44-10 (P)

Honeywell

HONEYWELL
INFORMATION
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ENGINEERING PRODUCT SPECIFICATION - 1
DSS181 and DSS190 Removable Media
Disk Storage Subsystems

L16-90 -BCO, LADC
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1. GENERAL DESCRIPTION

This document specifies the subsystem requirements for the DSS181, MSS450 and DSS190 Removable Media Disk Storage Subsystems. The basic elements of the subsystem are:

	1 Cont. Maximum	2 Cont. Cross Bar
Up to 2 Controllers (MPC)	1	2
Up to 4 Link Adapters (LA)	2	4
Up to 4 Controller Adapters (CA)	2	4
Up to 32 Disk Storage Units(DSU)	32	32

(See paragraph 2.1.4 for configurations.)

1.1 SUBSYSTEM OBJECTIVES

The objectives of the subsystem are to:

1. Provide a high degree of subsystem effectiveness (usefulness to the customer).
2. Provide a high degree of data availability.
3. Provide field upgrade from single to dual channel, add switched channels and additional devices.
4. Provide a high degree of subsystem modularity, including External User System (EUS) Interface, formats and performance capabilities.
5. Provide the capabilities necessary for a shared file subsystem between multiple 6000, and DATANET-355 systems.
6. Provide multiple sector length capability.

7. Provide on line diagnosis and maintainability and off line repair and adjustment.

8. Provide a competitive price/performance product offering.

9. Provide compatibility between the DSS181 and the DSS170 and DSS180 (media interchange).

10. Provide the ability to read information data written by an IBM 2314 on the DSS181 with a special command (Read Nonstandard) and interpret with software. Not in initial DSS181 (Ref. Section 1.8.1).

11. Provide compatibility between the DSU190 and NDM400 (media interchange).

12. Provide the capability to read information data written by an IBM 3330 subsystem on the DSS190 with a special command (Read Nonstandard) and interpret with software. This capability will be restricted to single channel operation in one controller. Dual channel operation may be provided by two controller subsystems (refer to Section 4.3.3).

13. Provide ease of upgrading from other mass storage subsystems through compatible software interface.

14. Provide the controller hardware necessary to meet the NPL mass storage area objectives and level 2 functionality. (Refer to Section 3.)

It is planned to accomplish the above using a microprogrammed peripheral controller (MPC) as the controller for the Disk Drives.

The sharing of the file system by two computer systems is viewed as a very important consideration. Design of the subsystem must provide for sharing or a direct data path between the H-6000 and the communication subsystem to the Disk Subsystem.

The design objectives of this subsystem are to provide maximum effective useful mass storage to the customer. The effectiveness of the subsystem is a function of throughput, data availability, reliability, maintainability, and data integrity.

1.2 PURPOSE

This Engineering Product Specification, Part 1, describes the DSS181, DSS190 and MSS450 subsystems performance requirements, characteristics, configurations, reliability, maintainability and general design requirements.

The controller comprises several pieces of hardware; however, the majority of this specification will treat it as a single box, since the external interface presented by the controller is the primary concern.

1.3 SCOPE OF THIS DOCUMENT

This document describes in general terms the hardware, design requirements, and interfaces that make up the subsystem.

This document is a system level specification and therefore, is broad in scope. Details of the individual module design and operation are not included in this specification, but will be found in the controller, device and interface engineering product specifications.

1.4 APPLICABLE DOCUMENTS

EPS-1 GCOS File System, 43A233715

CPB 1518C GE-600 Line Comprehensive Operating Supervisor (GCOS-III)

EPS-1 Microprogrammed Peripheral Controller (MPC), 43A177875

EPS-1 PSI Link Adapter (LA), 43A177879

Purchase Specification 11 High Disk Pack, M50EB00747

EPS-1 General Design Requirements Specification for GE-655 and GE-355, 43A177851

EPS-1 DATANET-355, 43A219609

EPS-1 GE-655 IOM Input/Output Multiplexor, 43A219604

EPS-1 DSC181/190 Controller, 43A232230

HIS Group Standard Environment B01-08

EPS-1 Peripheral Subsystem Interface (PSI), 43A177874

EPS-1 Mass Storage Device Level Interface (DLI), BL0026, BL0026, FSP-IF-300

EPS-1 655 IOM Peripheral Subsystem Interface Adapter, 43A177880

MPC Microprogramming Manual MPC-1

EPS-1 DSC175/180 Controller, 43A177863

EPS-1 DSU181 Disk Storage Unit, 59A301822

AREA OBJECTIVES for NPL Microprogrammed Peripheral Controller (MPC) Document BL0021, Rev. O, Draft 1

NPL Disk Subsystem Functional Specification NPL-FSP-MS-000 order number BL0004

Purchase Specification DSU190, 59A301821

NDM400 Mass Storage Device BL0034

NPL Peripheral Subsystem Interface Functional Specification FSP-IF-100 order number BL0000

NPL Mass Storage Subsystem Area Objectives number AOB-MS-000 order number BL003

EPS-1 DATANET355/Mass Storage Link, 43A232270

EPS-1 355 Computer Peripheral Subsystem Interface Channel (PSIC), 43A240087

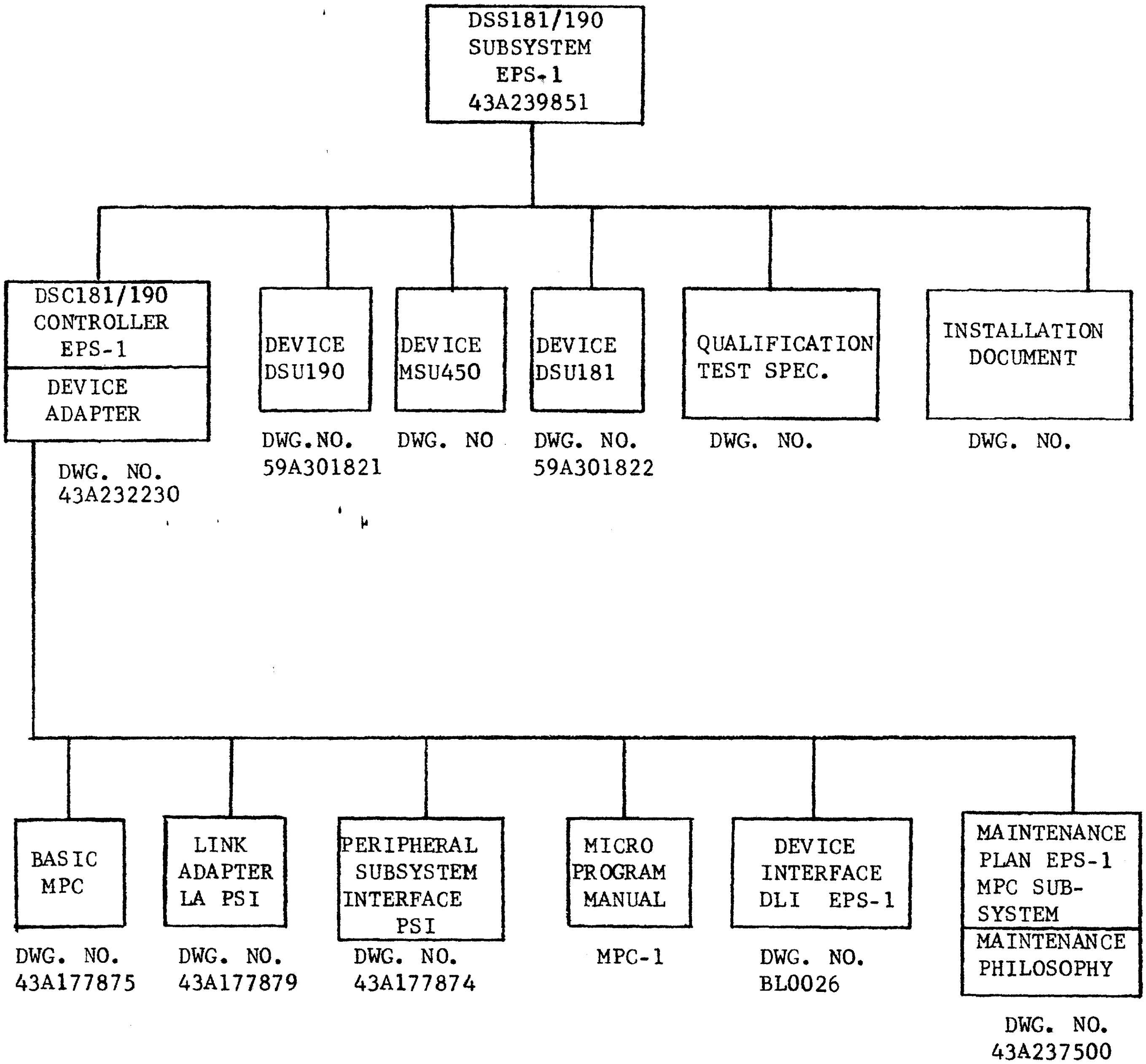
EPS-1 GCOS III Extensions for DSS170 and DSS167 Subsystems, 43A219621

MSU450 Mass Storage Unit

Functional Specification for MSS450, 58004035

Purchase Specification M4450 Disk Pack,

1.5 DOCUMENTATION TREE



1.6 DEFINITIONS

The following definitions are provided to be consistent with related documents:

EUS External User System. EUS refers to any 355 or 6000 line computer system with its associated peripheral subsystem interface (PSI).

PSI Peripheral Subsystem Interface. Refer to the PSI EPS-1 43A177874.

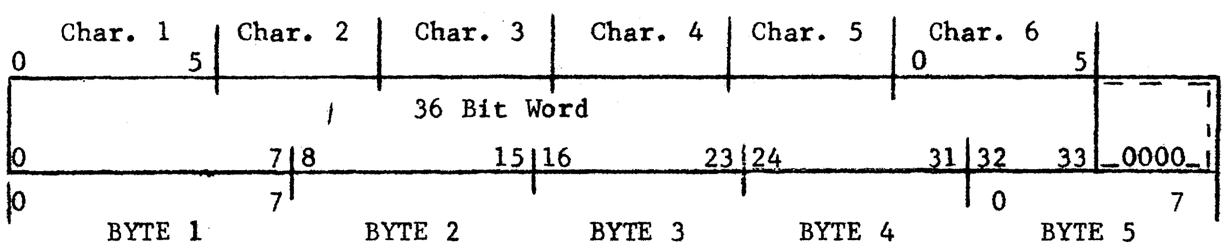
CHARACTER Six bits of information (as opposed to eight or nine bits).

WORD Six characters, 36 bits, referring to 6000 system word size (two words contain 9 bytes).

BYTE Eight bits of information.

DATA Data formats are described as either 6000 words (36 bits) on bytes (8 bits). Odd mod words are described as 4 1/2 bytes with the addition of four zeros to match the byte PSI interface. The relationship of bits, characters, bytes and words is shown below.

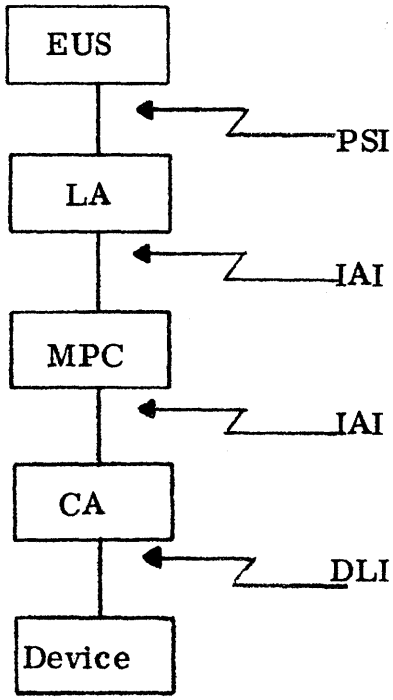
6 Bit Character



8 Bit Byte

LA Link Adapter
CA Controller Adapter
ITR Isolation Test Routines

MPC	Microprogrammed Peripheral Controller
DSC	Disk Storage Controller
IOM	Input/Output Multiplexor
HEF	High Efficiency Format
DLI	Device Level Interface
IAI	Internal Adapter Interface
DSU	Disk Storage Unit
SECTOR	Physical description of data between gaps. Random addressable.
RECORD	Data specified by one command, i.e., part of sector or several sectors.
DEVICES	Disk Storage Unit
MSU	Mass Storage Unit
DSS	Disk Storage Subsystem
MSS	Mass Storage Subsystem
64 WORD SECTOR	288 bytes, 384 characters.
320 WORD SECTOR	1440 bytes, 1920 characters.
CONTROLLER	MPC, LA, CA
COMMAND	Operational instructions from EUS (read, write, etc.)
CHANNEL	EUS connection path to the subsystem.
PHYSICAL CHANNEL	Hardware connection path (PSIA, LA and CA).
LOGICAL CHANNEL	IOM multiplexed connection path for a transaction, i.e., a channel program (IDCW, DCW's).
RPS	Rotational Position Sensing
EDAC	Error Detection and Correction
LOS	Level of Simultaneity
TOLTS	Total On Line Testing System
SYSTEM	Hardware modules connected together and under control of one operating system residing in the hardware modules.



External User System

Peripheral Subsystem Interface

Link Adapter

Internal Adapter Interface

Microprogrammed Peripheral Controller

Internal Adapter Interface

Controller Adapter

Device Level Interface

Device

1.6.1 Binary Data Transfer

The bytes are mapped into a pair of 36-bit words as shown below:

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7	BYTE 8
0 7	0 7	0 7	0 7	0 7	0 7	0 7	0 7	0 7
0 7	8 15	16 23	24 31	32-35 0 3	4 11	12 19	20 27	28 35

1st 36-bit word (8/8/8/8/4) — 2nd 36-bit word (4/8/8/8/8)

There are nine bytes per 72-bit word pair. The first 36-bit word is referred to as the 8/8/8/8/4 word, the second 36-bit word as the 4/8/8/8/8 word.

The bytes are transferred across the interface in the order Byte 0, Byte 1, . . . , Byte 8.

1.6.2 ASCII Data Transfer

The bytes are arranged in a 36-bit word as shown below:

0	BYTE 0 0 7	0	BYTE 1 0 7	0	BYTE 2 0 7	0	BYTE 3 0 7
0	1 8	9	10 17	18	19 26	27	28 35

Bits 0, 9, 18, and 27 of the 36-bit word do not appear on the PSI. They are not sent to the MPC during a write, and forced to 0 for storage in memory during a read.

1.7 OPTIONS

1.7.1 EUS Optional Functions

These options are under the control of the EUS operating system.

- Binary Addressing. The controller firmware shall provide for conversion of the contiguous binary address to cylinder, head and sector number for sector lengths of 64 words, 320 words and one sector per track.

1.7.2 Hardware Options

- Switched Channels
- Dual Channel
- 1-32 Drives
- Two Controllers

1.8 IMPLEMENTATION

1.8.1 DSS181

This EPS-1 covers both the DSS181, DSS190 and MSS450. Two lists are included here with references to the appropriate section to establish the differences in implementation requirements for the DSS181, DSS190 and MSS450.

1. The following list of capabilities are specified for the DSS190 and for future implementation on DSS181 when an update is defined.

    1) Automatic Alternate Track Handling

    2) Automatic End of Cylinder Handling

    3) Multiple EUS sharing a common data base (disk subsystem)

    4) Two devices types on one controller DSS181 and DSS190

    5) Read nonstandard size sector command

    6) Check character override (DSS181)

2. The following list of capabilities are specified for the DSS190 only.

    1) Block multiplexing and RPS.

    2) Error Detection and Correction (EDAC).

    For complete description of these capabilities refer to the controller EPS-1 (43A232230).

2. SYSTEM DESCRIPTION AND PERFORMANCE REQUIREMENTS

The subsystem uses a microprogrammed peripheral controller and removable media devices for performing data formatting, positioner control, data path switching, file protection, header search and associated functions required to reliable read and write data. Associated with the MPC are the link adapter for interfacing the controller to the EUS, and the controller adapter for interfacing the controller to the devices.

This EPS-1 describes the performance characteristics for the DSS181, DSS190 and MSS450 Removable Media Disk Subsystems. The principal difference in the use of the subsystems lies in the areas of capacity and addressing since the DSS190 and MSS450 have more sectors per track, more cylinders per pack and has 19 usable surfaces. The principal difference in performance characteristics lies in throughput, and data integrity. The DSS190 and MSS450 has block multiplexing, rotational position sensing, and error detection and correction. The MSS450 has two times the number of cylinders as the DSS190.

2.1 SUBSYSTEM CHARACTERISTICS AND CAPACITY

The DSS181 physical capacity for a single disk pack using double frequency recording and formatted 64 words (288 bytes) per sector is approximately 20.7 million bytes. Subsystem capacity based on the connectability of 32 on line devices is approximately 662.4 million bytes. The subsystem can be configured in many different ways to meet data availability and throughput requirements (refer to Section 2.1.4 for possible configurations).

The DSS190 physical capacity for a single disk pack formatted 320 words (1440 bytes) per sector is approximately 88.5 million bytes. Subsystem capacity based on the connectability of 32 on line devices is approximately 2.8 billion bytes.

The MSS450 physical capacity for a single disk pack formatted with High Efficiency Format (HEF) 64 words per sector is approximately 236 million characters.

2.1.1 Subsystem Characteristics and Capacity DSS181

The DSS181 subsystem will be a standard product offering for the 6000 line, and is an extension of the mass storage in-house development program.

Controller	MPC Microprogrammed Peripheral Controller
Controller Options	Single Channel Switch Channel Dual Channel Dual Simultaneous Redundant Controller
Devices/Controller	1 to 32
Capacity/Device	Refer to Table 2.1.2
Format	Sector sizes of 288, 1440 bytes and one sector per track.
Capacity/Subsystem	Refer to Table 2.1.2
Average Position Time	34 milliseconds
Average Latency Time	12.5 milliseconds
Removable Disk Pack	M4180 or equivalent
Transfer Rate	416KC nominal, 312K bytes nominal
Interface	NPL DLI

The maximum number of devices for the subsystem is 32, all of which may be on line to the EUS. However, it is not recommended that all 32 devices be on line in the user's production environment. Device availability requirements generally dictate that some number of on line devices be reserved as spares. (Refer to Section 2.2.5.).

2.1.1.1 Subsystem Characteristics and Capacity DSS190

The DSS190 subsystem is planned to provide a mass storage offering, competitive with IBM's 3330. The subsystem utilizes the MPC as a controller. Subsystem modularity will permit from 1 to 32 devices, all of which may be on line to the EUS. The DSS190 subsystem will accommodate both the purchased device 9754 from CDC and the NDM400. The device characteristics are the same, however; maintenance, T&D and construction are different. The purchased device will be designated DSS190A and the NDM400 will be designated DSS190B. Both devices will have the same software interface and will use the same device code.

Controller	MPC
Controller Options	Single Channel Dual Channel Switch Channels Dual Channel Redundant Controller
Devices/Controller	1 to 32
Capacity/Device	Refer to Table 2.1.2
Average Positioning Time	30 milliseconds
Format	Sector sizes of 288, 1440, 1152 bytes and one sector per track.
Average Latency	8.3 milliseconds
Removable Disk Pack	IBM 3336 or equivalent
Transfer Rate	806K bytes nominal

2.1.1.2 Subsystem Characteristics and Capacity DSS191

Controller	MPC
Controller Options	Single Channel Dual Channel Switch Channels Dual Channel Redundant Controller
Devices/Controller	1 to 32
Capacity/Device	Refer to Table 2.1.2
Average Positioning Time	30 milliseconds
Format	Sector sizes of 288 bytes
Average Latency	8.3 milliseconds
Removable Disk Pack	M4050
Transfer Rate	806K Bytes Nominal

2.1.1.3 Subsystem Characteristics and Capacity MSS450

The MSS450 subsystem is planned to provide a mass storage offering, competitive with IBM's 3330-II. The subsystem utilizes the MPC as a controller and MSU450 device. Subsystem modularity will permit from 1 to 32 devices, all of which may be on line to the EUS.

Controller	MPC
Controller Options	Single Channel Dual Channel Switch Channels Dual Channel Redundant Controller
Devices/Controller	1 to 32
Capacity/Device	Refer to Table 2.1.2
Average Positioning Time	30 milliseconds

Format	HEF 64 word sectors
Average Latency	8.3 milliseconds
Removable Disk Pack	M4450
Transfer Rate	806K Bytes Nominal

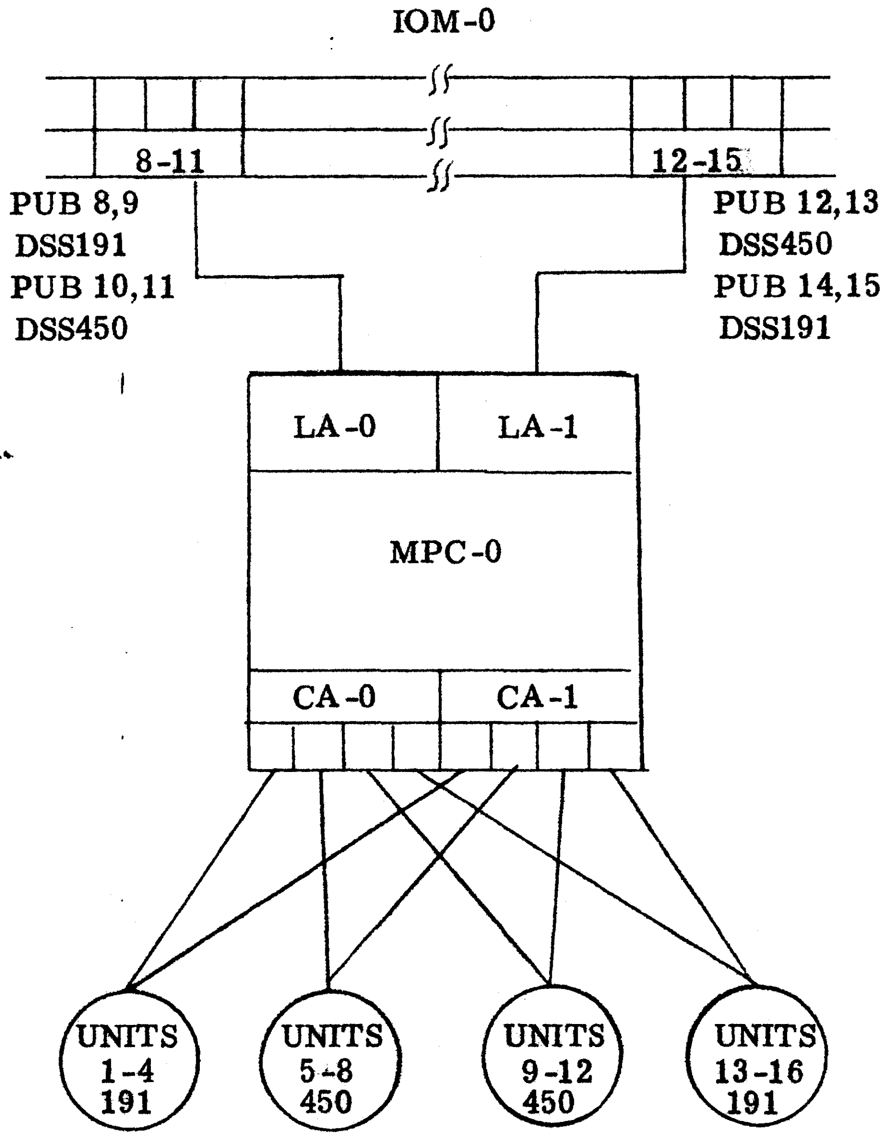
2.1.1.4 Mixed NDM400 and NDM450

The MSS450 subsystem shall have the capability of mixing NDM400 and NDM450 devices on the same controller. The DLI interface and EDAC and device status are the same. The difference is in addressable cylinders. The device type in the NDM450 shall use the High Efficiency Format (HEF, ICF, 191). All controller characteristics for the MSS450 shall be the same as the DSS191.

When mixed devices NDM400 and NDM450 are on the same controller both the 450 and 400 shall use the HEF format.

When mixed devices are configured the subsystem shall be configured as two subsystems to the system software. Each subsystem DSS450 and DSS191 shall be assigned separate logical channels.

When mixed devices are configured and the subsystems are used in a shared mass store environment each subsystem must have a logical channel zero defined for lock byte control.



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
GCOS	↓		↓	↑					↓	↓	↑					
T&D	↓		↓	↑					↓	↓	↑					

Figure 2.1.1.4a. 2x16 Subsystem

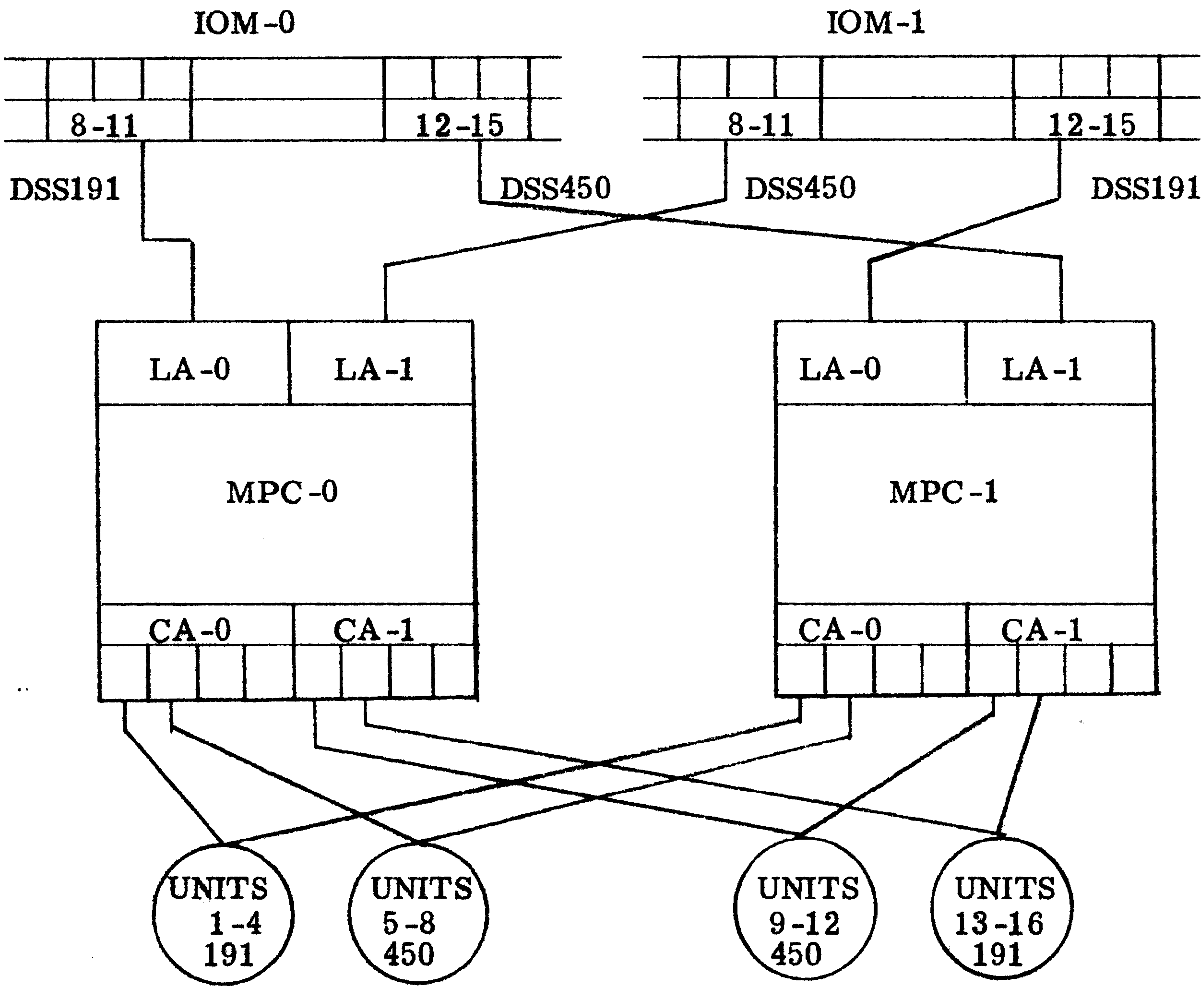
```
1      8          16
$      IOM-0      PUB-8,DISC*191,UNITS-8,NONSEQ
$      ETC        UNIT-1,NAME,UNIT-2,NAME,
         :        UNIT-3,NAME,UNIT-4,NAME,
         :        UNIT-13,NAME,UNIT-14,NAME,
$      ETC        UNIT-15,NAME,UNIT-16,NAME

$      XBAR       IOM-0,PUB-8,PUB-14,
$      ETC        IOM-0,PUB-9,PUB-15,

$      MPC-0      SIZE-4,PSI-0,IOM-0,PUB-8,PUB-9,PUB-10,PUB-11,
$      ETC        PSI-2,IOM-0,PUB-12,PUB-13,PUB-14,PUB-15

$      IOM-0      PUB-12,DISC*450,UNITS-8,NONSEQ
$      ETC        UNIT-5,NAME,UNIT-6,NAME,
         :        UNIT-7,NAME,UNIT-7,NAME,
         :        UNIT-9,NAME,UNIT-10,NAME,
$      ETC        UNIT-11,NAME,UNIT-12,NAME

3      XBAR       IOM-0,PUB-12,PUB-10,
                  IOM-0,PUB-12,PUB-11
```



MPC-0

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
GCOS	↓		↓	↓					↓	↓	↓					
T&D	↓															

MPC-1

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
GCOS	↓		↑	↑					↓	↓	↓					
T&D	↓															

Figure 2.1.1.4b. (2) 2x8 Subsystems
Suggested Configuration

```
1      8          16
$      IOM-0      PUB-8,DISC*191/190,UNITS-8,NONSEQ,
$      ETC        UNIT-1,NAME,UNIT-2,NAME,
         :        UNIT-3,NAME,UNIT-4,NAME,
         :        UNIT-13,NAME,UNIT-14,NAME,
$      ETC        UNIT-15,NAME,UNIT-16,NAME,

$      IOM-1      PUB-8,DISC*450,UNITS-7,NONSEQ,
$      ETC        UNIT-5,NAME,UNIT-6,NAME,
         :        UNIT-7,NAME,UNIT-8,NAME,
         :        UNIT-9,NAME,UNIT-10,NAME,
$      ETC        UNIT-11,NAME,UNIT-12,NAME

$      XBAR       IOM-0,PUB-8,IOM-1,PUB-12,
$      ETC        IOM-0,PUB-9,IOM-1,PUB-13,
$      ETC        IOM-0,PUB-10,IOM-1,PUB-14,
$      ETC        IOM-0,PUB-11,IOM-1,PUB-15

$      XBAR       IOM-1,PUB-8,IOM-0,PUB-12,
$      ETC        IOM-1,PUB-9,IOM-0,PUB-13,
$      ETC        IOM-1,PUB-10,IOM-9,PUB-14,
$      ETC        IOM-1,PUB-11,IOM-0,PUB-15

$      MPC-0      SIZE-4,PSI-0,IPM-0,PUB-8,PUB-9,PUB-10,PUB-11
$      ETC        PSI-2,IOM-1,PUB-8, PUB-9,PUB-12,PUB-11

$      MPC-1      SIZE-4,PSI-2,IOM-0,PUB-12,PUB-13,PUB-14,PUB-15
$      ETC        PSI-0,IOM-1,PUB-12,PUB-13,PUB-14,PUB-15
```

2.1.1.5 NDM400,NDM450 Interlock

An electrical interlock shall be provided in order to prevent reading or writing a NDM400 Pack (M4050) on the NDM450. The interlock shall be accomplished by changing the index decode in the NDM450. This will also prevent reading or writing an NDM450 pack (M4450) on the NDM400. If the wrong disk pack is placed on a device, a device fault will occur with detail device status of loss of index DS4 bit 2.

2.1.2 Device Capacity and Record Layout DSS181

Each device has a total of 203 cylinders. There are 203 tracks on each disk surface, and 20 heads per cylinder, for a total of 4060 tracks maximum. By convention, tracks on each disk surface are numbered from zero to 202, with 202 being the innermost track.

Cylinders are also numbered from zero to 202. Space allocation on the disk pack shall conform to the following:

- Cylinder 0 through 201 (4040 tracks); user data, systems labels, catalogs, alternate tracks, etc.
- Cylinder 202 (20 tracks); must be reserved for T&D use only.

2.1.3 Device Capacity and Record Layout DSS190

The track format is in sector lengths of 288, 1152, 1440 bytes and one sector per track.

Tracks per cylinder: 19

Cylinders per disk pack: 411

Cylinders 0-409: user data, catalogs, alternate tracks, etc.

Cylinder 410 (19 tracks): must be reserved for T&D use only

2.1.3.1 Device Capacity and Record Layout DSS191

The track format is in sector lengths of 288 bytes.

Sectors per track: 40

Tracks per cylinder: 19

Cylinders per disk pack: 411

Cylinders 0-409: user data, catalogs, alternate tracks, etc.

Cylinder 410 (19 tracks): must be reserved for T&D use only

2.1.3.2 Device Capacity and Record Layout MSS450

The track format is in sector lengths of 288 bytes.

Sectors per track: 40

Tracks per cylinder: 19

Cylinders per disk pack: 823

Cylinders 0-821: user data, catalogs, alternate tracks, etc.

Cylinder 822 (19 tracks): must be reserved for T&D use only.

Table 2.1.3
Device Capacity

	Bytes/ Sector	Sectors/ Track	Bytes/ Track	% of Full Capacity	Bytes/ Device $x 10^6$	Char/ Device $x 10^6$	No. of 36-Bit Words/ Sector	No. of 288 Byte Segments per Track
DSS181								
	288	18	5184	72%	20.7	27.6	64	18
	1440	4	5760	80%	23	30.7	320	20
	7200	1	7200	99%	28.8	38.4	1600	25
IBM	7249	1	7249	100%	29	38.6		
DSS190 Using IBM 3330 Formula								
	1440	8	11520	89%	88.5	118	320	40
	288	31	8928	69%	68.5	91.4	64	31
	12960	1	12960	99%	99.4	132.5	2880	45
IBM	13030	1	13030	100%	100	133.3		
DSS191 - DSS190 Using HEF								
	288	40	11520	89%	88.5	118	64	40
MSS450 Using HEF								
	288	40	11520	89%	177	236	64	40

Table 2.1.3
Device Capacity (cont.)

	Capacity/Subsystem Bytes				Capacity/Subsystem Char.				Char. per Sector	Char. per Cylinder
DSS181	1 Device	8 Devices	16 Devices	32 Devices	1 Device	8 Devices	16 Devices	32 Devices		
288				662.4 x 10^6				880 x 10^6	384	
1440				736 x 10^6					1920	
7200				921.6 x 10^6						
DSS190										
1440	88.5 x 10^6	708 x 10^6		2832 x 10^6					1920	
288	68.5 x 10^6	548 x 10^6		2192 x 10^6					384	
12960	99.4 x 10^6	795 x 10^6		3.18 x 10^9						
DSS191 HEF					118 x 10^6	944 x 10^6	1888 x 10^6	3.77 x 10^9	384	
DSS450 HEF					236 x 10^6	1888 x 10^6	3.77 x 10^9	7.55 x 10^9	384	

2.1.4 Configurations

Figures 2.1.4.1 through Figure 2.1.4.15 are block diagrams showing different configurations. Figure 2.1.4.3 is a block diagram showing a single controller, two link adapter channels (primary channel plus additional switched data channel).

1. One controller switch channel 1*1*16
2. One controller single channel 1*1*32
3. One controller single channel 1*1*32 (1SW)
4. One controller two channels, limited simultaneity, no crossbar, 16 devices on each channel 1*(1*16)(1*16)
5. One controller two channels, limited simultaneity, limited crossbar, 32 drives 1*2*32
6. One controller dual channel crossbar, full simultaneity 1x2x8
7. One controller dual channel crossbar, full simultaneity 1x2x16
8. One controller dual channel crossbar, full simultaneity, switch channel 1x2x16 (1SW)
9. One controller dual channel crossbar, full simultaneity, two switch channels, 1x2x16 (2SW)
10. Two controller dual channel full crossbar, 2x2x16
11. Two controller dual channel full crossbar, two levels of simultaneity, 2x2x32
12. Two controller dual channel full crossbar, full simultaneity, 2x2x32 (2SW)

13. Two controller four channels, two dual channel crossbar, 2*(2x8)(2x8)

14. Two controller four channels, two dual channel crossbar, 2*(2x16)(2x16)

15. Two controller four channels full dual crossbar, limited four channel simultaneity, 2x4*32 (4SW)

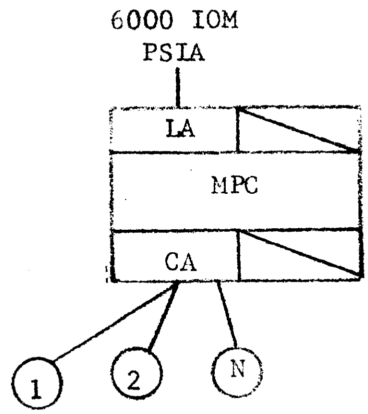
(*) means not crossbarred

(x) means crossbarred

Nomenclature

1x1xN (1SW)

Controller — Channel — Devices — Switched Channel



(*)means not crossbarred
(x)means crossbarred

Figure 2.1.4.1 1*1*N Configuration N ≤ 16

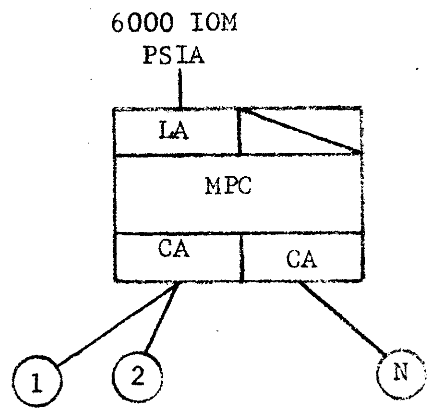


Figure 2.1.4.2 1*1*N Configuration N ≤ 32

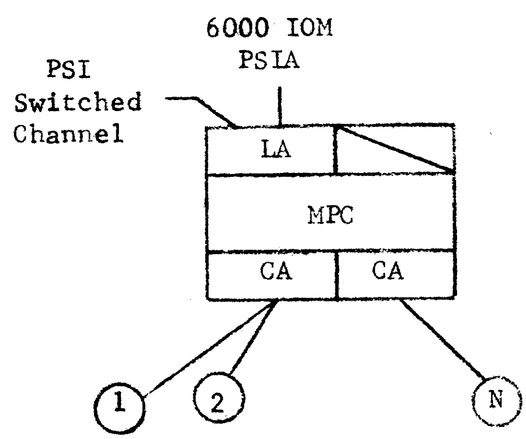


Figure 2.1.4.3 1*1*N (1SW) Configuration N ≤ 32
Plus Switched Channel

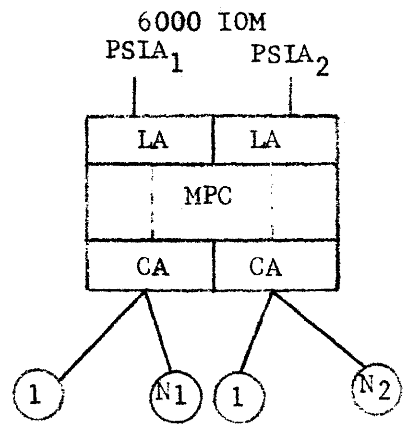


Figure 2.1.4.4 $1*(1*N_1)(1*N_2)$ Configuration $N_1, N_2 \leq 16$

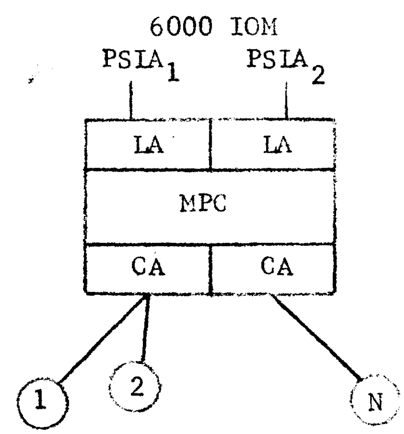


Figure 2.1.4.5 1*2*N Configuration $N \leq 32$

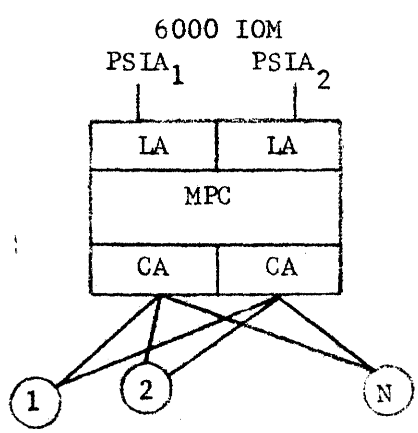


Figure 2.1.4.6 1x2xN Configuration $N \leq 8$

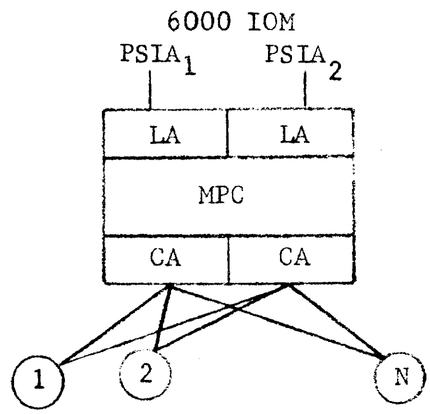


Figure 2.1.4.7 1x2xN Configuration N $\leq$ 16

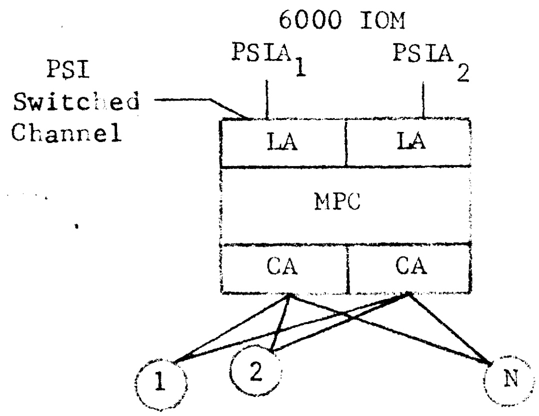


Figure 2.1.4.8 1x2xN (1SW) Mass Store Link Configuration N $\leq$ 16

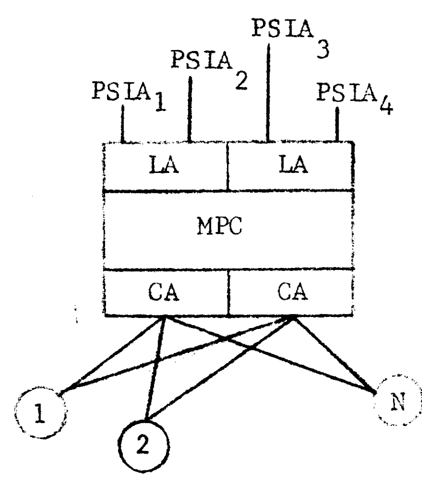


Figure 2.1.4.9 1x2xN (2SW) Configuration N $\leq$ 16

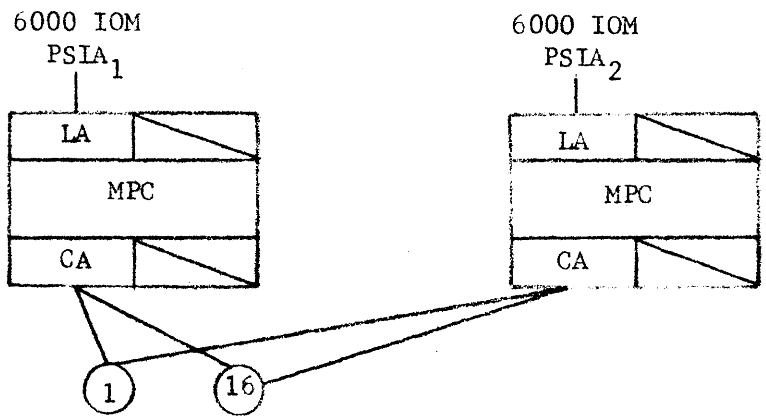


Figure 2.1.4.10 2x2xN Configuration N ≤ 16

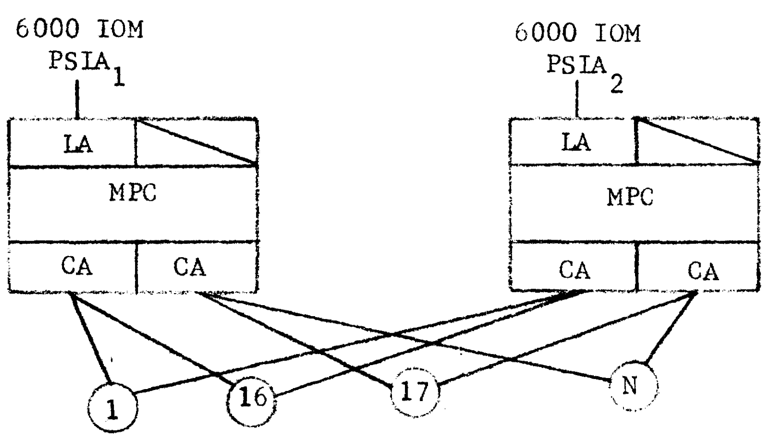


Figure 2.1.4.11 2x2xN Configuration N ≤ 32

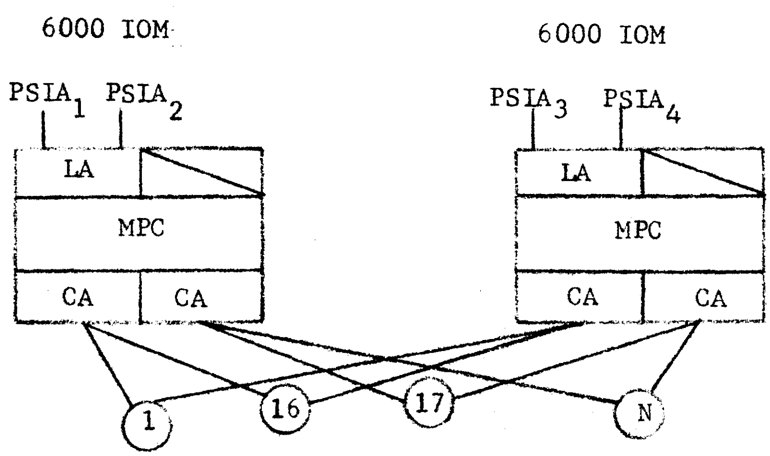


Figure 2.1.4.12 2x2xN (2SW) Configuration N ≤ 32

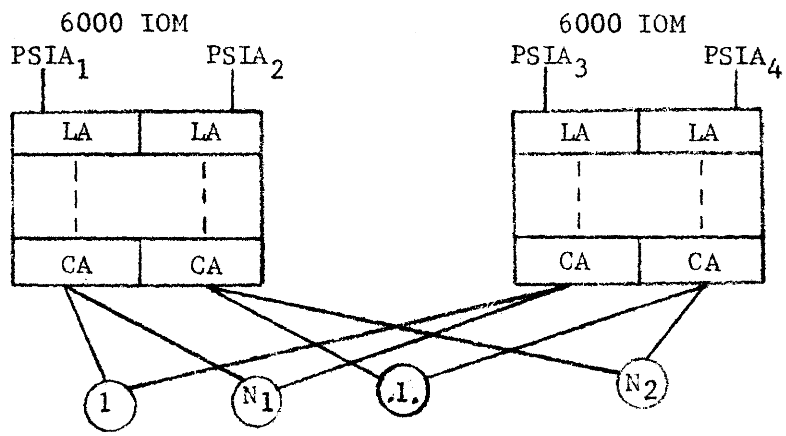


Figure 2.1.4.13 $2*(2xN_1)(2xN_2)$ Configuration $N_1, N_2 \leq 8$

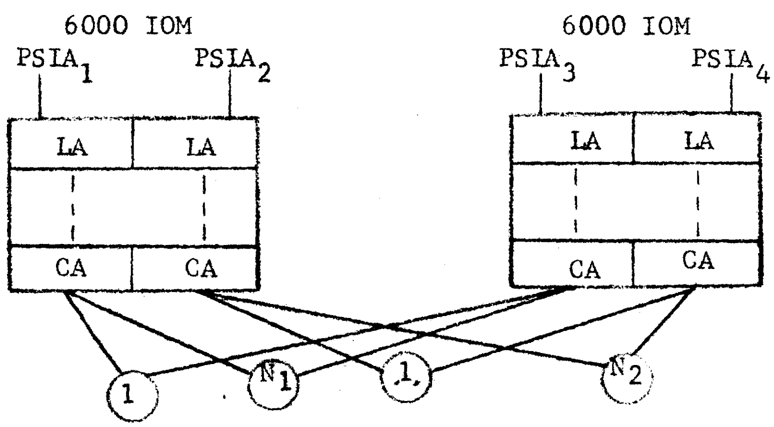


Figure 2.1.4.14 $2*(2xN_1)(2xN_2)$ Configuration $N_1, N_2 \leq 16$

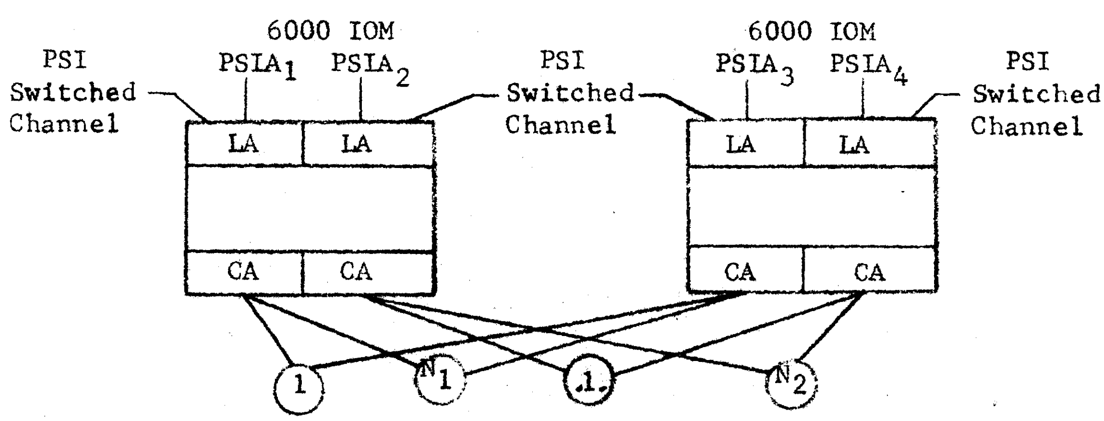


Figure 2.1.4.15 2x4*N (4SW) Maximum Configuration $N \leq 32$

2.1.4.1 Standard Configuration

The DSS181 shall have two logical channels for each physical PSI channel.

The DSS190 and MSS450 shall have four logical channels for each physical PSI channel. The DSS190 may have eight logical channels for each physical PSI channel as a special.

The DSS181, DSS190 and MSS450 may have a physical channel configured with only one logical channel. However, the performance will be reduced on those physical channels which have only one logical channel.

The normal recommended configurations include one device designated as spare.

- One Controller Single Channel
  Basic 1*1*16 Figure 2.1.4.1
- One Controller Dual Channel Crossbar
  Basic 1x2x16 Figure 2.1.4.7
- Two Controllers Dual Channel Crossbar
  Basic 2x2x32 Figure 2.1.4.11
- Two Controllers Dual Channel Crossbar plus Switched Channels
  Basic 2x2x32 (2SW) Figure 2.1.4.12
- Two Subsystems, Four Channels Two Dual Channel Crossbar
  Basic 2*(2x16)(2x16) Figure 2.1.4.14
- One Controller Switched Channels Mass Store Link
  Basic 1x2x16 (2SW) Figure 2.1.4.9

2.1.4.2 Field Upgrade

Subsystems may be upgraded in the field starting with the basic single channel up through all the standard configurations by the addition of switch option on LAs, dual port option in devices, CAs, LAs and devices.

2.2 THROUGHPUT AND SIMULTANEITY

Each physical channel (link adapter and controller adapter combination) shall be capable of accommodating a throughput of 900 x 10^3 bytes per second. Each controller (MPC) shall be capable of handling two (CA and LA) adapters with simultaneous data transfers. A subsystem with two controllers shall be capable of handling four physical channels with simultaneous data transfers.

2.2.1 Access Time

The DSU181 drives will have a rotational speed of 2400 RPM for an average latency of 12.5 milliseconds. Rotational tolerance shall not exceed ±2 percent. The DSU190 and MSU450 will have a rotational speed of 3600 RPM for an average latency of 8.3 milliseconds.

The DSU181 drives will have a maximum positioning time (track to track) of 10 milliseconds, maximum positioning time (track 000 to track 200) of 60 milliseconds and an average of 34 milliseconds.

The DSU190 and MSU450 will have a maximum positioning time (track to track) of 5 milliseconds, maximum positioning time (DSS190 track 000 to track 404) (MSS450 track 000 to track 822) of 45 milliseconds and an average of 25 milliseconds.

DSS181: Average data access time (including data transfer) For reference, an average data transfer of 320 words (1440 bytes) has been used. A data transfer of five sectors requires approximately 6.9 milliseconds. Therefore, average data access time shall be approximately 53.4 (34 + 12.5 + 6.9) milliseconds.

2.2.2 Seek Overlap

The subsystem shall be capable of accepting and executing simultaneously up to 32 seek positioning commands (preseeks), i.e., one positioning command for each device on the subsystem. Maximum utilization of overlapped seeks with minimum software overhead will be provided by preseeks and a seek complete register that provides seek status on a per device basis.

The controller will provide the ability to accept one additional seek/data transfer command pair for a device after a preseek has been issued. Proper use of this feature by system software can increase throughput but improper use will decrease subsystem throughput. Block multiplexing (Section 2.2.7) will provide the ability to accept eight additional seek/data transfer command pairs on each physical channel (PSI).

2.2.3 Transfer Rate

	TRANSFER RATE
DSU181	312K bytes/second, 416K characters per second
DSU190 and MSU450	806K bytes/second, 1074 characters per second

2.2.4 Configurations for Additional Throughput and Connectability

2.2.4.1 System Interfaces and Access

Figure 2.2.4.1 is a block diagram of a EUS System. A single character may have two simultaneous channels and two switched channels allowing multiple channels of a 6000 or a DATANET 355 to have simultaneous or alternate access to the Disk File Subsystem. Access by the 6000 is via the IOM (Input/Output Multiplexor). When high data availability is required, a second controller may be used to provide an independent data path to the storage units. Consistent with this second controller, the two data paths to all drives must be electrically independent.

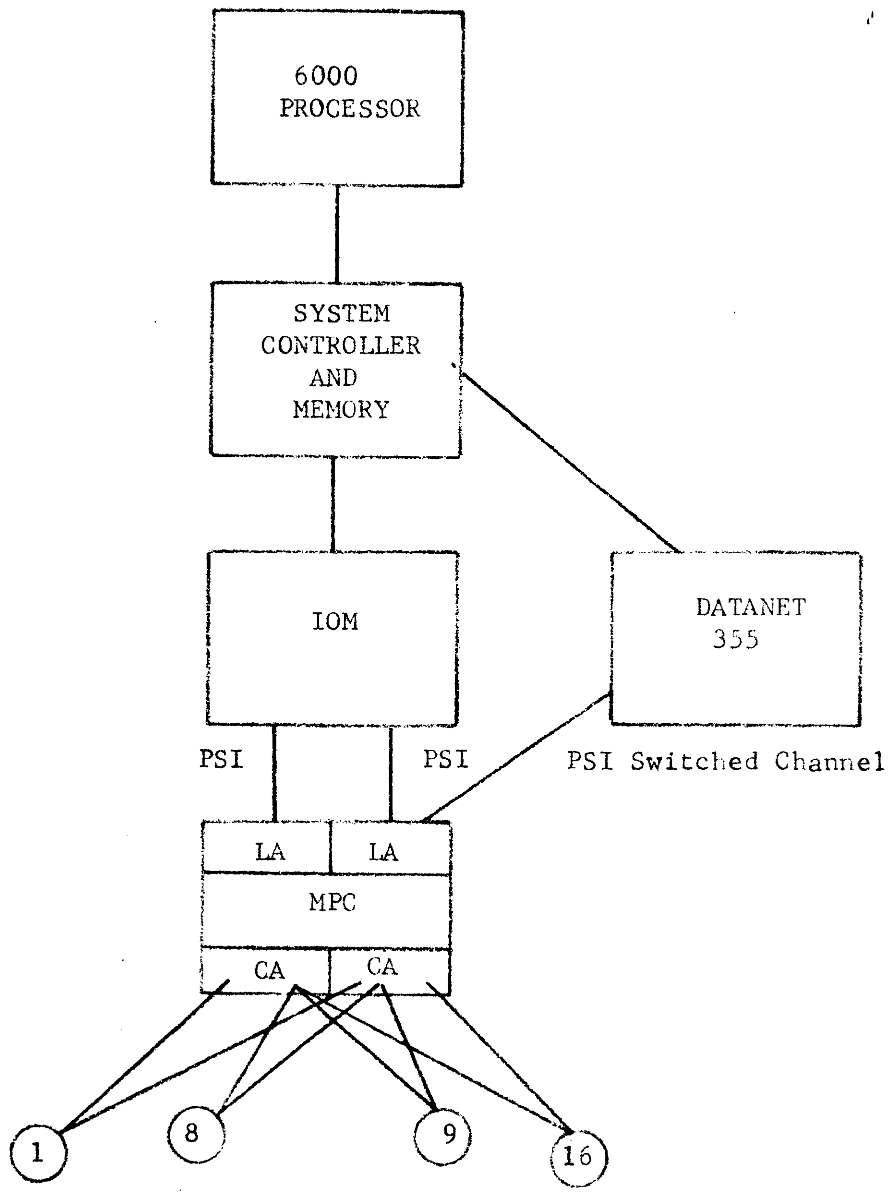


Figure 2.2.4.1 6000 System With Dual Channel and Mass Store Link

Additional drives may be added to the basic controller to complete a full 32-drive subsystem. Spare drives may be designated within the above configurations as required by the customer's applications.

2.2.4.2 Dual Channel

A subsystem with one MPC shall have the capability of handling dual simultaneous data transfers between two EUS channels and two devices. A subsystem with two MPC's shall have the capability of handling four simultaneous data transfers between four EUS channels and four devices. (Refer to Figure 2.1.4.14.)

2.2.4.3 Switch Channels

Each primary EUS channel may have one nonsimultaneous switched channel that shares the data transfer path to the devices.

The controller will be able to service up to two switched EUS channels in addition to the two primary EUS channels. At any given time the controller can provide dual, simultaneous data transfer to two EUS channels (a primary channel and its associated switched channels may transmit only one at a time). Requests from the alternate channel when one channel of the pair is busy, will be held until the channel is free.

2.2.4.3.1 Mass Store Link is an Application of the Switched Channel

Software will be provided in the DATANET 355 communications processor and in the 6000 to permit sharing of allocated file space on mass storage via a direct hardware link. This hardware link will be provided by a switched channel Link Adapter or dual channel Link Adapter. Initial implementation may be limited to dedicated space, external to the file system, on the DSS181 subsystem. This link will be utilized to store remote job input and output files. The subsystem must support multiple communication processors.

The purpose of the link is twofold:

a) It provides the means by which remote terminals may continue I/O through the communication processor(s) when the Central System is down but the mass storage subsystem is operational.

b) It provides for more efficient utilization of system resources, since communications data for mass storage will not be required to pass through the Central System.

2.2.5 Availability

A number of applications, especially in the service business, require that a high degree of data availability be provided. Consistent with this requirement, it shall be possible to configure the subsystem with two controllers and two port access at the devices such that the largest portion of the disk subsystem that is unavailable due to a single component failure shall be configured to a single drive and its associated switch. Further, it shall be possible to test and repair a single drive unit while the rest of the subsystem is on line. (This includes turning power off and on for a malfunctioning device without interferring with the operation of the remaining on line devices.) Availability is dependent upon the ability to remove a disk pack from a device that has failed and exchange packs with a spare drive and continue operation. All on line devides are addressable by the EUS. It is a requirement of this subsystem that a device be reserved from allocation (designated as spare) so that the exchange function can be performed. Refer to Controller EPS-1, 43A232230, Section 5.4.

2.2.6 Block Multiplexing (BM) DSS190 and MSS450

Block multiplexing on the PSI I/O channel of the IOM provides a facility for the subsystem to disconnect from a logical channel after an operation has been started such as a seek/data transfer sequence and to reconnect the logical channel when the device is ready to begin a data transfer.

This allows up to eight I/O requests (one per device) to be multiplexed under the control of the subsystem using eight logical I/O channels over a single physical channel.

Command stacking is the facility whereby the subsystem will accept and store up to one command sequence per device or up to eight command sequences per I/O channel. This capability when used with rotational position sensing allows the subsystem to service a greater number of I/O requests.

The controller will do latency reduction and change the logical channel number so that the correct DCW can be accessed in the IOM when data transfer starts. Each seek read/write pair will be a different logical channel number. The lowest logical channel number will have the highest priority from the physical channel to the controller. A Command Extension Modifier can be set in the IDCW to notify the controller to take a particuar command first and bypass latency reduction.

2.2.7 Rotational Position Sensing (RPS) DSS190 and MSS450

Rotational Position Sensing is the facility whereby the subsystem controller may determine the angular position of each disk pack on the subsystem. Knowing the angular position of the stored data and the outstanding data requests in the command stack the controller can determine the order for completing these requests.

The controller will select the device and read the relative angular position of the read/write head with reference to Index Mark. The controller can then calculate the latency remaining until the desired sector will be under the read/write head. This information will be used by the Block Multiplexing function to select the logical channel and device which will transfer data.

Relationship between Block Multiplexing, Command Stacking, and RPS for effecting an increase in subsystem throughput.

As the system generates a queue of I/O requests, these requests can be issued to the subsystem up to a maximum of one request per device and up to eight requests per physical I/O channel. A request in the form of a preseek command or a seek/read/write command sequence will be retained (command stacked) in the subsystem controller. Once a command(s) are received the physical I/O channel is immediately released and will not be reconnected until data transfer is ready to take place. The controller will monitor the angular position and determine the sequence for servicing the I/O requests. When a data field is about to come under the recording head of the disk, the controller will reconnect the logical channel for the I/O data transfer that is about to take place. By keeping the transfer channel free until an actual data transfer is to take place the channel will be used more efficiently, thereby greatly increasing throughput.

When block multiplexing is used together with Rotational Position Sensing and Command Stacking, approximately a 50 percent improvement in performance is realized on a single channel subsystem.

2.3 DATA INTEGRITY

2.3.1 Error Recovery

2.3.1.1 Retry

Seek and data transfer read/write commands will be accepted in pairs by the controller. Seek addresses will be held in the controller so that retries can be done by executing the current command again and retransmitting the data.

2.3.1.2 Recovery Techniques

The ultimate failure of any subsystem component cannot be forever avoided. Therefore, the primary objective is to keep the data available and avoid permanent loss of user files. Alternate data paths and the spare drive philosophy along with controller automatic retry and error detection and correction will be used to keep the data available.

A preferable objective of "recovery", however, would be the prevention of failures by means of the diagnosis of impending failure. Although this objective will probably never be fully achieved, the subsystem will be capable of accumulating statistical data on its operations which may well indicate impending problems.

2.3.1.3 Error Detection and Correction (EDAC) DSS190 and MSS450

All fields of information will be supplemented with seven bytes redundancy to allow for correction of any single burst-error of length 11 bits or less. A high percentage of noncorrectable errors will be detected as well.

The encloding of information will be done via a cyclic code. The basic generator in the CA will provide the encoding for all information fields. The generator hardware will also serve as the checker for verification of read information and will have the capability of identifying the location and error pattern of any error within the correctable error range. The error identification provided by this hardware will be used for computation of error displacement. The error pattern will be three bytes of information with logical ones representing the bits in error. The error identification and error pattern will be sent to the EUS so that the EUS can modify the data previously read in error (refer to Section 5.8.4 of Controller EPS-1, 43A232230).

2.3.1.4 Adjustment on Retry DSS190 and MSS450

The disk unit shall have the capability of accepting control signals from the controller to fine position the head in reference to center track position in reference to the data. This feature will be used on read retries when errors have occurred. This feature will also be used when pack interchange is done and the drives may not be aligned exactly the same.

2.3.2 Protection

2.3.2.1 Write Protect

The device operators panel shall be equipped with a facility which will permit the operator to write inhibit the device. In that protect or write inhibited mode, the device will not permit write or erase current to flow through any of the read/write transducers. In the protect mode, the device will permit reading of a disk pack to take place.

In the event that a device, which has been placed in the protect mode, is selected for a write operation, the device shall detect an error condition and will so reflect this condition to the controller.

2.3.2.2 Error Detection Features

The following features will be incorporated into the subsystem design:

- Parity check on all data transmitted from the EUS to the subsystem.
- Generate parity on all data transmission to the EUS.
- Check on proper instruction sequence, device code, and operation codes.
- Check bytes shall be generated on each field recorded on a disk. On readback, new check bytes shall be generated and compared against the previously recorded check bytes.
- Write and compare instruction that automatically reads the data after being written to verify that the data was written correctly.
- Transmission timing checks.
- Data block address (cylinder, head and sector address) confirmation on all blocks read or written.
- Command and address verification (sumchecks).

The following error detection features will be incorporated into the MPC.

- Byte parity is carried and checked on all data transfers and data storage within the MPC.
- Byte parity is carried on all microinstructions in Control Store, and is checked as microinstructions are pulled from Control Store.
- The arithmetic function network is duplicated, and the results of each network are compared for equality. Parity on the result is generated.

- Byte parity is carried on all data and control busses to the Internal Adapter Interface, and checked on all data and control busses from the Internal Adapter Interface.

- Byte parity is carried on all address and data transfers to read/write memory, and checked on all data transfers from read/write memory.

- Interval Timer is checked for reloading following runout.

- Detection is made of attempted access to non-existent Control Store.

- A timeout is made on all asynchronous operations which involve waiting for an external signal, and on all microinstruction executions. This includes waiting for an RPI signal from the Internal Adapter Interface during a DAI microinstruction; and waiting for a response from R/W memory during a memory microinstruction. The duration of this timeout will be determined during design, but will be no less than 8 microseconds and no more than 20 microseconds.

All error detections result in an Error Interrupt. At the time the Error Interrupt is generated the Error Data Register will be set to indicate the specific error causing the interrupt. Refer to the Controller EPS-1, 43A232230, Section 5.8.1.

2.3.2.3 Shared Access Control

Access Control and Data Protection:

When multiple access channels are provided to a common data base from more than a single computer system, data protection and security must be provided to assure that files are unavailable to alternate channels during update operations. Refer to Controller EPS-1, 43A232230, Section 5.4.5.

2.3.2.4 Device Fault Conditions

When an fault condition is detected, the FLT (Device Fault Line) is raised which indicates a device detected failure. The firmware has the responsibility to obtain summary status and any detailed status from the device to determine the fault condition.

The FLT status line indicates to the CA that the device selected has one or more of several faults. When this line is true and one of the five non-resettable fault conditions is true, the device will not perform any further operations until the fault condition is resolved. Refer to the Controller, EPS-1, 43A232230, Section 3.15.

2.3.3 Disk Pack Care and Media Characteristics

2.3.3.1 Care and Handling

High data availability to the customer also requires proper care and handling of the disk packs by the operator. Currently, FED is preparing a field memo designed to fulfill this need. In the interim, refer to the IBM SRL for 2316 disk packs, Form No. A26-5756-6.

Storage, Acclimatization, and Labeling of Disk Packs

The following information summarizes the major points of the aforementioned documents and is not intended to substitute for these documents.

Disk packs should not be stored in areas exposed to magnetic fields as stored data can be destroyed. For high security storage, the same precautions used for magnetic tape or microfilm record storage should be observed.

Computer room temperatures are best for disk pack storage as a pack expands or contracts with temperature change. If packs are stored at temperatures of less than 60 degrees or more than 90 degrees, they should be acclimatized to computer room temperature for two hours to prevent a loss of data due to shifts of tack location caused by thermal expansion or contraction of the metallic disk.

Affixing of disk labels on a pack can affect its dynamic balance. For this reason, no labels should be placed upon a pack. Labels should be placed on the plastic canister supplied with each disk pack. When a pack is mounted on a device, its canister should be stored with reference to the device number which has the pack mounted on it. Cross-reference of disk pack serial numbers on both pack and canister should be maintained. Such a discipline will ensure that the original and updated flagging information remains with the pack.

2.3.3.2 Media Characteristics; Effects on GCOS

The intent of the following information is to provide software and operation's personnel with a better understanding of removable media disk storage subsystems.

a) What "Certification" Means

The removable disk packs required for DSS181 operation are supply items which are available as type number M4180. Similar packs are also available from other vendors. All packs are tested on a disk pack tester prior to shipment to locate "bad" or marginal tracks. This information is provided to the user by most vendors on an external label which is glued to the bottom of the pack canister.

This company is one of the vendors that provides identification data to the user on the location of tracks which are deemed marginal for pack interchangeability purposes across spindles. Marginal tracks are also defined as tracks containing oxide areas which are likely to degrade over a period of time; i.e., several months. Note that marginal tracks will appear to be good, but only during an initial period. Therefore, from an operations point of view, marginal tracks are always treated as "bad" tracks. The test criteria used reflects mechanical and electrical extremees in both disk packs and disk drives. A safety margin is included in the test limits. Currently, no disk pack vendor ships "error free" packs using this stringent criteria. SA B-021 (issued 11-14-68) provides an excellent description of DCT170 packs. These packs are supplied by vendors who have demonstrated excellent substrate processing controls. They are then certified on a tester which is a recognized standard of the industry. Other vendors have procured pack testers from this company and now possess the capability of certifying packs to our standards.

Analysis of track errors in tests show that competitive disk packs very significantly from vendor to vendor and in general higher quality units cost more. This fact, plus a careful weighing of the costs of extra recovery and rerun processing time justifies the procurement of higher quality packs, and outweighs the initial savings provided in buying inferior packs.

While there should be no blanket prohibition against a customer's using competitive disk packs, Sales representatives should make their customers aware of the equipment warranty implications discussed in SA B-021 (issued 11-14-68) when this situation occurs.

b) H6000 Requirements for Good Tracks on DSS181 Disk Packs

- Disk Pack Label

  For anything but a 'stranger' Pack, Cylinder 199, Head 19 must be good.

- Structured Device Catalog

  For a Pack to be structured, LLINKS 0 thru 35 must be good. (Cylinder 0, Head 0 thru 9.) (Bare minimum, no perm files can be created on this pack.)

- Perm File Catalog

  For Perm Files to be created on a pack, LLINKS 0 thru 359 must be good. (Cylinder 0 thru 5, Head 0 thru 19.)

c) Media Deterioration

Pack switching allows computer room air, with its dust particles, to settle on disk pack recording surfaces. Occasionally, some of these particles will get between the head and pack recording surface. As the recording surface is softer, these particles will scratch it and thus increase error conditions. It has been observed that disk packs deteriorate slowly after six to twelve months of hard usage because of these scratches.

Momentary contact of heads and recording surface is normal when loading/unloading heads in removable mass storage subsystems. Therefore, surface marking on pack recording surfaces can be ignored, unless accompanied by operational problems.

d) Recoverable Read Errors

Information recorded on disk packs may not be recovered completely as a result of such things as prolonged media degradation, head crashes, or magnetic field exposure.

While the rate of media degradation is unpredictable, it will evidence itself in the form of an increasing rate of recoverable errors. This data is made available to operations and maintenance personnel on a daily basis via a GESEP routine to collect statistics on errors. This information can be used to evaluate deteriorating device or media performance, especially in conjunction with disk certification data.

In the present system, when a read error occurs, the operator is presented the "R" (Retry) option which directs the computer to retry the operation. By noting the results of "R" option usage a log of recoverable read errors should be established to evaluate deteriorating performance trends.

Before such recoverable errors become non-recoverable, it would be desirable if the suspect track could be declared defective and its data relocated to an alternate track. If more than a single error occurs within a one week period on a single track, it is recommended that the entire pack should be copied onto another preformatted pack, or user file space should be redistributed on the disk pack and the track removed from software tables defining available storage space.

e) Non-Recoverable Read Errors

When a non-recoverable read error occurs, the data should not be relocated to an alternate track by the GCOS-GPR routine, nor should the track be flagged defective by GPR. Data should be restored to the User file or files affected by a File Restore or similar type Utility program.

Consider the following:

Given that a non-recoverable read error occurred and GPR relocated the data on that track to an alternate track; then both "good" and "bad" sectors would be located on the alternate. Furthermore, in the process of rewriting the bad sector on the alternate track, a valid check character would be generated for the originally "bad" data sector. Therefore, the Data Integrity of the User file has been violated but the User (and GPR) can no longer detect the "bad" data sector.

An alternative of immediate use is to move the disk pack to another drive in order to attempt recovery of the data. This procedure requires changing packs and retrying the operation. If this procedure fails, the job should be aborted and the pack or User file reconstructed.

f) Write Errors

It is possible to get header verification failures or check word alerts during the writing process. As no user data has been written yet in these cases, the usage of an option to assign an alternate track is a recommended solution dependent upon "r" option results as mentioned in paragraph "c."

Consistent with other 6000 line mass storage subsystems (and the rest of the industry), no echo checking of the data written on the media surface is provided as is done in magnetic tape subsystems.

g) System Modules on Alternate Tracks

Alternate track processing using cylinders 200 and 201 is obviously slower than primary track processing. If system software resides on a disk pack where alternate tracks contain frequently accessed System information, System performance could be significantly affected.

It would be prudent, therefore, to always use the "best" disk packs for storing System software.

h) Retain "Bad" Track Information

Certification information ("bad" and/or marginal track locations) must be preserved at the customer site. If, over a period of time, more "bad" and/or marginal tracks develop, this information must also be preserved. It is recommended that some form of file (other than a stick-on label on the disk pack canister) be implemented at each site which identifies each disk pack (e.g., by serial number) and lists its "bad" or marginal tracks.

2.3.3.3 Disk Pack Use by T&D

T&D programs and test pages shall be designed to function with (User) formatted customer disk packs or CE packs. These disk packs fall into the following three general categories:

- GCOS disk packs; where the User data areas cannot be altered. Disk packs may be "structured" or "non-structured."
- "Scratch" GCOS disk packs, where the User data areas can be altered. Disk packs may be "structured" or "non-structured."
- Field Engineer Pack (CE Pack).

a) Common T&D Constraints for both types of disk packs

T&D programs shall be designed to not write (or otherwise destroy) disk packs labels, space allocation tables, catalog and file areas for both structured (and non-structured) GCOS III disk packs.

In addition, T&D shall restrict format type operations to cylinder 202 only, in order to ensure that track indicators are not inadvertently altered in User data areas.

T&D programs shall not execute write commands directed to alternate track areas (cylinders 200 and 201).

Cylinder 202 on all disk packs is dedicated solely for T&D use. Customer files and GCOS files shall not be stored on this cylinder.

If the T&D program cannot determine the location of a user data area on a non-structured disk pack; then the T&D program shall limit write operations to cylinder 202.

T&D programs shall be required to perform a validity check of the disk pack label before executing any write or format commands.

b) "Scratch" GCOS Disk packs

By definition, User data areas of a "scratch disk pack" can be altered or destroyed provided that the program complies with the constraints specified in paragraph (a) above. Therefore, T&D shall be permitted to execute write commands directed to User data areas if it is advantageous to do so.

GCOS shall allow T&D to execute read commands directed to all areas of the disk pack, including label and catalog areas.

c) GCOS Disk Packs

By definition, user data areas cannot be altered or destroyed by T&D programs. The constraints specified in paragraph (b) above also shall be complied with.

Therefore, T&D shall be permitted to execute write commands directed to cylinder 202 only.

GCOS shall allow T&D to execute read commands directed to all areas of the disk pack, including label and catalog areas.

d) Blank (Unformatted) or Stranger Disk Packs

T&D programs shall assume they are operating on a disk pack which has been formatted previously by the 6000 line system under GCOS III.

e) Field Engineering Pack (CE Pack)

T&D programs shall be permitted to use (execute read or write commands) cylinders on the CE pack.

2.3.4 Media Certification M4450

M4450 disk packs shall be certified at 400 tracks per inch in accordance with Disk Pack Purchase Specification M4450

All errors shall be identified on Atlas Track Label 74009057-002.

The letter "U" shall precede incorrectable errors and the letter "C" shall precede correctable errors. The label chall be attached to the inside of the bottom plastic disk pack cover.

The errors shall be identified by CC (cylinder number) HH (head number) and angular position of the defect. The angular position shall be in 128 increments around the track.

3. NPL AREA OBJECTIVES

The design of the controller hardware (MPC, LA, CA) excluding control microprograms, shall not preclude accomplishing NPL functions. New Control Store Microprograms would be required to handle the native mode commands and format. This capability applies only to the Subsystem connected to an H-6000 or "F" processor and H-6000 devices using the H-6000 PSI interface. Media interchange of NDM400 Disk Packs will be restricted to single channel operation in one controller. Dual Channel operation may be provided by two controller subsystems.

4. SUBSYSTEM COMPONENTS

4.1 CONTROLLER (MPC)

The controller shall be a microprogrammed controller and will use the basic (MPC) microprogrammed peripheral controller which will perform the control functions, a standard Link Adapter to interface the EUS and a personalized Controller Adapter to interface the devices.

The controller will accept macro type commands (seek, read, write, etc.) from the EUS and will issue the necessary micro type commands (load registers) to the devices via the CA. Control firmware will also obtain status from the devices and return the appropriate status to the EUS as specified in the DSC181/DSC190 Controller EPS-1.

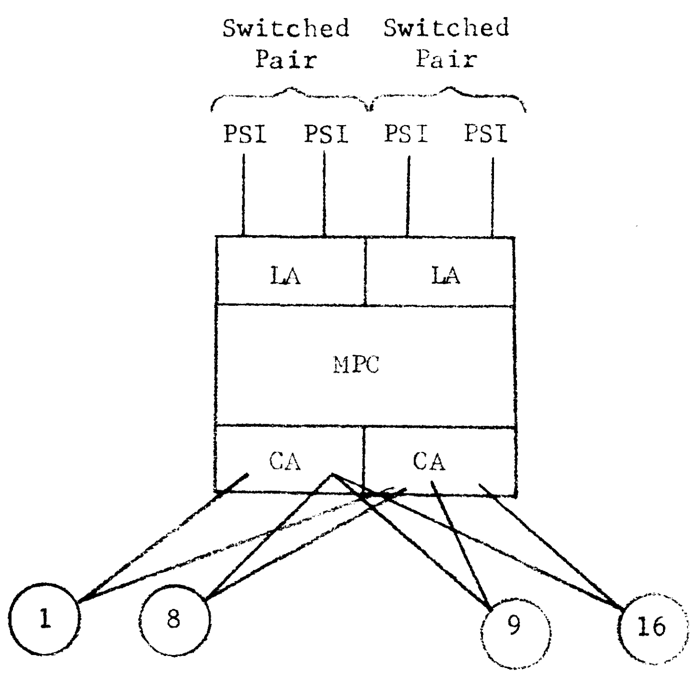


Figure 4.1

4.1.1 Basic MPC

The basic MPC is defined in the Microprogrammed Peripheral Controller (EPS-1 43A177875) (MPC) including its performance, functional capabilities, interface requirements, and general design requirements.

The MPC is the basic control element used in peripheral controller configurations. As shown in Figure 4.1, a peripheral controller configuration consists of the basic MPC and one or two Controller Adapters and one or two Link Adapters.

The MPC is a general purpose, register-to-register microinstruction processor. Its basic elements are a Control Store, Read/Write Memory, and a processing structure. By means of microinstructions which reside in the Control Store, the MPC can be microprogrammed to manipulate data between registers within the MPC, between registers and local MPC R/W Memory, and between registers and adapters. The Controller Adapter consists of the specialized logic and circuitry required for the control of a specific peripheral device(s).

The Link Adapter consists of the required logic and interface circuits to connect to a central system.

Connectability

The MPC will provide interfaces for four adapter ports. The configurations for DSS181 and DSS190 controllers shall be 1 or 2 Link Adapters and 1 or 2 Controller Adapters.

Dedicated High-Speed Device Control

The MPC will sustain a maximum burst transfer rate of 2.0 megabytes from a single, high-speed device. In this mode, data is transferred two bytes at a time, under microprogram control, between a Link Adapter and a Controller Adapter, with each two-byte transfer passing through an MPC hardware accumulator.

Two Simultaneous High-Speed Data Transfers

In this mode, the MPC will sustain simultaneous high-speed data transfers from two devices. The maximum data rate which can be controlled in this mode is 900K byte transfer rate per device.

4.1.1.1 Basic MPC Functions

Provide firmware and internal MPC hardware to perform the following:

- Request and receive EUS commands via the LA.
- Receive/transmit data from/to the EUS via the LA.
- Generate required instruction tables and control information to execute EUS commands.
- Issue instructions to disk via CA to"
  1) Control access mechanism (seek)
  2) Locate records or parts of records (search)
  3) Write a record or part of a record
  4) Read a record or part of a record
  5) Format disk packs
- Process status information for MPC, CA, and LA. Status map to EUS major and minor status as specified in the controller EPS-1.
- EUS status reporting and routing for multiple PSI.
- EUS data transfer routing for multiple logical channels (Block Multiplexors).
- Process Integrated Test Routines (ITR) for fault location within the MPC or adapters.

- Perform seek overlap - hold addresses, seek complete register, Baisc Block Multiplex.
- Alternate track processing.
- Retries under MPC control, execute last command again, hold seek address (including sector).
- Statistics gathering.
- Seek address conversion, binary to cylinder, head and sector.
- Retry seek errors, restore, reseek automatic in MPC.
- Command and address integrity (sum check character).
- RPS argument storage and comparison and implied block multiplex functions.
- Support of two independent EUS.

4.1.2 Link Adapter (LA)

The Link Adapter provides the interface between the MPC and the 6000 central system through the PSI adapter of the IOM. The Link Adapter interfaces to the MPC through the internal adapter interface.

The diagram, Figure 4.1, shows the Link Adapter as having two ports to two independent EUS channels. The Link Adapter can communicate to only one EUS channel at a time, i.e., switched channels.

The Link Adapter, with non-simultaneous dual port capability, provides the basic function required for configuring MPC disk subsystems to serve a variety of application requirements, such as the mass store link to the DATANET 355 communications subsystem and two central system configurations.

Link Adapter (LA) functions:

- Provide the EUS/MPC interface.
- Transfer, byte by byte, commands and data between EUS and MPC under control of the MPC firmware.
- Maintain LA status for use by MPC.

4.1.3 Controller Adapter (CA)

As shown in Figure 4.1, the Controller Adapter is connected to the MPC through an internal adapter interface port. The MPC and the Controller Adapter will be packaged in the same cabinet, and will share a common power supply.

The Controller Adapter shown in the diagram interfaces to/from 1-16 devices. Each device may be equipped with a 2 x 1 switch, allowing it to be connected to two independent Controller Adapters.

A Controller Adapter can transfer data from only one device at a time. Two independent Controller Adapters can each be transferring data to/from different devices simultaneously.

The MPC used in this application of disk control, can control two simultaneous data transfers through two independent Controller Adapters.

Dual simultaneous data transfer to an EUS, will require two Link Adapters. Each Link Adapter provides access to either Controller Adapter when two CA's are in the subsystem.

4.1.3.1 Controller Adapter Functions (CA)

- Provide the MPC/device level interface (DLI) and foreign interface.
- Receive two byte wide parallel data from the MPC, convert to serial, if required, and transfer to the device.
- Receive serial data or byte data from the device, convert to two byte wide parallel and transfer to the MPC.
- Provide synchronization and buffering of commands and data between MPC and device.
- Maintain a timer for use by the MPC microprogram.
- Maintain status of CA and device for use by the MPC.
- Provide internal diagnostic logic for CA fault location by the MPC.
- Check character generation/verification.
- Data compares.
- EDAC for DSS190 and MSS450.
- Address mark generation/recognition for DSS181.

4.1.4 Control Firmware

Control firmware is the microprogram module which runs in the MPC and uses the configuration data established at startup to establish parameter for all configurations enabling it, to control the devices and to transfer data records to and from the EUS.

Control firmware shall manage the data transfer, initiate and terminate I/O sequences, perform access control, perform limited command stacking (e.g., seek/read, seek/write), perform storage of multiple seek commands, control read/write observing the required format, and generate EUS interrupts for certain attention conditions.

4.1.4.1 Control Firmware Functions

- Interpret macro type instructions, received from the EUS into sequences of micro (type) commands for the CA/Device combination.

  Example: Macro type: Seek, Read, Write, Request status, etc.

  Example: Micro type: Set cylinder, Read enable, etc.

- The control firmware shall perform a status mapping function to convert status information received from the CA/Device into the common peripheral status format.

- The control firmware shall initiate micro sequences to reserve/release devices based on the macro type instructions received from the EUS. Note that the dual port shall physically reserve/release devices, and the dual port shall remember the devices "reserve" status for later interrogation by the controller.

- The control firmware shall process interrupts and perform status checks of the CA. The control firmware shall relate status to device (based on information received from the CA). In addition, the control firmware shall be responsible to return status to the EUS consistent with the priority structure for status, and additional status words giving more detail about the device and controller (refer to the DSC181/DSC190 Controller EPS-1.

- The control firmware shall convert the continuous binary seek address received from the EUS, into the Cylinder-Head-Sector address required by the device.

4.2 DEVICE (DSU)

4.2.1 DSU181

4.2.1.1 Disk Storage Unit (DSU)

The Disk Drive shall be a single unit. Each drive will have an independent voice coil positioner with a read/write head for each of 20 recording surfaces. Each drive shall have an independent power supply for the actuator and the electronics within the drive unit. Each drive shall have the capability for inclusion of dual port option which will allow dual non-simultaneous access.

The Subsystem shall be capable of handling up to 32 devices. It shall be possible to remove an individual device from service without interfering with other devices operating on the subsystem. By removing from serivce, it is meant that all power for a single device may be removed. The device shall also be restored to service without interference to other operating on-line devices.

Each device will be packaged separately and will be radially connected to the controller utilizing the DLI) Device Level Interface.

4.2.1.2 Device Electronics

Each device shall contain electronics and control for positioning the heads and serial reading and writing of digital data on any track of the removable disk pack. These functions include:

- Read/Write Logic
- Seek positioning mechanism
- Dual port option
- Power supplies for Drive and Logic
- Device to Controller Adapter Interface (DLI)

4.2.1.3 Dual Port Option

The dual port option shall be so configured that a single channel subsystem may be upgraded in the field through the addition of cables and dual port modules. Each dual port shall be associated with only one device and shall form a functional part of the device. The dual port module is part of the Basic DSU181.

4.2.1.4 Disk Storage Unit Characteristics

Disk Pack	M4180 (or equivalent)
Heads	
Number	20
Type	Saddle Erase; Ferrite
Recording	
Mode	Double Frequency
Density - outer track	1530 bits per inch
Density - inner track	2210 bits per inch
Access Times*	
1 track movement	10 milliseconds
67 track movement (1/3 stroke)	40 milliseconds
134 track movement (2/3 stroke)	50 milliseconds
199 track movement	60 milliseconds

*Does not include disk latency, or time to read data.

4.2.2 DSU190

4.2.2.1 Disk Storage Unit Characteristics

Magnetic Disks

Disk Pack Type	Honeywell M4050 (IBM 3336 or equivalent)
Number of Disks	12 (top and bottom disks for protection only)
Data Recording Surfaces	19
Prerecorded Servo Surface	1
Disk Diameter	14 inches (approximately)
Recording Media	Ferromagnetic Oxide

Data Capacity (based on one record/track)

Per Track	13,030 bytes
Per Cylinder	247,570 bytes
Per Spindle	100,000,000 bytes

Heads

R/W Heads	19
R/W Gap Length	100 microinches
R/W Gap Width	0.0043 inch
Loading Mechanism	Ramp
Servo Heads	One

Tracks

Tracks (cylinder) per disk surface	404 plus 7 spares
Track Density	192 tracks/inch
Track Spacing (℄ to ℄)	0.0052 inch
Outer Track Radius (Cyl ØØØ)	6.3813 inches
Inner Track Radius	4.2496 inches

Processing Speed

Spindle Speed	3600 rpm ± 2%
Head Positioning Time	55 milliseconds (maximum, 403 track seek)
	30 milliseconds (average*)
	10 milliseconds (minimum, one track seek)
Rotational Delay (Latency Time)	16.7 milliseconds (maximum) 8.3 milliseconds (average)
Head Selection Time	1.0 microsecond (maximum)

Recording

Mode	Modified frequency modulation (MFM)
Data Density (inner track)	4040 bits/inch
Data Density (outer track)	2684 bits/inch

*Average positioning time

$$= \frac{\Sigma \text{ Time for all possible positioning operations.}}{\text{Number of all possible positioning operations.}}$$

Recording (cont.)

Data Rate	806,000 bytes/second (6.45 megabits/second)
Bit Time	155 (±5) nanoseconds (nominal)
Byte Time	1.24 (±0.1) microseconds (instantaneous)

4.2.3 MSU450

4.2.3.1 Disk Storage Unit Characteristics

Magnetic Disks

Disk Pack Type	Honeywell M4450
Number of Disks	12 (top and bottom disks for protection only)
Data Recording Surfaces	19
Precorded Servo Surface	1
Disk Diameter	14 inches (approximately)
Recording Media	Ferromagnetic Oxide

Data Capacity (based on one record/track)

Per Track	13,030 bytes
Per Cylinder	247,570 bytes
Per Spindle	200,000,000 bytes

Heads

R/W Heads	19
R/W Gap Length	100 microinches
R/W Gap Width	0.0043 inch
Loading Mechanism	Ramp
Servo Heads	One

Tracks

Tracks (cylinder) per disk surface	823
Track Density	384 tracks/inch
Track Spacing (C to C)	0.0026 inch
Outer Track Radius (Cyl ØØØ)	6.3813 inches
Inner Track Radius	4.2496 inches

Processing Speed

Spindle Speed	3600 rpm $\pm 2\%$
Head Positioning Time	45 milliseconds (maximum 822 track seek) 25 milliseconds (average*) 5 milliseconds (minimum, one track seek)
Rotational Delay (Latency Time)	16.7 milliseconds (maximum) 8.3 milliseconds (average)

*Average positioning time

$$= \frac{\Sigma \text{ Time for all possible positioning operations.}}{\text{Number of all possible positioning operations.}}$$

Head Selection Time	1.0 microsecond (maximum)

Recording

Mode	Modified frequency modulation (MFM)
Data Density (inner track)	4040 bits/inch
Data Density (outer track)	2684 bits/inch
Data Rate	806,000 bytes/second (6.45 megabits/second)
Bit Time	155 (±5) nanoseconds (nominal)
Byte Time	1.24 (±0.1) microseconds (instantaneous)

4.3 MEDIA

4.3.1 Storage Media DSS181

The media to be used with this subsystem is a removable, interchangeable disk pack. The M4180 disk pack will be used and is mechanically and magnetically compatible with the industry standard established by the IBM 2316 Disk Pack. Magnetic compatibility is defined as the magnetic properties of the M4180 disk pack established to permit it to be used interchangeably with the IBM 2316 within a given subsystem.

The magnetic and mechanical characteristics of the disk pack are defined in the M4180 Purchase Specification, M50EB00747.

4.3.2 Storage Media DSS190

The media to be used with the DSS190 is a removable, interchangeable disk pack. The M4050 (IBM 3336 or equivalent) disk pack will be used.

4.3.3 Media Interchangeability (DSS181 and DSS190)

Disk packs will be interchangeable among all spindles of like devices within a subsystem or between subsystems if a customer has more than one subsystem at a given location; however, all spindles must be aligned with the same master alignment pack. Interchangeability is defined as the ability to read data on any spindle which was written on any other spindle; alignment with the master alignment pack may be required.

The format capability of the controller shall allow for media interchange between the DSS181 and DSS170 and DSS180.

The DSS181 shall be able to read records written by an IBM 2314 subsystem by using the read nonstandard format command. The read nonstandard format command will transfer all information bytes (headers, keys and data) on the track to the EUS. Special software can then be used to interpret the information and thereby reconstruct the data records. Not in initial DSS181 (refer to Section 1.8.1.)

The DSS190 shall be able to read records written by an IBM 3330 subsystem using the same procedure as above for the DSS181, when the DSU190 vendor has demonstrated this compatibility and the method is known in detail.

Initial DSS190 may not have the capability to read IBM 3330 Disk Packs. Revisions to both the CA and microprogram may be necessary to accomplish this.

In any event, this capability will be restricted to single channel operation in one controller.

In a dual channel controller the second channel will be temporarily held up while this operation is performed.

Dual channel operation may be provided by two controller subsystems.

4.3.4 Storage Media MSS450

The media to be used with the DSS190 is a removable, interchangeable disk pack. The M4450 disk pack will be used.

4.3.5 Media Interchangeability MSS450

Disk packs will be interchangeable among all spindles of like devices within a subsystem or between subsystems if a customer has more than one subsystem at a given location; however, all spindles must be aligned with the same master alignment pack. Interchangeability is defined as the ability to read data on any spindle which was written on any other spindle; alignment with the master alignment pack may be required.

4.4 SYSTEM SOFTWARE

4.4.1 Operating System DSS181

The subsystem will be supported within GCOS for the storage and retrieval of data and related file management functions. Initially, the command set will be similar to the DSS180 with appropriate status response. Future versions may make use of multiple sector size formats and search keys. Software for the subsystem shall be so implemented that a media and format compatible interchange exists with the DSS170, DSS180.

5. CONTROLLER INTERFACE REQUIREMENTS

5.1 EUS INTERFACE

5.1.1 PSI (Peripheral Subsystem Interface)

The Peripheral Subsystem Interface (PSI) is the mechanism by which the 6000 IOM is connected to peripheral subsystems (MPC's and devices). The physical interface is a one byte bidirectional data path with control lines. The connection is made in a star (two cables per unit) manner. The basic philosophy of the interface is to multiplex data on a burst basis; one burst per logical channel. The burst of data may be variable, consisting of a logical record to/from the media. (Refer to PSI EPS-1, 43A177874.) The physical cable shall have a maximum length of 75 feet.

The controller-to-system connection (PSI) cable will be built utilizing cable described by Drawing 43A229088, with individual conductors as described by Drawing 43A216155 with Burndy connectors, 43B133945P14 and 43B133945P15.

The controller will use a link adapter with a one byte wide PSI interface to the PSI adapter of the 6000 IOM or a 355.

5.1.2 Hardware Initialize, SCAM Control

Refer to MPC EPS-1, 43A177875.

5.2 DEVICE LEVEL INTERFACE (DLI)

The device interface shall be single radial (simplex) connection. For dual access with 2 x 1 switches in the device, a second radial cable shall be used. The radial cables shall have a maximum length for DSS181 of 40 feet and for DSS190 and MSS450, 75 feet. The device to controller interface is described in Device Level Interface (DLI) EPS-1, Drawing Number BL0026.

The controller will use Burndy connectors, 43B133945P14, with 85 ohm termination and DKL transmitters and receivers for the DLI device connection.

The device-to-controller cable, (DLI) will be built utilizing cable described by Drawing 43A229088, with individual coaxial conductors as described by Drawing 32A216155.

Initially the device will use Burndy connectors, 43B133945. At some point in the future when the NPL connector is available, the device will change to the NPL connector and the cables will be built with the 43A229088 cable and Burndy connector on the controller end and NPL connector on the device end.

5.3 OPERATOR PANEL

This panel will contain those switches and indicators which must be accessed by normal system operating personnel. The panel will be the standard MPC operator panel, (refer to MPC EPS-1 43A177875).

5.4 MAINTENANCE PANEL

The maintenance panel will contain the standard switches and indicators necessary to maintain the MPC. (Refer to MPC EPS-1, 43A177875.)

6. RELIABILITY AND MAINTAINABILITY

6.1 MAINTAINABILITY

The Maintainability System for the Mass Storage Controller and devices will be implemented in accordance with the requirements of the Common MPC Maintainability Specification 43A237500,

This section summarizes the common requirements and covers those details that are peculiar to the mass storage subsystem.

6.1.1 Test and Diagnostic Requirements

6.1.1.1 Logic Modules

Common MPC Logic modules (Basic Logic, Control Store, and Main Memory) and the Controller Adapter will be covered by Isolation Test Routines (ITR's) as defined in the common specification. The ITR system consists of a series of comprehensive test sequences and control routines for which all predictable failure modes have been preanalyzed and cataloged in a hard copy fault dictionary.

The ITR system utilizes test routines in both "read only" and writable control store that are executed in a predetermined sequence under control of the central system. The ITR system design assumes a failure may exist in any portion of the logic tested in such a fashion that there is no hardcore of logic within the MPC that must be operable in order to obtain isolation information.

Full ITR capability will be provided in both the on-line mode (under GCOS) and off-line (under MONITOR-II) with some limited capability (basic logic test only) in a completely freestanding mode. In general, ITR resolution will be to the integrated circuit level.

6.1.1.2 Device T&D

Electromechanical or device oriented electronic failures will be covered by functional T&D programs executed from the central system under control of either TOLTS (GCOS) or off-line under control of MONITOR-II. In general, these T&D programs will be executed with the normal controller firmware loaded into the MPC; but, if necessary to achieve optimum diagnostic testing, provision for overlaying normal firmware with special microroutines will be provided.

Device specifications will provide a detailed outline of the test sequences necessary to take full advantage of all device diagnostic commands and features to optimize functional and physical failure diagnosis.

The detailed outline of test sequences provided by the Device specification will include associated physical failure references and will be applicable for implementation within the framework of the 6000 Line T&D system.

The design goal of device T&D will be to achieve comprehensive physical failure isolation while requiring a minimum of detailed hardware knowledge on the part of the field engineer. When tradeoffs are absolutely necessary, priority will be placed on that portion of the device hardware that cannot be comprehensively tested via local maintenance control with the device in a freestanding mode. At a minimum, device T&D will provide detailed functional diagnosis and operating options sufficient to expedite conventional troubleshooting of all detected failures.

The following device T&D programs will be provided:

1. Installation Test
2. Comprehensive Diagnostic Test and Associated Fault Dictionary
3. Unit Performance Test (for error rate analysis during sustained operation).

The Installation Test T&D Package will include the testing of marginal or stress conditions as necessary to detect high probability incipient failure modes or maladjustments, such that successful test execution will provide a high confidence level that no maintenance activity of any kind is required on the subject device. Execution time for the installation test shall not exceed 5 minutes. This test package shall include an interchange test so that the interchangeability of disk packs among devices can be demonstrated. The interchange test will not be included in the 5 minute test time since time to move the packs must be included.

6.1.1.3 Controller Statistics Display

A privileged slave program analogous to DCSD for DSS180 will be used initially to provide visibility of DSS181, DSS190 and MSS450 controller statistics. Refer to Controller EPS-1 43A232230 Section 3.14 and Section 5.8.5. The display program will print all statistics counters by device and IOM channel for each DSS181, DSS190 and MSS450 controller, and will include information regarding subsystem configuration and released devices.

For final released implementation, the display program will be replaced by HEALS commands which the operator may use to select any of the display program functions. HEALS commands will also allow the operator to optionall reset the controller statistics counters.

6.1.2 Hardware Requirements

6.1.2.1 Logic Modules

The logic design guidelines included in this section should be followed as far as possible with each exception reviewed on an individual basis.

1. The use of JK type F/F's for all bistable elements except when RS type, cross-coupled NANDS, or special storage registers are absolutely necessary because of logic timing or hardware cost (in the case of large register banks such as the MPC RBA registers). The use of cross-coupled NANDS or special storage

register elements should be justified on an individual basis.

2. Full DC initialization capability should be provided on all bistable elements unless technically prohibited, (i.e., no provision on storage register chips). Connector pin limitation is not a valid reason for bypassing this requirement; DC initialization of all bistables (including data registers) is an extremely important maintainability requirement. Note that the requirement is DC initialization. This means no clock pulse required. When clocking is absolutely necessary for initialization, the clock pulse shall result from the initialization signal and be completely separated from the normal data or control clock distribution.

3. All free running counters and asynchronous or configuration variable interfaces should be designed to allow testing in a synchronous mode of operation, i.e, provisions for setting free running counters and substituting synchronous clock (such as execution clock) should be provided in a diagnostic mode under program control. Program controlled wrap-around should be provided at asynchronous or configuration variable interfaces.

4. The state of all common MPC logic module bistables should be observable in a static mode (no clock) via the MPC maintenance panel. All device adapter bistables should be accessible via the IAI interface without intermediate bistable levels. The capability for setting all controller adapter bistables to any desired state should be provided, but not necessarily by a direct load path.

5. The capability of simulating error conditions under program control should be provided to test all error detection logic.

6. Whenever possible, logic partitioning should optimize physical failure resolution. The fewest possible physical components or sub-assemblies should be placed in any given logic path, i.e., two 2 F/F chips with internal input gating structures are preferable to one 4 F/F chip that requires a separate chip for input gating. (Total chip count is the same.)

7. Logic implementation plans should be reviewed with the appropriate maintainability function as early as possible in the design cycle.

6.1.2.2 Device Hardware

1. Device hardware shall be designed such that any given failure, physically disconnecting the device from the subsystem or powering the device up or down, will not affect the normal operation of any other device on the same subsystem.

   In general, this requirement can be met by radial cabling of both power and logical connections, with device selection at the device adapter level. No daisy chain or bussed connection of logic interfaces or selection lines are acceptable.

2. Device hardware will be designed to allow programmed diagnosis to a physical replacement level whenever possible. The hardware design will include features necessary to comprehensively test all device functions including appropriate provisions for detecting high probability incipient failure modes and maladjustments and to distinguish media failures from intermittent or solid hardware failures whenever possible. The device features required, include but are not limited to:

- Conformance to logic module design guidelines covered in 6.1.2.1 whenever feasible.
- Diagnostic wraparound capability at appropriate physical modularity points in the read/write data path and major control signal paths. For the DSS181 with a bit serial data path, the wraparound will be at the controller adapter level. For the DSS190 and MSS450 with a byte data path to the device the wraparound will be at the device level.
- Program controlled capability for simulating error and malfunction conditions as necessary to test error circuitry.
- Ability to set and reset all status register F/F's under program control.
- Monitoring and detection of marginal or failed: write and erase current, voltage levels, disk rotation speed, and any other conditions deemed necessary to detect incipient failure modes.

3. Sufficient local maintenance control shall be provided, such that all functional areas of the device hardware where high confidence level physical isolation cannot be achieved under program control, will be capable of being comprehensively tested in an off line mode with the device disconnected from the subsystem.

4. Regardless of diagnostic requirements, device hardware will be designed and packaged such that the mean time required to repair or replace failed parts at the optimum replacement level will not exceed 0.2 hours. In no case, shall the maximum time required to replace any normally field replaceable part exceed one hour or require special tools not normally available to the field engineer. It is expected that, in general, the hardware will be packaged to expedite the replacement of the lowest reliability parts.

5. The hardware will be designed such that normal replacement, adjustment, or repair of failed parts at the optimum replacement level can be performed over the normal life of the equipment without measurably degrading reliability. Particular attention will be given to parts expected to require frequent replacement or adjustment.

6. Device hardware will be designed such that electromechanical and electronic adjustments are kept to a minimum. When adjustments are absolutely essential to the device design every possible effort must be made to remove interaction with other adjustments and to minimize the need for subjective judgment by field personnel. Calibrated dials and locking devices should be utilized whenever possible. In any case, the equipment shall be designed such that no adjustments will be required on a scheduled basis.

7. Device hardware will be designed such that the mean time between required preventive maintenance shall be greater than the mean time between failures and shall not be required on a scheduled basis. Cleaning operations required on a daily or weekly basis and minor part replacement (indicator lamps, etc.) will be such that they can be performed by customer personnel. Requirements for customer cleaning and replacement activities shall be coordinated with appropriate field engineering organizations.

8. Device hardware shall be designed to support rapid field installation and/or reconfiguration. This includes one man mobility and physical installation without requiring specific knowledge or training on the part of field personnel. The hardware shall be designed such that no mandatory installation procedure other than physical connection is necessary. This requires a high confidence level that adjustments or alignment will not change during shipment, and that any changes in adjustment or alignment can be detected under program control.

6.1.3 Software Requirements

Will be supplied later.

6.1.4 Performance Requirements

This section defines the minimum acceptable maintainability system performance characteristics for the initial ship and unlimited production phases of the MPC mass storage subsystem.

All characteristics are specified relative to the occurrence or testing of "solid" failures as defined in Section 2.1.5 of the Common Maintainability Specification 43A237500.

In general, a solid failure is defined as any failure mode which exists during the entire execution of an appropriate test sequence and which has a consistent effect on associated functions or logic networks.

Logic failure mode covered by the ITR system include:

1. Open output junctions or pins.

2. Open input junctions or pins.

3. Shorted output junctions (always low).

4. Open IC voltage pins.

5. Open connector pins.

6. Shorted input junctions.

6.1.4.1 Logic Failures in Common Modules and Controller Adapter

CHARACTERISTIC	DESIGN OBJECTIVE	DEMONSTRABLE PERFORMANCE INITIAL SHIP.	UNLIM. PRODUC.
1. Test Comprehensiveness	99%	90%	95%
2. Effectiveness	95%	80%	90%
3. Average Resolution	2 IC's	3 IC's	3 IC's
4. Worst Case Resolution	5 IC's	10 IC's	6 IC's
5. Procedure Time (Eff.%)	.4 Hrs.	.8 Hrs.	.6 Hrs.
6. Detailed Knowledge Required	No 95% Yes 5%	No 80% Yes 20%	No 85% Yes 15%

6.1.4.2 Power Supply Failures

CHARACTERISTIC	DESIGN OBJECTIVE	INITIAL SHIP.	UNLIM. PRODUC.
1. Comprehensiveness	99%	99%	99%
2. Effectiveness	95%	70%	85%
3. Replacement Level	Brd/ Component	Brd/ Module	Brd/ Module
4. Procedure Time (Eff.%)	.6 Hrs.	1.0 Hrs.	1.0 Hrs.
5. Detailed Knowledge Required	No 95% Yes 5%	No 70% Yes 30%	No 85% Yes 15%

6.1.4.3 Device Failures

CHARACTERISTIC	DESIGN OBJECTIVE	INITIAL SHIP.	UNLIM. PRODUC.
1. Test Comprehensiveness	99%	90%	95%
2. Incipient Failure Modes Tested			
A. Head Positioning	Yes	No	Yes
B. Rotational Speed	Yes	Yes	Yes
C. Write/Erase Current	Yes	Yes	Yes
3. Test Execution Time Per Device	.1 Hr.	.2 Hrs.	.2 Hrs.
4. Average Repair/Replace Time	.2 Hrs.	.5 Hrs.	.3 Hrs.

6.2 RELIABILITY

The DSC181/DSC190 Controller is a specific application of the MPC as a mass storage controller. Reliability is not a design criteria for this controller since the components, technology used as outlined in Section 7 are specified per existing standards for component reliability.

Forecast of subsystem reliability is summarized in Figure 6.2.1, Figure 6.2.2 and Figure 6.2.3.

SINGLE CHANNEL

DSU181 ON-LINE / TOTAL	8 / 8	7 / 8	12 / 12	11 / 12	10 / 12	16 / 16	15 / 16	14 / 16
Expected Mean Time Between Controller Failures/Hours	6865	6865	6615	6615	6615	6384	6384	6384
**Expected Mean Time Between DSU Failures/Hours	269	307	179	195	215	134	143	154
Expected Mean Time Between Subsystem Failures/Hours	259	6105	174	5155	6609	132	4264	6368

DUAL CHANNEL

Expected Mean Time Between Controller Failures/Hours	5236	5236	4951	4951	4951	4696	4696	4696
**Expected Mean Time Between DSU Failures/Hours	269	307	179	195	215	134	143	154
Expected Mean Time Between Subsystem Failures/Hours	256	4562	173	4085	4947	131	3484	4687

**Expected MTBF for on-line drives.
The assumption is made that the spare drives have not failed since being checked during the last PM.

DSU181 MTBF - 2150 hours
MTTR - 1.5 hours

Figure 6.2.1 DSS181 Reliability Forecast

SINGLE CHANNEL

DSU190 ON-LINE / TOTAL	8 / 8	7 / 8	12 / 12	11 / 12	10 / 12	16 / 16	15 / 16	14 / 16
Expected Mean Time Between Controller Failures/Hours	6296	6296	6085	6085	6085	5889	5889	5889
**Expected Mean Time Between DSU Failures/Hours	238	271	158	173	178	119	127	136
Expected Mean Time Between Subsystem Failurs/Hours	229	5539	155	4760	6070	117	3812	5851

DUAL CHANNEL

Expected Mean Time Between Controller Failures/Hours	4753	4753	4519	4519	4519	4304	4304	4304
**Expected Mean Time Between DSU Failures/Hours	238	271	158	173	178	119	127	136
Expected Mean Time Between Subsystem Failures/Hours	226	4338	153	3702	4511	116	3102	4285

**Expected MTBF for on-line drives.
The assumption is made that the spare drives have not failed since being checked during the last PM.

DSU190 MTBF - 1900 hours
MTTR - 1.5 hours

Figure 6.2.2 DSS190 Reliability Forecast

DSS181, DUAL MPC, DUAL CHANNEL

DSU ON-LINE / TOTAL	8/8	7/8	16/16	15/16	14/16	32/32	31/32	30/32
Expected Mean Time Between Failure of Either Controller/Hrs.	2618	2618	2348	2348	2348	1621	1621	1621
Expected Mean Time Between Failure of both Controllers/Hrs.	$27.X10^6$	$27.X10^6$	$22.X10^6$	$22.X10^6$	$22.X10^6$	$10.X10^6$	$10.X10^6$	$10.X10^6$
*Expected Mean Time Between DSU Failures/Hrs.	269	307	134	143	154	67	70	77
**Expected Mean Time Between Subsystem Failures/Hrs.	270	$48.X10^3$	135	$12.X10^3$	$1.08X10^6$	67	$3.1X10^3$	$14.X10^4$

DSS190, DUAL MPC, DUAL CHANNEL

Expected Mean Time Between Failure of Either Controller/Hrs.	2376	2376	2101	2101	2101	1525	1525	1525
Expected Mean Time Between Failure of both Controllers/Hrs.	$22.X10^6$	$22.X10^6$	$17.X10^6$	$17.X10^6$	$17.X10^6$	$9.X10^6$	$9.X10^6$	$9.X10^6$
*Expected Mean Time Between DSU Failures/Hrs.	238	271	119	127	136	58	63	68
**Expected Mean Time Between Subsystem Failures/Hrs.	238	$38.X10^3$	119	$9.5X10^3$	$74.X10^4$	58	$2.4X10^3$	$9.4X10^4$

*Expected MTBF for on-line drives assuming that the spare drives have not failed since being checked during last PM.

**The MTBF values above are valid only under the following conditions:

1) Optimal maintenance strategy is implemented.
2) The subsystem is configured such that failure of one Controller and/or a DSU is transparent to the system.

Refer to Figure 2.1.4.11.

Figure 6.2.3 DSS181 & DSS190 Dual Controller Reliability Forecast

6.3 ERROR RATES

6.3.1 Errors DSS181

An error is defined as any temporary malfunction, which can be cleared by the operator and does not require a service call to correct. Errors caused by identified and repaired hardware failures, and those attributed to the disk pack, or to system components outside the device, are to be disregarded when computing the device error rate.

6.3.1.1 Data Error Rates

Data error rates are in two categories: recoverable and nonrecoverable. A recoverable error is one which is corrected in three or fewer attempts. Errors which cannot be recovered in three or fewer attempts are nonrecoverable errors.

For the purposes of error rate specification, error rates apply only to DSU181's using disk packs meeting the requirements of Disk Pack Specification M50EB00747. Error rates do not apply to the use of flagged tracks. Use of flagged tracks, or of disk packs which do not satisfy the requirements of M50EB00747 are the users option with no performance guarantee.

6.3.1.2 Classification of Data Errors

a. Recoverable Read Error - an intermittent random read error, in which the data was properly recorded on the media and the media is satisfactory. Such an error can be caused by a transient in the system, which creates an environment which will cause the DSU181 to misinterpret the data on the pack.

b. Recoverable Write Error - an error in the recording of data on the disk pack. If the data can be recorded on the disk pack by a retry, the error is a recoverable error. Such an error can be caused by a system transient.

c. Nonrecoverable Write Error - an error on the disk pack which cannot be resolved by rewriting the same information (up to 12 retries) on the disk pack. A nonrecoverable write error caused by the following shall not be attributed to the DSU181:

1. Media failure
2. Hardware failure.

d. Nonrecoverable Read Error - an error which cannot be resolved by rereading the same information, although the data was properly recorded on the media, and the media is satisfactory. It may be caused by tolerance buildup of marginal components but with distortion within acceptable limits, or it may appear to be, but shall not be counted as, a nonrecoverable read error because of:

1. Nonrecoverable Write Error
2. Media failure
3. Hardware failure
4. Recoverable Write Error.

6.3.1.3 Seek Error Rates

Seek Errors are defined as recoverable and as nonrecoverable. A recoverable seek error is one in which the carriage positioner mechanism fails to seek to the correct cylinder when instructed to do so; however, upon receipt of a Recalibrate command followed by a Seek command to the same cylinder, the seek is executed correctly.

Nonrecoverable seek errors are the result of a subsystem hardware failure, and shall be charged to the device (control unit of DSU181) in which the failure occurs.

6.3.1.4 Error Rate Requirements

Using disk packs which satisfy the requirements of M4180 Disk Packs:

a. Recoverable Read Error Rate - shall be less than 1 error in 10 to the 9th bits transferred in read mode, operating in the written media interchange mode.

b. Recoverable Write Error Rate - shall be less than 1 error in 10 to the 12th bits transferred in write mode.

c. Nonrecoverable Read Error Rate - shall be less than 1 error in 10 to the 12th bits transferred in read mode, operating in the written media interchange mode.

d. Nonrecoverable Write Error Rate - shall be less than 1 error in 10 to the 12th bits transferred in write mode.

e. Recoverable Seek Error Rate - shall be less than 1 error in 10 to the 6th seek operations performed.

6.3.2 Errors DSS190

6.3.2.1 Recoverable Error

A recoverable error is one which can be resolved by the Disk Storage Unit rereading the same information within 26 attempts (revolutions), utilizing positioner and read clock phase shift features if normal retry logic is not effective.

6.3.2.2 Unrecoverable Errors

An unrecoverable error is one which cannot be read by the Disk Storage Unit within 27 attempts (including utilizing positioner and read clock phase shift features) because of an inability to correctly write or read the data or because of media degradation (flagged tracks excluded).

6.3.2.3 Seek Errors

A recoverable seek error is one in which the positioner fails to seek the correct cylinder position when instructed to do so. However, upon receipt of a Recalibrate command followed by a Seek command to the same cylinder, the seek is executed correctly.

Unrecoverable seek errors are the result of a hardware failure and shall be charged as a failure to either the Control Unit or the Disk Storage Unit.

6.3.2.4 Recoverable Error Rate

The recoverable error rate shall not be greater than one error in 10^9 data bits transferred on interchanged written media in dual channel overlapping seek environment. This error rate shall apply to interchange between vendor manufactured devices. In the event of interchange between vendor and IBM devices, the error rate shall be comparable to that experienced on interchange between the IBM devices.

6.3.2.5 Unrecoverable Error Rate

Unrecoverable error shall be considered as failures affecting MTBF.

6.3.2.6 Seek Error Rate

The Disk Storage Unit shall have a recoverable seek error rate of less than one seek error in 10^6 seek operations.

6.3.2.7 Media Defect Errors

Errors due to defects in media shall not be counted in error rate computation. However, if the data can be read correctly by at least two DSU190's, the error shall not be charged to a media defect.

6.3.3 Errors MSS450

6.3.3.1 Recoverable Error

A recoverable error is one which can be resolved by the Disk Storage Unit rereading the same information within 26 attempts (revolutions), utilizing positioner shift features if normal retry logic is not effective.

6.3.3.2 Unrecoverable Errors

An unrecoverable error is one which cannot be read by the Disk Storage Unit within 27 attempts (including utilizing positioner shift features) because of an inability to correctly write or read the data or because of media degradation (flagged tracks excluded).

6.3.3.3 Seek Errors

A recoverable seek error is one in which the positioner fails to seek the correct cylinder position when instructed to do so. However, upon receipt of a Recalibrate command followed by a Seek command to the same cylinder, the seek is executed correctly.

Unrecoverable seek errors are the result of a hardware failure and shall be charged as a failure to either the Control Unit or the Disk Storage Unit.

6.3.3.4 Recoverable Error Rate

The recoverable error rate shall not be greater than one error in 10^9 data bits transferred on interchanged written media in dual channel overlapping seek environment. This error rate shall apply to interchange between devices on the same sub-system.

6.3.3.5 Unrecoverable Error Rate

Unrecoverable errors shall be considered as failures affecting MTBF.

6.3.3.6 Seek Error Rate

The Disk Storage Unit shall have a recoverable seek error rate of less than one seek error in 10^6 seek operations.

6.3.3.7 Media Defect Errors

Errors due to defects in media shall not be counted in error rate computation. However, if the data can be read correctly by at least two MSU450's, the error shall not be charged to a media defect.

7. GENERAL DESIGN REQUIREMENTS

7.1 CONFORMANCE REQUIREMENT

The controller will conform to the requirements of 43A177851, General Design Requirements for 655 and 355 Systems. Each major unit (MPC, MSU450, DSU181, DSU190) will conform to the general design requirements of their respective Engineering Performance Specification (EPS). General requirements for primary power have been summarized in Section 7.5 for convenient reference and are so noted.

For Series 6000 applications, the storage subsystems described herein shall have the appearance, color, shape, and finish (to the extent that is practical from a cost viewpoint) of the Series 6000 Central System.

7.2 PHYSICAL PACKAGING

The Controller is to be considered a physical entity including Basic MPC, Control Store, R/W Memory, Power Supply, AC Control, Connector Bay, LA's and CA's which are packaged into a physical controller configuration.

The LA, CA, MPC shall be physically packaged in the controller using MQX wire wrapped and hybrid boards and interconnection technology.

The DSU181 disk drives are separately packaged. The circuit boards used in these drives are Bull GEAPS boards. The DSU190 will use vendor packaging and circuits as specified in the DSU190 Purchase Specification, 59A301821.

Maximum MQX boards per modules:

MPC	4
Control Store 8K 16 bit words	4
Read/Write Store 8K bytes	2
LA	1
CA	2
CA Device Interface	4
DPM/EDAC	1

The Controller will use the PCO standard 216400 circuit set.

The DSU181 will use 7400 and 9300 circuits.

7.3 PHYSICAL DIMENSIONS

Controller:

Height	38 inches
Width	55 inches
Depth	27 1/2 inches

Disk Unit: DSU181

Height	38 inches
Width	25 inches
Depth	31 inches
Weight	400 pounds

Disk Unit: DSU190

Height	38 inches
Width	22 inches
Depth	48 inches

7.4 AIR CONDITIONING

Cooling - only recirculation of room air will be provided; no provision is made for air from a positive pressure underfloor plenum.

Controller	4,650	BTU/hour
DSU181	4,425	BTU/hour
DSU190	4,425	BTU/hour

7.5 PRIMARY POWER

7.5.1 <u>A-C Input Power</u>

Primary a-c input power for the subsystem (refer to Section 4.1.3 of General Design Requirements fro 6000 Systems 43A177851).

Primary a-c power can be obtained from either a motor-generator, or from main branch circuits that provide 208 volts ac (+6%-14% Line-to-Neutral) 60 Hertz (+0.5 Hertz, -0.9 Hertz) 3 phases (120 degrees ± 6 degrees), 5-wire wye connection.

7.5.2 <u>Unit Power</u>

1) Controller (MPC & Adapters) for reference

- 208 volts ac ±10%
- 5 wire WYE, 3 Ø, neutral & safety
- 60 Hertz variation 50 to 65 Hertz
- 4.5 amperes per phase
- 1.6 KVA

2) DSU181 - for reference

- 208 volts ac ±10%
- 4 wire, 3 Ø and safety
- 60 Hertz variation ± 1/2 Hertz
- 4 amperes per phase
- 1.5 KVA
- 15 amperes maximum in rush per phase, input line rush when power is turned on.
- The DSU181 should be changed to meet the input power requirements of Group Standard B01.48 (+1.0 Hertz, -1.5 Hertz) at the earliest opportunity.

3) DSU190 - for reference

- 208 volts ac ±10%
- 4 wire wye, 3 phase and safety
- 60 Hertz variation ± 1/2 Hertz
- 1 Ø used in device
- 6.5 amperes operating
- 34 amperes inrush for 7 seconds
- 1.5 KVA

7.5.3 <u>A-C Power Distribution</u>

1. Controller

- One a-c power cable from system motor generator set.

The MPC and the Controller Adapters with which it is combined to form a physical controller configuration are to share common power supplies.

2. DSU181 and DSU190

- Radial cables from the main a-c power distribution source to each device.

3. A-C Power Connection, Cables and Connectors

Each unit (controller and devices) must permit hardware/conduit installation and permit permanently installed power cord connection. The connection may be provided by either a circuit breaker enclosure which will support conduit through insulated bushing and/or permit use of cable with strain relief, or covered junction box with terminal board. Location and structure of box will support conduit through insulated bushing and/or permit use of cable with strain relief.

When a power cord is supplied, the connector shall be Hubble 25415. It is the responsibility of the producer to communicate through appropriate FED/Marketing channels the need for the customer to supply wire and the mating Hubble 25403 receptacle.

Power supplies for devices, and device oriented electronics will be included in the device.

7.5.4 Power Sequencing

1. Controller

- POWER ON, POWER OFF buttons on MPC control panel. One button controls all power to the controller.

- Power sequencing after loss of power will require pushing POWER OFF then POWER ON.

- Emergency Power Off - Push POWER OFF button.

2. DSU181

- POWER ON, POWER OFF button on front of device cabinet.
- A-C Spindle Motor - START/STOP button on front of DSU cabinet.
- Power Sequencing - Push POWER ON - Push START button.
- Power Sequencing after loss of power - push POWER ON button then push A-C START button.
- Emergency Power Off - Push POWER OFF button.

Logic Control

- Controller to EUS - PSI, DKL circuits
- Controller to DSU - DLI, DKL circuits

Ride Through

1. Controller - 4 milliseconds after loss of power. Mg set 1.5 seconds.
2. DSU - 5 milliseconds

A-C RFI Filtering

1. Provided in Controller P.S.
2. Provided in Device P.S.

Program Power Control

1. Controller - SCAM
2. Device
   a) Device off-line, drops OPI.
   b) Standby (Spindle Off), Set Standby Command turns off spindle motor.

7.6 ENVIRONMENTAL REQUIREMENTS

The DSS181 and DSS190 shall be designed to operate in a Class 1 environment as defined in HIS Standard B01.08.

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DSS181/DSS190 Subsystem EPS-1

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