performance, and select either per port, all prioritized ports, or all non-prioritized ports. When monitoring the WWNs, you can collect data on the average performance only, and select either per WWN, all prioritized WWNs, or all non-prioritized WWNs.

The performance data can be displayed in graph format either in the real time mode or offline mode. The real time mode displays the performance data of the currently active ports or WWNs. The data is refreshed in every time that you specified between 1 and 15 minutes by minutes, and you can view the varying data in real time. The offline mode displays the stored performance data. Statistics are collected at a user-specified interval between 1 and 15 minutes, and stored between 1 and 15 days.

■ Monitoring and Graph Display Mode

When you activate the Prioritized Port Control option, the Select Mode panel where you can select either Port Real Time Mode, Port Offline Mode, WWN Real Time Mode, or WWN Offline Mode opens. When you select one of the modes, monitoring starts automatically and continues unless you stop monitoring. However, data can be stored for up to 15 days. To stop the monitoring function, exit the Prioritized Port Control option, and when a message asking if you want to stop monitoring is displayed, select the Yes button.

- The Port/WWN Real Time Mode is recommended if you want to monitor the port or WWN performance for a specific period of time (within 24 hours) of a day to check the performance in real time.
- The Port/WWN Offline Mode is recommended if you want to collect certain amount of the port or WWN performance data (maximum of one week), and check the performance in non-real time.

To determine a preliminary upper limit and threshold, run the development server by using the performance data collected from the production server that was run beforehand and check the changes of performance of a prioritized port. If the performance of the prioritized port does not change, set a value by increasing an upper limit of the non-prioritized port. After that, recollect and analyze the performance data. Repeat these steps to determine the optimized upper limit and threshold. (See Fig. 3.21.11.3-1.)

3.21.11.3 Procedure (Flow) of Prioritized Port Control

To perform the prioritized port control, determine the upper limit to the non-prioritized port by checking that the performance monitoring function does not affect production. Fig. 3.21.11.3-1 shows the procedures for prioritized port control.

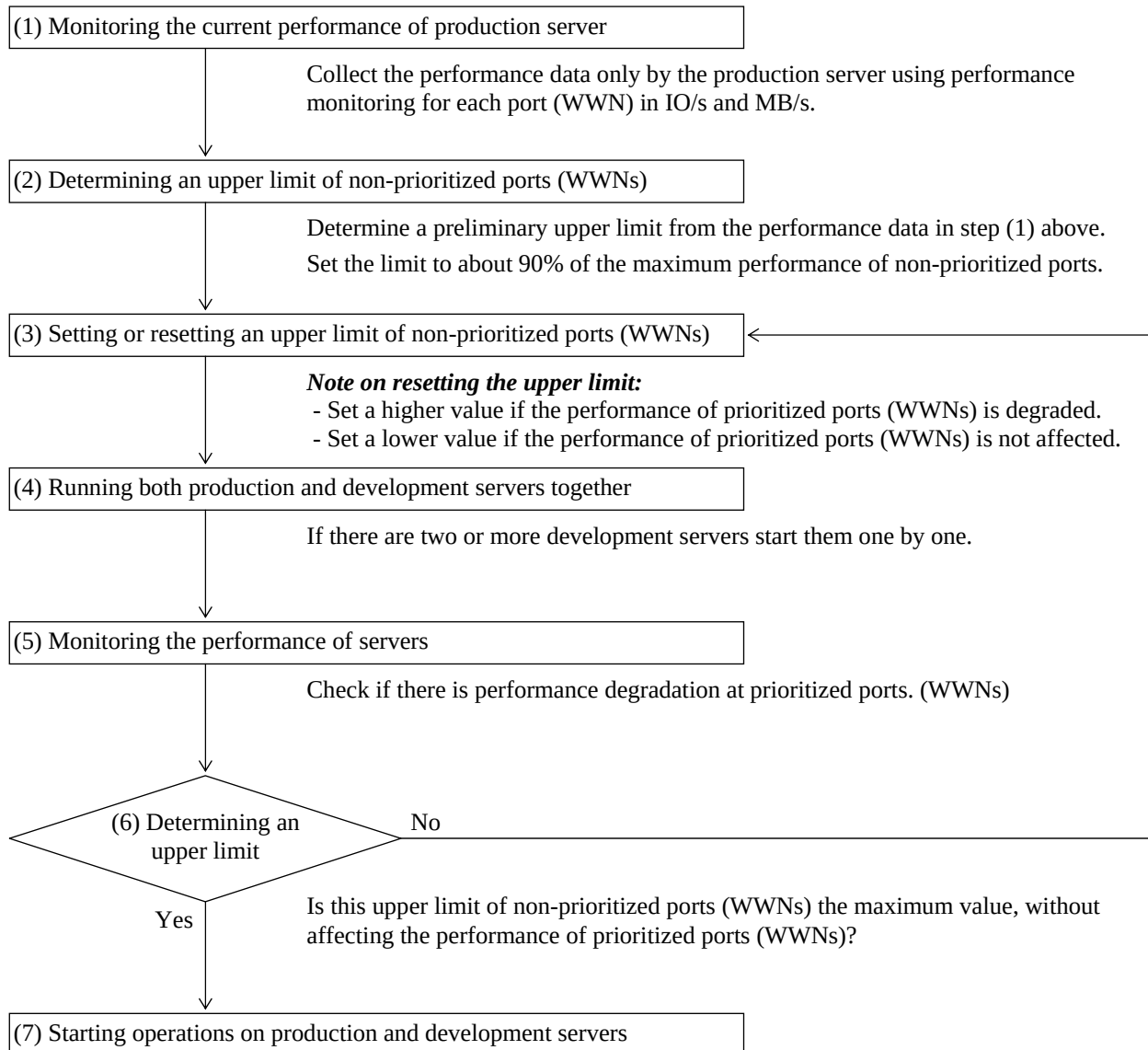


Fig. 3.21.11.3-1 Flow of Prioritized Ports Control

THEORY03-21-520**3.21.12 Online Micro-program Exchange****3.21.12.1 Outline**

The exchange of the micro-program can be done without making a host connected to the CHF stop issuing I/O instructions. (That is to say, micro-program replacement with Non Stop SCSI Host is possible.)

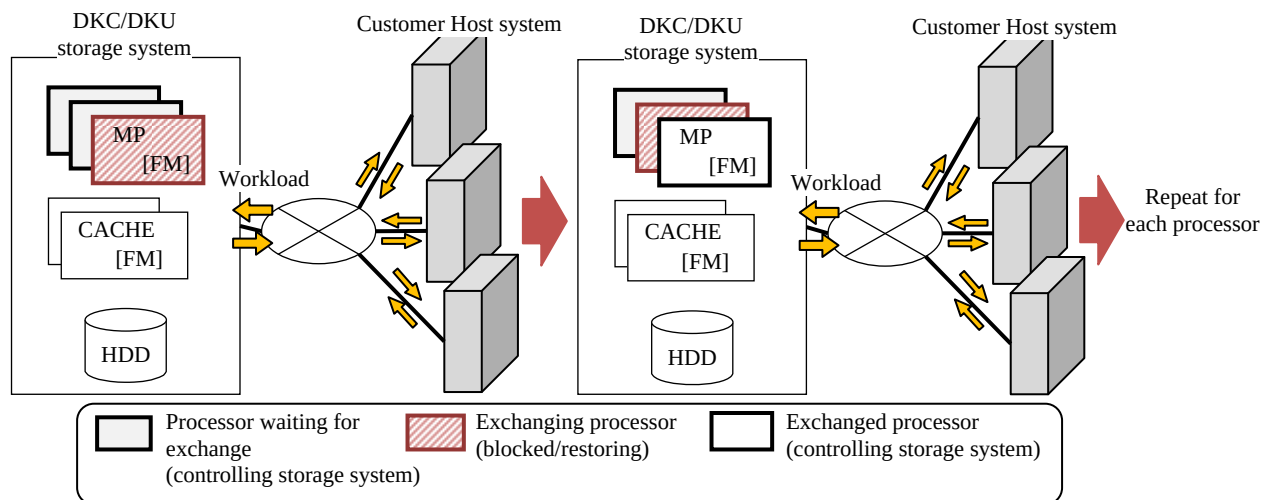
The exchange of the micro-program is possible without a fail-over even for a configuration with an alternative path.

Method	Specification
ONLINE Micro-program exchange	DKC proceeds the exchange of the micro-program without stopping host I/O on single SCSI path.

3.21.12.2 Overview of Micro-program Exchange

An online exchange of the micro-program is performed for each micro processor without blocking/restoring the storage system.

Maintaining the operation of the storage system by the processors waiting for the exchange, the micro-program can be exchanged without stopping the host I/O workload.



3.21.12.3 Notes on the exchange of Micro-program

If Non Stop SCSI Micro-program exchanging will be performed, please confirm that the following conditions are met.

Condition	Action	Influences
All of MP processing rate in DKC is less than 50%.	The exchange is possible.	Nothing.
MP processing rate larger than 50% with one or more MP in DKC.	Explain the influence caused by an exchange at the high MP operating rate and actions to be taken, and ask the customer to choose an action to determine whether to continue the exchange or not when a message is displayed.	• Some event should be logged on host servers. • Host server may look like in a hung up state temporary due to I/O time-out. • In case of using the multi path soft, fail-over will be occurred. • JOB may end abnormally.

3.21.12.4 Notice on Micro-program Exchange

3.21.12.4.1 Notice in case of applying P.P.

Pair operation and RCU operation of TrueCopy/global-active device and PPRC command do not work during a micro-program exchange. Do not perform those operations.

3.22 Mainframe Fibre Data Migration

This section describes the maintenance and the recovery operation (in case of failure) on the execution of Mainframe Fibre Data Migration (hereinafter referred to as Mainframe Fibre DM) functions.

3.22.1 Mainframe Fibre DM Function Overview

Mainframe Fibre DM is a function that uses when the data in the storage system migrates to VSP G1000 through the Mainframe Fibre I/F.

Please refer to the Mainframe Fibre Data Migration Operation Manual for further information of the necessary configurations to execute this function or of the operational procedures.

3.22.1.1 Mainframe Fibre DM Configuration

The following figure shows the configuration while migrating the data by the Mainframe Fibre DM.

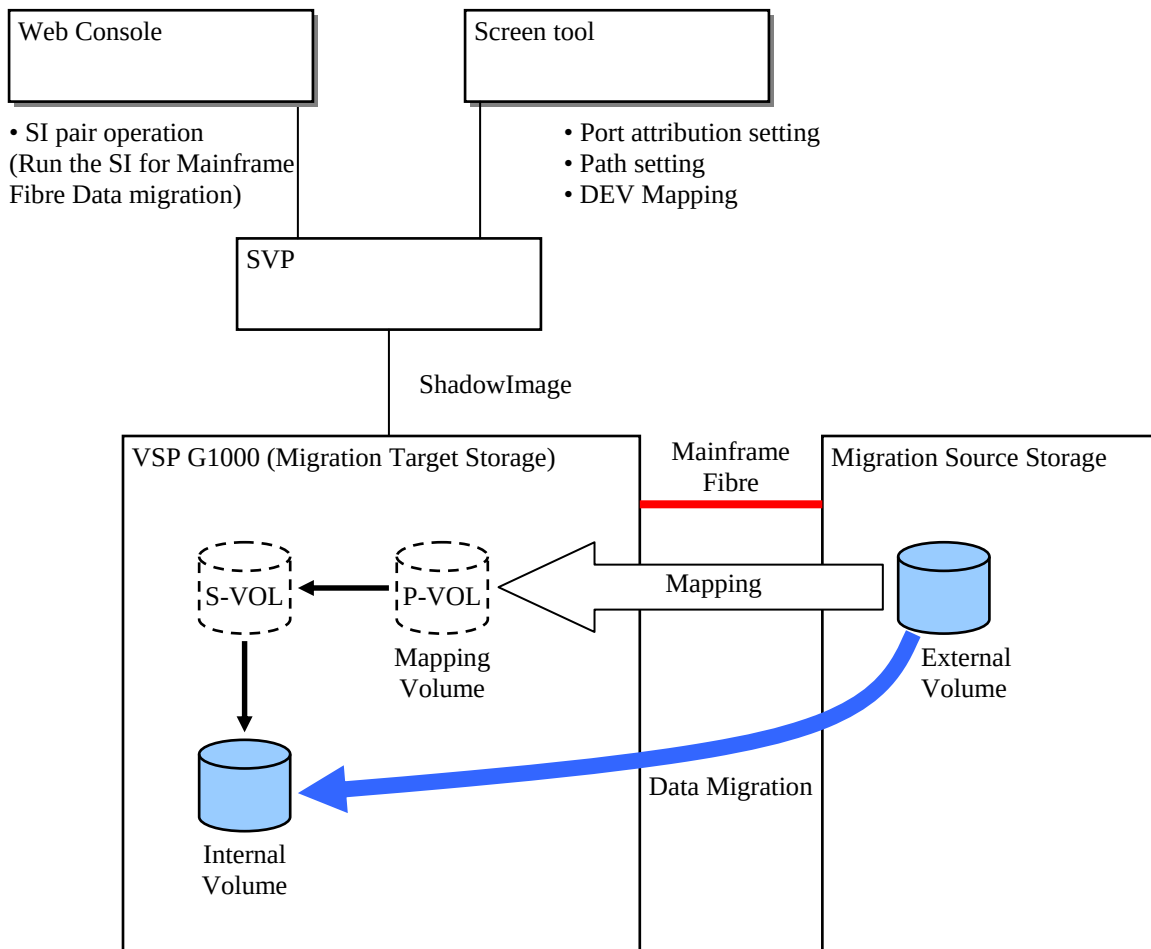


Fig. 3.22.1.1-1 Mainframe Fibre DM Configuration

The data migration by the Mainframe Fibre DM uses the screen tool of the Mainframe Fibre DM, and the ShadowImage (hereinafter referred to as SI) as shown on the above.

- (1) It maps the data migration source volume inside the VSP G1000 as a virtual volume. This mapping process runs the tool for Mainframe Fibre DM, whose program starts from the SVP.
- (2) It runs the Web Console from the SVP, and creates a pair: the above described mapping volume as a P-VOL of SI, and the migration target volume as a S-VOL of SI, with the SI for Mainframe Fibre DM.
- (3) SI for Mainframe Fibre DM tries to copy the data from the P-VOL of SI, but the actual data is in the Data migration source volume of the external storage. Therefore the data is read and copied to the S-VOL of SI in the VSP G1000, which is the destination.

This process realizes the data migration.

THEORY03-22-30**3.22.1.2 The Outline of Mainframe Fibre DM Operation**

The following shows the data migration process by the Mainframe Fibre DM.

*1: Operation by the local data migration operator

*2: Operation by the maintenance staff

1. Migration planning preparation (preparation) (*1)
2. Constructing of the Work Environment (2-1) Upgrade the version of the Micro-program of the Mainframe Fibre DM supported version (*2) (2-2) Necessary hardware installation (*2) (2-3) Installation of the Program Product that it related to Mainframe Fibre DM (*1) (2-4) Mainframe Fibre DM Tool Start-up (*1) (2-5) Port attribution setting by the Mainframe Fibre DM tool (*1) (2-6) Connection of the Mainframe Fibre physical cable (*2) (2-7) Physical path setting by the Mainframe Fibre DM tool (*1) (2-8) Offline the Host path of the migration source storage (*2) (2-9) CU path setting by the Mainframe Fibre DM tool (*1) (2-10) Virtual Volume mapping of the migration source volume by the Mainframe Fibre DM tool (*1)
3. Data Migration Operation (3-1) Data copy to the migration target volume by the SI for Mainframe (*1)
4. Confirmation operation of the Data migration completion (*1)
5. Cleanup after the operation completed (5-1) Delete the SI for Mainframe Pair (*1) (5-2) Unmapping the volume executed by the Mainframe Fibre DM tool (*1) (5-3) Delete the CU path executed by the Mainframe Fibre DM tool (*1) (5-4) Delete the physical path executed by the Mainframe Fibre DM tool (*1) (5-5) Remove the physical cable between the migration source storage and the migration target storage (*2) (5-6) Port attribution change from the Mainframe Fibre DM tool (FNP to HTP) (*1) (5-7) Uninstall the Program Product of the Mainframe Fibre DM (*1) (5-8) Uninstall the Program Product of the SI (Term & Unlimited) (*1) (5-9) Remote the hardware that is installed for the Mainframe Fibre DM operation (*2) (5-10) Confirm the state of device (*2) (5-11) SIM complete

- NOTE:
- (*1) When a failure occurred by such an incorrect operation of the local data migration operator, the maintenance operation such as the insert and remove of the cable may be requested for the maintenance staff.
 - About the timing of the online process from the host to the migration target volume, it should be executed by the instruction of the local data migration operator, based on the data migration plan.

3.22.2 Maintenance

This section describes the maintenance operation during the data migrating by the Mainframe Fibre DM.

Maintenance should not be done basically while operating the Mainframe Fibre DM unless the maintenance is required due to a failure occurrence, and so on.

3.22.2.1 PCB Maintenance

3.22.2.1.1 PCB Replacement

When replacing the PCB of the FNP attribution, if the physical path of the Mainframe Fibre DM is created on the PCB, a warning message is displayed to confirm whether it is the last path or not.

In this case, please ask to the local Mainframe Fibre DM data migration operator.

If the replacement is done in the state of existing the path, the incident is reported to the migration source storage. Therefore, you need to report to the customer that situation in advance.

After replacing the PCB, connect the cable to the same port before replacing. If the cable is not connected to those exact positions, the path will not be recovered.

3.22.2.1.2 Removing PCB

In the case of removing the Mainframe Fibre PCB (Mainframe Fibre initiator) which is set the FNP attribution, it cannot be removed if the Mainframe Fibre DM physical path is existed on the subject PCB.

In this case, please ask to the local Mainframe Fibre DM data migration operator.

3.22.2.2 Micro-program Exchange

3.22.2.2.1 Online Micro-program Exchange

The Online Micro-program Exchange is enabled even if the Mainframe Fibre DM is in use.

3.22.2.3 PS OFF/ON

Do not execute PS OFF/ON of the VSP G1000 or the external storage of the data destination during the use of Mainframe Fibre DM.

If the PS OFF/ON is required, contact the local data migration operator and request them to finish the data migration operation by the Mainframe Fibre DM, and then execute it.

3.23 Notes on maintenance during LDEV Format/drive copy operations

This section describes whether maintenance operations can be performed when Dynamic Sparing, Correction Copy, Copy Back, Correction Access or LDEV Format is running or when data copying to a spare disk is complete.

If Correction Copy runs due to a drive failure or Dynamic Sparing runs due to preventive maintenance on large-capacity disk drives or flash drives, it may take long to copy data. In the case of low-speed LDEV Format performed due to volume installation, it may take time depending on the I/O frequency because host I/Os are prioritized. In such a case, it is recommended to perform operations, such as replacement, installation, and removal, after Dynamic Sparing, LDEV Format etc. is completed, based on the basic maintenance policy, but the following maintenance operations are available.

THEORY03-23-20

Maintenance operation		Storage system status					
		Dynamic Sparing	Correction Copy	Copy Back	Correction Access	Copied to spare disk	LDEV Format
Replacement	CACHE	Impossible	Impossible	Impossible	Possible (*1)	Possible	Impossible
	MPB	Impossible	Impossible	Impossible	Possible (*1)	Possible	Impossible
	CHA	Impossible	Impossible	Impossible	Possible (*1)	Possible	Impossible
	Power supply	Possible	Possible	Possible	Possible	Possible	Possible
	SVP	Possible	Possible	Possible	Possible	Possible	Possible
	SSW	Impossible	Impossible	Impossible	Possible (*1)	Possible	Impossible
	DKA	Impossible	Impossible	Impossible	Possible (*1)	Possible	Impossible
	PDEV	Possible (*1)	Possible (*1)	Possible (*1)	Possible (*1)	Possible	Possible (*4)
Installation/ Removal	CACHE/SM	Impossible	Impossible	Impossible	Possible (*1)	Possible	Impossible
	MPB	Impossible	Impossible	Impossible	Possible (*1)	Possible	Impossible
	CHA	Impossible	Impossible	Impossible	Possible (*1)	Possible	Impossible
	Power supply	Possible	Possible	Possible	Possible	Possible	Possible
	SVP	Possible	Possible	Possible	Possible	Possible	Possible
	DKA	Impossible	Impossible	Impossible	Possible (*1)	Possible	Impossible
	PDEV	Impossible	Impossible	Impossible	Possible (*1)	Possible (*2)	Impossible
Micro-program exchange	Online	Possible (*3)	Possible (*3)	Possible (*3)	Possible (*1)	Possible (*1) (*3)	Impossible
	Offline	Impossible	Impossible	Impossible	Impossible	Possible	Impossible
	SVP only	Possible	Possible	Possible	Possible	Possible	Possible
LDEV maintenance	Blockade	Impossible	Impossible	Impossible	Possible	Possible	Impossible
	Restore	Impossible	Impossible	Impossible	Possible	Possible	Impossible
	Format	Possible (*5)	Possible (*5)	Possible (*5)	Possible	Possible	Impossible
	Verify	Impossible	Impossible	Impossible	Possible (*1)	Possible	Impossible

*1: It is prevented with a message, but you can perform it by entering the password.

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

*3: Micro-program exchange can be performed if HDD micro-program exchange is not included.

*4: It is impossible when high-speed LDEV Format is running. When low-speed LDEV Format is running, it is possible to replace PDEV in a RAID group in which LDEV Format is not running.

*5: It is possible to perform LDEV Format for LDEV defined in a RAID group in which Dynamic Sparing, Correction Copy, or Copy Back is not running.

3.24 Cache Management

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

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

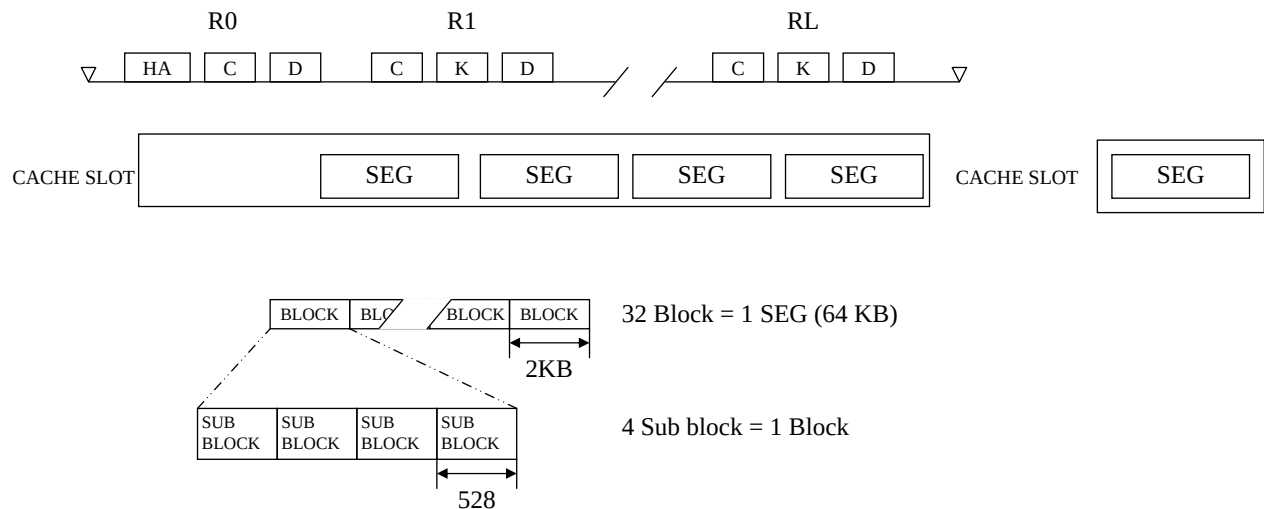


Fig. 3.24-1 Cache Data Structure

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

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

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

1 segment = 58 KB = 3390-X mainframe volume

4 segments = 256 KB = OPEN-V

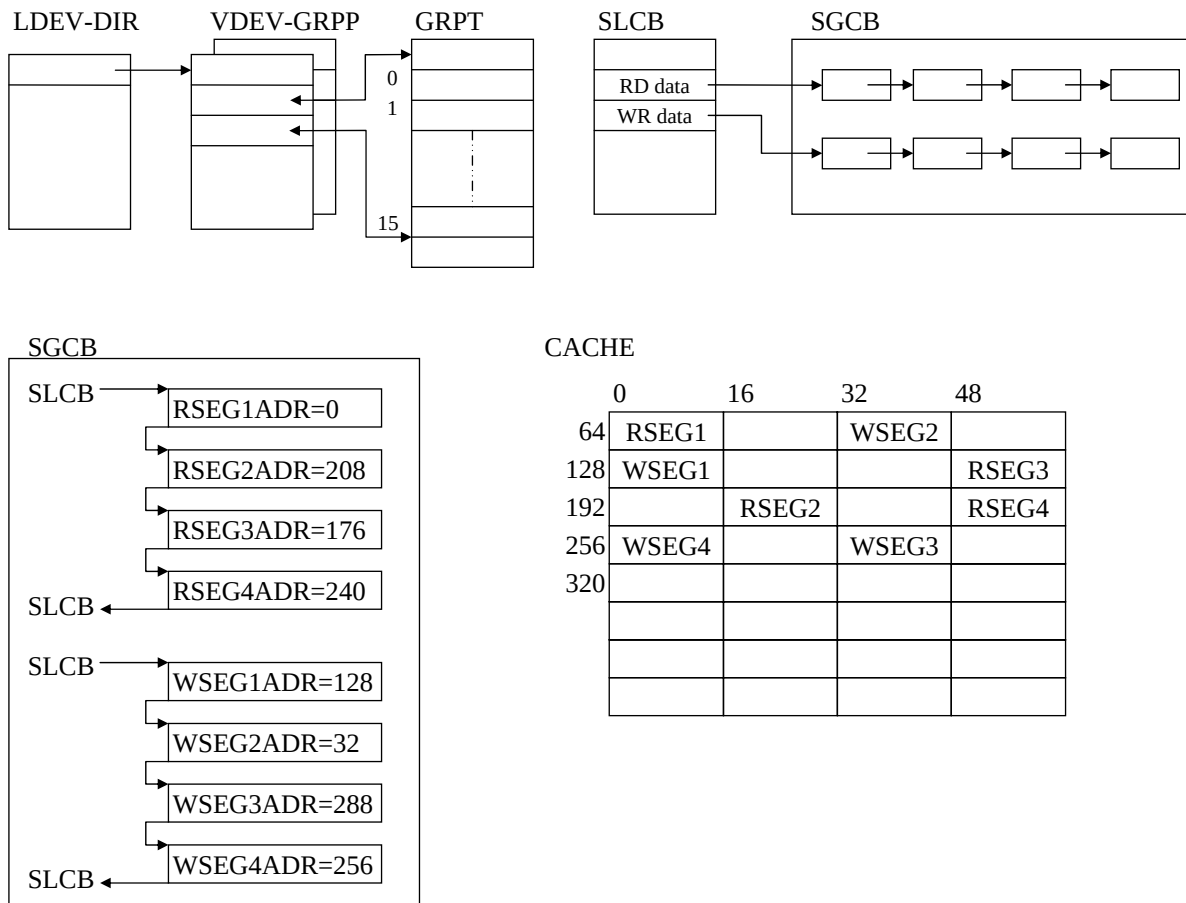
The directories VDEV-GRPP, CACHE-GRPT, CACHE-SLCB, and CACHE-SGCB are used to identify the cache hit and miss conditions. These control tables are stored in the shared memory.

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

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

(1) Cache control tables (directories)

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

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

VDEV-GRPP (Virtual DEV-group Pointer):

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

GRPT (Group Table):

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

SLCB (Slot Control Block):

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

SGCB (Segment Control Block):

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

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

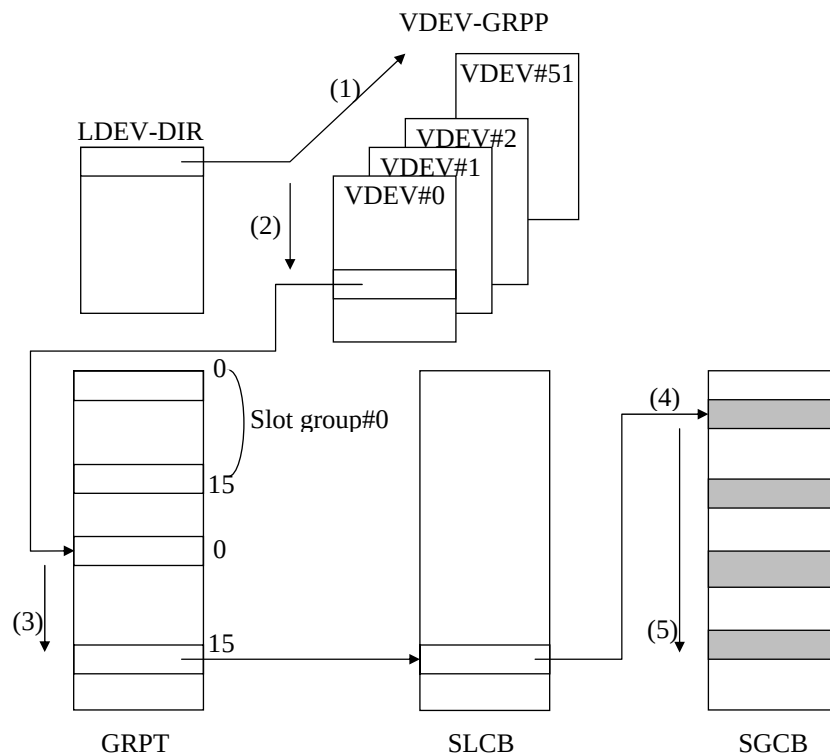


Fig. 3.24-2 Outline of Cache Control Table Access

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

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

Definition of VDEV number

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

Data VDEV number = LDEV number

Parity VDEV number = 1024 + LDEV number

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

(3) Queue structures

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

- CACHE-GRPT free queue

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

- CACHE-SLCB free queue

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

- CACHE-SGCB free queue

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

- Clean queue

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

- Bind queue

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

- Error queue

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

- Parity in-creation queue

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

- DFW queue (host dirty queue)

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

- CFW queue (host dirty queue)

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

- PDEV queue (physical dirty queue)

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

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

(4) Queue state transitions

Fig. 3.24-3 shows the state transitions of the queues used in. A brief description of the queue state transitions follows.

- State transition from a free queue

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

- State transition from a clean queue

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

- State transition from a host dirty queue

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

- State transition from the parity in-creation queue

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

- State transition from a physical dirty queue

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

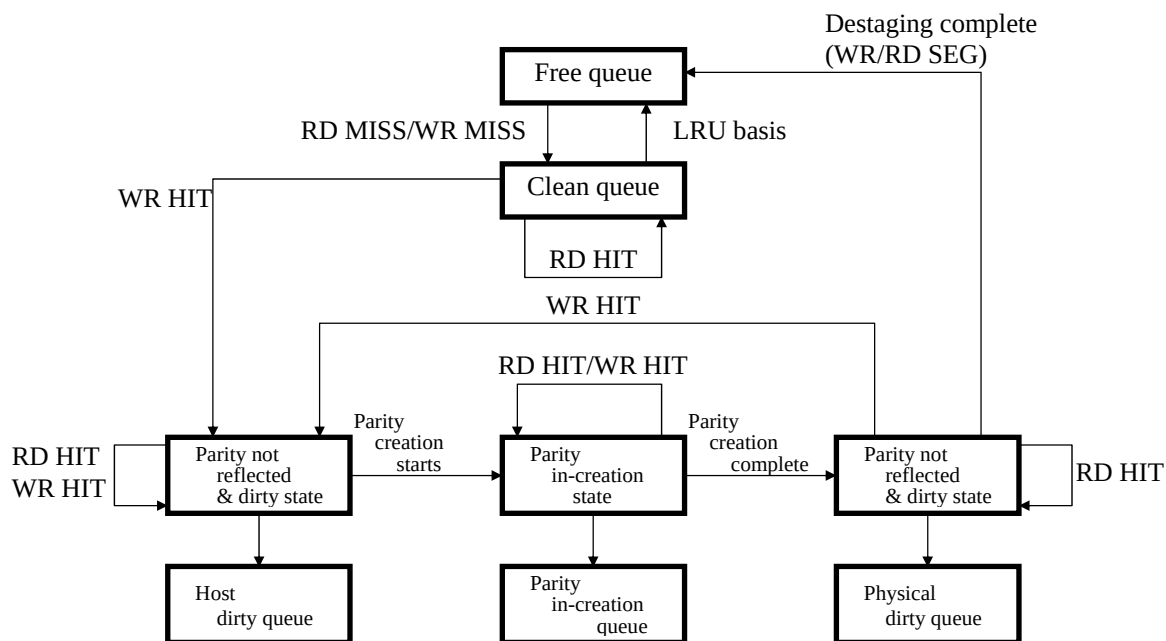
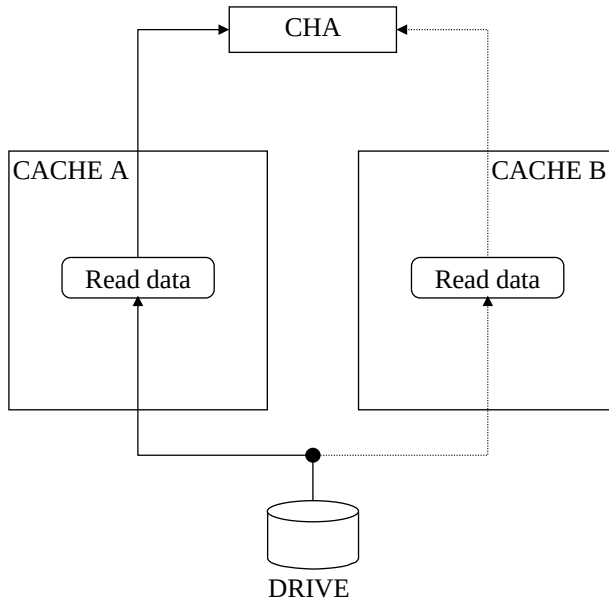


Fig. 3.24-3 Queue Segment State Transition Diagram

(5) Cache usage in the read mode



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

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

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

Fig. 3.24-4 Cache Usage in the Read Mode

Read data is not duplexed and its destaging cache area is determined by the formula shown in Fig. 3.24-4. Staging is performed not only on the segments containing the pertinent block but also on the subsequent segments up to the end of track (for increased hit ratio). Consequently, one track equivalence of data is prefetched starting at the target block. This formula is introduced so that the cache activity ratios for areas A and B are even. The staged cache area is called the cache area and the other area NVS area.

(6) Cache usage in the write mode

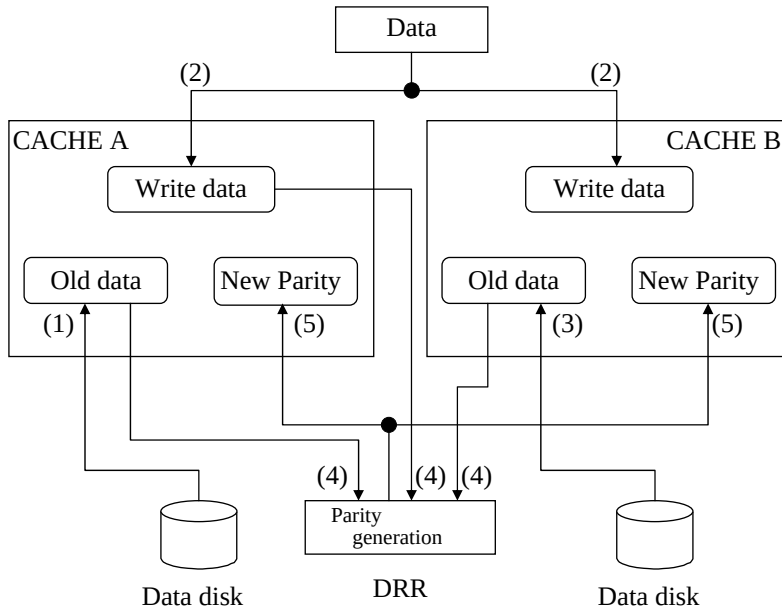


Fig. 3.24-5 Cache Usage in the Write Mode

This system handles write data (new data) and read data (old data) in separate segments as shown in Fig. 3.24-5 (not overwritten as in the conventional systems), whereby compensating for the write penalty.

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

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

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

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

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

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

3.25 Inter Mix of Drives and Emulation types

3.25.1 Drives to be Connected

The models of disk units which are connectable with the DKC810I storage system and the specifications of each disk unit are shown in Table 2.3-1 ([THEORY02-03-10](#)).

The DKC810I storage system can connect up to 1,152 disk drives mentioned above, though the number of connectable disk drives varies with the emulation types and the RAID configuration. These will be explained in detail in Section 3.25.2.

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SVP displays each drive model as the following table.

Disk drive model	SVP screen	Drive Form Factor
DKS5C-K300SS	DKS5C-K300SS	2.5 inch SAS HDD
SLB5A-M400SS	SLB5A-M400SS	2.5 inch SSD
SLR5C-M400SS	SLR5C-M400SS	2.5 inch SSD
DKR5D-J600SS	DKR5D-J600SS	2.5 inch SAS HDD
DKS5E-J600SS	DKS5E-J600SS	2.5 inch SAS HDD
SLB5A-M800SS	SLB5A-M800SS	2.5 inch SSD
SLR5C-M800SS	SLR5C-M800SS	2.5 inch SSD
DKR5D-J900SS	DKR5D-J900SS	2.5 inch SAS HDD
DKS5E-J900SS	DKS5E-J900SS	2.5 inch SAS HDD
DKR5E-J1R2SS	DKR5E-J1R2SS	2.5 inch SAS HDD
DKS5F-J1R2SS	DKS5F-J1R2SS	2.5 inch SAS HDD
NFHAA-P1R6SS	NFHAA-P1R6SS	Flash Module Drive
NFHAB-P3R2SS	NFHAB-P3R2SS	Flash Module Drive
DKS2E-H3R0SS	DKS2E-H3R0SS	3.5 inch SAS HDD
DKS2E-H4R0SS	DKS2E-H4R0SS	3.5 inch SAS HDD
DKR2E-H4R0SS	DKR2E-H4R0SS	3.5 inch SAS HDD

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Disk drive models (same capacity and same rotation speed) are intermixed in same ECC, Recommendation setting on SVP is following.

- The SVP Screen display of the drive that can put on UBX

Disk drive model	Recommendation setting
DKS2x-H3R0SS	DKS2E-H3R0SS
DKS2x-H4R0SS	DKS2E-H4R0SS
DKR2x-H4R0SS	
DKR5x-J600SS	DKR5D-J600SS
SLB5x-M400SS	SLB5A-M400SS

- The SVP Screen display of the drive that can put on SBX

Disk drive model	Recommendation setting
DKS5x-K300SS	DKS5C-K300SS
DKR5x-J600SS	DKR5D-J600SS
DKS5x-J600SS	
DKR5x-J900SS	DKR5D-J900SS
DKS5x-J900SS	
DKR5x-J1R2SS	DKR5E-J1R2SS
DKS5x-J1R2SS	
SLB5x-M400SS	SLB5A-M400SS
SLR5x-M400SS	
SLB5x-M800SS	SLB5A-M800SS
SLR5x-M800SS	

- The SVP Screen display of the drive that can put on FBX

Disk drive model	Recommendation setting
NFHAX-P1R6SS	NFHAA-P1R6SS
NFHAX-P3R2SS	NFHAB-P3R2SS

x: A, B, C...

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

- List of compatible drives that can be mounted on UBX

Before replacing	After replacing
DKS2x-H3R0SS	DKS2x-H3R0SS
DKS2x-H4R0SS	DKS2x-H4R0SS
	DKR2x-H4R0SS
DKR2x-H4R0SS	DKS2x-H4R0SS
	DKR2x-H4R0SS
DKR5x-J600SS	DKR5x-J600SS
SLB5x-M400SS	SLB5x-M400SS

- List of compatible drives that can be mounted on SBX

Before replacing	After replacing
DKS5x-K300SS	DKS5x-K300SS
DKR5x-J600SS	DKR5x-J600SS
	DKS5x-J600SS
DKS5x-J600SS	DKR5x-J600SS
	DKS5x-J600SS
DKR5x-J900SS	DKR5x-J900SS
	DKS5x-J900SS
DKS5x-J900SS	DKR5x-J900SS
	DKS5x-J900SS
DKR5x-J1R2SS	DKR5x-J1R2SS
	DKS5x-J1R2SS
DKS5x-J1R2SS	DKR5x-J1R2SS
	DKS5x-J1R2SS
SLB5x-M400SS	SLB5x-M400SS
	SLR5x-M400SS
SLR5x-M400SS	SLB5x-M400SS
	SLR5x-M400SS
SLB5x-M800SS	SLB5x-M800SS
	SLR5x-M800SS
SLR5x-M800SS	SLB5x-M800SS
	SLR5x-M800SS

- List of compatible drives that can be mounted on FBX

Before replacing	After replacing
NFHAx-P1R6SS	NFHAx-P1R6SS
NFHAx-P3R2SS	NFHAx-P3R2SS

x: A, B, C...

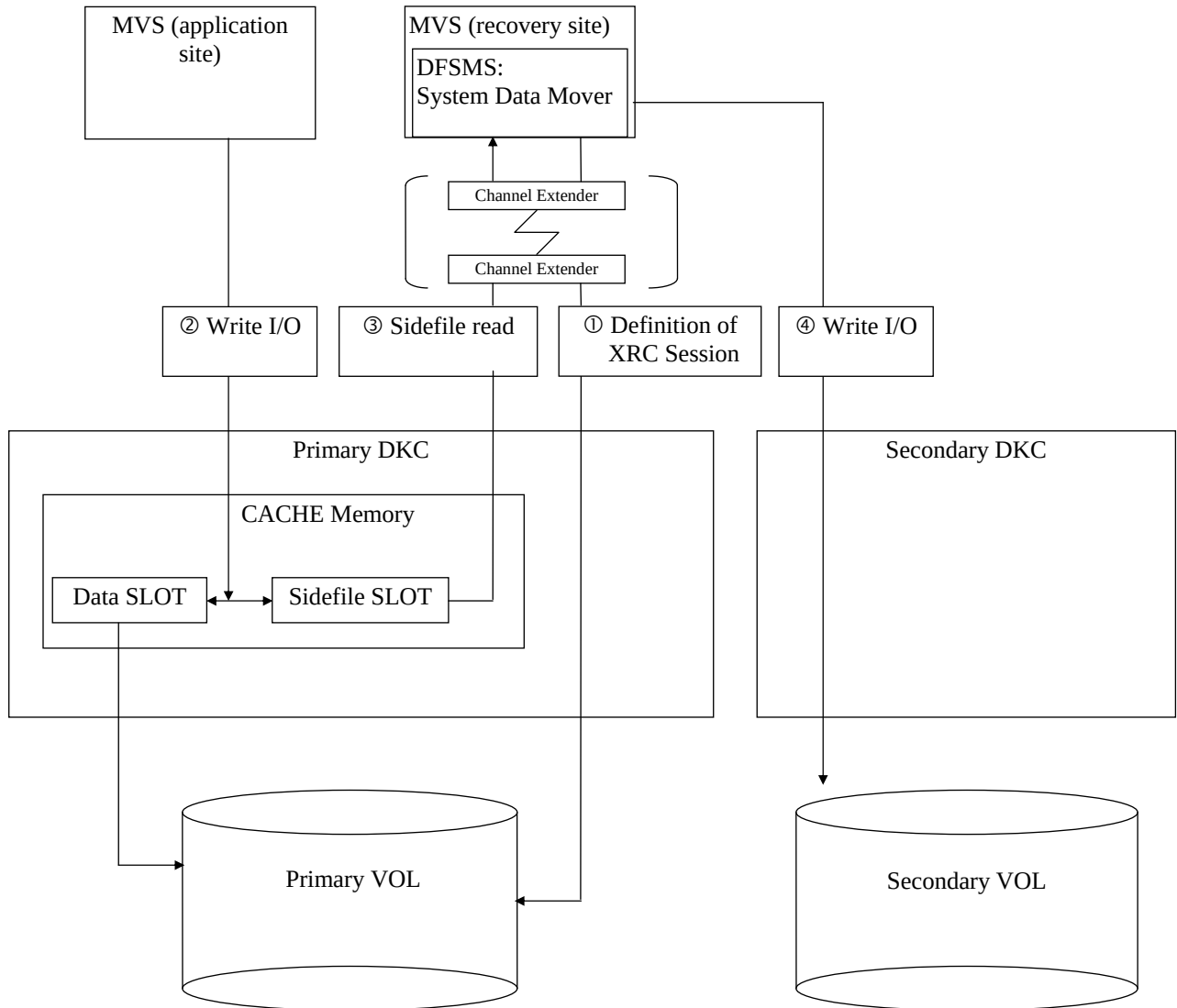
3.25.2 Emulation Device Type

For the emulation types of disk controller and disk units of the DKC810I, refer to “E.1 Emulation Type List” ([THEORY-E-10](#)).

3.26 XRC

3.26.1 Outline of XRC

XRC (eXtended Remote Copy) function provides remote data replication for disaster recovery.



- System Data Mover defines a XRC pair session. (①)
- When a write command is issued to the primary volume from the application site, the primary DKC makes Sidefile data (replication) into the cache memory. (②)
- System Data Mover reads the Sidefile data non-synchronously at the remote (recovery) site, and writes it to the secondary volume. (③, ④)

Fig. 3.26.1-1 Outline of XRC

3.26.2 XRC Support Requirements

3.26.2.1 OS

- (1) OS level
 - (a) MVS/ESA 4.3.0 or higher.
 - (b) DFSMS/MVS 1.1.0 or higher.

<Restriction of SMS 1.4 environment>

The maximum number of XRC pair per CU image is up to 128 under SMS 1.4 environment.

CCA (Channel Connection Address) such as '00' - '7F' can be specified to 128 logical devices per CU image CCA addresses '80' - 'FF' for XRC may be rejected by System Data Mover.

- (2) Conditions when using XRC
 - (a) I/O Patrol Value
 - (I) Without CHL Extender
 - Current patrol time(more than 30sec.)
 - (II) With CHL Extender
 - More than 70sec.
 - (b) Session ID
 - Up to 64Session ID's can be utilized per CU for Concurrent Copy (CC) and XRC.
 - Up to 64Session ID's can be utilized per CU for XRC.
 - Up to 16Session ID's can be utilized per VOL for Concurrent Copy (CC) and XRC.
 - Only 1Session ID can be utilized per VOL for XRC.

3.26.2.2 Hardware

(1) XRC Support Hardware Specification.

Table 3.26.2.2-1 XRC Support Hardware Specification

CU Type	2107
DEV Type	3390-3/9/L/M(*1)/A
DKC Model	Primary: DKC810I Recommended Secondary: DKC810I/DKC710I/DKC610I/DKC510I/DKC460I/ DKC410I/DKC310I/DKC210I/DKC80I/DKC90I
RAID Level	RAID6/RAID5/RAID1
Channel	FICON

*1: If DKU emulation type 3390-M is used, application of PTF 'UA18053: Support XRC volume SIZE up to 65520 CYL' is required.

(2) CACHE SIZE

Cache capacity should be doubled from the current cache size.

(The amount of Sidefile data may occupy up to 60% of total cache capacity.)

3.26.2.3 Micro-program

- (1) XRC supports Main Frame Micro-program from the 1st version.
- (2) CNT extender version 4.9 or higher level code is recommended.
- (3) Device Blocking Function and Load Balancing Control
DKC does not block Write I/Os to a logical device which has been specified the DONOTBLOCK option not to affect the performance of application programs.

<Requirements>

The following conditions are required to activate the DONOT BLOCK option.

For Operating system

- The operating system should support the DONOT BLOCK option.

For RAID system

- Set XRC option DONOT BLOCK = Enable for the DONOT BLOCK option.

DKC performs current load balancing control, if DONOT BLOCK = Disable (default).

- DONOT BLOCK = Disable (default) should be fixed, if the operating system does not support the function.

3.26.2.4 XRC recommendations

- (1) Set Data mover into the secondary site.
- (2) The path for Data Mover must be utilized only for reading Sidefile data.
- (3) Storage system configurations
 - Cache capacity : Should be doubled from the current cache size.
 - Confirmation for Number of channel paths for system data mover (SDM) is enough.
 - Confirmation for workloads for the storage system is appropriate.
- (4) Utility device for primary volume
 - Should be prepared for each XRC session.
 - A low activity device should be selected as a Utility Device
 - Utility Device should be specified before establishing pair volumes.
- (5) System Data Mover (SDM)
 - Confirmation for PTF levels is appropriate.
 - Confirm APAR #OW30183 and #OW33680 (No record found problem) are installed on the host.
 - Confirm the capacity and geometry of the data set for SDM data set are appropriate.
- (6) DB2
 - Confirm the APAR # II08859 (Broken VSAM index file problem) is installed on the host.
- (7) Others
 - Confirm the CPU MIPS is appropriate for XRC environment.
 - Confirm the LINE CAPACITY includes channel extender if appropriate for XRC environment.
- (8) XRC PP option
 - Install Program Product for XRC option before start using, otherwise ANTA5107E (RC=9014 REAS=604 OR REAS=608) console message will be displayed and XADDPAIR operation for setting XRC pairs might be failed.
 - Hitachi – Extended Remote Copy PP Option is available only on 2107 dkctype.
- (9) TOD setting or updating of Synchronization information

The amount of Sidefiles reaches the threshold and XRC pairs may be suspended due to the operation of “TOD Setting” or “Synchronization Information”.

3.26.3 Online Maintenance while using Concurrent Copy (CC)/XRC

(1) Availability of Installation and Removal.

Component	Maintenance Type	During initial copy		Established		Suspend	
		Primary	Secondary	Primary	Secondary	Primary	Secondary
HDD canister	Installation	*1	x	*1	x	*1	x
	Removal	*1	x	*1	x	*1	x
CM PK	Installation	*1	x	*1	x	*1	x
	Removal	*1	x	*1	x	*1	x
CHA	Installation	x	x	x	x	x	x
	Removal	x	x	x	x	x	x
DKA	Installation	x	x	x	x	x	x
	Removal	x	x	x	x	x	x
MP PK	Installation	x	x	x	x	x	x
	Removal	x	x	x	x	x	x

x: Maintenance is available.

*1: Maintenance process can be available when workload is low.

The followings are recommendations for maintenance procedures.

When a maintenance operation is needed while CC/XRC is running, I/O for CC/XRC pair volumes or CC/XRC itself should be stopped before the maintenance operation starts.

When the maintenance procedure should be executed during CC/XRC product is running, confirm that the usage of Sidefile monitor is less than 20% of total Cache capacity by monitoring each combination of MPPK and CLPR usage before the maintenance procedure is started. The procedure can be executed only when the usage of Sidefile monitor is less than 20% of total Cache capacity.

Refer to “Monitoring” in the SVP SECTION about Sidefile monitor.

- Select the [Monitor] button in the SVP main panel to start the monitoring feature.
- From the menu in the ‘Monitor’ panel, select [Monitor]-[Open...].
- Select ‘Cache’ from [Object] and ‘Cache Sidefile’ from [Item] in the “Select Monitor Item” panel. After that, select [=>] button and then the [OK] button.

(2) Availability of the System tuning .

If the procedure of system tuning should be executed during CC/XRC product is running, stop the entire CC/XRC product before the system tuning is started.

System tuning operation such as setting the DKC number, SSID, and/or DKC Emulation type, cannot be executed when CC/XRC product is running.

(3) Availability of the Replacement.

Component	Maintenance Type	During initial copy		Established		Suspend	
		Primary	Secondary	Primary	Secondary	Primary	Secondary
Logical Device	Blockade	*2	*2	*2	*2	*2	*2
	Recovery	*2	*2	*2	*2	*2	*2
	Format	*2	*2	*2	*2	*2	*2
	Verify	x	x	x	x	x	x
HDD canister	Replace	x	x	x	x	x	x
CM PK	Replace	*1	x	*1	x	*1	x
CHA	Replace	x	x	x	x	x	x
DKA	Replace	x	x	x	x	x	x
MP PK	Replace	x	x	x	x	x	x

x: Maintenance is available

*1: Maintenance is available but it should take place when workload is low. The followings are recommendations.

When a replacement operation is needed while CC/XRC is running, I/O for CC/XRC pair volumes or CC/XRC itself should be stopped before the replacement operation starts.

When the replacement procedure should be executed during CC/XRC product is running, confirm that the usage of Sidefile monitor is less than 20% of total Cache capacity by monitoring each combination of MPPK and CLPR usage before the maintenance procedure is started. The procedure can be executed only when the usage of Sidefile monitor is less than 20% of total Cache capacity.

Refer to “Monitoring” in the SVP SECTION about Sidefile monitor.

- Select the [Monitor] button in the SVP main panel to start the monitoring feature.
- From the menu in the ‘Monitor’ panel, select [Monitor]-[Open...].
- Select ‘Cache’ from [Object] and ‘Cache Sidefile’ from [Item] in the “Select Monitor Item” panel. After that, select [=>] button and then the [OK] button.

*2: If the maintenance procedure should be executed during CC/XRC product is running, stop the entire CC/XRC product before the procedure is started.

3.27 Data Formats

(1) Data Conversion Overview

Since the storage system uses SCSI drives, data in the CKD format are converted to the FBA format on an interface before being written on the drives. The data format is shown in Fig. 3.27-1.

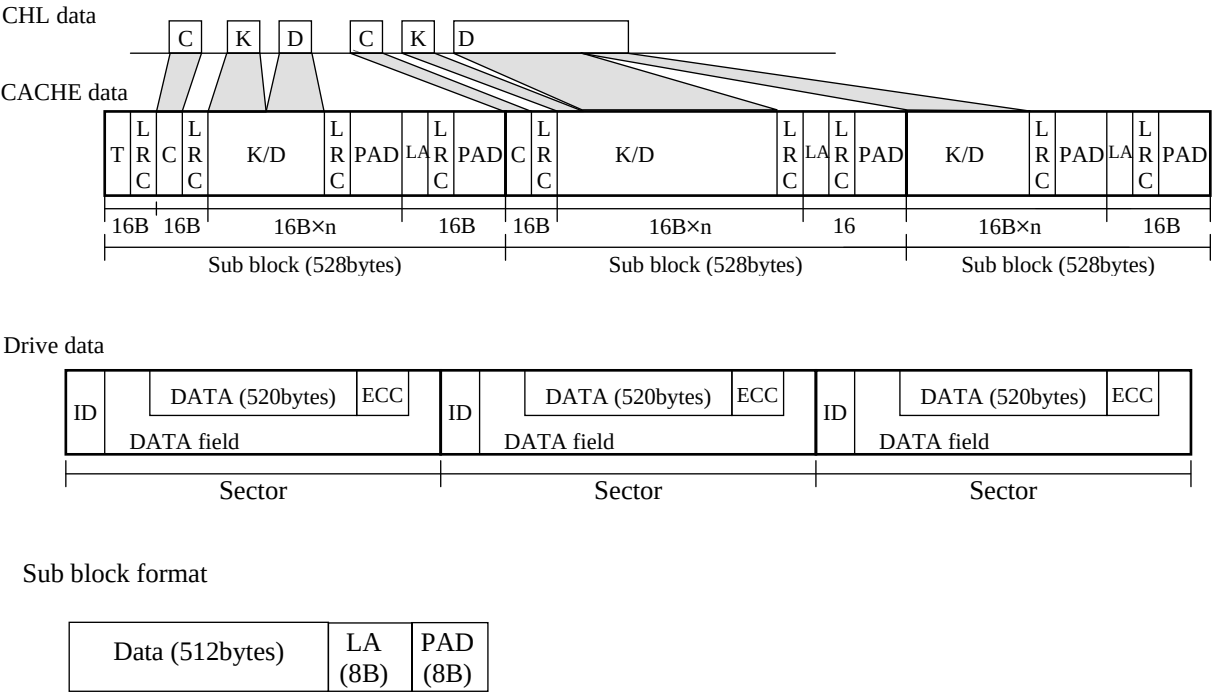
CKD-to-FBA conversion is carried out by the CHA. Data is stored in cache (in the DKC) in the FBA format. Consequently, the drive need not be aware of the data format when transferring to and receiving data from cache.

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

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

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

On a physical drive, data is recorded data fields in 520-byte units (physical data format). The format of the LA in the sub block in cache is shown in Fig. 3.28-1. The last 8 bytes of the LA area are padding data which is insignificant (the reason for this is because data is transferred to cache in 16 byte units). When data is transferred to a drive from cache, the last 8 bytes of each LA area are discarded and 520 bytes are transferred.



(2) Block format

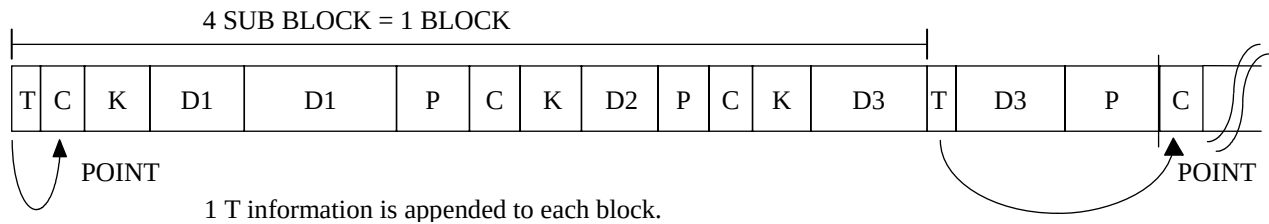


Fig. 3.27-2 Block Format

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

1 block = 4 sub blocks = 2 KB

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

As seen from Fig. 3.27-2, the T information points to the closest count area in its block in the form of an SN (segment number). The drive computes the block number from the sector number with the SET SECT and searches the T information for the target block. From the T information, the drive computes the location of the closest count area and starts processing the block at the count area. This means that the information plays the role of the AM of the conventional disk storage.

(3) Data integrity provided

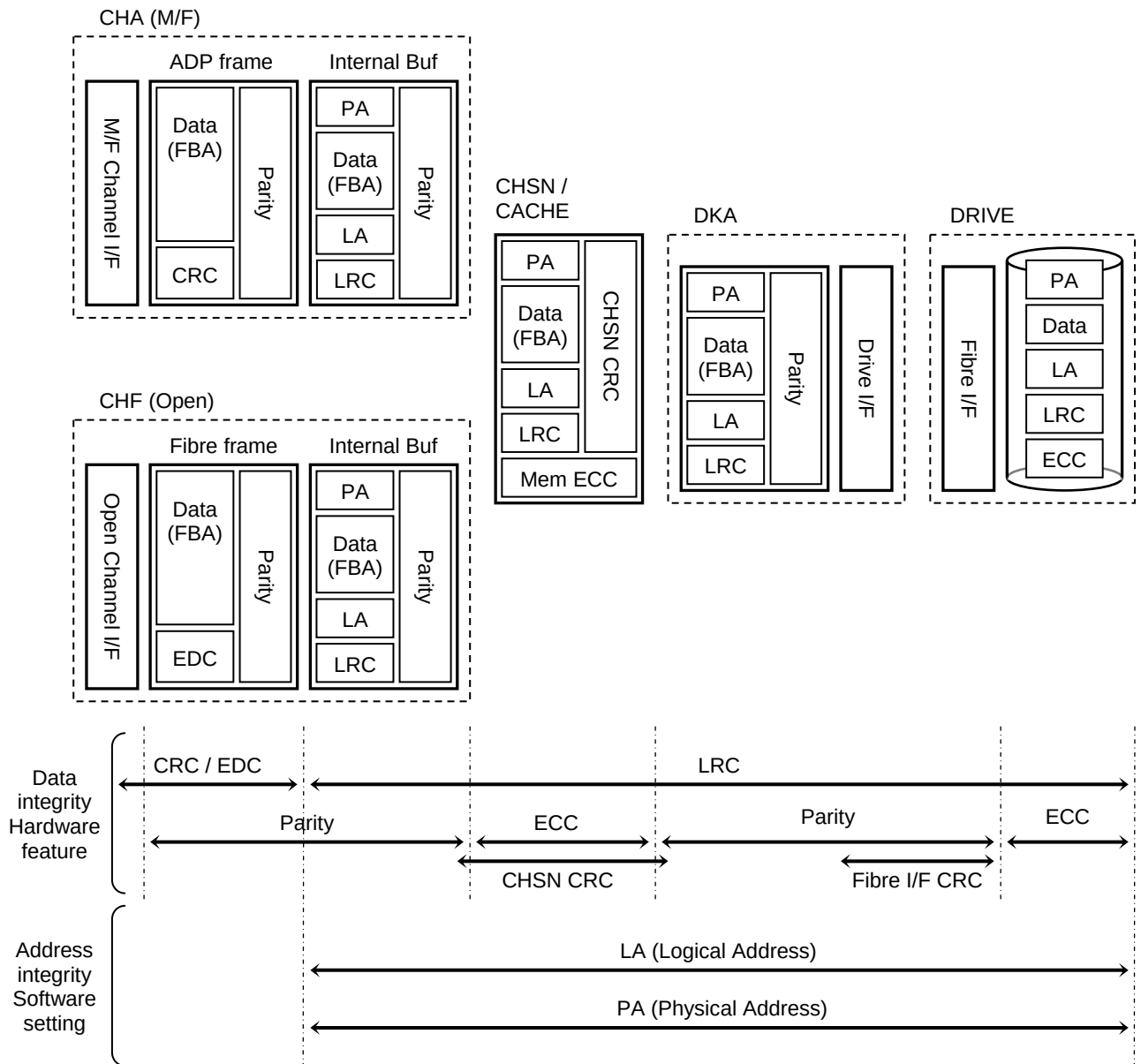


Fig. 3.27-3 Outline of Data Integrity

In the DKC and DKU system, a data integrity code is appended to the data being transferred at each component as shown in Fig. 3.27-3. Since data is striped onto two or more disk devices and the address integrity code is also appended. The data integrity codes are appended by hardware and the address integrity codes by software.

3.28 Cautions when Stopping the Storage system

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

3.28.1 Precautions in a Power Off Mode

NOTICE: Before you turn off the distribution panel breaker or the PDU breaker, make sure to turn off the power of the SVP. (Refer to SVP SECTION “1.8 Power Off” ([SVP01-170](#)))

Do not remove the BKM from the storage system when the storage system has electricity and the BS-ON LED is lit (breakers ON and AC input has electricity). If you do so, the abnormality of the batteries may be detected as the batteries are being charged and have electricity during the BS-ON LED is lit.

If you power on the storage system when the abnormality of the batteries is detected in both the clusters, the storage system is prohibited from starting for a certain period of time (maximum 85 minutes) and the battery charging SIM = FE0000 is generated as cache data backup cannot be performed in the case of power outage.

If the battery charging SIM = FE0000 is generated, follow “3.12 Recovery procedure of SIM occurrence during battery charge (SIM = FE0000)” ([TRBL03-12-10](#)) and perform recovery operation.

Even if the PDU breaker is immediately after turning on, or the equipment is in the state of the power off after the process of the power off is completed, the equipment is in a standby mode. In this standby mode, the AC input is supplied to the power supply in the storage system, and this supplies the power supply to the FANs, the cache memory modules and some PCBs.

Execute the following process when the standby electricity must be controlled, because the standby electricity (*1) exists in the equipment under this condition.

- (1) When the equipment is powered on
Turn on the breaker of each PDU just before the power on processing.
- (2) When the equipment is powered off
After the power off processing is completed, turn each PDU breaker off.
When turning each PDU breaker off, make sure the power off processing is completed in advance. When the breaker is turned off during the power off processing, the battery power is burned and the power on time may take little longer at the next power on processing depending on to the battery charge, because the equipment shifts to the emergency SSD transfer processing of the data with the battery. Moreover, in advance of the turning each PDU breaker off, make sure the AC cables of the other equipment are not connected to the PDU that is turned off.
The management information stored in the memory is transferred to the nonvolatile memory (CFM) in the cache backup Module adapter during the power off process, therefore, leaving the breaker of the PDUs on is needless for the data retention.

*1: Refer to Table 3.28.1-1.

Table 3.28.1-1 Maximum Standby Electricity per Chassis

No.	Chassis	Maximum Standby Electricity [VA]
1	CBXA/CBXB (Controller Chassis)	500
2	SBX (SFF Drive Chassis)	1,120
3	UBX (LFF Drive Chassis)	720
4	FBX (FMD Chassis)	1,280

3.28.2 Operations when a distribution panel breaker is turned off

NOTICE: Before you turn off the distribution panel breaker or the PDU breaker, make sure to turn off the power of the SVP. (Refer to SVP SECTION “1.8 Power Off” ([SVP01-170](#)))

Do not remove the BKM from the storage system even after the storage system is powered off and the breakers on the PDPs or the PDUs are turned off.

If you leave the breakers of the devices off for more than one month, charge the batteries before powering on the storage system at the time of the next startup of the storage system.

Procedure for charging the batteries:

Turn on the breakers on the PDPs and the PDUs, which makes the BS-ON LED lit, and then charge the batteries until the BATTERY CHARGE LED (See LOCATION SECTION ([LOC03-100](#)).) goes from blinking (charge in progress) to solid (charge completed).

(Charging time is up to 30 minutes in the case that the breakers are kept off for more than one month.)

When the distribution panel breaker or the PDU breaker is turned off, execute the operation after making sure that the power supply of the storage system was normally turned off, by confirming the PS was normally turned off according to the Power OFF Event Log (Refer to 3.14.2 Power OFF Procedure in INSTALLATION SECTION.) of SVP.

When the Power OFF Event Log confirmation is impossible, suspend the operation and request customers to restart the storage system to confirm that the PS is normally turned off.

NOTICE: Request the thoroughness in the following operations to the customer if the distribution panel breaker or the PDU is impossible to keep the on-state after the power of the storage system is turned off.

1. Point to be checked before turning the breaker off

Request the customer to make sure that the power off processing of the storage system is completed (READY lamp, MESSAGE lamp and ALARM lamp are turned off) before turning off the breaker.

2. Operation when breaker is turned off for two weeks or more

A built-in battery spontaneously becomes a state of discharge when the distribution panel breaker or PDU breaker is turned off after the storage system is powered off. Therefore, when the breaker is turned off for two weeks or more, charging the built-in battery to full will take a maximum of 4.5 hours. Accordingly, request the customer to charge the battery prior to the restarting of the storage system.

3.29 PDEV Erase

3.29.1 PDEV Erase

3.29.1.1 Overview

When the specified system option (*1) is set, the DKC deletes the data of PDEV automatically in the case according Table 3.29.1.1-2.

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

Table 3.29.1.1-1 Overview

No.	Item	Content
1	SVP Operation	Select system option from “Install”.
2	Status	DKC only reports on SIM of starting the function. The progress status is not displayed.
3	Result	DKC reports on SIM of normality or abnormal end.
4	Recovery procedure at failure	Re-Erase of PDEV that terminates abnormally is impossible. Please exchange it for new service parts.
5	PS off or B/K off	The Erase processing fails. It doesn't restart after PS on.
6	How to stop the “PDEV Erase”	Please execute Replace from the Maintenance screen of the SVP operation, and exchange PDEV that Erase wants to stop for new service parts.

Table 3.29.1.1-2 PDEV Erase execution case

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

3.29.1.2 Rough estimate of Erase time

The Erase time is decided by capacity and the rotational speed of PDEV.

Time is indicated as follows. (Time is a standard and it might take the TOV.)

Table 3.29.1.2-1 PDEV Erase completion expectation time

No.	Kind of PDEV	300GB	400GB	600GB	800GB	900GB	1.2TB	1.6TB	3TB	3.2TB	4TB
1	SAS (7.2krpm)	—	—	—	—	—	—	—	450M	—	480M
2	SAS (10krpm)	—	—	80M	—	120M	140M	—	—	—	—
3	SAS (15krpm)	30M	—	—	—	—	—	—	—	—	—
4	Flash Drive	—	25M	—	50M	—	—	—	—	—	—
5	Flash Module Drive	—	—	—	—	—	—	15M	—	30M	—

Table 3.29.1.2-2 PDEV Erase TOV

No.	Kind of PDEV	300GB	400GB	600GB	800GB	900GB	1.2TB	1.6TB	3TB	3.2TB	4TB
1	SAS (7.2krpm)	—	—	—	—	—	—	—	1135M	—	1410M
2	SAS (10krpm)	—	—	210M	—	340M	370M	—	—	—	—
3	SAS (15krpm)	115M	—	—	—	—	—	—	—	—	—
4	Flash Drive	—	120M	—	150M	—	—	—	—	—	—
5	Flash Module Drive	—	—	—	—	—	—	170M	—	270M	—

3.29.1.3 Influence in combination with other maintenance operation

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

Table 3.29.1.3-1 PDEV Replace

No.	Object part	Influence	Countermeasure
1	Replace from SVP as for PDEV that does PDEV Erase.	PDEV Erase terminates abnormally.	—
2	Replace from SVP as for PDEV that does not PDEV Erase.	Nothing	—
3	User Replace	Please do not execute the user replacement during PDEV Erase.	Please execute it after completing PDEV Erase.

Table 3.29.1.3-2 DKA Replace

No.	Object part	Influence	Countermeasure
1	DKA connected with PDEV that is executed PDEV Erase	[SVP4198W] may be displayed. The DKA replacement might fail by [ONL2412E] when the password is entered. (*2)	<SIM4c2xxx/4c3xxx about this PDEV is not reported> Please replace PDEV (to which Erase is done) to new service parts. (*1) The DKA replacement might fail by [ONL2412E] when the password is entered. (*2)
2	DKA other than the above	Nothing	Nothing

Table 3.29.1.3-3 MPB Replace/MPB Removal

No.	Object part	Influence	Countermeasure
1	MPB that is executed PDEV Erase	[SVP4198W] may be displayed. The MPB replacement might fail by [ONL2412E] when the password is entered. (*2)	<SIM4c2xxx/4c3xxx about this PDEV is not reported> Please replace PDEV (to which Erase is done) to new service parts. (*1) The MPB replacement might fail by [ONL2412E] when the password is entered. (*2)
2	MPB other than the above	Nothing	Nothing

Table 3.29.1.3-4 SSW Replace

No.	Object part	Influence	Countermeasure
1	SSW connected with DKA connected with HDD that does PDEV Erase	[SVP4198W] may be displayed. The SSW replacement might fail by [ONL2788E] [ONL3395E] when the password is entered. (*2)	<SIM4c2xxx/4c3xxx about this PDEV is not reported> Please replace PDEV (to which Erase is done) to new service parts. (*1) The SSW replacement might fail by [ONL2788E][ONL3395E] when the password is entered. (*2)
2	SSW other than the above	Nothing	Nothing

Table 3.29.1.3-5 PDEV installation/Removal

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

Table 3.29.1.3-6 Exchanging microcode

No.	Object part	Influence	Countermeasure
1	DKC MAIN	[SVP0732W] may be displayed. Microcode exchanging might fail by [SMT2433E], when the password is entered. (*2)	Please wait for the Erase completion or replace PDEV (to which Erase is done) to new service parts. (*1)
2	DKU	[SVP0732W] may be displayed. Microcode exchanging might fail by [SMT2433E], when the password is entered. (*2)	Please wait for the Erase completion or replace PDEV (to which Erase is done) to new service parts. (*1)

Table 3.29.1.3-7 LDEV Format

No.	Object part	Influence	Countermeasure
1	ANY	There is a possibility that PATH-Inline fails. There is a possibility that the cable connection cannot be checked when the password is entered.	Please wait for the Erase completion or replace PDEV (to which Erase is done) to new service parts. (*1)

Table 3.29.1.3-8 PATH-Inline

No.	Object part	Influence	Countermeasure
1	DKA connected with PDEV that is executed PDEV Erase	There is a possibility of detecting the trouble by PATH-Inline.	Please wait for the Erase completion or replace PDEV (to which Erase is done) to new service parts. (*1)

Table 3.29.1.3-9 PS/OFF

No.	Object part	Influence	Countermeasure
1	ANY	PDEV Erase terminates abnormally.	<SIM4c2xxx/4c3xxx about this PDEV is not reported> Please wait for the Erase completion or replace PDEV (to which Erase is done) to new service parts. (*1)

*1: When PDEV that stops PDEV Erase is installed into DKC again, it might fail by Spin-up failure.

*2: It is not likely to be able to maintain it when failing because of concerned MSG until HDD Erase is completed or terminates abnormally.

3.29.1.4 Notes of various failures

Notes of the failure during PDEV Erase become as follows.

No.	Failure	Object part	Notice	Countermeasure
1	B/K OFF/ Black Out	DKU BOX	There is a possibility that PDEV Erase fails due to the failure.	Please replace PDEV of the Erase object to new service parts after PS on.
2		DKC BOX	Because watch JOB of Erase disappears, it is not possible to report on normality/abnormal termination SIM of Erase.	Please replace PDEV of the Erase object to new service parts after PS on.
3	MP failure	DKP	[E/C 9470 is reported at the MP failure] JOB of the Erase watch is reported on E/C:9470 when Abort is done due to the MP failure, and ends processing. In this case, it is not possible to report on normality/abnormal termination SIM of Erase.	Please replace PDEV of the Erase object to new service parts after the recovery of MP failure.
4			[E/C 9470 is not reported at the MP failure] It becomes impossible to communicate with the controller who is doing Erase due to the MP failure. In this case, it becomes TOV of watch JOB with E/C:9450, and reports abnormal SIM.	Please replace PDEV to new service parts after judging the Erase success or failure after it waits while TOV of PDEV Erase after the recovery of MP.

3.30 Encryption License Key

3.30.1 Overview of encryption

In DKC810I storage system, you are able to encrypt data stored in volumes in the storage system by using Encryption License Key.

By encrypting data, you can prevent data from being leaked when you replace the storage system or hard disks in the storage system or when these are stolen.

Disk Adapter (DKA) that support encryption is required. DKA type is exchangeable online.

3.30.2 Specifications of encryption

Table 3.30.2-1 shows the specifications of encryption with Encryption License Key.

Table 3.30.2-1 Specifications of encryption with Encryption License Key

Item		Specifications
Hardware spec	Encryption algorithm	AES 256bit
Volume to encrypt	Volume type	Open volumes, mainframe volumes, multiplatform volumes
	Emulation type	All emulation types
Encryption key management	Unit of creating encryption key	PDEV
	Number of encryption keys	4,096
	Type of encryption keys	DEK (Disk Encryption Key) CEK (Certificate Encryption Key) KEK (Key Encryption Key)
	Unit of setting encryption	RAID group
Converting non-encrypted data/encrypted data	Encryption of existing data	Convert non-encrypted data/encrypted data for RAID group in which encryption is set by using the existing function (Volume Migration, ShadowImage etc.).

3.30.3 Notes on using Encryption License Key

Please note the following when using Encryption License Key.

Table 3.30.3-1 Notes on Encryption License Key

#	Item	Content
1	Volumes to encrypt	Only internal volumes in the storage system can be encrypted with Encryption License Key. External volumes cannot be encrypted.
2	LDEV format	You cannot perform high-speed format (drive format) for disks under RAID group in which encryption is set. Time required for LDEV format performed for the RAID group in which encryption is set depends on the number of RAID groups.
3	Encryption/ non-encryption status of volumes	When encrypting user data, set encryption for all volumes in which the data is stored in order to prevent the data from being leaked. Example : In the case a copy function is used, and when encryption is set for P-VOL, set it also for S-VOL. When encryption is set for P-VOL, and non-encryption is set for S-VOL (or vice versa), you cannot prevent data on the non-encrypted volume from being leaked.
4	Convert non-encrypted data/ encrypted data	The specifications of converting non-encrypted data/encrypted data comply with the specifications of the copy function (Volume Migration, ShadowImage etc.) used for conversion.
5		In the case of Volume Migration, you cannot perform such an auto migration that would switch encryption/non-encryption status.
6	Switch encryption setting	When you switch the encryption setting of RAID group, you need to perform LDEV format again. To switch the encryption setting, back up data as necessary.
7	[Protect the Key Encryption Key at the Key Management Server] Check Box	When you select [Protect the Key Encryption Key at the Key Management Server] Check Box, the KEK is stored in the key management server. Registration of 2 key management servers is required for this operation. When you perform PS ON for the DKC, the SVP gets the key from the key management server. Therefore, the communication between the SVP and the key management server should be available. Before you perform PS ON for the DKC, make sure that the communication between the SVP and the key management server is available.

3.30.4 Creation of encryption key

An encryption key is used for data encryption and decryption. 4,096 encryption keys can be created in a storage system. When Security Administrator completes Encryption Environmental Settings, the storage system creates the maximum number of encryption keys automatically.

Encryption key is needed when installing new drives, replacing drives, replacing DKA and rekeying Certificate Encryption Key (CEK). Customer's Security Administrator have to create encryption keys as the number of keys comes down.

Only customer's Security Administrators are able to create encryption keys.

In the following cases, however, creation of encryption key is inhibited to avoid data corruption.

- Due to a failure in the storage system, the storage system does not have any encryption key but it has a RAID group in which encryption is set.
In this case, restore the backed up encryption key.

3.30.5 Backup of encryption key

There are two types of encryption key backup; backup within the storage system and backup outside the storage system. In the case of backup within the storage system, the encryption key is backed up in the flash memory in the storage system. In the case of backup outside the storage system, it is backed up in the machine in which Storage Navigator is running (Storage Navigator PC).

- Backup within the storage system
Encryption key created on SM is backed up in the flash memory in the storage system.
Encryption key is automatically backed up within the storage system at the time it is created, deletion, a state are changed.
- Backup outside the storage system
Encryption key created on SM is backed up in the Storage Navigator PC. Backup outside the storage system is performed when requested by the user from Storage Navigator.

3.30.6 Restoration of encryption key

There are two types of encryption key restoration, restoration from backup within the storage system and restoration from backup outside the storage system.

- Restoration from backup within the storage system

When the encryption key on SM cannot be used, the encryption key backed up within the storage system is restored.

Restoration from backup within the storage system is automatically performed in the storage system.

- Restoration from backup outside the storage system

When encryption keys including the encryption key backed up within the storage system cannot be used in the storage system, the encryption key backed up outside the storage system is restored.

Restoration from backup outside the storage system is performed when requested by the security administrator from Storage Navigator.

3.30.7 Setting and releasing encryption

You can set and release encryption by specifying a RAID group. Set and release encryption in the Parity Group list window in Storage Navigator.

NOTE: • Encryption can be set and released only when all volumes that belong to the RAID group are blocked, or when there is no volume in the RAID group.

When the RAID group contains at least one volume that is not blocked, you cannot set and release encryption.

- When you switch the encryption setting, you need to perform LDEV format again. Therefore set encryption before formatting the entire RAID group when installing RAID groups etc.

3.30.8 Encryption format

To format a RAID group in which encryption is set, format the entire disk area by writing encrypted 0 data in the entire disk area. This is called Encryption format.

When encryption is set for a RAID group, encryption format is needed before user data is written.

When encryption is released, normal format is needed before user data is written.

NOTE: Encryption format can be performed only when all volumes in the RAID group can be formatted. When at least one volume cannot be formatted, encryption format cannot be performed.

3.30.9 Converting non-encrypted data/encrypted data

To encrypt existing data, create a RAID group in which encryption is set in advance and use a copy Program Product, such as Volume Migration, and ShadowImage, to convert data. Data conversion is performed per LDEV.

The specifications of converting non-encrypted data/encrypted data comply with the specifications of the copy function (Volume Migration, ShadowImage etc.) used for conversion.

3.30.10 Deleting encryption keys

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

3.30.11 Reference of encryption setting

You can check the encryption setting (Encryption: Enable/Disable) per RAID group from [Install]-[Refer Configuration] 'Device Emulation Configuration' screen of SVP or Parity Groups screen of Storage Navigator.

3.31 global virtualization

global virtualization is a function to realize virtualization.

By responding virtual information to the server (INQUIRY response of SCSI commands), multiple storage systems can be recognized by the server as one virtual storage machine (*1).

By installing P.P. license of Resource Partition Manager contained in SVOS (Storage Virtualization Operating System), the virtualization function can be used.

*1: Virtual storage machine is a group by the unit of virtual device (serial number) to manage virtualized resources.

The P.P. which used the virtual function of global virtualization is as shown below. For the descriptions of the following P.P., refer to the subsequent sections.

- nondisruptive migration
- Global-active device

3.31.1 nondisruptive migration

3.31.1.1 Outline

nondisruptive migration is a P.P. for data migration to replace storage systems.

If nondisruptive migration is used, data including the P.P. configuration can be migrated while remaining the online tasks. Even when a new storage system is implemented in the future, multiple storage systems can be accessed from the server as one virtual storage machine.

Fig. 3.31.1.1.-1 is a concept diagram that data of a ShadowImage pair of the migration source is migrated to the migration target in the circumstances that the ShadowImage pair on a virtual storage machine is recognized.

The source storage systems can be removed after data migration, and replacement can be done without affecting server tasks.

Effects of data migration (*1) by nondisruptive migration are as shown below.

1. P.P. migration (P.P. can be migrated in concert with data migration.)
2. Operability (No user intervention during data migration.)
3. Permanent operation (The virtual storage machine enables Raid replacements for generations.)
4. Duplication (Write data is guaranteed during data migration.)

*1: Data of virtual volumes of Dynamic Provisioning and Dynamic Tiering or data of external volumes can be migrated.

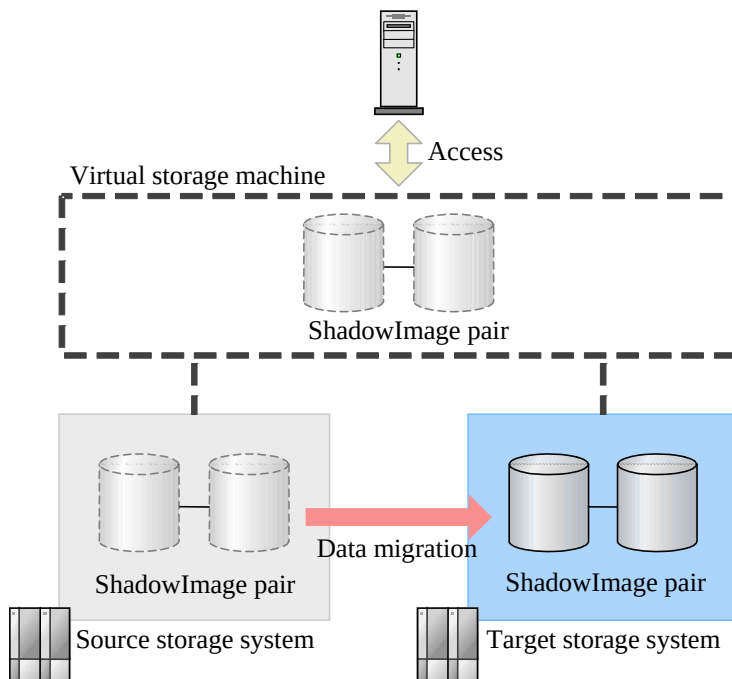


Fig. 3.31.1.1-1 nondisruptive migration function
(data migration of a ShadowImage pair)

THEORY03-31-30**3.31.1.2 Data migration**

The flow that data is migrated from a source storage system to a target storage system is as shown below.

Table 3.31.1.2-1 Procedure of data migration

#	Target part	Work to do	Note	Who to do
1	Common	Judgment to apply the solution		Person in charge of solution
2		Making an arrangement of required components		
3		Preliminary survey		
4		Estimation of work time		
5	Source storage system	Acquiring source storage system configuration information	Acquire the configuration information of the source MM-DKC/R-DKC when the P.P. configuration exists in the source storage system.	Person in charge of solution
6	Common	Preparation of storage system	Installing DKC810I.	Maintenance personnel
7		SAN environment configuration	Setting physical paths.	
8		Raid Manager Version up		
9	Target storage system	Environment configuration of the target storage system	• Create a virtual storage machine in the target storage system. • Reserve LDEV IDs of the target volumes in the virtual storage machine. • Map the source volume to the target storage system. • Create the target volumes from external volume group • Acquire the configuration information of the target M-DKC/R-DKC when the P.P. configuration exists in the target storage system.	Person in charge of solution
10	Server (primary)	Switching alternative paths (online)	• Switch I/O of the server from the source storage system to the target storage system. • Switch the cache mode.	Server administrator
11	Target M-DKC	Environment configuration of target storage system (cache mode change)		Person in charge of solution
12	Target storage system	Construction of P.P. configuration	Execute only when the P.P. configuration exists in the source storage system.	Person in charge of solution
13	Server (secondary)	Switching alternative paths (offline)	Execute only when the P.P. configuration exists in the source storage system.	Person in charge of solution
14	Target M-DKC	Data migration by creating Volume Migration pairs		Person in charge of solution
15	Common	Removal of environment created for migration		Person in charge of solution
16	Common	Removal of unnecessary SAN environment		Maintenance personnel
17		Removal of the source M-DKC/R-DKC		

3.31.1.2.1 System configuration example and components for data migration

Fig. 3.31.1.2.1-1 and Table 3.31.1.2.1.-1 explain the system configuration example and components for data migration.

NOTE: ① ~ ⑧ in Fig. 3.31.1.2.1-1 correspond to the item numbers of Table 3.31.1.2.1.-1.

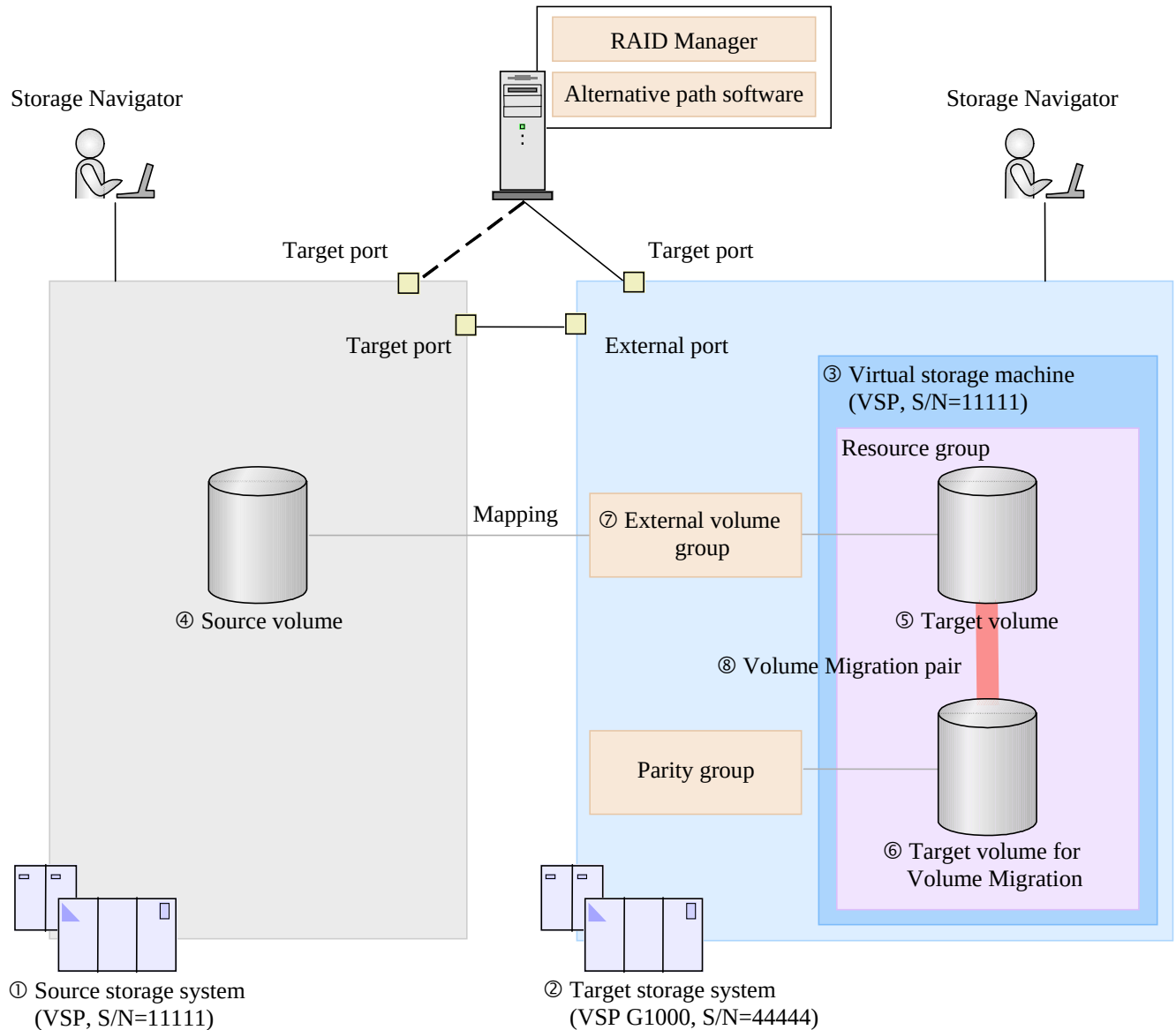


Fig. 3.31.1.2.1-1 System configuration example for data migration

Table 3.31.1.2.1-1 Components for data migration

#	Item	Composition	Note
①	Storage system	Source storage system	Corresponding storage system and applicable micro program version : DKC710I (70-06-00-XX/XX or later) DKC610I (60-08-20-XX/XX or later)
②	Storage system	Target storage system	Corresponding storage system and applicable micro program version : DKC810I (80-01-2X-XX/XX or later)
③	Storage system	Virtual storage machine	Create in the target storage system. The model name and serial number of the virtual storage machine are the same as those of the source storage system. Multiple resource groups can be created in a virtual storage machine.
④	Volume	Source volume	It is also the source volume of the Volume Migration pair. Use the following volumes as the source volume. • The volume whose emulation type is OPEN-V or OPEN-3/8/9/E/K/L • The volume is less than 4TB • LUSE volume • Virtual volume for Dynamic Provisioning • External volume • The volume configured Reserve or Persistent Reserve from the server (DKC610I or DKC615I)
⑤	Volume	Target volume	Use the following volumes as the target volume. • The volume whose emulation type is OPEN-V • The volume is less than 4TB • Virtual volume for Dynamic Provisioning • External volume
⑥	Volume	The target volume of the Volume Migration pair	It is the internal volume of the target storage system. Data is migrated by swapping with the target group created from the external volume group.
⑦	External volume group	External volume group	It is used when the source volume is mapped to the target volume. Create the target volume from the external volume group which was created in the target storage system.
⑧	Pair	Volume Migration pair	It is used to migrate the data from the external volume which was created in the target storage system to the internal volume created in the target storage system.

3.31.1.3 P.P. used in combination with nondisruptive migration

Table 3.31.1.3-1 shows P.P. used in combination with nondisruptive migration.

Table 3.31.1.3-1 P.P. usable with nondisruptive migration

#	Item	Reference for outline
1	Dynamic Provisioning	3.31.1.3 (1)
2	Dynamic Tiering	3.31.1.3 (2)
3	ShadowImage	3.31.1.3 (3)
4	TrueCopy	3.31.1.3 (4)
5	Universal Replicator	3.31.1.3 (5)
6	Universal Volume Manager	3.31.1.3 (6)
7	Thin Image	3.31.1.3 (7)

(1) Dynamic Provisioning

Data of Dynamic Provisioning virtual volume can be migrated.

However, the target volume does not take over page assignment status of the source volume.

When migrating data of Dynamic Provisioning virtual volume, prepare a pool exceeding capacity of the target virtual volume.

(2) Dynamic Tiering

Data of Dynamic Tiering virtual volume can be migrated. However, the target volume does not take over the page I/O load information and the tier structure of the source volume.

When migrating data of Dynamic Tiering virtual volume, prepare a pool exceeding capacity of the target virtual volume.

(3) ShadowImage

Data of the primary volume of a ShadowImage pair can be migrated. By designating the same consistency group number as the target storage system to create a ShadowImage pair on the target storage system, information of the consistency group can be migrated at the same time.

However, the pair status is not taken over.

Secondary volume data of the ShadowImage pair cannot be migrated either. Because the ShadowImage pair is created in the target storage system after the primary volume data is copied from the source storage system to the target storage system, the pair status at the completion of data migration is PAIR.

Also, differential information between the primary volume and the secondary volumes is not taken over either.

The ShadowImage pair structure whose data can be migrated at a time is as follows.

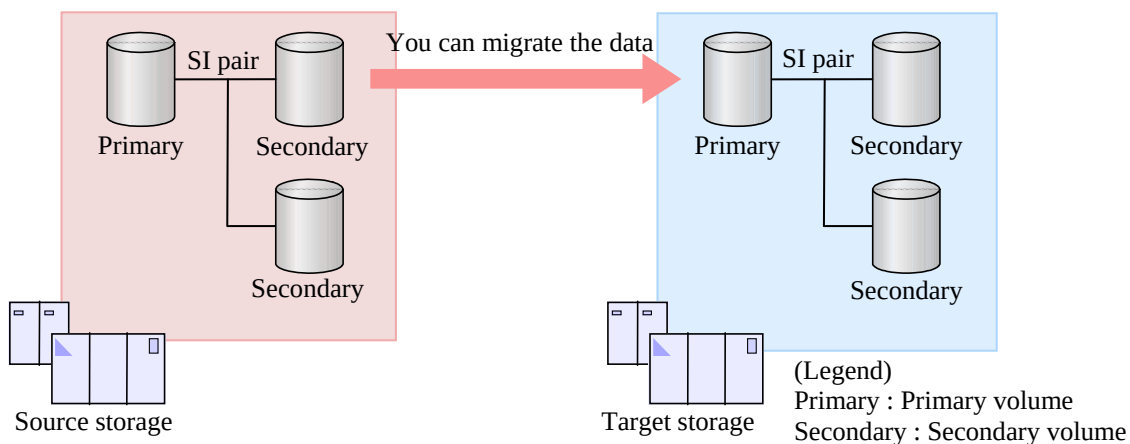


Fig. 3.31.1.3-1 ShadowImage
(Example of the configuration which can be migrated at a time)

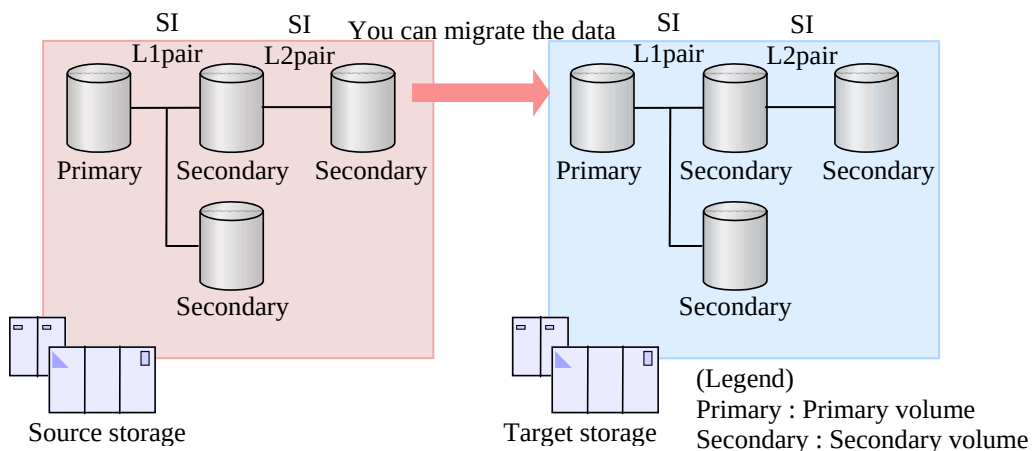


Fig. 3.31.1.3-2 ShadowImage
(Example of the cascade configuration which can be migrated at a time)

(4) TrueCopy

You can migrate data in the volumes that make up a TrueCopy pair.

However, the pair status is not taken over. Because a TrueCopy pair is created in the target storage system after the primary volume data is copied from the source storage system to the target storage system, the pair status at the completion of data migration is PAIR.

Also, differential information between the primary volume and the second volumes is not taken over either.

After the primary volume data is copied from the source storage system to the target storage system, and then a TrueCopy pair is created in the target storage system. Data duplication can be maintained during migration.

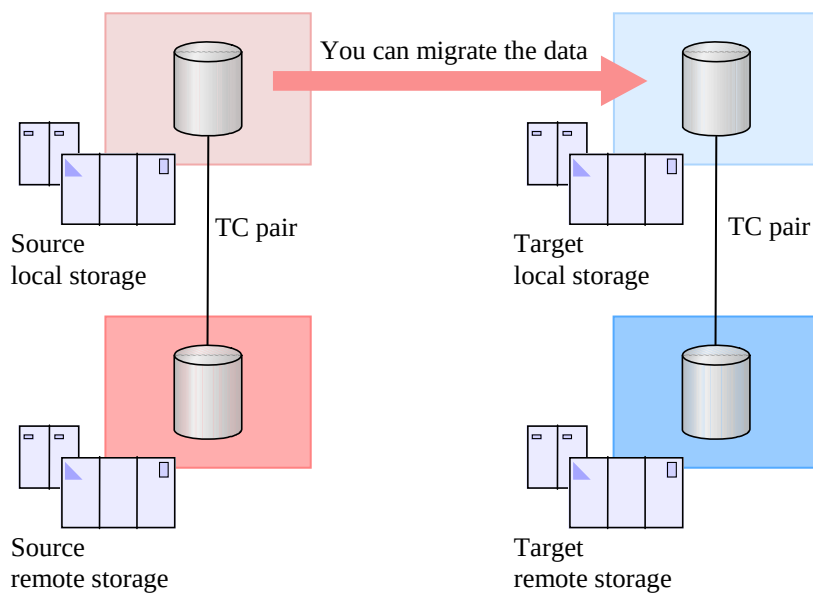


Fig. 3.31.1.3-3 TrueCopy (Configuration example 1 for data migration)

You can create the target secondary volumes in the storage system of the source secondary volumes.

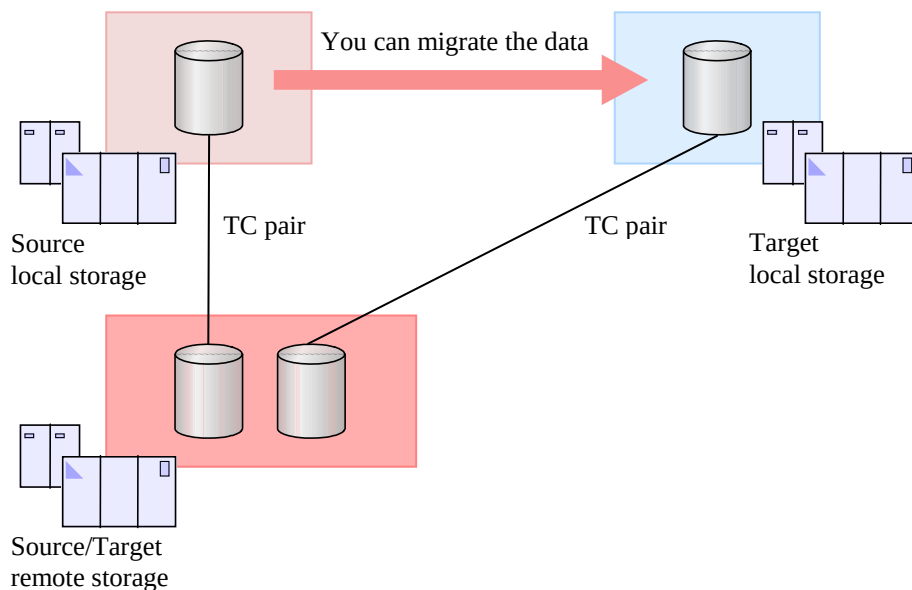


Fig. 3.31.1.3-4 TrueCopy (Configuration example 2 for data migration)

NOTE: You cannot only migrate data in either the primary volume or the secondary volume.

(5) Universal Replicator

You can migrate data in the volume that make up a Universal Replicator pair.

However, the pair status is not taken over.

Because a Universal Replicator pair is created in the target storage system after the primary volume data is copied from the source storage system to the target storage system, the pair status at the completion of data migration is PAIR.

Also, differential information between the primary volume and the secondary volumes is not taken over either.

After the primary volume data is copied from the source storage system to the target storage system, and then a Universal Replicator pair is created in the target storage system. Data duplication can be maintained during migration

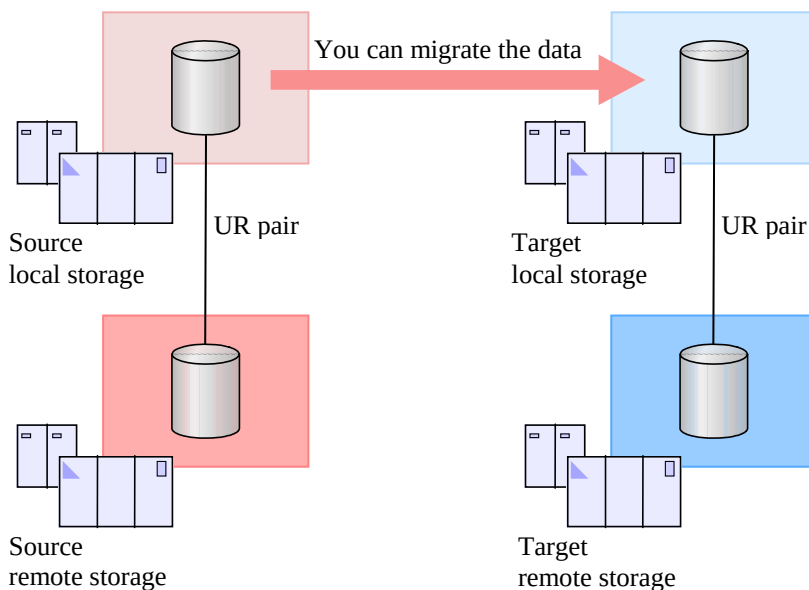


Fig. 3.31.1.3-5 Universal Replicator (Configuration example 1 for data migration)

You can create the target secondary volumes in the storage system of the source secondary volumes.

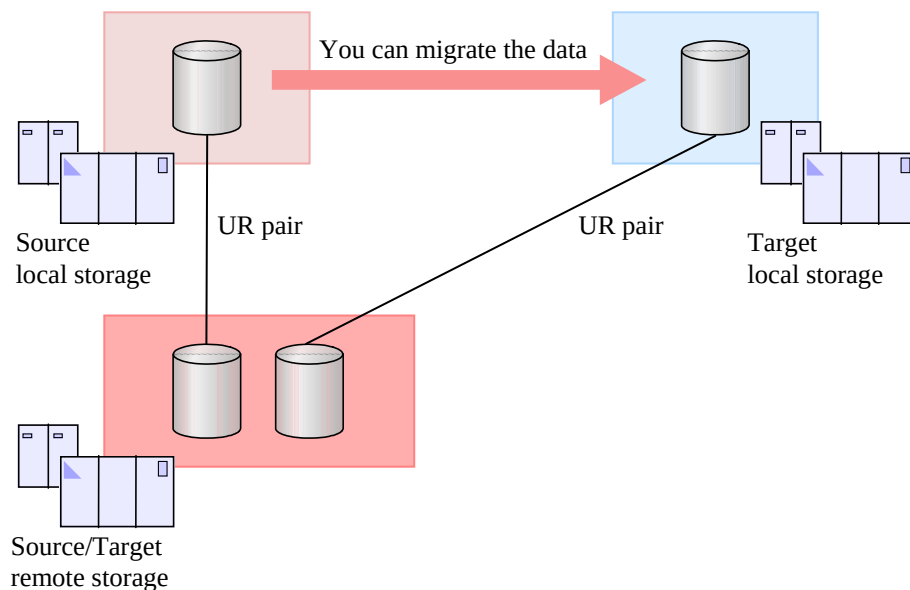


Fig. 3.31.1.3-6 Universal Replicator (Configuration example 2 for data migration)

NOTE: You cannot only migrate data in either the primary volume or the secondary volumes.

(6) Universal Volume Manager

You can migrate external volume data of the source storage system.

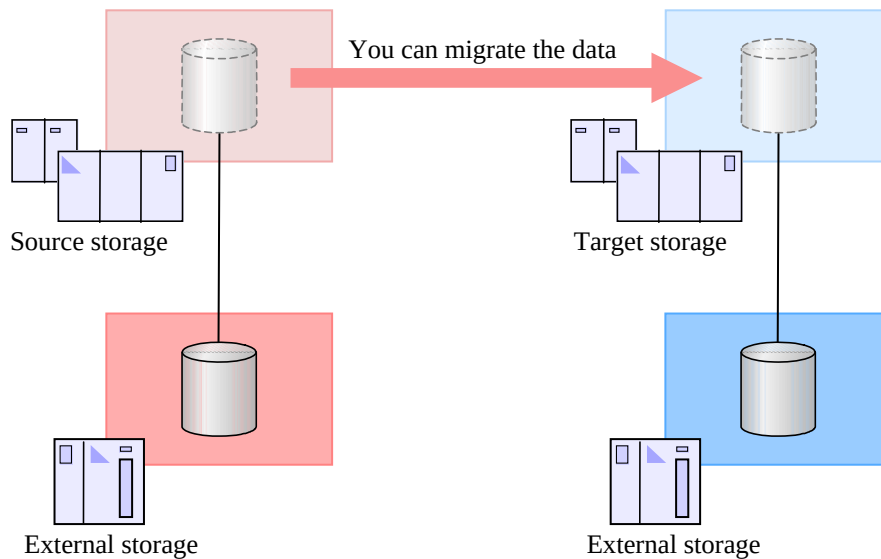


Fig. 3.31.1.3-7 Universal Volume Manager
(Configuration example for data migration)

NOTE: If the source storage system and the target storage system share the same external storage system, you cannot migrate the data.

(7) Thin Image

You cannot migrate data in the volumes that make up Thin Image pair and Copy-on-Write Snapshot pair. Form a Thin Image pair after completing the data migration.

3.31.2 Global-active device

3.31.2.1 Global-active device configuration

The configuration of global-active device (GAD) is shown below.

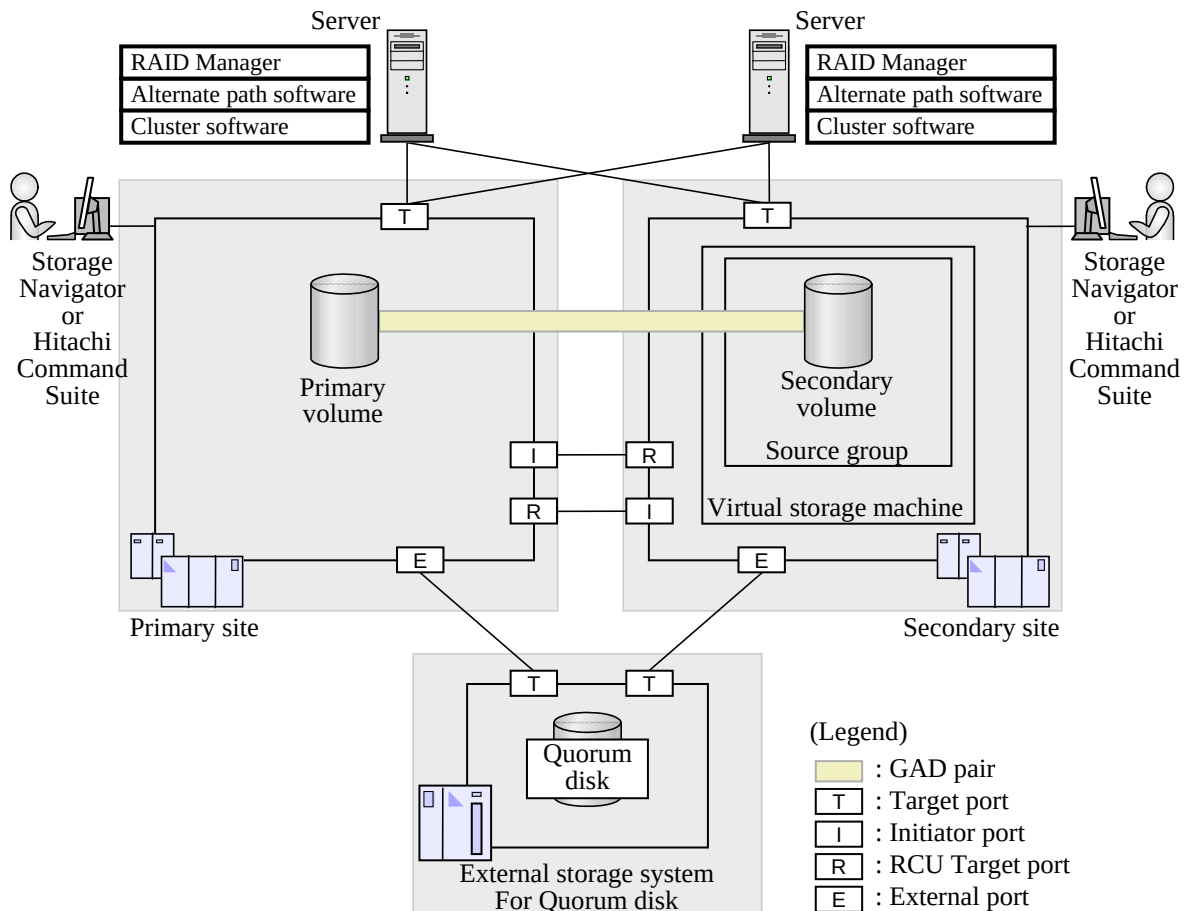


Fig 3.31.2.1-1 Global-active device configuration

(1) Storage system

Install DKC810I in both primary and secondary sites. Also, an external storage system is required to place Quorum disk.

Set the emulation type of the primary and secondary sites to the same.

For the external storage system of Quorum disk, use a storage system which can use Universal Volume Manager.

NOTE: Global-active device licenses are needed for the storage systems of the primary and secondary sites.

NOTE: The maximum distance that can connect between storage systems of the primary and secondary sites is 100 km.

NOTE: The maximum distance that can connect the external storage systems for the Quorum disk between the primary and secondary sites is 1,500 km.

(2) Pair volume

A GAD pair consists of one primary volume and one secondary volume. When a GAD pair is created in the storage system of the primary site, a volume in the primary site is the primary volume, and a volume in the secondary site is the secondary volume.

NOTE: Set the both primary and secondary volumes to be the virtual volumes of DynamicProvisioning.

NOTE: Configure the pair volume in the virtual storage machine that has the same model and serial number as DKC810I in either one of the primary or secondary volumes.

NOTE: Set the emulation type of the primary and secondary volumes to OPEN-V.

NOTE: Set the primary and secondary volumes to be the same capacity.

NOTE: The maximum capacity of the primary and secondary volumes is 4,194,304.000 MB (8,589,934,592 blocks).

(3) Quorum disk

Quorum disk is used to decide which storage system continues I/O from servers when a failure occurs in a path or a storage system. Install Quorum disk in an external storage system.

Quorum disk is necessary to use GAD.

The specification of Quorum disk is as follows.

- Up to 32 Quorum disk can be set per one storage system of the primary or secondary site.
- Quorum disk ID can be the value from 0 to 31.
- Maximum 65,280 GAD pairs per Quorum disk can be created.
- Set OPEN-V for the emulation type of Quorum disk.
- The minimum capacity of Quorum disk is 12,292 MB (25,174,016 blocks).
- There is no limitation for the maximum capacity of Quorum disk. However, as Quorum disk is the volume of the external storage system, the maximum capacity (4TB) of the external volume of Universal Volume Manager is applied.
- It must be set to be the volume mapped to one external volume group.

(4) Virtual storage machine

It is a virtual storage machine created in a storage system. GAD creates a virtual storage machine, which has the same model and serial number as the storage system of the primary site, in a storage system of the secondary site so that servers recognize them as one virtual storage machine.

The specification of the virtual storage machine is as follows.

- Maximum 8 virtual storage machines can be set in one storage system.
- Maximum 65,280 volumes can be set in one virtual storage machine.

NOTE: If 65,280 volumes are set in one virtual storage machine, no volume can be set in other virtual storage machines.

(5) Path and port

Physical paths connect between servers and storage systems and between each storage system.

- The port of storage systems of the primary and secondary sites connected to servers is Target port.
- Configure Initiator ports and RCU Target ports so that data can be sent and received in storage systems of the primary and secondary sites.
- The port used to connect to an external storage system is External port. For communication between storage systems, not only physical paths but logical paths (remote paths and external paths) must be configured. A bidirectional path setting is needed between storage systems of the primary and secondary sites (maximum 8 paths per site).

(6) Alternate path software

Alternate path software is software to achieve redundancy of a path from a server to a volume and to distribute workloads between paths. It is needed to form GAD configuration with one server or cross path configuration with two servers.

(7) Cluster software

Cluster software is software to constitute one system with multiple servers, and to switch tasks to other servers when a failure occurs in a server. It is needed to form a GAD configuration with two servers.

(8) RAID Manager

It is an interface to operate a storage system by CLI to be installed in a server. It is used to construct virtual storage machines and to operate paths, ports, and Quorum disk. Also, it is used for a GAD pair operation.

(9) Storage Navigator

It is an interface to operate storage systems by GUI. A client PC accesses a storage system. It is used for a GAD pair operation and a performance monitoring.

(10) Hitachi Command Suite

Hitachi Command Suite can also be used to operate GAD.

3.31.2.2 Purpose and system configuration of GAD

Purpose and system configuration of GAD are as follows.

Table 3.31.2.2-1 Purpose and system configuration of GAD

#	Purpose	Process description	Software to be used		Configuration name
			Alternate path software	Cluster software	
1	Continuous server I/O (at failure occurrence in the storage system)	When a failure occurs in one storage system used by GAD, I/O from servers can be continued in the other storage system.	Yes	No	Single server configuration
2	Failover/failback of a server without operating a storage system	When using two servers, failover and failback are available by using the cluster software of servers. Suspending or resynchronizing of GAD pairs in the storage system is not required.	No	Yes	Server cluster configuration
3	Movement of a virtual machine in a server without operating a storage system	When a workload of a virtual machine in one server is high, the virtual machine only can be moved to the server of the secondary site without operating the storage system. Using the virtualization function of the server, the virtual machine is moved from the primary site server to the secondary site server. As the same data is stored in the primary and secondary volumes of the GAD pair, it is unnecessary to migrate data in storage systems.	No	Yes	Server cluster configuration
4	Both of the following • Continuous server I/O (at failure occurrence in the storage system) • Failover/failback of a server without operating a storage system	—	Yes	Yes	Cross path configuration
Yes : Required No : Not Required					

(1) Single server configuration

One server is connected to storage systems in the primary and secondary sites. When a failure occurs in one storage system, I/O from the server can be switched to the other site by using alternate path software.

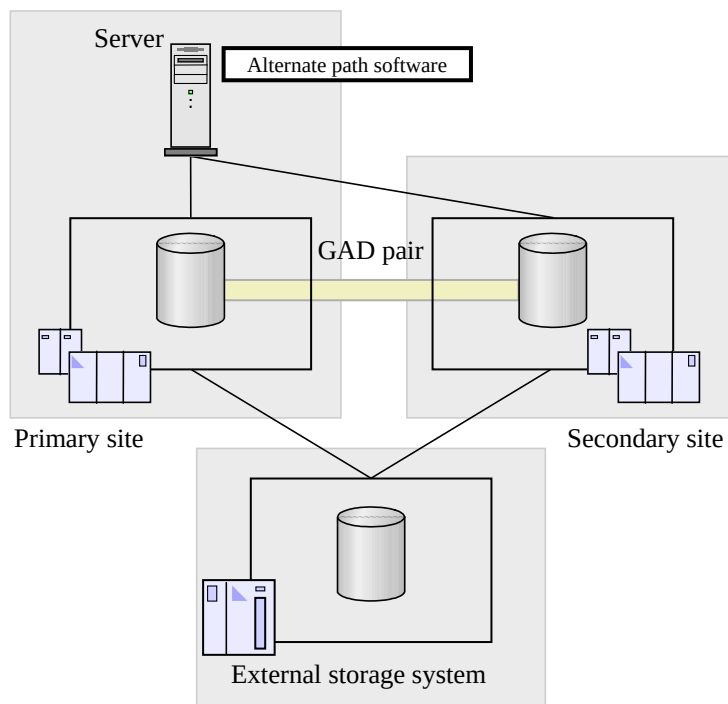


Fig. 3.31.2.2-1 Single server configuration

(2) Server cluster configuration

The server in the primary site is connected to the storage system in the primary site, and the server in the secondary site is connected to the storage system in the secondary site. Use the cluster software to failover and failback servers. Also, when a workload of a virtual machine in one server is high, the virtual machine can be moved to the other server to distribute the workload.

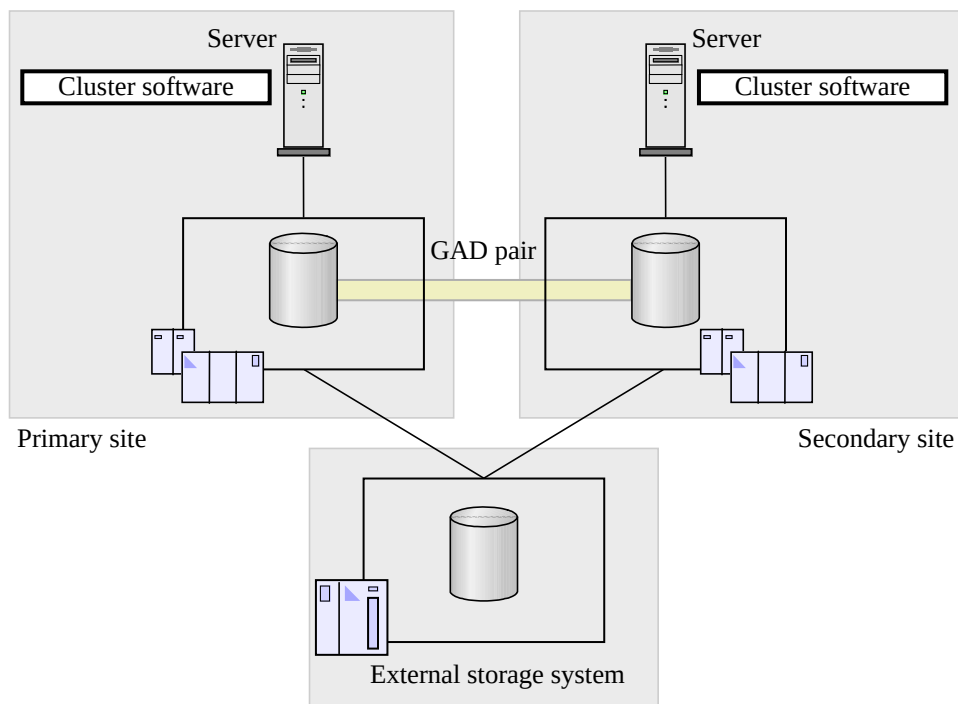


Fig. 3.31.2.2-2 Server cluster configuration

(3) Cross path configuration

Each server of the primary and secondary sites is connected to both storage systems of the primary and secondary sites.

When a failure occurs in one storage system, I/O from servers can be switched to the other site by using the alternate path software. Also, use the cluster software to failover and failback servers.

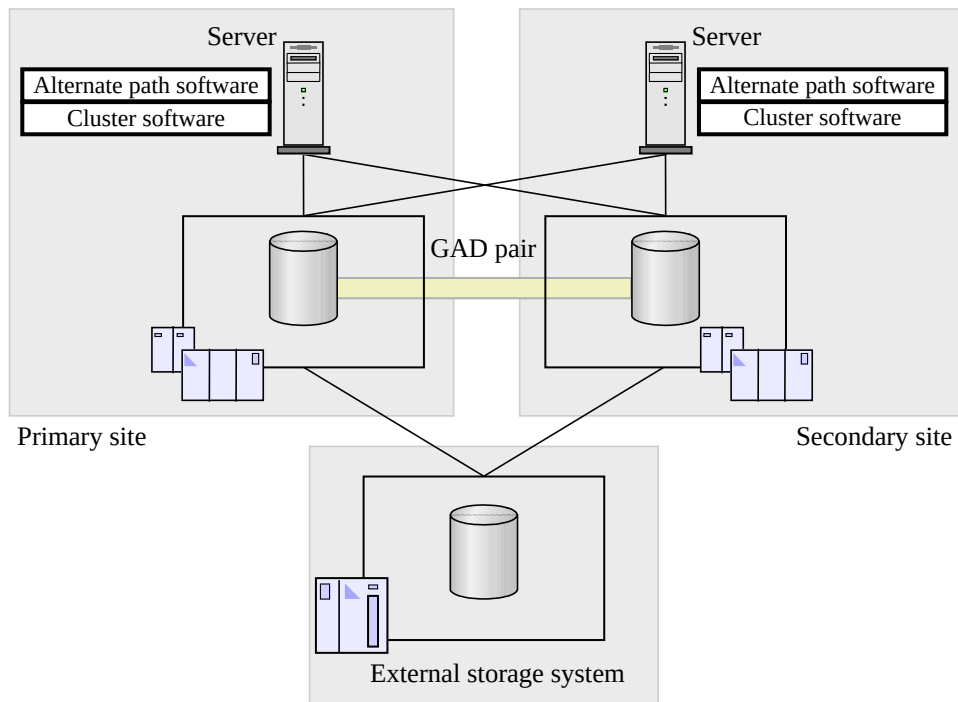


Fig. 3.31.2.2-3 Cross path configuration

3.31.2.3 GAD state management

GAD is managed by the following states and mode.

Table 3.31.2.3-1 GAD state management

GAD state	State of GAD. It is decided by combination of the pair state and the I/O mode. It is not shown in RAID Manager and Storage Navigator.
Pair state	Pair status of the primary and secondary volumes. It is shown in RAID Manager and Storage Navigator.
I/O mode	I/O mode of the primary and secondary volumes. It is shown in RAID Manager and Storage Navigator.

(1) GAD state

GAD has the following five states. These states are called GAD states.

Table 3.31.2.3-2 GAD state

GAD state	Explanation	Data duplication	Updated volume that has the copy completed area	The volume having the latest data (*1)
Initial	State before creating a GAD pair.	No	—	—
Duplicating	It transits to the duplication state. There are the following two kinds of states. • Preparing Quorum Disk. • Copying data from the primary volume to the secondary volume of a GAD pair.	No	Primary and secondary	Primary
Duplication	State where a GAD pair runs normally.	Yes	Primary and secondary	Primary and secondary
Suspension	State where a GAD pair is suspended. Either one of the primary or secondary volume has the latest data, and I/O from servers will be established only for the volume of the latest data. When a failure occurs or the pair is suspended, the GAD state is changed to suspension.	No	Primary or secondary	Primary or secondary
Block	State where I/O from servers to a volume of a GAD pair is not accepted. There are the following two kinds of states. • Status that both primary and secondary volumes have the latest data, and in which I/O from servers can be restarted in either one of volumes by forced deletion of GAD pairs. • State where a failure occurs in a storage system of the primary or secondary site and the other volume's I/O from servers is stopped. The GAD state is changed to block when multiple failures concurrently occur.	No	None	Primary and secondary
Yes : Data is duplicated. No : Data is not duplicated. Primary : the primary volume Secondary : the secondary volume — : Not applicable *1 : For how to decide which volume is the latest, the primary or the secondary, refer to Table 3.31.2.3-5.				

(2) Transition of GAD state

GAD state changes depending on pair operations or failures. Transition of the GAD state is as follows.

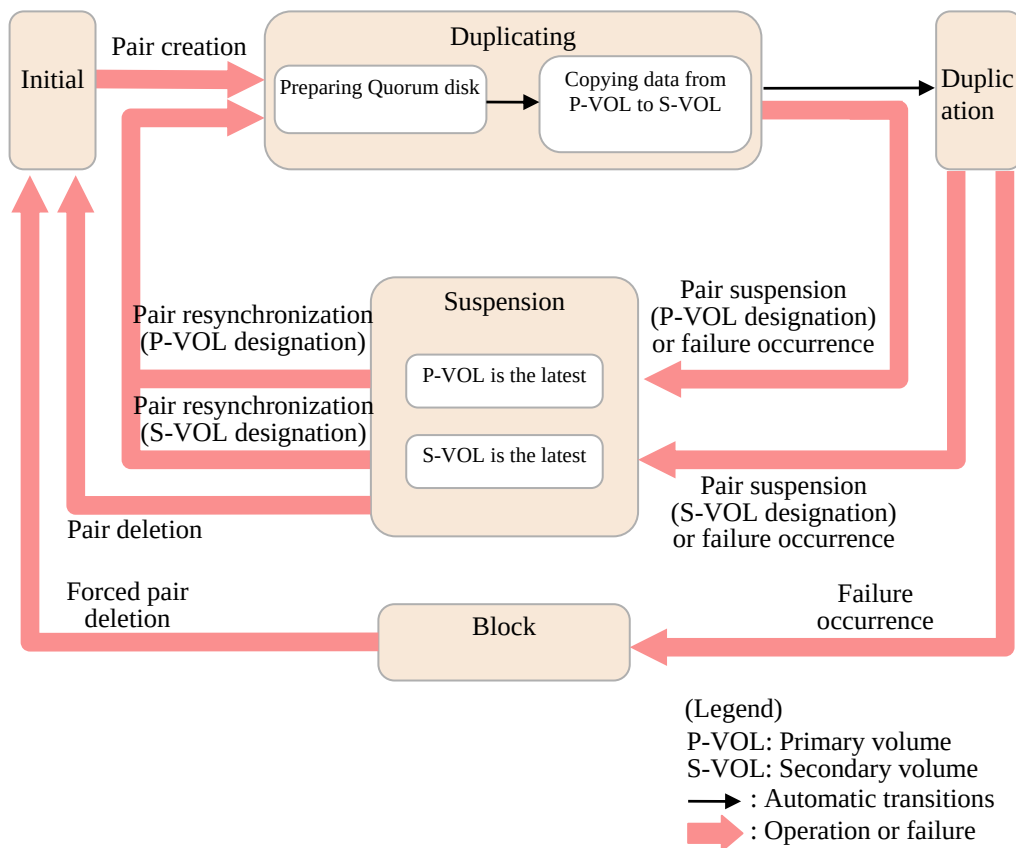


Fig. 3.31.2.3-1 Transition of GAD state

When the primary volume is designated to suspend the pair, I/O from servers continues in the primary volume. When the secondary volume is designated to suspend the pair, I/O from servers continues in the secondary volume.

When the primary volume is designated to resynchronize the pair from the state where the primary volume is designated to suspend the pair, the pair is resynchronized with continuing I/O from servers in the primary volume.

When the secondary volume is designated to resynchronize the pair from the state where the secondary volume is designated to suspend the pair, the primary volume is switched with the secondary volume to resynchronize the pair with continuing I/O from servers in the new primary volume.

When data copying is completed from the primary volume to the secondary volume to establish a duplication state, the secondary volume is able to accept I/O from servers.

(3) GAD pair state

Pair state is a volume state that the primary and secondary volumes have respectively.

Table 3.31.2.3-3 GAD pair state

Pair state		Explanation
Expression in RAID Manager	Expression in Storage Navigator	
SMPL	SMPL	Volume which does not form a GAD pair.
COPY	INIT/COPY	This volume executes initial copy or resynchronizes a GAD pair. (including creation of GAD pairs without copying data) Quorum Disk is being prepared.
	COPY	This volume executes initial copy or resynchronizes a GAD pair. (including creation of GAD pairs without copying data) Data is being copied from the primary volume to the secondary volume.
PAIR	PAIR	A GAD pair is formed by using this volume. Data is also duplicated.
PSUS	PSUS	The GAD pair using this volume is suspended by a pair suspension operation. This state is shown in the primary volume.
PSUE	PSUE	The GAD pair using this volume is suspended by failures.
SSUS	SSUS	The GAD pair using this volume is suspended by a pair suspension operation. This state is shown in the secondary volume. Update of the secondary volume is stopped.
SSWS	SSWS	The GAD pair using this volume is suspended by a pair suspension operation or failures. This state is shown in the secondary volume. Update of the primary volume is stopped.

(4) I/O mode of GAD

I/O mode means I/O behaviors that the primary and secondary volumes of a GAD pair have respectively.

Table 3.31.2.3-4 I/O mode of GAD

I/O mode		READ process	WRITE process
Expression in RAID Manager	Expression in Storage Navigator		
Mirror (RL)	Mirror (Local READ)	Sends data of the storage system received a READ request to servers.	Writes data in both primary and secondary volumes in that order.
Local	Local	Sends data of the storage system received a READ request to servers.	Writes data in the volume only of the storage system received a WRITE request.
Block	Block	Responds Illegal request.	Responds Illegal request.

LU undefined response returns to Report LUN command and Inquiry command for the volume whose I/O mode is Block. Therefore, the volume whose I/O mode is Block is the status that is not recognized by servers or in which the path status is blocked.

(5) Relationship of a GAD state, a pair state, and an I/O mode

The relationship of a GAD state, a pair state, and an I/O mode is as follows.

Table 3.31.2.3-5 Relationship of a GAD state, a pair state, and an I/O mode

GAD state		Trigger of suspension	Primary volume		Secondary volume		Volume that has the latest data
			Pair state	I/O mode	Pair state	I/O mode	
Initial		—	SMPL	—	SMPL	—	—
Duplicating	Quorum Disk is being prepared.	—	INIT	Mirror (RL)	INIT	Block	Primary
	Data is being copied from the primary volume to the secondary volume	—	COPY	Mirror (RL)	COPY	Block	Primary
Duplication		—	PAIR	Mirror (RL)	PAIR	Mirror (RL)	Primary and secondary
Suspension	The primary volume is the latest.	Pair operation	PSUS	Local	SSUS	Block	Primary
		Failure	PSUE	Local	PSUE	Block	Primary
	The secondary volume is the latest.	Pair operation	PSUS	Block	SSWS	Local	Secondary
		Failure	PSUE	Block	SSWS	Local	Secondary
Block		—	PSUE	Block	PSUE	Block	Primary and secondary
		—	PSUE	Block	—	—	Primary and secondary
		—	—	—	PSUE	Block	Primary and secondary
— : Not applicable							

3.31.2.4 GAD and server I/O

I/O processing from servers to a GAD volume is managed by the I/O mode of the volume. Also, combination of I/O modes of the primary and secondary volumes varies by the GAD state. A flow of I/O processing from servers is explained here for each GAD state.

(1) Server I/O when the GAD state is duplication.

The I/O mode and the flow of I/O from servers are as follows when the GAD state is duplication.

Volume	Primary volume	Secondary volume
I/O volume	Mirror (RL)	Mirror (RL)

(i) Flow of WRITE process

When a volume of a GAD pair is written from the server, WRITE completion is responded to the server after both volumes of the GAD pair are written.

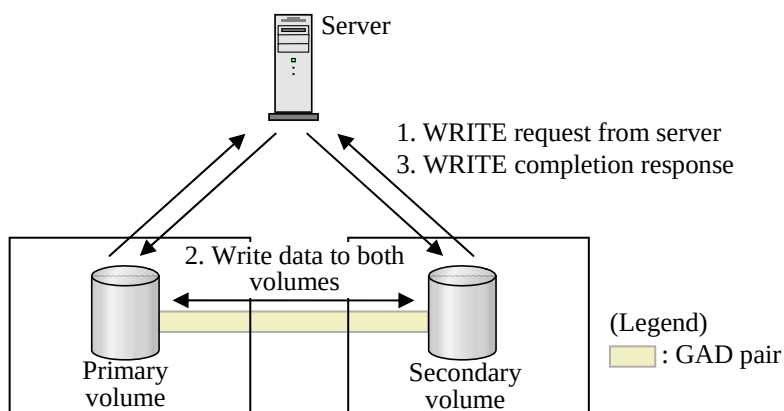


Fig. 3.31.2.4-1 Flow of WRITE process

(ii) Flow of READ process

When a volume of a GAD pair is read from the server, data is read from the volume connected to the server to be sent to the server. No communication arises between storage systems of the primary and secondary sites.

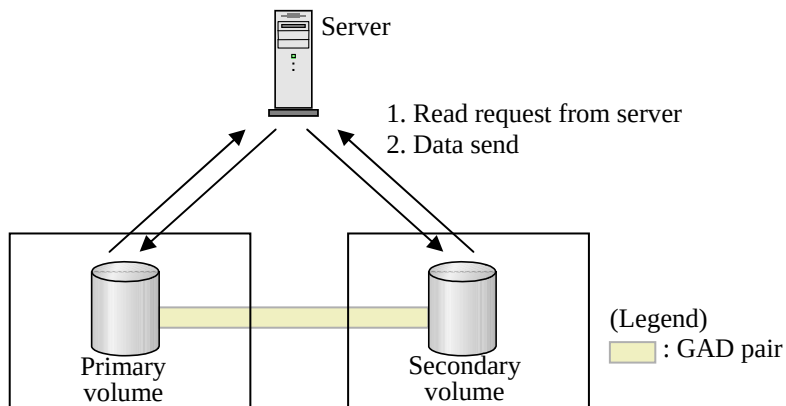


Fig. 3.31.2.4-2 Flow of READ process

(2) I/O when the GAD state is duplicating

The I/O mode and the flow of I/O from servers are as follows when the GAD state is duplicating.

Volume	Primary volume	Secondary volume
I/O mode	Mirror (RL)	Block

(i) Flow of WRITE process

When a volume of a GAD pair is written from the server, WRITE completion is responded to the server after both volumes of the GAD pair are written. The secondary volume whose I/O mode is Block does not accept I/O from servers. However, the data written to the primary volume is also written to the secondary volume.

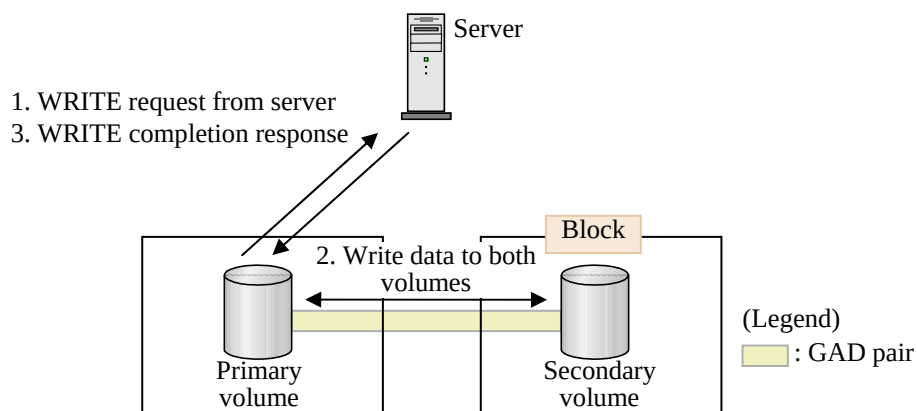


Fig. 3.31.2.4-3 Flow of WRITE process

(ii) Flow of READ process

When a volume of a GAD pair is read from the server, data is read from the primary volume of the GAD pair to be sent to the server. No communication arises between storage systems of the primary and secondary sites.

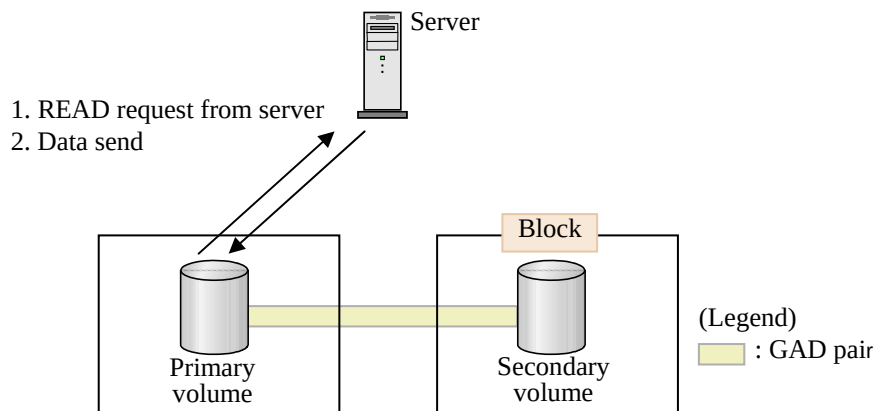


Fig. 3.31.2.4-4 Flow of READ process

(3) Server I/O when the GAD state is suspension

The I/O mode and the I/O flow from the server are as follows when the GAD state is suspension.

When data of the primary volume is the latest

Volume	Primary volume	Secondary volume
I/O mode	Local	Block

When data of the secondary volume is the latest

Volume	Primary volume	Secondary volume
I/O mode	Block	Local

(i) Flow of WRITE process (when data of the primary volume is the latest)

When a volume of the GAD pair is written from the server, WRITE completion is responded to the server after the primary volume of the GAD pair is written. The secondary volume whose I/O mode is Block does not accept I/O from the server. Also, the data written to the primary volume is not written to the secondary volume.

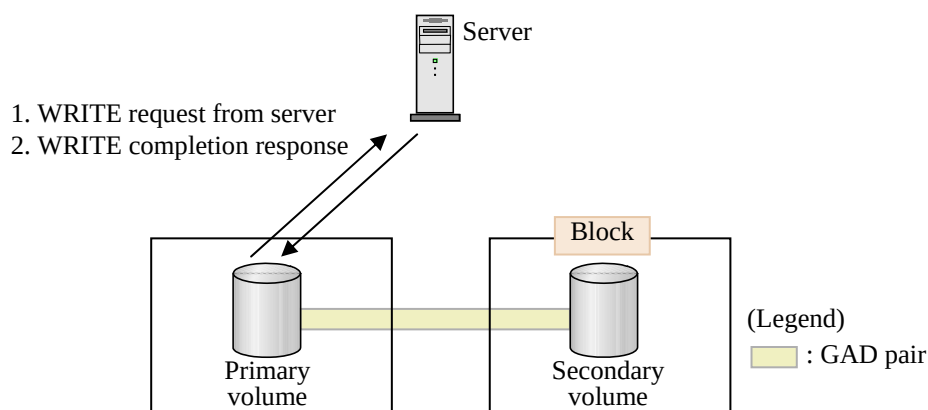


Fig. 3.31.2.4-5 Flow of WRITE process

(ii) Flow of READ process (when data of the primary volume is the latest)

When a volume of a GAD pair is read from the server, data is read from the primary volume of the GAD to be sent to the server. No communication arises between storage systems of the primary and secondary sites.

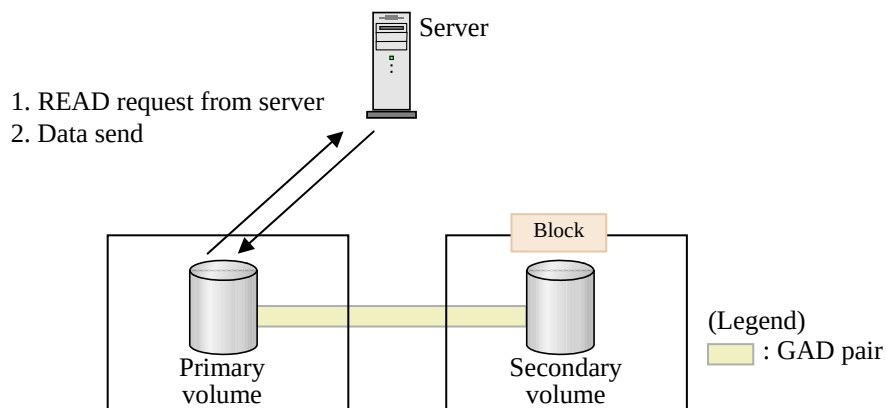


Fig. 3.31.2.4-6 Flow of READ process

(4) Server I/O when the GAD state is Block

The I/O mode is as follows when the GAD state is Block.

Volume	Primary volume	Secondary volume
I/O mode	Block	Block

As both volumes of the GAD pair do not accept I/O, there will be no WRITE or READ of data to volumes.

3.31.2.5 Quorum Disk and server I/O

Quorum Disk is a volume of an external storage system to decide which storage system continues I/O from servers when failure occurs in a path or storage system.

When no communication is available between storage systems of the primary and secondary sites using the path between the storage systems, each storage system behaves as follows.

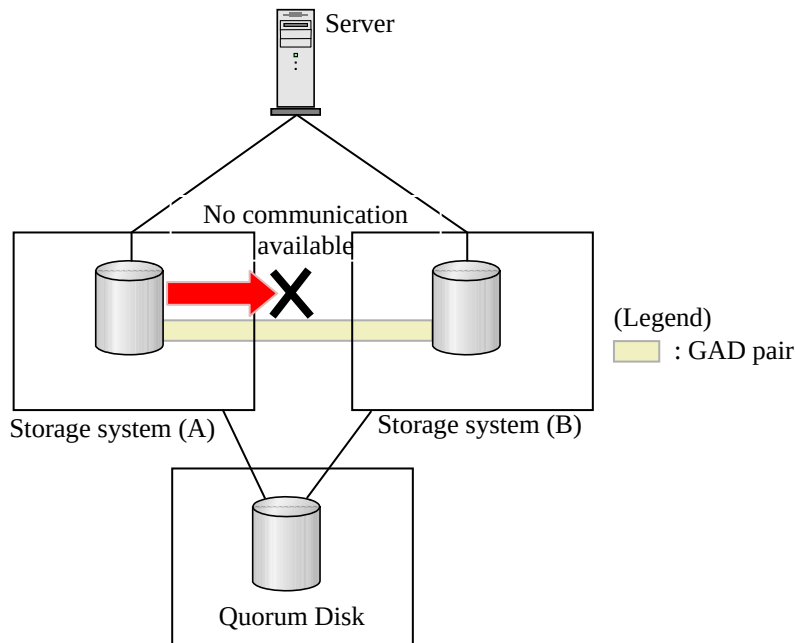


Fig. 3.31.2.5-1 Quorum Disk and server I/O

1. Storage system (A) that cannot communicate writes its status, in which no communication is available, to Quorum Disk.
2. When storage system (B) detects writing of no available communication with Quorum Disk, storage system (B) terminates to accept I/O.
3. Storage system (B) writes its status, in which no I/O is accepted, to Quorum Disk.
4. When storage system (A) detects that storage system (B) is in the status where no I/O is accepted, storage system (A) suspends the GAD pair and continues I/O.

When the status where storage system (B) accepts no I/O is not detected in Quorum Disk within five seconds after storage system (A) writes the status, in which no communication is available, to Quorum Disk, storage system (A) suspends the GAD pair and continues I/O.

Additionally, when both storage systems write to Quorum Disk concurrently that both systems are in the status of no available communication, the storage system whose serial number is smaller is regarded as the storage system that writes the status of no available communication.

(1) Server I/O when detecting writing of I/O stop by other systems

When detecting writing of I/O stop by other system, the judgment of the volume that continues I/O from servers differs depending on the pair status of each volume at the detection.

Pair status of the GAD pair	Volume that continues I/O
PAIR	Volume that writes the status of no available communication
INIT/COPY	Primary volume
PSUS,PSUE,SSWS or SSUS	Volume whose I/O mode is Local

(2) Server I/O when not detecting writing of I/O stop by other storage systems

When no writing of I/O stop by other systems is detected within five seconds, basically the volume of the storage system that writes the status of no available communication continues I/O from servers. However, I/O continuation is decided by the pair status and I/O mode of the volume that is not detected.

Pair status of the GAD pair	I/O status
PAIR	• I/O continues
INIT/COPY	• In the primary volume case, I/O continues. • In the secondary volume case, I/O stops.
PSUS,PSUE,SSWS or SSUS	• When the I/O mode of the volume is Local, I/O continues. • When the I/O mode of the volume is Block, I/O stops.

3.31.2.6 GAD copy type

GAD has the following two types of copying.

(1) Initial copy

All data of the primary volume is copied to the secondary volume to match data of both volumes. It is used to change the GAD state from initial to duplication.

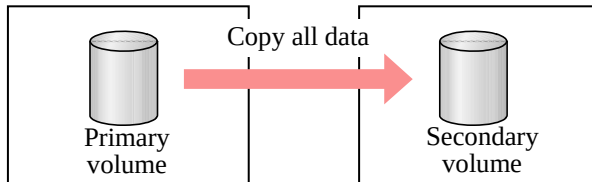


Fig. 3.31.2.6-1 Initial copy

(2) Differential copy

Only the differential between the primary and secondary volumes is copied to match data of both volumes. It is used to change the GAD state from suspension to duplication.

When the GAD state is suspension, the storage system records updated locations of data to manage the differential.

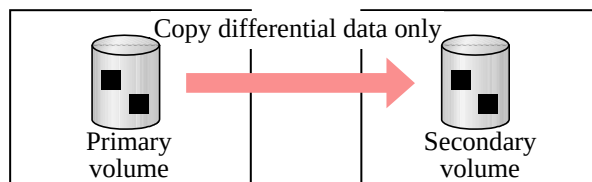


Fig. 3.31.2.6-2 Differential copy

GAD has an option (maximum initial copy number) to designate the maximum pair number of initial copy that can be concurrently executed in one storage system.

The maximum initial copy number is totally 512 for GAD, TrueCopy, and TrueCopy for Mainframe.

If initial copy or differential copy of TrueCopy or TrueCopy for Mainframe has already run in the same storage system when copying a GAD pair, the smaller number among “512 – (running copy number of TrueCopy)” and “the maximum initial copy number of GAD” is the number of GAD pair that runs first.

3.31.2.7 Flow to start a GAD operation

The following is a flow to start a GAD operation.

Table 3.31.2.7-1 Flow to start a GAD operation

Procedure		Operation target	Interface		
			Storage Navigator	RAID Manager	Hitachi Command Suite
Install and connect hardware		—	—	—	—
Install program products		Primary site, secondary site	×	—	—
Start RAID Manager	Create command devices	Primary site, secondary site	×	—	—
	Create a configuration definition file and start	Server	—	× (*1)	—
Connect the storage systems of the primary site and the secondary site	Change the port attribute to Initiator and RCU target	Primary site, secondary site	×	×	×
	Add remote connection	Primary site, secondary site	×	×	×
Create Quorum Disk	Change the port attribute to External	Primary site, secondary site	×	×	×
	Map the external volume	Primary site, secondary site	×	×	×
	Configure Quorum Disk	Primary site, secondary site	×	×	×
Configure the storage system of the secondary site	Create a virtual storage machine	Secondary site	—	×	×
	Reserve the secondary volume	Secondary site	×	×	×
	Create the secondary volume	Secondary site	×	×	×
	Set an LU path to the secondary volume	Secondary site	×	×	×
Create a GAD pair		Primary site	×	×	×
Set an alternate path to the secondary volume		Server	—	—	—
Primary site: the storage system of the primary site Secondary site: the storage system of the secondary site × : Available — : Not available / Not applicable *1: Use a text editor etc. to create the configuration definition file.					

For how to operate GAD using Hitachi Command Suite, refer to Hitachi Command Suite manual.

THEORY03-31-390**3.31.2.8 Feasibility of combined use of GAD with other functions**

The following table shows whether the volume used by functions other than GAD can be used as the primary or secondary volume of GAD.

To use each function except GAD, the license for each function is required.

Table 3.31.2.8-1 Combined use of GAD with other functions

Function	Volume	Availability as the primary volume of GAD	Availability as the secondary volume of GAD	Availability as Quorum Disk
Dynamic Provisioning/ Dynamic Tiering	Virtual volume	×	×	—
	Pool volume	—	—	—
ShadowImage/ Thin Image	Primary volume	×	×	—
	Secondary volume	—	—	—
TrueCopy	Primary volume	—	—	—
	Secondary volume	—	—	—
Universal Replicator	Primary volume	—	—	—
	Secondary volume	—	—	—
	Journal volume	—	—	—
Universal Volume Manager	External volume	—	—	×
Data Retention Utility	Volume in which the access attribute is configured	×	× (*1)	—
Volume Migration	Source volume	—	—	—
	Target volume	—	—	—
Cache Residency Manager	Volume in which Cache Residency Manager is configured	—	—	—
Virtual LUN	Virtual LUN volume	—	—	× (*2)
LUN Manager	Volume in which paths are defined	×	×	—
	Volume in which paths are not defined	—	—	×
Command device	Command device	—	—	—
	Remote command device	—	—	—
Encryption License Key	Volume of the encrypted parity group	×	×	Encrypted volumes in the external storage system can be used as Quorum disk. (*3)

× : Available

— : Not available

*1 : When the secondary VOL denial attribute of Data Retention Utility is set on the secondary volume, GAD pair operation from RAID Manager will be restricted. Cancel the secondary VOL denial attribute of the secondary volume, and then operate GAD pairs.

*2 : Only the external volume of the configuration where one external volume group is mapped to one external volume can be set in Quorum disk.

*3 : Quorum disk that is not encrypted in the external storage system cannot be encrypted in VSP G1000 of the primary and secondary sites.

3.31.2.9 Function switch

GAD behavior specification can be changed by releasing the setting of remote replica function switches. How to configure, release, and display function switches is described in refer to WEB CONSOLE SECTION “3.4.1 Remote Replica Function Switch” ([WEB03-70](#)).

Functions assigned to each switch are as follows.

- 15: It is effective when Switch #17 is on. Combination of Switch #15 and Switch #20 can change path failure thresholds. (17: Refer to Table <Path failure thresholds>.)
- 17: The path is blocked when the number of path failures (LIP, RSCN, Time Over) reaches the threshold within a certain period. And performance decrease of GAD caused by using the trouble path is prevented. The path failure threshold values are changed by combination of function switch #15 and switch #20.

<The path failure threshold values>

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

- 18: In the case where the switch switch #17 is turned on, the count of link failures that occur in the fibre path is also a factor that results in a detachment caused by an excess of a threshold value.
- 20: It is effective when #17 is on. Combination of Switch #15 and Switch #20 can change path failure thresholds.
- 33: In the cases that a PDCM function of McData ES3232 is being used on MCU-RCU path, when response of LOGIN response is late, path status of MCU is changed to non-normal.
- 41 ~ 42: When RIO response delay occurs in a specific path between MCU-RCU, and if the occurrence number of the RIO response delay exceeds the threshold, degradation of remote copy performance caused by use of the response delay path is prevented by blocking the logical path by the threshold. Combination of Switch #41 and Switch #42 can change RIO response delay time to be counted.

<The threshold value of RIO response time delay>

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

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

<Blockade of path less than minimum path>

Switch #43	Blockade of path
OFF	Not blocked
ON	blocked

NOTE: Function switch 15, 17, 18, 20, 33, 41, 42, 43 are common in TC/TC-MF/GAD.
When configured, the configuration is effective in all functions of TC/TC-MF/GAD.

3.31.2.10 Planned shutdown of the storage system that GAD uses

Planned shutdown of the storage system that GAD uses and startup operation after the planned shutdown are explained.

(1) Planned shutdown of the storage system

Table 3.31.2.10-1 shows “Planned shutdown patterns of the storage system”.

And Fig. 3.31.2.10-1 shows operation outline of planned shutdown patterns.

Table 3.31.2.10-1 Planned shutdown patterns of the storage system

Planned shutdown patterns of the storage system	Storage system to be powered off (*4)			Storage system to continue I/O		Storage system in which a GAD pair is suspended		Disconnect ion of Quorum disk (*5)
	Primary site	Secondary site	External (*1)	Primary site	Secondary site	Primary site	Secondary site	
A	×	×	×	—	—	×	—	×
B	×	×	—	—	—	×	—	—
C	×	—	×	—	×	—	×	×
D	×	—	—	—	×	—	×	—
E	—	×	×	×	—	×	—	×
F	—	×	—	×	—	×	—	—
G (*2)	—	—	×	×	—	×	—	×
H (*3)	—	—	×	—	×	—	×	×

× : To be performed
 — : Not performed
 *1: External storage systems for Quorum disk.
 *2: I/O continues in the storage system of the primary site when the external storage system is stopped.
 *3: I/O continues in the storage system of the secondary site when the external storage system is stopped.
 *4: The order of power off of the storage system is not regulated. Power off is available from wherever “×” is marked.
 *5: SIM of Quorum disk blockade may be reported on storage system of primary and/or secondary site by disconnection of Quorum disk.

For operation procedures, refer to the description on planned shutdown of the storage system in the Hitachi Virtual Storage Platform G1000 Global-Active Device User Guide.

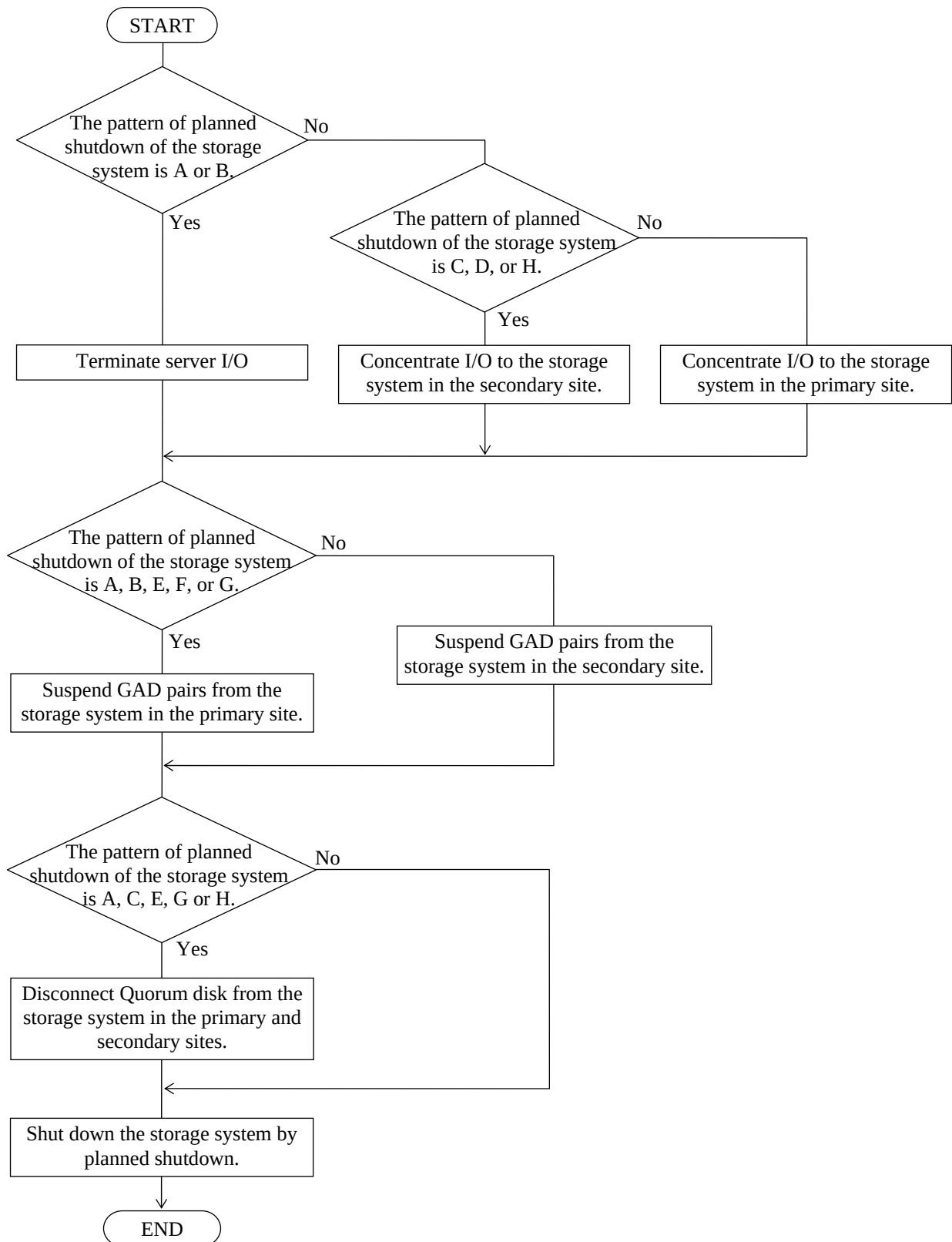


Fig. 3.31.2.10-1 Operation outline of planned shutdown patterns of the storage system

(2) Startup of the storage system after planned shutdown

Table 3.31.2.10-2 shows “Startup patterns of the storage system after planned shutdown”. And Fig. 3.31.2.10-2 shows operation outline (flow) of startup patterns of the storage system after planned shutdown”.

Table 3.31.2.10-2 Startup patterns of the storage system after planned shutdown

Startup patterns of the storage system after planned shutdown	Storage system to be powered on (*5)			Storage system to continue I/O		Storage system in which GAD pairs are resynchronized		Connect Quorum disk (*7)
	Primary site	Secondary site	External (*1)	Primary site	Secondary site	Primary site	Secondary site	
A	×	×	×	(*6)	(*6)	×	—	×
B	×	×	—	(*6)	(*6)	×	—	—
C	×	—	×	(*6)	×	—	× (*4)	×
D	×	—	—	(*6)	×	—	× (*4)	—
E	—	×	×	×	(*6)	×	—	×
F	—	×	—	×	(*6)	×	—	—
G (*2)	—	—	×	×	(*6)	×	—	×
H (*3)	—	—	×	(*6)	×	—	× (*4)	×

× : To be performed

— : Not performed

*1: External storage systems for Quorum disk.

*2: I/O continues in the storage system of the primary site when the external storage system is stopped.

*3: I/O continues in the storage system of the secondary site when the external storage system is stopped.

*4: A GAD pair is resynchronized in the storage system of the secondary site by swapping the primary volume for the secondary volume (Swap resync).

*5: The order of power on of the storage system is not regulated. Power on is available from wherever “×” is marked.

*6: Storage system in which I/O restarts.

*7: In case of SIM of Quorum disk blockade was reported on storage system of primary or secondary site by disconnection of Quorum disk, please delete the SIM after connection of Quorum disk.

For operation procedures, refer to the description on planned shutdown of the storage system in the Hitachi Virtual Storage Platform G1000 Global-Active Device User Guide.

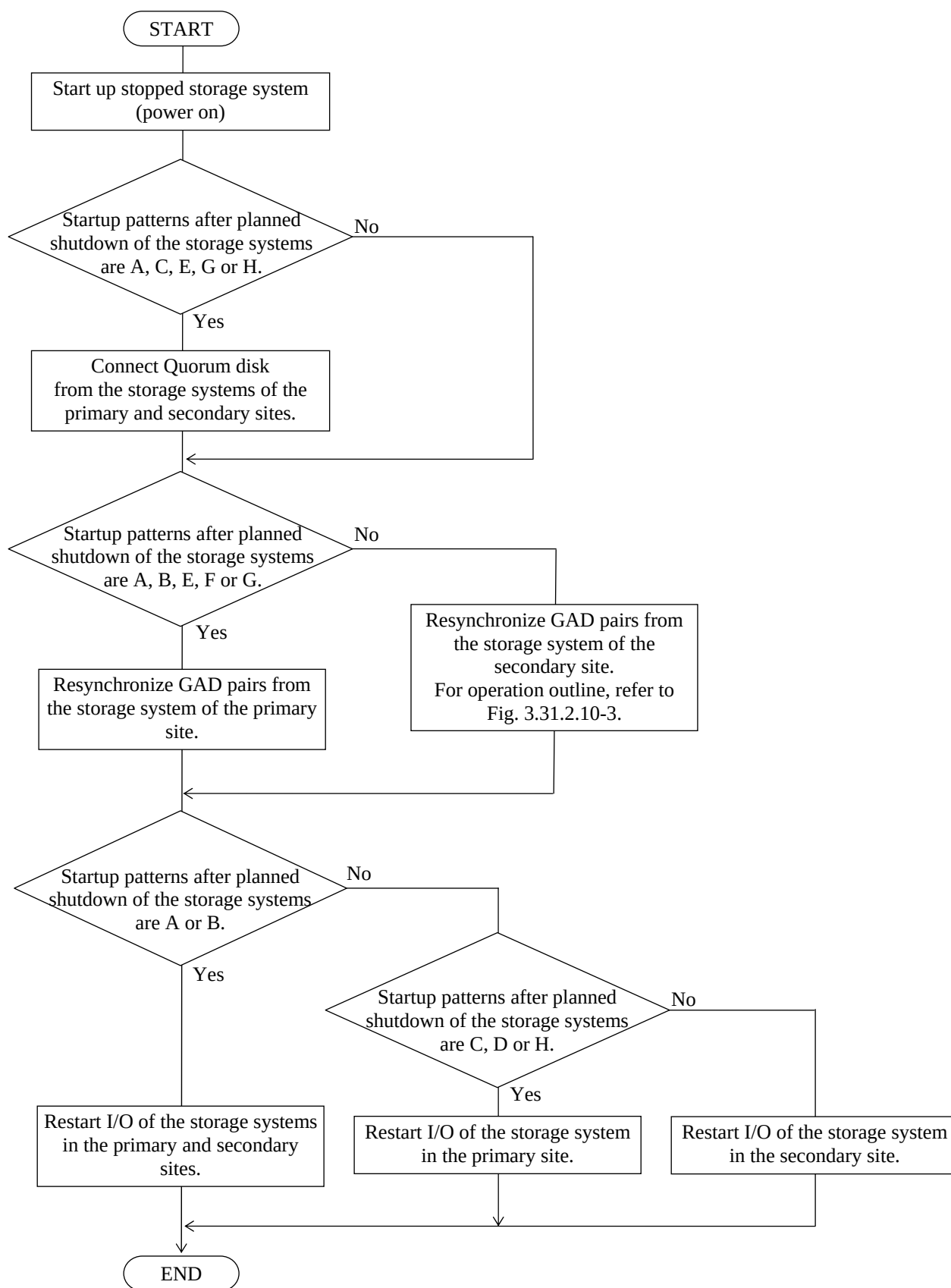


Fig. 3.31.2.10-2 Operation outline in startup patterns after planned shutdown of the storage system

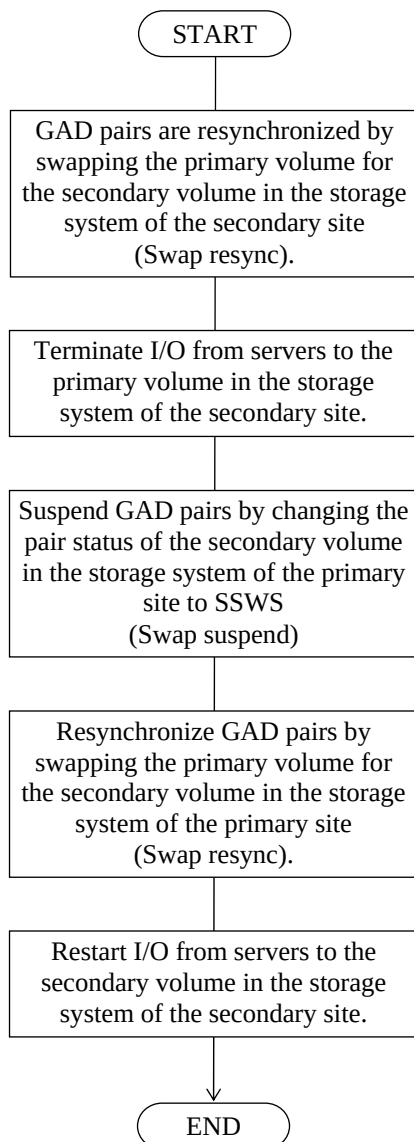


Fig. 3.31.2.10-3 Resynchronization of GAD pairs from the storage system in the secondary site

4. Power-on Sequences

4.1 IMPL Sequence

The IMPL sequence, which is executed when power is turned on, is comprised of the following four modules:

(1) BIOS

The BIOS starts other MP cores after a ROM boot. Subsequently, the BIOS expands the OS loader from the flash memory into the local memory and OS loader is executed.

(2) OS loader

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

(3) Real Time OS modules

Real Time OS is a root task that initializes the tables in the local memory that are used for intertask communications. Real Time OS also initializes network environment, and create the DKC task.

(4) DKC task

When the DKC task is created, it executes initialization routines. Initialization routines initialize the most part of the environment that the DKC task uses. When the environment is established so that the DKC task can start scanning, the DKC task notifies the SVP of a power event log. Subsequently, the DKC task turns on the power for the physical drives and, when the logical drives become ready, The DKC task notifies the host processor of an NRTR.

The control flow of IMPL processing is shown in Fig. 4.1-1.

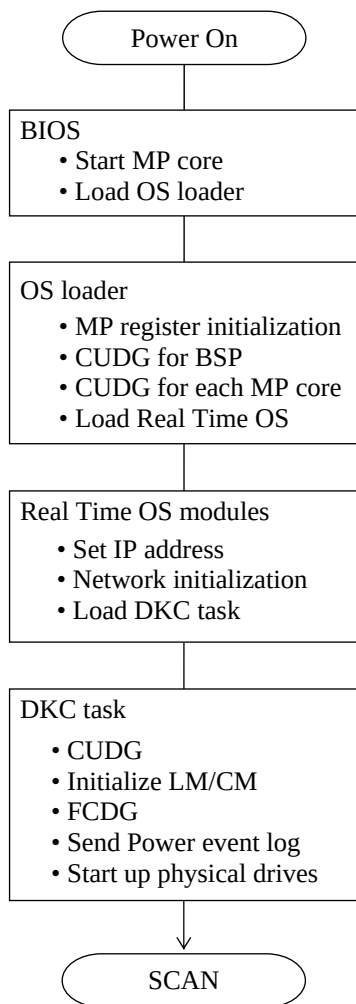


Fig. 4.1-1 IMPL Sequence

4.2 Drive Power-on Sequence

An overcurrent condition may occur if two or more drives which connected with same HDD-PWR started at the same time. To preclude the overcurrent condition, HDDs connected with same HDD-PWR is started one by one at approximately 5 second intervals in cases of 3.5 inch HDD BOX, and at approximately 3 second intervals in cases of 3.5 inch HDD BOX.

When the logical devices become ready as the result of the startup of the physical drives, the host processor is notified to that effect.

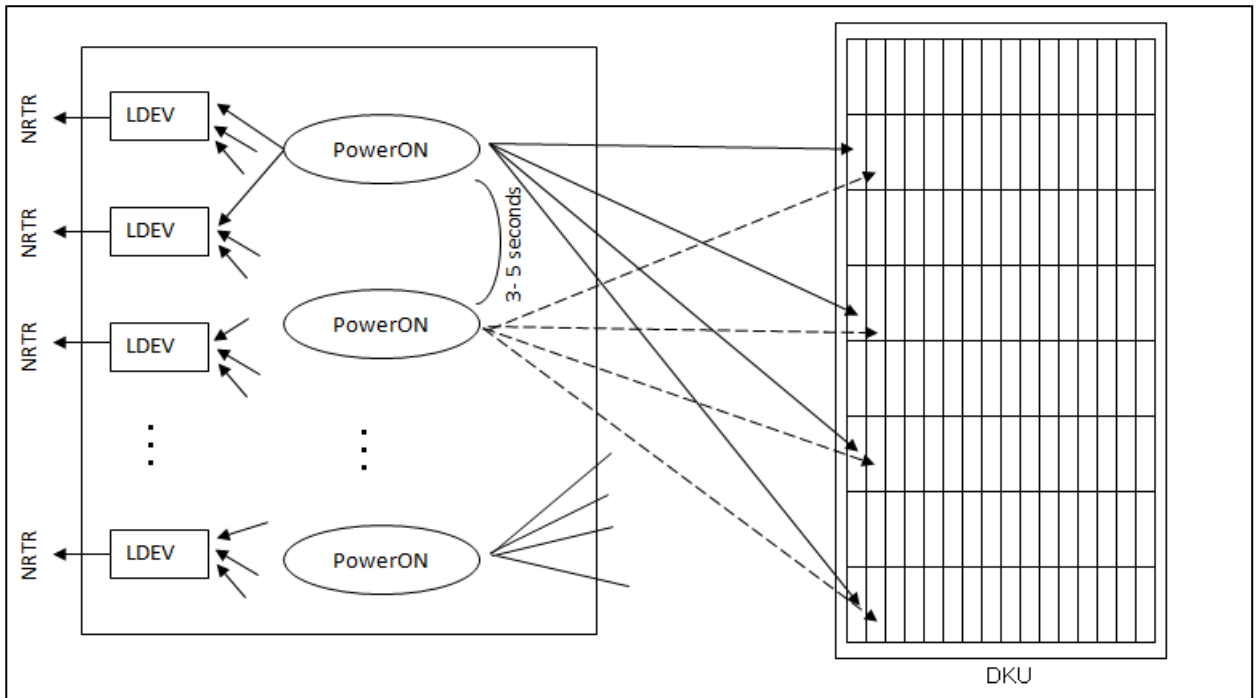


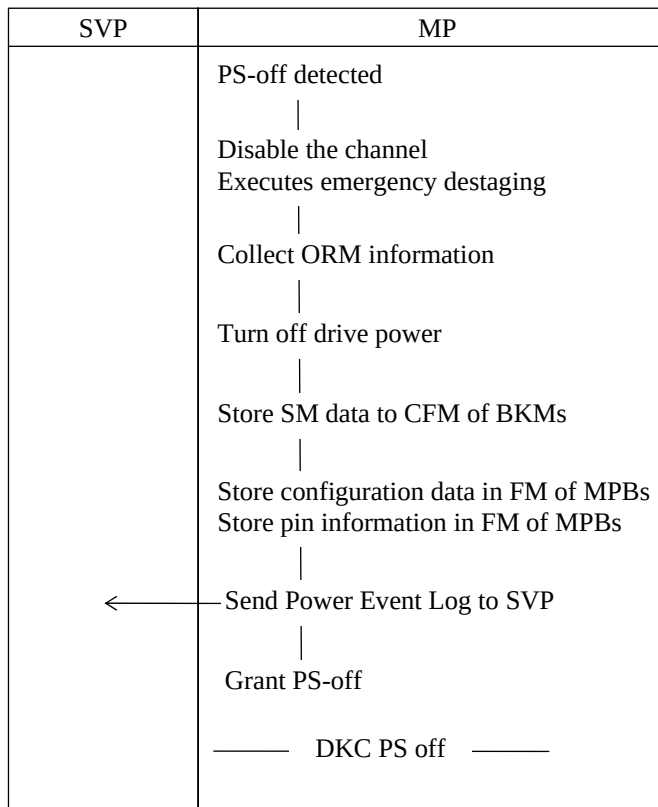
Fig. 4.2-1 Drive Power-on Sequence

4.3 Planned Stop

When a power-off is specified by a maintenance personnel, this storage system checks for termination of tasks that are blocked or running on all logical devices. When all the tasks are terminated, this storage system disables the CHL and executes emergency destaging. If a track for which destaging fails (pinned track) occurs, this storage system stores the pin information in shared memory.

Subsequently, this storage system saves the configuration data and the pin information (which is used as hand-over information) in flash memory of MPBs, save all SM data (which is used as non-volatile power on) in CFM of BKMs. Then, sends Power Event Log to the SVP, notifies the hardware of the grant to turn off the power.

The hardware turns off main power when power-off grants for all processors are presented.



Appendixes A

A.1 Commands

These storage system commands are classified into the following eight categories:

(1) Read commands

The read commands transfer the readout data from devices to channels.

(2) Write commands

The write commands write the transfer data from channels to devices.

(3) Search commands

The search commands follow a control command and logically search for the target data.

(4) Control commands

The control commands include the SEEK command that positions cylinder and head positions. The SET SECTOR command that executes latency time processing, the LOCATE RECORD command that specifies the operation of the ECKD command, the SET FILE MASK command that defines the permissible ranges for the WRITE and SEEK operations, and the DEFINE EXTENT command that defines the permissible ranges for the WRITE and SEEK operations and that defines the cache access mode.

(5) Sense commands

The sense commands transfer sense bytes and device specifications.

(6) Path control commands

The path control commands enable and disable the exclusive control of devices.

(7) TEST I/O command

The TEST I/O command transfers the specified device and its path state to a given channel in the form of DSBs.

(8) Storage system commands

The storage system commands include the commands which define cache control information in the DKCs and the commands which transfer cache-related information to channels.

Table A.1-1 Command Summary (1/3)

Command Name			Command Code	
			Single Track	Multitrack
Read commands	READ INITIAL PROGRAM LOAD	(RD IPL)	02	—
	READ HOME ADDRESS	(RD HA)	1A	9A
	READ RECORD ZERO	(RD R0)	16	96
	READ COUNT,KEY,DATA	(RD CKD)	1E	9E
	READ KEY,DATA	(RD KD)	0E	8E
	READ DATA	(RD D)	06	86
	READ COUNT	(RD C)	12	92
	READ MULTIPLE COUNT,KEY AND DATA	(RD MCKD)	5E	—
	READ TRACK	(RD TRK)	DE	—
	READ SPECIAL HOME ADDRESS	(RD SP HA)	0A	—
WRITE commands	WRITE HOME ADDRESS	(WR HA)	19	—
	WRITE RECORD ZORO	(WR R0)	15	—
	WRITE COUNT,KEY,DATA	(WR CKD)	1D	—
	WRITE COUNT,KEY,DATA NEXT TRACK	(WR CKD NT)	9D	—
	ERASE	(ERS)	11	—
	WRITE KEY AND DATA	(WR KD)	0D	—
	WRITE UPDATE KEY AND DATA	(WR UP KD)	8D	—
	WRITE DATA	(WR D)	05	—
	WRITE UPDATE DATA	(WR UP D)	85	—
	WRITE SPECIAL HOME ADDRESS	(WR SP HA)	09	—
SEARCH commands	SEARCH HOME ADDRESS	(SCH HA EQ)	39	B9
	SEARCH ID EQUAL	(SCH ID EQ)	31	B1
	SEARCH ID HIGH	(SCH ID HI)	51	D1
	SEARCH ID HIGH OR EQUAL	(SCH ID HE)	71	F1
	SEARCH KEY EQUAL	(SCH KEY EQ)	29	A9
	SEARCH KEY HIGH	(SCH KEY HI)	49	C9
	SEARCH KEY HIGH OR EQUAL	(SCH KEYD HE)	69	E9

Table A.1-1 Command Summary (2/3)

Command Name			Command Code	
			Single Track	Multitrack
CONTROL commands	DEFINE EXTENT	(DEF EXT)	63	—
	LOCATE RECORD	(LOCATE)	47	—
	LOCATE RECORD EXTENDED	(LOCATE EXT)	4B	—
	SEEK	(SK)	07	—
	SEEK CYLINDER	(SK CYL)	0B	—
	SEEK HEAD	(SK HD)	1B	—
	RECALIBRATE	(RECAL)	13	—
	SET SECTOR	(SET SECT)	23	—
	SET FILE MASK	(SET FM)	1F	—
	READ SECTOR	(RD SECT)	22	—
	SPACE COUNT	(SPC)	0F	—
	NO OPERATION	(NOP)	03	—
	RESTORE	(REST)	17	—
	DIAGNOSTIC CONTROL	(DIAG CTL)	F3	—
SENSE commands	SENSE	(SNS)	04	—
	READ AND RESET BUFFERED LOG	(RRBL)	A4	—
	SENSE IDENTIFICATION	(SNS ID)	E4	—
	READ DEVICE CHARACTERISTICS	(RD CHR)	64	—
	DIAGNOSTIC SENSE/READ	(DIAG SNS/RD)	C4	—
PATH CONTROL commands	DEVICE RESERVE	(RSV)	B4	—
	DEVICE RELEASE	(RLS)	94	—
	UNCONDITIONAL RESERVE	(UNCON RSV)	14	—
	SET PATH GROUP ID	(SET PI)	AF	—
	SENSE SET PATH GROUP ID	(SNS PI)	34	—
	SUSPEND MULTIPATH RECONNECTION	(SUSP MPR)	5B	—
	RESET ALLEGIANCE	(RST ALG)	44	—
TST I/O	TEST I/O	(TIO)	00	—
TIC	TRANSFER IN CHANNEL	(TIC)	X8	—

Table A.1-1 Command Summary (3/3)

Command Name		Command Code	
		Single Track	Multitrack
STORAGE SYSTEM commands	SET STORAGE SYSTEM MODE (SET SUB MD)	87	—
	PERFORM STORAGE SYSTEM FUNCTION (PERF SUB FUNC)	27	—
	READ STORAGE SYSTEM DATA (RD SUB DATA)	3E	—
	SENSE STORAGE SYSTEM STATUS (SNS SUB STS)	54	—
	READ MESSAGE ID (RD MSG IDL)	4E	—

NOTE:

- Command Reject, format 0, and message 1 are issued for the commands that are not listed in this table.
- TEST I/O is a CPU instruction and cannot be specified directly. However, it appears as a command to the interface.
- TIC is a type of command but runs only on a channel. It will never be visible to the interface.

A.2 Comparison of pair status on SVP, Web Console, RAID Manager

Table A.2-1 Comparison of pair status on SVP, Web Console, RAID Manager

No.	Event	Status on RAID Manager	Status on SVP, Web Console
1	Simplex Volume	P-VOL: SMPL S-VOL: SMPL	P-VOL: SMPL S-VOL: SMPL
2	Copying Volume	P-VOL: COPY S-VOL: COPY	P-VOL: COPY S-VOL: COPY
3	Pair volume	P-VOL: PAIR S-VOL: PAIR	P-VOL: PAIR S-VOL: PAIR
4	Pairsplit operation to P-VOL	P-VOL: PSUS S-VOL: SSUS	P-VOL: PSUS (S-VOL by operator) S-VOL: PSUS (S-VOL by operator)/SSUS
5	Pairsplit operation to S-VOL	P-VOL: PSUS S-VOL: PSUS	P-VOL: PSUS (S-VOL by operator) S-VOL: PSUS (S-VOL by operator)
6	Pairsplit -P operation (*1) (P-VOL failure, SYNC only)	P-VOL: PSUS S-VOL: SSUS	P-VOL: PSUS (P-VOL by operator) S-VOL: PSUS (by MCU)/SSUS
7	Pairsplit -R operation (*1)	P-VOL: PSUS S-VOL: SMPL	P-VOL: PSUS (Delete pair to RCU) S-VOL: SMPL
8	P-VOL Suspend (failure)	P-VOL: PSUE S-VOL: SSUS	P-VOL: PSUE (S-VOL failure) S-VOL: PSUE (S-VOL failure)/SSUS
9	S-VOL Suspend (failure)	P-VOL: PSUE S-VOL: PSUE	P-VOL: PSUE (S-VOL failure) S-VOL: PSUE (S-VOL failure)
10	PS ON failure	P-VOL: PSUE S-VOL: —	P-VOL: PSUE (MCU IMPL) S-VOL: —
11	Copy failure (P-VOL failure)	P-VOL: PSUE S-VOL: SSUS	P-VOL: PSUE (Initial copy failed) S-VOL: PSUE (Initial copy failed)/SSUS
12	Copy failure (S-VOL failure)	P-VOL: PSUE S-VOL: PSUE	P-VOL: PSUE (Initial copy failed) S-VOL: PSUE (Initial copy failed)
13	RCU accepted the notification of MCU's PS OFF	P-VOL: — S-VOL: SSUS	P-VOL: — S-VOL: PSUE (MCU PS OFF)/SSUS
14	MCU detected the obstacle of RCU	P-VOL: PSUE S-VOL: PSUE	P-VOL: PSUS (by RCU)/PSUE S-VOL: PSUE (S-VOL failure)

*1: Operation on RAID Manager

A.3 CHA/DKA PCB-LR#, DMA#, DRR#, SASCTL#, Port# Matrixes

Table A.3-1 Relationship between CHA/DKA PCB and LR#, DMA#, DRR#, SASCTL#, Port# (1/2)

Device Module	Location	LR#	DMA#	DRR#	Channel Port#	SASCTL#	SASPort#
Basic Module (Module#0)	CHA-1PC	0x00	0x00-0x03	0x00-0x01	0x00-0x07	—	—
	CHA-1PD	0x01	0x04-0x07	0x02-0x03	0x10-0x17	—	—
	CHA-1PE	0x02	0x08-0x0b	0x04-0x05	0x08-0x0F	—	—
	CHA-1PF	0x03	0x0c-0x0f	0x06-0x07	0x18-0x1F	—	—
	CHA-1PA	0x04	0x10-0x13	0x08-0x09	0x40-0x47	—	—
	CHA-1PB	0x05	0x14-0x17	0x0a-0x0b	0x50-0x57	—	—
	CHA-2PC	0x08	0x20-0x23	0x10-0x11	0x80-0x87	—	—
	CHA-2PD	0x09	0x24-0x27	0x12-0x13	0x90-0x97	—	—
	CHA-2PE	0x0a	0x28-0x2b	0x14-0x15	0x88-0x8F	—	—
	CHA-2PF	0x0b	0x2c-0x2f	0x16-0x17	0x98-0x9F	—	—
	CHA-2PA	0x0c	0x30-0x33	0x18-0x19	0xC0-0xC7	—	—
	CHA-2PB	0x0d	0x34-0x37	0x1a-0x1b	0xD0-0xD7	—	—
	DKA-1PA	0x04	0x10-0x13	0x08-0x09	—	0x00	0x00/0x01/0x20/0x21
						0x01	0x02/0x03/0x22/0x23
	DKA-1PB	0x05	0x14-0x17	0x0a-0x0b	—	0x02	0x04/0x05/0x24/0x25
						0x03	0x06/0x07/0x26/0x27
	DKA-2PA	0x0c	0x30-0x33	0x18-0x19	—	0x04	0x08/0x09/0x28/0x29
						0x05	0x0A/0x0B/0x2A/0x2B
	DKA-2PB	0x0d	0x34-0x37	0x1a-0x1b	—	0x06	0x0C/0x0D/0x2C/0x2D
						0x07	0x0E/0x0F/0x2E/0x2F

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Table A.3-1 Relationship between CHA/DKA PCB and LR#, DMA#, DRR#, SASCTL#, Port# (2/2)

Device Module	Location	LR#	DMA#	DRR#	Channel Port#	SASCTL#	SASPort#
Option Module (Module#1)	CHA-1PJ	0x10	0x40-0x43	0x40-0x43	0x20-0x27	—	—
	CHA-1PK	0x11	0x44-0x47	0x44-0x47	0x30-0x37	—	—
	CHA-1PL	0x12	0x48-0x4b	0x48-0x4b	0x28-0x2F	—	—
	CHA-1PM	0x13	0x4c-0x4f	0x4c-0x4f	0x38-0x3F	—	—
	CHA-1PG	0x14	0x50-0x53	0x50-0x53	0x60-0x67	—	—
	CHA-1PH	0x15	0x54-0x57	0x54-0x57	0x70-0x77	—	—
	CHA-2PJ	0x18	0x60-0x63	0x60-0x63	0xA0-0xA7	—	—
	CHA-2PK	0x19	0x64-0x67	0x64-0x67	0xB0-0xB7	—	—
	CHA-2PL	0x1a	0x68-0x6b	0x68-0x6b	0xA8-0xAF	—	—
	CHA-2PM	0x1b	0x6c-0x6f	0x6c-0x6f	0xB8-0xBF	—	—
	CHA-2PG	0x1c	0x70-0x73	0x70-0x73	0xE0-0xE7	—	—
	CHA-2PH	0x1d	0x74-0x77	0x74-0x77	0xF0-0xF7	—	—
	DKA-1PG	0x14	0x50-0x53	0x28-0x29	—	0x08	0x10/0x11/0x30/0x31
						0x09	0x12/0x13/0x32/0x33
	DKA-1PH	0x15	0x54-0x57	0x2a-0x2b	—	0x0A	0x14/0x15/0x34/0x35
						0x0B	0x16/0x17/0x36/0x37
	DKA-2PG	0x1c	0x70-0x73	0x38-0x39	—	0x0C	0x18/0x19/0x38/0x39
						0x0D	0x1A/0x1B/0x3A/0x3B
	DKA-2PH	0x1d	0x74-0x77	0x3a-0x3b	—	0x0E	0x1C/0x1D/0x3C/0x3D
						0x0F	0x1E/0x1F/0x3E/0x3F

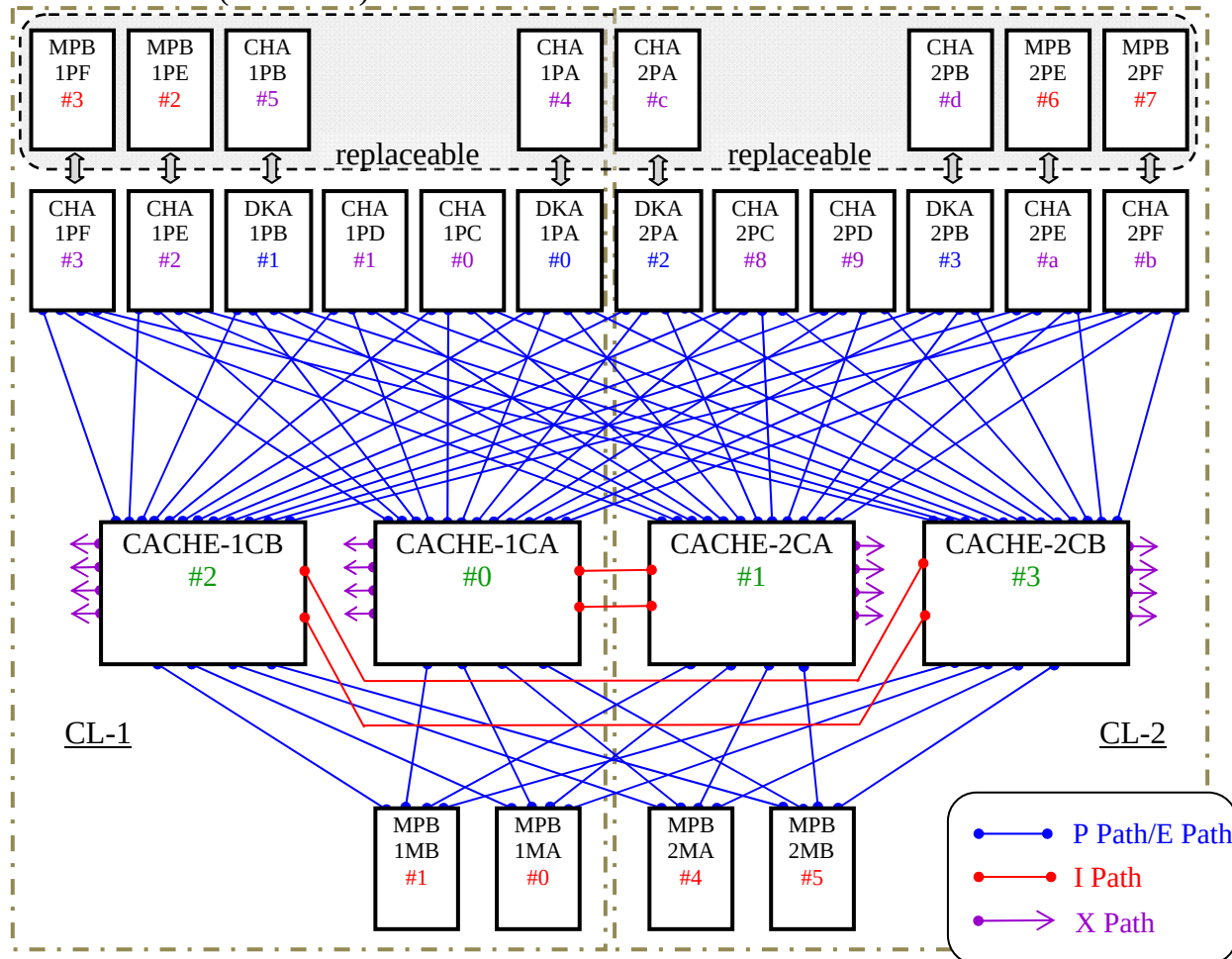
A.4 MPB - MPB#, MP# Matrixes

Table A.4-1 Relationship between MPB Location and MPB#, MP#

Device Module	Location	MPB#	MP#
Basic Module (Module#0)	MPB-1MA	0x00	0x00-0x07
	MPB-1MB	0x01	0x08-0x0f
	MPB-1PE	0x02	0x10-0x17
	MPB-1PF	0x03	0x18-0x1f
	MPB-2MA	0x04	0x20-0x27
	MPB-2MB	0x05	0x28-0x2f
	MPB-2PE	0x06	0x30-0x37
	MPB-2PF	0x07	0x38-0x3f
Option Module (Module#1)	MPB-1MC	0x08	0x40-0x47
	MPB-1MD	0x09	0x48-0x4f
	MPB-1FL	0x0a	0x50-0x57
	MPB-1FM	0x0b	0x58-0x5f
	MPB-2MC	0x0c	0x60-0x67
	MPB-2MD	0x0d	0x68-0x6f
	MPB-2PL	0x0e	0x70-0x77
	MPB-2PM	0x0f	0x78-0x7f

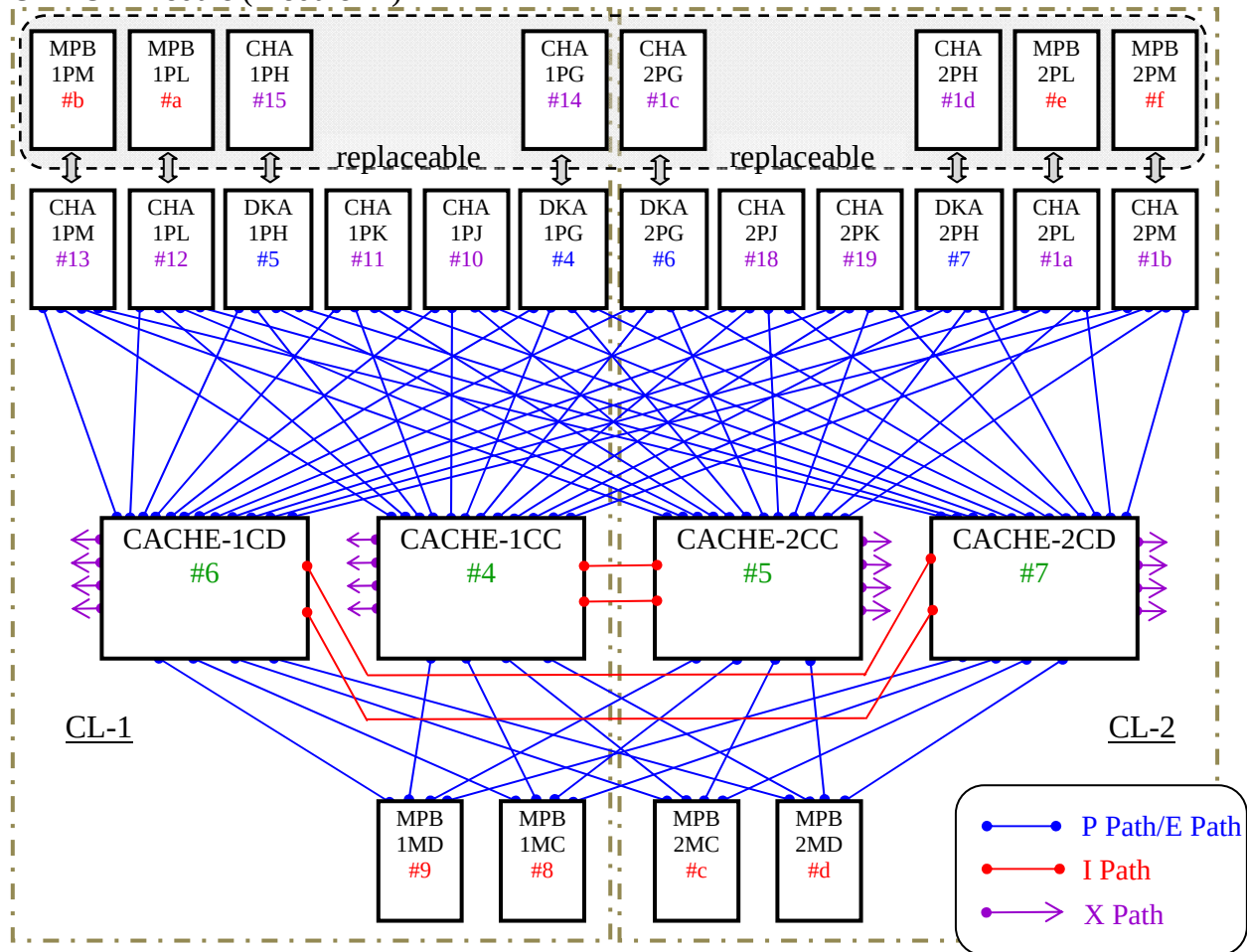
THEORY-A-90**A.5 Connection Diagram of DKC**

BASIC Module (Module#0)



THEORY-A-100

OPTION Module (Module #1)



Appendixes B

B.1 Physical - Logical Device Matrixes (2.5 INCH DRIVE BOX)

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (1/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-000	HDD000-00	00/00	01-01	01-01	01-01
	HDD000-01	00/01	01-02	01-02	
	HDD000-02	00/02	01-03	01-03	01-03
	HDD000-03	00/03	01-04	01-04	
	HDD000-04	00/04	01-05	01-05	01-05
	HDD000-05	00/05	01-06	01-06	
	HDD000-06	00/06	01-07	01-07	01-07
	HDD000-07	00/07	01-08	01-08	
	HDD000-08	00/08	01-09	01-09	01-09
	HDD000-09	00/09	01-10	01-10	
	HDD000-10	00/0A	01-11	01-11	01-11
	HDD000-11	00/0B	01-12	01-12	
	HDD000-12	00/0C	01-13	01-13	01-13
	HDD000-13	00/0D	01-14	01-14	
	HDD000-14	00/0E	01-15	01-15	01-15
	HDD000-15	00/0F	01-16	01-16	
	HDD000-16	00/10	01-17	01-17	01-17
	HDD000-17	00/11	01-18	01-18	
	HDD000-18	00/12	01-19	01-19	01-19
	HDD000-19	00/13	01-20	01-20	
	HDD000-20	00/14	01-21	01-21	01-21
	HDD000-21	00/15	01-22	01-22	
	HDD000-22	00/16	01-23	01-23	01-23
	HDD000-23	00/17	01-24/Spare	01-24/Spare	01-23/Spare

THEORY-B-20**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (2/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-001	HDD001-00	04/00	02-01	01-01	01-01
	HDD001-01	04/01	02-02	01-02	
	HDD001-02	04/02	02-03	01-03	01-03
	HDD001-03	04/03	02-04	01-04	
	HDD001-04	04/04	02-05	01-05	01-05
	HDD001-05	04/05	02-06	01-06	
	HDD001-06	04/06	02-07	01-07	01-07
	HDD001-07	04/07	02-08	01-08	
	HDD001-08	04/08	02-09	01-09	01-09
	HDD001-09	04/09	02-10	01-10	
	HDD001-10	04/0A	02-11	01-11	01-11
	HDD001-11	04/0B	02-12	01-12	
	HDD001-12	04/0C	02-13	01-13	01-13
	HDD001-13	04/0D	02-14	01-14	
	HDD001-14	04/0E	02-15	01-15	01-15
	HDD001-15	04/0F	02-16	01-16	
	HDD001-16	04/10	02-17	01-17	01-17
	HDD001-17	04/11	02-18	01-18	
	HDD001-18	04/12	02-19	01-19	01-19
	HDD001-19	04/13	02-20	01-20	
	HDD001-20	04/14	02-21	01-21	01-21
	HDD001-21	04/15	02-22	01-22	
	HDD001-22	04/16	02-23	01-23	01-23
	HDD001-23	04/17	02-24/Spare	01-24/Spare	01-23/Spare

THEORY-B-30**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (3/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-002	HDD002-00	01/00	01-01	01-01	01-01
	HDD002-01	01/01	01-02	01-02	
	HDD002-02	01/02	01-03	01-03	01-03
	HDD002-03	01/03	01-04	01-04	
	HDD002-04	01/04	01-05	01-05	01-05
	HDD002-05	01/05	01-06	01-06	
	HDD002-06	01/06	01-07	01-07	01-07
	HDD002-07	01/07	01-08	01-08	
	HDD002-08	01/08	01-09	01-09	01-09
	HDD002-09	01/09	01-10	01-10	
	HDD002-10	01/0A	01-11	01-11	01-11
	HDD002-11	01/0B	01-12	01-12	
	HDD002-12	01/0C	01-13	01-13	01-13
	HDD002-13	01/0D	01-14	01-14	
	HDD002-14	01/0E	01-15	01-15	01-15
	HDD002-15	01/0F	01-16	01-16	
	HDD002-16	01/10	01-17	01-17	01-17
	HDD002-17	01/11	01-18	01-18	
	HDD002-18	01/12	01-19	01-19	01-19
	HDD002-19	01/13	01-20	01-20	
	HDD002-20	01/14	01-21	01-21	01-21
	HDD002-21	01/15	01-22	01-22	
	HDD002-22	01/16	01-23	01-23	01-23
	HDD002-23	01/17	01-24/Spare	01-24/Spare	01-23/Spare

THEORY-B-40**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (4/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-003	HDD003-00	05/00	02-01	01-01	01-01
	HDD003-01	05/01	02-02	01-02	
	HDD003-02	05/02	02-03	01-03	01-03
	HDD003-03	05/03	02-04	01-04	
	HDD003-04	05/04	02-05	01-05	01-05
	HDD003-05	05/05	02-06	01-06	
	HDD003-06	05/06	02-07	01-07	01-07
	HDD003-07	05/07	02-08	01-08	
	HDD003-08	05/08	02-09	01-09	01-09
	HDD003-09	05/09	02-10	01-10	
	HDD003-10	05/0A	02-11	01-11	01-11
	HDD003-11	05/0B	02-12	01-12	
	HDD003-12	05/0C	02-13	01-13	01-13
	HDD003-13	05/0D	02-14	01-14	
	HDD003-14	05/0E	02-15	01-15	01-15
	HDD003-15	05/0F	02-16	01-16	
	HDD003-16	05/10	02-17	01-17	01-17
	HDD003-17	05/11	02-18	01-18	
	HDD003-18	05/12	02-19	01-19	01-19
	HDD003-19	05/13	02-20	01-20	
	HDD003-20	05/14	02-21	01-21	01-21
	HDD003-21	05/15	02-22	01-22	
	HDD003-22	05/16	02-23	01-23	01-23
	HDD003-23	05/17	02-24/Spare	01-24/Spare	01-23/Spare

THEORY-B-50**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (5/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-004	HDD004-00	02/00	01-01	01-01	01-01
	HDD004-01	02/01	01-02	01-02	
	HDD004-02	02/02	01-03	01-03	01-03
	HDD004-03	02/03	01-04	01-04	
	HDD004-04	02/04	01-05	01-05	01-05
	HDD004-05	02/05	01-06	01-06	
	HDD004-06	02/06	01-07	01-07	01-07
	HDD004-07	02/07	01-08	01-08	
	HDD004-08	02/08	01-09	01-09	01-09
	HDD004-09	02/09	01-10	01-10	
	HDD004-10	02/0A	01-11	01-11	01-11
	HDD004-11	02/0B	01-12	01-12	
	HDD004-12	02/0C	01-13	01-13	01-13
	HDD004-13	02/0D	01-14	01-14	
	HDD004-14	02/0E	01-15	01-15	01-15
	HDD004-15	02/0F	01-16	01-16	
	HDD004-16	02/10	01-17	01-17	01-17
	HDD004-17	02/11	01-18	01-18	
	HDD004-18	02/12	01-19	01-19	01-19
	HDD004-19	02/13	01-20	01-20	
	HDD004-20	02/14	01-21	01-21	01-21
	HDD004-21	02/15	01-22	01-22	
	HDD004-22	02/16	01-23	01-23	01-23
	HDD004-23	02/17	01-24/Spare	01-24/Spare	01-23/Spare

THEORY-B-60**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (6/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-005	HDD005-00	06/00	02-01	01-01	01-01
	HDD005-01	06/01	02-02	01-02	
	HDD005-02	06/02	02-03	01-03	01-03
	HDD005-03	06/03	02-04	01-04	
	HDD005-04	06/04	02-05	01-05	01-05
	HDD005-05	06/05	02-06	01-06	
	HDD005-06	06/06	02-07	01-07	01-07
	HDD005-07	06/07	02-08	01-08	
	HDD005-08	06/08	02-09	01-09	01-09
	HDD005-09	06/09	02-10	01-10	
	HDD005-10	06/0A	02-11	01-11	01-11
	HDD005-11	06/0B	02-12	01-12	
	HDD005-12	06/0C	02-13	01-13	01-13
	HDD005-13	06/0D	02-14	01-14	
	HDD005-14	06/0E	02-15	01-15	01-15
	HDD005-15	06/0F	02-16	01-16	
	HDD005-16	06/10	02-17	01-17	01-17
	HDD005-17	06/11	02-18	01-18	
	HDD005-18	06/12	02-19	01-19	01-19
	HDD005-19	06/13	02-20	01-20	
	HDD005-20	06/14	02-21	01-21	01-21
	HDD005-21	06/15	02-22	01-22	
	HDD005-22	06/16	02-23	01-23	01-23
	HDD005-23	06/17	02-24/Spare	01-24/Spare	01-23/Spare

THEORY-B-70**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (7/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-006	HDD006-00	03/00	01-01	01-01	01-01
	HDD006-01	03/01	01-02	01-02	
	HDD006-02	03/02	01-03	01-03	01-03
	HDD006-03	03/03	01-04	01-04	
	HDD006-04	03/04	01-05	01-05	01-05
	HDD006-05	03/05	01-06	01-06	
	HDD006-06	03/06	01-07	01-07	01-07
	HDD006-07	03/07	01-08	01-08	
	HDD006-08	03/08	01-09	01-09	01-09
	HDD006-09	03/09	01-10	01-10	
	HDD006-10	03/0A	01-11	01-11	01-11
	HDD006-11	03/0B	01-12	01-12	
	HDD006-12	03/0C	01-13	01-13	01-13
	HDD006-13	03/0D	01-14	01-14	
	HDD006-14	03/0E	01-15	01-15	01-15
	HDD006-15	03/0F	01-16	01-16	
	HDD006-16	03/10	01-17	01-17	01-17
	HDD006-17	03/11	01-18	01-18	
	HDD006-18	03/12	01-19	01-19	01-19
	HDD006-19	03/13	01-20	01-20	
	HDD006-20	03/14	01-21	01-21	01-21
	HDD006-21	03/15	01-22	01-22	
	HDD006-22	03/16	01-23	01-23	01-23
	HDD006-23	03/17	01-24/Spare	01-24/Spare	01-23/Spare

THEORY-B-80**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (8/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-007	HDD007-00	07/00	02-01	01-01	01-01
	HDD007-01	07/01	02-02	01-02	
	HDD007-02	07/02	02-03	01-03	01-03
	HDD007-03	07/03	02-04	01-04	
	HDD007-04	07/04	02-05	01-05	01-05
	HDD007-05	07/05	02-06	01-06	
	HDD007-06	07/06	02-07	01-07	01-07
	HDD007-07	07/07	02-08	01-08	
	HDD007-08	07/08	02-09	01-09	01-09
	HDD007-09	07/09	02-10	01-10	
	HDD007-10	07/0A	02-11	01-11	01-11
	HDD007-11	07/0B	02-12	01-12	
	HDD007-12	07/0C	02-13	01-13	01-13
	HDD007-13	07/0D	02-14	01-14	
	HDD007-14	07/0E	02-15	01-15	01-15
	HDD007-15	07/0F	02-16	01-16	
	HDD007-16	07/10	02-17	01-17	01-17
	HDD007-17	07/11	02-18	01-18	
	HDD007-18	07/12	02-19	01-19	01-19
	HDD007-19	07/13	02-20	01-20	
	HDD007-20	07/14	02-21	01-21	01-21
	HDD007-21	07/15	02-22	01-22	
	HDD007-22	07/16	02-23	01-23	01-23
	HDD007-23	07/17	02-24/Spare	01-24/Spare	01-23/Spare

THEORY-B-90**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (9/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-100	HDD100-00	30/00	03-01	03-01	03-01
	HDD100-01	30/01	03-02	03-02	
	HDD100-02	30/02	03-03	03-03	03-03
	HDD100-03	30/03	03-04	03-04	
	HDD100-04	30/04	03-05	03-05	03-05
	HDD100-05	30/05	03-06	03-06	
	HDD100-06	30/06	03-07	03-07	03-07
	HDD100-07	30/07	03-08	03-08	
	HDD100-08	30/08	03-09	03-09	03-09
	HDD100-09	30/09	03-10	03-10	
	HDD100-10	30/0A	03-11	03-11	03-11
	HDD100-11	30/0B	03-12	03-12	
	HDD100-12	30/0C	03-13	03-13	03-13
	HDD100-13	30/0D	03-14	03-14	
	HDD100-14	30/0E	03-15	03-15	03-15
	HDD100-15	30/0F	03-16	03-16	
	HDD100-16	30/10	03-17	03-17	03-17
	HDD100-17	30/11	03-18	03-18	
	HDD100-18	30/12	03-19	03-19	03-19
	HDD100-19	30/13	03-20	03-20	
	HDD100-20	30/14	03-21	03-21	03-21
	HDD100-21	30/15	03-22	03-22	
	HDD100-22	30/16	03-23	03-23	03-23
	HDD100-23	30/17	03-24/Spare	03-24/Spare	03-23/Spare

THEORY-B-100**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (10/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-101	HDD101-00	34/00	04-01	03-01	03-01
	HDD101-01	34/01	04-02	03-02	
	HDD101-02	34/02	04-03	03-03	03-03
	HDD101-03	34/03	04-04	03-04	
	HDD101-04	34/04	04-05	03-05	03-05
	HDD101-05	34/05	04-06	03-06	
	HDD101-06	34/06	04-07	03-07	03-07
	HDD101-07	34/07	04-08	03-08	
	HDD101-08	34/08	04-09	03-09	03-09
	HDD101-09	34/09	04-10	03-10	
	HDD101-10	34/0A	04-11	03-11	03-11
	HDD101-11	34/0B	04-12	03-12	
	HDD101-12	34/0C	04-13	03-13	03-13
	HDD101-13	34/0D	04-14	03-14	
	HDD101-14	34/0E	04-15	03-15	03-15
	HDD101-15	34/0F	04-16	03-16	
	HDD101-16	34/10	04-17	03-17	03-17
	HDD101-17	34/11	04-18	03-18	
	HDD101-18	34/12	04-19	03-19	03-19
	HDD101-19	34/13	04-20	03-20	
	HDD101-20	34/14	04-21	03-21	03-21
	HDD101-21	34/15	04-22	03-22	
	HDD101-22	34/16	04-23	03-23	03-23
	HDD101-23	34/17	04-24/Spare	03-24/Spare	03-23/Spare

THEORY-B-110**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (11/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-102	HDD102-00	31/00	03-01	03-01	03-01
	HDD102-01	31/01	03-02	03-02	
	HDD102-02	31/02	03-03	03-03	03-03
	HDD102-03	31/03	03-04	03-04	
	HDD102-04	31/04	03-05	03-05	03-05
	HDD102-05	31/05	03-06	03-06	
	HDD102-06	31/06	03-07	03-07	03-07
	HDD102-07	31/07	03-08	03-08	
	HDD102-08	31/08	03-09	03-09	03-09
	HDD102-09	31/09	03-10	03-10	
	HDD102-10	31/0A	03-11	03-11	03-11
	HDD102-11	31/0B	03-12	03-12	
	HDD102-12	31/0C	03-13	03-13	03-13
	HDD102-13	31/0D	03-14	03-14	
	HDD102-14	31/0E	03-15	03-15	03-15
	HDD102-15	31/0F	03-16	03-16	
	HDD102-16	31/10	03-17	03-17	03-17
	HDD102-17	31/11	03-18	03-18	
	HDD102-18	31/12	03-19	03-19	03-19
	HDD102-19	31/13	03-20	03-20	
	HDD102-20	31/14	03-21	03-21	03-21
	HDD102-21	31/15	03-22	03-22	
	HDD102-22	31/16	03-23	03-23	03-23
	HDD102-23	31/17	03-24/Spare	03-24/Spare	03-23/Spare

THEORY-B-120**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (12/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-103	HDD103-00	35/00	04-01	03-01	03-01
	HDD103-01	35/01	04-02	03-02	
	HDD103-02	35/02	04-03	03-03	03-03
	HDD103-03	35/03	04-04	03-04	
	HDD103-04	35/04	04-05	03-05	03-05
	HDD103-05	35/05	04-06	03-06	
	HDD103-06	35/06	04-07	03-07	03-07
	HDD103-07	35/07	04-08	03-08	
	HDD103-08	35/08	04-09	03-09	03-09
	HDD103-09	35/09	04-10	03-10	
	HDD103-10	35/0A	04-11	03-11	03-11
	HDD103-11	35/0B	04-12	03-12	
	HDD103-12	35/0C	04-13	03-13	03-13
	HDD103-13	35/0D	04-14	03-14	
	HDD103-14	35/0E	04-15	03-15	03-15
	HDD103-15	35/0F	04-16	03-16	
	HDD103-16	35/10	04-17	03-17	03-17
	HDD103-17	35/11	04-18	03-18	
	HDD103-18	35/12	04-19	03-19	03-19
	HDD103-19	35/13	04-20	03-20	
	HDD103-20	35/14	04-21	03-21	03-21
	HDD103-21	35/15	04-22	03-22	
	HDD103-22	35/16	04-23	03-23	03-23
	HDD103-23	35/17	04-24/Spare	03-24/Spare	03-23/Spare

THEORY-B-130**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (13/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-104	HDD104-00	32/00	03-01	03-01	03-01
	HDD104-01	32/01	03-02	03-02	
	HDD104-02	32/02	03-03	03-03	03-03
	HDD104-03	32/03	03-04	03-04	
	HDD104-04	32/04	03-05	03-05	03-05
	HDD104-05	32/05	03-06	03-06	
	HDD104-06	32/06	03-07	03-07	03-07
	HDD104-07	32/07	03-08	03-08	
	HDD104-08	32/08	03-09	03-09	03-09
	HDD104-09	32/09	03-10	03-10	
	HDD104-10	32/0A	03-11	03-11	03-11
	HDD104-11	32/0B	03-12	03-12	
	HDD104-12	32/0C	03-13	03-13	03-13
	HDD104-13	32/0D	03-14	03-14	
	HDD104-14	32/0E	03-15	03-15	03-15
	HDD104-15	32/0F	03-16	03-16	
	HDD104-16	32/10	03-17	03-17	03-17
	HDD104-17	32/11	03-18	03-18	
	HDD104-18	32/12	03-19	03-19	03-19
	HDD104-19	32/13	03-20	03-20	
	HDD104-20	32/14	03-21	03-21	03-21
	HDD104-21	32/15	03-22	03-22	
	HDD104-22	32/16	03-23	03-23	03-23
	HDD104-23	32/17	03-24/Spare	03-24/Spare	03-23/Spare

THEORY-B-140**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (14/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-105	HDD105-00	36/00	04-01	03-01	03-01
	HDD105-01	36/01	04-02	03-02	
	HDD105-02	36/02	04-03	03-03	03-03
	HDD105-03	36/03	04-04	03-04	
	HDD105-04	36/04	04-05	03-05	03-05
	HDD105-05	36/05	04-06	03-06	
	HDD105-06	36/06	04-07	03-07	03-07
	HDD105-07	36/07	04-08	03-08	
	HDD105-08	36/08	04-09	03-09	03-09
	HDD105-09	36/09	04-10	03-10	
	HDD105-10	36/0A	04-11	03-11	03-11
	HDD105-11	36/0B	04-12	03-12	
	HDD105-12	36/0C	04-13	03-13	03-13
	HDD105-13	36/0D	04-14	03-14	
	HDD105-14	36/0E	04-15	03-15	03-15
	HDD105-15	36/0F	04-16	03-16	
	HDD105-16	36/10	04-17	03-17	03-17
	HDD105-17	36/11	04-18	03-18	
	HDD105-18	36/12	04-19	03-19	03-19
	HDD105-19	36/13	04-20	03-20	
	HDD105-20	36/14	04-21	03-21	03-21
	HDD105-21	36/15	04-22	03-22	
	HDD105-22	36/16	04-23	03-23	03-23
	HDD105-23	36/17	04-24/Spare	03-24/Spare	03-23/Spare

THEORY-B-150**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (15/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-106	HDD106-00	33/00	03-01	03-01	03-01
	HDD106-01	33/01	03-02	03-02	
	HDD106-02	33/02	03-03	03-03	03-03
	HDD106-03	33/03	03-04	03-04	
	HDD106-04	33/04	03-05	03-05	03-05
	HDD106-05	33/05	03-06	03-06	
	HDD106-06	33/06	03-07	03-07	03-07
	HDD106-07	33/07	03-08	03-08	
	HDD106-08	33/08	03-09	03-09	03-09
	HDD106-09	33/09	03-10	03-10	
	HDD106-10	33/0A	03-11	03-11	03-11
	HDD106-11	33/0B	03-12	03-12	
	HDD106-12	33/0C	03-13	03-13	03-13
	HDD106-13	33/0D	03-14	03-14	
	HDD106-14	33/0E	03-15	03-15	03-15
	HDD106-15	33/0F	03-16	03-16	
	HDD106-16	33/10	03-17	03-17	03-17
	HDD106-17	33/11	03-18	03-18	
	HDD106-18	33/12	03-19	03-19	03-19
	HDD106-19	33/13	03-20	03-20	
	HDD106-20	33/14	03-21	03-21	03-21
	HDD106-21	33/15	03-22	03-22	
	HDD106-22	33/16	03-23	03-23	03-23
	HDD106-23	33/17	03-24/Spare	03-24/Spare	03-23/Spare

THEORY-B-160**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (16/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-107	HDD107-00	37/00	04-01	03-01	03-01
	HDD107-01	37/01	04-02	03-02	
	HDD107-02	37/02	04-03	03-03	03-03
	HDD107-03	37/03	04-04	03-04	
	HDD107-04	37/04	04-05	03-05	03-05
	HDD107-05	37/05	04-06	03-06	
	HDD107-06	37/06	04-07	03-07	03-07
	HDD107-07	37/07	04-08	03-08	
	HDD107-08	37/08	04-09	03-09	03-09
	HDD107-09	37/09	04-10	03-10	
	HDD107-10	37/0A	04-11	03-11	03-11
	HDD107-11	37/0B	04-12	03-12	
	HDD107-12	37/0C	04-13	03-13	03-13
	HDD107-13	37/0D	04-14	03-14	
	HDD107-14	37/0E	04-15	03-15	03-15
	HDD107-15	37/0F	04-16	03-16	
	HDD107-16	37/10	04-17	03-17	03-17
	HDD107-17	37/11	04-18	03-18	
	HDD107-18	37/12	04-19	03-19	03-19
	HDD107-19	37/13	04-20	03-20	
	HDD107-20	37/14	04-21	03-21	03-21
	HDD107-21	37/15	04-22	03-22	
	HDD107-22	37/16	04-23	03-23	03-23
	HDD107-23	37/17	04-24/Spare	03-24/Spare	03-23/Spare

THEORY-B-170**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (17/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-010	HDD010-00	08/00	05-01	05-01	05-01
	HDD010-01	08/01	05-02	05-02	
	HDD010-02	08/02	05-03	05-03	05-03
	HDD010-03	08/03	05-04	05-04	
	HDD010-04	08/04	05-05	05-05	05-05
	HDD010-05	08/05	05-06	05-06	
	HDD010-06	08/06	05-07	05-07	05-07
	HDD010-07	08/07	05-08	05-08	
	HDD010-08	08/08	05-09	05-09	05-09
	HDD010-09	08/09	05-10	05-10	
	HDD010-10	08/0A	05-11	05-11	05-11
	HDD010-11	08/0B	05-12	05-12	
	HDD010-12	08/0C	05-13	05-13	05-13
	HDD010-13	08/0D	05-14	05-14	
	HDD010-14	08/0E	05-15	05-15	05-15
	HDD010-15	08/0F	05-16	05-16	
	HDD010-16	08/10	05-17	05-17	05-17
	HDD010-17	08/11	05-18	05-18	
	HDD010-18	08/12	05-19	05-19	05-19
	HDD010-19	08/13	05-20	05-20	
	HDD010-20	08/14	05-21	05-21	05-21
	HDD010-21	08/15	05-22	05-22	
	HDD010-22	08/16	05-23	05-23	05-23
	HDD010-23	08/17	05-24/Spare	05-24/Spare	05-23/Spare

THEORY-B-180

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (18/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-011	HDD011-00	0C/00	06-01	05-01	05-01
	HDD011-01	0C/01	06-02	05-02	
	HDD011-02	0C/02	06-03	05-03	05-03
	HDD011-03	0C/03	06-04	05-04	
	HDD011-04	0C/04	06-05	05-05	05-05
	HDD011-05	0C/05	06-06	05-06	
	HDD011-06	0C/06	06-07	05-07	05-07
	HDD011-07	0C/07	06-08	05-08	
	HDD011-08	0C/08	06-09	05-09	05-09
	HDD011-09	0C/09	06-10	05-10	
	HDD011-10	0C/0A	06-11	05-11	05-11
	HDD011-11	0C/0B	06-12	05-12	
	HDD011-12	0C/0C	06-13	05-13	05-13
	HDD011-13	0C/0D	06-14	05-14	
	HDD011-14	0C/0E	06-15	05-15	05-15
	HDD011-15	0C/0F	06-16	05-16	
	HDD011-16	0C/10	06-17	05-17	05-17
	HDD011-17	0C/11	06-18	05-18	
	HDD011-18	0C/12	06-19	05-19	05-19
	HDD011-19	0C/13	06-20	05-20	
	HDD011-20	0C/14	06-21	05-21	05-21
	HDD011-21	0C/15	06-22	05-22	
	HDD011-22	0C/16	06-23	05-23	05-23
	HDD011-23	0C/17	06-24/Spare	06-24/Spare	05-23/Spare

THEORY-B-190**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (19/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-012	HDD012-00	09/00	05-01	05-01	05-01
	HDD012-01	09/01	05-02	05-02	
	HDD012-02	09/02	05-03	05-03	05-03
	HDD012-03	09/03	05-04	05-04	
	HDD012-04	09/04	05-05	05-05	05-05
	HDD012-05	09/05	05-06	05-06	
	HDD012-06	09/06	05-07	05-07	05-07
	HDD012-07	09/07	05-08	05-08	
	HDD012-08	09/08	05-09	05-09	05-09
	HDD012-09	09/09	05-10	05-10	
	HDD012-10	09/0A	05-11	05-11	05-11
	HDD012-11	09/0B	05-12	05-12	
	HDD012-12	09/0C	05-13	05-13	05-13
	HDD012-13	09/0D	05-14	05-14	
	HDD012-14	09/0E	05-15	05-15	05-15
	HDD012-15	09/0F	05-16	05-16	
	HDD012-16	09/10	05-17	05-17	05-17
	HDD012-17	09/11	05-18	05-18	
	HDD012-18	09/12	05-19	05-19	05-19
	HDD012-19	09/13	05-20	05-20	
	HDD012-20	09/14	05-21	05-21	05-21
	HDD012-21	09/15	05-22	05-22	
	HDD012-22	09/16	05-23	05-23	05-23
	HDD012-23	09/17	05-24/Spare	05-24/Spare	05-23/Spare

THEORY-B-200**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (20/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-013	HDD013-00	0D/00	06-01	05-01	05-01
	HDD013-01	0D/01	06-02	05-02	
	HDD013-02	0D/02	06-03	05-03	05-03
	HDD013-03	0D/03	06-04	05-04	
	HDD013-04	0D/04	06-05	05-05	05-05
	HDD013-05	0D/05	06-06	05-06	
	HDD013-06	0D/06	06-07	05-07	05-07
	HDD013-07	0D/07	06-08	05-08	
	HDD013-08	0D/08	06-09	05-09	05-09
	HDD013-09	0D/09	06-10	05-10	
	HDD013-10	0D/0A	06-11	05-11	05-11
	HDD013-11	0D/0B	06-12	05-12	
	HDD013-12	0D/0C	06-13	05-13	05-13
	HDD013-13	0D/0D	06-14	05-14	
	HDD013-14	0D/0E	06-15	05-15	05-15
	HDD013-15	0D/0F	06-16	05-16	
	HDD013-16	0D/10	06-17	05-17	05-17
	HDD013-17	0D/11	06-18	05-18	
	HDD013-18	0D/12	06-19	05-19	05-19
	HDD013-19	0D/13	06-20	05-20	
	HDD013-20	0D/14	06-21	05-21	05-21
	HDD013-21	0D/15	06-22	05-22	
	HDD013-22	0D/16	06-23	05-23	05-23
	HDD013-23	0D/17	06-24/Spare	05-24/Spare	05-23/Spare

THEORY-B-210**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (21/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-014	HDD014-00	0A/00	05-01	05-01	05-01
	HDD014-01	0A/01	05-02	05-02	
	HDD014-02	0A/02	05-03	05-03	05-03
	HDD014-03	0A/03	05-04	05-04	
	HDD014-04	0A/04	05-05	05-05	05-05
	HDD014-05	0A/05	05-06	05-06	
	HDD014-06	0A/06	05-07	05-07	05-07
	HDD014-07	0A/07	05-08	05-08	
	HDD014-08	0A/08	05-09	05-09	05-09
	HDD014-09	0A/09	05-10	05-10	
	HDD014-10	0A/0A	05-11	05-11	05-11
	HDD014-11	0A/0B	05-12	05-12	
	HDD014-12	0A/0C	05-13	05-13	05-13
	HDD014-13	0A/0D	05-14	05-14	
	HDD014-14	0A/0E	05-15	05-15	05-15
	HDD014-15	0A/0F	05-16	05-16	
	HDD014-16	0A/10	05-17	05-17	05-17
	HDD014-17	0A/11	05-18	05-18	
	HDD014-18	0A/12	05-19	05-19	05-19
	HDD014-19	0A/13	05-20	05-20	
	HDD014-20	0A/14	05-21	05-21	05-21
	HDD014-21	0A/15	05-22	05-22	
	HDD014-22	0A/16	05-23	05-23	05-23
	HDD014-23	0A/17	05-24/Spare	05-24/Spare	05-23/Spare

THEORY-B-220**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (22/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-015	HDD015-00	0E/00	06-01	05-01	05-01
	HDD015-01	0E/01	06-02	05-02	
	HDD015-02	0E/02	06-03	05-03	05-03
	HDD015-03	0E/03	06-04	05-04	
	HDD015-04	0E/04	06-05	05-05	05-05
	HDD015-05	0E/05	06-06	05-06	
	HDD015-06	0E/06	06-07	05-07	05-07
	HDD015-07	0E/07	06-08	05-08	
	HDD015-08	0E/08	06-09	05-09	05-09
	HDD015-09	0E/09	06-10	05-10	
	HDD015-10	0E/0A	06-11	05-11	05-11
	HDD015-11	0E/0B	06-12	05-12	
	HDD015-12	0E/0C	06-13	05-13	05-13
	HDD015-13	0E/0D	06-14	05-14	
	HDD015-14	0E/0E	06-15	05-15	05-15
	HDD015-15	0E/0F	06-16	05-16	
	HDD015-16	0E/10	06-17	05-17	05-17
	HDD015-17	0E/11	06-18	05-18	
	HDD015-18	0E/12	06-19	05-19	05-19
	HDD015-19	0E/13	06-20	05-20	
	HDD015-20	0E/14	06-21	05-21	05-21
	HDD015-21	0E/15	06-22	05-22	
	HDD015-22	0E/16	06-23	05-23	05-23
	HDD015-23	0E/17	06-24/Spare	05-24/Spare	05-23/Spare

THEORY-B-230**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (23/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-016	HDD016-00	0B/00	05-01	05-01	05-01
	HDD016-01	0B/01	05-02	05-02	
	HDD016-02	0B/02	05-03	05-03	05-03
	HDD016-03	0B/03	05-04	05-04	
	HDD016-04	0B/04	05-05	05-05	05-05
	HDD016-05	0B/05	05-06	05-06	
	HDD016-06	0B/06	05-07	05-07	05-07
	HDD016-07	0B/07	05-08	05-08	
	HDD016-08	0B/08	05-09	05-09	05-09
	HDD016-09	0B/09	05-10	05-10	
	HDD016-10	0B/0A	05-11	05-11	05-11
	HDD016-11	0B/0B	05-12	05-12	
	HDD016-12	0B/0C	05-13	05-13	05-13
	HDD016-13	0B/0D	05-14	05-14	
	HDD016-14	0B/0E	05-15	05-15	05-15
	HDD016-15	0B/0F	05-16	05-16	
	HDD016-16	0B/10	05-17	05-17	05-17
	HDD016-17	0B/11	05-18	05-18	
	HDD016-18	0B/12	05-19	05-19	05-19
	HDD016-19	0B/13	05-20	05-20	
	HDD016-20	0B/14	05-21	05-21	05-21
	HDD016-21	0B/15	05-22	05-22	
	HDD016-22	0B/16	05-23	05-23	05-23
	HDD016-23	0B/17	05-24/Spare	05-24/Spare	05-23/Spare

THEORY-B-240**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (24/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-017	HDD017-00	0F/00	06-01	05-01	05-01
	HDD017-01	0F/01	06-02	05-02	
	HDD017-02	0F/02	06-03	05-03	05-03
	HDD017-03	0F/03	06-04	05-04	
	HDD017-04	0F/04	06-05	05-05	05-05
	HDD017-05	0F/05	06-06	05-06	
	HDD017-06	0F/06	06-07	05-07	05-07
	HDD017-07	0F/07	06-08	05-08	
	HDD017-08	0F/08	06-09	05-09	05-09
	HDD017-09	0F/09	06-10	05-10	
	HDD017-10	0F/0A	06-11	05-11	05-11
	HDD017-11	0F/0B	06-12	05-12	
	HDD017-12	0F/0C	06-13	05-13	05-13
	HDD017-13	0F/0D	06-14	05-14	
	HDD017-14	0F/0E	06-15	05-15	05-15
	HDD017-15	0F/0F	06-16	05-16	
	HDD017-16	0F/10	06-17	05-17	05-17
	HDD017-17	0F/11	06-18	05-18	
	HDD017-18	0F/12	06-19	05-19	05-19
	HDD017-19	0F/13	06-20	05-20	
	HDD017-20	0F/14	06-21	05-21	05-21
	HDD017-21	0F/15	06-22	05-22	
	HDD017-22	0F/16	06-23	05-23	05-23
	HDD017-23	0F/17	06-24/Spare	05-24/Spare	05-23/Spare

THEORY-B-250**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (25/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-110	HDD110-00	38/00	07-01	07-01	07-01
	HDD110-01	38/01	07-02	07-02	
	HDD110-02	38/02	07-03	07-03	07-03
	HDD110-03	38/03	07-04	07-04	
	HDD110-04	38/04	07-05	07-05	07-05
	HDD110-05	38/05	07-06	07-06	
	HDD110-06	38/06	07-07	07-07	07-07
	HDD110-07	38/07	07-08	07-08	
	HDD110-08	38/08	07-09	07-09	07-09
	HDD110-09	38/09	07-10	07-10	
	HDD110-10	38/0A	07-11	07-11	07-11
	HDD110-11	38/0B	07-12	07-12	
	HDD110-12	38/0C	07-13	07-13	07-13
	HDD110-13	38/0D	07-14	07-14	
	HDD110-14	38/0E	07-15	07-15	07-15
	HDD110-15	38/0F	07-16	07-16	
	HDD110-16	38/10	07-17	07-17	07-17
	HDD110-17	38/11	07-18	07-18	
	HDD110-18	38/12	07-19	07-19	07-19
	HDD110-19	38/13	07-20	07-20	
	HDD110-20	38/14	07-21	07-21	07-21
	HDD110-21	38/15	07-22	07-22	
	HDD110-22	38/16	07-23	07-23	07-23
	HDD110-23	38/17	07-24/Spare	07-24/Spare	07-23/Spare

THEORY-B-260**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (26/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-111	HDD111-00	3C/00	08-01	07-01	07-01
	HDD111-01	3C/01	08-02	07-02	
	HDD111-02	3C/02	08-03	07-03	07-03
	HDD111-03	3C/03	08-04	07-04	
	HDD111-04	3C/04	08-05	07-05	07-05
	HDD111-05	3C/05	08-06	07-06	
	HDD111-06	3C/06	08-07	07-07	07-07
	HDD111-07	3C/07	08-08	07-08	
	HDD111-08	3C/08	08-09	07-09	07-09
	HDD111-09	3C/09	08-10	07-10	
	HDD111-10	3C/0A	08-11	07-11	07-11
	HDD111-11	3C/0B	08-12	07-12	
	HDD111-12	3C/0C	08-13	07-13	07-13
	HDD111-13	3C/0D	08-14	07-14	
	HDD111-14	3C/0E	08-15	07-15	07-15
	HDD111-15	3C/0F	08-16	07-16	
	HDD111-16	3C/10	08-17	07-17	07-17
	HDD111-17	3C/11	08-18	07-18	
	HDD111-18	3C/12	08-19	07-19	07-19
	HDD111-19	3C/13	08-20	07-20	
	HDD111-20	3C/14	08-21	07-21	07-21
	HDD111-21	3C/15	08-22	07-22	
	HDD111-22	3C/16	08-23	07-23	07-23
	HDD111-23	3C/17	08-24/Spare	07-24/Spare	07-23/Spare

THEORY-B-270**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (27/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-112	HDD112-00	39/00	07-01	07-01	07-01
	HDD112-01	39/01	07-02	07-02	
	HDD112-02	39/02	07-03	07-03	07-03
	HDD112-03	39/03	07-04	07-04	
	HDD112-04	39/04	07-05	07-05	07-05
	HDD112-05	39/05	07-06	07-06	
	HDD112-06	39/06	07-07	07-07	07-07
	HDD112-07	39/07	07-08	07-08	
	HDD112-08	39/08	07-09	07-09	07-09
	HDD112-09	39/09	07-10	07-10	
	HDD112-10	39/0A	07-11	07-11	07-11
	HDD112-11	39/0B	07-12	07-12	
	HDD112-12	39/0C	07-13	07-13	07-13
	HDD112-13	39/0D	07-14	07-14	
	HDD112-14	39/0E	07-15	07-15	07-15
	HDD112-15	39/0F	07-16	07-16	
	HDD112-16	39/10	07-17	07-17	07-17
	HDD112-17	39/11	07-18	07-18	
	HDD112-18	39/12	07-19	07-19	07-19
	HDD112-19	39/13	07-20	07-20	
	HDD112-20	39/14	07-21	07-21	07-21
	HDD112-21	39/15	07-22	07-22	
	HDD112-22	39/16	07-23	07-23	07-23
	HDD112-23	39/17	07-24/Spare	07-24/Spare	07-23/Spare

THEORY-B-280**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (28/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-113	HDD113-00	3D/00	08-01	07-01	07-01
	HDD113-01	3D/01	08-02	07-02	
	HDD113-02	3D/02	08-03	07-03	07-03
	HDD113-03	3D/03	08-04	07-04	
	HDD113-04	3D/04	08-05	07-05	07-05
	HDD113-05	3D/05	08-06	07-06	
	HDD113-06	3D/06	08-07	07-07	07-07
	HDD113-07	3D/07	08-08	07-08	
	HDD113-08	3D/08	08-09	07-09	07-09
	HDD113-09	3D/09	08-10	07-10	
	HDD113-10	3D/0A	08-11	07-11	07-11
	HDD113-11	3D/0B	08-12	07-12	
	HDD113-12	3D/0C	08-13	07-13	07-13
	HDD113-13	3D/0D	08-14	07-14	
	HDD113-14	3D/0E	08-15	07-15	07-15
	HDD113-15	3D/0F	08-16	07-16	
	HDD113-16	3D/10	08-17	07-17	07-17
	HDD113-17	3D/11	08-18	07-18	
	HDD113-18	3D/12	08-19	07-19	07-19
	HDD113-19	3D/13	08-20	07-20	
	HDD113-20	3D/14	08-21	07-21	07-21
	HDD113-21	3D/15	08-22	07-22	
	HDD113-22	3D/16	08-23	07-23	07-23
	HDD113-23	3D/17	08-24/Spare	07-24/Spare	07-23/Spare

THEORY-B-290**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (29/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-114	HDD114-00	3A/00	07-01	07-01	07-01
	HDD114-01	3A/01	07-02	07-02	
	HDD114-02	3A/02	07-03	07-03	07-03
	HDD114-03	3A/03	07-04	07-04	
	HDD114-04	3A/04	07-05	07-05	07-05
	HDD114-05	3A/05	07-06	07-06	
	HDD114-06	3A/06	07-07	07-07	07-07
	HDD114-07	3A/07	07-08	07-08	
	HDD114-08	3A/08	07-09	07-09	07-09
	HDD114-09	3A/09	07-10	07-10	
	HDD114-10	3A/0A	07-11	07-11	07-11
	HDD114-11	3A/0B	07-12	07-12	
	HDD114-12	3A/0C	07-13	07-13	07-13
	HDD114-13	3A/0D	07-14	07-14	
	HDD114-14	3A/0E	07-15	07-15	07-15
	HDD114-15	3A/0F	07-16	07-16	
	HDD114-16	3A/10	07-17	07-17	07-17
	HDD114-17	3A/11	07-18	07-18	
	HDD114-18	3A/12	07-19	07-19	07-19
	HDD114-19	3A/13	07-20	07-20	
	HDD114-20	3A/14	07-21	07-21	07-21
	HDD114-21	3A/15	07-22	07-22	
	HDD114-22	3A/16	07-23	07-23	07-23
	HDD114-23	3A/17	07-24/Spare	07-24/Spare	07-23/Spare

THEORY-B-300**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (30/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-115	HDD115-00	3E/00	08-01	07-01	07-01
	HDD115-01	3E/01	08-02	07-02	
	HDD115-02	3E/02	08-03	07-03	07-03
	HDD115-03	3E/03	08-04	07-04	
	HDD115-04	3E/04	08-05	07-05	07-05
	HDD115-05	3E/05	08-06	07-06	
	HDD115-06	3E/06	08-07	07-07	07-07
	HDD115-07	3E/07	08-08	07-08	
	HDD115-08	3E/08	08-09	07-09	07-09
	HDD115-09	3E/09	08-10	07-10	
	HDD115-10	3E/0A	08-11	07-11	07-11
	HDD115-11	3E/0B	08-12	07-12	
	HDD115-12	3E/0C	08-13	07-13	07-13
	HDD115-13	3E/0D	08-14	07-14	
	HDD115-14	3E/0E	08-15	07-15	07-15
	HDD115-15	3E/0F	08-16	07-16	
	HDD115-16	3E/10	08-17	07-17	07-17
	HDD115-17	3E/11	08-18	07-18	
	HDD115-18	3E/12	08-19	07-19	07-19
	HDD115-19	3E/13	08-20	07-20	
	HDD115-20	3E/14	08-21	07-21	07-21
	HDD115-21	3E/15	08-22	07-22	
	HDD115-22	3E/16	08-23	07-23	07-23
	HDD115-23	3E/17	08-24/Spare	07-24/Spare	07-23/Spare

THEORY-B-310**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (31/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-116	HDD116-00	3B/00	07-01	07-01	07-01
	HDD116-01	3B/01	07-02	07-02	
	HDD116-02	3B/02	07-03	07-03	07-03
	HDD116-03	3B/03	07-04	07-04	
	HDD116-04	3B/04	07-05	07-05	07-05
	HDD116-05	3B/05	07-06	07-06	
	HDD116-06	3B/06	07-07	07-07	07-07
	HDD116-07	3B/07	07-08	07-08	
	HDD116-08	3B/08	07-09	07-09	07-09
	HDD116-09	3B/09	07-10	07-10	
	HDD116-10	3B/0A	07-11	07-11	07-11
	HDD116-11	3B/0B	07-12	07-12	
	HDD116-12	3B/0C	07-13	07-13	07-13
	HDD116-13	3B/0D	07-14	07-14	
	HDD116-14	3B/0E	07-15	07-15	07-15
	HDD116-15	3B/0F	07-16	07-16	
	HDD116-16	3B/10	07-17	07-17	07-17
	HDD116-17	3B/11	07-18	07-18	
	HDD116-18	3B/12	07-19	07-19	07-19
	HDD116-19	3B/13	07-20	07-20	
	HDD116-20	3B/14	07-21	07-21	07-21
	HDD116-21	3B/15	07-22	07-22	
	HDD116-22	3B/16	07-23	07-23	07-23
	HDD116-23	3B/17	07-24/Spare	07-24/Spare	07-23/Spare

THEORY-B-320**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (32/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-117	HDD117-00	3F/00	08-01	07-01	07-01
	HDD117-01	3F/01	08-02	07-02	
	HDD117-02	3F/02	08-03	07-03	07-03
	HDD117-03	3F/03	08-04	07-04	
	HDD117-04	3F/04	08-05	07-05	07-05
	HDD117-05	3F/05	08-06	07-06	
	HDD117-06	3F/06	08-07	07-07	07-07
	HDD117-07	3F/07	08-08	07-08	
	HDD117-08	3F/08	08-09	07-09	07-09
	HDD117-09	3F/09	08-10	07-10	
	HDD117-10	3F/0A	08-11	07-11	07-11
	HDD117-11	3F/0B	08-12	07-12	
	HDD117-12	3F/0C	08-13	07-13	07-13
	HDD117-13	3F/0D	08-14	07-14	
	HDD117-14	3F/0E	08-15	07-15	07-15
	HDD117-15	3F/0F	08-16	07-16	
	HDD117-16	3F/10	08-17	07-17	07-17
	HDD117-17	3F/11	08-18	07-18	
	HDD117-18	3F/12	08-19	07-19	07-19
	HDD117-19	3F/13	08-20	07-20	
	HDD117-20	3F/14	08-21	07-21	07-21
	HDD117-21	3F/15	08-22	07-22	
	HDD117-22	3F/16	08-23	07-23	07-23
	HDD117-23	3F/17	08-24/Spare	07-24/Spare	07-23/Spare

THEORY-B-330

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (33/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-020	HDD020-00	10/00	09-01	09-01	09-01
	HDD020-01	10/01	09-02	09-02	
	HDD020-02	10/02	09-03	09-03	09-03
	HDD020-03	10/03	09-04	09-04	
	HDD020-04	10/04	09-05	09-05	09-05
	HDD020-05	10/05	09-06	09-06	
	HDD020-06	10/06	09-07	09-07	09-07
	HDD020-07	10/07	09-08	09-08	
	HDD020-08	10/08	09-09	09-09	09-09
	HDD020-09	10/09	09-10	09-10	
	HDD020-10	10/0A	09-11	09-11	09-11
	HDD020-11	10/0B	09-12	09-12	
	HDD020-12	10/0C	09-13	09-13	09-13
	HDD020-13	10/0D	09-14	09-14	
	HDD020-14	10/0E	09-15	09-15	09-15
	HDD020-15	10/0F	09-16	09-16	
	HDD020-16	10/10	09-17	09-17	09-17
	HDD020-17	10/11	09-18	09-18	
	HDD020-18	10/12	09-19	09-19	09-19
	HDD020-19	10/13	09-20	09-20	
	HDD020-20	10/14	09-21	09-21	09-21
	HDD020-21	10/15	09-22	09-22	
	HDD020-22	10/16	09-23	09-23	09-23
	HDD020-23	10/17	09-24/Spare	09-24/Spare	09-23/Spare

THEORY-B-340

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (34/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-021	HDD021-00	14/00	10-01	09-01	09-01
	HDD021-01	14/01	10-02	09-02	
	HDD021-02	14/02	10-03	09-03	09-03
	HDD021-03	14/03	10-04	09-04	
	HDD021-04	14/04	10-05	09-05	09-05
	HDD021-05	14/05	10-06	09-06	
	HDD021-06	14/06	10-07	09-07	09-07
	HDD021-07	14/07	10-08	09-08	
	HDD021-08	14/08	10-09	09-09	09-09
	HDD021-09	14/09	10-10	09-10	
	HDD021-10	14/0A	10-11	09-11	09-11
	HDD021-11	14/0B	10-12	09-12	
	HDD021-12	14/0C	10-13	09-13	09-13
	HDD021-13	14/0D	10-14	09-14	
	HDD021-14	14/0E	10-15	09-15	09-15
	HDD021-15	14/0F	10-16	09-16	
	HDD021-16	14/10	10-17	09-17	09-17
	HDD021-17	14/11	10-18	09-18	
	HDD021-18	14/12	10-19	09-19	09-19
	HDD021-19	14/13	10-20	09-20	
	HDD021-20	14/14	10-21	09-21	09-21
	HDD021-21	14/15	10-22	09-22	
	HDD021-22	14/16	10-23	09-23	09-23
	HDD021-23	14/17	10-24/Spare	09-24/Spare	09-23/Spare

THEORY-B-350**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (35/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-022	HDD022-00	11/00	09-01	09-01	09-01
	HDD022-01	11/01	09-02	09-02	
	HDD022-02	11/02	09-03	09-03	09-03
	HDD022-03	11/03	09-04	09-04	
	HDD022-04	11/04	09-05	09-05	09-05
	HDD022-05	11/05	09-06	09-06	
	HDD022-06	11/06	09-07	09-07	09-07
	HDD022-07	11/07	09-08	09-08	
	HDD022-08	11/08	09-09	09-09	09-09
	HDD022-09	11/09	09-10	09-10	
	HDD022-10	11/0A	09-11	09-11	09-11
	HDD022-11	11/0B	09-12	09-12	
	HDD022-12	11/0C	09-13	09-13	09-13
	HDD022-13	11/0D	09-14	09-14	
	HDD022-14	11/0E	09-15	09-15	09-15
	HDD022-15	11/0F	09-16	09-16	
	HDD022-16	11/10	09-17	09-17	09-17
	HDD022-17	11/11	09-18	09-18	
	HDD022-18	11/12	09-19	09-19	09-19
	HDD022-19	11/13	09-20	09-20	
	HDD022-20	11/14	09-21	09-21	09-21
	HDD022-21	11/15	09-22	09-22	
	HDD022-22	11/16	09-23	09-23	09-23
	HDD022-23	11/17	09-24/Spare	09-24/Spare	09-23/Spare

THEORY-B-360**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (36/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-023	HDD023-00	15/00	10-01	09-01	09-01
	HDD023-01	15/01	10-02	09-02	
	HDD023-02	15/02	10-03	09-03	09-03
	HDD023-03	15/03	10-04	09-04	
	HDD023-04	15/04	10-05	09-05	09-05
	HDD023-05	15/05	10-06	09-06	
	HDD023-06	15/06	10-07	09-07	09-07
	HDD023-07	15/07	10-08	09-08	
	HDD023-08	15/08	10-09	09-09	09-09
	HDD023-09	15/09	10-10	09-10	
	HDD023-10	15/0A	10-11	09-11	09-11
	HDD023-11	15/0B	10-12	09-12	
	HDD023-12	15/0C	10-13	09-13	09-13
	HDD023-13	15/0D	10-14	09-14	
	HDD023-14	15/0E	10-15	09-15	09-15
	HDD023-15	15/0F	10-16	09-16	
	HDD023-16	15/10	10-17	09-17	09-17
	HDD023-17	15/11	10-18	09-18	
	HDD023-18	15/12	10-19	09-19	09-19
	HDD023-19	15/13	10-20	09-20	
	HDD023-20	15/14	10-21	09-21	09-21
	HDD023-21	15/15	10-22	09-22	
	HDD023-22	15/16	10-23	09-23	09-23
	HDD023-23	15/17	10-24/Spare	09-24/Spare	09-23/Spare

THEORY-B-370**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (37/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-024	HDD024-00	12/00	09-01	09-01	09-01
	HDD024-01	12/01	09-02	09-02	
	HDD024-02	12/02	09-03	09-03	09-03
	HDD024-03	12/03	09-04	09-04	
	HDD024-04	12/04	09-05	09-05	09-05
	HDD024-05	12/05	09-06	09-06	
	HDD024-06	12/06	09-07	09-07	09-07
	HDD024-07	12/07	09-08	09-08	
	HDD024-08	12/08	09-09	09-09	09-09
	HDD024-09	12/09	09-10	09-10	
	HDD024-10	12/0A	09-11	09-11	09-11
	HDD024-11	12/0B	09-12	09-12	
	HDD024-12	12/0C	09-13	09-13	09-13
	HDD024-13	12/0D	09-14	09-14	
	HDD024-14	12/0E	09-15	09-15	09-15
	HDD024-15	12/0F	09-16	09-16	
	HDD024-16	12/10	09-17	09-17	09-17
	HDD024-17	12/11	09-18	09-18	
	HDD024-18	12/12	09-19	09-19	09-19
	HDD024-19	12/13	09-20	09-20	
	HDD024-20	12/14	09-21	09-21	09-21
	HDD024-21	12/15	09-22	09-22	
	HDD024-22	12/16	09-23	09-23	09-23
	HDD024-23	12/17	09-24/Spare	09-24/Spare	09-23/Spare

THEORY-B-380

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (38/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-025	HDD025-00	16/00	10-01	09-01	09-01
	HDD025-01	16/01	10-02	09-02	
	HDD025-02	16/02	10-03	09-03	09-03
	HDD025-03	16/03	10-04	09-04	
	HDD025-04	16/04	10-05	09-05	09-05
	HDD025-05	16/05	10-06	09-06	
	HDD025-06	16/06	10-07	09-07	09-07
	HDD025-07	16/07	10-08	09-08	
	HDD025-08	16/08	10-09	09-09	09-09
	HDD025-09	16/09	10-10	09-10	
	HDD025-10	16/0A	10-11	09-11	09-11
	HDD025-11	16/0B	10-12	09-12	
	HDD025-12	16/0C	10-13	09-13	09-13
	HDD025-13	16/0D	10-14	09-14	
	HDD025-14	16/0E	10-15	09-15	09-15
	HDD025-15	16/0F	10-16	09-16	
	HDD025-16	16/10	10-17	09-17	09-17
	HDD025-17	16/11	10-18	09-18	
	HDD025-18	16/12	10-19	09-19	09-19
	HDD025-19	16/13	10-20	09-20	
	HDD025-20	16/14	10-21	09-21	09-21
	HDD025-21	16/15	10-22	09-22	
	HDD025-22	16/16	10-23	09-23	09-23
	HDD025-23	16/17	10-24/Spare	09-24/Spare	09-23/Spare

THEORY-B-390**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (39/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-026	HDD026-00	13/00	09-01	09-01	09-01
	HDD026-01	13/01	09-02	09-02	
	HDD026-02	13/02	09-03	09-03	09-03
	HDD026-03	13/03	09-04	09-04	
	HDD026-04	13/04	09-05	09-05	09-05
	HDD026-05	13/05	09-06	09-06	
	HDD026-06	13/06	09-07	09-07	09-07
	HDD026-07	13/07	09-08	09-08	
	HDD026-08	13/08	09-09	09-09	09-09
	HDD026-09	13/09	09-10	09-10	
	HDD026-10	13/0A	09-11	09-11	09-11
	HDD026-11	13/0B	09-12	09-12	
	HDD026-12	13/0C	09-13	09-13	09-13
	HDD026-13	13/0D	09-14	09-14	
	HDD026-14	13/0E	09-15	09-15	09-15
	HDD026-15	13/0F	09-16	09-16	
	HDD026-16	13/10	09-17	09-17	09-17
	HDD026-17	13/11	09-18	09-18	
	HDD026-18	13/12	09-19	09-19	09-19
	HDD026-19	13/13	09-20	09-20	
	HDD026-20	13/14	09-21	09-21	09-21
	HDD026-21	13/15	09-22	09-22	
	HDD026-22	13/16	09-23	09-23	09-23
	HDD026-23	13/17	09-24/Spare	09-24/Spare	09-23/Spare

THEORY-B-400**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (40/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-027	HDD027-00	17/00	10-01	09-01	09-01
	HDD027-01	17/01	10-02	09-02	
	HDD027-02	17/02	10-03	09-03	09-03
	HDD027-03	17/03	10-04	09-04	
	HDD027-04	17/04	10-05	09-05	09-05
	HDD027-05	17/05	10-06	09-06	
	HDD027-06	17/06	10-07	09-07	09-07
	HDD027-07	17/07	10-08	09-08	
	HDD027-08	17/08	10-09	09-09	09-09
	HDD027-09	17/09	10-10	09-10	
	HDD027-10	17/0A	10-11	09-11	09-11
	HDD027-11	17/0B	10-12	09-12	
	HDD027-12	17/0C	10-13	09-13	09-13
	HDD027-13	17/0D	10-14	09-14	
	HDD027-14	17/0E	10-15	09-15	09-15
	HDD027-15	17/0F	10-16	09-16	
	HDD027-16	17/10	10-17	09-17	09-17
	HDD027-17	17/11	10-18	09-18	
	HDD027-18	17/12	10-19	09-19	09-19
	HDD027-19	17/13	10-20	09-20	
	HDD027-20	17/14	10-21	09-21	09-21
	HDD027-21	17/15	10-22	09-22	
	HDD027-22	17/16	10-23	09-23	09-23
	HDD027-23	17/17	10-24/Spare	09-24/Spare	09-23/Spare

THEORY-B-410**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (41/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-120	HDD120-00	40/00	11-01	11-01	11-01
	HDD120-01	40/01	11-02	11-02	
	HDD120-02	40/02	11-03	11-03	11-03
	HDD120-03	40/03	11-04	11-04	
	HDD120-04	40/04	11-05	11-05	11-05
	HDD120-05	40/05	11-06	11-06	
	HDD120-06	40/06	11-07	11-07	11-07
	HDD120-07	40/07	11-08	11-08	
	HDD120-08	40/08	11-09	11-09	11-09
	HDD120-09	40/09	11-10	11-10	
	HDD120-10	40/0A	11-11	11-11	11-11
	HDD120-11	40/0B	11-12	11-12	
	HDD120-12	40/0C	11-13	11-13	11-13
	HDD120-13	40/0D	11-14	11-14	
	HDD120-14	40/0E	11-15	11-15	11-15
	HDD120-15	40/0F	11-16	11-16	
	HDD120-16	40/10	11-17	11-17	11-17
	HDD120-17	40/11	11-18	11-18	
	HDD120-18	40/12	11-19	11-19	11-19
	HDD120-19	40/13	11-20	11-20	
	HDD120-20	40/14	11-21	11-21	11-21
	HDD120-21	40/15	11-22	11-22	
	HDD120-22	40/16	11-23	11-23	11-23
	HDD120-23	40/17	11-24/Spare	11-24/Spare	11-23/Spare

THEORY-B-420**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (42/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-121	HDD121-00	44/00	12-01	11-01	11-01
	HDD121-01	44/01	12-02	11-02	
	HDD121-02	44/02	12-03	11-03	11-03
	HDD121-03	44/03	12-04	11-04	
	HDD121-04	44/04	12-05	11-05	11-05
	HDD121-05	44/05	12-06	11-06	
	HDD121-06	44/06	12-07	11-07	11-07
	HDD121-07	44/07	12-08	11-08	
	HDD121-08	44/08	12-09	11-09	11-09
	HDD121-09	44/09	12-10	11-10	
	HDD121-10	44/0A	12-11	11-11	11-11
	HDD121-11	44/0B	12-12	11-12	
	HDD121-12	44/0C	12-13	11-13	11-13
	HDD121-13	44/0D	12-14	11-14	
	HDD121-14	44/0E	12-15	11-15	11-15
	HDD121-15	44/0F	12-16	11-16	
	HDD121-16	44/10	12-17	11-17	11-17
	HDD121-17	44/11	12-18	11-18	
	HDD121-18	44/12	12-19	11-19	11-19
	HDD121-19	44/13	12-20	11-20	
	HDD121-20	44/14	12-21	11-21	11-21
	HDD121-21	44/15	12-22	11-22	
	HDD121-22	44/16	12-23	11-23	11-23
	HDD121-23	44/17	12-24/Spare	11-24/Spare	11-23/Spare

THEORY-B-430

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (43/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-122	HDD122-00	41/00	11-01	11-01	11-01
	HDD122-01	41/01	11-02	11-02	
	HDD122-02	41/02	11-03	11-03	11-03
	HDD122-03	41/03	11-04	11-04	
	HDD122-04	41/04	11-05	11-05	11-05
	HDD122-05	41/05	11-06	11-06	
	HDD122-06	41/06	11-07	11-07	11-07
	HDD122-07	41/07	11-08	11-08	
	HDD122-08	41/08	11-09	11-09	11-09
	HDD122-09	41/09	11-10	11-10	
	HDD122-10	41/0A	11-11	11-11	11-11
	HDD122-11	41/0B	11-12	11-12	
	HDD122-12	41/0C	11-13	11-13	11-13
	HDD122-13	41/0D	11-14	11-14	
	HDD122-14	41/0E	11-15	11-15	11-15
	HDD122-15	41/0F	11-16	11-16	
	HDD122-16	41/10	11-17	11-17	11-17
	HDD122-17	41/11	11-18	11-18	
	HDD122-18	41/12	11-19	11-19	11-19
	HDD122-19	41/13	11-20	11-20	
	HDD122-20	41/14	11-21	11-21	11-21
	HDD122-21	41/15	11-22	11-22	
	HDD122-22	41/16	11-23	11-23	11-23
	HDD122-23	41/17	11-24/Spare	11-24/Spare	11-23/Spare

THEORY-B-440**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (44/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-123	HDD123-00	45/00	12-01	11-01	11-01
	HDD123-01	45/01	12-02	11-02	
	HDD123-02	45/02	12-03	11-03	11-03
	HDD123-03	45/03	12-04	11-04	
	HDD123-04	45/04	12-05	11-05	11-05
	HDD123-05	45/05	12-06	11-06	
	HDD123-06	45/06	12-07	11-07	11-07
	HDD123-07	45/07	12-08	11-08	
	HDD123-08	45/08	12-09	11-09	11-09
	HDD123-09	45/09	12-10	11-10	
	HDD123-10	45/0A	12-11	11-11	11-11
	HDD123-11	45/0B	12-12	11-12	
	HDD123-12	45/0C	12-13	11-13	11-13
	HDD123-13	45/0D	12-14	11-14	
	HDD123-14	45/0E	12-15	11-15	11-15
	HDD123-15	45/0F	12-16	11-16	
	HDD123-16	45/10	12-17	11-17	11-17
	HDD123-17	45/11	12-18	11-18	
	HDD123-18	45/12	12-19	11-19	11-19
	HDD123-19	45/13	12-20	11-20	
	HDD123-20	45/14	12-21	11-21	11-21
	HDD123-21	45/15	12-22	11-22	
	HDD123-22	45/16	12-23	11-23	11-23
	HDD123-23	45/17	12-24/Spare	11-24/Spare	11-23/Spare

THEORY-B-450**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (45/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-124	HDD124-00	42/00	11-01	11-01	11-01
	HDD124-01	42/01	11-02	11-02	
	HDD124-02	42/02	11-03	11-03	11-03
	HDD124-03	42/03	11-04	11-04	
	HDD124-04	42/04	11-05	11-05	11-05
	HDD124-05	42/05	11-06	11-06	
	HDD124-06	42/06	11-07	11-07	11-07
	HDD124-07	42/07	11-08	11-08	
	HDD124-08	42/08	11-09	11-09	11-09
	HDD124-09	42/09	11-10	11-10	
	HDD124-10	42/0A	11-11	11-11	11-11
	HDD124-11	42/0B	11-12	11-12	
	HDD124-12	42/0C	11-13	11-13	11-13
	HDD124-13	42/0D	11-14	11-14	
	HDD124-14	42/0E	11-15	11-15	11-15
	HDD124-15	42/0F	11-16	11-16	
	HDD124-16	42/10	11-17	11-17	11-17
	HDD124-17	42/11	11-18	11-18	
	HDD124-18	42/12	11-19	11-19	11-19
	HDD124-19	42/13	11-20	11-20	
	HDD124-20	42/14	11-21	11-21	11-21
	HDD124-21	42/15	11-22	11-22	
	HDD124-22	42/16	11-23	11-23	11-23
	HDD124-23	42/17	11-24/Spare	11-24/Spare	11-23/Spare

THEORY-B-460**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (46/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-125	HDD125-00	46/00	12-01	11-01	11-01
	HDD125-01	46/01	12-02	11-02	
	HDD125-02	46/02	12-03	11-03	11-03
	HDD125-03	46/03	12-04	11-04	
	HDD125-04	46/04	12-05	11-05	11-05
	HDD125-05	46/05	12-06	11-06	
	HDD125-06	46/06	12-07	11-07	11-07
	HDD125-07	46/07	12-08	11-08	
	HDD125-08	46/08	12-09	11-09	11-09
	HDD125-09	46/09	12-10	11-10	
	HDD125-10	46/0A	12-11	11-11	11-11
	HDD125-11	46/0B	12-12	11-12	
	HDD125-12	46/0C	12-13	11-13	11-13
	HDD125-13	46/0D	12-14	11-14	
	HDD125-14	46/0E	12-15	11-15	11-15
	HDD125-15	46/0F	12-16	11-16	
	HDD125-16	46/10	12-17	11-17	11-17
	HDD125-17	46/11	12-18	11-18	
	HDD125-18	46/12	12-19	11-19	11-19
	HDD125-19	46/13	12-20	11-20	
	HDD125-20	46/14	12-21	11-21	11-21
	HDD125-21	46/15	12-22	11-22	
	HDD125-22	46/16	12-23	11-23	11-23
	HDD125-23	46/17	12-24/Spare	11-24/Spare	11-23/Spare

THEORY-B-470**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (47/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-126	HDD126-00	43/00	11-01	11-01	11-01
	HDD126-01	43/01	11-02	11-02	
	HDD126-02	43/02	11-03	11-03	11-03
	HDD126-03	43/03	11-04	11-04	
	HDD126-04	43/04	11-05	11-05	11-05
	HDD126-05	43/05	11-06	11-06	
	HDD126-06	43/06	11-07	11-07	11-07
	HDD126-07	43/07	11-08	11-08	
	HDD126-08	43/08	11-09	11-09	11-09
	HDD126-09	43/09	11-10	11-10	
	HDD126-10	43/0A	11-11	11-11	11-11
	HDD126-11	43/0B	11-12	11-12	
	HDD126-12	43/0C	11-13	11-13	11-13
	HDD126-13	43/0D	11-14	11-14	
	HDD126-14	43/0E	11-15	11-15	11-15
	HDD126-15	43/0F	11-16	11-16	
	HDD126-16	43/10	11-17	11-17	11-17
	HDD126-17	43/11	11-18	11-18	
	HDD126-18	43/12	11-19	11-19	11-19
	HDD126-19	43/13	11-20	11-20	
	HDD126-20	43/14	11-21	11-21	11-21
	HDD126-21	43/15	11-22	11-22	
	HDD126-22	43/16	11-23	11-23	11-23
	HDD126-23	43/17	11-24/Spare	11-24/Spare	11-23/Spare

THEORY-B-480

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (48/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-127	HDD127-00	47/00	12-01	11-01	11-01
	HDD127-01	47/01	12-02	11-02	
	HDD127-02	47/02	12-03	11-03	11-03
	HDD127-03	47/03	12-04	11-04	
	HDD127-04	47/04	12-05	11-05	11-05
	HDD127-05	47/05	12-06	11-06	
	HDD127-06	47/06	12-07	11-07	11-07
	HDD127-07	47/07	12-08	11-08	
	HDD127-08	47/08	12-09	11-09	11-09
	HDD127-09	47/09	12-10	11-10	
	HDD127-10	47/0A	12-11	11-11	11-11
	HDD127-11	47/0B	12-12	11-12	
	HDD127-12	47/0C	12-13	11-13	11-13
	HDD127-13	47/0D	12-14	11-14	
	HDD127-14	47/0E	12-15	11-15	11-15
	HDD127-15	47/0F	12-16	11-16	
	HDD127-16	47/10	12-17	11-17	11-17
	HDD127-17	47/11	12-18	11-18	
	HDD127-18	47/12	12-19	11-19	11-19
	HDD127-19	47/13	12-20	11-20	
	HDD127-20	47/14	12-21	11-21	11-21
	HDD127-21	47/15	12-22	11-22	
	HDD127-22	47/16	12-23	11-23	11-23
	HDD127-23	47/17	12-24/Spare	11-24/Spare	11-23/Spare

THEORY-B-490**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (49/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-030	HDD030-00	18/00	13-01	13-01	13-01
	HDD030-01	18/01	13-02	13-02	
	HDD030-02	18/02	13-03	13-03	13-03
	HDD030-03	18/03	13-04	13-04	
	HDD030-04	18/04	13-05	13-05	13-05
	HDD030-05	18/05	13-06	13-06	
	HDD030-06	18/06	13-07	13-07	13-07
	HDD030-07	18/07	13-08	13-08	
	HDD030-08	18/08	13-09	13-09	13-09
	HDD030-09	18/09	13-10	13-10	
	HDD030-10	18/0A	13-11	13-11	13-11
	HDD030-11	18/0B	13-12	13-12	
	HDD030-12	18/0C	13-13	13-13	13-13
	HDD030-13	18/0D	13-14	13-14	
	HDD030-14	18/0E	13-15	13-15	13-15
	HDD030-15	18/0F	13-16	13-16	
	HDD030-16	18/10	13-17	13-17	13-17
	HDD030-17	18/11	13-18	13-18	
	HDD030-18	18/12	13-19	13-19	13-19
	HDD030-19	18/13	13-20	13-20	
	HDD030-20	18/14	13-21	13-21	13-21
	HDD030-21	18/15	13-22	13-22	
	HDD030-22	18/16	13-23	13-23	13-23
	HDD030-23	18/17	13-24/Spare	13-24/Spare	13-23/Spare

THEORY-B-500**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (50/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-031	HDD031-00	1C/00	14-01	13-01	13-01
	HDD031-01	1C/01	14-02	13-02	
	HDD031-02	1C/02	14-03	13-03	13-03
	HDD031-03	1C/03	14-04	13-04	
	HDD031-04	1C/04	14-05	13-05	13-05
	HDD031-05	1C/05	14-06	13-06	
	HDD031-06	1C/06	14-07	13-07	13-07
	HDD031-07	1C/07	14-08	13-08	
	HDD031-08	1C/08	14-09	13-09	13-09
	HDD031-09	1C/09	14-10	13-10	
	HDD031-10	1C/0A	14-11	13-11	13-11
	HDD031-11	1C/0B	14-12	13-12	
	HDD031-12	1C/0C	14-13	13-13	13-13
	HDD031-13	1C/0D	14-14	13-14	
	HDD031-14	1C/0E	14-15	13-15	13-15
	HDD031-15	1C/0F	14-16	13-16	
	HDD031-16	1C/10	14-17	13-17	13-17
	HDD031-17	1C/11	14-18	13-18	
	HDD031-18	1C/12	14-19	13-19	13-19
	HDD031-19	1C/13	14-20	13-20	
	HDD031-20	1C/14	14-21	13-21	13-21
	HDD031-21	1C/15	14-22	13-22	
	HDD031-22	1C/16	14-23	13-23	13-23
	HDD031-23	1C/17	14-24/Spare	13-24/Spare	13-23/Spare

THEORY-B-510**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (51/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-032	HDD032-00	19/00	13-01	13-01	13-01
	HDD032-01	19/01	13-02	13-02	
	HDD032-02	19/02	13-03	13-03	13-03
	HDD032-03	19/03	13-04	13-04	
	HDD032-04	19/04	13-05	13-05	13-05
	HDD032-05	19/05	13-06	13-06	
	HDD032-06	19/06	13-07	13-07	13-07
	HDD032-07	19/07	13-08	13-08	
	HDD032-08	19/08	13-09	13-09	13-09
	HDD032-09	19/09	13-10	13-10	
	HDD032-10	19/0A	13-11	13-11	13-11
	HDD032-11	19/0B	13-12	13-12	
	HDD032-12	19/0C	13-13	13-13	13-13
	HDD032-13	19/0D	13-14	13-14	
	HDD032-14	19/0E	13-15	13-15	13-15
	HDD032-15	19/0F	13-16	13-16	
	HDD032-16	19/10	13-17	13-17	13-17
	HDD032-17	19/11	13-18	13-18	
	HDD032-18	19/12	13-19	13-19	13-19
	HDD032-19	19/13	13-20	13-20	
	HDD032-20	19/14	13-21	13-21	13-21
	HDD032-21	19/15	13-22	13-22	
	HDD032-22	19/16	13-23	13-23	13-23
	HDD032-23	19/17	13-24/Spare	13-24/Spare	13-23/Spare

THEORY-B-520**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (52/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-033	HDD033-00	1D/00	14-01	13-01	13-01
	HDD033-01	1D/01	14-02	13-02	
	HDD033-02	1D/02	14-03	13-03	13-03
	HDD033-03	1D/03	14-04	13-04	
	HDD033-04	1D/04	14-05	13-05	13-05
	HDD033-05	1D/05	14-06	13-06	
	HDD033-06	1D/06	14-07	13-07	13-07
	HDD033-07	1D/07	14-08	13-08	
	HDD033-08	1D/08	14-09	13-09	13-09
	HDD033-09	1D/09	14-10	13-10	
	HDD033-10	1D/0A	14-11	13-11	13-11
	HDD033-11	1D/0B	14-12	13-12	
	HDD033-12	1D/0C	14-13	13-13	13-13
	HDD033-13	1D/0D	14-14	13-14	
	HDD033-14	1D/0E	14-15	13-15	13-15
	HDD033-15	1D/0F	14-16	13-16	
	HDD033-16	1D/10	14-17	13-17	13-17
	HDD033-17	1D/11	14-18	13-18	
	HDD033-18	1D/12	14-19	13-19	13-19
	HDD033-19	1D/13	14-20	13-20	
	HDD033-20	1D/14	14-21	13-21	13-21
	HDD033-21	1D/15	14-22	13-22	
	HDD033-22	1D/16	14-23	13-23	13-23
	HDD033-23	1D/17	14-24/Spare	13-24/Spare	13-23/Spare

THEORY-B-530**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (53/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-034	HDD034-00	1A/00	13-01	13-01	13-01
	HDD034-01	1A/01	13-02	13-02	
	HDD034-02	1A/02	13-03	13-03	13-03
	HDD034-03	1A/03	13-04	13-04	
	HDD034-04	1A/04	13-05	13-05	13-05
	HDD034-05	1A/05	13-06	13-06	
	HDD034-06	1A/06	13-07	13-07	13-07
	HDD034-07	1A/07	13-08	13-08	
	HDD034-08	1A/08	13-09	13-09	13-09
	HDD034-09	1A/09	13-10	13-10	
	HDD034-10	1A/0A	13-11	13-11	13-11
	HDD034-11	1A/0B	13-12	13-12	
	HDD034-12	1A/0C	13-13	13-13	13-13
	HDD034-13	1A/0D	13-14	13-14	
	HDD034-14	1A/0E	13-15	13-15	13-15
	HDD034-15	1A/0F	13-16	13-16	
	HDD034-16	1A/10	13-17	13-17	13-17
	HDD034-17	1A/11	13-18	13-18	
	HDD034-18	1A/12	13-19	13-19	13-19
	HDD034-19	1A/13	13-20	13-20	
	HDD034-20	1A/14	13-21	13-21	13-21
	HDD034-21	1A/15	13-22	13-22	
	HDD034-22	1A/16	13-23	13-23	13-23
	HDD034-23	1A/17	13-24/Spare	13-24/Spare	13-23/Spare

THEORY-B-540**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (54/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-035	HDD035-00	1E/00	14-01	13-01	13-01
	HDD035-01	1E/01	14-02	13-02	
	HDD035-02	1E/02	14-03	13-03	13-03
	HDD035-03	1E/03	14-04	13-04	
	HDD035-04	1E/04	14-05	13-05	13-05
	HDD035-05	1E/05	14-06	13-06	
	HDD035-06	1E/06	14-07	13-07	13-07
	HDD035-07	1E/07	14-08	13-08	
	HDD035-08	1E/08	14-09	13-09	13-09
	HDD035-09	1E/09	14-10	13-10	
	HDD035-10	1E/0A	14-11	13-11	13-11
	HDD035-11	1E/0B	14-12	13-12	
	HDD035-12	1E/0C	14-13	13-13	13-13
	HDD035-13	1E/0D	14-14	13-14	
	HDD035-14	1E/0E	14-15	13-15	13-15
	HDD035-15	1E/0F	14-16	13-16	
	HDD035-16	1E/10	14-17	13-17	13-17
	HDD035-17	1E/11	14-18	13-18	
	HDD035-18	1E/12	14-19	13-19	13-19
	HDD035-19	1E/13	14-20	13-20	
	HDD035-20	1E/14	14-21	13-21	13-21
	HDD035-21	1E/15	14-22	13-22	
	HDD035-22	1E/16	14-23	13-23	13-23
	HDD035-23	1E/17	14-24/Spare	13-24/Spare	13-23/Spare

THEORY-B-550**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (55/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-036	HDD036-00	1B/00	13-01	13-01	13-01
	HDD036-01	1B/01	13-02	13-02	
	HDD036-02	1B/02	13-03	13-03	13-03
	HDD036-03	1B/03	13-04	13-04	
	HDD036-04	1B/04	13-05	13-05	13-05
	HDD036-05	1B/05	13-06	13-06	
	HDD036-06	1B/06	13-07	13-07	13-07
	HDD036-07	1B/07	13-08	13-08	
	HDD036-08	1B/08	13-09	13-09	13-09
	HDD036-09	1B/09	13-10	13-10	
	HDD036-10	1B/0A	13-11	13-11	13-11
	HDD036-11	1B/0B	13-12	13-12	
	HDD036-12	1B/0C	13-13	13-13	13-13
	HDD036-13	1B/0D	13-14	13-14	
	HDD036-14	1B/0E	13-15	13-15	13-15
	HDD036-15	1B/0F	13-16	13-16	
	HDD036-16	1B/10	13-17	13-17	13-17
	HDD036-17	1B/11	13-18	13-18	
	HDD036-18	1B/12	13-19	13-19	13-19
	HDD036-19	1B/13	13-20	13-20	
	HDD036-20	1B/14	13-21	13-21	13-21
	HDD036-21	1B/15	13-22	13-22	
	HDD036-22	1B/16	13-23	13-23	13-23
	HDD036-23	1B/17	13-24/Spare	13-24/Spare	13-23/Spare

THEORY-B-560**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (56/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-037	HDD037-00	1F/00	14-01	13-01	13-01
	HDD037-01	1F/01	14-02	13-02	
	HDD037-02	1F/02	14-03	13-03	13-03
	HDD037-03	1F/03	14-04	13-04	
	HDD037-04	1F/04	14-05	13-05	13-05
	HDD037-05	1F/05	14-06	13-06	
	HDD037-06	1F/06	14-07	13-07	13-07
	HDD037-07	1F/07	14-08	13-08	
	HDD037-08	1F/08	14-09	13-09	13-09
	HDD037-09	1F/09	14-10	13-10	
	HDD037-10	1F/0A	14-11	13-11	13-11
	HDD037-11	1F/0B	14-12	13-12	
	HDD037-12	1F/0C	14-13	13-13	13-13
	HDD037-13	1F/0D	14-14	13-14	
	HDD037-14	1F/0E	14-15	13-15	13-15
	HDD037-15	1F/0F	14-16	13-16	
	HDD037-16	1F/10	14-17	13-17	13-17
	HDD037-17	1F/11	14-18	13-18	
	HDD037-18	1F/12	14-19	13-19	13-19
	HDD037-19	1F/13	14-20	13-20	
	HDD037-20	1F/14	14-21	13-21	13-21
	HDD037-21	1F/15	14-22	13-22	
	HDD037-22	1F/16	14-23	13-23	13-23
	HDD037-23	1F/17	14-24/Spare	13-24/Spare	13-23/Spare

THEORY-B-570**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (57/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-130	HDD130-00	48/00	15-01	15-01	15-01
	HDD130-01	48/01	15-02	15-02	
	HDD130-02	48/02	15-03	15-03	15-03
	HDD130-03	48/03	15-04	15-04	
	HDD130-04	48/04	15-05	15-05	15-05
	HDD130-05	48/05	15-06	15-06	
	HDD130-06	48/06	15-07	15-07	15-07
	HDD130-07	48/07	15-08	15-08	
	HDD130-08	48/08	15-09	15-09	15-09
	HDD130-09	48/09	15-10	15-10	
	HDD130-10	48/0A	15-11	15-11	15-11
	HDD130-11	48/0B	15-12	15-12	
	HDD130-12	48/0C	15-13	15-13	15-13
	HDD130-13	48/0D	15-14	15-14	
	HDD130-14	48/0E	15-15	15-15	15-15
	HDD130-15	48/0F	15-16	15-16	
	HDD130-16	48/10	15-17	15-17	15-17
	HDD130-17	48/11	15-18	15-18	
	HDD130-18	48/12	15-19	15-19	15-19
	HDD130-19	48/13	15-20	15-20	
	HDD130-20	48/14	15-21	15-21	15-21
	HDD130-21	48/15	15-22	15-22	
	HDD130-22	48/16	15-23	15-23	15-23
	HDD130-23	48/17	15-24/Spare	15-24/Spare	15-23/Spare

THEORY-B-580

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (58/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-131	HDD131-00	4C/00	16-01	15-01	15-01
	HDD131-01	4C/01	16-02	15-02	
	HDD131-02	4C/02	16-03	15-03	15-03
	HDD131-03	4C/03	16-04	15-04	
	HDD131-04	4C/04	16-05	15-05	15-05
	HDD131-05	4C/05	16-06	15-06	
	HDD131-06	4C/06	16-07	15-07	15-07
	HDD131-07	4C/07	16-08	15-08	
	HDD131-08	4C/08	16-09	15-09	15-09
	HDD131-09	4C/09	16-10	15-10	
	HDD131-10	4C/0A	16-11	15-11	15-11
	HDD131-11	4C/0B	16-12	15-12	
	HDD131-12	4C/0C	16-13	15-13	15-13
	HDD131-13	4C/0D	16-14	15-14	
	HDD131-14	4C/0E	16-15	15-15	15-15
	HDD131-15	4C/0F	16-16	15-16	
	HDD131-16	4C/10	16-17	15-17	15-17
	HDD131-17	4C/11	16-18	15-18	
	HDD131-18	4C/12	16-19	15-19	15-19
	HDD131-19	4C/13	16-20	15-20	
	HDD131-20	4C/14	16-21	15-21	15-21
	HDD131-21	4C/15	16-22	15-22	
	HDD131-22	4C/16	16-23	15-23	15-23
	HDD131-23	4C/17	16-24/Spare	15-24/Spare	15-23/Spare

THEORY-B-590**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (59/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-132	HDD132-00	49/00	15-01	15-01	15-01
	HDD132-01	49/01	15-02	15-02	
	HDD132-02	49/02	15-03	15-03	15-03
	HDD132-03	49/03	15-04	15-04	
	HDD132-04	49/04	15-05	15-05	15-05
	HDD132-05	49/05	15-06	15-06	
	HDD132-06	49/06	15-07	15-07	15-07
	HDD132-07	49/07	15-08	15-08	
	HDD132-08	49/08	15-09	15-09	15-09
	HDD132-09	49/09	15-10	15-10	
	HDD132-10	49/0A	15-11	15-11	15-11
	HDD132-11	49/0B	15-12	15-12	
	HDD132-12	49/0C	15-13	15-13	15-13
	HDD132-13	49/0D	15-14	15-14	
	HDD132-14	49/0E	15-15	15-15	15-15
	HDD132-15	49/0F	15-16	15-16	
	HDD132-16	49/10	15-17	15-17	15-17
	HDD132-17	49/11	15-18	15-18	
	HDD132-18	49/12	15-19	15-19	15-19
	HDD132-19	49/13	15-20	15-20	
	HDD132-20	49/14	15-21	15-21	15-21
	HDD132-21	49/15	15-22	15-22	
	HDD132-22	49/16	15-23	15-23	15-23
	HDD132-23	49/17	15-24/Spare	15-24/Spare	15-23/Spare

THEORY-B-600**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (60/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-133	HDD133-00	4D/00	16-01	15-01	15-01
	HDD133-01	4D/01	16-02	15-02	
	HDD133-02	4D/02	16-03	15-03	15-03
	HDD133-03	4D/03	16-04	15-04	
	HDD133-04	4D/04	16-05	15-05	15-05
	HDD133-05	4D/05	16-06	15-06	
	HDD133-06	4D/06	16-07	15-07	15-07
	HDD133-07	4D/07	16-08	15-08	
	HDD133-08	4D/08	16-09	15-09	15-09
	HDD133-09	4D/09	16-10	15-10	
	HDD133-10	4D/0A	16-11	15-11	15-11
	HDD133-11	4D/0B	16-12	15-12	
	HDD133-12	4D/0C	16-13	15-13	15-13
	HDD133-13	4D/0D	16-14	15-14	
	HDD133-14	4D/0E	16-15	15-15	15-15
	HDD133-15	4D/0F	16-16	15-16	
	HDD133-16	4D/10	16-17	15-17	15-17
	HDD133-17	4D/11	16-18	15-18	
	HDD133-18	4D/12	16-19	15-19	15-19
	HDD133-19	4D/13	16-20	15-20	
	HDD133-20	4D/14	16-21	15-21	15-21
	HDD133-21	4D/15	16-22	15-22	
	HDD133-22	4D/16	16-23	15-23	15-23
	HDD133-23	4D/17	16-24/Spare	15-24/Spare	15-23/Spare

THEORY-B-610**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (61/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-134	HDD134-00	4A/00	15-01	15-01	15-01
	HDD134-01	4A/01	15-02	15-02	
	HDD134-02	4A/02	15-03	15-03	15-03
	HDD134-03	4A/03	15-04	15-04	
	HDD134-04	4A/04	15-05	15-05	15-05
	HDD134-05	4A/05	15-06	15-06	
	HDD134-06	4A/06	15-07	15-07	15-07
	HDD134-07	4A/07	15-08	15-08	
	HDD134-08	4A/08	15-09	15-09	15-09
	HDD134-09	4A/09	15-10	15-10	
	HDD134-10	4A/0A	15-11	15-11	15-11
	HDD134-11	4A/0B	15-12	15-12	
	HDD134-12	4A/0C	15-13	15-13	15-13
	HDD134-13	4A/0D	15-14	15-14	
	HDD134-14	4A/0E	15-15	15-15	15-15
	HDD134-15	4A/0F	15-16	15-16	
	HDD134-16	4A/10	15-17	15-17	15-17
	HDD134-17	4A/11	15-18	15-18	
	HDD134-18	4A/12	15-19	15-19	15-19
	HDD134-19	4A/13	15-20	15-20	
	HDD134-20	4A/14	15-21	15-21	15-21
	HDD134-21	4A/15	15-22	15-22	
	HDD134-22	4A/16	15-23	15-23	15-23
	HDD134-23	4A/17	15-24/Spare	15-24/Spare	15-23/Spare

THEORY-B-620**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (62/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-135	HDD135-00	4E/00	16-01	15-01	15-01
	HDD135-01	4E/01	16-02	15-02	
	HDD135-02	4E/02	16-03	15-03	15-03
	HDD135-03	4E/03	16-04	15-04	
	HDD135-04	4E/04	16-05	15-05	15-05
	HDD135-05	4E/05	16-06	15-06	
	HDD135-06	4E/06	16-07	15-07	15-07
	HDD135-07	4E/07	16-08	15-08	
	HDD135-08	4E/08	16-09	15-09	15-09
	HDD135-09	4E/09	16-10	15-10	
	HDD135-10	4E/0A	16-11	15-11	15-11
	HDD135-11	4E/0B	16-12	15-12	
	HDD135-12	4E/0C	16-13	15-13	15-13
	HDD135-13	4E/0D	16-14	15-14	
	HDD135-14	4E/0E	16-15	15-15	15-15
	HDD135-15	4E/0F	16-16	15-16	
	HDD135-16	4E/10	16-17	15-17	15-17
	HDD135-17	4E/11	16-18	15-18	
	HDD135-18	4E/12	16-19	15-19	15-19
	HDD135-19	4E/13	16-20	15-20	
	HDD135-20	4E/14	16-21	15-21	15-21
	HDD135-21	4E/15	16-22	15-22	
	HDD135-22	4E/16	16-23	15-23	15-23
	HDD135-23	4E/17	16-24/Spare	15-24/Spare	15-23/Spare

THEORY-B-630**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (63/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-136	HDD136-00	4B/00	15-01	15-01	15-01
	HDD136-01	4B/01	15-02	15-02	
	HDD136-02	4B/02	15-03	15-03	15-03
	HDD136-03	4B/03	15-04	15-04	
	HDD136-04	4B/04	15-05	15-05	15-05
	HDD136-05	4B/05	15-06	15-06	
	HDD136-06	4B/06	15-07	15-07	15-07
	HDD136-07	4B/07	15-08	15-08	
	HDD136-08	4B/08	15-09	15-09	15-09
	HDD136-09	4B/09	15-10	15-10	
	HDD136-10	4B/0A	15-11	15-11	15-11
	HDD136-11	4B/0B	15-12	15-12	
	HDD136-12	4B/0C	15-13	15-13	15-13
	HDD136-13	4B/0D	15-14	15-14	
	HDD136-14	4B/0E	15-15	15-15	15-15
	HDD136-15	4B/0F	15-16	15-16	
	HDD136-16	4B/10	15-17	15-17	15-17
	HDD136-17	4B/11	15-18	15-18	
	HDD136-18	4B/12	15-19	15-19	15-19
	HDD136-19	4B/13	15-20	15-20	
	HDD136-20	4B/14	15-21	15-21	15-21
	HDD136-21	4B/15	15-22	15-22	
	HDD136-22	4B/16	15-23	15-23	15-23
	HDD136-23	4B/17	15-24/Spare	15-24/Spare	15-23/Spare

THEORY-B-640**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (64/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-137	HDD137-00	4F/00	16-01	15-01	15-01
	HDD137-01	4F/01	16-02	15-02	
	HDD137-02	4F/02	16-03	15-03	15-03
	HDD137-03	4F/03	16-04	15-04	
	HDD137-04	4F/04	16-05	15-05	15-05
	HDD137-05	4F/05	16-06	15-06	
	HDD137-06	4F/06	16-07	15-07	15-07
	HDD137-07	4F/07	16-08	15-08	
	HDD137-08	4F/08	16-09	15-09	15-09
	HDD137-09	4F/09	16-10	15-10	
	HDD137-10	4F/0A	16-11	15-11	15-11
	HDD137-11	4F/0B	16-12	15-12	
	HDD137-12	4F/0C	16-13	15-13	15-13
	HDD137-13	4F/0D	16-14	15-14	
	HDD137-14	4F/0E	16-15	15-15	15-15
	HDD137-15	4F/0F	16-16	15-16	
	HDD137-16	4F/10	16-17	15-17	15-17
	HDD137-17	4F/11	16-18	15-18	
	HDD137-18	4F/12	16-19	15-19	15-19
	HDD137-19	4F/13	16-20	15-20	
	HDD137-20	4F/14	16-21	15-21	15-21
	HDD137-21	4F/15	16-22	15-22	
	HDD137-22	4F/16	16-23	15-23	15-23
	HDD137-23	4F/17	16-24/Spare	15-24/Spare	15-23/Spare

THEORY-B-650**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (65/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-040	HDD040-00	20/00	17-01	17-01	17-01
	HDD040-01	20/01	17-02	17-02	
	HDD040-02	20/02	17-03	17-03	17-03
	HDD040-03	20/03	17-04	17-04	
	HDD040-04	20/04	17-05	17-05	17-05
	HDD040-05	20/05	17-06	17-06	
	HDD040-06	20/06	17-07	17-07	17-07
	HDD040-07	20/07	17-08	17-08	
	HDD040-08	20/08	17-09	17-09	17-09
	HDD040-09	20/09	17-10	17-10	
	HDD040-10	20/0A	17-11	17-11	17-11
	HDD040-11	20/0B	17-12	17-12	
	HDD040-12	20/0C	17-13	17-13	17-13
	HDD040-13	20/0D	17-14	17-14	
	HDD040-14	20/0E	17-15	17-15	17-15
	HDD040-15	20/0F	17-16	17-16	
	HDD040-16	20/10	17-17	17-17	17-17
	HDD040-17	20/11	17-18	17-18	
	HDD040-18	20/12	17-19	17-19	17-19
	HDD040-19	20/13	17-20	17-20	
	HDD040-20	20/14	17-21	17-21	17-21
	HDD040-21	20/15	17-22	17-22	
	HDD040-22	20/16	17-23	17-23	17-23
	HDD040-23	20/17	17-24/Spare	17-24/Spare	17-23/Spare

THEORY-B-660**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (66/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-041	HDD041-00	24/00	18-01	17-01	17-01
	HDD041-01	24/01	18-02	17-02	
	HDD041-02	24/02	18-03	17-03	17-03
	HDD041-03	24/03	18-04	17-04	
	HDD041-04	24/04	18-05	17-05	17-05
	HDD041-05	24/05	18-06	17-06	
	HDD041-06	24/06	18-07	17-07	17-07
	HDD041-07	24/07	18-08	17-08	
	HDD041-08	24/08	18-09	17-09	17-09
	HDD041-09	24/09	18-10	17-10	
	HDD041-10	24/0A	18-11	17-11	17-11
	HDD041-11	24/0B	18-12	17-12	
	HDD041-12	24/0C	18-13	17-13	17-13
	HDD041-13	24/0D	18-14	17-14	
	HDD041-14	24/0E	18-15	17-15	17-15
	HDD041-15	24/0F	18-16	17-16	
	HDD041-16	24/10	18-17	17-17	17-17
	HDD041-17	24/11	18-18	17-18	
	HDD041-18	24/12	18-19	17-19	17-19
	HDD041-19	24/13	18-20	17-20	
	HDD041-20	24/14	18-21	17-21	17-21
	HDD041-21	24/15	18-22	17-22	
	HDD041-22	24/16	18-23	17-23	17-23
	HDD041-23	24/17	18-24/Spare	17-24/Spare	17-23/Spare

THEORY-B-670**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (67/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-042	HDD042-00	21/00	17-01	17-01	17-01
	HDD042-01	21/01	17-02	17-02	
	HDD042-02	21/02	17-03	17-03	17-03
	HDD042-03	21/03	17-04	17-04	
	HDD042-04	21/04	17-05	17-05	17-05
	HDD042-05	21/05	17-06	17-06	
	HDD042-06	21/06	17-07	17-07	17-07
	HDD042-07	21/07	17-08	17-08	
	HDD042-08	21/08	17-09	17-09	17-09
	HDD042-09	21/09	17-10	17-10	
	HDD042-10	21/0A	17-11	17-11	17-11
	HDD042-11	21/0B	17-12	17-12	
	HDD042-12	21/0C	17-13	17-13	17-13
	HDD042-13	21/0D	17-14	17-14	
	HDD042-14	21/0E	17-15	17-15	17-15
	HDD042-15	21/0F	17-16	17-16	
	HDD042-16	21/10	17-17	17-17	17-17
	HDD042-17	21/11	17-18	17-18	
	HDD042-18	21/12	17-19	17-19	17-19
	HDD042-19	21/13	17-20	17-20	
	HDD042-20	21/14	17-21	17-21	17-21
	HDD042-21	21/15	17-22	17-22	
	HDD042-22	21/16	17-23	17-23	17-23
	HDD042-23	21/17	17-24/Spare	17-24/Spare	17-23/Spare

THEORY-B-680**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (68/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-043	HDD043-00	25/00	18-01	17-01	17-01
	HDD043-01	25/01	18-02	17-02	
	HDD043-02	25/02	18-03	17-03	17-03
	HDD043-03	25/03	18-04	17-04	
	HDD043-04	25/04	18-05	17-05	17-05
	HDD043-05	25/05	18-06	17-06	
	HDD043-06	25/06	18-07	17-07	17-07
	HDD043-07	25/07	18-08	17-08	
	HDD043-08	25/08	18-09	17-09	17-09
	HDD043-09	25/09	18-10	17-10	
	HDD043-10	25/0A	18-11	17-11	17-11
	HDD043-11	25/0B	18-12	17-12	
	HDD043-12	25/0C	18-13	17-13	17-13
	HDD043-13	25/0D	18-14	17-14	
	HDD043-14	25/0E	18-15	17-15	17-15
	HDD043-15	25/0F	18-16	17-16	
	HDD043-16	25/10	18-17	17-17	17-17
	HDD043-17	25/11	18-18	17-18	
	HDD043-18	25/12	18-19	17-19	17-19
	HDD043-19	25/13	18-20	17-20	
	HDD043-20	25/14	18-21	17-21	17-21
	HDD043-21	25/15	18-22	17-22	
	HDD043-22	25/16	18-23	17-23	17-23
	HDD043-23	25/17	18-24/Spare	17-24/Spare	17-23/Spare

THEORY-B-690**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (69/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-044	HDD044-00	22/00	17-01	17-01	17-01
	HDD044-01	22/01	17-02	17-02	
	HDD044-02	22/02	17-03	17-03	17-03
	HDD044-03	22/03	17-04	17-04	
	HDD044-04	22/04	17-05	17-05	17-05
	HDD044-05	22/05	17-06	17-06	
	HDD044-06	22/06	17-07	17-07	17-07
	HDD044-07	22/07	17-08	17-08	
	HDD044-08	22/08	17-09	17-09	17-09
	HDD044-09	22/09	17-10	17-10	
	HDD044-10	22/0A	17-11	17-11	17-11
	HDD044-11	22/0B	17-12	17-12	
	HDD044-12	22/0C	17-13	17-13	17-13
	HDD044-13	22/0D	17-14	17-14	
	HDD044-14	22/0E	17-15	17-15	17-15
	HDD044-15	22/0F	17-16	17-16	
	HDD044-16	22/10	17-17	17-17	17-17
	HDD044-17	22/11	17-18	17-18	
	HDD044-18	22/12	17-19	17-19	17-19
	HDD044-19	22/13	17-20	17-20	
	HDD044-20	22/14	17-21	17-21	17-21
	HDD044-21	22/15	17-22	17-22	
	HDD044-22	22/16	17-23	17-23	17-23
	HDD044-23	22/17	17-24/Spare	17-24/Spare	17-23/Spare

THEORY-B-700**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (70/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-045	HDD045-00	26/00	18-01	17-01	17-01
	HDD045-01	26/01	18-02	17-02	
	HDD045-02	26/02	18-03	17-03	17-03
	HDD045-03	26/03	18-04	17-04	
	HDD045-04	26/04	18-05	17-05	17-05
	HDD045-05	26/05	18-06	17-06	
	HDD045-06	26/06	18-07	17-07	17-07
	HDD045-07	26/07	18-08	17-08	
	HDD045-08	26/08	18-09	17-09	17-09
	HDD045-09	26/09	18-10	17-10	
	HDD045-10	26/0A	18-11	17-11	17-11
	HDD045-11	26/0B	18-12	17-12	
	HDD045-12	26/0C	18-13	17-13	17-13
	HDD045-13	26/0D	18-14	17-14	
	HDD045-14	26/0E	18-15	17-15	17-15
	HDD045-15	26/0F	18-16	17-16	
	HDD045-16	26/10	18-17	17-17	17-17
	HDD045-17	26/11	18-18	17-18	
	HDD045-18	26/12	18-19	17-19	17-19
	HDD045-19	26/13	18-20	17-20	
	HDD045-20	26/14	18-21	17-21	17-21
	HDD045-21	26/15	18-22	17-22	
	HDD045-22	26/16	18-23	17-23	17-23
	HDD045-23	26/17	18-24/Spare	17-24/Spare	17-23/Spare

THEORY-B-710**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (71/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-046	HDD046-00	23/00	17-01	17-01	17-01
	HDD046-01	23/01	17-02	17-02	
	HDD046-02	23/02	17-03	17-03	17-03
	HDD046-03	23/03	17-04	17-04	
	HDD046-04	23/04	17-05	17-05	17-05
	HDD046-05	23/05	17-06	17-06	
	HDD046-06	23/06	17-07	17-07	17-07
	HDD046-07	23/07	17-08	17-08	
	HDD046-08	23/08	17-09	17-09	17-09
	HDD046-09	23/09	17-10	17-10	
	HDD046-10	23/0A	17-11	17-11	17-11
	HDD046-11	23/0B	17-12	17-12	
	HDD046-12	23/0C	17-13	17-13	17-13
	HDD046-13	23/0D	17-14	17-14	
	HDD046-14	23/0E	17-15	17-15	17-15
	HDD046-15	23/0F	17-16	17-16	
	HDD046-16	23/10	17-17	17-17	17-17
	HDD046-17	23/11	17-18	17-18	
	HDD046-18	23/12	17-19	17-19	17-19
	HDD046-19	23/13	17-20	17-20	
	HDD046-20	23/14	17-21	17-21	17-21
	HDD046-21	23/15	17-22	17-22	
	HDD046-22	23/16	17-23	17-23	17-23
	HDD046-23	23/17	17-24/Spare	17-24/Spare	17-23/Spare

THEORY-B-720**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (72/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-047	HDD047-00	27/00	18-01	17-01	17-01
	HDD047-01	27/01	18-02	17-02	
	HDD047-02	27/02	18-03	17-03	17-03
	HDD047-03	27/03	18-04	17-04	
	HDD047-04	27/04	18-05	17-05	17-05
	HDD047-05	27/05	18-06	17-06	
	HDD047-06	27/06	18-07	17-07	17-07
	HDD047-07	27/07	18-08	17-08	
	HDD047-08	27/08	18-09	17-09	17-09
	HDD047-09	27/09	18-10	17-10	
	HDD047-10	27/0A	18-11	17-11	17-11
	HDD047-11	27/0B	18-12	17-12	
	HDD047-12	27/0C	18-13	17-13	17-13
	HDD047-13	27/0D	18-14	17-14	
	HDD047-14	27/0E	18-15	17-15	17-15
	HDD047-15	27/0F	18-16	17-16	
	HDD047-16	27/10	18-17	17-17	17-17
	HDD047-17	27/11	18-18	17-18	
	HDD047-18	27/12	18-19	17-19	17-19
	HDD047-19	27/13	18-20	17-20	
	HDD047-20	27/14	18-21	17-21	17-21
	HDD047-21	27/15	18-22	17-22	
	HDD047-22	27/16	18-23	17-23	17-23
	HDD047-23	27/17	18-24/Spare	17-24/Spare	17-23/Spare

THEORY-B-730**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (73/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-140	HDD140-00	50/00	19-01	19-01	19-01
	HDD140-01	50/01	19-02	19-02	
	HDD140-02	50/02	19-03	19-03	19-03
	HDD140-03	50/03	19-04	19-04	
	HDD140-04	50/04	19-05	19-05	19-05
	HDD140-05	50/05	19-06	19-06	
	HDD140-06	50/06	19-07	19-07	19-07
	HDD140-07	50/07	19-08	19-08	
	HDD140-08	50/08	19-09	19-09	19-09
	HDD140-09	50/09	19-10	19-10	
	HDD140-10	50/0A	19-11	19-11	19-11
	HDD140-11	50/0B	19-12	19-12	
	HDD140-12	50/0C	19-13	19-13	19-13
	HDD140-13	50/0D	19-14	19-14	
	HDD140-14	50/0E	19-15	19-15	19-15
	HDD140-15	50/0F	19-16	19-16	
	HDD140-16	50/10	19-17	19-17	19-17
	HDD140-17	50/11	19-18	19-18	
	HDD140-18	50/12	19-19	19-19	19-19
	HDD140-19	50/13	19-20	19-20	
	HDD140-20	50/14	19-21	19-21	19-21
	HDD140-21	50/15	19-22	19-22	
	HDD140-22	50/16	19-23	19-23	19-23
	HDD140-23	50/17	19-24/Spare	19-24/Spare	19-23/Spare

THEORY-B-740**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (74/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-141	HDD141-00	54/00	20-01	19-01	19-01
	HDD141-01	54/01	20-02	19-02	
	HDD141-02	54/02	20-03	19-03	19-03
	HDD141-03	54/03	20-04	19-04	
	HDD141-04	54/04	20-05	19-05	19-05
	HDD141-05	54/05	20-06	19-06	
	HDD141-06	54/06	20-07	19-07	19-07
	HDD141-07	54/07	20-08	19-08	
	HDD141-08	54/08	20-09	19-09	19-09
	HDD141-09	54/09	20-10	19-10	
	HDD141-10	54/0A	20-11	19-11	19-11
	HDD141-11	54/0B	20-12	19-12	
	HDD141-12	54/0C	20-13	19-13	19-13
	HDD141-13	54/0D	20-14	19-14	
	HDD141-14	54/0E	20-15	19-15	19-15
	HDD141-15	54/0F	20-16	19-16	
	HDD141-16	54/10	20-17	19-17	19-17
	HDD141-17	54/11	20-18	19-18	
	HDD141-18	54/12	20-19	19-19	19-19
	HDD141-19	54/13	20-20	19-20	
	HDD141-20	54/14	20-21	19-21	19-21
	HDD141-21	54/15	20-22	19-22	
	HDD141-22	54/16	20-23	19-23	19-23
	HDD141-23	54/17	20-24/Spare	19-24/Spare	19-23/Spare

THEORY-B-750**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (75/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-142	HDD142-00	51/00	19-01	19-01	19-01
	HDD142-01	51/01	19-02	19-02	
	HDD142-02	51/02	19-03	19-03	19-03
	HDD142-03	51/03	19-04	19-04	
	HDD142-04	51/04	19-05	19-05	19-05
	HDD142-05	51/05	19-06	19-06	
	HDD142-06	51/06	19-07	19-07	19-07
	HDD142-07	51/07	19-08	19-08	
	HDD142-08	51/08	19-09	19-09	19-09
	HDD142-09	51/09	19-10	19-10	
	HDD142-10	51/0A	19-11	19-11	19-11
	HDD142-11	51/0B	19-12	19-12	
	HDD142-12	51/0C	19-13	19-13	19-13
	HDD142-13	51/0D	19-14	19-14	
	HDD142-14	51/0E	19-15	19-15	19-15
	HDD142-15	51/0F	19-16	19-16	
	HDD142-16	51/10	19-17	19-17	19-17
	HDD142-17	51/11	19-18	19-18	
	HDD142-18	51/12	19-19	19-19	19-19
	HDD142-19	51/13	19-20	19-20	
	HDD142-20	51/14	19-21	19-21	19-21
	HDD142-21	51/15	19-22	19-22	
	HDD142-22	51/16	19-23	19-23	19-23
	HDD142-23	51/17	19-24/Spare	19-24/Spare	19-23/Spare

THEORY-B-760

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (76/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-143	HDD143-00	55/00	20-01	19-01	19-01
	HDD143-01	55/01	20-02	19-02	
	HDD143-02	55/02	20-03	19-03	19-03
	HDD143-03	55/03	20-04	19-04	
	HDD143-04	55/04	20-05	19-05	19-05
	HDD143-05	55/05	20-06	19-06	
	HDD143-06	55/06	20-07	19-07	19-07
	HDD143-07	55/07	20-08	19-08	
	HDD143-08	55/08	20-09	19-09	19-09
	HDD143-09	55/09	20-10	19-10	
	HDD143-10	55/0A	20-11	19-11	19-11
	HDD143-11	55/0B	20-12	19-12	
	HDD143-12	55/0C	20-13	19-13	19-13
	HDD143-13	55/0D	20-14	19-14	
	HDD143-14	55/0E	20-15	19-15	19-15
	HDD143-15	55/0F	20-16	19-16	
	HDD143-16	55/10	20-17	19-17	19-17
	HDD143-17	55/11	20-18	19-18	
	HDD143-18	55/12	20-19	19-19	19-19
	HDD143-19	55/13	20-20	19-20	
	HDD143-20	55/14	20-21	19-21	19-21
	HDD143-21	55/15	20-22	19-22	
	HDD143-22	55/16	20-23	19-23	19-23
	HDD143-23	55/17	20-24/Spare	19-24/Spare	19-23/Spare

THEORY-B-770**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (77/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-144	HDD144-00	52/00	19-01	19-01	19-01
	HDD144-01	52/01	19-02	19-02	
	HDD144-02	52/02	19-03	19-03	19-03
	HDD144-03	52/03	19-04	19-04	
	HDD144-04	52/04	19-05	19-05	19-05
	HDD144-05	52/05	19-06	19-06	
	HDD144-06	52/06	19-07	19-07	19-07
	HDD144-07	52/07	19-08	19-08	
	HDD144-08	52/08	19-09	19-09	19-09
	HDD144-09	52/09	19-10	19-10	
	HDD144-10	52/0A	19-11	19-11	19-11
	HDD144-11	52/0B	19-12	19-12	
	HDD144-12	52/0C	19-13	19-13	19-13
	HDD144-13	52/0D	19-14	19-14	
	HDD144-14	52/0E	19-15	19-15	19-15
	HDD144-15	52/0F	19-16	19-16	
	HDD144-16	52/10	19-17	19-17	19-17
	HDD144-17	52/11	19-18	19-18	
	HDD144-18	52/12	19-19	19-19	19-19
	HDD144-19	52/13	19-20	19-20	
	HDD144-20	52/14	19-21	19-21	19-21
	HDD144-21	52/15	19-22	19-22	
	HDD144-22	52/16	19-23	19-23	19-23
	HDD144-23	52/17	19-24/Spare	19-24/Spare	19-23/Spare

THEORY-B-780**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (78/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-145	HDD145-00	56/00	20-01	19-01	19-01
	HDD145-01	56/01	20-02	19-02	
	HDD145-02	56/02	20-03	19-03	19-03
	HDD145-03	56/03	20-04	19-04	
	HDD145-04	56/04	20-05	19-05	19-05
	HDD145-05	56/05	20-06	19-06	
	HDD145-06	56/06	20-07	19-07	19-07
	HDD145-07	56/07	20-08	19-08	
	HDD145-08	56/08	20-09	19-09	19-09
	HDD145-09	56/09	20-10	19-10	
	HDD145-10	56/0A	20-11	19-11	19-11
	HDD145-11	56/0B	20-12	19-12	
	HDD145-12	56/0C	20-13	19-13	19-13
	HDD145-13	56/0D	20-14	19-14	
	HDD145-14	56/0E	20-15	19-15	19-15
	HDD145-15	56/0F	20-16	19-16	
	HDD145-16	56/10	20-17	19-17	19-17
	HDD145-17	56/11	20-18	19-18	
	HDD145-18	56/12	20-19	19-19	19-19
	HDD145-19	56/13	20-20	19-20	
	HDD145-20	56/14	20-21	19-21	19-21
	HDD145-21	56/15	20-22	19-22	
	HDD145-22	56/16	20-23	19-23	19-23
	HDD145-23	56/17	20-24/Spare	19-24/Spare	19-23/Spare

THEORY-B-790**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (79/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-146	HDD146-00	53/00	19-01	19-01	19-01
	HDD146-01	53/01	19-02	19-02	
	HDD146-02	53/02	19-03	19-03	19-03
	HDD146-03	53/03	19-04	19-04	
	HDD146-04	53/04	19-05	19-05	19-05
	HDD146-05	53/05	19-06	19-06	
	HDD146-06	53/06	19-07	19-07	19-07
	HDD146-07	53/07	19-08	19-08	
	HDD146-08	53/08	19-09	19-09	19-09
	HDD146-09	53/09	19-10	19-10	
	HDD146-10	53/0A	19-11	19-11	19-11
	HDD146-11	53/0B	19-12	19-12	
	HDD146-12	53/0C	19-13	19-13	19-13
	HDD146-13	53/0D	19-14	19-14	
	HDD146-14	53/0E	19-15	19-15	19-15
	HDD146-15	53/0F	19-16	19-16	
	HDD146-16	53/10	19-17	19-17	19-17
	HDD146-17	53/11	19-18	19-18	
	HDD146-18	53/12	19-19	19-19	19-19
	HDD146-19	53/13	19-20	19-20	
	HDD146-20	53/14	19-21	19-21	19-21
	HDD146-21	53/15	19-22	19-22	
	HDD146-22	53/16	19-23	19-23	19-23
	HDD146-23	53/17	19-24/Spare	19-24/Spare	19-23/Spare

THEORY-B-800**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (80/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-147	HDD147-00	57/00	20-01	19-01	19-01
	HDD147-01	57/01	20-02	19-02	
	HDD147-02	57/02	20-03	19-03	19-03
	HDD147-03	57/03	20-04	19-04	
	HDD147-04	57/04	20-05	19-05	19-05
	HDD147-05	57/05	20-06	19-06	
	HDD147-06	57/06	20-07	19-07	19-07
	HDD147-07	57/07	20-08	19-08	
	HDD147-08	57/08	20-09	19-09	19-09
	HDD147-09	57/09	20-10	19-10	
	HDD147-10	57/0A	20-11	19-11	19-11
	HDD147-11	57/0B	20-12	19-12	
	HDD147-12	57/0C	20-13	19-13	19-13
	HDD147-13	57/0D	20-14	19-14	
	HDD147-14	57/0E	20-15	19-15	19-15
	HDD147-15	57/0F	20-16	19-16	
	HDD147-16	57/10	20-17	19-17	19-17
	HDD147-17	57/11	20-18	19-18	
	HDD147-18	57/12	20-19	19-19	19-19
	HDD147-19	57/13	20-20	19-20	
	HDD147-20	57/14	20-21	19-21	19-21
	HDD147-21	57/15	20-22	19-22	
	HDD147-22	57/16	20-23	19-23	19-23
	HDD147-23	57/17	20-24/Spare	19-24/Spare	19-23/Spare

THEORY-B-810

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (81/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-050	HDD050-00	28/00	21-01	21-01	21-01
	HDD050-01	28/01	21-02	21-02	
	HDD050-02	28/02	21-03	21-03	21-03
	HDD050-03	28/03	21-04	21-04	
	HDD050-04	28/04	21-05	21-05	21-05
	HDD050-05	28/05	21-06	21-06	
	HDD050-06	28/06	21-07	21-07	21-07
	HDD050-07	28/07	21-08	21-08	
	HDD050-08	28/08	21-09	21-09	21-09
	HDD050-09	28/09	21-10	21-10	
	HDD050-10	28/0A	21-11	21-11	21-11
	HDD050-11	28/0B	21-12	21-12	
	HDD050-12	28/0C	21-13	21-13	21-13
	HDD050-13	28/0D	21-14	21-14	
	HDD050-14	28/0E	21-15	21-15	21-15
	HDD050-15	28/0F	21-16	21-16	
	HDD050-16	28/10	21-17	21-17	21-17
	HDD050-17	28/11	21-18	21-18	
	HDD050-18	28/12	21-19	21-19	21-19
	HDD050-19	28/13	21-20	21-20	
	HDD050-20	28/14	21-21	21-21	21-21
	HDD050-21	28/15	21-22	21-22	
	HDD050-22	28/16	21-23	21-23	21-23
	HDD050-23	28/17	21-24/Spare	21-24/Spare	21-23/Spare

THEORY-B-820**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (82/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-051	HDD051-00	2C/00	22-01	21-01	21-01
	HDD051-01	2C/01	22-02	21-02	
	HDD051-02	2C/02	22-03	21-03	21-03
	HDD051-03	2C/03	22-04	21-04	
	HDD051-04	2C/04	22-05	21-05	21-05
	HDD051-05	2C/05	22-06	21-06	
	HDD051-06	2C/06	22-07	21-07	21-07
	HDD051-07	2C/07	22-08	21-08	
	HDD051-08	2C/08	22-09	21-09	21-09
	HDD051-09	2C/09	22-10	21-10	
	HDD051-10	2C/0A	22-11	21-11	21-11
	HDD051-11	2C/0B	22-12	21-12	
	HDD051-12	2C/0C	22-13	21-13	21-13
	HDD051-13	2C/0D	22-14	21-14	
	HDD051-14	2C/0E	22-15	21-15	21-15
	HDD051-15	2C/0F	22-16	21-16	
	HDD051-16	2C/10	22-17	21-17	21-17
	HDD051-17	2C/11	22-18	21-18	
	HDD051-18	2C/12	22-19	21-19	21-19
	HDD051-19	2C/13	22-20	21-20	
	HDD051-20	2C/14	22-21	21-21	21-21
	HDD051-21	2C/15	22-22	21-22	
	HDD051-22	2C/16	22-23	21-23	21-23
	HDD051-23	2C/17	22-24/Spare	21-24/Spare	21-23/Spare

THEORY-B-830**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (83/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-052	HDD052-00	29/00	21-01	21-01	21-01
	HDD052-01	29/01	21-02	21-02	
	HDD052-02	29/02	21-03	21-03	21-03
	HDD052-03	29/03	21-04	21-04	
	HDD052-04	29/04	21-05	21-05	21-05
	HDD052-05	29/05	21-06	21-06	
	HDD052-06	29/06	21-07	21-07	21-07
	HDD052-07	29/07	21-08	21-08	
	HDD052-08	29/08	21-09	21-09	21-09
	HDD052-09	29/09	21-10	21-10	
	HDD052-10	29/0A	21-11	21-11	21-11
	HDD052-11	29/0B	21-12	21-12	
	HDD052-12	29/0C	21-13	21-13	21-13
	HDD052-13	29/0D	21-14	21-14	
	HDD052-14	29/0E	21-15	21-15	21-15
	HDD052-15	29/0F	21-16	21-16	
	HDD052-16	29/10	21-17	21-17	21-17
	HDD052-17	29/11	21-18	21-18	
	HDD052-18	29/12	21-19	21-19	21-19
	HDD052-19	29/13	21-20	21-20	
	HDD052-20	29/14	21-21	21-21	21-21
	HDD052-21	29/15	21-22	21-22	
	HDD052-22	29/16	21-23	21-23	21-23
	HDD052-23	29/17	21-24/Spare	21-24/Spare	21-23/Spare

THEORY-B-840

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (84/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-053	HDD053-00	2D/00	22-01	21-01	21-01
	HDD053-01	2D/01	22-02	21-02	
	HDD053-02	2D/02	22-03	21-03	21-03
	HDD053-03	2D/03	22-04	21-04	
	HDD053-04	2D/04	22-05	21-05	21-05
	HDD053-05	2D/05	22-06	21-06	
	HDD053-06	2D/06	22-07	21-07	21-07
	HDD053-07	2D/07	22-08	21-08	
	HDD053-08	2D/08	22-09	21-09	21-09
	HDD053-09	2D/09	22-10	21-10	
	HDD053-10	2D/0A	22-11	21-11	21-11
	HDD053-11	2D/0B	22-12	21-12	
	HDD053-12	2D/0C	22-13	21-13	21-13
	HDD053-13	2D/0D	22-14	21-14	
	HDD053-14	2D/0E	22-15	21-15	21-15
	HDD053-15	2D/0F	22-16	21-16	
	HDD053-16	2D/10	22-17	21-17	21-17
	HDD053-17	2D/11	22-18	21-18	
	HDD053-18	2D/12	22-19	21-19	21-19
	HDD053-19	2D/13	22-20	21-20	
	HDD053-20	2D/14	22-21	21-21	21-21
	HDD053-21	2D/15	22-22	21-22	
	HDD053-22	2D/16	22-23	21-23	21-23
	HDD053-23	2D/17	22-24/Spare	21-24/Spare	21-23/Spare

THEORY-B-850**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (85/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-054	HDD054-00	2A/00	21-01	21-01	21-01
	HDD054-01	2A/01	21-02	21-02	
	HDD054-02	2A/02	21-03	21-03	21-03
	HDD054-03	2A/03	21-04	21-04	
	HDD054-04	2A/04	21-05	21-05	21-05
	HDD054-05	2A/05	21-06	21-06	
	HDD054-06	2A/06	21-07	21-07	21-07
	HDD054-07	2A/07	21-08	21-08	
	HDD054-08	2A/08	21-09	21-09	21-09
	HDD054-09	2A/09	21-10	21-10	
	HDD054-10	2A/0A	21-11	21-11	21-11
	HDD054-11	2A/0B	21-12	21-12	
	HDD054-12	2A/0C	21-13	21-13	21-13
	HDD054-13	2A/0D	21-14	21-14	
	HDD054-14	2A/0E	21-15	21-15	21-15
	HDD054-15	2A/0F	21-16	21-16	
	HDD054-16	2A/10	21-17	21-17	21-17
	HDD054-17	2A/11	21-18	21-18	
	HDD054-18	2A/12	21-19	21-19	21-19
	HDD054-19	2A/13	21-20	21-20	
	HDD054-20	2A/14	21-21	21-21	21-21
	HDD054-21	2A/15	21-22	21-22	
	HDD054-22	2A/16	21-23	21-23	21-23
	HDD054-23	2A/17	21-24/Spare	21-24/Spare	21-23/Spare

THEORY-B-860**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (86/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-055	HDD055-00	2E/00	22-01	21-01	21-01
	HDD055-01	2E/01	22-02	21-02	
	HDD055-02	2E/02	22-03	21-03	21-03
	HDD055-03	2E/03	22-04	21-04	
	HDD055-04	2E/04	22-05	21-05	21-05
	HDD055-05	2E/05	22-06	21-06	
	HDD055-06	2E/06	22-07	21-07	21-07
	HDD055-07	2E/07	22-08	21-08	
	HDD055-08	2E/08	22-09	21-09	21-09
	HDD055-09	2E/09	22-10	21-10	
	HDD055-10	2E/0A	22-11	21-11	21-11
	HDD055-11	2E/0B	22-12	21-12	
	HDD055-12	2E/0C	22-13	21-13	21-13
	HDD055-13	2E/0D	22-14	21-14	
	HDD055-14	2E/0E	22-15	21-15	21-15
	HDD055-15	2E/0F	22-16	21-16	
	HDD055-16	2E/10	22-17	21-17	21-17
	HDD055-17	2E/11	22-18	21-18	
	HDD055-18	2E/12	22-19	21-19	21-19
	HDD055-19	2E/13	22-20	21-20	
	HDD055-20	2E/14	22-21	21-21	21-21
	HDD055-21	2E/15	22-22	21-22	
	HDD055-22	2E/16	22-23	21-23	21-23
	HDD055-23	2E/17	22-24/Spare	21-24/Spare	21-23/Spare

THEORY-B-870**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (87/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-056	HDD056-00	2B/00	21-01	21-01	21-01
	HDD056-01	2B/01	21-02	21-02	
	HDD056-02	2B/02	21-03	21-03	21-03
	HDD056-03	2B/03	21-04	21-04	
	HDD056-04	2B/04	21-05	21-05	21-05
	HDD056-05	2B/05	21-06	21-06	
	HDD056-06	2B/06	21-07	21-07	21-07
	HDD056-07	2B/07	21-08	21-08	
	HDD056-08	2B/08	21-09	21-09	21-09
	HDD056-09	2B/09	21-10	21-10	
	HDD056-10	2B/0A	21-11	21-11	21-11
	HDD056-11	2B/0B	21-12	21-12	
	HDD056-12	2B/0C	21-13	21-13	21-13
	HDD056-13	2B/0D	21-14	21-14	
	HDD056-14	2B/0E	21-15	21-15	21-15
	HDD056-15	2B/0F	21-16	21-16	
	HDD056-16	2B/10	21-17	21-17	21-17
	HDD056-17	2B/11	21-18	21-18	
	HDD056-18	2B/12	21-19	21-19	21-19
	HDD056-19	2B/13	21-20	21-20	
	HDD056-20	2B/14	21-21	21-21	21-21
	HDD056-21	2B/15	21-22	21-22	
	HDD056-22	2B/16	21-23	21-23	21-23
	HDD056-23	2B/17	21-24/Spare	21-24/Spare	21-23/Spare

THEORY-B-880**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (88/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-057	HDD057-00	2F/00	22-01	21-01	21-01
	HDD057-01	2F/01	22-02	21-02	
	HDD057-02	2F/02	22-03	21-03	21-03
	HDD057-03	2F/03	22-04	21-04	
	HDD057-04	2F/04	22-05	21-05	21-05
	HDD057-05	2F/05	22-06	21-06	
	HDD057-06	2F/06	22-07	21-07	21-07
	HDD057-07	2F/07	22-08	21-08	
	HDD057-08	2F/08	22-09	21-09	21-09
	HDD057-09	2F/09	22-10	21-10	
	HDD057-10	2F/0A	22-11	21-11	21-11
	HDD057-11	2F/0B	22-12	21-12	
	HDD057-12	2F/0C	22-13	21-13	21-13
	HDD057-13	2F/0D	22-14	21-14	
	HDD057-14	2F/0E	22-15	21-15	21-15
	HDD057-15	2F/0F	22-16	21-16	
	HDD057-16	2F/10	22-17	21-17	21-17
	HDD057-17	2F/11	22-18	21-18	
	HDD057-18	2F/12	22-19	21-19	21-19
	HDD057-19	2F/13	22-20	21-20	
	HDD057-20	2F/14	22-21	21-21	21-21
	HDD057-21	2F/15	22-22	21-22	
	HDD057-22	2F/16	22-23	21-23	21-23
	HDD057-23	2F/17	22-24/Spare	21-24/Spare	21-23/Spare

THEORY-B-890**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (89/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-150	HDD150-00	58/00	23-01	23-01	23-01
	HDD150-01	58/01	23-02	23-02	
	HDD150-02	58/02	23-03	23-03	23-03
	HDD150-03	58/03	23-04	23-04	
	HDD150-04	58/04	23-05	23-05	23-05
	HDD150-05	58/05	23-06	23-06	
	HDD150-06	58/06	23-07	23-07	23-07
	HDD150-07	58/07	23-08	23-08	
	HDD150-08	58/08	23-09	23-09	23-09
	HDD150-09	58/09	23-10	23-10	
	HDD150-10	58/0A	23-11	23-11	23-11
	HDD150-11	58/0B	23-12	23-12	
	HDD150-12	58/0C	23-13	23-13	23-13
	HDD150-13	58/0D	23-14	23-14	
	HDD150-14	58/0E	23-15	23-15	23-15
	HDD150-15	58/0F	23-16	23-16	
	HDD150-16	58/10	23-17	23-17	23-17
	HDD150-17	58/11	23-18	23-18	
	HDD150-18	58/12	23-19	23-19	23-19
	HDD150-19	58/13	23-20	23-20	
	HDD150-20	58/14	23-21	23-21	23-21
	HDD150-21	58/15	23-22	23-22	
	HDD150-22	58/16	23-23	23-23	23-23
	HDD150-23	58/17	23-24/Spare	23-24/Spare	23-23/Spare

THEORY-B-900**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (90/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-151	HDD151-00	5C/00	24-01	23-01	23-01
	HDD151-01	5C/01	24-02	23-02	
	HDD151-02	5C/02	24-03	23-03	23-03
	HDD151-03	5C/03	24-04	23-04	
	HDD151-04	5C/04	24-05	23-05	23-05
	HDD151-05	5C/05	24-06	23-06	
	HDD151-06	5C/06	24-07	23-07	23-07
	HDD151-07	5C/07	24-08	23-08	
	HDD151-08	5C/08	24-09	23-09	23-09
	HDD151-09	5C/09	24-10	23-10	
	HDD151-10	5C/0A	24-11	23-11	23-11
	HDD151-11	5C/0B	24-12	23-12	
	HDD151-12	5C/0C	24-13	23-13	23-13
	HDD151-13	5C/0D	24-14	23-14	
	HDD151-14	5C/0E	24-15	23-15	23-15
	HDD151-15	5C/0F	24-16	23-16	
	HDD151-16	5C/10	24-17	23-17	23-17
	HDD151-17	5C/11	24-18	23-18	
	HDD151-18	5C/12	24-19	23-19	23-19
	HDD151-19	5C/13	24-20	23-20	
	HDD151-20	5C/14	24-21	23-21	23-21
	HDD151-21	5C/15	24-22	23-22	
	HDD151-22	5C/16	24-23	23-23	23-23
	HDD151-23	5C/17	24-24/Spare	23-24/Spare	23-23/Spare

THEORY-B-910**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (91/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-152	HDD152-00	59/00	23-01	23-01	23-01
	HDD152-01	59/01	23-02	23-02	
	HDD152-02	59/02	23-03	23-03	23-03
	HDD152-03	59/03	23-04	23-04	
	HDD152-04	59/04	23-05	23-05	23-05
	HDD152-05	59/05	23-06	23-06	
	HDD152-06	59/06	23-07	23-07	23-07
	HDD152-07	59/07	23-08	23-08	
	HDD152-08	59/08	23-09	23-09	23-09
	HDD152-09	59/09	23-10	23-10	
	HDD152-10	59/0A	23-11	23-11	23-11
	HDD152-11	59/0B	23-12	23-12	
	HDD152-12	59/0C	23-13	23-13	23-13
	HDD152-13	59/0D	23-14	23-14	
	HDD152-14	59/0E	23-15	23-15	23-15
	HDD152-15	59/0F	23-16	23-16	
	HDD152-16	59/10	23-17	23-17	23-17
	HDD152-17	59/11	23-18	23-18	
	HDD152-18	59/12	23-19	23-19	23-19
	HDD152-19	59/13	23-20	23-20	
	HDD152-20	59/14	23-21	23-21	23-21
	HDD152-21	59/15	23-22	23-22	
	HDD152-22	59/16	23-23	23-23	23-23
	HDD152-23	59/17	23-24/Spare	23-24/Spare	23-23/Spare

THEORY-B-920**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (92/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-153	HDD153-00	5D/00	24-01	23-01	23-01
	HDD153-01	5D/01	24-02	23-02	
	HDD153-02	5D/02	24-03	23-03	23-03
	HDD153-03	5D/03	24-04	23-04	
	HDD153-04	5D/04	24-05	23-05	23-05
	HDD153-05	5D/05	24-06	23-06	
	HDD153-06	5D/06	24-07	23-07	23-07
	HDD153-07	5D/07	24-08	23-08	
	HDD153-08	5D/08	24-09	23-09	23-09
	HDD153-09	5D/09	24-10	23-10	
	HDD153-10	5D/0A	24-11	23-11	23-11
	HDD153-11	5D/0B	24-12	23-12	
	HDD153-12	5D/0C	24-13	23-13	23-13
	HDD153-13	5D/0D	24-14	23-14	
	HDD153-14	5D/0E	24-15	23-15	23-15
	HDD153-15	5D/0F	24-16	23-16	
	HDD153-16	5D/10	24-17	23-17	23-17
	HDD153-17	5D/11	24-18	23-18	
	HDD153-18	5D/12	24-19	23-19	23-19
	HDD153-19	5D/13	24-20	23-20	
	HDD153-20	5D/14	24-21	23-21	23-21
	HDD153-21	5D/15	24-22	23-22	
	HDD153-22	5D/16	24-23	23-23	23-23
	HDD153-23	5D/17	24-24/Spare	23-24/Spare	23-23/Spare

THEORY-B-930**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (93/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-154	HDD154-00	5A/00	23-01	23-01	23-01
	HDD154-01	5A/01	23-02	23-02	
	HDD154-02	5A/02	23-03	23-03	23-03
	HDD154-03	5A/03	23-04	23-04	
	HDD154-04	5A/04	23-05	23-05	23-05
	HDD154-05	5A/05	23-06	23-06	
	HDD154-06	5A/06	23-07	23-07	23-07
	HDD154-07	5A/07	23-08	23-08	
	HDD154-08	5A/08	23-09	23-09	23-09
	HDD154-09	5A/09	23-10	23-10	
	HDD154-10	5A/0A	23-11	23-11	23-11
	HDD154-11	5A/0B	23-12	23-12	
	HDD154-12	5A/0C	23-13	23-13	23-13
	HDD154-13	5A/0D	23-14	23-14	
	HDD154-14	5A/0E	23-15	23-15	23-15
	HDD154-15	5A/0F	23-16	23-16	
	HDD154-16	5A/10	23-17	23-17	23-17
	HDD154-17	5A/11	23-18	23-18	
	HDD154-18	5A/12	23-19	23-19	23-19
	HDD154-19	5A/13	23-20	23-20	
	HDD154-20	5A/14	23-21	23-21	23-21
	HDD154-21	5A/15	23-22	23-22	
	HDD154-22	5A/16	23-23	23-23	23-23
	HDD154-23	5A/17	23-24/Spare	24-24/Spare	23-23/Spare

THEORY-B-940**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (94/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-155	HDD155-00	5E/00	24-01	23-01	23-01
	HDD155-01	5E/01	24-02	23-02	
	HDD155-02	5E/02	24-03	23-03	23-03
	HDD155-03	5E/03	24-04	23-04	
	HDD155-04	5E/04	24-05	23-05	23-05
	HDD155-05	5E/05	24-06	23-06	
	HDD155-06	5E/06	24-07	23-07	23-07
	HDD155-07	5E/07	24-08	23-08	
	HDD155-08	5E/08	24-09	23-09	23-09
	HDD155-09	5E/09	24-10	23-10	
	HDD155-10	5E/0A	24-11	23-11	23-11
	HDD155-11	5E/0B	24-12	23-12	
	HDD155-12	5E/0C	24-13	23-13	23-13
	HDD155-13	5E/0D	24-14	23-14	
	HDD155-14	5E/0E	24-15	23-15	23-15
	HDD155-15	5E/0F	24-16	23-16	
	HDD155-16	5E/10	24-17	23-17	23-17
	HDD155-17	5E/11	24-18	23-18	
	HDD155-18	5E/12	24-19	23-19	23-19
	HDD155-19	5E/13	24-20	23-20	
	HDD155-20	5E/14	24-21	23-21	23-21
	HDD155-21	5E/15	24-22	23-22	
	HDD155-22	5E/16	24-23	23-23	23-23
	HDD155-23	5E/17	24-24/Spare	24-24/Spare	23-23/Spare

THEORY-B-950**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (95/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-156	HDD156-00	5B/00	23-01	23-01	23-01
	HDD156-01	5B/01	23-02	23-02	
	HDD156-02	5B/02	23-03	23-03	23-03
	HDD156-03	5B/03	23-04	23-04	
	HDD156-04	5B/04	23-05	23-05	23-05
	HDD156-05	5B/05	23-06	23-06	
	HDD156-06	5B/06	23-07	23-07	23-07
	HDD156-07	5B/07	23-08	23-08	
	HDD156-08	5B/08	23-09	23-09	23-09
	HDD156-09	5B/09	23-10	23-10	
	HDD156-10	5B/0A	23-11	23-11	23-11
	HDD156-11	5B/0B	23-12	23-12	
	HDD156-12	5B/0C	23-13	23-13	23-13
	HDD156-13	5B/0D	23-14	23-14	
	HDD156-14	5B/0E	23-15	23-15	23-15
	HDD156-15	5B/0F	23-16	23-16	
	HDD156-16	5B/10	23-17	23-17	23-17
	HDD156-17	5B/11	23-18	23-18	
	HDD156-18	5B/12	23-19	23-19	23-19
	HDD156-19	5B/13	23-20	23-20	
	HDD156-20	5B/14	23-21	23-21	23-21
	HDD156-21	5B/15	23-22	23-22	
	HDD156-22	5B/16	23-23	23-23	23-23
	HDD156-23	5B/17	23-24/Spare	24-24/Spare	23-23/Spare

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RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (2.5 INCH DRIVE BOX) (96/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-157	HDD157-00	5F/00	24-01	23-01	23-01
	HDD157-01	5F/01	24-02	23-02	
	HDD157-02	5F/02	24-03	23-03	23-03
	HDD157-03	5F/03	24-04	23-04	
	HDD157-04	5F/04	24-05	23-05	23-05
	HDD157-05	5F/05	24-06	23-06	
	HDD157-06	5F/06	24-07	23-07	23-07
	HDD157-07	5F/07	24-08	23-08	
	HDD157-08	5F/08	24-09	23-09	23-09
	HDD157-09	5F/09	24-10	23-10	
	HDD157-10	5F/0A	24-11	23-11	23-11
	HDD157-11	5F/0B	24-12	23-12	
	HDD157-12	5F/0C	24-13	23-13	23-13
	HDD157-13	5F/0D	24-14	23-14	
	HDD157-14	5F/0E	24-15	23-15	23-15
	HDD157-15	5F/0F	24-16	23-16	
	HDD157-16	5F/10	24-17	23-17	23-17
	HDD157-17	5F/11	24-18	23-18	
	HDD157-18	5F/12	24-19	23-19	23-19
	HDD157-19	5F/13	24-20	23-20	
	HDD157-20	5F/14	24-21	23-21	23-21
	HDD157-21	5F/15	24-22	23-22	
	HDD157-22	5F/16	24-23	23-23	23-23
	HDD157-23	5F/17	24-24/Spare	24-24/Spare	23-23/Spare

Appendixes C

C.1 Physical-Logical Device Matrixes (3.5 INCH DRIVE BOX)

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (1/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-000	HDD000-00	00/00	01-01	01-01	01-01
	HDD000-01	00/01	01-02	01-02	
	HDD000-02	00/02	01-03	01-03	01-03
	HDD000-03	00/03	01-04	01-04	
	HDD000-04	00/04	01-05	01-05	01-05
	HDD000-05	00/05	01-06	01-06	
	HDD000-06	00/06	01-07	01-07	01-07
	HDD000-07	00/07	01-08	01-08	
	HDD000-08	00/08	01-09	01-09	01-09
	HDD000-09	00/09	01-10	01-10	
	HDD000-10	00/0A	01-11	01-11	01-11
	HDD000-11	00/0B	01-12/Spare	01-12/Spare	01-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (2/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-001	HDD001-00	04/00	02-01	01-01	01-01
	HDD001-01	04/01	02-02	01-02	
	HDD001-02	04/02	02-03	01-03	01-03
	HDD001-03	04/03	02-04	01-04	
	HDD001-04	04/04	02-05	01-05	01-05
	HDD001-05	04/05	02-06	01-06	
	HDD001-06	04/06	02-07	01-07	01-07
	HDD001-07	04/07	02-08	01-08	
	HDD001-08	04/08	02-09	01-09	01-09
	HDD001-09	04/09	02-10	01-10	
	HDD001-10	04/0A	02-11	01-11	01-11
	HDD001-11	04/0B	02-12/Spare	01-11/Spare	01-11/Spare

THEORY-C-20**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (3/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-002	HDD002-00	01/00	01-01	01-01	01-01
	HDD002-01	01/01	01-02	01-02	
	HDD002-02	01/02	01-03	01-03	01-03
	HDD002-03	01/03	01-04	01-04	
	HDD002-04	01/04	01-05	01-05	01-05
	HDD002-05	01/05	01-06	01-06	
	HDD002-06	01/06	01-07	01-07	01-07
	HDD002-07	01/07	01-08	01-08	
	HDD002-08	01/08	01-09	01-09	01-09
	HDD002-09	01/09	01-10	01-10	
	HDD002-10	01/0A	01-11	01-11	01-11
	HDD002-11	01/0B	01-12/Spare	01-12/Spare	01-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (4/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-003	HDD003-00	05/00	02-01	01-01	01-01
	HDD003-01	05/01	02-02	01-02	
	HDD003-02	05/02	02-03	01-03	01-03
	HDD003-03	05/03	02-04	01-04	
	HDD003-04	05/04	02-05	01-05	01-05
	HDD003-05	05/05	02-06	01-06	
	HDD003-06	05/06	02-07	01-07	01-07
	HDD003-07	05/07	02-08	01-08	
	HDD003-08	05/08	02-09	01-09	01-09
	HDD003-09	05/09	02-10	01-10	
	HDD003-10	05/0A	02-11	01-11	01-11
	HDD003-11	05/0B	02-12/Spare	01-12/Spare	01-11/Spare

THEORY-C-30**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (5/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-004	HDD004-00	02/00	01-01	01-01	01-01
	HDD004-01	02/01	01-02	01-02	
	HDD004-02	02/02	01-03	01-03	01-03
	HDD004-03	02/03	01-04	01-04	
	HDD004-04	02/04	01-05	01-05	01-05
	HDD004-05	02/05	01-06	01-06	
	HDD004-06	02/06	01-07	01-07	01-07
	HDD004-07	02/07	01-08	01-08	
	HDD004-08	02/08	01-09	01-09	01-09
	HDD004-09	02/09	01-10	01-10	
	HDD004-10	02/0A	01-11	01-11	01-11
	HDD004-11	02/0B	01-12/Spare	01-12/Spare	01-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (6/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-005	HDD005-00	06/00	02-01	01-01	01-01
	HDD005-01	06/01	02-02	01-02	
	HDD005-02	06/02	02-03	01-03	01-03
	HDD005-03	06/03	02-04	01-04	
	HDD005-04	06/04	02-05	01-05	01-05
	HDD005-05	06/05	02-06	01-06	
	HDD005-06	06/06	02-07	01-07	01-07
	HDD005-07	06/07	02-08	01-08	
	HDD005-08	06/08	02-09	01-09	01-09
	HDD005-09	06/09	02-10	01-10	
	HDD005-10	06/0A	02-11	01-11	01-11
	HDD005-11	06/0B	02-12/Spare	01-12/Spare	01-11/Spare

THEORY-C-40**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (7/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-006	HDD006-00	03/00	01-01	01-01	01-01
	HDD006-01	03/01	01-02	01-02	
	HDD006-02	03/02	01-03	01-03	01-03
	HDD006-03	03/03	01-04	01-04	
	HDD006-04	03/04	01-05	01-05	01-05
	HDD006-05	03/05	01-06	01-06	
	HDD006-06	03/06	01-07	01-07	01-07
	HDD006-07	03/07	01-08	01-08	
	HDD006-08	03/08	01-09	01-09	01-09
	HDD006-09	03/09	01-10	01-10	
	HDD006-10	03/0A	01-11	01-11	01-11
	HDD006-11	03/0B	01-12/Spare	01-12/Spare	01-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (8/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-007	HDD007-00	07/00	02-01	01-01	01-01
	HDD007-01	07/01	02-02	01-02	
	HDD007-02	07/02	02-03	01-03	01-03
	HDD007-03	07/03	02-04	01-04	
	HDD007-04	07/04	02-05	01-05	01-05
	HDD007-05	07/05	02-06	01-06	
	HDD007-06	07/06	02-07	01-07	01-07
	HDD007-07	07/07	02-08	01-08	
	HDD007-08	07/08	02-09	01-09	01-09
	HDD007-09	07/09	02-10	01-10	
	HDD007-10	07/0A	02-11	01-11	01-11
	HDD007-11	07/0B	02-12/Spare	01-12/Spare	01-11/Spare

THEORY-C-50**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (9/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-100	HDD100-00	30/00	03-01	03-01	03-01
	HDD100-01	30/01	03-02	03-02	
	HDD100-02	30/02	03-03	03-03	03-03
	HDD100-03	30/03	03-04	03-04	
	HDD100-04	30/04	03-05	03-05	03-05
	HDD100-05	30/05	03-06	03-06	
	HDD100-06	30/06	03-07	03-07	03-07
	HDD100-07	30/07	03-08	03-08	
	HDD100-08	30/08	03-09	03-09	03-09
	HDD100-09	30/09	03-10	03-10	
	HDD100-10	30/0A	03-11	03-11	03-11
	HDD100-11	30/0B	03-12/Spare	03-12/Spare	03-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (10/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-101	HDD101-00	34/00	04-01	03-01	03-01
	HDD101-01	34/01	04-02	03-02	
	HDD101-02	34/02	04-03	03-03	03-03
	HDD101-03	34/03	04-04	03-04	
	HDD101-04	34/04	04-05	03-05	03-05
	HDD101-05	34/05	04-06	03-06	
	HDD101-06	34/06	04-07	03-07	03-07
	HDD101-07	34/07	04-08	03-08	
	HDD101-08	34/08	04-09	03-09	03-09
	HDD101-09	34/09	04-10	03-10	
	HDD101-10	34/0A	04-11	03-11	03-11
	HDD101-11	34/0B	04-12/Spare	03-12/Spare	03-11/Spare

THEORY-C-60**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (11/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-102	HDD102-00	31/00	03-01	03-01	03-01
	HDD102-01	31/01	03-02	03-02	
	HDD102-02	31/02	03-03	03-03	03-03
	HDD102-03	31/03	03-04	03-04	
	HDD102-04	31/04	03-05	03-05	03-05
	HDD102-05	31/05	03-06	03-06	
	HDD102-06	31/06	03-07	03-07	03-07
	HDD102-07	31/07	03-08	03-08	
	HDD102-08	31/08	03-09	03-09	03-09
	HDD102-09	31/09	03-10	03-10	
	HDD102-10	31/0A	03-11	03-11	03-11
	HDD102-11	31/0B	03-12/Spare	03-12/Spare	03-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (12/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-103	HDD103-00	35/00	04-01	03-01	03-01
	HDD103-01	35/01	04-02	03-02	
	HDD103-02	35/02	04-03	03-03	03-03
	HDD103-03	35/03	04-04	03-04	
	HDD103-04	35/04	04-05	03-05	03-05
	HDD103-05	35/05	04-06	03-06	
	HDD103-06	35/06	04-07	03-07	03-07
	HDD103-07	35/07	04-08	03-08	
	HDD103-08	35/08	04-09	03-09	03-09
	HDD103-09	35/09	04-10	03-10	
	HDD103-10	35/0A	04-11	03-11	03-11
	HDD103-11	35/0B	04-12/Spare	03-12/Spare	03-11/Spare

THEORY-C-70**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (13/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-104	HDD104-00	32/00	03-01	03-01	03-01
	HDD104-01	32/01	03-02	03-02	
	HDD104-02	32/02	03-03	03-03	03-03
	HDD104-03	32/03	03-04	03-04	
	HDD104-04	32/04	03-05	03-05	03-05
	HDD104-05	32/05	03-06	03-06	
	HDD104-06	32/06	03-07	03-07	03-07
	HDD104-07	32/07	03-08	03-08	
	HDD104-08	32/08	03-09	03-09	03-09
	HDD104-09	32/09	03-10	03-10	
	HDD104-10	32/0A	03-11	03-11	03-11
	HDD104-11	32/0B	03-12/Spare	03-12/Spare	03-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (14/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-105	HDD105-00	36/00	04-01	03-01	03-01
	HDD105-01	36/01	04-02	03-02	
	HDD105-02	36/02	04-03	03-03	03-03
	HDD105-03	36/03	04-04	03-04	
	HDD105-04	36/04	04-05	03-05	03-05
	HDD105-05	36/05	04-06	03-06	
	HDD105-06	36/06	04-07	03-07	03-07
	HDD105-07	36/07	04-08	03-08	
	HDD105-08	36/08	04-09	03-09	03-09
	HDD105-09	36/09	04-10	03-10	
	HDD105-10	36/0A	04-11	03-11	03-11
	HDD105-11	36/0B	04-12/Spare	03-12/Spare	03-11/Spare

THEORY-C-80**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (15/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-106	HDD106-00	33/00	03-01	03-01	03-01
	HDD106-01	33/01	03-02	03-02	
	HDD106-02	33/02	03-03	03-03	03-03
	HDD106-03	33/03	03-04	03-04	
	HDD106-04	33/04	03-05	03-05	03-05
	HDD106-05	33/05	03-06	03-06	
	HDD106-06	33/06	03-07	03-07	03-07
	HDD106-07	33/07	03-08	03-08	
	HDD106-08	33/08	03-09	03-09	03-09
	HDD106-09	33/09	03-10	03-10	
	HDD106-10	33/0A	03-11	03-11	03-11
	HDD106-11	33/0B	03-12/Spare	03-12/Spare	03-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (16/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-107	HDD107-00	37/00	04-01	03-01	03-01
	HDD107-01	37/01	04-02	03-02	
	HDD107-02	37/02	04-03	03-03	03-03
	HDD107-03	37/03	04-04	03-04	
	HDD107-04	37/04	04-05	03-05	03-05
	HDD107-05	37/05	04-06	03-06	
	HDD107-06	37/06	04-07	03-07	03-07
	HDD107-07	37/07	04-08	03-08	
	HDD107-08	37/08	04-09	03-09	03-09
	HDD107-09	37/09	04-10	03-10	
	HDD107-10	37/0A	04-11	03-11	03-11
	HDD107-11	37/0B	04-12/Spare	03-12/Spare	03-11/Spare

THEORY-C-90**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (17/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-010	HDD010-00	08/00	05-01	05-01	05-01
	HDD010-01	08/01	05-02	05-02	
	HDD010-02	08/02	05-03	05-03	05-03
	HDD010-03	08/03	05-04	05-04	
	HDD010-04	08/04	05-05	05-05	05-05
	HDD010-05	08/05	05-06	05-06	
	HDD010-06	08/06	05-07	05-07	05-07
	HDD010-07	08/07	05-08	05-08	
	HDD010-08	08/08	05-09	05-09	05-09
	HDD010-09	08/09	05-10	05-10	
	HDD010-10	08/0A	05-11	05-11	05-11
	HDD010-11	08/0B	05-12/Spare	05-12/Spare	05-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (18/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-011	HDD011-00	0C/00	06-01	05-01	05-01
	HDD011-01	0C/01	06-02	05-02	
	HDD011-02	0C/02	06-03	05-03	05-03
	HDD011-03	0C/03	06-04	05-04	
	HDD011-04	0C/04	06-05	05-05	05-05
	HDD011-05	0C/05	06-06	05-06	
	HDD011-06	0C/06	06-07	05-07	05-07
	HDD011-07	0C/07	06-08	05-08	
	HDD011-08	0C/08	06-09	05-09	05-09
	HDD011-09	0C/09	06-10	05-10	
	HDD011-10	0C/0A	06-11	05-11	05-11
	HDD011-11	0C/0B	06-12/Spare	05-12/Spare	05-11/Spare

THEORY-C-100**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (19/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-012	HDD012-00	09/00	05-01	05-01	05-01
	HDD012-01	09/01	05-02	05-02	
	HDD012-02	09/02	05-03	05-03	05-03
	HDD012-03	09/03	05-04	05-04	
	HDD012-04	09/04	05-05	05-05	05-05
	HDD012-05	09/05	05-06	05-06	
	HDD012-06	09/06	05-07	05-07	05-07
	HDD012-07	09/07	05-08	05-08	
	HDD012-08	09/08	05-09	05-09	05-09
	HDD012-09	09/09	05-10	05-10	
	HDD012-10	09/0A	05-11	05-11	05-11
	HDD012-11	09/0B	05-12/Spare	05-12/Spare	05-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (20/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-013	HDD013-00	0D/00	06-01	05-01	05-01
	HDD013-01	0D/01	06-02	05-02	
	HDD013-02	0D/02	06-03	05-03	05-03
	HDD013-03	0D/03	06-04	05-04	
	HDD013-04	0D/04	06-05	05-05	05-05
	HDD013-05	0D/05	06-06	05-06	
	HDD013-06	0D/06	06-07	05-07	05-07
	HDD013-07	0D/07	06-08	05-08	
	HDD013-08	0D/08	06-09	05-09	05-09
	HDD013-09	0D/09	06-10	05-10	
	HDD013-10	0D/0A	06-11	05-11	05-11
	HDD013-11	0D/0B	06-12/Spare	05-12/Spare	05-11/Spare

THEORY-C-110**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (21/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-014	HDD014-00	0A/00	05-01	05-01	05-01
	HDD014-01	0A/01	05-02	05-02	
	HDD014-02	0A/02	05-03	05-03	05-03
	HDD014-03	0A/03	05-04	05-04	
	HDD014-04	0A/04	05-05	05-05	05-05
	HDD014-05	0A/05	05-06	05-06	
	HDD014-06	0A/06	05-07	05-07	05-07
	HDD014-07	0A/07	05-08	05-08	
	HDD014-08	0A/08	05-09	05-09	05-09
	HDD014-09	0A/09	05-10	05-10	
	HDD014-10	0A/0A	05-11	05-11	05-11
	HDD014-11	0A/0B	05-12/Spare	05-12/Spare	05-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (22/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-015	HDD015-00	0E/00	06-01	05-01	05-01
	HDD015-01	0E/01	06-02	05-02	
	HDD015-02	0E/02	06-03	05-03	05-03
	HDD015-03	0E/03	06-04	05-04	
	HDD015-04	0E/04	06-05	05-05	05-05
	HDD015-05	0E/05	06-06	05-06	
	HDD015-06	0E/06	06-07	05-07	05-07
	HDD015-07	0E/07	06-08	05-08	
	HDD015-08	0E/08	06-09	05-09	05-09
	HDD015-09	0E/09	06-10	05-10	
	HDD015-10	0E/0A	06-11	05-11	05-11
	HDD015-11	0E/0B	06-12/Spare	05-12/Spare	05-11/Spare

THEORY-C-120**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (23/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-016	HDD016-00	0B/00	05-01	05-01	05-01
	HDD016-01	0B/01	05-02	05-02	
	HDD016-02	0B/02	05-03	05-03	05-03
	HDD016-03	0B/03	05-04	05-04	
	HDD016-04	0B/04	05-05	05-05	05-05
	HDD016-05	0B/05	05-06	05-06	
	HDD016-06	0B/06	05-07	05-07	05-07
	HDD016-07	0B/07	05-08	05-08	
	HDD016-08	0B/08	05-09	05-09	05-09
	HDD016-09	0B/09	05-10	05-10	
	HDD016-10	0B/0A	05-11	05-11	05-11
	HDD016-11	0B/0B	05-12/Spare	05-12/Spare	05-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (24/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-017	HDD017-00	0F/00	06-01	05-01	05-01
	HDD017-01	0F/01	06-02	05-02	
	HDD017-02	0F/02	06-03	05-03	05-03
	HDD017-03	0F/03	06-04	05-04	
	HDD017-04	0F/04	06-05	05-05	05-05
	HDD017-05	0F/05	06-06	05-06	
	HDD017-06	0F/06	06-07	05-07	05-07
	HDD017-07	0F/07	06-08	05-08	
	HDD017-08	0F/08	06-09	05-09	05-09
	HDD017-09	0F/09	06-10	05-10	
	HDD017-10	0F/0A	06-11	05-11	05-11
	HDD017-11	0F/0B	06-12/Spare	05-12/Spare	05-11/Spare

THEORY-C-130**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (25/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-110	HDD110-00	38/00	07-01	07-01	07-01
	HDD110-01	38/01	07-02	07-02	
	HDD110-02	38/02	07-03	07-03	07-03
	HDD110-03	38/03	07-04	07-04	
	HDD110-04	38/04	07-05	07-05	07-05
	HDD110-05	38/05	07-06	07-06	
	HDD110-06	38/06	07-07	07-07	07-07
	HDD110-07	38/07	07-08	07-08	
	HDD110-08	38/08	07-09	07-09	07-09
	HDD110-09	38/09	07-10	07-10	
	HDD110-10	38/0A	07-11	07-11	07-11
	HDD110-11	38/0B	07-12/Spare	07-12/Spare	07-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (26/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-111	HDD111-00	3C/00	08-01	07-01	07-01
	HDD111-01	3C/01	08-02	07-02	
	HDD111-02	3C/02	08-03	07-03	07-03
	HDD111-03	3C/03	08-04	07-04	
	HDD111-04	3C/04	08-05	07-05	07-05
	HDD111-05	3C/05	08-06	07-06	
	HDD111-06	3C/06	08-07	07-07	07-07
	HDD111-07	3C/07	08-08	07-08	
	HDD111-08	3C/08	08-09	07-09	07-09
	HDD111-09	3C/09	08-10	07-10	
	HDD111-10	3C/0A	08-11	07-11	07-11
	HDD111-11	3C/0B	08-12/Spare	07-12/Spare	07-11/Spare

THEORY-C-140**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (27/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-112	HDD112-00	39/00	07-01	07-01	07-01
	HDD112-01	39/01	07-02	07-02	
	HDD112-02	39/02	07-03	07-03	07-03
	HDD112-03	39/03	07-04	07-04	
	HDD112-04	39/04	07-05	07-05	07-05
	HDD112-05	39/05	07-06	07-06	
	HDD112-06	39/06	07-07	07-07	07-07
	HDD112-07	39/07	07-08	07-08	
	HDD112-08	39/08	07-09	07-09	07-09
	HDD112-09	39/09	07-10	07-10	
	HDD112-10	39/0A	07-11	07-11	07-11
	HDD112-11	39/0B	07-12/Spare	07-12/Spare	07-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (28/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-113	HDD113-00	3D/00	08-01	07-01	07-01
	HDD113-01	3D/01	08-02	07-02	
	HDD113-02	3D/02	08-03	07-03	07-03
	HDD113-03	3D/03	08-04	07-04	
	HDD113-04	3D/04	08-05	07-05	07-05
	HDD113-05	3D/05	08-06	07-06	
	HDD113-06	3D/06	08-07	07-07	07-07
	HDD113-07	3D/07	08-08	07-08	
	HDD113-08	3D/08	08-09	07-09	07-09
	HDD113-09	3D/09	08-10	07-10	
	HDD113-10	3D/0A	08-11	07-11	07-11
	HDD113-11	3D/0B	08-12/Spare	07-12/Spare	07-11/Spare

THEORY-C-150**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (29/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-114	HDD114-00	3A/00	07-01	07-01	07-01
	HDD114-01	3A/01	07-02	07-02	
	HDD114-02	3A/02	07-03	07-03	07-03
	HDD114-03	3A/03	07-04	07-04	
	HDD114-04	3A/04	07-05	07-05	07-05
	HDD114-05	3A/05	07-06	07-06	
	HDD114-06	3A/06	07-07	07-07	07-07
	HDD114-07	3A/07	07-08	07-08	
	HDD114-08	3A/08	07-09	07-09	07-09
	HDD114-09	3A/09	07-10	07-10	
	HDD114-10	3A/0A	07-11	07-11	07-11
	HDD114-11	3A/0B	07-12/Spare	07-12/Spare	07-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (30/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-115	HDD115-00	3E/00	08-01	07-01	07-01
	HDD115-01	3E/01	08-02	07-02	
	HDD115-02	3E/02	08-03	07-03	07-03
	HDD115-03	3E/03	08-04	07-04	
	HDD115-04	3E/04	08-05	07-05	07-05
	HDD115-05	3E/05	08-06	07-06	
	HDD115-06	3E/06	08-07	07-07	07-07
	HDD115-07	3E/07	08-08	07-08	
	HDD115-08	3E/08	08-09	07-09	07-09
	HDD115-09	3E/09	08-10	07-10	
	HDD115-10	3E/0A	08-11	07-11	07-11
	HDD115-11	3E/0B	08-12/Spare	07-12/Spare	07-11/Spare

THEORY-C-160**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (31/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-116	HDD116-00	3B/00	07-01	07-01	07-01
	HDD116-01	3B/01	07-02	07-02	
	HDD116-02	3B/02	07-03	07-03	07-03
	HDD116-03	3B/03	07-04	07-04	
	HDD116-04	3B/04	07-05	07-05	07-05
	HDD116-05	3B/05	07-06	07-06	
	HDD116-06	3B/06	07-07	07-07	07-07
	HDD116-07	3B/07	07-08	07-08	
	HDD116-08	3B/08	07-09	07-09	07-09
	HDD116-09	3B/09	07-10	07-10	
	HDD116-10	3B/0A	07-11	07-11	07-11
	HDD116-11	3B/0B	07-12/Spare	07-12/Spare	07-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (32/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-117	HDD117-00	3F/00	08-01	07-01	07-01
	HDD117-01	3F/01	08-02	07-02	
	HDD117-02	3F/02	08-03	07-03	07-03
	HDD117-03	3F/03	08-04	07-04	
	HDD117-04	3F/04	08-05	07-05	07-05
	HDD117-05	3F/05	08-06	07-06	
	HDD117-06	3F/06	08-07	07-07	07-07
	HDD117-07	3F/07	08-08	07-08	
	HDD117-08	3F/08	08-09	07-09	07-09
	HDD117-09	3F/09	08-10	07-10	
	HDD117-10	3F/0A	08-11	07-11	07-11
	HDD117-11	3F/0B	08-12/Spare	07-12/Spare	07-11/Spare

THEORY-C-170**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (33/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-020	HDD020-00	10/00	09-01	09-01	09-01
	HDD020-01	10/01	09-02	09-02	
	HDD020-02	10/02	09-03	09-03	09-03
	HDD020-03	10/03	09-04	09-04	
	HDD020-04	10/04	09-05	09-05	09-05
	HDD020-05	10/05	09-06	09-06	
	HDD020-06	10/06	09-07	09-07	09-07
	HDD020-07	10/07	09-08	09-08	
	HDD020-08	10/08	09-09	09-09	09-09
	HDD020-09	10/09	09-10	09-10	
	HDD020-10	10/0A	09-11	09-11	09-11
	HDD020-11	10/0B	09-12/Spare	09-12/Spare	09-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (34/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-021	HDD021-00	14/00	10-01	09-01	09-01
	HDD021-01	14/01	10-02	09-02	
	HDD021-02	14/02	10-03	09-03	09-03
	HDD021-03	14/03	10-04	09-04	
	HDD021-04	14/04	10-05	09-05	09-05
	HDD021-05	14/05	10-06	09-06	
	HDD021-06	14/06	10-07	09-07	09-07
	HDD021-07	14/07	10-08	09-08	
	HDD021-08	14/08	10-09	09-09	09-09
	HDD021-09	14/09	10-10	09-10	
	HDD021-10	14/0A	10-11	09-11	09-11
	HDD021-11	14/0B	10-12/Spare	09-12/Spare	09-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (35/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-022	HDD022-00	11/00	09-01	09-01	09-01
	HDD022-01	11/01	09-02	09-02	
	HDD022-02	11/02	09-03	09-03	09-03
	HDD022-03	11/03	09-04	09-04	
	HDD022-04	11/04	09-05	09-05	09-05
	HDD022-05	11/05	09-06	09-06	
	HDD022-06	11/06	09-07	09-07	09-07
	HDD022-07	11/07	09-08	09-08	
	HDD022-08	11/08	09-09	09-09	09-09
	HDD022-09	11/09	09-10	09-10	
	HDD022-10	11/0A	09-11	09-11	09-11
	HDD022-11	11/0B	09-12/Spare	09-12/Spare	09-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (36/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-023	HDD023-00	15/00	10-01	09-01	09-01
	HDD023-01	15/01	10-02	09-02	
	HDD023-02	15/02	10-03	09-03	09-03
	HDD023-03	15/03	10-04	09-04	
	HDD023-04	15/04	10-05	09-05	09-05
	HDD023-05	15/05	10-06	09-06	
	HDD023-06	15/06	10-07	09-07	09-07
	HDD023-07	15/07	10-08	09-08	
	HDD023-08	15/08	10-09	09-09	09-09
	HDD023-09	15/09	10-10	09-10	
	HDD023-10	15/0A	10-11	09-11	09-11
	HDD023-11	15/0B	10-12/Spare	09-12/Spare	09-11/Spare

THEORY-C-190**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (37/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-024	HDD024-00	12/00	09-01	09-01	09-01
	HDD024-01	12/01	09-02	09-02	
	HDD024-02	12/02	09-03	09-03	09-03
	HDD024-03	12/03	09-04	09-04	
	HDD024-04	12/04	09-05	09-05	09-05
	HDD024-05	12/05	09-06	09-06	
	HDD024-06	12/06	09-07	09-07	09-07
	HDD024-07	12/07	09-08	09-08	
	HDD024-08	12/08	09-09	09-09	09-09
	HDD024-09	12/09	09-10	09-10	
	HDD024-10	12/0A	09-11	09-11	09-11
	HDD024-11	12/0B	09-12/Spare	09-12/Spare	09-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (38/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-025	HDD025-00	16/00	10-01	09-01	09-01
	HDD025-01	16/01	10-02	09-02	
	HDD025-02	16/02	10-03	09-03	09-03
	HDD025-03	16/03	10-04	09-04	
	HDD025-04	16/04	10-05	09-05	09-05
	HDD025-05	16/05	10-06	09-06	
	HDD025-06	16/06	10-07	09-07	09-07
	HDD025-07	16/07	10-08	09-08	
	HDD025-08	16/08	10-09	09-09	09-09
	HDD025-09	16/09	10-10	09-10	
	HDD025-10	16/0A	10-11	09-11	09-11
	HDD025-11	16/0B	10-12/Spare	09-12/Spare	09-11/Spare

THEORY-C-200**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (39/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-026	HDD026-00	13/00	09-01	09-01	09-01
	HDD026-01	13/01	09-02	09-02	
	HDD026-02	13/02	09-03	09-03	09-03
	HDD026-03	13/03	09-04	09-04	
	HDD026-04	13/04	09-05	09-05	09-05
	HDD026-05	13/05	09-06	09-06	
	HDD026-06	13/06	09-07	09-07	09-07
	HDD026-07	13/07	09-08	09-08	
	HDD026-08	13/08	09-09	09-09	09-09
	HDD026-09	13/09	09-10	09-10	
	HDD026-10	13/0A	09-11	09-11	09-11
	HDD026-11	13/0B	09-12/Spare	09-12/Spare	09-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (40/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-027	HDD027-00	17/00	10-01	09-01	09-01
	HDD027-01	17/01	10-02	09-02	
	HDD027-02	17/02	10-03	09-03	09-03
	HDD027-03	17/03	10-04	09-04	
	HDD027-04	17/04	10-05	09-05	09-05
	HDD027-05	17/05	10-06	09-06	
	HDD027-06	17/06	10-07	09-07	09-07
	HDD027-07	17/07	10-08	09-08	
	HDD027-08	17/08	10-09	09-09	09-09
	HDD027-09	17/09	10-10	09-10	
	HDD027-10	17/0A	10-11	09-11	09-11
	HDD027-11	17/0B	10-12/Spare	09-12/Spare	09-11/Spare

THEORY-C-210**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (41/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-120	HDD120-00	40/00	11-01	11-01	11-01
	HDD120-01	40/01	11-02	11-02	
	HDD120-02	40/02	11-03	11-03	11-03
	HDD120-03	40/03	11-04	11-04	
	HDD120-04	40/04	11-05	11-05	11-05
	HDD120-05	40/05	11-06	11-06	
	HDD120-06	40/06	11-07	11-07	11-07
	HDD120-07	40/07	11-08	11-08	
	HDD120-08	40/08	11-09	11-09	11-09
	HDD120-09	40/09	11-10	11-10	
	HDD120-10	40/0A	11-11	11-11	11-11
	HDD120-11	40/0B	11-12/Spare	11-12/Spare	11-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (42/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-121	HDD121-00	44/00	12-01	11-01	11-01
	HDD121-01	44/01	12-02	11-02	
	HDD121-02	44/02	12-03	11-03	11-03
	HDD121-03	44/03	12-04	11-04	
	HDD121-04	44/04	12-05	11-05	11-05
	HDD121-05	44/05	12-06	11-06	
	HDD121-06	44/06	12-07	11-07	11-07
	HDD121-07	44/07	12-08	11-08	
	HDD121-08	44/08	12-09	11-09	11-09
	HDD121-09	44/09	12-10	11-10	
	HDD121-10	44/0A	12-11	11-11	11-11
	HDD121-11	44/0B	12-12/Spare	11-12/Spare	11-11/Spare

THEORY-C-220**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (43/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-122	HDD122-00	41/00	11-01	11-01	11-01
	HDD122-01	41/01	11-02	11-02	
	HDD122-02	41/02	11-03	11-03	11-03
	HDD122-03	41/03	11-04	11-04	
	HDD122-04	41/04	11-05	11-05	11-05
	HDD122-05	41/05	11-06	11-06	
	HDD122-06	41/06	11-07	11-07	11-07
	HDD122-07	41/07	11-08	11-08	
	HDD122-08	41/08	11-09	11-09	11-09
	HDD122-09	41/09	11-10	11-10	
	HDD122-10	41/0A	11-11	11-11	11-11
	HDD122-11	41/0B	11-12/Spare	11-12/Spare	11-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (44/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-123	HDD123-00	45/00	12-01	11-01	11-01
	HDD123-01	45/01	12-02	11-02	
	HDD123-02	45/02	12-03	11-03	11-03
	HDD123-03	45/03	12-04	11-04	
	HDD123-04	45/04	12-05	11-05	11-05
	HDD123-05	45/05	12-06	11-06	
	HDD123-06	45/06	12-07	11-07	11-07
	HDD123-07	45/07	12-08	11-08	
	HDD123-08	45/08	12-09	11-09	11-09
	HDD123-09	45/09	12-10	11-10	
	HDD123-10	45/0A	12-11	11-11	11-11
	HDD123-11	45/0B	12-12/Spare	11-12/Spare	11-11/Spare

THEORY-C-230**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (45/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-124	HDD124-00	42/00	11-01	11-01	11-01
	HDD124-01	42/01	11-02	11-02	
	HDD124-02	42/02	11-03	11-03	11-03
	HDD124-03	42/03	11-04	11-04	
	HDD124-04	42/04	11-05	11-05	11-05
	HDD124-05	42/05	11-06	11-06	
	HDD124-06	42/06	11-07	11-07	11-07
	HDD124-07	42/07	11-08	11-08	
	HDD124-08	42/08	11-09	11-09	11-09
	HDD124-09	42/09	11-10	11-10	
	HDD124-10	42/0A	11-11	11-11	11-11
	HDD124-11	42/0B	11-12/Spare	11-12/Spare	11-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (46/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-125	HDD125-00	46/00	12-01	11-01	11-01
	HDD125-01	46/01	12-02	11-02	
	HDD125-02	46/02	12-03	11-03	11-03
	HDD125-03	46/03	12-04	11-04	
	HDD125-04	46/04	12-05	11-05	11-05
	HDD125-05	46/05	12-06	11-06	
	HDD125-06	46/06	12-07	11-07	11-07
	HDD125-07	46/07	12-08	11-08	
	HDD125-08	46/08	12-09	11-09	11-09
	HDD125-09	46/09	12-10	11-10	
	HDD125-10	46/0A	12-11	11-11	11-11
	HDD125-11	46/0B	12-12/Spare	11-12/Spare	11-11/Spare

THEORY-C-240**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (47/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-126	HDD126-00	43/00	11-01	11-01	11-01
	HDD126-01	43/01	11-02	11-02	
	HDD126-02	43/02	11-03	11-03	11-03
	HDD126-03	43/03	11-04	11-04	
	HDD126-04	43/04	11-05	11-05	11-05
	HDD126-05	43/05	11-06	11-06	
	HDD126-06	43/06	11-07	11-07	11-07
	HDD126-07	43/07	11-08	11-08	
	HDD126-08	43/08	11-09	11-09	11-09
	HDD126-09	43/09	11-10	11-10	
	HDD126-10	43/0A	11-11	11-11	11-11
	HDD126-11	43/0B	11-12/Spare	11-12/Spare	11-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (48/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-127	HDD127-00	47/00	12-01	11-01	11-01
	HDD127-01	47/01	12-02	11-02	
	HDD127-02	47/02	12-03	11-03	11-03
	HDD127-03	47/03	12-04	11-04	
	HDD127-04	47/04	12-05	11-05	11-05
	HDD127-05	47/05	12-06	11-06	
	HDD127-06	47/06	12-07	11-07	11-07
	HDD127-07	47/07	12-08	11-08	
	HDD127-08	47/08	12-09	11-09	11-09
	HDD127-09	47/09	12-10	11-10	
	HDD127-10	47/0A	12-11	11-11	11-11
	HDD127-11	47/0B	12-12/Spare	11-12/Spare	11-11/Spare

THEORY-C-250**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (49/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-030	HDD030-00	18/00	13-01	13-01	13-01
	HDD030-01	18/01	13-02	13-02	
	HDD030-02	18/02	13-03	13-03	13-03
	HDD030-03	18/03	13-04	13-04	
	HDD030-04	18/04	13-05	13-05	13-05
	HDD030-05	18/05	13-06	13-06	
	HDD030-06	18/06	13-07	13-07	13-07
	HDD030-07	18/07	13-08	13-08	
	HDD030-08	18/08	13-09	13-09	13-09
	HDD030-09	18/09	13-10	13-10	
	HDD030-10	18/0A	13-11	13-11	13-11
	HDD030-11	18/0B	13-12/Spare	13-12/Spare	13-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (50/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-031	HDD031-00	1C/00	14-01	13-01	13-01
	HDD031-01	1C/01	14-02	13-02	
	HDD031-02	1C/02	14-03	13-03	13-03
	HDD031-03	1C/03	14-04	13-04	
	HDD031-04	1C/04	14-05	13-05	13-05
	HDD031-05	1C/05	14-06	13-06	
	HDD031-06	1C/06	14-07	13-07	13-07
	HDD031-07	1C/07	14-08	13-08	
	HDD031-08	1C/08	14-09	13-09	13-09
	HDD031-09	1C/09	14-10	13-10	
	HDD031-10	1C/0A	14-11	13-11	13-11
	HDD031-11	1C/0B	14-12/Spare	13-12/Spare	13-11/Spare

THEORY-C-260**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (51/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-032	HDD032-00	19/00	13-01	13-01	13-01
	HDD032-01	19/01	13-02	13-02	
	HDD032-02	19/02	13-03	13-03	13-03
	HDD032-03	19/03	13-04	13-04	
	HDD032-04	19/04	13-05	13-05	13-05
	HDD032-05	19/05	13-06	13-06	
	HDD032-06	19/06	13-07	13-07	13-07
	HDD032-07	19/07	13-08	13-08	
	HDD032-08	19/08	13-09	13-09	13-09
	HDD032-09	19/09	13-10	13-10	
	HDD032-10	19/0A	13-11	13-11	13-11
	HDD032-11	19/0B	13-12/Spare	13-12/Spare	13-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (52/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-033	HDD033-00	1D/00	14-01	13-01	13-01
	HDD033-01	1D/01	14-02	13-02	
	HDD033-02	1D/02	14-03	13-03	13-03
	HDD033-03	1D/03	14-04	13-04	
	HDD033-04	1D/04	14-05	13-05	13-05
	HDD033-05	1D/05	14-06	13-06	
	HDD033-06	1D/06	14-07	13-07	13-07
	HDD033-07	1D/07	14-08	13-08	
	HDD033-08	1D/08	14-09	13-09	13-09
	HDD033-09	1D/09	14-10	13-10	
	HDD033-10	1D/0A	14-11	13-11	13-11
	HDD033-11	1D/0B	14-12/Spare	13-12/Spare	13-11/Spare

THEORY-C-270**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (53/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-034	HDD034-00	1A/00	13-01	13-01	13-01
	HDD034-01	1A/01	13-02	13-02	
	HDD034-02	1A/02	13-03	13-03	13-03
	HDD034-03	1A/03	13-04	13-04	
	HDD034-04	1A/04	13-05	13-05	13-05
	HDD034-05	1A/05	13-06	13-06	
	HDD034-06	1A/06	13-07	13-07	13-07
	HDD034-07	1A/07	13-08	13-08	
	HDD034-08	1A/08	13-09	13-09	13-09
	HDD034-09	1A/09	13-10	13-10	
	HDD034-10	1A/0A	13-11	13-11	13-11
	HDD034-11	1A/0B	13-12/Spare	13-12/Spare	13-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (54/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-035	HDD035-00	1E/00	14-01	13-01	13-01
	HDD035-01	1E/01	14-02	13-02	
	HDD035-02	1E/02	14-03	13-03	13-03
	HDD035-03	1E/03	14-04	13-04	
	HDD035-04	1E/04	14-05	13-05	13-05
	HDD035-05	1E/05	14-06	13-06	
	HDD035-06	1E/06	14-07	13-07	13-07
	HDD035-07	1E/07	14-08	13-08	
	HDD035-08	1E/08	14-09	13-09	13-09
	HDD035-09	1E/09	14-10	13-10	
	HDD035-10	1E/0A	14-11	13-11	13-11
	HDD035-11	1E/0B	14-12/Spare	13-12/Spare	13-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (55/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-036	HDD036-00	1B/00	13-01	13-01	13-01
	HDD036-01	1B/01	13-02	13-02	
	HDD036-02	1B/02	13-03	13-03	13-03
	HDD036-03	1B/03	13-04	13-04	
	HDD036-04	1B/04	13-05	13-05	13-05
	HDD036-05	1B/05	13-06	13-06	
	HDD036-06	1B/06	13-07	13-07	13-07
	HDD036-07	1B/07	13-08	13-08	
	HDD036-08	1B/08	13-09	13-09	13-09
	HDD036-09	1B/09	13-10	13-10	
	HDD036-10	1B/0A	13-11	13-11	13-11
	HDD036-11	1B/0B	13-12/Spare	13-12/Spare	13-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (56/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-037	HDD037-00	1F/00	14-01	13-01	13-01
	HDD037-01	1F/01	14-02	13-02	
	HDD037-02	1F/02	14-03	13-03	13-03
	HDD037-03	1F/03	14-04	13-04	
	HDD037-04	1F/04	14-05	13-05	13-05
	HDD037-05	1F/05	14-06	13-06	
	HDD037-06	1F/06	14-07	13-07	13-07
	HDD037-07	1F/07	14-08	13-08	
	HDD037-08	1F/08	14-09	13-09	13-09
	HDD037-09	1F/09	14-10	13-10	
	HDD037-10	1F/0A	14-11	13-11	13-11
	HDD037-11	1F/0B	14-12/Spare	13-12/Spare	13-11/Spare

THEORY-C-290**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (57/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-130	HDD130-00	48/00	15-01	15-01	15-01
	HDD130-01	48/01	15-02	15-02	
	HDD130-02	48/02	15-03	15-03	15-03
	HDD130-03	48/03	15-04	15-04	
	HDD130-04	48/04	15-05	15-05	15-05
	HDD130-05	48/05	15-06	15-06	
	HDD130-06	48/06	15-07	15-07	15-07
	HDD130-07	48/07	15-08	15-08	
	HDD130-08	48/08	15-09	15-09	15-09
	HDD130-09	48/09	15-10	15-10	
	HDD130-10	48/0A	15-11	15-11	15-11
	HDD130-11	48/0B	15-12/Spare	15-12/Spare	15-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (58/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-131	HDD131-00	4C/00	16-01	15-01	15-01
	HDD131-01	4C/01	16-02	15-02	
	HDD131-02	4C/02	16-03	15-03	15-03
	HDD131-03	4C/03	16-04	15-04	
	HDD131-04	4C/04	16-05	15-05	15-05
	HDD131-05	4C/05	16-06	15-06	
	HDD131-06	4C/06	16-07	15-07	15-07
	HDD131-07	4C/07	16-08	15-08	
	HDD131-08	4C/08	16-09	15-09	15-09
	HDD131-09	4C/09	16-10	15-10	
	HDD131-10	4C/0A	16-11	15-11	15-11
	HDD131-11	4C/0B	16-12/Spare	15-12/Spare	15-11/Spare

THEORY-C-300**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (59/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-132	HDD132-00	49/00	15-01	15-01	15-01
	HDD132-01	49/01	15-02	15-02	
	HDD132-02	49/02	15-03	15-03	15-03
	HDD132-03	49/03	15-04	15-04	
	HDD132-04	49/04	15-05	15-05	15-05
	HDD132-05	49/05	15-06	15-06	
	HDD132-06	49/06	15-07	15-07	15-07
	HDD132-07	49/07	15-08	15-08	
	HDD132-08	49/08	15-09	15-09	15-09
	HDD132-09	49/09	15-10	15-10	
	HDD132-10	49/0A	15-11	15-11	15-11
	HDD132-11	49/0B	15-12/Spare	15-12/Spare	15-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (60/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-133	HDD133-00	4D/00	16-01	15-01	15-01
	HDD133-01	4D/01	16-02	15-02	
	HDD133-02	4D/02	16-03	15-03	15-03
	HDD133-03	4D/03	16-04	15-04	
	HDD133-04	4D/04	16-05	15-05	15-05
	HDD133-05	4D/05	16-06	15-06	
	HDD133-06	4D/06	16-07	15-07	15-07
	HDD133-07	4D/07	16-08	15-08	
	HDD133-08	4D/08	16-09	15-09	15-09
	HDD133-09	4D/09	16-10	15-10	
	HDD133-10	4D/0A	16-11	15-11	15-11
	HDD133-11	4D/0B	16-12/Spare	15-12/Spare	15-11/Spare

THEORY-C-310**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (61/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-134	HDD134-00	4A/00	15-01	15-01	15-01
	HDD134-01	4A/01	15-02	15-02	
	HDD134-02	4A/02	15-03	15-03	15-03
	HDD134-03	4A/03	15-04	15-04	
	HDD134-04	4A/04	15-05	15-05	15-05
	HDD134-05	4A/05	15-06	15-06	
	HDD134-06	4A/06	15-07	15-07	15-07
	HDD134-07	4A/07	15-08	15-08	
	HDD134-08	4A/08	15-09	15-09	15-09
	HDD134-09	4A/09	15-10	15-10	
	HDD134-10	4A/0A	15-11	15-11	15-11
	HDD134-11	4A/0B	15-12/Spare	15-12/Spare	15-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (62/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-135	HDD135-00	4E/00	16-01	15-01	15-01
	HDD135-01	4E/01	16-02	15-02	
	HDD135-02	4E/02	16-03	15-03	15-03
	HDD135-03	4E/03	16-04	15-04	
	HDD135-04	4E/04	16-05	15-05	15-05
	HDD135-05	4E/05	16-06	15-06	
	HDD135-06	4E/06	16-07	15-07	15-07
	HDD135-07	4E/07	16-08	15-08	
	HDD135-08	4E/08	16-09	15-09	15-09
	HDD135-09	4E/09	16-10	15-10	
	HDD135-10	4E/0A	16-11	15-11	15-11
	HDD135-11	4E/0B	16-12/Spare	15-12/Spare	15-11/Spare

THEORY-C-320**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (63/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-136	HDD136-00	4B/00	15-01	15-01	15-01
	HDD136-01	4B/01	15-02	15-02	
	HDD136-02	4B/02	15-03	15-03	15-03
	HDD136-03	4B/03	15-04	15-04	
	HDD136-04	4B/04	15-05	15-05	15-05
	HDD136-05	4B/05	15-06	15-06	
	HDD136-06	4B/06	15-07	15-07	15-07
	HDD136-07	4B/07	15-08	15-08	
	HDD136-08	4B/08	15-09	15-09	15-09
	HDD136-09	4B/09	15-10	15-10	
	HDD136-10	4B/0A	15-11	15-11	15-11
	HDD136-11	4B/0B	15-12/Spare	15-12/Spare	15-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (64/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-137	HDD137-00	4F/00	16-01	15-01	15-01
	HDD137-01	4F/01	16-02	15-02	
	HDD137-02	4F/02	16-03	15-03	15-03
	HDD137-03	4F/03	16-04	15-04	
	HDD137-04	4F/04	16-05	15-05	15-05
	HDD137-05	4F/05	16-06	15-06	
	HDD137-06	4F/06	16-07	15-07	15-07
	HDD137-07	4F/07	16-08	15-08	
	HDD137-08	4F/08	16-09	15-09	15-09
	HDD137-09	4F/09	16-10	15-10	
	HDD137-10	4F/0A	16-11	15-11	15-11
	HDD137-11	4F/0B	16-12/Spare	15-12/Spare	15-11/Spare

THEORY-C-330**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (65/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-040	HDD040-00	20/00	17-01	17-01	17-01
	HDD040-01	20/01	17-02	17-02	
	HDD040-02	20/02	17-03	17-03	17-03
	HDD040-03	20/03	17-04	17-04	
	HDD040-04	20/04	17-05	17-05	17-05
	HDD040-05	20/05	17-06	17-06	
	HDD040-06	20/06	17-07	17-07	17-07
	HDD040-07	20/07	17-08	17-08	
	HDD040-08	20/08	17-09	17-09	17-09
	HDD040-09	20/09	17-10	17-10	
	HDD040-10	20/0A	17-11	17-11	17-11
	HDD040-11	20/0B	17-12/Spare	17-12/Spare	17-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (66/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-041	HDD041-00	24/00	18-01	17-01	17-01
	HDD041-01	24/01	18-02	17-02	
	HDD041-02	24/02	18-03	17-03	17-03
	HDD041-03	24/03	18-04	17-04	
	HDD041-04	24/04	18-05	17-05	17-05
	HDD041-05	24/05	18-06	17-06	
	HDD041-06	24/06	18-07	17-07	17-07
	HDD041-07	24/07	18-08	17-08	
	HDD041-08	24/08	18-09	17-09	17-09
	HDD041-09	24/09	18-10	17-10	
	HDD041-10	24/0A	18-11	17-11	17-11
	HDD041-11	24/0B	18-12/Spare	17-12/Spare	17-11/Spare

THEORY-C-340**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (67/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-042	HDD042-00	21/00	17-01	17-01	17-01
	HDD042-01	21/01	17-02	17-02	
	HDD042-02	21/02	17-03	17-03	17-03
	HDD042-03	21/03	17-04	17-04	
	HDD042-04	21/04	17-05	17-05	17-05
	HDD042-05	21/05	17-06	17-06	
	HDD042-06	21/06	17-07	17-07	17-07
	HDD042-07	21/07	17-08	17-08	
	HDD042-08	21/08	17-09	17-09	17-09
	HDD042-09	21/09	17-10	17-10	
	HDD042-10	21/0A	17-11	17-11	17-11
	HDD042-11	21/0B	17-12/Spare	17-12/Spare	17-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (68/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-043	HDD043-00	25/00	18-01	17-01	17-01
	HDD043-01	25/01	18-02	17-02	
	HDD043-02	25/02	18-03	17-03	17-03
	HDD043-03	25/03	18-04	17-04	
	HDD043-04	25/04	18-05	17-05	17-05
	HDD043-05	25/05	18-06	17-06	
	HDD043-06	25/06	18-07	17-07	17-07
	HDD043-07	25/07	18-08	17-08	
	HDD043-08	25/08	18-09	17-09	17-09
	HDD043-09	25/09	18-10	17-10	
	HDD043-10	25/0A	18-11	17-11	17-11
	HDD043-11	25/0B	18-12/Spare	17-12/Spare	17-11/Spare

THEORY-C-350**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (69/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-044	HDD044-00	22/00	17-01	17-01	17-01
	HDD044-01	22/01	17-02	17-02	
	HDD044-02	22/02	17-03	17-03	17-03
	HDD044-03	22/03	17-04	17-04	
	HDD044-04	22/04	17-05	17-05	17-05
	HDD044-05	22/05	17-06	17-06	
	HDD044-06	22/06	17-07	17-07	17-07
	HDD044-07	22/07	17-08	17-08	
	HDD044-08	22/08	17-09	17-09	17-09
	HDD044-09	22/09	17-10	17-10	
	HDD044-10	22/0A	17-11	17-11	17-11
	HDD044-11	22/0B	17-12/Spare	17-12/Spare	17-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (70/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-045	HDD045-00	26/00	18-01	17-01	17-01
	HDD045-01	26/01	18-02	17-02	
	HDD045-02	26/02	18-03	17-03	17-03
	HDD045-03	26/03	18-04	17-04	
	HDD045-04	26/04	18-05	17-05	17-05
	HDD045-05	26/05	18-06	17-06	
	HDD045-06	26/06	18-07	17-07	17-07
	HDD045-07	26/07	18-08	17-08	
	HDD045-08	26/08	18-09	17-09	17-09
	HDD045-09	26/09	18-10	17-10	
	HDD045-10	26/0A	18-11	17-11	17-11
	HDD045-11	26/0B	18-12/Spare	17-12/Spare	17-11/Spare

THEORY-C-360**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (71/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-046	HDD046-00	23/00	17-01	17-01	17-01
	HDD046-01	23/01	17-02	17-02	
	HDD046-02	23/02	17-03	17-03	17-03
	HDD046-03	23/03	17-04	17-04	
	HDD046-04	23/04	17-05	17-05	17-05
	HDD046-05	23/05	17-06	17-06	
	HDD046-06	23/06	17-07	17-07	17-07
	HDD046-07	23/07	17-08	17-08	
	HDD046-08	23/08	17-09	17-09	17-09
	HDD046-09	23/09	17-10	17-10	
	HDD046-10	23/0A	17-11	17-11	17-11
	HDD046-11	23/0B	17-12/Spare	17-12/Spare	17-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (72/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-047	HDD047-00	27/00	18-01	17-01	17-01
	HDD047-01	27/01	18-02	17-02	
	HDD047-02	27/02	18-03	17-03	17-03
	HDD047-03	27/03	18-04	17-04	
	HDD047-04	27/04	18-05	17-05	17-05
	HDD047-05	27/05	18-06	17-06	
	HDD047-06	27/06	18-07	17-07	17-07
	HDD047-07	27/07	18-08	17-08	
	HDD047-08	27/08	18-09	17-09	17-09
	HDD047-09	27/09	18-10	17-10	
	HDD047-10	27/0A	18-11	17-11	17-11
	HDD047-11	27/0B	18-12/Spare	17-12/Spare	17-11/Spare

THEORY-C-370**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (73/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-140	HDD140-00	50/00	19-01	19-01	19-01
	HDD140-01	50/01	19-02	19-02	
	HDD140-02	50/02	19-03	19-03	19-03
	HDD140-03	50/03	19-04	19-04	
	HDD140-04	50/04	19-05	19-05	19-05
	HDD140-05	50/05	19-06	19-06	
	HDD140-06	50/06	19-07	19-07	19-07
	HDD140-07	50/07	19-08	19-08	
	HDD140-08	50/08	19-09	19-09	19-09
	HDD140-09	50/09	19-10	19-10	
	HDD140-10	50/0A	19-11	19-11	19-11
	HDD140-11	50/0B	19-12/Spare	19-12/Spare	19-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (74/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-141	HDD141-00	54/00	20-01	19-01	17-01
	HDD141-01	54/01	20-02	19-02	
	HDD141-02	54/02	20-03	19-03	17-03
	HDD141-03	54/03	20-04	19-04	
	HDD141-04	54/04	20-05	19-05	17-05
	HDD141-05	54/05	20-06	19-06	
	HDD141-06	54/06	20-07	19-07	17-07
	HDD141-07	54/07	20-08	19-08	
	HDD141-08	54/08	20-09	19-09	17-09
	HDD141-09	54/09	20-10	19-10	
	HDD141-10	54/0A	20-11	19-11	17-11
	HDD141-11	54/0B	20-12/Spare	19-12/Spare	17-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (75/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-142	HDD142-00	51/00	19-01	19-01	19-01
	HDD142-01	51/01	19-02	19-02	
	HDD142-02	51/02	19-03	19-03	19-03
	HDD142-03	51/03	19-04	19-04	
	HDD142-04	51/04	19-05	19-05	19-05
	HDD142-05	51/05	19-06	19-06	
	HDD142-06	51/06	19-07	19-07	19-07
	HDD142-07	51/07	19-08	19-08	
	HDD142-08	51/08	19-09	19-09	19-09
	HDD142-09	51/09	19-10	19-10	
	HDD142-10	51/0A	19-11	19-11	19-11
	HDD142-11	51/0B	19-12/Spare	19-12/Spare	19-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (76/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-143	HDD143-00	55/00	20-01	19-01	17-01
	HDD143-01	55/01	20-02	19-02	
	HDD143-02	55/02	20-03	19-03	17-03
	HDD143-03	55/03	20-04	19-04	
	HDD143-04	55/04	20-05	19-05	17-05
	HDD143-05	55/05	20-06	19-06	
	HDD143-06	55/06	20-07	19-07	17-07
	HDD143-07	55/07	20-08	19-08	
	HDD143-08	55/08	20-09	19-09	17-09
	HDD143-09	55/09	20-10	19-10	
	HDD143-10	55/0A	20-11	19-11	17-11
	HDD143-11	55/0B	20-12/Spare	19-12/Spare	17-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (77/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-144	HDD144-00	52/00	19-01	19-01	19-01
	HDD144-01	52/01	19-02	19-02	
	HDD144-02	52/02	19-03	19-03	19-03
	HDD144-03	52/03	19-04	19-04	
	HDD144-04	52/04	19-05	19-05	19-05
	HDD144-05	52/05	19-06	19-06	
	HDD144-06	52/06	19-07	19-07	19-07
	HDD144-07	52/07	19-08	19-08	
	HDD144-08	52/08	19-09	19-09	19-09
	HDD144-09	52/09	19-10	19-10	
	HDD144-10	52/0A	19-11	19-11	19-11
	HDD144-11	52/0B	19-12/Spare	19-12/Spare	19-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (78/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-145	HDD145-00	56/00	20-01	19-01	17-01
	HDD145-01	56/01	20-02	19-02	
	HDD145-02	56/02	20-03	19-03	17-03
	HDD145-03	56/03	20-04	19-04	
	HDD145-04	56/04	20-05	19-05	17-05
	HDD145-05	56/05	20-06	19-06	
	HDD145-06	56/06	20-07	19-07	17-07
	HDD145-07	56/07	20-08	19-08	
	HDD145-08	56/08	20-09	19-09	17-09
	HDD145-09	56/09	20-10	19-10	
	HDD145-10	56/0A	20-11	19-11	17-11
	HDD145-11	56/0B	20-12/Spare	19-12/Spare	17-11/Spare

THEORY-C-400**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (79/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-146	HDD146-00	53/00	19-01	19-01	19-01
	HDD146-01	53/01	19-02	19-02	
	HDD146-02	53/02	19-03	19-03	19-03
	HDD146-03	53/03	19-04	19-04	
	HDD146-04	53/04	19-05	19-05	19-05
	HDD146-05	53/05	19-06	19-06	
	HDD146-06	53/06	19-07	19-07	19-07
	HDD146-07	53/07	19-08	19-08	
	HDD146-08	53/08	19-09	19-09	19-09
	HDD146-09	53/09	19-10	19-10	
	HDD146-10	53/0A	19-11	19-11	19-11
	HDD146-11	53/0B	19-12/Spare	19-12/Spare	19-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (80/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-147	HDD147-00	57/00	20-01	19-01	17-01
	HDD147-01	57/01	20-02	19-02	
	HDD147-02	57/02	20-03	19-03	17-03
	HDD147-03	57/03	20-04	19-04	
	HDD147-04	57/04	20-05	19-05	17-05
	HDD147-05	57/05	20-06	19-06	
	HDD147-06	57/06	20-07	19-07	17-07
	HDD147-07	57/07	20-08	19-08	
	HDD147-08	57/08	20-09	19-09	17-09
	HDD147-09	57/09	20-10	19-10	
	HDD147-10	57/0A	20-11	19-11	17-11
	HDD147-11	57/0B	20-12/Spare	19-12/Spare	17-11/Spare

THEORY-C-410**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (81/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-050	HDD050-00	28/00	21-01	21-01	21-01
	HDD050-01	28/01	21-02	21-02	
	HDD050-02	28/02	21-03	21-03	21-03
	HDD050-03	28/03	21-04	21-04	
	HDD050-04	28/04	21-05	21-05	21-05
	HDD050-05	28/05	21-06	21-06	
	HDD050-06	28/06	21-07	21-07	21-07
	HDD050-07	28/07	21-08	21-08	
	HDD050-08	28/08	21-09	21-09	21-09
	HDD050-09	28/09	21-10	21-10	
	HDD050-10	28/0A	21-11	21-11	21-11
	HDD050-11	28/0B	21-12/Spare	21-12/Spare	02-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (82/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-051	HDD051-00	2C/00	22-01	21-01	21-01
	HDD051-01	2C/01	22-02	21-02	
	HDD051-02	2C/02	22-03	21-03	21-03
	HDD051-03	2C/03	22-04	21-04	
	HDD051-04	2C/04	22-05	21-05	21-05
	HDD051-05	2C/05	22-06	21-06	
	HDD051-06	2C/06	22-07	21-07	21-07
	HDD051-07	2C/07	22-08	21-08	
	HDD051-08	2C/08	22-09	21-09	21-09
	HDD051-09	2C/09	22-10	21-10	
	HDD051-10	2C/0A	22-11	21-11	21-11
	HDD051-11	2C/0B	22-12/Spare	21-11/Spare	21-11/Spare

THEORY-C-420**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (83/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-052	HDD052-00	29/00	21-01	21-01	21-01
	HDD052-01	29/01	21-02	21-02	
	HDD052-02	29/02	21-03	21-03	21-03
	HDD052-03	29/03	21-04	21-04	
	HDD052-04	29/04	21-05	21-05	21-05
	HDD052-05	29/05	21-06	21-06	
	HDD052-06	29/06	21-07	21-07	21-07
	HDD052-07	29/07	21-08	21-08	
	HDD052-08	29/08	21-09	21-09	21-09
	HDD052-09	29/09	21-10	21-10	
	HDD052-10	29/0A	21-11	21-11	21-11
	HDD052-11	29/0B	21-12/Spare	21-12/Spare	02-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (84/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-053	HDD053-00	2D/00	22-01	21-01	21-01
	HDD053-01	2D/01	22-02	21-02	
	HDD053-02	2D/02	22-03	21-03	21-03
	HDD053-03	2D/03	22-04	21-04	
	HDD053-04	2D/04	22-05	21-05	21-05
	HDD053-05	2D/05	22-06	21-06	
	HDD053-06	2D/06	22-07	21-07	21-07
	HDD053-07	2D/07	22-08	21-08	
	HDD053-08	2D/08	22-09	21-09	21-09
	HDD053-09	2D/09	22-10	21-10	
	HDD053-10	2D/0A	22-11	21-11	21-11
	HDD053-11	2D/0B	22-12/Spare	21-11/Spare	21-11/Spare

THEORY-C-430**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (85/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-054	HDD054-00	2A/00	21-01	21-01	21-01
	HDD054-01	2A/01	21-02	21-02	
	HDD054-02	2A/02	21-03	21-03	21-03
	HDD054-03	2A/03	21-04	21-04	
	HDD054-04	2A/04	21-05	21-05	21-05
	HDD054-05	2A/05	21-06	21-06	
	HDD054-06	2A/06	21-07	21-07	21-07
	HDD054-07	2A/07	21-08	21-08	
	HDD054-08	2A/08	21-09	21-09	21-09
	HDD054-09	2A/09	21-10	21-10	
	HDD054-10	2A/0A	21-11	21-11	21-11
	HDD054-11	2A/0B	21-12/Spare	21-12/Spare	02-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (86/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-055	HDD055-00	2E/00	22-01	21-01	21-01
	HDD055-01	2E/01	22-02	21-02	
	HDD055-02	2E/02	22-03	21-03	21-03
	HDD055-03	2E/03	22-04	21-04	
	HDD055-04	2E/04	22-05	21-05	21-05
	HDD055-05	2E/05	22-06	21-06	
	HDD055-06	2E/06	22-07	21-07	21-07
	HDD055-07	2E/07	22-08	21-08	
	HDD055-08	2E/08	22-09	21-09	21-09
	HDD055-09	2E/09	22-10	21-10	
	HDD055-10	2E/0A	22-11	21-11	21-11
	HDD055-11	2E/0B	22-12/Spare	21-11/Spare	21-11/Spare

THEORY-C-440**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (87/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-056	HDD056-00	2B/00	21-01	21-01	21-01
	HDD056-01	2B/01	21-02	21-02	
	HDD056-02	2B/02	21-03	21-03	21-03
	HDD056-03	2B/03	21-04	21-04	
	HDD056-04	2B/04	21-05	21-05	21-05
	HDD056-05	2B/05	21-06	21-06	
	HDD056-06	2B/06	21-07	21-07	21-07
	HDD056-07	2B/07	21-08	21-08	
	HDD056-08	2B/08	21-09	21-09	21-09
	HDD056-09	2B/09	21-10	21-10	
	HDD056-10	2B/0A	21-11	21-11	21-11
	HDD056-11	2B/0B	21-12/Spare	21-12/Spare	02-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (88/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-057	HDD057-00	2F/00	22-01	21-01	21-01
	HDD057-01	2F/01	22-02	21-02	
	HDD057-02	2F/02	22-03	21-03	21-03
	HDD057-03	2F/03	22-04	21-04	
	HDD057-04	2F/04	22-05	21-05	21-05
	HDD057-05	2F/05	22-06	21-06	
	HDD057-06	2F/06	22-07	21-07	21-07
	HDD057-07	2F/07	22-08	21-08	
	HDD057-08	2F/08	22-09	21-09	21-09
	HDD057-09	2F/09	22-10	21-10	
	HDD057-10	2F/0A	22-11	21-11	21-11
	HDD057-11	2F/0B	22-12/Spare	21-11/Spare	21-11/Spare

THEORY-C-450**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (89/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-150	HDD150-00	58/00	23-01	23-01	23-01
	HDD150-01	58/01	23-02	23-02	
	HDD150-02	58/02	23-03	23-03	23-03
	HDD150-03	58/03	23-04	23-04	
	HDD150-04	58/04	23-05	23-05	23-05
	HDD150-05	58/05	23-06	23-06	
	HDD150-06	58/06	23-07	23-07	23-07
	HDD150-07	58/07	23-08	23-08	
	HDD150-08	58/08	23-09	23-09	23-09
	HDD150-09	58/09	23-10	23-10	
	HDD150-10	58/0A	23-11	23-11	23-11
	HDD150-11	58/0B	23-12/Spare	23-12/Spare	23-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (90/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-151	HDD151-00	5C/00	24-01	23-01	23-01
	HDD151-01	5C/01	24-02	23-02	
	HDD151-02	5C/02	24-03	23-03	23-03
	HDD151-03	5C/03	24-04	23-04	
	HDD151-04	5C/04	24-05	23-05	23-05
	HDD151-05	5C/05	24-06	23-06	
	HDD151-06	5C/06	24-07	23-07	23-07
	HDD151-07	5C/07	24-08	23-08	
	HDD151-08	5C/08	24-09	23-09	23-09
	HDD151-09	5C/09	24-10	23-10	
	HDD151-10	5C/0A	24-11	23-11	23-11
	HDD151-11	5C/0B	24-12/Spare	23-11/Spare	23-11/Spare

THEORY-C-460**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (91/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-152	HDD152-00	59/00	23-01	23-01	23-01
	HDD152-01	59/01	23-02	23-02	
	HDD152-02	59/02	23-03	23-03	23-03
	HDD152-03	59/03	23-04	23-04	
	HDD152-04	59/04	23-05	23-05	23-05
	HDD152-05	59/05	23-06	23-06	
	HDD152-06	59/06	23-07	23-07	23-07
	HDD152-07	59/07	23-08	23-08	
	HDD152-08	59/08	23-09	23-09	23-09
	HDD152-09	59/09	23-10	23-10	
	HDD152-10	59/0A	23-11	23-11	23-11
	HDD152-11	59/0B	23-12/Spare	23-12/Spare	23-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (92/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-153	HDD153-00	5D/00	24-01	23-01	23-01
	HDD153-01	5D/01	24-02	23-02	
	HDD153-02	5D/02	24-03	23-03	23-03
	HDD153-03	5D/03	24-04	23-04	
	HDD153-04	5D/04	24-05	23-05	23-05
	HDD153-05	5D/05	24-06	23-06	
	HDD153-06	5D/06	24-07	23-07	23-07
	HDD153-07	5D/07	24-08	23-08	
	HDD153-08	5D/08	24-09	23-09	23-09
	HDD153-09	5D/09	24-10	23-10	
	HDD153-10	5D/0A	24-11	23-11	23-11
	HDD153-11	5D/0B	24-12/Spare	23-11/Spare	23-11/Spare

THEORY-C-470**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (93/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-154	HDD154-00	5A/00	23-01	23-01	23-01
	HDD154-01	5A/01	23-02	23-02	
	HDD154-02	5A/02	23-03	23-03	23-03
	HDD154-03	5A/03	23-04	23-04	
	HDD154-04	5A/04	23-05	23-05	23-05
	HDD154-05	5A/05	23-06	23-06	
	HDD154-06	5A/06	23-07	23-07	23-07
	HDD154-07	5A/07	23-08	23-08	
	HDD154-08	5A/08	23-09	23-09	23-09
	HDD154-09	5A/09	23-10	23-10	
	HDD154-10	5A/0A	23-11	23-11	23-11
	HDD154-11	5A/0B	23-12/Spare	23-12/Spare	23-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (94/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-155	HDD155-00	5E/00	24-01	23-01	23-01
	HDD155-01	5E/01	24-02	23-02	
	HDD155-02	5E/02	24-03	23-03	23-03
	HDD155-03	5E/03	24-04	23-04	
	HDD155-04	5E/04	24-05	23-05	23-05
	HDD155-05	5E/05	24-06	23-06	
	HDD155-06	5E/06	24-07	23-07	23-07
	HDD155-07	5E/07	24-08	23-08	
	HDD155-08	5E/08	24-09	23-09	23-09
	HDD155-09	5E/09	24-10	23-10	
	HDD155-10	5E/0A	24-11	23-11	23-11
	HDD155-11	5E/0B	24-12/Spare	23-11/Spare	23-11/Spare

THEORY-C-480**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (95/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-156	HDD156-00	5B/00	23-01	23-01	23-01
	HDD156-01	5B/01	23-02	23-02	
	HDD156-02	5B/02	23-03	23-03	23-03
	HDD156-03	5B/03	23-04	23-04	
	HDD156-04	5B/04	23-05	23-05	23-05
	HDD156-05	5B/05	23-06	23-06	
	HDD156-06	5B/06	23-07	23-07	23-07
	HDD156-07	5B/07	23-08	23-08	
	HDD156-08	5B/08	23-09	23-09	23-09
	HDD156-09	5B/09	23-10	23-10	
	HDD156-10	5B/0A	23-11	23-11	23-11
	HDD156-11	5B/0B	23-12/Spare	23-12/Spare	23-11/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (3.5 INCH DRIVE BOX) (96/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-157	HDD157-00	5F/00	24-01	23-01	23-01
	HDD157-01	5F/01	24-02	23-02	
	HDD157-02	5F/02	24-03	23-03	23-03
	HDD157-03	5F/03	24-04	23-04	
	HDD157-04	5F/04	24-05	23-05	23-05
	HDD157-05	5F/05	24-06	23-06	
	HDD157-06	5F/06	24-07	23-07	23-07
	HDD157-07	5F/07	24-08	23-08	
	HDD157-08	5F/08	24-09	23-09	23-09
	HDD157-09	5F/09	24-10	23-10	
	HDD157-10	5F/0A	24-11	23-11	23-11
	HDD157-11	5F/0B	24-12/Spare	23-11/Spare	23-11/Spare

Appendixes D

D.1 Physical-Logical Device Matrixes (FMD BOX)

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (1/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-000	HDD000-00	00/00	01-01	01-01	01-01
	HDD000-01	00/01	01-02	01-02	
	HDD000-02	00/02	01-03	01-03	01-03
	HDD000-03	00/03	01-04	01-04	
	HDD000-04	00/04	01-05	01-05	01-05
	HDD000-05	00/05	01-06/Spare	01-06/Spare	01-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (2/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-001	HDD001-00	04/00	02-01	01-01	01-01
	HDD001-01	04/01	02-02	01-02	
	HDD001-02	04/02	02-03	01-03	01-03
	HDD001-03	04/03	02-04	01-04	
	HDD001-04	04/04	02-05	01-05	01-05
	HDD001-05	04/05	02-06/Spare	01-06/Spare	01-05/Spare

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RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)

(3/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-002	HDD002-00	01/00	01-01	01-01	01-01
	HDD002-01	01/01	01-02	01-02	
	HDD002-02	01/02	01-03	01-03	01-03
	HDD002-03	01/03	01-04	01-04	
	HDD002-04	01/04	01-05	01-05	01-05
	HDD002-05	01/05	01-06/Spare	01-06/Spare	01-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)

(4/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-003	HDD003-00	05/00	02-01	01-01	01-01
	HDD003-01	05/01	02-02	01-02	
	HDD003-02	05/02	02-03	01-03	01-03
	HDD003-03	05/03	02-04	01-04	
	HDD003-04	05/04	02-05	01-05	01-05
	HDD003-05	05/05	02-06/Spare	01-06/Spare	01-05/Spare

THEORY-D-30

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (5/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-004	HDD004-00	02/00	01-01	01-01	01-01
	HDD004-01	02/01	01-02	01-02	
	HDD004-02	02/02	01-03	01-03	01-03
	HDD004-03	02/03	01-04	01-04	
	HDD004-04	02/04	01-05	01-05	01-05
	HDD004-05	02/05	01-06/Spare	01-06/Spare	01-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (6/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-005	HDD005-00	06/00	02-01	01-01	01-01
	HDD005-01	06/01	02-02	01-02	
	HDD005-02	06/02	02-03	01-03	01-03
	HDD005-03	06/03	02-04	01-04	
	HDD005-04	06/04	02-05	01-05	01-05
	HDD005-05	06/05	02-06/Spare	01-06/Spare	01-05/Spare

THEORY-D-40

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (7/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-006	HDD006-00	03/00	01-01	01-01	01-01
	HDD006-01	03/01	01-02	01-02	
	HDD006-02	03/02	01-03	01-03	01-03
	HDD006-03	03/03	01-04	01-04	
	HDD006-04	03/04	01-05	01-05	01-05
	HDD006-05	03/05	01-06/Spare	01-06/Spare	01-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (8/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-007	HDD007-00	07/00	02-01	01-01	01-01
	HDD007-01	07/01	02-02	01-02	
	HDD007-02	07/02	02-03	01-03	01-03
	HDD007-03	07/03	02-04	01-04	
	HDD007-04	07/04	02-05	01-05	01-05
	HDD007-05	07/05	02-06/Spare	01-06/Spare	01-05/Spare

THEORY-D-50

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (9/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-100	HDD100-00	30/00	03-01	03-01	03-01
	HDD100-01	30/01	03-02	03-02	
	HDD100-02	30/02	03-03	03-03	03-03
	HDD100-03	30/03	03-04	03-04	
	HDD100-04	30/04	03-05	03-05	03-05
	HDD100-05	30/05	03-06/Spare	03-06/Spare	03-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (10/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-101	HDD101-00	34/00	04-01	03-01	03-01
	HDD101-01	34/01	04-02	03-02	
	HDD101-02	34/02	04-03	03-03	03-03
	HDD101-03	34/03	04-04	03-04	
	HDD101-04	34/04	04-05	03-05	03-05
	HDD101-05	34/05	04-06/Spare	03-06/Spare	03-05/Spare

THEORY-D-60

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (11/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-102	HDD102-00	31/00	03-01	03-01	03-01
	HDD102-01	31/01	03-02	03-02	
	HDD102-02	31/02	03-03	03-03	03-03
	HDD102-03	31/03	03-04	03-04	
	HDD102-04	31/04	03-05	03-05	03-05
	HDD102-05	31/05	03-06/Spare	03-06/Spare	03-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (12/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-103	HDD103-00	35/00	04-01	03-01	03-01
	HDD103-01	35/01	04-02	03-02	
	HDD103-02	35/02	04-03	03-03	03-03
	HDD103-03	35/03	04-04	03-04	
	HDD103-04	35/04	04-05	03-05	03-05
	HDD103-05	35/05	04-06/Spare	03-06/Spare	03-05/Spare

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RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (13/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-104	HDD104-00	32/00	03-01	03-01	03-01
	HDD104-01	32/01	03-02	03-02	
	HDD104-02	32/02	03-03	03-03	03-03
	HDD104-03	32/03	03-04	03-04	
	HDD104-04	32/04	03-05	03-05	03-05
	HDD104-05	32/05	03-06/Spare	03-06/Spare	03-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (14/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-105	HDD105-00	36/00	04-01	03-01	03-01
	HDD105-01	36/01	04-02	03-02	
	HDD105-02	36/02	04-03	03-03	03-03
	HDD105-03	36/03	04-04	03-04	
	HDD105-04	36/04	04-05	03-05	03-05
	HDD105-05	36/05	04-06/Spare	03-06/Spare	03-05/Spare

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RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (15/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-106	HDD106-00	33/00	03-01	03-01	03-01
	HDD106-01	33/01	03-02	03-02	
	HDD106-02	33/02	03-03	03-03	03-03
	HDD106-03	33/03	03-04	03-04	
	HDD106-04	33/04	03-05	03-05	03-05
	HDD106-05	33/05	03-06/Spare	03-06/Spare	03-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (16/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-107	HDD107-00	37/00	04-01	03-01	03-01
	HDD107-01	37/01	04-02	03-02	
	HDD107-02	37/02	04-03	03-03	03-03
	HDD107-03	37/03	04-04	03-04	
	HDD107-04	37/04	04-05	03-05	03-05
	HDD107-05	37/05	04-06/Spare	03-06/Spare	03-05/Spare

THEORY-D-90

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (17/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-010	HDD010-00	08/00	05-01	05-01	05-01
	HDD010-01	08/01	05-02	05-02	
	HDD010-02	08/02	05-03	05-03	05-03
	HDD010-03	08/03	05-04	05-04	
	HDD010-04	08/04	05-05	05-05	05-05
	HDD010-05	08/05	05-06/Spare	05-06/Spare	05-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (18/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-011	HDD011-00	0C/00	06-01	05-01	05-01
	HDD011-01	0C/01	06-02	05-02	
	HDD011-02	0C/02	06-03	05-03	05-03
	HDD011-03	0C/03	06-04	05-04	
	HDD011-04	0C/04	06-05	05-05	05-05
	HDD011-05	0C/05	06-06/Spare	05-06/Spare	05-05/Spare

THEORY-D-100

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (19/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-012	HDD012-00	09/00	05-01	05-01	05-01
	HDD012-01	09/01	05-02	05-02	
	HDD012-02	09/02	05-03	05-03	05-03
	HDD012-03	09/03	05-04	05-04	
	HDD012-04	09/04	05-05	05-05	05-05
	HDD012-05	09/05	05-06/Spare	05-06/Spare	05-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (20/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-013	HDD013-00	0D/00	06-01	05-01	05-01
	HDD013-01	0D/01	06-02	05-02	
	HDD013-02	0D/02	06-03	05-03	05-03
	HDD013-03	0D/03	06-04	05-04	
	HDD013-04	0D/04	06-05	05-05	05-05
	HDD013-05	0D/05	06-06/Spare	05-06/Spare	05-05/Spare

THEORY-D-110

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (21/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-014	HDD014-00	0A/00	05-01	05-01	05-01
	HDD014-01	0A/01	05-02	05-02	
	HDD014-02	0A/02	05-03	05-03	05-03
	HDD014-03	0A/03	05-04	05-04	
	HDD014-04	0A/04	05-05	05-05	05-05
	HDD014-05	0A/05	05-06/Spare	05-06/Spare	05-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (22/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-015	HDD015-00	0E/00	06-01	05-01	05-01
	HDD015-01	0E/01	06-02	05-02	
	HDD015-02	0E/02	06-03	05-03	05-03
	HDD015-03	0E/03	06-04	05-04	
	HDD015-04	0E/04	06-05	05-05	05-05
	HDD015-05	0E/05	06-06/Spare	05-06/Spare	05-05/Spare

THEORY-D-120

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (23/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-016	HDD016-00	0B/00	05-01	05-01	05-01
	HDD016-01	0B/01	05-02	05-02	
	HDD016-02	0B/02	05-03	05-03	05-03
	HDD016-03	0B/03	05-04	05-04	
	HDD016-04	0B/04	05-05	05-05	05-05
	HDD016-05	0B/05	05-06/Spare	05-06/Spare	05-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (24/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-017	HDD017-00	0F/00	06-01	05-01	05-01
	HDD017-01	0F/01	06-02	05-02	
	HDD017-02	0F/02	06-03	05-03	05-03
	HDD017-03	0F/03	06-04	05-04	
	HDD017-04	0F/04	06-05	05-05	05-05
	HDD017-05	0F/05	06-06/Spare	05-06/Spare	05-05/Spare

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RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (25/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-110	HDD110-00	38/00	07-01	07-01	07-01
	HDD110-01	38/01	07-02	07-02	
	HDD110-02	38/02	07-03	07-03	07-03
	HDD110-03	38/03	07-04	07-04	
	HDD110-04	38/04	07-05	07-05	07-05
	HDD110-05	38/05	07-06/Spare	07-06/Spare	07-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (26/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-111	HDD111-00	3C/00	08-01	07-01	07-01
	HDD111-01	3C/01	08-02	07-02	
	HDD111-02	3C/02	08-03	07-03	07-03
	HDD111-03	3C/03	08-04	07-04	
	HDD111-04	3C/04	08-05	07-05	07-05
	HDD111-05	3C/05	08-06/Spare	07-06/Spare	07-05/Spare

THEORY-D-140

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (27/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-112	HDD112-00	39/00	07-01	07-01	07-01
	HDD112-01	39/01	07-02	07-02	
	HDD112-02	39/02	07-03	07-03	07-03
	HDD112-03	39/03	07-04	07-04	
	HDD112-04	39/04	07-05	07-05	07-05
	HDD112-05	39/05	07-06/Spare	07-06/Spare	07-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (28/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-113	HDD113-00	3D/00	08-01	07-01	07-01
	HDD113-01	3D/01	08-02	07-02	
	HDD113-02	3D/02	08-03	07-03	07-03
	HDD113-03	3D/03	08-04	07-04	
	HDD113-04	3D/04	08-05	07-05	07-05
	HDD113-05	3D/05	08-06/Spare	07-06/Spare	07-05/Spare

THEORY-D-150

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (29/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-114	HDD114-00	3A/00	07-01	07-01	07-01
	HDD114-01	3A/01	07-02	07-02	
	HDD114-02	3A/02	07-03	07-03	07-03
	HDD114-03	3A/03	07-04	07-04	
	HDD114-04	3A/04	07-05	07-05	07-05
	HDD114-05	3A/05	07-06/Spare	07-06/Spare	07-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (30/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-115	HDD115-00	3E/00	08-01	07-01	07-01
	HDD115-01	3E/01	08-02	07-02	
	HDD115-02	3E/02	08-03	07-03	07-03
	HDD115-03	3E/03	08-04	07-04	
	HDD115-04	3E/04	08-05	07-05	07-05
	HDD115-05	3E/05	08-06/Spare	07-06/Spare	07-05/Spare

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RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (31/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-116	HDD116-00	3B/00	07-01	07-01	07-01
	HDD116-01	3B/01	07-02	07-02	
	HDD116-02	3B/02	07-03	07-03	07-03
	HDD116-03	3B/03	07-04	07-04	
	HDD116-04	3B/04	07-05	07-05	07-05
	HDD116-05	3B/05	07-06/Spare	07-06/Spare	07-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (32/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-117	HDD117-00	3F/00	08-01	07-01	07-01
	HDD117-01	3F/01	08-02	07-02	
	HDD117-02	3F/02	08-03	07-03	07-03
	HDD117-03	3F/03	08-04	07-04	
	HDD117-04	3F/04	08-05	07-05	07-05
	HDD117-05	3F/05	08-06/Spare	07-06/Spare	07-05/Spare

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RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (33/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-020	HDD020-00	10/00	09-01	09-01	09-01
	HDD020-01	10/01	09-02	09-02	
	HDD020-02	10/02	09-03	09-03	09-03
	HDD020-03	10/03	09-04	09-04	
	HDD020-04	10/04	09-05	09-05	09-05
	HDD020-05	10/05	09-06/Spare	09-06/Spare	09-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (34/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-021	HDD021-00	14/00	10-01	09-01	09-01
	HDD021-01	14/01	10-02	09-02	
	HDD021-02	14/02	10-03	09-03	09-03
	HDD021-03	14/03	10-04	09-04	
	HDD021-04	14/04	10-05	09-05	09-05
	HDD021-05	14/05	10-06/Spare	09-06/Spare	09-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (35/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-022	HDD022-00	11/00	09-01	09-01	09-01
	HDD022-01	11/01	09-02	09-02	
	HDD022-02	11/02	09-03	09-03	09-03
	HDD022-03	11/03	09-04	09-04	
	HDD022-04	11/04	09-05	09-05	09-05
	HDD022-05	11/05	09-06/Spare	09-06/Spare	09-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (36/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-023	HDD023-00	15/00	10-01	09-01	09-01
	HDD023-01	15/01	10-02	09-02	
	HDD023-02	15/02	10-03	09-03	09-03
	HDD023-03	15/03	10-04	09-04	
	HDD023-04	15/04	10-05	09-05	09-05
	HDD023-05	15/05	10-06/Spare	09-06/Spare	09-05/Spare

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RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (37/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-024	HDD024-00	12/00	09-01	09-01	09-01
	HDD024-01	12/01	09-02	09-02	
	HDD024-02	12/02	09-03	09-03	09-03
	HDD024-03	12/03	09-04	09-04	
	HDD024-04	12/04	09-05	09-05	09-05
	HDD024-05	12/05	09-06/Spare	09-06/Spare	09-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (38/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-025	HDD025-00	16/00	10-01	09-01	09-01
	HDD025-01	16/01	10-02	09-02	
	HDD025-02	16/02	10-03	09-03	09-03
	HDD025-03	16/03	10-04	09-04	
	HDD025-04	16/04	10-05	09-05	09-05
	HDD025-05	16/05	10-06/Spare	09-06/Spare	09-05/Spare

THEORY-D-200

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (39/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-026	HDD026-00	13/00	09-01	09-01	09-01
	HDD026-01	13/01	09-02	09-02	
	HDD026-02	13/02	09-03	09-03	09-03
	HDD026-03	13/03	09-04	09-04	
	HDD026-04	13/04	09-05	09-05	09-05
	HDD026-05	13/05	09-06/Spare	09-06/Spare	09-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (40/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-027	HDD027-00	17/00	10-01	09-01	09-01
	HDD027-01	17/01	10-02	09-02	
	HDD027-02	17/02	10-03	09-03	09-03
	HDD027-03	17/03	10-04	09-04	
	HDD027-04	17/04	10-05	09-05	09-05
	HDD027-05	17/05	10-06/Spare	09-06/Spare	09-05/Spare

THEORY-D-210**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(41/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-120	HDD120-00	40/00	11-01	11-01	11-01
	HDD120-01	40/01	11-02	11-02	
	HDD120-02	40/02	11-03	11-03	11-03
	HDD120-03	40/03	11-04	11-04	
	HDD120-04	40/04	11-05	11-05	11-05
	HDD120-05	40/05	11-06/Spare	11-06/Spare	11-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(42/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-121	HDD121-00	44/00	12-01	11-01	11-01
	HDD121-01	44/01	12-02	11-02	
	HDD121-02	44/02	12-03	11-03	11-03
	HDD121-03	44/03	12-04	11-04	
	HDD121-04	44/04	12-05	11-05	11-05
	HDD121-05	44/05	12-06/Spare	11-06/Spare	11-05/Spare

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RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (43/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-122	HDD122-00	41/00	11-01	11-01	11-01
	HDD122-01	41/01	11-02	11-02	
	HDD122-02	41/02	11-03	11-03	11-03
	HDD122-03	41/03	11-04	11-04	
	HDD122-04	41/04	11-05	11-05	11-05
	HDD122-05	41/05	11-06/Spare	11-06/Spare	11-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (44/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-123	HDD123-00	45/00	12-01	11-01	11-01
	HDD123-01	45/01	12-02	11-02	
	HDD123-02	45/02	12-03	11-03	11-03
	HDD123-03	45/03	12-04	11-04	
	HDD123-04	45/04	12-05	11-05	11-05
	HDD123-05	45/05	12-06/Spare	11-06/Spare	11-05/Spare

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RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (45/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-124	HDD124-00	42/00	11-01	11-01	11-01
	HDD124-01	42/01	11-02	11-02	
	HDD124-02	42/02	11-03	11-03	11-03
	HDD124-03	42/03	11-04	11-04	
	HDD124-04	42/04	11-05	11-05	11-05
	HDD124-05	42/05	11-06/Spare	11-06/Spare	11-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (46/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-125	HDD125-00	46/00	12-01	11-01	11-01
	HDD125-01	46/01	12-02	11-02	
	HDD125-02	46/02	12-03	11-03	11-03
	HDD125-03	46/03	12-04	11-04	
	HDD125-04	46/04	12-05	11-05	11-05
	HDD125-05	46/05	12-06/Spare	11-06/Spare	11-05/Spare

THEORY-D-240**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(47/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-126	HDD126-00	43/00	11-01	11-01	11-01
	HDD126-01	43/01	11-02	11-02	
	HDD126-02	43/02	11-03	11-03	11-03
	HDD126-03	43/03	11-04	11-04	
	HDD126-04	43/04	11-05	11-05	11-05
	HDD126-05	43/05	11-06/Spare	11-06/Spare	11-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(48/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-127	HDD127-00	47/00	12-01	11-01	11-01
	HDD127-01	47/01	12-02	11-02	
	HDD127-02	47/02	12-03	11-03	11-03
	HDD127-03	47/03	12-04	11-04	
	HDD127-04	47/04	12-05	11-05	11-05
	HDD127-05	47/05	12-06/Spare	11-06/Spare	11-05/Spare

THEORY-D-250**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(49/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-030	HDD030-00	18/00	13-01	13-01	13-01
	HDD030-01	18/01	13-02	13-02	
	HDD030-02	18/02	13-03	13-03	13-03
	HDD030-03	18/03	13-04	13-04	
	HDD030-04	18/04	13-05	13-05	13-05
	HDD030-05	18/05	13-06/Spare	13-06/Spare	13-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(50/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-031	HDD031-00	1C/00	14-01	13-01	13-01
	HDD031-01	1C/01	14-02	13-02	
	HDD031-02	1C/02	14-03	13-03	13-03
	HDD031-03	1C/03	14-04	13-04	
	HDD031-04	1C/04	14-05	13-05	13-05
	HDD031-05	1C/05	14-06/Spare	13-06/Spare	13-05/Spare

THEORY-D-260

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (51/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-032	HDD032-00	19/00	13-01	13-01	13-01
	HDD032-01	19/01	13-02	13-02	
	HDD032-02	19/02	13-03	13-03	13-03
	HDD032-03	19/03	13-04	13-04	
	HDD032-04	19/04	13-05	13-05	13-05
	HDD032-05	19/05	13-06/Spare	13-06/Spare	13-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (52/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-033	HDD033-00	1D/00	14-01	13-01	13-01
	HDD033-01	1D/01	14-02	13-02	
	HDD033-02	1D/02	14-03	13-03	13-03
	HDD033-03	1D/03	14-04	13-04	
	HDD033-04	1D/04	14-05	13-05	13-05
	HDD033-05	1D/05	14-06/Spare	13-06/Spare	13-05/Spare

THEORY-D-270

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (53/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-034	HDD034-00	1A/00	13-01	13-01	13-01
	HDD034-01	1A/01	13-02	13-02	
	HDD034-02	1A/02	13-03	13-03	13-03
	HDD034-03	1A/03	13-04	13-04	
	HDD034-04	1A/04	13-05	13-05	13-05
	HDD034-05	1A/05	13-06/Spare	13-06/Spare	13-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (54/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-035	HDD035-00	1E/00	14-01	13-01	13-01
	HDD035-01	1E/01	14-02	13-02	
	HDD035-02	1E/02	14-03	13-03	13-03
	HDD035-03	1E/03	14-04	13-04	
	HDD035-04	1E/04	14-05	13-05	13-05
	HDD035-05	1E/05	14-06/Spare	13-06/Spare	13-05/Spare

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RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (55/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-036	HDD036-00	1B/00	13-01	13-01	13-01
	HDD036-01	1B/01	13-02	13-02	
	HDD036-02	1B/02	13-03	13-03	13-03
	HDD036-03	1B/03	13-04	13-04	
	HDD036-04	1B/04	13-05	13-05	13-05
	HDD036-05	1B/05	13-06/Spare	13-06/Spare	13-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (56/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-037	HDD037-00	1F/00	14-01	13-01	13-01
	HDD037-01	1F/01	14-02	13-02	
	HDD037-02	1F/02	14-03	13-03	13-03
	HDD037-03	1F/03	14-04	13-04	
	HDD037-04	1F/04	14-05	13-05	13-05
	HDD037-05	1F/05	14-06/Spare	13-06/Spare	13-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (57/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-130	HDD130-00	48/00	15-01	15-01	15-01
	HDD130-01	48/01	15-02	15-02	
	HDD130-02	48/02	15-03	15-03	15-03
	HDD130-03	48/03	15-04	15-04	
	HDD130-04	48/04	15-05	15-05	15-05
	HDD130-05	48/05	15-06/Spare	15-06/Spare	15-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (58/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-131	HDD131-00	4C/00	16-01	15-01	15-01
	HDD131-01	4C/01	16-02	15-02	
	HDD131-02	4C/02	16-03	15-03	15-03
	HDD131-03	4C/03	16-04	15-04	
	HDD131-04	4C/04	16-05	15-05	15-05
	HDD131-05	4C/05	16-06/Spare	15-06/Spare	15-05/Spare

THEORY-D-300**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(59/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-132	HDD132-00	49/00	15-01	15-01	15-01
	HDD132-01	49/01	15-02	15-02	
	HDD132-02	49/02	15-03	15-03	15-03
	HDD132-03	49/03	15-04	15-04	
	HDD132-04	49/04	15-05	15-05	15-05
	HDD132-05	49/05	15-06/Spare	15-06/Spare	15-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(60/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-133	HDD133-00	4D/00	16-01	15-01	15-01
	HDD133-01	4D/01	16-02	15-02	
	HDD133-02	4D/02	16-03	15-03	15-03
	HDD133-03	4D/03	16-04	15-04	
	HDD133-04	4D/04	16-05	15-05	15-05
	HDD133-05	4D/05	16-06/Spare	15-06/Spare	15-05/Spare

THEORY-D-310**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(61/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-134	HDD134-00	4A/00	15-01	15-01	15-01
	HDD134-01	4A/01	15-02	15-02	
	HDD134-02	4A/02	15-03	15-03	15-03
	HDD134-03	4A/03	15-04	15-04	
	HDD134-04	4A/04	15-05	15-05	15-05
	HDD134-05	4A/05	15-06/Spare	15-06/Spare	15-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(62/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-135	HDD135-00	4E/00	16-01	15-01	15-01
	HDD135-01	4E/01	16-02	15-02	
	HDD135-02	4E/02	16-03	15-03	15-03
	HDD135-03	4E/03	16-04	15-04	
	HDD135-04	4E/04	16-05	15-05	15-05
	HDD135-05	4E/05	16-06/Spare	15-06/Spare	15-05/Spare

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RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (63/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-136	HDD136-00	4B/00	15-01	15-01	15-01
	HDD136-01	4B/01	15-02	15-02	
	HDD136-02	4B/02	15-03	15-03	15-03
	HDD136-03	4B/03	15-04	15-04	
	HDD136-04	4B/04	15-05	15-05	15-05
	HDD136-05	4B/05	15-06/Spare	15-06/Spare	15-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (64/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-137	HDD137-00	4F/00	16-01	15-01	15-01
	HDD137-01	4F/01	16-02	15-02	
	HDD137-02	4F/02	16-03	15-03	15-03
	HDD137-03	4F/03	16-04	15-04	
	HDD137-04	4F/04	16-05	15-05	15-05
	HDD137-05	4F/05	16-06/Spare	15-06/Spare	15-05/Spare

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RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (65/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-040	HDD040-00	20/00	17-01	17-01	17-01
	HDD040-01	20/01	17-02	17-02	
	HDD040-02	20/02	17-03	17-03	17-03
	HDD040-03	20/03	17-04	17-04	
	HDD040-04	20/04	17-05	17-05	17-05
	HDD040-05	20/05	17-06/Spare	17-06/Spare	17-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (66/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-041	HDD041-00	24/00	18-01	17-01	17-01
	HDD041-01	24/01	18-02	17-02	
	HDD041-02	24/02	18-03	17-03	17-03
	HDD041-03	24/03	18-04	17-04	
	HDD041-04	24/04	18-05	17-05	17-05
	HDD041-05	24/05	18-06/Spare	17-06/Spare	17-05/Spare

THEORY-D-340

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (67/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-042	HDD042-00	21/00	17-01	17-01	17-01
	HDD042-01	21/01	17-02	17-02	
	HDD042-02	21/02	17-03	17-03	17-03
	HDD042-03	21/03	17-04	17-04	
	HDD042-04	21/04	17-05	17-05	17-05
	HDD042-05	21/05	17-06/Spare	17-06/Spare	17-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (68/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-043	HDD043-00	25/00	18-01	17-01	17-01
	HDD043-01	25/01	18-02	17-02	
	HDD043-02	25/02	18-03	17-03	17-03
	HDD043-03	25/03	18-04	17-04	
	HDD043-04	25/04	18-05	17-05	17-05
	HDD043-05	25/05	18-06/Spare	17-06/Spare	17-05/Spare

THEORY-D-350**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(69/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-044	HDD044-00	22/00	17-01	17-01	17-01
	HDD044-01	22/01	17-02	17-02	
	HDD044-02	22/02	17-03	17-03	17-03
	HDD044-03	22/03	17-04	17-04	
	HDD044-04	22/04	17-05	17-05	17-05
	HDD044-05	22/05	17-06/Spare	17-06/Spare	17-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(70/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-045	HDD045-00	26/00	18-01	17-01	17-01
	HDD045-01	26/01	18-02	17-02	
	HDD045-02	26/02	18-03	17-03	17-03
	HDD045-03	26/03	18-04	17-04	
	HDD045-04	26/04	18-05	17-05	17-05
	HDD045-05	26/05	18-06/Spare	17-06/Spare	17-05/Spare

THEORY-D-360

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (71/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-046	HDD046-00	23/00	17-01	17-01	17-01
	HDD046-01	23/01	17-02	17-02	
	HDD046-02	23/02	17-03	17-03	17-03
	HDD046-03	23/03	17-04	17-04	
	HDD046-04	23/04	17-05	17-05	17-05
	HDD046-05	23/05	17-06/Spare	17-06/Spare	17-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (72/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-047	HDD047-00	27/00	18-01	17-01	17-01
	HDD047-01	27/01	18-02	17-02	
	HDD047-02	27/02	18-03	17-03	17-03
	HDD047-03	27/03	18-04	17-04	
	HDD047-04	27/04	18-05	17-05	17-05
	HDD047-05	27/05	18-06/Spare	17-06/Spare	17-05/Spare

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RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (73/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-140	HDD140-00	50/00	19-01	19-01	19-01
	HDD140-01	50/01	19-02	19-02	
	HDD140-02	50/02	19-03	19-03	19-03
	HDD140-03	50/03	19-04	19-04	
	HDD140-04	50/04	19-05	19-05	19-05
	HDD140-05	50/05	19-06/Spare	19-06/Spare	19-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (74/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-141	HDD141-00	54/00	20-01	19-01	19-01
	HDD141-01	54/01	20-02	19-02	
	HDD141-02	54/02	20-03	19-03	19-03
	HDD141-03	54/03	20-04	19-04	
	HDD141-04	54/04	20-05	19-05	19-05
	HDD141-05	54/05	20-06/Spare	19-06/Spare	19-05/Spare

THEORY-D-380**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(75/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-142	HDD142-00	51/00	19-01	19-01	19-01
	HDD142-01	51/01	19-02	19-02	
	HDD142-02	51/02	19-03	19-03	19-03
	HDD142-03	51/03	19-04	19-04	
	HDD142-04	51/04	19-05	19-05	19-05
	HDD142-05	51/05	19-06/Spare	19-06/Spare	19-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(76/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-143	HDD143-00	55/00	20-01	19-01	19-01
	HDD143-01	55/01	20-02	19-02	
	HDD143-02	55/02	20-03	19-03	19-03
	HDD143-03	55/03	20-04	19-04	
	HDD143-04	55/04	20-05	19-05	19-05
	HDD143-05	55/05	20-06/Spare	19-06/Spare	19-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (77/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-144	HDD144-00	52/00	19-01	19-01	19-01
	HDD144-01	52/01	19-02	19-02	
	HDD144-02	52/02	19-03	19-03	19-03
	HDD144-03	52/03	19-04	19-04	
	HDD144-04	52/04	19-05	19-05	19-05
	HDD144-05	52/05	19-06/Spare	19-06/Spare	19-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (78/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-145	HDD145-00	56/00	20-01	19-01	19-01
	HDD145-01	56/01	20-02	19-02	
	HDD145-02	56/02	20-03	19-03	19-03
	HDD145-03	56/03	20-04	19-04	
	HDD145-04	56/04	20-05	19-05	19-05
	HDD145-05	56/05	20-06/Spare	19-06/Spare	19-05/Spare

THEORY-D-400**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(79/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-146	HDD146-00	53/00	19-01	19-01	19-01
	HDD146-01	53/01	19-02	19-02	
	HDD146-02	53/02	19-03	19-03	19-03
	HDD146-03	53/03	19-04	19-04	
	HDD146-04	53/04	19-05	19-05	19-05
	HDD146-05	53/05	19-06/Spare	19-06/Spare	19-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(80/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-147	HDD147-00	57/00	20-01	19-01	19-01
	HDD147-01	57/01	20-02	19-02	
	HDD147-02	57/02	20-03	19-03	19-03
	HDD147-03	57/03	20-04	19-04	
	HDD147-04	57/04	20-05	19-05	19-05
	HDD147-05	57/05	20-06/Spare	19-06/Spare	19-05/Spare

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RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (81/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-050	HDD050-00	28/00	21-01	21-01	21-01
	HDD050-01	28/01	21-02	21-02	
	HDD050-02	28/02	21-03	21-03	21-03
	HDD050-03	28/03	21-04	21-04	
	HDD050-04	28/04	21-05	21-05	21-05
	HDD050-05	28/05	21-06/Spare	21-06/Spare	21-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (82/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-051	HDD051-00	2C/00	22-01	21-01	21-01
	HDD051-01	2C/01	22-02	21-02	
	HDD051-02	2C/02	22-03	21-03	21-03
	HDD051-03	2C/03	22-04	21-04	
	HDD051-04	2C/04	22-05	21-05	21-05
	HDD051-05	2C/05	22-06/Spare	21-06/Spare	21-05/Spare

THEORY-D-420

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (83/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-052	HDD052-00	29/00	21-01	21-01	21-01
	HDD052-01	29/01	21-02	21-02	
	HDD052-02	29/02	21-03	21-03	21-03
	HDD052-03	29/03	21-04	21-04	
	HDD052-04	29/04	21-05	21-05	21-05
	HDD052-05	29/05	21-06/Spare	21-06/Spare	21-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (84/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-053	HDD053-00	2D/00	22-01	21-01	21-01
	HDD053-01	2D/01	22-02	21-02	
	HDD053-02	2D/02	22-03	21-03	21-03
	HDD053-03	2D/03	22-04	21-04	
	HDD053-04	2D/04	22-05	21-05	21-05
	HDD053-05	2D/05	22-06/Spare	21-06/Spare	21-05/Spare

THEORY-D-430

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (85/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-054	HDD054-00	2A/00	21-01	21-01	21-01
	HDD054-01	2A/01	21-02	21-02	
	HDD054-02	2A/02	21-03	21-03	21-03
	HDD054-03	2A/03	21-04	21-04	
	HDD054-04	2A/04	21-05	21-05	21-05
	HDD054-05	2A/05	21-06/Spare	21-06/Spare	21-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (86/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-055	HDD055-00	2E/00	22-01	21-01	21-01
	HDD055-01	2E/01	22-02	21-02	
	HDD055-02	2E/02	22-03	21-03	21-03
	HDD055-03	2E/03	22-04	21-04	
	HDD055-04	2E/04	22-05	21-05	21-05
	HDD055-05	2E/05	22-06/Spare	21-06/Spare	21-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (87/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-056	HDD056-00	2B/00	21-01	21-01	21-01
	HDD056-01	2B/01	21-02	21-02	
	HDD056-02	2B/02	21-03	21-03	21-03
	HDD056-03	2B/03	21-04	21-04	
	HDD056-04	2B/04	21-05	21-05	21-05
	HDD056-05	2B/05	21-06/Spare	21-06/Spare	21-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (88/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-057	HDD057-00	2F/00	22-01	21-01	21-01
	HDD057-01	2F/01	22-02	21-02	
	HDD057-02	2F/02	22-03	21-03	21-03
	HDD057-03	2F/03	22-04	21-04	
	HDD057-04	2F/04	22-05	21-05	21-05
	HDD057-05	2F/05	22-06/Spare	21-06/Spare	21-05/Spare

THEORY-D-450

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (89/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-150	HDD150-00	58/00	23-01	23-01	23-01
	HDD150-01	58/01	23-02	23-02	
	HDD150-02	58/02	23-03	23-03	23-03
	HDD150-03	58/03	23-04	23-04	
	HDD150-04	58/04	23-05	23-05	23-05
	HDD150-05	58/05	23-06/Spare	23-06/Spare	23-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (90/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-151	HDD151-00	5C/00	24-01	23-01	23-01
	HDD151-01	5C/01	24-02	23-02	
	HDD151-02	5C/02	24-03	23-03	23-03
	HDD151-03	5C/03	24-04	23-04	
	HDD151-04	5C/04	24-05	23-05	23-05
	HDD151-05	5C/05	24-06/Spare	23-06/Spare	23-05/Spare

THEORY-D-460

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (91/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-152	HDD152-00	59/00	23-01	23-01	23-01
	HDD152-01	59/01	23-02	23-02	
	HDD152-02	59/02	23-03	23-03	23-03
	HDD152-03	59/03	23-04	23-04	
	HDD152-04	59/04	23-05	23-05	23-05
	HDD152-05	59/05	23-06/Spare	23-06/Spare	23-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (92/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-153	HDD153-00	5D/00	24-01	23-01	23-01
	HDD153-01	5D/01	24-02	23-02	
	HDD153-02	5D/02	24-03	23-03	23-03
	HDD153-03	5D/03	24-04	23-04	
	HDD153-04	5D/04	24-05	23-05	23-05
	HDD153-05	5D/05	24-06/Spare	23-06/Spare	23-05/Spare

THEORY-D-470

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (93/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-154	HDD154-00	5A/00	23-01	23-01	23-01
	HDD154-01	5A/01	23-02	23-02	
	HDD154-02	5A/02	23-03	23-03	23-03
	HDD154-03	5A/03	23-04	23-04	
	HDD154-04	5A/04	23-05	23-05	23-05
	HDD154-05	5A/05	23-06/Spare	23-06/Spare	23-05/Spare

RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX) (94/96)

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDU-155	HDD155-00	5E/00	24-01	23-01	23-01
	HDD155-01	5E/01	24-02	23-02	
	HDD155-02	5E/02	24-03	23-03	23-03
	HDD155-03	5E/03	24-04	23-04	
	HDD155-04	5E/04	24-05	23-05	23-05
	HDD155-05	5E/05	24-06/Spare	23-06/Spare	23-05/Spare

THEORY-D-480**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(95/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-156	HDD156-00	5B/00	23-01	23-01	23-01
	HDD156-01	5B/01	23-02	23-02	
	HDD156-02	5B/02	23-03	23-03	23-03
	HDD156-03	5B/03	23-04	23-04	
	HDD156-04	5B/04	23-05	23-05	23-05
	HDD156-05	5B/05	23-06/Spare	23-06/Spare	23-05/Spare

**RELATIONSHIP BETWEEN DISK DRIVE# AND PARITY GROUP# (FMD BOX)
(96/96)**

HDD BOX Number	Disk Drive Number	C# / R#	Parity Group Number (RAID5 3D+1P) (RAID1 2D+2D)	Parity Group Number (RAID5 7D+1P) (RAID6 6D+2P)	Parity Group Number (RAID6 14D+2P)
HDDU-157	HDD157-00	5F/00	24-01	23-01	23-01
	HDD157-01	5F/01	24-02	23-02	
	HDD157-02	5F/02	24-03	23-03	23-03
	HDD157-03	5F/03	24-04	23-04	
	HDD157-04	5F/04	24-05	23-05	23-05
	HDD157-05	5F/05	24-06/Spare	23-06/Spare	23-05/Spare

Appendixes E

E.1 Emulation Type List

The emulation modes supported in DKC810I storage system are shown in Table E.1-1, the model number of disk drives and the supported RAID levels are shown in Table E.1-2, and the number of volumes, the number of parity groups, and the storage system capacity for each supported emulation are shown in Table E.1-3 and subsequent tables.

Table E.1-1 Conversion List for Supported Emulation Modes

	DKC810I (for M series)	DKC810I (for domestic PCM)
Emulation Mode (capacity of volume)	N/A	3390-3 (2.838GB/vol)
	N/A	N/A
	N/A	3390-9 (8.510GB/vol)
	N/A	3390-L (27.8GB/vol)
	N/A	3390-M (55.689GB/vol)
	N/A	3390-A (223.257GB/vol)
	N/A	3390-V (712.062GB/vol)
	OPEN-3 (2.461GB/vol)	
	OPEN-8 (7.347GB/vol)	
	OPEN-9 (7.384GB/vol)	
	OPEN-E (14.567GB/vol)	
	OPEN-L (36.450GB/vol)	
	OPEN-V (variable, depends on the capacity of RAID group)	

Table E.1-2 Disk Drive Model Number List

Model Number	Disk Drive Model	RAID Level	Remarks
DKC-F810I-300KCM	DKS5C-K300SS	RAID1 (2D+2D)	
DKC-F810I-400MCM	SLB5A-M400SS SLR5C-M400SS	RAID5 (3D+1P, 7D+1P)	
DKC-F810I-400M5M	SLB5A-M400SS	RAID6 (6D+2P, 14D+2P)	
DKC-F810I-600JCM	DKR5D-J600SS DKS5E-J600SS		
DKC-F810I-600J5M	DKR5D-J600SS		
DKC-F810I-800MCM	DKS5E-J900SS SLR5C-M800SS		
DKC-F810I-900JCM	DKR5D-J900SS DKS5E-J900SS		
DKC-F810I-1R2JCM	DKR5E-J1R2SS DKS5F-J1R2SS		
DKC-F810I-1R6FM	NFHAA-P1R6SS		
DKC-F810I-3R0H3M	DKS2E-H3R0SS		
DKC-F810I-3R2FM	NFHAB-P3R2SS		
DKC-F810I-4R0H3M	DKR2E-H4R0SS DKS2E-H4R0SS		

NOTE: In RAID1 (2D+2D) concatenation of two parity groups is possible (8HDDs).

In this case the number of volumes is doubled.

In RAID5 (7D+1P) two concatenation and four concatenation of RAID groups are possible (16HDDs or 32HDDs).

In this case the number of volumes is tripled or quadrupled.

When setting an OPEN-V in the above-mentioned concatenated parity groups, the maximum volume size becomes the parity cycle size of the source (2D+2D) or (7D+1P). It does not become tripled or quadrupled.

NOTE: The storage system capacities in the tables are different from that on SVP, because they are calculated based on 1GB=1000³byte.

THEORY-E-30**Table E.1-3 Emulation Type List for Domestic PCM/M Series in RAID5 (3D+1P) (1/5)**

Emulation Type	DKC		—			
	DKU		OPEN-3	OPEN-8	OPEN-9	OPEN-E
	Volume capacity		2,461	7,347	7,384	14,567
Number of volumes/ parity group	DKC-F810I-300KCM		350	117	116	59
	DKC-F810I-600JCM		700	234	233	118
	DKC-F810I-600J5M		700	234	233	118
	DKC-F810I-900JCM		1,000	352	350	177
	DKC-F810I-1R2JCM		—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—
	DKC-F810I-400MCM/M5M		478	160	159	81
	DKC-F810I-800MCM		957	320	319	162
	DKC-F810I-1R6FM		—	—	—	—
	DKC-F810I-3R2FM		—	—	—	—
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		186	557	562	575
	DKC-F810I-600JCM		93	278	280	553
	DKC-F810I-600J5M		93	278	280	287
	DKC-F810I-900JCM		65	185	186	368
	DKC-F810I-1R2JCM		—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—
	DKC-F810I-400MCM/M5M		96	96	96	96
	DKC-F810I-800MCM		68	96	96	96
	DKC-F810I-1R6FM		—	—	—	—
	DKC-F810I-3R2FM		—	—	—	—
Maximum number of volumes/ storage system	DKC-F810I-300KCM		65,100	65,169	65,192	33,925
	DKC-F810I-600JCM		65,100	65,052	65,240	65,254
	DKC-F810I-600J5M		65,100	65,052	65,240	33,866
	DKC-F810I-900JCM		65,000	65,120	65,100	65,136
	DKC-F810I-1R2JCM		—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—
	DKC-F810I-400MCM/M5M		45,888	15,360	15,264	7,776
	DKC-F810I-800MCM		65,076	30,720	30,624	15,552
	DKC-F810I-1R6FM		—	—	—	—
	DKC-F810I-3R2FM		—	—	—	—
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	861	860	857	859
		MAX	160,211	478,797	481,378	494,185
	DKC-F810I-600JCM	MIN	1,723	1,719	1,720	1,719
		MAX	160,211	477,937	481,732	950,555
	DKC-F810I-600J5M	MIN	1,723	1,719	1,720	1,719
		MAX	160,211	477,937	481,732	493,326
	DKC-F810I-900JCM	MIN	2,461	2,586	2,584	2,578
		MAX	159,965	478,437	480,698	948,836
	DKC-F810I-1R2JCM	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-3R0H3M	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-4R0H3M	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-400MCM/ M5M	MIN	1,176	1,176	1,174	1,180
		MAX	112,930	112,850	112,709	113,273
	DKC-F810I-800MCM	MIN	2,355	2,351	2,355	2,360
		MAX	160,152	225,700	226,128	226,546
	DKC-F810I-1R6FM	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-3R2FM	MIN	—	—	—	—
		MAX	—	—	—	—

THEORY-E-40**Table E.1-3 Emulation Type List for Domestic PCM/M Series in RAID5 (3D+1P) (2/5)**

Emulation Type	DKC		—			
	DKU		OPEN-L	OPEN-V		
	Volume capacity		36.45	1		
Number of volumes/ parity group	DKC-F810I-300KCM		23	1		
	DKC-F810I-600JCM		47	1		
	DKC-F810I-600J5M		47	1		
	DKC-F810I-900JCM		71	1		
	DKC-F810I-1R2JCM		—	2		
	DKC-F810I-3R0H3M		—	3		
	DKC-F810I-4R0H3M		—	4		
	DKC-F810I-400MCM/M5M		32	1		
	DKC-F810I-800MCM		64	1		
	DKC-F810I-1R6FM		—	2		
	DKC-F810I-3R2FM		—	4		
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		575	575		
	DKC-F810I-600JCM		575	575		
	DKC-F810I-600J5M		287	287		
	DKC-F810I-900JCM		575	575		
	DKC-F810I-1R2JCM		—	575		
	DKC-F810I-3R0H3M		—	287		
	DKC-F810I-4R0H3M		—	287		
	DKC-F810I-400MCM/M5M		96	96		
	DKC-F810I-800MCM		96	96		
	DKC-F810I-1R6FM		—	47		
	DKC-F810I-3R2FM		—	47		
Maximum number of volumes/ storage system	DKC-F810I-300KCM		13,225	575		
	DKC-F810I-600JCM		27,025	575		
	DKC-F810I-600J5M		13,489	287		
	DKC-F810I-900JCM		40,825	575		
	DKC-F810I-1R2JCM		—	1,150		
	DKC-F810I-3R0H3M		—	861		
	DKC-F810I-4R0H3M		—	1,148		
	DKC-F810I-400MCM/M5M		3,072	96		
	DKC-F810I-800MCM		6,144	96		
	DKC-F810I-1R6FM		—	94		
	DKC-F810I-3R2FM		—	188		
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	838	865		
		MAX	482,051	497,088		
	DKC-F810I-600JCM	MIN	1,713	1,729		
		MAX	985,061	994,233		
	DKC-F810I-600J5M	MIN	1,713	1,729		
		MAX	491,674	496,252		
	DKC-F810I-900JCM	MIN	2,588	2,594		
		MAX	1,488,071	1,491,493		
	DKC-F810I-1R2JCM	MIN	—	3,458		
		MAX	—	1,988,523		
	DKC-F810I-3R0H3M	MIN	—	8,811		
		MAX	—	2,528,843		
	DKC-F810I-4R0H3M	MIN	—	11,748		
		MAX	—	3,371,791		
	DKC-F810I-400MCM/ M5M	MIN	1,166	1,182		
		MAX	111,974	113,424		
	DKC-F810I-800MCM	MIN	2,333	2,363		
		MAX	223,949	226,848		
	DKC-F810I-1R6FM	MIN	—	5,278		
		MAX	—	248,047		
	DKC-F810I-3R2FM	MIN	—	10,555		
		MAX	—	496,099		

THEORY-E-50**Table E.1-3 Emulation Type List for Domestic PCM/M Series in RAID5 (3D+1P) (3/5)**

Emulation Type	DKC		—				
	DKU		3390-3	3390-3A/3B/3C	3390-9	3390-9A/9B/9C	3390-L
	Volume capacity		2.838	2.975	8.514	8.924	27.844
Number of volumes/ parity group	DKC-F810I-300KCM		275	280	92	93	28
	DKC-F810I-600JCM		551	560	185	186	56
	DKC-F810I-600J5M		551	560	185	186	56
	DKC-F810I-900JCM		826	841	277	280	85
	DKC-F810I-1R2JCM		—	—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—	—
	DKC-F810I-400MCM/M5M		389	396	130	132	40
	DKC-F810I-800MCM		779	792	261	264	80
	DKC-F810I-1R6FM		—	—	—	—	—
DKC-F810I-3R2FM		—	—	—	—	—	
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		237	233	575	575	575
	DKC-F810I-600JCM		118	116	352	350	575
	DKC-F810I-600J5M		118	116	287	287	287
	DKC-F810I-900JCM		79	77	235	233	575
	DKC-F810I-1R2JCM		—	—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—	—
	DKC-F810I-400MCM/M5M		96	96	96	96	96
	DKC-F810I-800MCM		83	82	96	96	96
	DKC-F810I-1R6FM		—	—	—	—	—
DKC-F810I-3R2FM		—	—	—	—	—	
Maximum number of volumes/ storage system	DKC-F810I-300KCM		65,175	65,240	52,900	53,475	16,100
	DKC-F810I-600JCM		65,018	64,960	65,120	65,100	32,200
	DKC-F810I-600J5M		65,018	64,960	53,095	53,382	16,072
	DKC-F810I-900JCM		65,254	64,757	65,095	65,240	48,875
	DKC-F810I-1R2JCM		—	—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—	—
	DKC-F810I-400MCM/M5M		37,344	38,016	12,480	12,672	3,840
	DKC-F810I-800MCM		64,657	64,944	25,056	25,344	7,680
	DKC-F810I-1R6FM		—	—	—	—	—
DKC-F810I-3R2FM		—	—	—	—	—	
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	780	833	783	830	780
		MAX	184,967	194,089	450,391	477,211	448,288
	DKC-F810I-600JCM	MIN	1,564	1,666	1,575	1,660	1,559
		MAX	184,521	193,256	554,432	580,952	896,577
	DKC-F810I-600J5M	MIN	1,564	1,666	1,575	1,660	1,559
		MAX	184,521	193,256	452,051	476,381	447,509
	DKC-F810I-900JCM	MIN	2,344	2,502	2,358	2,499	2,367
		MAX	185,191	192,652	554,219	582,202	1,360,876
	DKC-F810I-1R2JCM	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-3R0H3M	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-4R0H3M	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-400MCM/ M5M	MIN	1,104	1,178	1,107	1,178	1,114
		MAX	105,982	113,098	106,255	113,085	106,921
	DKC-F810I-800MCM	MIN	2,211	2,356	2,222	2,356	2,228
		MAX	183,497	193,208	213,327	226,170	213,842
	DKC-F810I-1R6FM	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-3R2FM	MIN	—	—	—	—	—
		MAX	—	—	—	—	—

THEORY-E-60**Table E.1-3 Emulation Type List for Domestic PCM/M Series in RAID5 (3D+1P) (4/5)**

Emulation Type	DKC		—				
	DKU		3390-LA/LB/LC	3390-M	3390-MA/MB/MC	3390-A	3390-A (3 Type)
	Volume capacity		29.185	55.689	58.37	223.257	2.838
Number of volumes/ parity group	DKC-F810I-300KCM		28	14	14	3	279
	DKC-F810I-600JCM		57	28	28	7	558
	DKC-F810I-600J5M		57	28	28	7	558
	DKC-F810I-900JCM		85	42	42	10	837
	DKC-F810I-1R2JCM		—	56	57	14	—
	DKC-F810I-3R0H3M		—	144	145	36	—
	DKC-F810I-4R0H3M		—	193	194	48	—
	DKC-F810I-400MCM/M5M		40	20	20	5	394
	DKC-F810I-800MCM		80	40	40	10	789
DKC-F810I-1R6FM		—	89	90	22	—	
DKC-F810I-3R2FM		—	179	180	44	—	
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		575	575	575	575	233
	DKC-F810I-600JCM		575	575	575	575	116
	DKC-F810I-600J5M		287	287	287	287	116
	DKC-F810I-900JCM		575	575	575	575	77
	DKC-F810I-1R2JCM		—	575	575	575	—
	DKC-F810I-3R0H3M		—	287	287	287	—
	DKC-F810I-4R0H3M		—	287	287	287	—
	DKC-F810I-400MCM/M5M		96	96	96	96	96
	DKC-F810I-800MCM		96	96	96	96	82
DKC-F810I-1R6FM		—	47	47	47	—	
DKC-F810I-3R2FM		—	47	47	47	—	
Maximum number of volumes/ storage system	DKC-F810I-300KCM		16,100	8,050	8,050	1,725	65,007
	DKC-F810I-600JCM		32,775	16,100	16,100	4,025	64,728
	DKC-F810I-600J5M		16,359	8,036	8,036	2,009	64,728
	DKC-F810I-900JCM		48,875	24,150	24,150	5,750	64,449
	DKC-F810I-1R2JCM		—	32,200	32,775	8,050	—
	DKC-F810I-3R0H3M		—	41,328	41,615	10,332	—
	DKC-F810I-4R0H3M		—	55,391	55,678	13,776	—
	DKC-F810I-400MCM/M5M		3,840	1,920	1,920	480	37,824
	DKC-F810I-800MCM		7,680	3,840	3,840	960	64,698
DKC-F810I-1R6FM		—	4,183	4,230	1,034	—	
DKC-F810I-3R2FM		—	8,413	8,460	2,068	—	
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	817	780	817	670	792
		MAX	469,879	448,296	469,879	385,118	184,490
	DKC-F810I-600JCM	MIN	1,664	1,559	1,634	1,563	1,584
		MAX	956,538	896,593	939,757	898,609	183,698
	DKC-F810I-600J5M	MIN	1,664	1,559	1,634	1,563	1,584
		MAX	477,437	447,517	469,061	448,523	183,698
	DKC-F810I-900JCM	MIN	2,481	2,339	2,452	2,233	2,375
		MAX	1,426,417	1,344,889	1,409,636	1,283,728	182,906
	DKC-F810I-1R2JCM	MIN	—	3,119	3,327	3,126	—
		MAX	—	1,793,186	1,913,077	1,797,219	—
	DKC-F810I-3R0H3M	MIN	—	8,019	8,464	8,037	—
		MAX	—	2,301,515	2,429,068	2,306,691	—
	DKC-F810I-4R0H3M	MIN	—	10,748	11,324	10,716	—
		MAX	—	3,084,669	3,249,925	3,075,588	—
	DKC-F810I-400MCM/ M5M	MIN	1,167	1,114	1,167	1,116	1,118
		MAX	112,070	106,923	112,070	107,163	107,345
	DKC-F810I-800MCM	MIN	2,335	2,228	2,335	2,233	2,239
		MAX	224,141	213,846	224,141	214,327	183,613
	DKC-F810I-1R6FM	MIN	—	4,956	5,253	4,912	—
		MAX	—	232,947	246,905	230,848	—
	DKC-F810I-3R2FM	MIN	—	9,968	10,507	9,823	—
		MAX	—	468,512	493,810	461,695	—

THEORY-E-70**Table E.1-3 Emulation Type List for Domestic PCM/M Series in RAID5 (3D+1P) (5/5)**

Emulation Type	DKC		—			
	DKU		3390-A (9 Type)	3390-A (L Type)	3390-A (M Type)	3390-V
	Volume capacity		8,514	27,844	55,689	712,062
Number of volumes/ parity group	DKC-F810I-300KCM		93	27	14	1
	DKC-F810I-600JCM		186	55	28	2
	DKC-F810I-600J5M		186	55	28	2
	DKC-F810I-900JCM		279	83	42	3
	DKC-F810I-1R2JCM		—	—	56	4
	DKC-F810I-3R0H3M		—	—	144	11
	DKC-F810I-4R0H3M		—	—	192	15
	DKC-F810I-400MCM/M5M		131	39	20	1
	DKC-F810I-800MCM		263	78	40	3
	DKC-F810I-1R6FM		—	—	89	7
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		—	—	179	14
	DKC-F810I-300KCM		575	575	575	575
	DKC-F810I-600JCM		350	575	575	575
	DKC-F810I-600J5M		287	287	287	287
	DKC-F810I-900JCM		233	575	575	575
	DKC-F810I-1R2JCM		—	—	575	575
	DKC-F810I-3R0H3M		—	—	287	287
	DKC-F810I-4R0H3M		—	—	287	287
	DKC-F810I-400MCM/M5M		96	96	96	96
	DKC-F810I-800MCM		96	96	96	96
Maximum number of volumes/ storage system	DKC-F810I-1R6FM		—	—	47	47
	DKC-F810I-3R2FM		—	—	47	47
	DKC-F810I-300KCM		53,475	15,525	8,050	575
	DKC-F810I-600JCM		65,100	31,625	16,100	1,150
	DKC-F810I-600J5M		53,382	15,785	8,036	574
	DKC-F810I-900JCM		65,007	47,725	24,150	1,725
	DKC-F810I-1R2JCM		—	—	32,200	2,300
	DKC-F810I-3R0H3M		—	—	41,328	3,157
	DKC-F810I-4R0H3M		—	—	55,104	4,305
	DKC-F810I-400MCM/M5M		12,576	3,744	1,920	96
MIN/MAX storage system capacity (GB)	DKC-F810I-800MCM		25,248	7,488	3,840	288
	DKC-F810I-1R6FM		—	—	4,183	329
	DKC-F810I-3R2FM		—	—	8,413	658
	DKC-F810I-300KCM	MIN	792	752	780	712
		MAX	455,286	432,278	448,296	409,436
	DKC-F810I-600JCM	MIN	1,584	1,531	1,559	1,424
		MAX	554,261	880,567	896,593	818,871
	DKC-F810I-600J5M	MIN	1,584	1,531	1,559	1,424
		MAX	454,494	439,518	447,517	408,724
	DKC-F810I-900JCM	MIN	2,375	2,311	2,339	2,136
		MAX	553,470	1,328,855	1,344,889	1,228,307
	DKC-F810I-1R2JCM	MIN	—	—	3,119	2,848
		MAX	—	—	1,793,186	1,637,743
	DKC-F810I-3R0H3M	MIN	—	—	8,019	7,833
		MAX	—	—	2,301,515	2,247,980
	DKC-F810I-4R0H3M	MIN	—	—	10,692	10,681
		MAX	—	—	3,068,687	3,065,427
	DKC-F810I-400MCM/ M5M	MIN	1,115	1,086	1,114	712
		MAX	107,072	104,248	106,923	68,358
	DKC-F810I-800MCM	MIN	2,239	2,172	2,228	2,136
		MAX	214,961	208,496	213,846	205,074
	DKC-F810I-1R6FM	MIN	—	—	4,956	4,984
		MAX	—	—	232,947	234,268
	DKC-F810I-3R2FM	MIN	—	—	9,968	9,969
		MAX	—	—	468,512	468,537

NOTE: The values of OPEN-V are the default values on an installation of a parity group.
The capacity of an OPEN-V varies depending on the RAID level and DKU (HDD)
type because OPEN-V is CVS basis. The default volume size is nearly equal to that of
a parity group.

THEORY-E-80**Table E.1-4 Emulation Type List for Domestic PCM/M Series in RAID5 (7D+1P) (1/5)**

Emulation Type	DKC		—			
	DKU		OPEN-3	OPEN-8	OPEN-9	OPEN-E
	Volume capacity		2,461	7,347	7,384	14,567
Number of volumes/ parity group	DKC-F810I-300KCM		817	273	272	138
	DKC-F810I-600JCM		1,634	547	544	276
	DKC-F810I-600J5M		1,634	547	544	276
	DKC-F810I-900JCM		2,000	821	817	415
	DKC-F810I-1R2JCM		—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—
	DKC-F810I-400MCM/M5M		1,116	374	372	189
	DKC-F810I-800MCM		2,000	748	744	378
	DKC-F810I-1R6FM		—	—	—	—
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		79	239	240	287
	DKC-F810I-600JCM		39	119	120	236
	DKC-F810I-600J5M		39	119	120	143
	DKC-F810I-900JCM		32	79	79	157
	DKC-F810I-1R2JCM		—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—
	DKC-F810I-400MCM/M5M		48	48	48	48
	DKC-F810I-800MCM		32	48	48	48
	DKC-F810I-1R6FM		—	—	—	—
Maximum number of volumes/ storage system	DKC-F810I-300KCM		64,543	65,247	65,280	39,606
	DKC-F810I-600JCM		63,726	65,093	65,280	65,136
	DKC-F810I-600J5M		63,726	65,093	65,280	39,468
	DKC-F810I-900JCM		64,000	64,859	64,543	65,155
	DKC-F810I-1R2JCM		—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—
	DKC-F810I-400MCM/M5M		53,568	17,952	17,856	9,072
	DKC-F810I-800MCM		64,000	35,904	35,712	18,144
	DKC-F810I-1R6FM		—	—	—	—
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	2,011	2,006	2,008	2,010
		MAX	158,840	479,370	482,028	576,941
	DKC-F810I-600JCM	MIN	4,021	4,019	4,017	4,020
		MAX	156,830	478,238	482,028	948,836
	DKC-F810I-600J5M	MIN	4,021	4,019	4,017	4,020
		MAX	156,830	478,238	482,028	574,930
	DKC-F810I-900JCM	MIN	4,922	6,032	6,033	6,045
		MAX	157,504	476,519	476,586	949,113
	DKC-F810I-1R2JCM	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-3R0H3M	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-4R0H3M	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-400MCM/ M5M	MIN	2,746	2,748	2,747	2,753
		MAX	131,831	131,893	131,849	132,152
	DKC-F810I-800MCM	MIN	4,922	5,496	5,494	5,506
		MAX	157,504	263,787	263,697	264,304
	DKC-F810I-1R6FM	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-3R2FM	MIN	—	—	—	—
		MAX	—	—	—	—

THEORY-E-90**Table E.1-4 Emulation Type List for Domestic PCM/M Series in RAID5 (7D+1P) (2/5)**

Emulation Type	DKC		—			
	DKU		OPEN-L	OPEN-V		
	Volume capacity		36.45	1		
Number of volumes/ parity group	DKC-F810I-300KCM		55	1		
	DKC-F810I-600JCM		110	2		
	DKC-F810I-600J5M		110	2		
	DKC-F810I-900JCM		166	2		
	DKC-F810I-1R2JCM		—	3		
	DKC-F810I-3R0H3M		—	7		
	DKC-F810I-4R0H3M		—	9		
	DKC-F810I-400MCM/M5M		75	1		
	DKC-F810I-800MCM		151	2		
	DKC-F810I-1R6FM		—	4		
	DKC-F810I-3R2FM		—	8		
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		287	287		
	DKC-F810I-600JCM		287	287		
	DKC-F810I-600J5M		143	143		
	DKC-F810I-900JCM		287	287		
	DKC-F810I-1R2JCM		—	287		
	DKC-F810I-3R0H3M		—	143		
	DKC-F810I-4R0H3M		—	143		
	DKC-F810I-400MCM/M5M		48	48		
	DKC-F810I-800MCM		48	48		
	DKC-F810I-1R6FM		—	23		
	DKC-F810I-3R2FM		—	23		
Maximum number of volumes/ storage system	DKC-F810I-300KCM		15,785	287		
	DKC-F810I-600JCM		31,570	574		
	DKC-F810I-600J5M		15,730	286		
	DKC-F810I-900JCM		47,642	574		
	DKC-F810I-1R2JCM		—	861		
	DKC-F810I-3R0H3M		—	1,001		
	DKC-F810I-4R0H3M		—	1,287		
	DKC-F810I-400MCM/M5M		3,600	48		
	DKC-F810I-800MCM		7,248	96		
	DKC-F810I-1R6FM		—	92		
	DKC-F810I-3R2FM		—	184		
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	2,005	2,017		
		MAX	575,363	578,965		
	DKC-F810I-600JCM	MIN	4,010	4,035		
		MAX	1,150,727	1,157,959		
	DKC-F810I-600J5M	MIN	4,010	4,035		
		MAX	573,359	576,962		
	DKC-F810I-900JCM	MIN	6,051	6,053		
		MAX	1,736,551	1,737,068		
	DKC-F810I-1R2JCM	MIN	—	8,070		
		MAX	—	2,315,947		
	DKC-F810I-3R0H3M	MIN	—	20,560		
		MAX	—	2,940,037		
	DKC-F810I-4R0H3M	MIN	—	27,413		
		MAX	—	3,920,059		
	DKC-F810I-400MCM/ M5M	MIN	2,734	2,757		
		MAX	131,220	132,331		
	DKC-F810I-800MCM	MIN	5,504	5,514		
		MAX	264,190	264,662		
	DKC-F810I-1R6FM	MIN	—	12,315		
		MAX	—	283,234		
	DKC-F810I-3R2FM	MIN	—	24,629		
		MAX	—	566,467		

THEORY-E-100**Table E.1-4 Emulation Type List for Domestic PCM/M Series in RAID5 (7D+1P) (3/5)**

Emulation Type	DKC		—				
	DKU		3390-3	3390-3A/3B/3C	3390-9	3390-9A/9B/9C	3390-L
	Volume capacity		2.838	2.975	8.514	8.924	27.844
Number of volumes/ parity group	DKC-F810I-300KCM		642	654	216	217	66
	DKC-F810I-600JCM		1,285	1,308	432	435	132
	DKC-F810I-600J5M		1,285	1,308	432	435	132
	DKC-F810I-900JCM		1,928	1,963	648	653	198
	DKC-F810I-1R2JCM		—	—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—	—
	DKC-F810I-400MCM/M5M		908	925	305	308	93
	DKC-F810I-800MCM		1,817	1,850	611	616	187
	DKC-F810I-1R6FM		—	—	—	—	—
DKC-F810I-3R2FM		—	—	—	—	—	
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		101	99	287	287	287
	DKC-F810I-600JCM		50	49	151	150	287
	DKC-F810I-600J5M		50	49	143	143	143
	DKC-F810I-900JCM		33	33	100	99	287
	DKC-F810I-1R2JCM		—	—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—	—
	DKC-F810I-400MCM/M5M		48	48	48	48	48
	DKC-F810I-800MCM		35	35	48	48	48
	DKC-F810I-1R6FM		—	—	—	—	—
DKC-F810I-3R2FM		—	—	—	—	—	
Maximum number of volumes/ storage system	DKC-F810I-300KCM		64,842	64,746	61,992	62,279	18,942
	DKC-F810I-600JCM		64,250	64,092	65,232	65,250	37,884
	DKC-F810I-600J5M		64,250	64,092	61,776	62,205	18,876
	DKC-F810I-900JCM		63,624	64,779	64,800	64,647	56,826
	DKC-F810I-1R2JCM		—	—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—	—
	DKC-F810I-400MCM/M5M		43,584	44,400	14,640	14,784	4,464
	DKC-F810I-800MCM		63,595	64,750	29,328	29,568	8,976
	DKC-F810I-1R6FM		—	—	—	—	—
DKC-F810I-3R2FM		—	—	—	—	—	
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	1,822	1,946	1,839	1,937	1,838
		MAX	184,022	192,619	527,800	555,778	527,421
	DKC-F810I-600JCM	MIN	3,647	3,891	3,678	3,882	3,675
		MAX	182,342	190,674	555,385	582,291	1,054,842
	DKC-F810I-600J5M	MIN	3,647	3,891	3,678	3,882	3,675
		MAX	182,342	190,674	525,961	555,117	525,583
	DKC-F810I-900JCM	MIN	5,472	5,840	5,517	5,827	5,513
		MAX	180,565	192,718	551,707	576,910	1,582,263
	DKC-F810I-1R2JCM	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-3R0H3M	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-4R0H3M	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-400MCM/ M5M	MIN	2,577	2,752	2,597	2,749	2,589
		MAX	123,691	132,090	124,645	131,932	124,296
	DKC-F810I-800MCM	MIN	5,157	5,504	5,202	5,497	5,207
		MAX	180,483	192,631	249,699	263,865	249,928
	DKC-F810I-1R6FM	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-3R2FM	MIN	—	—	—	—	—
		MAX	—	—	—	—	—

THEORY-E-110**Table E.1-4 Emulation Type List for Domestic PCM/M Series in RAID5 (7D+1P) (4/5)**

Emulation Type	DKC		—			
	DKU		3390- LA/LB/LC	3390-M	3390- MA/MB/MC	3390-A (3 Type)
	Volume capacity		29,185	55,689	58,37	223,257
Number of volumes/ parity group	DKC-F810I-300KCM		66	33	33	8
	DKC-F810I-600JCM		133	66	66	16
	DKC-F810I-600J5M		133	66	66	16
	DKC-F810I-900JCM		200	99	100	24
	DKC-F810I-1R2JCM		—	132	133	33
	DKC-F810I-3R0H3M		—	338	340	84
	DKC-F810I-4R0H3M		—	450	453	112
	DKC-F810I-400MCM/M5M		94	46	47	11
	DKC-F810I-800MCM		188	93	94	23
	DKC-F810I-1R6FM		—	209	210	52
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		—	418	421	104
	DKC-F810I-600JCM		287	287	287	287
	DKC-F810I-600J5M		287	287	287	287
	DKC-F810I-900JCM		143	143	143	143
	DKC-F810I-1R2JCM		287	287	287	287
	DKC-F810I-3R0H3M		—	287	287	287
	DKC-F810I-4R0H3M		—	143	143	143
	DKC-F810I-400MCM/M5M		—	143	143	143
	DKC-F810I-800MCM		48	48	48	48
	DKC-F810I-1R6FM		48	48	48	48
Maximum number of volumes/ storage system	DKC-F810I-300KCM		—	23	23	23
	DKC-F810I-600JCM		18,942	9,471	9,471	2,296
	DKC-F810I-600J5M		38,171	18,942	18,942	4,592
	DKC-F810I-900JCM		19,019	9,438	9,438	2,288
	DKC-F810I-1R2JCM		57,400	28,413	28,700	6,888
	DKC-F810I-3R0H3M		—	37,884	38,171	9,471
	DKC-F810I-4R0H3M		—	48,334	48,620	12,012
	DKC-F810I-400MCM/M5M		—	64,350	64,779	16,016
	DKC-F810I-800MCM		4,512	2,208	2,256	528
	DKC-F810I-1R6FM		9,024	4,464	4,512	1,104
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM		—	23	23	23
	DKC-F810I-300KCM	MIN	1,926	1,838	1,926	1,786
		MAX	552,822	527,431	552,822	512,598
	DKC-F810I-600JCM	MIN	3,882	3,675	3,852	3,572
		MAX	1,114,021	1,054,861	1,105,645	1,025,196
	DKC-F810I-600J5M	MIN	3,882	3,675	3,852	3,572
		MAX	555,070	525,593	550,896	510,812
	DKC-F810I-900JCM	MIN	5,837	5,513	5,837	5,358
		MAX	1,675,219	1,582,292	1,675,219	1,537,794
	DKC-F810I-1R2JCM	MIN	—	7,351	7,763	7,367
		MAX	—	2,109,722	2,228,041	2,114,467
	DKC-F810I-3R0H3M	MIN	—	18,823	19,846	18,754
		MAX	—	2,691,672	2,837,949	2,681,763
	DKC-F810I-4R0H3M	MIN	—	25,060	26,442	25,005
		MAX	—	3,583,587	3,781,150	3,575,684
	DKC-F810I-400MCM/ M5M	MIN	2,743	2,562	2,743	2,456
		MAX	131,683	122,961	131,683	117,880
	DKC-F810I-800MCM	MIN	5,487	5,179	5,487	5,135
		MAX	263,365	248,596	263,365	246,476
	DKC-F810I-1R6FM	MIN	—	11,639	12,258	11,609
		MAX	—	267,697	281,927	267,015
	DKC-F810I-3R2FM	MIN	—	23,278	24,574	23,219
		MAX	—	535,394	565,197	534,031

THEORY-E-120**Table E.1-4 Emulation Type List for Domestic PCM/M Series in RAID5 (7D+1P) (5/5)**

Emulation Type	DKC		—			
	DKU		3390-A (9 Type)	3390-A (L Type)	3390-A (M Type)	3390-V
Volume capacity			8,514	27,844	55,689	712,062
Number of volumes/ parity group	DKC-F810I-300KCM		217	65	33	2
	DKC-F810I-600JCM		434	130	66	5
	DKC-F810I-600J5M		434	130	66	5
	DKC-F810I-900JCM		651	195	99	7
	DKC-F810I-1R2JCM		—	—	132	10
	DKC-F810I-3R0H3M		—	—	337	26
	DKC-F810I-4R0H3M		—	—	450	35
	DKC-F810I-400MCM/M5M		307	92	46	3
	DKC-F810I-800MCM		614	184	93	7
	DKC-F810I-1R6FM		—	—	209	16
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		—	—	418	32
	DKC-F810I-300KCM		287	287	287	287
	DKC-F810I-600JCM		150	287	287	287
	DKC-F810I-600J5M		143	143	143	143
	DKC-F810I-900JCM		100	287	287	287
	DKC-F810I-1R2JCM		—	—	287	287
	DKC-F810I-3R0H3M		—	—	143	143
	DKC-F810I-4R0H3M		—	—	143	143
	DKC-F810I-400MCM/M5M		48	48	48	48
	DKC-F810I-800MCM		48	48	48	48
Maximum number of volumes/ storage system	DKC-F810I-1R6FM		—	—	23	23
	DKC-F810I-3R2FM		—	—	23	23
	DKC-F810I-300KCM		62,279	18,655	9,471	574
	DKC-F810I-600JCM		65,100	37,310	18,942	1,435
	DKC-F810I-600J5M		62,062	18,590	9,438	715
	DKC-F810I-900JCM		65,100	55,965	28,413	2,009
	DKC-F810I-1R2JCM		—	—	37,884	2,870
	DKC-F810I-3R0H3M		—	—	48,191	3,718
	DKC-F810I-4R0H3M		—	—	64,350	5,005
	DKC-F810I-400MCM/M5M		14,736	4,416	2,208	144
MIN/MAX storage system capacity (GB)	DKC-F810I-800MCM		29,472	8,832	4,464	336
	DKC-F810I-1R6FM		—	—	4,807	368
	DKC-F810I-3R2FM		—	—	9,614	736
	DKC-F810I-300KCM	MIN	1,848	1,810	1,838	1,424
		MAX	530,243	519,430	527,431	408,724
	DKC-F810I-600JCM	MIN	3,695	3,620	3,675	3,560
		MAX	554,261	1,038,860	1,054,861	1,021,809
	DKC-F810I-600J5M	MIN	3,695	3,620	3,675	3,560
		MAX	528,396	517,620	525,593	509,124
	DKC-F810I-900JCM	MIN	5,543	5,430	5,513	4,984
		MAX	554,261	1,558,289	1,582,292	1,430,533
	DKC-F810I-1R2JCM	MIN	—	—	7,351	7,121
		MAX	—	—	2,109,722	2,043,618
	DKC-F810I-3R0H3M	MIN	—	—	18,767	18,514
		MAX	—	—	2,683,709	2,647,447
	DKC-F810I-4R0H3M	MIN	—	—	25,060	24,922
		MAX	—	—	3,583,587	3,563,870
	DKC-F810I-400MCM/ M5M	MIN	2,614	2,562	2,562	2,136
		MAX	125,462	122,959	122,961	102,537
	DKC-F810I-800MCM	MIN	5,228	5,123	5,179	4,984
		MAX	250,925	245,918	248,596	239,253
	DKC-F810I-1R6FM	MIN	—	—	11,639	11,393
		MAX	—	—	267,697	262,039
	DKC-F810I-3R2FM	MIN	—	—	23,278	22,786
		MAX	—	—	535,394	524,078

NOTE: The values of OPEN-V are the default values on an installation of a parity group.
The capacity of an OPEN-V varies depending on the RAID level and DKU (HDD)
type because OPEN-V is CVS basis. The default volume size is nearly equal to that of
a parity group.

THEORY-E-130**Table E.1-5 Emulation Type List for Domestic PCM/M Series in RAID1 (2D+2D) (1/5)**

Emulation Type	DKC		—			
	DKU		OPEN-3	OPEN-8	OPEN-9	OPEN-E
	Volume capacity		2,461	7,347	7,384	14,567
Number of volumes/ parity group	DKC-F810I-300KCM		233	78	77	39
	DKC-F810I-600JCM		467	156	155	79
	DKC-F810I-600J5M		467	156	155	79
	DKC-F810I-900JCM		700	234	233	118
	DKC-F810I-1R2JCM		—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—
	DKC-F810I-400MCM/M5M		319	106	106	54
	DKC-F810I-800MCM		638	213	212	108
	DKC-F810I-1R6FM		—	—	—	—
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		280	575	575	575
	DKC-F810I-600JCM		139	418	421	575
	DKC-F810I-600J5M		139	287	287	287
	DKC-F810I-900JCM		93	278	280	553
	DKC-F810I-1R2JCM		—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—
	DKC-F810I-400MCM/M5M		96	96	96	96
	DKC-F810I-800MCM		96	96	96	96
	DKC-F810I-1R6FM		—	—	—	—
Maximum number of volumes/ storage system	DKC-F810I-300KCM		65,240	44,850	44,275	22,425
	DKC-F810I-600JCM		64,913	65,208	65,255	45,425
	DKC-F810I-600J5M		64,913	44,772	44,485	22,673
	DKC-F810I-900JCM		65,100	65,052	65,240	65,254
	DKC-F810I-1R2JCM		—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—
	DKC-F810I-400MCM/M5M		30,624	10,176	10,176	5,184
	DKC-F810I-800MCM		61,248	20,448	20,352	10,368
	DKC-F810I-1R6FM		—	—	—	—
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	573	573	569	568
		MAX	160,556	329,513	326,927	326,665
	DKC-F810I-600JCM	MIN	1,149	1,146	1,145	1,151
		MAX	159,751	479,083	481,843	661,706
	DKC-F810I-600J5M	MIN	1,149	1,146	1,145	1,151
		MAX	159,751	328,940	328,477	330,278
	DKC-F810I-900JCM	MIN	1,723	1,719	1,720	1,719
		MAX	160,211	477,937	481,732	950,555
	DKC-F810I-1R2JCM	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-3R0H3M	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-4R0H3M	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-400MCM/ M5M	MIN	785	779	783	787
		MAX	75,366	74,763	75,140	75,515
	DKC-F810I-800MCM	MIN	1,570	1,565	1,565	1,573
		MAX	150,731	150,231	150,279	151,031
	DKC-F810I-1R6FM	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-3R2FM	MIN	—	—	—	—
		MAX	—	—	—	—

THEORY-E-140**Table E.1-5 Emulation Type List for Domestic PCM/M Series in RAID1 (2D+2D) (2/5)**

Emulation Type	DKC		—			
	DKU		OPEN-L	OPEN-V		
	Volume capacity		36.45	1		
Number of volumes/ parity group	DKC-F810I-300KCM		15	1		
	DKC-F810I-600JCM		31	1		
	DKC-F810I-600J5M		31	1		
	DKC-F810I-900JCM		47	1		
	DKC-F810I-1R2JCM		—	1		
	DKC-F810I-3R0H3M		—	2		
	DKC-F810I-4R0H3M		—	3		
	DKC-F810I-400MCM/M5M		21	1		
	DKC-F810I-800MCM		43	1		
	DKC-F810I-1R6FM		—	2		
	DKC-F810I-3R2FM		—	3		
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		575	575		
	DKC-F810I-600JCM		575	575		
	DKC-F810I-600J5M		287	287		
	DKC-F810I-900JCM		575	575		
	DKC-F810I-1R2JCM		—	575		
	DKC-F810I-3R0H3M		—	287		
	DKC-F810I-4R0H3M		—	287		
	DKC-F810I-400MCM/M5M		96	96		
	DKC-F810I-800MCM		96	96		
	DKC-F810I-1R6FM		—	47		
	DKC-F810I-3R2FM		—	47		
Maximum number of volumes/ storage system	DKC-F810I-300KCM		8,625	575		
	DKC-F810I-600JCM		17,825	575		
	DKC-F810I-600J5M		8,897	287		
	DKC-F810I-900JCM		27,025	575		
	DKC-F810I-1R2JCM		—	575		
	DKC-F810I-3R0H3M		—	574		
	DKC-F810I-4R0H3M		—	861		
	DKC-F810I-400MCM/M5M		2,016	96		
	DKC-F810I-800MCM		4,128	96		
	DKC-F810I-1R6FM		—	94		
	DKC-F810I-3R2FM		—	141		
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	547	576		
		MAX	314,381	331,373		
	DKC-F810I-600JCM	MIN	1,130	1,153		
		MAX	649,721	662,803		
	DKC-F810I-600J5M	MIN	1,130	1,153		
		MAX	324,296	330,825		
	DKC-F810I-900JCM	MIN	1,713	1,729		
		MAX	985,061	994,290		
	DKC-F810I-1R2JCM	MIN	—	2,306		
		MAX	—	1,325,663		
	DKC-F810I-3R0H3M	MIN	—	5,874		
		MAX	—	1,685,895		
	DKC-F810I-4R0H3M	MIN	—	7,832		
		MAX	—	2,247,841		
	DKC-F810I-400MCM/ M5M	MIN	765	788		
		MAX	73,483	75,610		
	DKC-F810I-800MCM	MIN	1,567	1,575		
		MAX	150,466	151,229		
	DKC-F810I-1R6FM	MIN	—	3,518		
		MAX	—	165,365		
	DKC-F810I-3R2FM	MIN	—	7,037		
		MAX	—	330,730		

THEORY-E-150**Table E.1-5 Emulation Type List for Domestic PCM/M Series in RAID1 (2D+2D) (3/5)**

Emulation Type	DKC		—				
	DKU		3390-3	3390-3A/3B/3C	3390-9	3390-9A/9B/9C	3390-L
	Volume capacity		2.838	2.975	8.514	8.924	27.844
Number of volumes/ parity group	DKC-F810I-300KCM		183	186	61	62	18
	DKC-F810I-600JCM		367	373	123	124	37
	DKC-F810I-600J5M		367	373	123	124	37
	DKC-F810I-900JCM		551	560	185	186	56
	DKC-F810I-1R2JCM		—	—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—	—
	DKC-F810I-400MCM/M5M		259	264	87	88	26
	DKC-F810I-800MCM		519	528	174	176	53
	DKC-F810I-1R6FM		—	—	—	—	—
DKC-F810I-3R2FM		—	—	—	—	—	
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		356	350	575	575	575
	DKC-F810I-600JCM		177	175	530	526	575
	DKC-F810I-600J5M		177	175	287	287	287
	DKC-F810I-900JCM		118	116	352	350	575
	DKC-F810I-1R2JCM		—	—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—	—
	DKC-F810I-400MCM/M5M		96	96	96	96	96
	DKC-F810I-800MCM		96	96	96	96	96
	DKC-F810I-1R6FM		—	—	—	—	—
DKC-F810I-3R2FM		—	—	—	—	—	
Maximum number of volumes/ storage system	DKC-F810I-300KCM		65,148	65,100	35,075	35,650	10,350
	DKC-F810I-600JCM		64,959	65,275	65,190	65,224	21,275
	DKC-F810I-600J5M		64,959	65,275	35,301	35,588	10,619
	DKC-F810I-900JCM		65,018	64,960	65,120	65,100	32,200
	DKC-F810I-1R2JCM		—	—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—	—
	DKC-F810I-400MCM/M5M		24,864	25,344	8,352	8,448	2,496
	DKC-F810I-800MCM		49,824	50,688	16,704	16,896	5,088
	DKC-F810I-1R6FM		—	—	—	—	—
DKC-F810I-3R2FM		—	—	—	—	—	
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	519	553	519	553	501
		MAX	184,890	193,673	298,629	318,141	288,185
	DKC-F810I-600JCM	MIN	1,042	1,110	1,047	1,107	1,030
		MAX	184,354	194,193	555,028	582,059	592,381
	DKC-F810I-600J5M	MIN	1,042	1,110	1,047	1,107	1,030
		MAX	184,354	194,193	300,553	317,587	295,675
	DKC-F810I-900JCM	MIN	1,564	1,666	1,575	1,660	1,559
		MAX	184,521	193,256	554,432	580,952	896,577
	DKC-F810I-1R2JCM	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-3R0H3M	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-4R0H3M	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-400MCM/ M5M	MIN	735	785	741	785	724
		MAX	70,564	75,398	71,109	75,390	69,499
	DKC-F810I-800MCM	MIN	1,473	1,571	1,481	1,571	1,476
		MAX	141,401	150,797	142,218	150,780	141,670
	DKC-F810I-1R6FM	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-3R2FM	MIN	—	—	—	—	—
		MAX	—	—	—	—	—

THEORY-E-160**Table E.1-5 Emulation Type List for Domestic PCM/M Series in RAID1 (2D+2D) (4/5)**

Emulation Type	DKC		—			
	DKU		3390- LA/LB/LC	3390-M	3390- MA/MB/MC	3390-A (3 Type)
Volume capacity			29,185	55,689	58,37	223,257
Number of volumes/ parity group	DKC-F810I-300KCM		19	9	9	186
	DKC-F810I-600JCM		38	18	19	372
	DKC-F810I-600J5M		38	18	19	372
	DKC-F810I-900JCM		57	28	28	558
	DKC-F810I-1R2JCM		—	37	38	—
	DKC-F810I-3R0H3M		—	96	97	24
	DKC-F810I-4R0H3M		—	128	129	32
	DKC-F810I-400MCM/M5M		26	13	13	3
	DKC-F810I-800MCM		53	26	26	6
	DKC-F810I-1R6FM		—	59	60	14
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		—	119	120	29
	DKC-F810I-600JCM		575	575	575	575
	DKC-F810I-600J5M		575	575	575	575
	DKC-F810I-900JCM		287	287	287	287
	DKC-F810I-1R2JCM		575	575	575	575
	DKC-F810I-3R0H3M		—	575	575	—
	DKC-F810I-4R0H3M		—	287	287	287
	DKC-F810I-400MCM/M5M		—	287	287	287
	DKC-F810I-800MCM		96	96	96	96
	DKC-F810I-1R6FM		96	96	96	96
Maximum number of volumes/ storage system	DKC-F810I-300KCM		—	47	47	47
	DKC-F810I-600JCM		—	47	47	47
	DKC-F810I-600J5M		10,925	5,175	5,175	1,150
	DKC-F810I-900JCM		21,850	10,350	10,925	2,300
	DKC-F810I-1R2JCM		10,906	5,166	5,453	1,148
	DKC-F810I-3R0H3M		32,775	16,100	16,100	4,025
	DKC-F810I-4R0H3M		—	21,275	21,850	5,175
	DKC-F810I-400MCM/M5M		—	27,552	27,839	6,888
	DKC-F810I-800MCM		—	36,736	37,023	9,184
	DKC-F810I-1R6FM		2,496	1,248	1,248	288
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM		5,088	2,496	2,496	576
	DKC-F810I-600JCM		—	2,773	2,820	658
	DKC-F810I-600J5M		—	5,593	5,640	1,363
	DKC-F810I-900JCM		MIN	555	501	525
	DKC-F810I-1R2JCM		MAX	318,846	288,191	302,065
	DKC-F810I-3R0H3M		MIN	1,109	1,002	1,109
	DKC-F810I-4R0H3M		MAX	637,692	576,381	637,692
	DKC-F810I-400MCM/M5M		MIN	1,109	1,002	1,109
	DKC-F810I-800MCM		MAX	318,292	287,689	318,292
	DKC-F810I-1R6FM		MIN	1,664	1,559	1,634
	DKC-F810I-3R2FM		MAX	956,538	896,593	939,757
	DKC-F810I-300KCM		MIN	—	2,060	2,218
	DKC-F810I-600JCM		MAX	—	1,184,783	1,275,385
	DKC-F810I-600J5M		MIN	—	5,346	5,662
	DKC-F810I-900JCM		MAX	—	1,534,343	1,624,962
	DKC-F810I-1R2JCM		MIN	—	7,128	7,530
	DKC-F810I-3R0H3M		MAX	—	2,045,791	2,161,033
	DKC-F810I-4R0H3M		MIN	759	724	759
	DKC-F810I-400MCM/M5M		MAX	72,846	69,500	72,846
	DKC-F810I-800MCM		MIN	1,547	1,448	1,518
	DKC-F810I-1R6FM		MAX	148,493	139,000	145,692
	DKC-F810I-3R2FM		MIN	—	3,286	3,502
	DKC-F810I-300KCM		MAX	—	154,426	164,603
	DKC-F810I-600JCM		MIN	—	6,627	7,004
	DKC-F810I-600J5M		MAX	—	311,469	329,207
	DKC-F810I-900JCM		MIN	—	304,299	—
	DKC-F810I-1R2JCM		MAX	—	—	—

THEORY-E-170**Table E.1-5 Emulation Type List for Domestic PCM/M Series in RAID1 (2D+2D) (5/5)**

Emulation Type	DKC		—			
	DKU		3390-A (9 Type)	3390-A (L Type)	3390-A (M Type)	3390-V
Volume capacity			8,514	27,844	55,689	712,062
Number of volumes/ parity group	DKC-F810I-300KCM		62	18	9	1
	DKC-F810I-600JCM		124	37	18	1
	DKC-F810I-600J5M		124	37	18	1
	DKC-F810I-900JCM		186	55	28	2
	DKC-F810I-1R2JCM		—	—	37	2
	DKC-F810I-3R0H3M		—	—	96	7
	DKC-F810I-4R0H3M		—	—	128	10
	DKC-F810I-400MCM/M5M		87	26	13	1
	DKC-F810I-800MCM		175	52	26	2
	DKC-F810I-1R6FM		—	—	59	4
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		—	—	119	9
	DKC-F810I-600JCM		575	575	575	575
	DKC-F810I-600J5M		526	575	575	575
	DKC-F810I-900JCM		287	287	287	287
	DKC-F810I-1R2JCM		350	575	575	575
	DKC-F810I-1R2JCM		—	—	575	575
	DKC-F810I-3R0H3M		—	—	287	287
	DKC-F810I-4R0H3M		—	—	287	287
	DKC-F810I-400MCM/M5M		96	96	96	96
	DKC-F810I-800MCM		96	96	96	96
Maximum number of volumes/ storage system	DKC-F810I-1R6FM		—	—	47	47
	DKC-F810I-3R2FM		—	—	47	47
	DKC-F810I-300KCM		35,650	10,350	5,175	575
	DKC-F810I-600JCM		65,224	21,275	10,350	575
	DKC-F810I-600J5M		35,588	10,619	5,166	287
	DKC-F810I-900JCM		65,100	31,625	16,100	1,150
	DKC-F810I-1R2JCM		—	—	21,275	1,150
	DKC-F810I-3R0H3M		—	—	27,552	2,009
	DKC-F810I-4R0H3M		—	—	36,736	2,870
	DKC-F810I-400MCM/M5M		8,352	2,496	1,248	96
MIN/MAX storage system capacity (GB)	DKC-F810I-800MCM		16,800	4,992	2,496	192
	DKC-F810I-1R6FM		—	—	2,773	188
	DKC-F810I-3R2FM		—	—	5,593	423
	DKC-F810I-300KCM	MIN	528	501	501	532
		MAX	303,524	288,185	288,191	305,654
	DKC-F810I-600JCM	MIN	1,056	1,030	1,002	712
		MAX	555,317	592,381	576,381	409,436
	DKC-F810I-600J5M	MIN	1,056	1,030	1,002	712
		MAX	302,996	295,675	287,689	204,362
	DKC-F810I-900JCM	MIN	1,584	1,531	1,559	1,424
		MAX	554,261	880,567	896,593	818,871
	DKC-F810I-1R2JCM	MIN	—	—	2,060	1,424
		MAX	—	—	1,184,783	818,871
	DKC-F810I-3R0H3M	MIN	—	—	5,346	4,984
		MAX	—	—	1,534,343	1,430,533
	DKC-F810I-4R0H3M	MIN	—	—	7,128	7,121
		MAX	—	—	2,045,791	2,043,618
	DKC-F810I-400MCM/ M5M	MIN	741	724	724	712
		MAX	71,109	69,499	69,500	68,358
	DKC-F810I-800MCM	MIN	1,490	1,448	1,448	1,424
		MAX	143,035	138,997	139,000	136,716
	DKC-F810I-1R6FM	MIN	—	—	3,286	2,848
		MAX	—	—	154,426	133,868
	DKC-F810I-3R2FM	MIN	—	—	6,627	6,409
		MAX	—	—	311,469	301,202

NOTE: The values of OPEN-V are the default values on an installation of a parity group.
The capacity of an OPEN-V varies depending on the RAID level and DKU (HDD)
type because OPEN-V is CVS basis. The default volume size is nearly equal to that of
a parity group.

THEORY-E-180**Table E.1-6 Emulation Type List for Domestic PCM/M Series in RAID6 (6D+2P) (1/5)**

Emulation Type	DKC		—			
	DKU		OPEN-3	OPEN-8	OPEN-9	OPEN-E
	Volume capacity		2,461	7,347	7,384	14,567
Number of volumes/ parity group	DKC-F810I-300KCM		700	234	233	118
	DKC-F810I-600JCM		1,401	469	466	237
	DKC-F810I-600J5M		1,401	469	466	237
	DKC-F810I-900JCM		2,000	704	700	355
	DKC-F810I-1R2JCM		—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—
	DKC-F810I-400MCM/M5M		957	320	319	162
	DKC-F810I-800MCM		1,915	641	638	324
	DKC-F810I-1R6FM		—	—	—	—
	DKC-F810I-3R2FM		—	—	—	—
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		93	278	280	287
	DKC-F810I-600JCM		46	139	140	275
	DKC-F810I-600J5M		46	139	140	143
	DKC-F810I-900JCM		32	92	93	183
	DKC-F810I-1R2JCM		—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—
	DKC-F810I-400MCM/M5M		48	48	48	48
	DKC-F810I-800MCM		34	48	48	48
	DKC-F810I-1R6FM		—	—	—	—
	DKC-F810I-3R2FM		—	—	—	—
Maximum number of volumes/ storage system	DKC-F810I-300KCM		65,100	65,052	65,240	33,866
	DKC-F810I-600JCM		64,446	65,191	65,240	65,175
	DKC-F810I-600J5M		64,446	65,191	65,240	33,891
	DKC-F810I-900JCM		64,000	64,768	65,100	64,965
	DKC-F810I-1R2JCM		—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—
	DKC-F810I-400MCM/M5M		45,936	15,360	15,312	7,776
	DKC-F810I-800MCM		65,110	30,768	30,624	15,552
	DKC-F810I-1R6FM		—	—	—	—
	DKC-F810I-3R2FM		—	—	—	—
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	1,723	1,719	1,720	1,719
		MAX	160,211	477,937	481,732	493,326
	DKC-F810I-600JCM	MIN	3,448	3,446	3,441	3,452
		MAX	158,602	478,958	481,732	949,404
	DKC-F810I-600J5M	MIN	3,448	3,446	3,441	3,452
		MAX	158,602	478,958	481,732	493,690
	DKC-F810I-900JCM	MIN	4,922	5,172	5,169	5,171
		MAX	157,504	475,850	480,698	946,345
	DKC-F810I-1R2JCM	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-3R0H3M	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-4R0H3M	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-400MCM/ M5M	MIN	2,355	2,351	2,355	2,360
		MAX	113,048	112,850	113,064	113,273
	DKC-F810I-800MCM	MIN	4,713	4,709	4,711	4,720
		MAX	160,236	226,052	226,128	226,546
	DKC-F810I-1R6FM	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-3R2FM	MIN	—	—	—	—
		MAX	—	—	—	—

THEORY-E-190**Table E.1-6 Emulation Type List for Domestic PCM/M Series in RAID6 (6D+2P) (2/5)**

Emulation Type	DKC		—			
	DKU		OPEN-L	OPEN-V		
	Volume capacity		36.45	1		
Number of volumes/ parity group	DKC-F810I-300KCM		47	1		
	DKC-F810I-600JCM		94	2		
	DKC-F810I-600J5M		94	2		
	DKC-F810I-900JCM		142	2		
	DKC-F810I-1R2JCM		—	3		
	DKC-F810I-3R0H3M		—	6		
	DKC-F810I-4R0H3M		—	8		
	DKC-F810I-400MCM/M5M		64	1		
	DKC-F810I-800MCM		129	2		
	DKC-F810I-1R6FM		—	4		
	DKC-F810I-3R2FM		—	7		
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		287	287		
	DKC-F810I-600JCM		287	287		
	DKC-F810I-600J5M		143	143		
	DKC-F810I-900JCM		287	287		
	DKC-F810I-1R2JCM		—	287		
	DKC-F810I-3R0H3M		—	143		
	DKC-F810I-4R0H3M		—	143		
	DKC-F810I-400MCM/M5M		48	48		
	DKC-F810I-800MCM		48	48		
	DKC-F810I-1R6FM		—	23		
	DKC-F810I-3R2FM		—	23		
Maximum number of volumes/ storage system	DKC-F810I-300KCM		13,489	287		
	DKC-F810I-600JCM		26,978	574		
	DKC-F810I-600J5M		13,442	286		
	DKC-F810I-900JCM		40,754	574		
	DKC-F810I-1R2JCM		—	861		
	DKC-F810I-3R0H3M		—	858		
	DKC-F810I-4R0H3M		—	1,144		
	DKC-F810I-400MCM/M5M		3,072	48		
	DKC-F810I-800MCM		6,192	96		
	DKC-F810I-1R6FM		—	92		
	DKC-F810I-3R2FM		—	161		
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	1,713	1,729		
		MAX	491,674	496,252		
	DKC-F810I-600JCM	MIN	3,426	3,458		
		MAX	983,348	992,532		
	DKC-F810I-600J5M	MIN	3,426	3,458		
		MAX	489,961	494,537		
	DKC-F810I-900JCM	MIN	5,176	5,188		
		MAX	1,485,483	1,488,899		
	DKC-F810I-1R2JCM	MIN	—	6,917		
		MAX	—	1,985,093		
	DKC-F810I-3R0H3M	MIN	—	17,623		
		MAX	—	2,520,032		
	DKC-F810I-4R0H3M	MIN	—	23,497		
		MAX	—	3,360,042		
	DKC-F810I-400MCM/ M5M	MIN	2,333	2,363		
		MAX	111,974	113,424		
	DKC-F810I-800MCM	MIN	4,702	4,726		
		MAX	225,698	226,853		
	DKC-F810I-1R6FM	MIN	—	10,555		
		MAX	—	242,772		
	DKC-F810I-3R2FM	MIN	—	21,111		
		MAX	—	485,544		

THEORY-E-200**Table E.1-6 Emulation Type List for Domestic PCM/M Series in RAID6 (6D+2P) (3/5)**

Emulation Type	DKC		—				
	DKU		3390-3	3390-3A/3B/3C	3390-9	3390-9A/9B/9C	3390-L
	Volume capacity		2.838	2.975	8.514	8.924	27.844
Number of volumes/ parity group	DKC-F810I-300KCM		551	560	185	186	56
	DKC-F810I-600JCM		1,102	1,121	370	373	113
	DKC-F810I-600J5M		1,102	1,121	370	373	113
	DKC-F810I-900JCM		1,653	1,681	555	560	170
	DKC-F810I-1R2JCM		—	—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—	—
	DKC-F810I-400MCM/M5M		779	792	261	264	80
	DKC-F810I-800MCM		1,558	1,584	523	528	160
	DKC-F810I-1R6FM		—	—	—	—	—
DKC-F810I-3R2FM		—	—	—	—	—	
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		118	116	287	287	287
	DKC-F810I-600JCM		59	58	176	175	287
	DKC-F810I-600J5M		59	58	143	143	143
	DKC-F810I-900JCM		39	38	117	116	287
	DKC-F810I-1R2JCM		—	—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—	—
	DKC-F810I-400MCM/M5M		48	48	48	48	48
	DKC-F810I-800MCM		41	41	48	48	48
	DKC-F810I-1R6FM		—	—	—	—	—
DKC-F810I-3R2FM		—	—	—	—	—	
Maximum number of volumes/ storage system	DKC-F810I-300KCM		65,018	64,960	53,095	53,382	16,072
	DKC-F810I-600JCM		65,018	65,018	65,120	65,275	32,431
	DKC-F810I-600J5M		65,018	65,018	52,910	53,339	16,159
	DKC-F810I-900JCM		64,467	63,878	64,935	64,960	48,790
	DKC-F810I-1R2JCM		—	—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—	—
	DKC-F810I-400MCM/M5M		37,392	38,016	12,528	12,672	3,840
	DKC-F810I-800MCM		63,878	64,944	25,104	25,344	7,680
	DKC-F810I-1R6FM		—	—	—	—	—
DKC-F810I-3R2FM		—	—	—	—	—	
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	1,564	1,666	1,575	1,660	1,559
		MAX	184,521	193,256	452,051	476,381	447,509
	DKC-F810I-600JCM	MIN	3,127	3,335	3,150	3,329	3,146
		MAX	184,521	193,429	554,432	582,514	903,009
	DKC-F810I-600J5M	MIN	3,127	3,335	3,150	3,329	3,146
		MAX	184,521	193,429	450,476	475,997	449,931
	DKC-F810I-900JCM	MIN	4,691	5,001	4,725	4,997	4,733
		MAX	182,957	190,037	552,857	579,703	1,358,509
	DKC-F810I-1R2JCM	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-3R0H3M	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-4R0H3M	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-400MCM/ M5M	MIN	2,211	2,356	2,222	2,356	2,228
		MAX	106,118	113,098	106,663	113,085	106,921
	DKC-F810I-800MCM	MIN	4,422	4,712	4,453	4,712	4,455
		MAX	181,286	193,208	213,735	226,170	213,842
	DKC-F810I-1R6FM	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-3R2FM	MIN	—	—	—	—	—
		MAX	—	—	—	—	—

THEORY-E-210**Table E.1-6 Emulation Type List for Domestic PCM/M Series in RAID6 (6D+2P) (4/5)**

Emulation Type	DKC		—				
	DKU		3390- LA/LB/LC	3390-M	3390- MA/MB/MC	3390-A	3390-A (3 Type)
	Volume capacity		29.185	55.689	58.37	223.257	2.838
Number of volumes/ parity group	DKC-F810I-300KCM		57	28	28	7	558
	DKC-F810I-600JCM		114	56	57	14	1,116
	DKC-F810I-600J5M		114	56	57	14	1,116
	DKC-F810I-900JCM		171	85	85	21	1,675
	DKC-F810I-1R2JCM		—	113	114	28	—
	DKC-F810I-3R0H3M		—	289	291	72	—
	DKC-F810I-4R0H3M		—	386	388	96	—
	DKC-F810I-400MCM/M5M		80	40	40	10	789
	DKC-F810I-800MCM		161	80	80	20	1,578
	DKC-F810I-1R6FM		—	179	180	44	—
DKC-F810I-3R2FM		—	359	361	89	—	
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		287	287	287	287	116
	DKC-F810I-600JCM		287	287	287	287	58
	DKC-F810I-600J5M		143	143	143	143	58
	DKC-F810I-900JCM		287	287	287	287	38
	DKC-F810I-1R2JCM		—	287	287	287	—
	DKC-F810I-3R0H3M		—	143	143	143	—
	DKC-F810I-4R0H3M		—	143	143	143	—
	DKC-F810I-400MCM/M5M		48	48	48	48	48
	DKC-F810I-800MCM		48	48	48	48	41
	DKC-F810I-1R6FM		—	23	23	23	—
DKC-F810I-3R2FM		—	23	23	23	—	
Maximum number of volumes/ storage system	DKC-F810I-300KCM		16,359	8,036	8,036	2,009	64,728
	DKC-F810I-600JCM		32,718	16,072	16,359	4,018	64,728
	DKC-F810I-600J5M		16,302	8,008	8,151	2,002	64,728
	DKC-F810I-900JCM		49,077	24,395	24,395	6,027	63,650
	DKC-F810I-1R2JCM		—	32,431	32,718	8,036	—
	DKC-F810I-3R0H3M		—	41,327	41,613	10,296	—
	DKC-F810I-4R0H3M		—	55,198	55,484	13,728	—
	DKC-F810I-400MCM/M5M		3,840	1,920	1,920	480	37,872
	DKC-F810I-800MCM		7,728	3,840	3,840	960	64,698
	DKC-F810I-1R6FM		—	4,117	4,140	1,012	—
DKC-F810I-3R2FM		—	8,257	8,303	2,047	—	
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	1,664	1,559	1,634	1,563	1,584
		MAX	477,437	447,517	469,061	448,523	183,698
	DKC-F810I-600JCM	MIN	3,327	3,119	3,327	3,126	3,167
		MAX	954,875	895,034	954,875	897,047	183,698
	DKC-F810I-600J5M	MIN	3,327	3,119	3,327	3,126	3,167
		MAX	475,774	445,958	475,774	446,961	183,698
	DKC-F810I-900JCM	MIN	4,991	4,734	4,961	4,688	4,754
		MAX	1,432,312	1,358,533	1,423,936	1,345,570	180,639
	DKC-F810I-1R2JCM	MIN	—	6,293	6,654	6,251	—
		MAX	—	1,806,050	1,909,750	1,794,093	—
	DKC-F810I-3R0H3M	MIN	—	16,094	16,986	16,075	—
		MAX	—	2,301,459	2,428,951	2,298,654	—
	DKC-F810I-4R0H3M	MIN	—	21,496	22,648	21,433	—
		MAX	—	3,073,921	3,238,601	3,064,872	—
	DKC-F810I-400MCM/ M5M	MIN	2,335	2,228	2,335	2,233	2,239
		MAX	112,070	106,923	112,070	107,163	107,481
	DKC-F810I-800MCM	MIN	4,699	4,455	4,670	4,465	4,478
		MAX	225,542	213,846	224,141	214,327	183,613
	DKC-F810I-1R6FM	MIN	—	9,968	10,507	9,823	—
		MAX	—	229,272	241,652	225,936	—
	DKC-F810I-3R2FM	MIN	—	19,992	21,072	19,870	—
		MAX	—	459,824	484,646	457,007	—

THEORY-E-220**Table E.1-6 Emulation Type List for Domestic PCM/M Series in RAID6 (6D+2P) (5/5)**

Emulation Type	DKC		—			
	DKU		3390-A (9 Type)	3390-A (L Type)	3390-A (M Type)	3390-V
Volume capacity			8,514	27,844	55,689	712,062
Number of volumes/ parity group	DKC-F810I-300KCM		186	55	28	2
	DKC-F810I-600JCM		372	111	56	4
	DKC-F810I-600J5M		372	111	56	4
	DKC-F810I-900JCM		558	167	85	6
	DKC-F810I-1R2JCM		—	—	113	8
	DKC-F810I-3R0H3M		—	—	289	22
	DKC-F810I-4R0H3M		—	—	385	30
	DKC-F810I-400MCM/M5M		263	78	40	3
	DKC-F810I-800MCM		526	157	80	6
	DKC-F810I-1R6FM		—	—	179	14
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		—	—	358	28
	DKC-F810I-300KCM		287	287	287	287
	DKC-F810I-600JCM		175	287	287	287
	DKC-F810I-600J5M		143	143	143	143
	DKC-F810I-900JCM		116	287	287	287
	DKC-F810I-1R2JCM		—	—	287	287
	DKC-F810I-3R0H3M		—	—	143	143
	DKC-F810I-4R0H3M		—	—	143	143
	DKC-F810I-400MCM/M5M		48	48	48	48
	DKC-F810I-800MCM		48	48	48	48
Maximum number of volumes/ storage system	DKC-F810I-1R6FM		—	—	23	23
	DKC-F810I-3R2FM		—	—	23	23
	DKC-F810I-300KCM		53,382	15,785	8,036	574
	DKC-F810I-600JCM		65,100	31,857	16,072	1,148
	DKC-F810I-600J5M		53,196	15,873	8,008	572
	DKC-F810I-900JCM		64,728	47,929	24,395	1,722
	DKC-F810I-1R2JCM		—	—	32,431	2,296
	DKC-F810I-3R0H3M		—	—	41,327	3,146
	DKC-F810I-4R0H3M		—	—	55,055	4,290
	DKC-F810I-400MCM/M5M		12,624	3,744	1,920	144
MIN/MAX storage system capacity (GB)	DKC-F810I-800MCM		25,248	7,536	3,840	288
	DKC-F810I-1R6FM		—	—	4,117	322
	DKC-F810I-3R2FM		—	—	8,234	644
	DKC-F810I-300KCM	MIN	1,584	1,531	1,559	1,424
		MAX	454,494	439,518	447,517	408,724
	DKC-F810I-600JCM	MIN	3,167	3,091	3,119	2,848
		MAX	554,261	887,026	895,034	817,447
	DKC-F810I-600J5M	MIN	3,167	3,091	3,119	2,848
		MAX	452,911	441,968	445,958	407,299
	DKC-F810I-900JCM	MIN	4,751	4,650	4,734	4,272
		MAX	551,094	1,334,535	1,358,533	1,226,171
	DKC-F810I-1R2JCM	MIN	—	—	6,293	5,696
		MAX	—	—	1,806,050	1,634,894
	DKC-F810I-3R0H3M	MIN	—	—	16,094	15,665
		MAX	—	—	2,301,459	2,240,147
	DKC-F810I-4R0H3M	MIN	—	—	21,440	21,362
		MAX	—	—	3,065,958	3,054,746
	DKC-F810I-400MCM/ M5M	MIN	2,239	2,172	2,228	2,136
		MAX	107,481	104,248	106,923	102,537
	DKC-F810I-800MCM	MIN	4,478	4,372	4,455	4,272
		MAX	214,961	209,832	213,846	205,074
	DKC-F810I-1R6FM	MIN	—	—	9,968	9,969
		MAX	—	—	229,272	229,284
	DKC-F810I-3R2FM	MIN	—	—	19,937	19,938
		MAX	—	—	458,543	458,568

NOTE: The values of OPEN-V are the default values on an installation of a parity group.
The capacity of an OPEN-V varies depending on the RAID level and DKU (HDD)
type because OPEN-V is CVS basis. The default volume size is nearly equal to that of
a parity group.

THEORY-E-230**Table E.1-7 Emulation Type List for Domestic PCM/M Series in RAID6 (14D+2P) (1/5)**

Emulation Type	DKC		—			
	DKU		OPEN-3	OPEN-8	OPEN-9	OPEN-E
	Volume capacity		2.461	7.347	7.384	14.567
Number of volumes/ parity group	DKC-F810I-300KCM		—	—	—	—
	DKC-F810I-600JCM		—	—	—	—
	DKC-F810I-600J5M		—	—	—	—
	DKC-F810I-900JCM		—	—	—	—
	DKC-F810I-1R2JCM		—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—
	DKC-F810I-400MCM/M5M		—	—	—	—
	DKC-F810I-800MCM		—	—	—	—
	DKC-F810I-1R6FM		—	—	—	—
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		—	—	—	—
	DKC-F810I-600JCM		—	—	—	—
	DKC-F810I-600J5M		—	—	—	—
	DKC-F810I-900JCM		—	—	—	—
	DKC-F810I-1R2JCM		—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—
	DKC-F810I-400MCM/M5M		—	—	—	—
	DKC-F810I-800MCM		—	—	—	—
	DKC-F810I-1R6FM		—	—	—	—
Maximum number of volumes/ storage system	DKC-F810I-300KCM		—	—	—	—
	DKC-F810I-600JCM		—	—	—	—
	DKC-F810I-600J5M		—	—	—	—
	DKC-F810I-900JCM		—	—	—	—
	DKC-F810I-1R2JCM		—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—
	DKC-F810I-400MCM/M5M		—	—	—	—
	DKC-F810I-800MCM		—	—	—	—
	DKC-F810I-1R6FM		—	—	—	—
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-600JCM	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-600J5M	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-900JCM	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-1R2JCM	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-3R0H3M	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-4R0H3M	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-400MCM/ M5M	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-800MCM	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-1R6FM	MIN	—	—	—	—
		MAX	—	—	—	—
	DKC-F810I-3R2FM	MIN	—	—	—	—
		MAX	—	—	—	—

THEORY-E-240**Table E.1-7 Emulation Type List for Domestic PCM/M Series in RAID6 (14D+2P) (2/5)**

Emulation Type	DKC		—			
	DKU		OPEN-L	OPEN-V		
	Volume capacity		36.45	1		
Number of volumes/ parity group	DKC-F810I-300KCM		—	2		
	DKC-F810I-600JCM		—	3		
	DKC-F810I-600J5M		—	3		
	DKC-F810I-900JCM		—	4		
	DKC-F810I-1R2JCM		—	5		
	DKC-F810I-3R0H3M		—	13		
	DKC-F810I-4R0H3M		—	17		
	DKC-F810I-400MCM/M5M		—	2		
	DKC-F810I-800MCM		—	4		
	DKC-F810I-1R6FM		—	8		
	DKC-F810I-3R2FM		—	15		
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		—	143		
	DKC-F810I-600JCM		—	143		
	DKC-F810I-600J5M		—	71		
	DKC-F810I-900JCM		—	143		
	DKC-F810I-1R2JCM		—	143		
	DKC-F810I-3R0H3M		—	71		
	DKC-F810I-4R0H3M		—	71		
	DKC-F810I-400MCM/M5M		—	24		
	DKC-F810I-800MCM		—	24		
	DKC-F810I-1R6FM		—	11		
	DKC-F810I-3R2FM		—	11		
Maximum number of volumes/ storage system	DKC-F810I-300KCM		—	286		
	DKC-F810I-600JCM		—	429		
	DKC-F810I-600J5M		—	213		
	DKC-F810I-900JCM		—	572		
	DKC-F810I-1R2JCM		—	715		
	DKC-F810I-3R0H3M		—	923		
	DKC-F810I-4R0H3M		—	1,207		
	DKC-F810I-400MCM/M5M		—	48		
	DKC-F810I-800MCM		—	96		
	DKC-F810I-1R6FM		—	88		
	DKC-F810I-3R2FM		—	165		
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	—	4,035		
		MAX	—	576,962		
	DKC-F810I-600JCM	MIN	—	8,070		
		MAX	—	1,153,939		
	DKC-F810I-600J5M	MIN	—	8,070		
		MAX	—	572,935		
	DKC-F810I-900JCM	MIN	—	12,105		
		MAX	—	1,731,015		
	DKC-F810I-1R2JCM	MIN	—	16,139		
		MAX	—	2,307,877		
	DKC-F810I-3R0H3M	MIN	—	41,120		
		MAX	—	2,919,485		
	DKC-F810I-4R0H3M	MIN	—	54,826		
		MAX	—	3,892,646		
	DKC-F810I-400MCM/ M5M	MIN	—	5,514		
		MAX	—	132,331		
	DKC-F810I-800MCM	MIN	—	11,028		
		MAX	—	264,662		
	DKC-F810I-1R6FM	MIN	—	24,629		
		MAX	—	270,919		
	DKC-F810I-3R2FM	MIN	—	49,258		
		MAX	—	541,839		

THEORY-E-250**Table E.1-7 Emulation Type List for Domestic PCM/M Series in RAID6 (14D+2P) (3/5)**

Emulation Type	DKC		—				
	DKU		3390-3	3390-3A/3B/3C	3390-9	3390-9A/9B/9C	3390-L
	Volume capacity		2.838	2.975	8.514	8.924	27.844
Number of volumes/ parity group	DKC-F810I-300KCM		—	—	—	—	—
	DKC-F810I-600JCM		—	—	—	—	—
	DKC-F810I-600J5M		—	—	—	—	—
	DKC-F810I-900JCM		—	—	—	—	—
	DKC-F810I-1R2JCM		—	—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—	—
	DKC-F810I-400MCM/M5M		—	—	—	—	—
	DKC-F810I-800MCM		—	—	—	—	—
DKC-F810I-1R6FM		—	—	—	—	—	
DKC-F810I-3R2FM		—	—	—	—	—	
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		—	—	—	—	—
	DKC-F810I-600JCM		—	—	—	—	—
	DKC-F810I-600J5M		—	—	—	—	—
	DKC-F810I-900JCM		—	—	—	—	—
	DKC-F810I-1R2JCM		—	—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—	—
	DKC-F810I-400MCM/M5M		—	—	—	—	—
	DKC-F810I-800MCM		—	—	—	—	—
DKC-F810I-1R6FM		—	—	—	—	—	
DKC-F810I-3R2FM		—	—	—	—	—	
Maximum number of volumes/ storage system	DKC-F810I-300KCM		—	—	—	—	—
	DKC-F810I-600JCM		—	—	—	—	—
	DKC-F810I-600J5M		—	—	—	—	—
	DKC-F810I-900JCM		—	—	—	—	—
	DKC-F810I-1R2JCM		—	—	—	—	—
	DKC-F810I-3R0H3M		—	—	—	—	—
	DKC-F810I-4R0H3M		—	—	—	—	—
	DKC-F810I-400MCM/M5M		—	—	—	—	—
	DKC-F810I-800MCM		—	—	—	—	—
DKC-F810I-1R6FM		—	—	—	—	—	
DKC-F810I-3R2FM		—	—	—	—	—	
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-600JCM	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-600J5M	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-900JCM	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-1R2JCM	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-3R0H3M	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-4R0H3M	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-400MCM/ M5M	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
	DKC-F810I-800MCM	MIN	—	—	—	—	—
		MAX	—	—	—	—	—
DKC-F810I-1R6FM	MIN	—	—	—	—	—	
	MAX	—	—	—	—	—	
DKC-F810I-3R2FM	MIN	—	—	—	—	—	
	MAX	—	—	—	—	—	

THEORY-E-260**Table E.1-7 Emulation Type List for Domestic PCM/M Series in RAID6 (14D+2P) (4/5)**

Emulation Type	DKC		—				
	DKU		3390- LA/LB/LC	3390-M	3390- MA/MB/MC	3390-A	3390-A (3 Type)
	Volume capacity		29.185	55.689	58.37	223.257	2.838
Number of volumes/ parity group	DKC-F810I-300KCM		—	66	66	16	—
	DKC-F810I-600JCM		—	132	133	33	—
	DKC-F810I-600J5M		—	132	133	33	—
	DKC-F810I-900JCM		—	199	200	49	—
	DKC-F810I-1R2JCM		—	265	267	66	—
	DKC-F810I-3R0H3M		—	676	680	168	—
	DKC-F810I-4R0H3M		—	901	907	225	—
	DKC-F810I-400MCM/M5M		—	93	94	23	—
	DKC-F810I-800MCM		—	187	188	46	—
	DKC-F810I-1R6FM		—	418	421	104	—
DKC-F810I-3R2FM		—	837	843	209	—	
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		—	143	143	143	—
	DKC-F810I-600JCM		—	143	143	143	—
	DKC-F810I-600J5M		—	71	71	71	—
	DKC-F810I-900JCM		—	143	143	143	—
	DKC-F810I-1R2JCM		—	143	143	143	—
	DKC-F810I-3R0H3M		—	71	71	71	—
	DKC-F810I-4R0H3M		—	71	71	71	—
	DKC-F810I-400MCM/M5M		—	24	24	24	—
	DKC-F810I-800MCM		—	24	24	24	—
DKC-F810I-1R6FM		—	11	11	11	—	
DKC-F810I-3R2FM		—	11	11	11	—	
Maximum number of volumes/ storage system	DKC-F810I-300KCM		—	9,438	9,438	2,288	—
	DKC-F810I-600JCM		—	18,876	19,019	4,719	—
	DKC-F810I-600J5M		—	9,372	9,443	2,343	—
	DKC-F810I-900JCM		—	28,457	28,600	7,007	—
	DKC-F810I-1R2JCM		—	37,895	38,181	9,438	—
	DKC-F810I-3R0H3M		—	47,996	48,280	11,928	—
	DKC-F810I-4R0H3M		—	63,971	64,397	15,975	—
	DKC-F810I-400MCM/M5M		—	2,232	2,256	552	—
	DKC-F810I-800MCM		—	4,488	4,512	1,104	—
DKC-F810I-1R6FM		—	4,598	4,631	1,144	—	
DKC-F810I-3R2FM		—	9,207	9,273	2,299	—	
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	—	3,675	3,852	3,572	—
		MAX	—	525,593	550,896	510,812	—
	DKC-F810I-600JCM	MIN	—	7,351	7,763	7,367	—
		MAX	—	1,051,186	1,110,139	1,053,550	—
	DKC-F810I-600J5M	MIN	—	7,351	7,763	7,367	—
		MAX	—	521,917	551,188	523,091	—
	DKC-F810I-900JCM	MIN	—	11,082	11,674	10,940	—
		MAX	—	1,584,742	1,669,382	1,564,362	—
	DKC-F810I-1R2JCM	MIN	—	14,758	15,585	14,735	—
		MAX	—	2,110,335	2,228,625	2,107,100	—
	DKC-F810I-3R0H3M	MIN	—	37,646	39,692	37,507	—
		MAX	—	2,672,849	2,818,104	2,663,009	—
	DKC-F810I-4R0H3M	MIN	—	50,176	52,942	50,233	—
		MAX	—	3,562,481	3,758,853	3,566,531	—
	DKC-F810I-400MCM/ M5M	MIN	—	5,179	5,487	5,135	—
		MAX	—	124,298	131,683	123,238	—
	DKC-F810I-800MCM	MIN	—	10,414	10,974	10,270	—
		MAX	—	249,932	263,365	246,476	—
	DKC-F810I-1R6FM	MIN	—	23,278	24,574	23,219	—
		MAX	—	256,058	270,311	255,406	—
	DKC-F810I-3R2FM	MIN	—	46,612	49,206	46,661	—
		MAX	—	512,729	541,265	513,268	—

THEORY-E-270**Table E.1-7 Emulation Type List for Domestic PCM/M Series in RAID6 (14D+2P) (5/5)**

Emulation Type	DKC		—				
	DKU		3390-A (9 Type)	3390-A (L Type)	3390-A (M Type)	3390-V	
	Volume capacity		8.514	27.844	55.689	712.062	
Number of volumes/ parity group	DKC-F810I-300KCM		—	—	66	5	
	DKC-F810I-600JCM		—	—	132	10	
	DKC-F810I-600J5M		—	—	132	10	
	DKC-F810I-900JCM		—	—	198	15	
	DKC-F810I-1R2JCM		—	—	265	20	
	DKC-F810I-3R0H3M		—	—	675	53	
	DKC-F810I-4R0H3M		—	—	900	71	
	DKC-F810I-400MCM/M5M		—	—	93	7	
	DKC-F810I-800MCM		—	—	187	14	
	DKC-F810I-1R6FM		—	—	418	32	
DKC-F810I-3R2FM		—	—	836	65		
Maximum number of parity groups/ storage system	DKC-F810I-300KCM		—	—	143	143	
	DKC-F810I-600JCM		—	—	143	143	
	DKC-F810I-600J5M		—	—	71	71	
	DKC-F810I-900JCM		—	—	143	143	
	DKC-F810I-1R2JCM		—	—	143	143	
	DKC-F810I-3R0H3M		—	—	71	71	
	DKC-F810I-4R0H3M		—	—	71	71	
	DKC-F810I-400MCM/M5M		—	—	24	24	
	DKC-F810I-800MCM		—	—	24	24	
	DKC-F810I-1R6FM		—	—	11	11	
DKC-F810I-3R2FM		—	—	11	11		
Maximum number of volumes/ storage system	DKC-F810I-300KCM		—	—	9,438	715	
	DKC-F810I-600JCM		—	—	18,876	1,430	
	DKC-F810I-600J5M		—	—	9,372	710	
	DKC-F810I-900JCM		—	—	28,314	2,145	
	DKC-F810I-1R2JCM		—	—	37,895	2,860	
	DKC-F810I-3R0H3M		—	—	47,925	3,763	
	DKC-F810I-4R0H3M		—	—	63,900	5,041	
	DKC-F810I-400MCM/M5M		—	—	2,232	168	
	DKC-F810I-800MCM		—	—	4,488	336	
	DKC-F810I-1R6FM		—	—	4,598	352	
DKC-F810I-3R2FM		—	—	9,196	715		
MIN/MAX storage system capacity (GB)	DKC-F810I-300KCM	MIN	—	—	3,675	3,560	
		MAX	—	—	525,593	509,124	
	DKC-F810I-600JCM	MIN	—	—	7,351	7,121	
		MAX	—	—	1,051,186	1,018,249	
	DKC-F810I-600J5M	MIN	—	—	7,351	7,121	
		MAX	—	—	521,917	505,564	
	DKC-F810I-900JCM	MIN	—	—	11,026	10,681	
		MAX	—	—	1,576,778	1,527,373	
	DKC-F810I-1R2JCM	MIN	—	—	14,758	14,241	
		MAX	—	—	2,110,335	2,036,497	
	DKC-F810I-3R0H3M	MIN	—	—	37,590	37,739	
		MAX	—	—	2,668,895	2,679,489	
	DKC-F810I-4R0H3M	MIN	—	—	50,120	50,556	
		MAX	—	—	3,558,527	3,589,505	
	DKC-F810I-400MCM/ M5M	MIN	—	—	5,179	4,984	
		MAX	—	—	124,298	119,626	
	DKC-F810I-800MCM	MIN	—	—	10,414	9,969	
		MAX	—	—	249,932	239,253	
	DKC-F810I-1R6FM	MIN	—	—	23,278	22,786	
		MAX	—	—	256,058	250,646	
	DKC-F810I-3R2FM	MIN	—	—	46,556	46,284	
		MAX	—	—	512,116	509,124	

NOTE: The values of OPEN-V are the default values on an installation of a parity group.
The capacity of an OPEN-V varies depending on the RAID level and DKU (HDD)
type because OPEN-V is CVS basis. The default volume size is nearly equal to that of
a parity group.

Table E.1-8 Relation between OPEN-V Capacity and RAID Level/DKU Type

DKU type		Capacity		Number of LDEV
		MB	Logical BlockSR	
RAID5 (3D+1P)	DKC-F810I-300KCM	824536.5	1688650752	1
	DKC-F810I-600JCM/J5M	1649074.5	3377304576	1
	DKC-F810I-900JCM	2473764.0	5066268672	1
	DKC-F810I-1R2JCM	3298149.0	6754609152	2
	DKC-F810I-3R0H3M	8403129.0	17209608192	3
	DKC-F810I-4R0H3M	11204172.0	22946144256	4
	DKC-F810I-400MCM/M5M	1126801.5	2307689472	1
	DKC-F810I-800MCM	2253604.5	4615382016	1
	DKC-F810I-1R6FM	5033157.0	10307905536	2
	DKC-F810I-3R2FM	10066320.0	20615823360	4
RAID5 (7D+1P)	DKC-F810I-300KCM	1923918.5	3940185088	1
	DKC-F810I-600JCM/J5M	3847837.0	7880370176	2
	DKC-F810I-900JCM	5772116.0	11821293568	2
	DKC-F810I-1R2JCM	7695681.0	15760754688	3
	DKC-F810I-3R0H3M	19607301.0	40155752448	7
	DKC-F810I-4R0H3M	26143078.5	53541024768	9
	DKC-F810I-400MCM/M5M	2629203.5	5384608768	1
	DKC-F810I-800MCM	5258407.0	10769217536	2
	DKC-F810I-1R6FM	11744026.0	24051765248	4
	DKC-F810I-3R2FM	23488080.0	48103587840	8
RAID1 (2D+2D)	DKC-F810I-300KCM	549691.0	1125767168	1
	DKC-F810I-600JCM/J5M	1099383.0	2251536384	1
	DKC-F810I-900JCM	1649176.0	3377512448	1
	DKC-F810I-1R2JCM	2198766.0	4503072768	1
	DKC-F810I-3R0H3M	5602088.0	11473076224	2
	DKC-F810I-4R0H3M	7469451.0	15297435648	3
	DKC-F810I-400MCM/M5M	751201.0	1538459648	1
	DKC-F810I-800MCM	1502403.0	3076921344	1
	DKC-F810I-1R6FM	3355438.0	6871937024	2
	DKC-F810I-3R2FM	6710883.0	13743888384	3
RAID6 (6D+2P)	DKC-F810I-300KCM	1649073.0	3377301504	1
	DKC-F810I-600JCM/J5M	3298146.0	6754603008	2
	DKC-F810I-900JCM	4947528.0	10132537344	2
	DKC-F810I-1R2JCM	6596298.0	13509218304	3
	DKC-F810I-3R0H3M	16806258.0	34419216384	6
	DKC-F810I-4R0H3M	22408344.0	45892288512	8
	DKC-F810I-400MCM/M5M	2253603.0	4615378944	1
	DKC-F810I-800MCM	4507206.0	9230757888	2
	DKC-F810I-1R6FM	10066308.0	20615798784	4
	DKC-F810I-3R2FM	20132637.0	41231640576	7
RAID6 (14D+2P)	DKC-F810I-300KCM	3847840.5	7880377344	2
	DKC-F810I-600JCM/J5M	7695681.0	15760754688	3
	DKC-F810I-900JCM	11544232.0	23642587136	4
	DKC-F810I-1R2JCM	15391355.0	31521495040	5
	DKC-F810I-3R0H3M	39214616.0	80311533568	13
	DKC-F810I-4R0H3M	52286101.0	107081934848	17
	DKC-F810I-400MCM/M5M	5258410.5	10769224704	2
	DKC-F810I-800MCM	10516800.0	21538406400	4
	DKC-F810I-1R6FM	23488024.0	48103473152	8
	DKC-F810I-3R2FM	46976160.0	96207175680	15