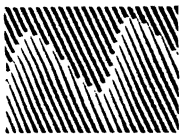

MEMOREX TELEX

3890-2
Disk Storage Subsystem
General Information Manual

3890-2.00-00

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Preface

The 3890-2 Disk Storage Subsystem is a high-performance, disk-based subsystem that consists of the 3898-2 Cluster Control Unit and from one to four 3890 Disk Modules. This subsystem offers the customer increased storage capacity, reduced floor space requirements, and a host of other benefits. Memorex Telex publishes several manuals and brochures that describe various aspects of the product line. Some of this material focuses on the advantages and design of the subsystem; other documents furnish operating instructions, programming information, etc. The purpose of this *General Information Manual* is to furnish the customer with a discussion of such subjects as installation planning, functional hardware, maintenance processing, advanced features, etc. Customers considering the 3890 subsystem will find this manual helpful in deciding how best to utilize the performance characteristics of the subsystem. The manual is structured as follows.

> ***Note:*** *For the purposes of this manual, the term "3898" refers to the 3898-2 cluster control unit and the term "3890" refers to the 3890 disk module unless otherwise specified.*

Section 1 — This section introduces the 3890-2 disk storage subsystem and outlines the features available in the subsystem. Additionally, Section 1 covers basic configuration parameters and device attachments.

Section 2 — This section provides information that the customer will find useful when planning an installation. Included in Section 2 are discussions of the activities completed during installation, the installation specifications for the 3898-2, installation specifications for the 3890, and subsystem addressing schemes.

Section 3 — This section summarizes the hardware architecture for the subsystem. Section 3 describes both the 3898-2 and the 3890 on a physical level; special attention is given to the subsystem operator control panels.

Section 4 — In support of the physical description, Section 4 furnishes a basic functional overview of the subsystem.

Section 5 — This section covers the maintenance philosophy for the subsystem. The Portable Maintenance Terminal (PMT), the remote link, and the drive diagnostic panel are discussed.

Designed for use during the system planning phases, the *3890-2 General Information Manual* focuses on issues that prove crucial when developing the overall configuration scheme. This manual also provides a useful reference for those who wish to familiarize themselves with subsystem performance, features, and hardware. To supplement the *General Information Manual*, Memorex Telex provides a companion manual — the *3890-2 Product Reference Manual*. This manual covers such subjects as channel commands, powering sequences, safety precautions, sense information, track format, etc.; the *Product Reference Manual* is intended for use by the system programmer and operator.

In addition to user documentation, Memorex Telex provides a full range of service documentation for the 3890-2 subsystem. This documentation set includes such items as maintenance manuals, functional descriptions, etc., and is listed below.

Title	Publication Number
3890-2 Maintenance Manual	3890-2.20-xx
3890-2 Functional Description	3890-2.21-xx
3890-2 Installation Manual	3890-2.22-xx
3890-2 Illustrated Parts Catalog	3890-2.23-xx
3890-2 Fault Isolation Procedure (FIPS) Manual	3890-2.24-xx
3890-2 Microdiagnostics Manual	3890-2.50-xx

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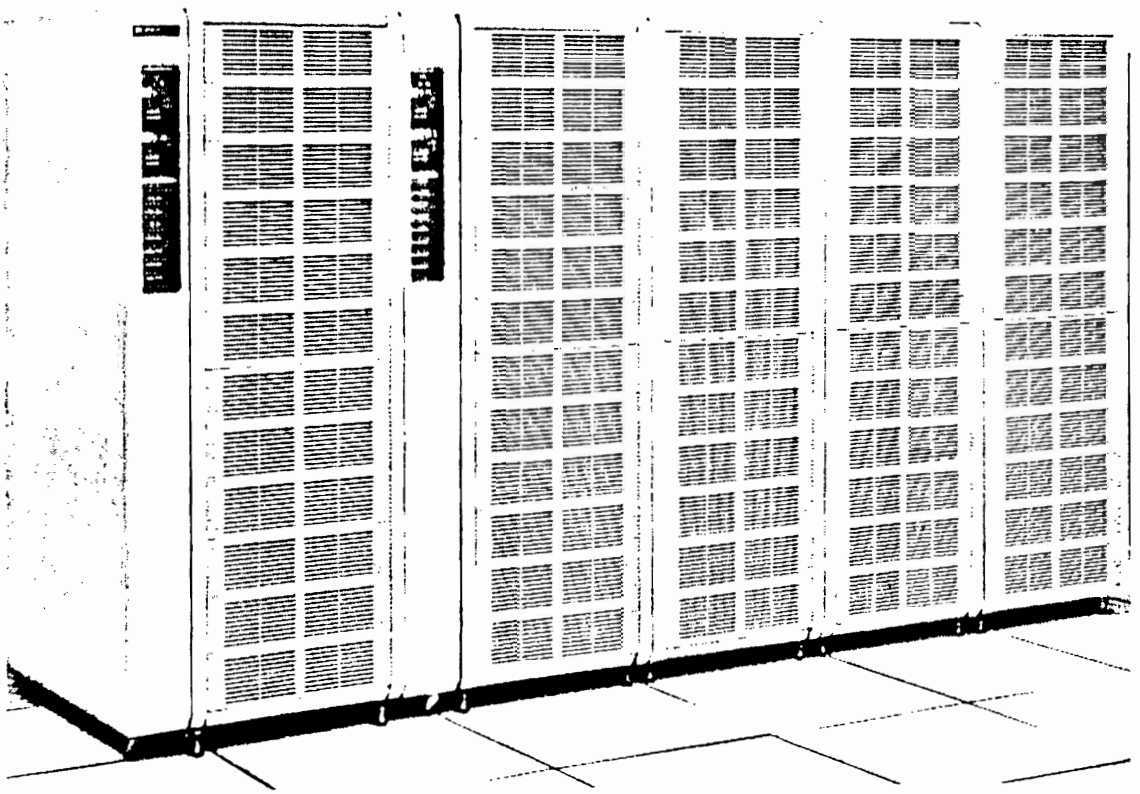


Section 1
Introduction

1.1 Introduction to the 3890-2 Disk Storage Subsystem

The 3890-2 Disk Storage Subsystem is a large capacity, fast-access disk subsystem comprising two elements: a 3898-2 Cluster Control Unit and one or more 3890 Disk Modules. The following briefly describes some of the characteristics and advantages of these two units.

The 3898-2 cluster control unit is a disk management device that provides a significant floor space and environmental savings while offering superior product performance. Traditional disk subsystem architecture incorporates three distinct units: the Storage Control Unit (SCU), the string controller, and the disk drive. The 3898-2 represents a marriage of the SCU and string controller functions in a single, integrated cluster control unit with two storage clusters that provide four independent access paths to the disk storage media in the 3890 disk modules. The 3898-2 attaches directly to the host channel, furnishing the drive string with the complete spectrum of control and interface capabilities required for subsystem operation. By merging the SCU and string controller logic into a single physical unit, the 3898-2 reduces control function floor space by as much as 50% over prior product generations. Customers installing multiple 3890-2 subsystems will recognize the special advantages that this reduction represents in terms of computer room real estate. The architectural integration of the SCU and string controller functions also provides measurable performance benefits over competitive subsystems.

In addition to the space savings and performance advantages inherent in the 3898-2, the unit yields an energy cost savings. One of the byproducts of combining the SCU and string controller in a single module is a lower subcomponent population for the overall function. With fewer components, the reliability of the functional module increases. Additionally, the 3898-2 utilizes large scale circuit integration to a greater extent than prior models, thus providing a more dependable unit. For prior product generations, the error correction algorithms executed at the controller level handled only certain fields on the disk track; controllers sent the error correction algorithms for the Data field to the host system for processing. To increase the overall reliability of the subsystem, the 3898-2 now performs internal error correction on all track fields, including the Data field. This measure reduces the number of errors that are passed to a higher level and saves valuable system execution time.

In keeping with current architectural standards, the 3898-2 is composed of four independent controller functions, or Storage Paths (SPs), that attach to the host channel(s) via the unit's channel interface function. There are two SPs in a storage cluster and the 3898-2 cluster control unit includes two storage clusters. Each SP can access any volume in the attached string via the Volume Level Selection Enhanced (VLSE) feature. VLSE permits four simultaneous read/write operations per string on

any four volumes in the string; this feature includes enhanced communications protocol for the SP/channel interface link to speed data turnaround.

The 3890-2 subsystem is available in three versions: the J-type subsystem, the K-type subsystem, and the intermixed J and K subsystem. The subsystem type is based on the drive module type that the customer selects; subsystems containing 3890-00J4 or 3890-02J4 disk modules are defined as J-type subsystems while subsystems that contain 3890-00K4 or 3890-02K4 disk modules are defined as K-type subsystems. The intermixed version contains both J and K disk modules. Although the J-type subsystem and the K-type subsystem share a similar overall architecture, these two subsystems address different customer needs. The K-type subsystem provides an ideal solution for the customer concerned with maximizing storage capacity whereas the J-type subsystem increases data throughput rates by reducing access time. Customers who require an additional measure of configuration flexibility may intermix J-type devices and K-type devices in the same subsystem; this approach allows the customer to tailor the subsystem characteristics to effectively handle the expected job load, job timing, and application. To familiarize the customer with the performance benefits inherent in these three subsystem types, the following paragraphs review the performance factors crucial to each subsystem.

Among the issues facing today's computer facility planner is the need for greater data storage capabilities in a smaller space. The K-type subsystem answers this issue by providing higher subsystem storage capacities per square foot. In comparative terms, a 3890 K-type disk module represents a 67% floor space savings over the IBM 3380 K-type equivalent; this percentage is based on a gigabyte per square meter comparison. Incorporating three times the storage space of the J-type volume, each K-type volume has a capacity of 1.89 gigabytes (GB), or a total of 60.48 GB per string (four 3890 disk modules). To ensure a high level of product reliability, the disk drives employed in the 3890 are based on field-proven, 8-inch Winchester technology. The K-type subsystem employs microprocessor-based architecture, allowing greatly improved component level diagnostic and maintenance capabilities. K-type drives have an average seek time of 16 milliseconds and a data transfer rate of 3.0 megabytes/second.

Some computer installations require extremely fast disk turnaround times in addition to large storage capacities. To meet this need, the 3890 J-type subsystem furnishes a significant reduction in access time and a consequent increase in subsystem throughput. The J-type disk module provides 630 megabytes (MB) of storage capacity per volume with a maximum of 40.32 GB for the subsystem (four 3890 disk modules). Although this storage capacity is lower than that of the K-type disk module, the speed at which the drive accesses data has improved by 25%. In quantifiable terms, the average access time for the J-type disk is measured at 12 milliseconds as compared to the 16-millisecond average access time for the K-type disk. Customers requiring a balance between fast access and large storage capacities should note that 3890 J-type strings may be field upgraded to include 3890 K-type devices as well as J-type devices; the resulting string is known as an "intermixed" string and allows the customer a tailored approach to subsystem configuration. In intermixed strings, applications requiring a great deal of storage space may be allocated to the string's K-type devices and those that are time-critical may be reserved for the J-type devices. The J-type disk module provides reliability benefits identical to those of the K-type disk module. As with the K-type unit, the J-type unit employs Winchester-type, 8-inch disk drives. The subsystem also utilizes microprocessor-based architecture to enhance component level diagnostic and

maintenance capabilities. The subsystem allows a data transfer rate of 3.0 megabytes/second.

To ensure a high degree of maintainability, the 3890-2 subsystem incorporates maintenance-oriented circuitry that helps the Memorex Telex Customer Engineer (CE) minimize subsystem down time. Each 3898-2 SP contains its own microprocessor. This feature allows the CE to perform maintenance on one SP without impacting the operation of the other three. Thus, the drive string remains available to the system via the other SPs, allowing the normal job stream to continue. Cluster control unit maintenance and subsystem maintenance are handled by a Portable Maintenance Terminal (PMT) which attaches directly to the SP for isolation of the problem area. Using the PMT, the SP can perform diagnostics on itself or any volume in the attached string. The CE can also attach the PMT to the power sequencing unit (PSU). Under this attachment, the CE can perform a specialized set of diagnostics designed to exercise the power sequencing functions. The 3898-2 also provides an interface for an RS232 port; this capability permits remote analysis and diagnostics to be performed via telephone. By emulating the PMT at a remote location, product specialists in area office locations can analyze complex failures without traveling to the customer site. As a further maintenance enhancement, the 3890 J-type and K-type drives are equipped for direct testing via a special diagnostic panel. If a specific drive experiences a problem, the CE attaches the portable drive diagnostic panel to a connection point on the drive. With the aid of the diagnostic panel, the CE can isolate a variety of drive failures to the Printed Circuit Board (PCB) level. By correcting the problem at the PCB level, the CE can generally eliminate the need to replace an entire drive; this measure lowers the potential for temporary dataset migrations and extensive backups.

The numerous advantages offered by the 3890-2 subsystem make it one of the most cost-effective disk management strategies currently available for the IBM plug-compatible marketplace.

1.2 Subsystem Configurations

Designed to provide a flexible attachment strategy, the 3890-2 subsystem is supported by a variety of host processors. The subsystem attaches to the data streaming or block multiplexer channels of the following IBM processors or compatible models.

- 308X
- 3090
- 4361*
- 4381
- 9375
- 9377
- Amdahl Processors (3.0 MB/second, data streaming only)
- NAS Processors (3.0 MB/second, data streaming only)

* Model 3 is not supported.

To ensure operation under a wide range of environments, the 3890-2 subsystem is compatible with several operating systems. The spectrum of compatible operating environments is as follows:

- MVS/XA
- MVS/ESA
- VM/XA SF
- VM/SP HPO
- VSE/SP
- VSE/AF

Note: *For proper subsystem function, these operating systems must include appropriate support packages; further information on this subject is available in the 3890-2 Product Reference Manual (3890-2.01-xx).*

The 3898-2 cluster control unit consists of two storage clusters; each cluster contains two storage paths (SPs). Each SP can support 64 logical volumes of storage and each has the ability to access all logical volumes in the string via the Volume Level Selection Enhanced (VLSE) feature (see Figure 1-1). VLSE permits four simultaneous read/write operations per string on any four volumes in the string. The VLSE feature utilizes advanced protocol to improve throughput and performance. To further promote subsystem availability, each SP attaches to the host system via two- or four-channel switching; the SPs can be connected to the same channel, to separate channels in the same processor, or to channels in different processors. The data transfer rate for the 3898 is 3.0 megabytes/second for disk transactions.

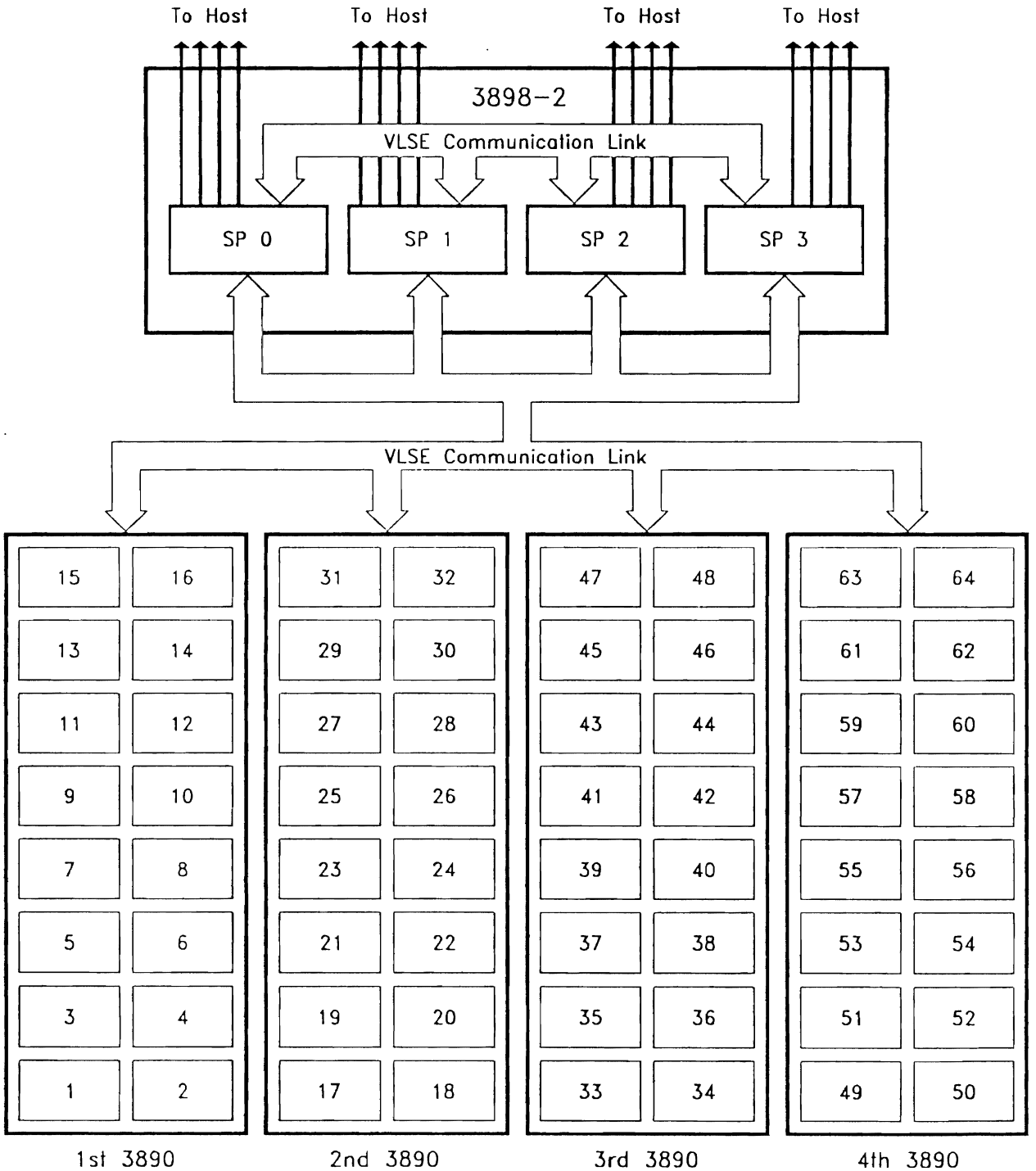


Figure 1-1. Disk Modules with VLSE Pathing

As stated, the 3898-2 supports up to four 3890 disk modules. The disk module provides the following basic components: an SP/device interface, redundant interface power supplies, and a set of either four, eight, twelve, or sixteen drive drawers. Each drive drawer, in turn, houses a high-reliability disk drive, a disk drive power supply, and a cooling system. For the purposes of discussion, this text refers to each set of four drive drawers as a storage increment. The 3890 disk module is available in three versions: the J-type module, the K-type module, and an intermixed module. These versions yield different customer benefits. Prior discussion has noted that the J-type module offers a faster average seek time while the K-type module features a higher storage capacity. Table 1-1 presents some of the basic specifications for the J-type and K-type subsystems.

Table 1-1. Comparative Specifications for J- and K-Type Units.

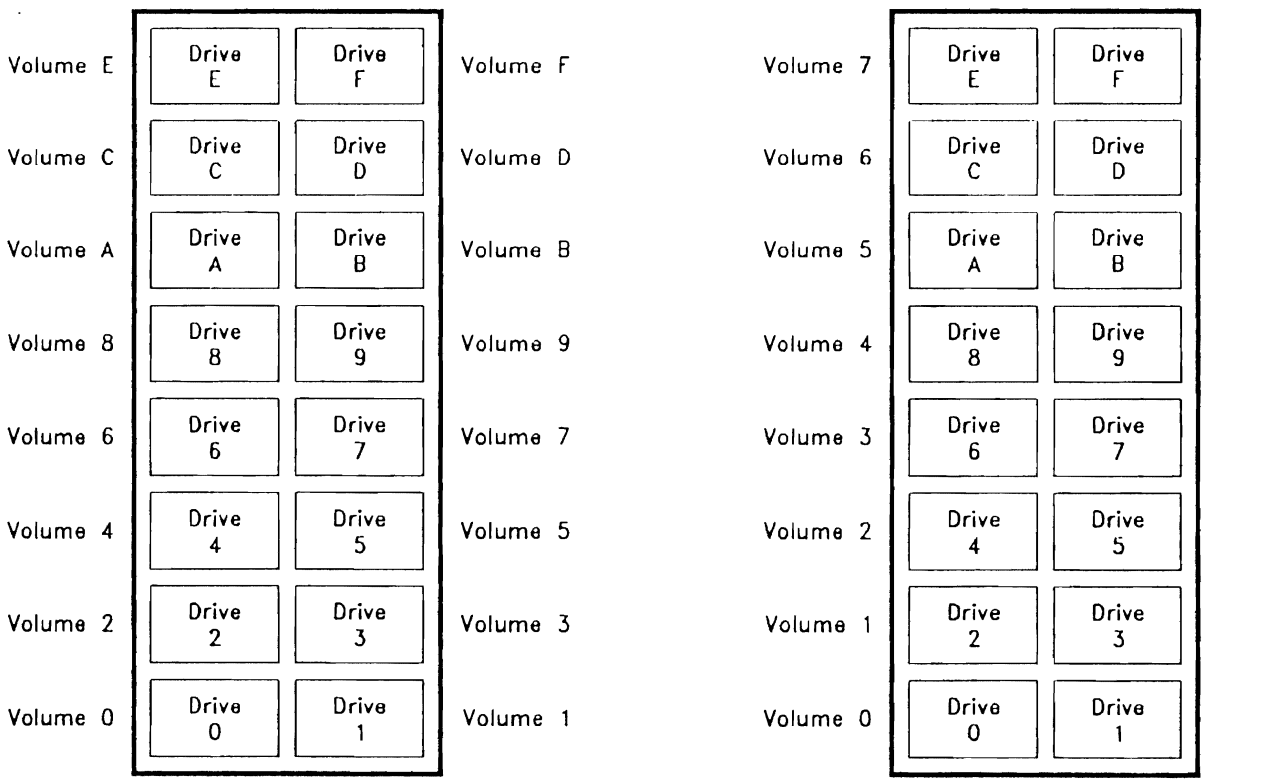
	J-type Units	K-type Units
Maximum Capacity:*	630 MB per volume 2.52 GB per storage increment 10.08 GB per 3890 disk module 40.32 GB per string**	1.89 GB per volume 3.78 GB per storage increment 15.12 GB per 3890 disk module 60.48 GB per string
Maximum Addressable Volumes:	64	32
Cylinders per Actuator:	885	2,655
Tracks per Cylinder:	15	15
Access Time — Seek:	12 ms (average)	16 ms (average)
Bytes per Cylinder:	712,140 (formatted as a single record without keys)	
Bytes per Track:	47,476 (formatted as a single record without keys)	
Data Transfer Rate:	3 MB/second	
Access Time — Latency:	8.3 ms (average)	

* Totals represent formatted capacities.

** Totals are higher for intermixed strings.

1.2.1 Model J Configuration

The reader will note that the 3890 J-type disk module features volumes that have an individual storage capacity of 630 MB and an average seek time of 12 ms. With all J-type modules, each logical volume in the subsystem corresponds to one physical disk drive (see Figure 1-2). Depending on the needs of the installation site, the customer may choose between several J-type models. The first of these, the 3890-00J4, includes one storage increment (four drawers, four volumes) and has a capacity of 2.52 GB. This model is considered the minimum configuration for the 3890 J-type subsystem as indicated in Figure 1-3. Each subsequent J-type model furnishes 2.52 GB of storage increment (four drawers, four volumes) up to a maximum of 10.08 GB per disk module. There may be a total of four disk modules in a maximum configuration as shown in Figure 1-4.



*Shown for one, fully loaded disk mudule.

Figure 1-2. Disk/Volume Layout

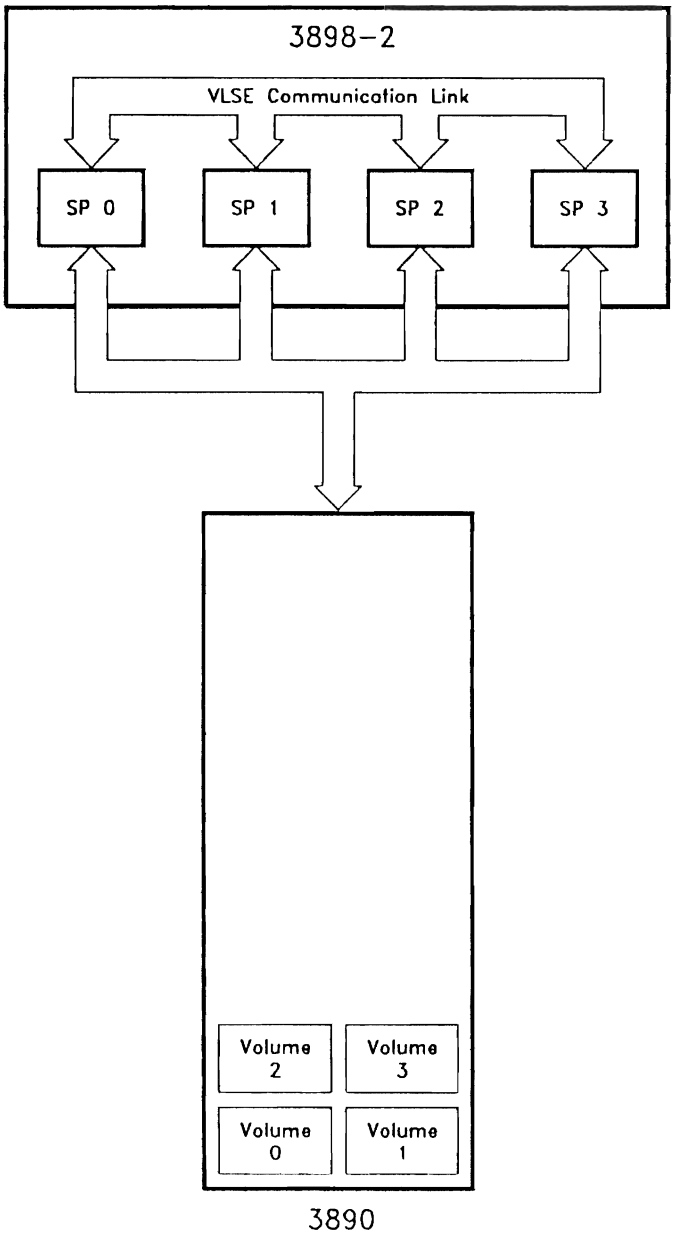


Figure 1-3. Minimum J-Type Configuration

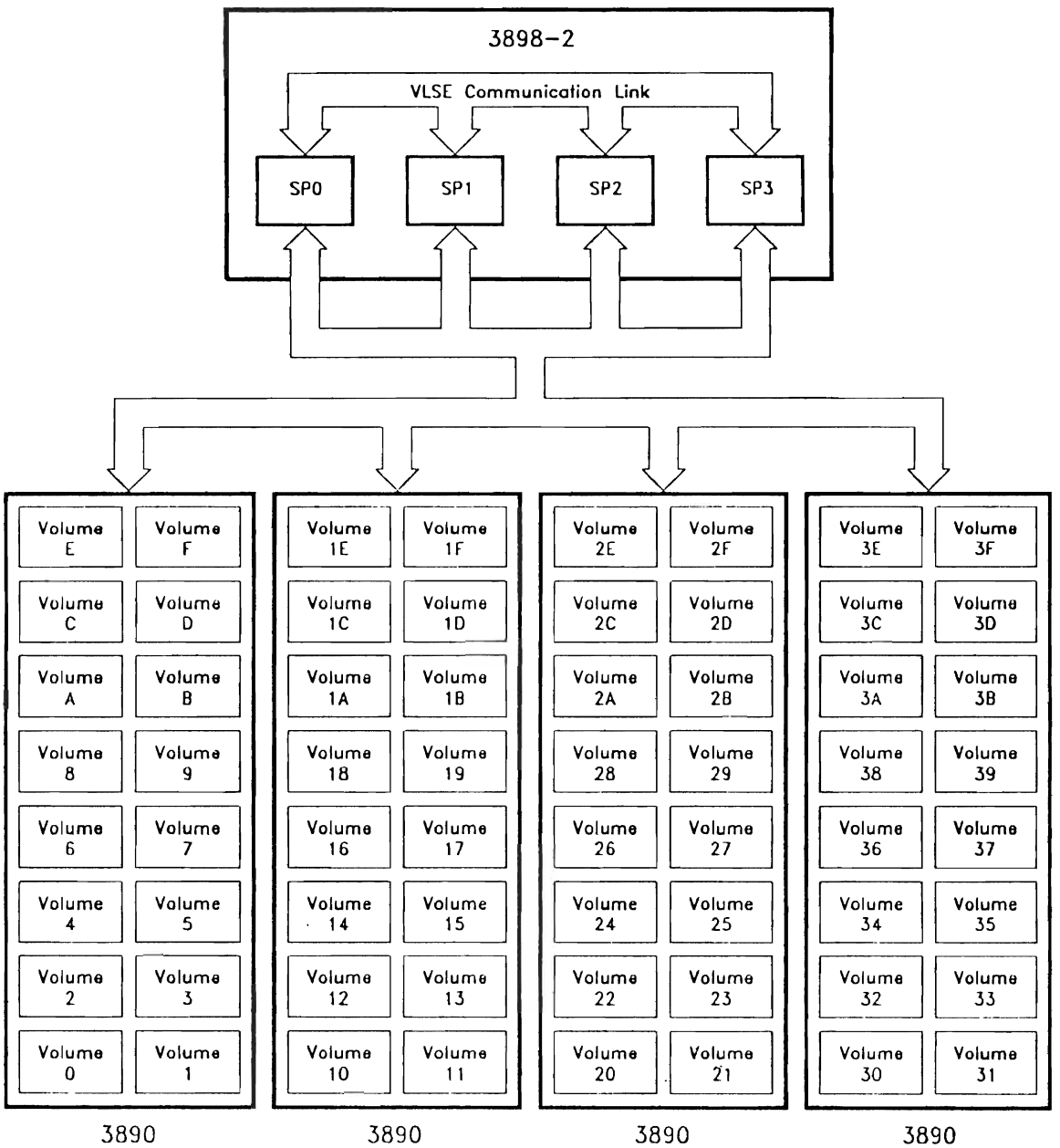


Figure 1-4. Maximum J-Type Configuration

1.2.2 Model K Configuration

Furnishing one and one half times the storage capacity of the J-type subsystem, the 3890 K-type disk module features volumes that have an individual storage capacity of 1.89 GB. In this case, however, the average seek time is 16 ms. For all K-type modules, each logical volume corresponds to two physical disk drives (see Figure 1-2); thus, two adjacent drive drawers comprise one logical volume. The use of two disk drives to emulate a single logical volume is a product of the high level mapping algorithms incorporated at the SP/device interface level. This interface controls all data placement and track addressing conversions required to successfully transmit the data to and from its target location. Each K-type disk module is also available in four models. The first of these, the 3890-00K4, includes one storage increment (four drawers, two volumes) and has a capacity of 3.78 GB. This model is considered the minimum configuration for the 3890 K-type subsystem as indicated in Figure 1-5. Each storage increment similarly provides 3.78 GB up to a maximum of four storage increments per disk module (15.12 GB). A maximum 3890 K-type subsystem consists of four, fully loaded K-type disk modules providing 32 addressable volumes (refer to Figure 1-6). Table 1-2 clarifies the different K-type configurations that the customer may order.

Table 1-2. K-Type Configurations

Number of Drawers	Number of Volumes	Number of Storage Increments	Number of Disk Modules	Storage Capacity
4	2	1	1	3.78 GB
8	4	2	1	7.56 GB
12	6	3	1	11.34 GB
16	8	4	1	15.12 GB
20	10	5	2	18.90 GB
24	12	6	2	22.68 GB
28	14	7	2	26.46 GB
32	16	8	2	30.24 GB
36	18	9	3	34.02 GB
40	20	10	3	37.80 GB
44	22	11	3	41.58 GB
48	24	12	3	45.36 GB
52	26	13	4	49.14 GB
56	28	14	4	52.92 GB
60	30	15	4	56.70 GB
64	32	16	4	60.48 GB

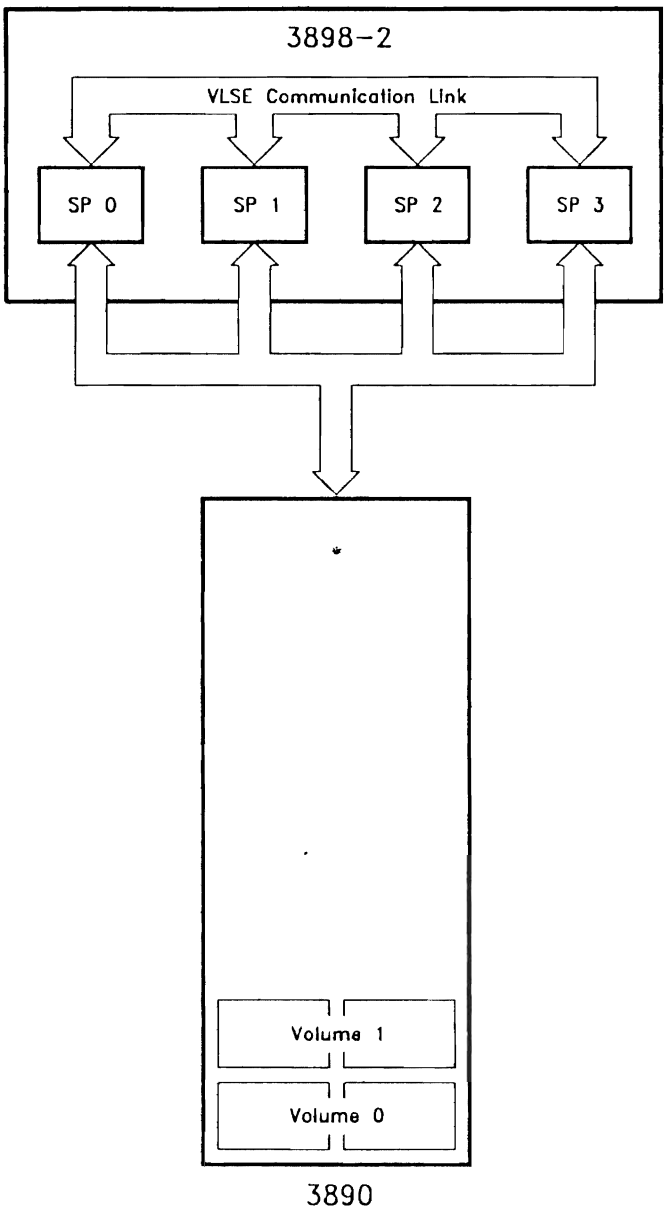


Figure 1-5. Minimum K-Type Configuration

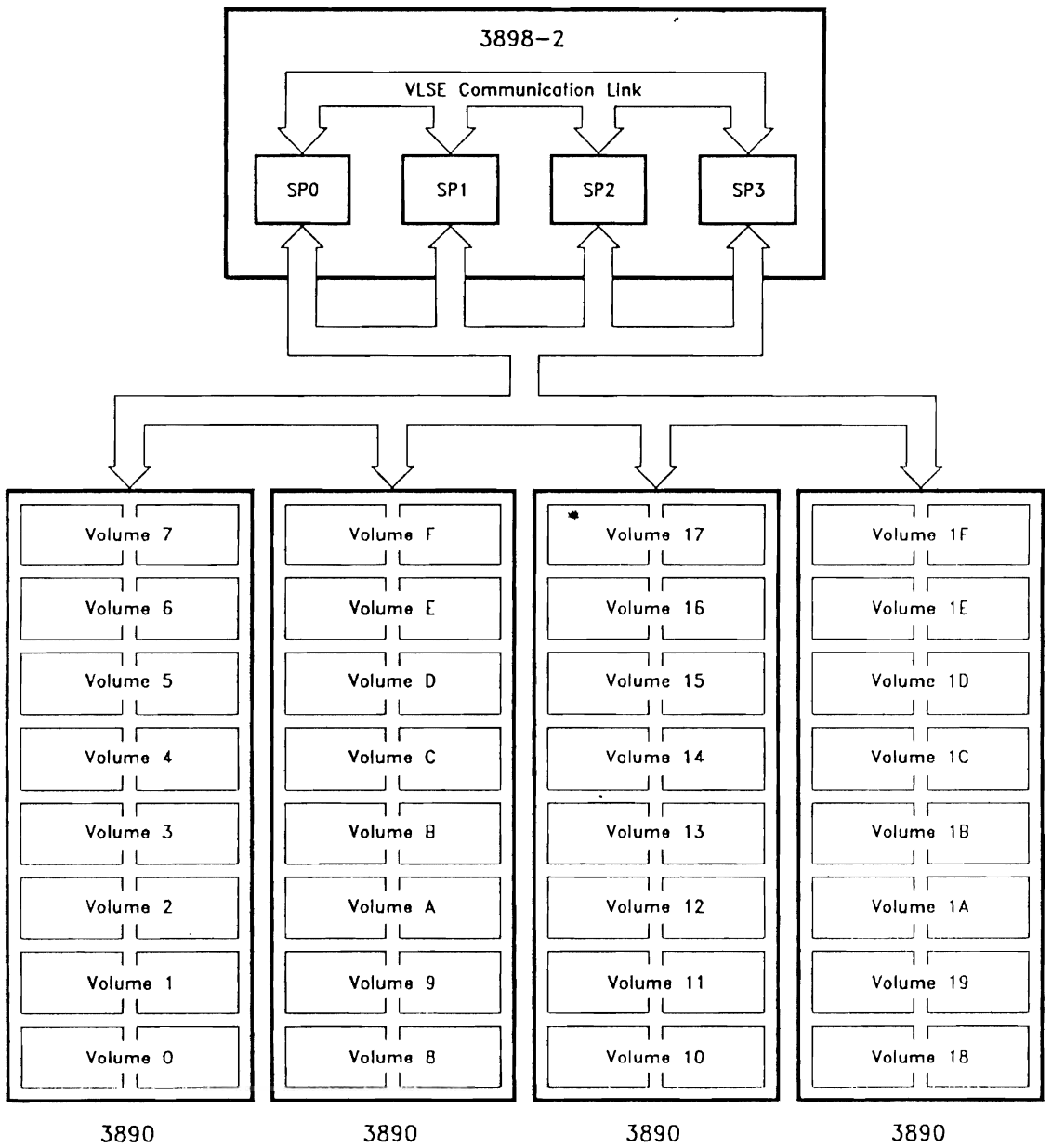


Figure 1-6. Maximum K-Type Configuration

1.2.3 Intermix Configuration

To ensure a high degree of configuration flexibility, the 3890-2 subsystem is offered in intermixed configurations. Intermixed configurations allow the customer who wishes an optimal balance between performance and capacity to utilize both J-type and K-type volumes in the same subsystem. As with all 3898-2 attachments, the total number of logical volumes for intermixed subsystems may not exceed 64. When planning an intermixed subsystem, the customer should base storage totals on the capacity of each storage increment because the capacity of an intermixed configuration can differ significantly from typical capacities. The customer should note that the J-type and K-type disk modules are shipped as isolated entities; in other words, at installation time, J-type modules include only J-type drives and K-type modules incorporate only K-type drives. Customers who require intermix may field-upgrade the 3890 to include both J-type and K-type drives in the same disk module. The customer should note that subsystem configurations which include intermixed disk modules offer a maximum storage capacity of 55.44 GB and consist of 16 volumes of J-type drives and 24 volumes of K-type drives. Table 1-3 summarizes the available configurations of the disk modules to provide a review of the different storage options.

Note: *There are many combinations of the J-type and K-type models available. However, intermixed configurations are governed by certain constraints. Customers interested in intermixed configurations should consult their Memorex Telex sales representative to determine appropriate volume assignments.*

Figure 1-7 presents an example of an intermixed system. In this case, the customer needs to store approximately 11 GB of data; most of the data sets are the same size. Approximately one third of the data is high-priority, frequently accessed data. The amount of floor space available at the installation site is limited. To best answer these conditions, the customer orders one 3890-02J4 disk module with four storage increments and field upgrades two of the storage increments; the upgraded storage increments are now the equivalent of a 3890-00K4. The J-type volumes store 5.04 GB of the total data and the K-type volumes store 7.56 GB of the total data, yielding the correct performance/capacity mix. To increase subsystem availability and data transaction speed, the customer orders the four-channel switch feature. Additionally, the customer saves the floor space required for a second module by specifying an upgrade rather than adding a module.

Table 1-3. Configuration Storage Capacities (Gigabytes)

Storage Increments (Drawers)	Disk Modules Required	J Capacity	K Capacity	Intermix Capacity (J + K Volumes*)
1 (4)	One	2.52	3.78	0
2 (8)	One	5.04	7.56	0
3 (12)	One	7.56	11.34	8.92 (8J + 2K)
4 (16)	One	10.08	15.12	12.60 (8J + 4K)
5 (20)	Two	12.60	18.90	13.86 (16J + 2K) 16.38 (8J + 6K)
6 (24)	Two	15.12	22.68	20.16 (8J + 8K) 17.64 (16J + 4K)
7 (28)	Two	17.64	26.46	23.94 (8J + 10K) 21.42 (16J + 6K)
8 (32)	Two	20.16	30.24	27.72 (8J + 12K) 25.20 (16J + 8K)
9 (36)	Three	22.68	34.02	31.50 (8J + 12K + 4J) 28.98 (16J + 10K) 32.76 (16K + 4J)
10 (40)	Three	25.20	37.80	32.76 (8J + 12K + 8J) 32.76 (16J + 12K) 35.28 (16K + 8J)
11 (44)	Three	27.72	41.58	35.28 (8J + 12K + 12J) 36.54 (16J + 14K) 37.80 (16K + 12J)
12 (48)	Three	30.24	45.36	37.80 (8J + 12K + 16J) 40.32 (16J + 16K) 40.32 (16K + 16J)
13 (52)	Four	32.76	49.14	40.32 (8J + 12K + 20J) 44.10 (16J + 18K) 42.84 (16K + 20J)
14 (56)	Four	35.28	52.92	42.84 (8J + 12K + 24J) 47.88 (16J + 20K) 45.36 (16K + 24J)
15 (60)	Four	37.80	56.70	45.36 (8J + 12K + 28J) 51.66 (16J + 22K) 47.88 (16K + 28J)
16 (64)	Four	40.32	60.48	47.88 (8J + 12K + 32J) 55.44 (16J + 24K) 50.40 (16K + 32J)

* Volumes are presented in the order of their addressed priorities.

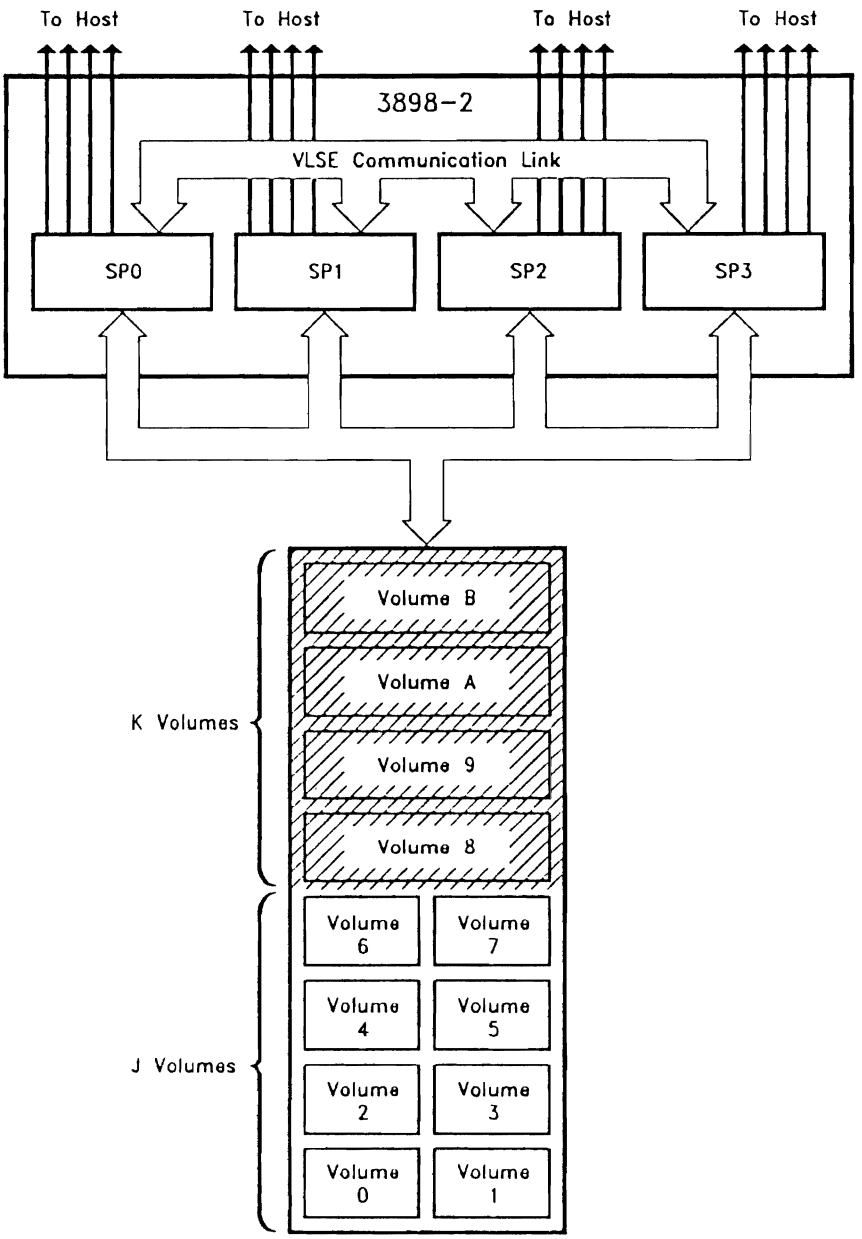


Figure 1-7. Intermixed 3890-2 Subsystem (Single 3890 Disk Module)

1.3 Subsystem Features

The standard features for the 3890-2 subsystem are as follows:

Four Independent Storage Paths

Maximizes data availability by providing four storage paths (two storage paths per storage cluster and there are two storage clusters per 3898-2 cluster control unit). Each storage path can support one of the following configurations:

— one string of 64 3890 J-type volumes

— one string of 32 3890 K-type volumes

— one intermixed string of 3890 J-type and K-type volumes totaling a maximum of 52 logical volumes.

Skip Defect Processing

Provides a method of skipping up to seven defective recording areas per track, improving performance by reducing the need to seek to an alternate track.

Full Track Error Checking and Correction

Corrects single error bursts of up to 17 bits of data (32 bits if contained within adjacent half words of data). Error correction for all fields (Home Address, Count, Key, and Data) is performed by the 3898-2 cluster control unit.

Unique Error Detection Code for Read/Write Unit Data Transfers

Ensures the accuracy of data transfers between the channel and read/write unit. The cluster control unit logic internally develops a 2-byte error detection code that verifies the integrity of the inbound or outbound read/write data.

Command Retry

Minimizes system overhead by enabling the 3898-2 and channel to recover from certain subsystem errors.

Disconnected Command Chaining

Allows disconnection during seek operations, providing greater channel and storage path availability.

Rotational Position Sensing

Allows disconnection during rotational delay, furnishing greater channel and storage path availability.

Write Format Release

Enhances subsystem performance by permitting a single actuator to continue padding from the end of certain format write operations while the balance of the subsystem is free for other functions.

ECKD Support

Supports the ECKD (Extended Count, Key, and Data) mode of the Define Extent command.

Volume Level Selection Enhanced (VLSE)

Uses the storage paths and volumes, together with an enhanced communications protocol between the 3898-2 storage paths, to improve performance and throughput. With VLSE, any storage path can access any volume and any four volumes can transfer data simultaneously.

1.4 Cluster Control Unit Features

The standard features of the 3898-2 cluster control unit are as follows:

XA/Dynamic Device Reconnect Support

Allows each logical volume to be accessed by any storage path. This feature also permits each volume to be reserved for a specific system over one or more paths.

Separate Microprocessors

Provides a microprocessor for each storage path, allowing individual task execution.

3.0 MB/second Channel Data Transfer Rate for Disk Volume Transactions

Designed for interface compatibility with IBM channels or the equivalent.

Two-Channel Switch

Permits storage path access via two channels from the same or different CPU(s). In this configuration, eight channels, two per storage path, have access to the 3898-2.

Four Maintenance Interfaces

Allows maintenance on one storage path without impacting the other three. Maintenance is performed via the Portable Maintenance Terminal (PMT) or remote hookup; remote hookup to field experts is available via an RS232 port that interfaces with telephone circuitry.

Two to Sixty-four Volumes per Storage Path

Permits minimum configuration while offering maximum subsystem storage capability. String capacities for J-type volumes range from 2.52 to 40.32 gigabytes; intermixed strings can yield higher storage capacities. For K-type volumes, string capacities extend from 3.78 to 60.48 gigabytes.

For those installations requiring increased channel accessibility for each of the four storage paths, the following is available as an optional feature on the 3898-2.

Four-Channel Switch

Allows storage path access via four channels from the same or different CPU(s). In this configuration, sixteen channels, four per storage path, have access to the 3898-2.

1.5 Disk Module Features

The standard 3890 disk module features are as follows:

Microprocessor-controlled Drive Interface

Permits decoding and execution of various servo/seek routines. The microprocessor determines the cylinder required by the system and seeks to that cylinder. It also monitors various servo signals to ensure proper operation. Additionally, the microprocessor supervises the read/write data transfer operation, continually reporting drive status and error conditions when detected.

Quad Data Path

Allows access to any volume by any of the four storage paths, enabling simultaneous operations to occur on as many as four volumes.

Intermixed Storage Types

Allows the system planner to tailor the subsystem to fit the needs of the proposed site. By mixing volume types, the planner may optimize the subsystem for the most favorable storage capacity/access speed ratio.

Large Capacity

Provides maximum storage capacity in minimum space as follows.

3890 (J-type) — 630 MB per volume; 2.52 GB per storage increment; 10.8 GB per disk module; 40.32 GB per string. These specifications assume a nonintermix string; intermixed strings have larger storage capacities.

3890 (K-type) — 1.89 GB per volume; 3.78 GB per storage increment; 15.12 GB per disk module; 60.48 GB per string.

Customer-selectable Storage Increments

Offers flexibility in choosing desired storage capacity and savings in computer room floor space.

Drive Diagnostic Panel

Improves drive maintainability by allowing the CE to execute a select spectrum of diagnostic tests at the drive level.

Section 2
Hardware Installation Planning

2.1 General Installation Activities

Careful planning is an important part of efficient installation procedures. This section provides a summary of installation considerations and requirements. Further information is available in the *3890-2 Installation Manual* and through consultation with company representatives.

The 3890-2 subsystem is shipped via commercial carrier. All equipment needed to install the units is delivered with the subsystem. The equipment includes two power cords, interconnecting cables, and documentation. All installation activities, from unpacking to customer turnover for operational use, are performed by Memorex Telex Customer Engineers (CEs). They bring to the customer site all special tools, all test equipment, and the installation expertise needed to meet the installation requirements as well as to verify the results of the installation process through subsystem testing. Installation is a rigidly controlled process; step-by-step instructions are delivered as part of the installation accessories. Instructions are included for:

- Unpacking and visual inspection for shipping damage.
- Mechanical preparations, as required, to remove shipping materials which protect internal assemblies from shipping vibrations and loadings.
- Physical placement and leveling.
- Terminal board checks to assure that boards, associated connectors, cables, and hardware are not damaged.
- Power configuration verification to assure that the 3898-2 cluster control unit's power configurations are compatible with the available power source at the site and that each part of the unit is properly grounded.
- Data cabling as needed for interconnections by multiplex cables and read/write cables, as well as any power cabling required for subsystem input and SP-to-volume connection.
- System testing (prepower and power-on checks) and readiness testing as needed to prepare for operational testing.
- Cabling for interconnections between the SP and the SP/device interface.
- Channel cabling for interconnections between the SPs and the CPU.
- Fitting of any special features.

In the event of installation difficulties, the CEs can implement contingency procedures at the local, district, or regional level, whichever is appropriate.

2.2 3898-2 Installation Specifications

Dimensions:
Height: 175.2 cm (69 in.)
Width: 86.4 cm (34.0 in.) with one side cover
Depth: 92.2 cm (36.3 in.) with covers*
Weight: 344.7 kg (760 lbs)

Service Clearances:
Front: 76.2 cm (30 in.)
Rear: 76.2 cm (30 in.)
Sides: No access required

Cable Lengths:
AC Power: 4.57 m (15 ft.)** each — unit includes two power cords
I/O Channel: 121 m (400 ft.) maximum***

Environmental Conditions:
Operating:
Temperature: 13° to 35°C (55° to 95° F)
Relative Humidity: 10% to 80%
Maximum Wet Bulb: 30° C (86° F)
Temperature Variation: 10° C/hour (18° F/hour)
Humidity Variations: 10%/hour

Nonoperating:
Temperature: –40° to 60° C (–40° to 140° F)
Relative Humidity: 8% to 80%
Maximum Wet Bulb: 27° C (80° F)
Temperature Variation: No condensation

Shipping:
Temperature: –40° to 65° C (–40° to 149° F)
Relative Humidity: 95%
Maximum Wet Bulb: 40° C (105° F)

Power Requirements:

	60 Hz	50 Hz
Voltage:	208/220/230/240 +6/ –13%	380/400/415/440 +6/ –13% 200 ± 10%
Frequency:	60 + 1%/ –2% Hz	50 + 1%/ –2% Hz
Phase:	Three-phase	Three-phase
Branch Service:	60 amperes	45 amperes

Maximum Heat Dissipation: 1.9 kcal/hr (7500 BTU/hr)

Power Consumption: 3.6 kVA, 2.2 kW

Airflow: 21.0 m^3/min (740 cfm)

* This measurement does not include the optional stabilizer foot at the front of the unit. The stabilizer foot adds 27.9 cm (11 in.) to this dimension.

** For 50 Hz configurations, these cables are 5.48 m (18 ft.) long.

*** Reduce this length by 5 m (15 ft.) for each intervening unit connected between the 3898-2 and the channel.

2.3 3890 Installation Specifications*

Dimensions:
Height: 175.2 cm (69 in.)
Width: 57.5 cm (22.75 in.) with one side cover
Depth: 92.2 cm (36.3 in.) with covers**
Weight: 620.5 kg (1368 lbs)***

Service Clearances:
Front: 76.2 cm (30 in.)
Rear: 76.2 cm (30 in.)
Sides: No access required

Environmental Conditions:
Operating:
Temperature: 13° to 35° C (55° to 95° F)
Relative Humidity: 10% to 80%
Maximum Wet Bulb: 30° C (86° F)
Temperature Variation: 10° C/hour (18° F/hour)
Humidity Variations: 10%/hour

Nonoperating:
Temperature: –40° to 60° C (–40° to 140° F)
Relative Humidity: 8% to 80%
Maximum Wet Bulb: 27° C (80° F)
Temperature Variation: No condensation

Shipping:
Temperature: –40° to 65° C (–40° to 149° F)
Relative Humidity: 95%
Maximum Wet Bulb: 40° C (105° F)

Power Requirements: Receives power from the 3898-2

Maximum Heat Dissipation: 3.2 kcal/hr (12,600 BTU/hr)****

Power Consumption: 4.3 kVA, 3.7 kW****

Airflow: 21.5 m^3/min (760 cfm)

* These specifications have been developed for a fully loaded 3890; the unit contains sixteen drawers.

** This measurement does not include the mandatory stabilizer foot at the front of the unit. The stabilizer foot adds 27.9 cm (11 in.) to this dimension.

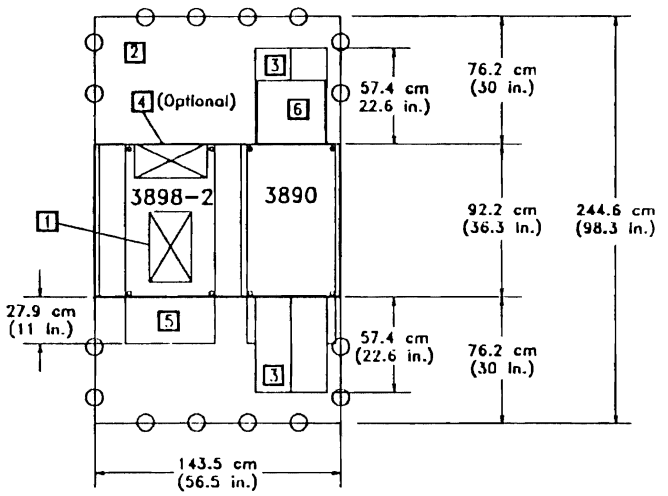
*** The 3890 is a heavy piece of equipment. When planning the installation, the customer should ensure that all flooring between the unloading area and the final location of the module is strong enough to support the 3890. All customer personnel should stay well clear of the unit while it is being moved.

**** Although the 3890 disk module receives power from the 3898-2, its heat dissipation and power consumption specifications are not included in those for the 3898-2.

2.4 Physical Placement

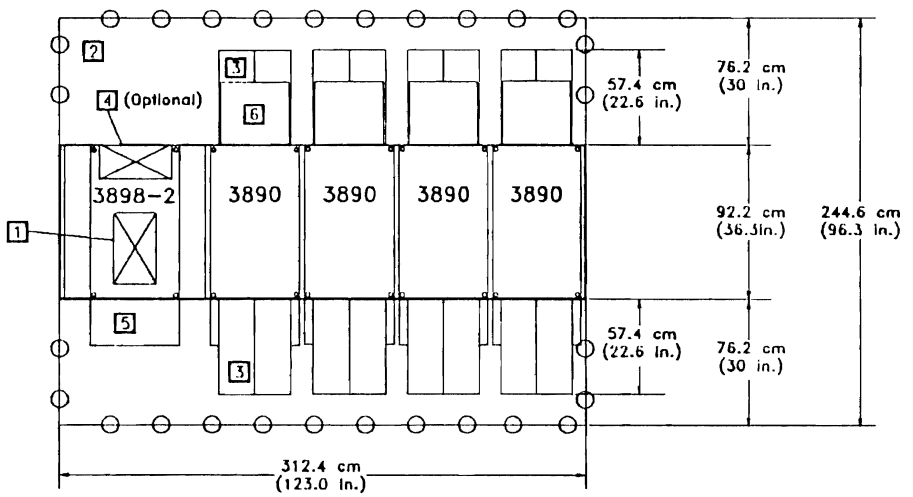
Figure 2-1 illustrates various subsystem layouts. Installation specialists are available to assist in site preparations and installation planning with the customer.

MINIMUM STRING CONFIGURATION



FRONT

MAXIMUM STRING CONFIGURATION



FRONT

NOTES

1. CABLE ENTRIES REQUIRED ON THE 3898–2 CLUSTER CONTROL UNIT ONLY.
2. CUSTOMER MUST PROVIDE CLEAR ACCESS TO BOTH FRONT AND REAR SERVICE AREAS.
3. DRIVE DRAWERS ARE SHOWN EXTENDED TO THE FRONT AND REAR FOR SERVICE.
4. POWER CABLE ENTRY. (1 CAN ALSO BE USED AS THE POWER CABLE ENTRY POINT.)
5. STABILZER FOOT IS OPTIONAL ON THE 3898 AND MANDATORY ON THE 3890. STABILIZER FOOT IS 0.64 cm (0.25 in.) THICK.
6. LOGIC GATE POWER SUPPLY DRAWER SHOWN EXTENDED FOR SERVICE.

LEGEND

- • LEVELING PADS
- CABLE ENTRY (MINIMUM)
- SERVICE CLEARANCE BOUNDARY

SCALE: 2 cm = 1 m
(.25 In. = 1 ft.)

Figure 2-1. Installation Planning Template

2.5 Backup and Recovery

Among the issues that the customer should consider when planning an installation is the generation and maintenance of backup files. The creation of a backup system is advisable for customers who wish to safeguard against the possibility of data loss. The type of backup system implemented is, of course, the customer's prerogative and depends on the equipment available for this task. Data stored on the 3890 drive string may be backed up onto disk media or tape media. Thus, the customer may employ an alternate drive of the same type, any of the previous drive generations, or a tape drive to perform the backup. The customer should note, however, that since the storage capacity and format of the 3890 differs from that of previous drive generations, the data transferred to the backup device may require reblocking and a greater number of disk units. Data may be backed up by volume, data set, or specific track(s).

Prior to installation, the customer should develop an approach to ensure ongoing backup for all critical files. The development of this approach will aid the installation process by facilitating conversion and reformatting for these files which will ultimately be stored on the drive. Following installation, the focus of the backup system will change from conversion to data safety. In this situation, a batch backup system may be used to perform a regular, journal-logged backup. The frequency with which this type of backup is performed depends on how frequently the data sets are updated. Because files may be backed up on a data set basis, the customer may find it convenient to backup those data sets that undergo a high degree of change more frequently than those that are relatively static. In addition to the batch backup system, the customer may wish to implement methods for online data recovery, thus allowing data to be restored immediately after a failure is remedied.

2.6 Subsystem Addressing

At installation time, the CE assigns an I/O address to each 3898-2 storage path channel interface. The assigned storage path address and associated volume address are expressed in a single address byte formatted as follows.

Storage Path and Volume Address

Subsystem Component	3898-2 SP*	3890 Volume
Bit	0 1 : 2 3	4 5 6 7

* Bits 2 and 3 can be SP address bits or volume address bits (e.g., if there are more than 32 logical volumes, then bits 0 - 1 are the SP address and bits 2 - 7 are the volume address bits).

The storage path adaddress is contained in the first nibble of the address byte. It may be bits 0 - 1, 0 - 2, or 0 - 3, depending on the address range of the 3890 volumes. The 3898-2 storage path channel interface can be configured to respond to a 64-volume address range, a 32-volume address range, or a 16-volume address range. No two storage paths on the same channel path should be assigned the same address. The CE and customer should note, however, that the operating system in question may impose certain addressing restrictions; for a discussion of these restrictions, the reader should refer to the *IBM I/O Configuration Program User's Guide* (publication number GC28-1027). Disk module volume addressing is performed automatically by the SP/device interface. Consequently, the CE is not required to manually assign volume addresses at installation. When SYSGENing the CPU, the customer should note that volume addresses may be specified in a 00-0F, 00-1F, or 00-3F. The customer should ensure that all volume addresses are contiguous. In other words, the customer should not skip volume addresses when defining the volume address range. As an aid to the customer, the addresses assigned to the subsystem are reflected on the 3898-2 operator control panels through the use of addressing labels applied by the CE during installation. These address labels define the subsystem ID, the device (volume) address range and, depending on the host system, either the logical address or the channel path identifier for each storage path.

Section 3
Physical Description

This section describes the physical assemblies that constitute each unit in the subsystem. The discussion handles the 3898—2 cluster control unit and the 3890 disk module separately.

3.1 Cluster Control Unit

The 3898-2 cluster control unit is composed of the electronic and mechanical assemblies shown in Figure 3-1. These major assemblies are the logic gates, the power supplies, the power sequencing unit, the ac input assemblies, the input/output tailgate chassis, and the operator control panels. The ensuing paragraphs describe each of these assemblies.

3.1.1 Logic Gates

The logic gates contain the operating electronics for the cluster control unit. There are two logic gates containing printed circuit board (PCB) electronics for four independent storage paths. Also, each logic gate contains cooling fans and a backplane. Each storage path has five functional groups of PCBs as follows: the microprocessor/diagnostic interface boards, the read/write boards, the data transfer buffer boards, the channel interface boards, and the microprocessor-to-microprocessor interface boards.

3.1.2 Logic Gate Power Supplies

The logic gate power supplies provide two dc voltage levels to each of the four storage paths in the storage control unit. The two voltage levels are defined as follows: +5V dc and 5.2V dc–5.2V dc. The 3898-2 houses four logic gate power supplies: two for the electronics of the storage paths in one logic gate and two for the storage paths in the second logic gate. The operation of these supplies is controlled by the power sequencing unit in conjunction with the operator control panel and the remote power interface.

3.1.3 Power Sequencing Unit

The power sequencing unit performs several related functions for both the cluster control unit and the attached disk modules. As its main task, the PSU controls power sequencing for various cluster control unit components; these components include the logic gate power supplies and portions of the operator control panels. Additionally, the PSU manages the power-up sequence for the disk modules and 3890-2 logic gate. In executing this function, the PSU ensures a 10-second interval between power initialization for each component (logic gate and drives); this measure prevents unwanted power surges while the drive string is powering up.

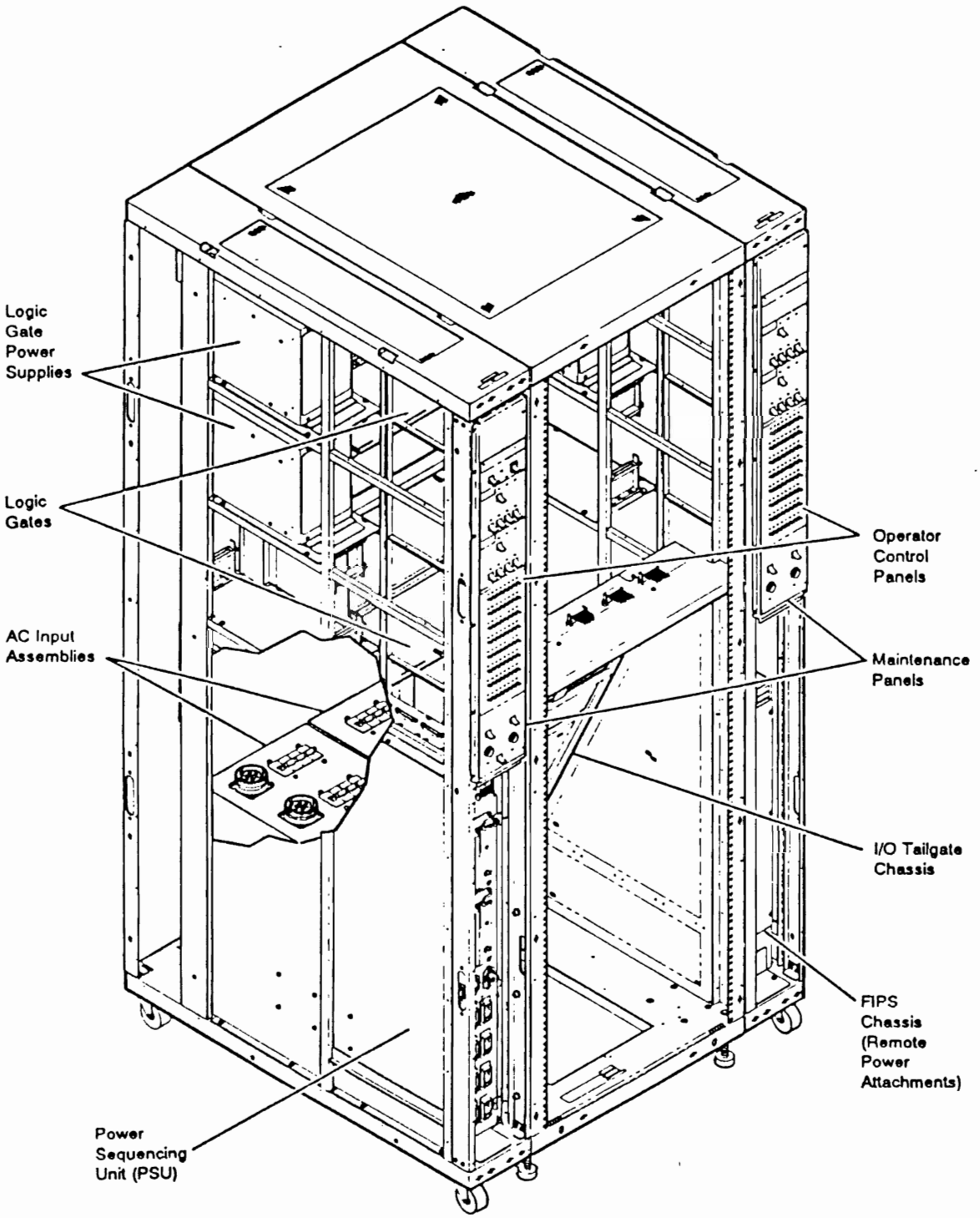


Figure 3-1. 3898-2 Cluster Control Unit Component Layout

The 3890-2 subsystem contains a number of fault-tolerant power supplies. The PSU monitors the status of these supplies and, if a problem occurs, reports the failure to the operator control panel. Simultaneously, a message is passed to the host system, via the storage path microcode, to notify it of the problem.

The PSU also monitors the temperature in the logic gates and disk drive drawers. When a high temperature condition is sensed, the PSU reports the failure to the operator control panel. At the same time, a message is passed to the host system, via the storage path microcode, to notify it of the problem. In the event that an overtemperature condition is reached, the PSU automatically shuts off the associated power supply.

3.1.4 AC Input Assemblies

The 3898-2 contains two ac input assemblies defined as AC1 and AC2; both assemblies provide power cords that connect to the facility source. AC1 and AC2 provide power to two independent power service regions. This allows major power fault rectification and power servicing within one region without the need to remove power from the entire subsystem.

As a safety measure, the ac input assemblies include a circuit breaker for the PSU as well as for each attached disk module. These circuit breakers trip individually whenever overcurrent conditions are detected. If an emergency power-off is initiated at the operator panel, the entire bank of each assembly's circuit breakers trips.

3.1.5 Input/Output Tailgate Chassis

The input/output tailgate chassis houses the inbound and outbound channel data and control lines for two channels per storage path. If the optional four-channel switch feature is ordered, the I/O tailgate houses the inbound and outbound data and control lines for a maximum of 16 channels, four per storage path.

3.1.6 Operator Control Panels

The cluster control unit provides two easily accessed panels of switches and indicators which allow the system operator to manage all of the storage paths and attached disk modules from one convenient location. Each panel provides the controls and indicators for all drives in the subsystem and two storage paths. The control panel itself comprises two subpanels — the operator panel and the maintenance panel.

The operator panel provides the customer with four control functions: subsystem management, storage path management, channel interface management, and device (or volume) interface management. All operator panel switches and indicators are fully visible to the user; each panel is illustrated in Figure 3-2.

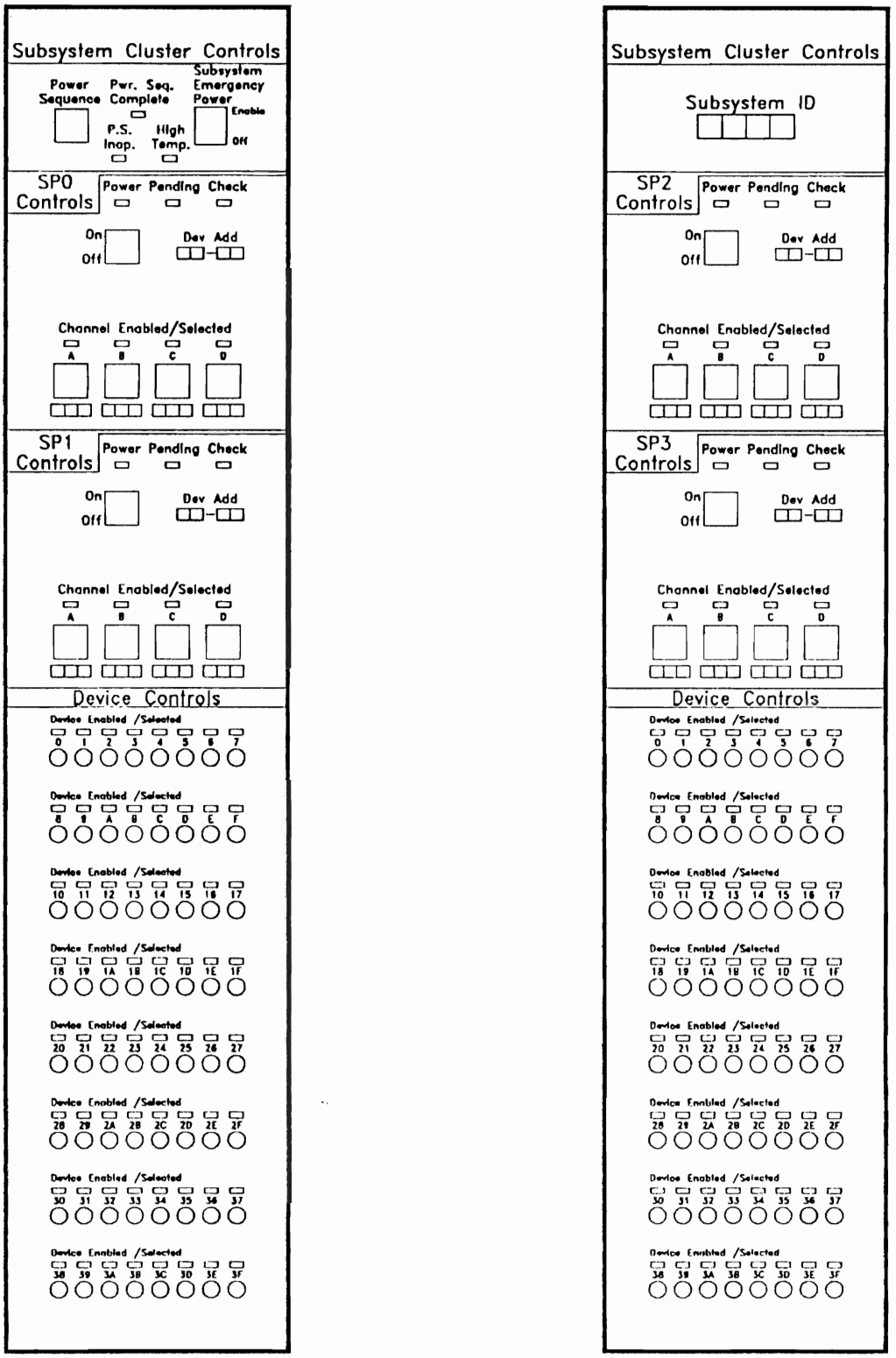


Figure 3-2. Subsystem Operator Control Panels

The maintenance panel furnishes a series of control functions activated during subsystem installation and troubleshooting. Because the maintenance panels are intended for CE use only, these panels lie inside the cabinet and cannot be accessed by the operator. The ensuing discussion introduces the switches and indicators available on the operator panel and defines their use. To help familiarize the reader with the organization of the panel, this presentation has been divided according to the four functional categories.

Note: Maintenance panel functions are not utilized by the customer and are, therefore, omitted from this manual. Reference data on the maintenance panel is provided in the 3890-2 Maintenance Manual (3890-2.20-xx).

Subsystem Management Switches and Indicators (Figure 3-3)

Subsystem Emergency Power Switch — This lever switch acts as the emergency power off (EPO) control for the subsystem. In the Enable (up) position, this switch allows power to pass from the wall outlets to the ac input assemblies and, subsequently, to the power sequencing unit, storage paths, and drives. When pushed down to the Off position, this switch immediately trips the main ac input assembly circuit breakers, thus halting ac power flow from the ac input assemblies to the subsystem. The user should note that the subsystem **cannot** be powered up until the circuit breakers have been reset by a Memorex Telex CE.

Note: The detection of some overtemperature conditions will result in a subsystem power shutdown. This type of shutdown is identical to the EPO sequence initiated by the Subsystem Emergency Power switch and requires CE intervention to correct.

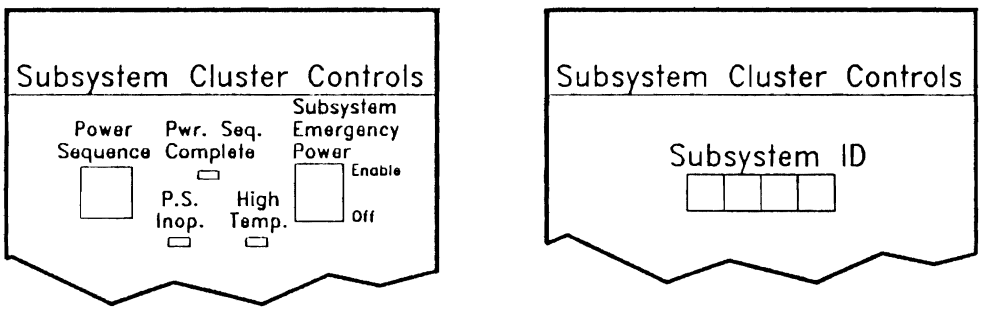


Figure 3-3. Subsystem Management Switches and Indicators

Power Sequence Switch — If operating the subsystem in Local mode, this momentary lever switch controls power to the storage paths and the drives. When pressed upward, this switch signals the PSU to begin the power-up sequence for the storage paths (providing the SP's power switch is on) and the drives. When pressed downward, this switch inhibits the flow of power to the storage paths and the drive string. If operating the subsystem in Remote mode, the Power Sequence switch has no control for powering up but will power down the units.

Power Sequence Complete Indicator — This LED lights when power is applied to all drives; the drives power up at 10-second intervals starting with Drive 0. The power-up sequence may be initiated via the Power Sequence switch (local mode) or from the host system (remote mode).

P.S. Inop. Indicator — This LED lights when the PSU microcode detects any error in the power control subsystem or when any of several subsystem power supplies has failed. Since the subsystem is designed to minimize the impact of power faults through the use of backup supplies, this LED does **not** typically indicate that the subsystem has halted operations. However, the operator should contact the CE immediately. This measure minimizes the risk of downtime in the event that the backup power supply also experiences a problem.

High Temp. Indicator — This LED lights when one or more of the drives or logic gates experiences a high temperature condition. The High Temp. LED also remains on for most overtemperature conditions although, as already noted, some overtemperature conditions will result in a subsystem power shutdown as well. A high temperature condition may be isolated to the failing area via a power system diagnostic function. High temperature conditions are reported as a warning only. However, the operator is encouraged to contact the CE as soon as possible to ensure that the condition is quickly remedied. The operator should note that an overtemperature condition will result in a shutdown of that part of the subsystem. This could be the drive, a storage path, or the whole subsystem.

Subsystem ID — On the right-hand panel, Subsystem ID is an area reserved for the CE to apply an adhesive label to identify the subsystem unit identifier.

SP Management Switches and Indicators (Figure 3-4)

SP Power Switches (one per SP) — These lever switches furnish SP power control. Assuming that the Emergency Power switch is enabled and the unit has been told to power on, the SP power switch, when set to On, sequences power to the associated SP. If set to Off, the switch inhibits power to the SP.

SP Power Indicators (one per SP) — These LEDs light when the corresponding SP has been powered up via the SP Power switch or from the computer system (remote mode). The LED in question lights approximately two seconds after the associated SP Power switch is set or remote power-up occurs. This indicator may turn off during certain maintenance procedures.

SP Pending Indicators (one per SP) — These LEDs light whenever the SP awaits acceptance of status bytes by the channel or response to a retry requested for a drive experiencing certain errors.

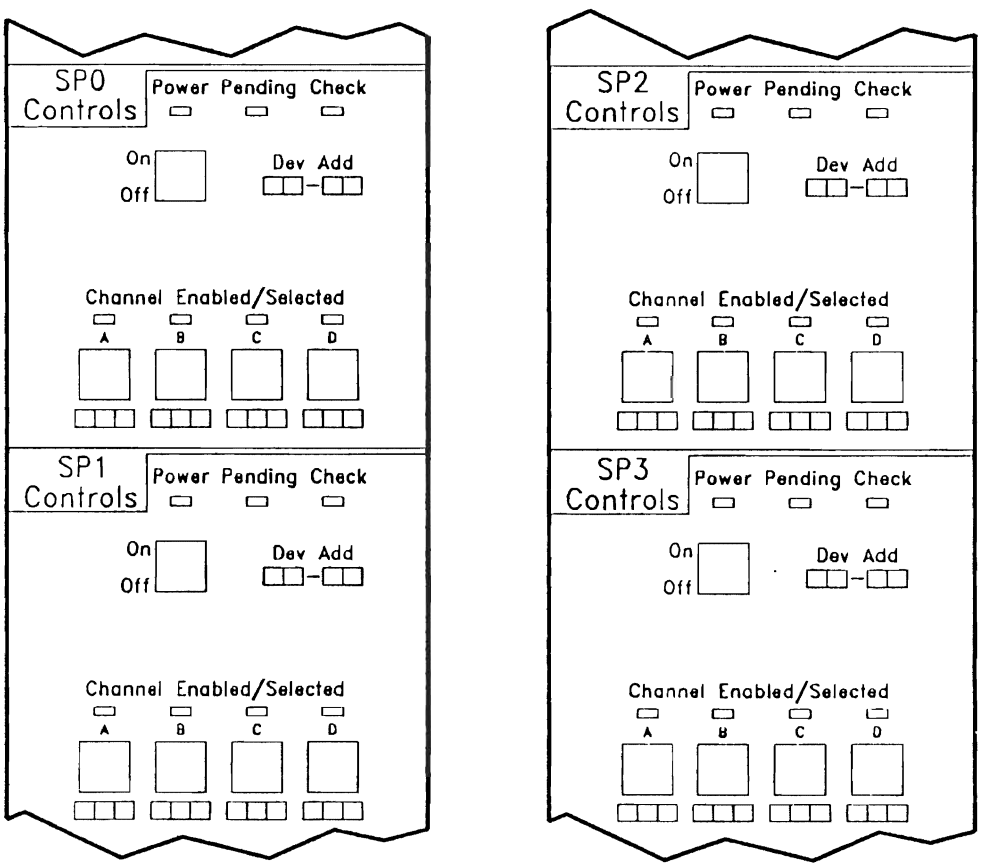


Figure 3-4. SP and Channel Interface Management Switches and Indicators

SP Check Indicators (one per SP) — These LEDs illuminate when the associated SP experiences a Check-1 error. Additionally, these indicators flash four times when the internal power-up diagnostic series completes successfully. If an SP Check indicator lights and remains lit, the corresponding SP is inoperative.

Device Address — This area on each of the panels allows the CE to apply an adhesive label to the surface of the panel which defines the device (volume) address range accessible to the storage paths.

Channel Interface Management Switches and Indicators (Figure 3-4)

Channel Enabled/Selected Indicators (one per channel for each SP) — These dual colored LEDs illuminate in green whenever the associated channel interface is logically enabled. These LEDs light in yellow whenever the channel in question selects the SP.

Channel Enabled/Selected Switches (one per channel for each SP) — These lever switches, in the enabled (up) position, activate the specified channel for the SP in question if that channel is physically installed. When set to the disabled (down) position, these switches inhibit communication between the specified channel and the SP.

The area beneath these switches identifies positions reserved for the CE to apply an adhesive label which defines either the logical address or the channel path identifier for each storage path.

Device Interface Management Switches and Indicators (Figure 3-5)

Device Enabled/Selected Indicators (on each panel, one per volume) — These dual colored LEDs light in green whenever the associated device interface is logically enabled. These LEDs illuminate in yellow whenever the corresponding volume is selected for command execution.

Device Enabled/Selected Switches (on each panel, one per volume) — These lever switches are duplicated on each operator control panel as shown in Figure 3-5. For the device interface to be enabled for **all** storage paths, the associated switch on **both** operator control panels must be in the up position; if the associated switch is enabled on only one control panel, only the storage paths controlled by that panel can access the associated volume. Similarly, **either** switch in the down position inhibits communication with the associated volume for the two storage paths managed by that panel. When both switches associated with a volume are down, the device interface is disabled for all storage paths.

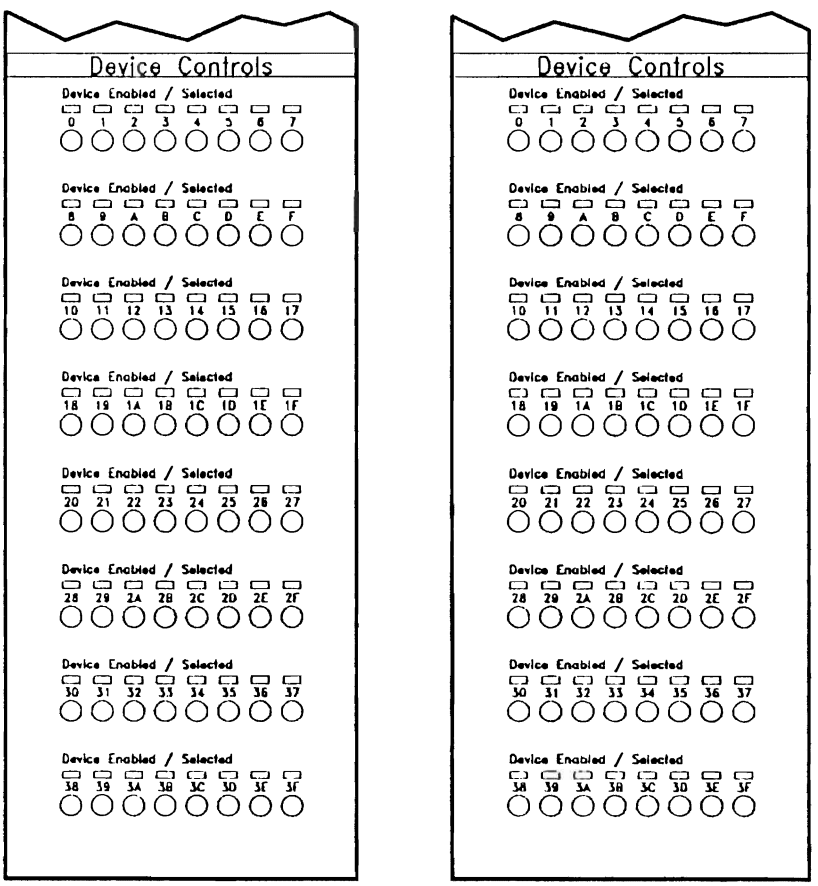


Figure 3-5. Device Interface Management Switches and Indicators

3.2 Disk Module

The 3890 disk module comprises four basic assemblies, as shown in Figure 3-6: the logic gate, the logic gate power supplies, the disk drive drawer, and the airflow system.

3.2.1 Logic Gate

The logic gate contains a configuration-dependent number of PCBs, internal and external interface connectors, and power connections. The logic gate includes two types of PCBs. One type handles direct communications between the SP and drive; the other type manages command conversions and mapping functions for the drive. The following list defines and describes each of the PCBs.

- **SP Interface PCB (SDIF2 PCB)** — This board transfers information between the SP and the DRQP PCB as well as to the drive via the DRQP PCB drivers. The logic gate provides four such boards — one per SP.
- **Drive Interface PCB (DRQP PCB)** — This board receives commands via the SDIF2 PCB, converts them for the drive, and performs various mapping and translation functions. The logic gate furnishes one DRQP PCB per installed drive.

3.2.2 Logic Gate Power Supplies

The logic gate power supplies provide two dc voltage levels to the disk module logic gate. These voltage levels are defined as follows: +5V dc and 5V dc–5.2V dc. The 3890 houses two logic gate power supplies. Both power supplies work in parallel, sharing half of the load. If one supply fails, the other takes on the complete load. The operation of these supplies is monitored by the PSU. In the event of a power supply failure, the PSU reports the fault at the operator control panel and via a system message to the operator.

3.2.3 Disk Drive Drawer

As mentioned, the 3890 disk module cabinet provides various configurations of drive drawers. Each drawer contains one high-performance, high-capacity disk drive, a power supply, fans, and thermal sensors. The 3890 disk drives utilize nonremovable disks and Winchester-type ferrite heads. To complement this technology, the disk media is oxide-based. The disks are housed in a factory-sealed disk enclosure; this approach mitigates the effects of atmospheric change and ensures that the disks are not exposed to external contaminants. The disk drive is equipped with eight disk platters for data storage; the actuator design incorporates twenty-seven data heads and one servo head. The overall storage capacity of each drive is approximately one gigabyte (unformatted).

Each disk drive is composed of four subassemblies: the disk enclosure, the filter system, the spindle drive motor, and the PCBs. The following text briefly describes these components.

Disk Enclosure — The disk enclosure is a factory-sealed assembly containing the disks, heads, spindle, drive motor, and actuator. As a reliability measure, the actuator is statically balanced to reduce the effects of vibration and shock. The enclosure is sealed to prevent head and media damage.

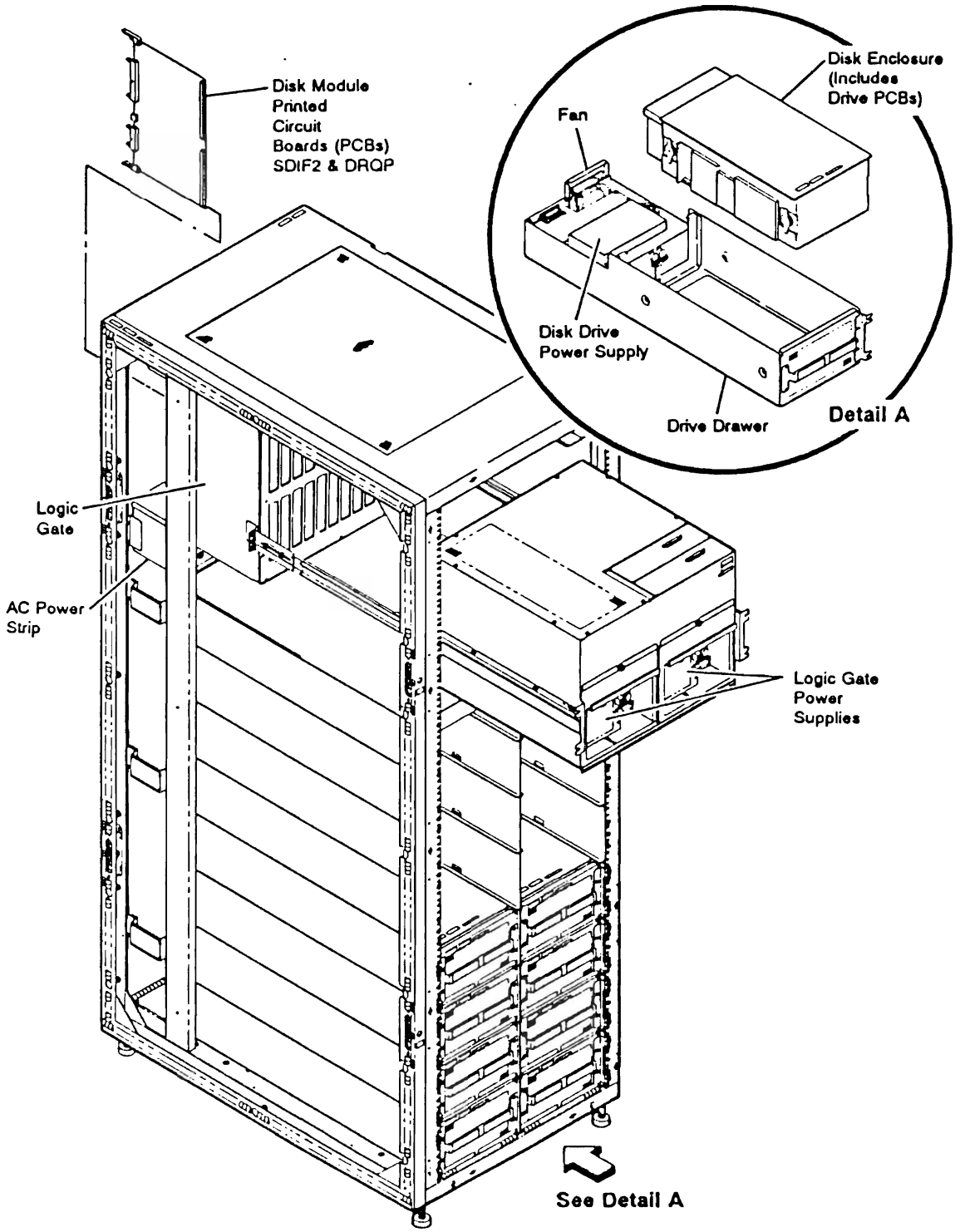


Figure 3-6. 3890 Disk Module Component Layout

Air Filtration System — The air filtration system consists of an internal filter which optimizes purge efficiency and ensures that all air circulating within the disk enclosure is free of atmospheric contamination. The disk enclosure also includes a small breather plug to minimize the effect of pressure changes.

Spindle Drive Motor — The spindle drive motor spins the disks at a steady 3,620 rpm. Both ends of the attached spindle are fully supported, lowering the assembly's susceptibility to shock. The spindle drive motor is a dc-powered motor giving improved reliability.

Drive PCBs — The disk drive furnishes a complement of three PCBs: the Main Control Circuit PCB, the Subcontrol Circuit PCB, and the Power Amplifier PCB. The Main Control Circuit PCB handles all interface functions. The Subcontrol Circuit PCB performs head positioning, seek operations, etc. The Power Amplifier PCB is associated with spindle activities and power-up sequences. Each of the PCBs is field-replaceable to reduce disk downtime and to protect the user's data.

The disk drive power supplies provide four dc voltage levels to the disk drive. These voltage levels are defined as follows: +5V dc, 5V dc–5.2V dc, 12V dc–12V dc, and +24V dc. The 3890 provides one power supply per drive for added reliability. The power-on sequence for each power supply is governed by the PSU.

The disk drive drawer also contains cooling fans and thermal sensors. The fans add air circulation within the cabinet and serve to protect the drawer components. The thermal sensors detect both high and overtemperature conditions. On detecting a high temperature condition, the High Temp indicator lights on the operator control panel and the system operator is alerted to the problem via a message to the operating system. If the situation deteriorates into an overtemperature condition, the PSU automatically powers down the affected drive.

3.2.4 Airflow System

The cabinet airflow system draws room air from the front of the cabinet into the interior of the cabinet. Fresh air flows freely through the rear cabinet louvers, maintaining an even temperature within the unit. Further cooling is provided by muffin fans located in each drive drawer and in the logic gate. These fans increase open-air circulation for those 3890 components that require additional cooling as well as for the cabinet as a whole.

Section 4
Functional Description

To familiarize the customer with the basics of this subsystem's architecture, this section describes the functional hardware groups that constitute the 3898-02 cluster control unit and 3890 disk module.

4.1 Cluster Control Unit Functional Description

The 3898-02 cluster control unit is composed of six functional hardware blocks: the channel interface, microprocessor, read/write unit, Volume Level Selection Enhanced (VLSE) function, the buffer, and the device interface. The following paragraphs describe each of these functions individually.

4.1.1 Channel Interface

The cluster control unit can be attached to eight channels or, with the channel expansion feature, a maximum of sixteen channels. Channel connections are arranged with two (standard) or four (optional) channels interfacing into each of the four storage paths.

The channel interface allows communication between the SP and the active channel. It receives commands, data, and device selection information from the channel via a 9-bit Bus Out line (8 bits of data, 1 bit for parity). Conversely, the channel interface transmits data, selected I/O addresses, status information, and sense data to the channel via a 9-bit Bus In line. The channel interface uses Tag lines to define the type of information that it transmits. Tag lines perform interlocking and controlling tasks as well as special sequences. The subsystem transmits data across the channel at a rate of three megabytes per second.

4.1.2 Microprocessor Function

The microprocessor acts as a central managing device for SP operations. As its main function, the microprocessor interprets commands, establishes certain conditions required for command execution, performs diagnosis, monitors interrupts, handles interface data and command transfers, monitors microprocessor-detected error conditions and executes various selection tasks. The microprocessor consists of control storage which contains the current program and ROM control storage which contains functional and diagnostic programs required by the SP. The registers contain current instructions, current external interrupt levels, internal pointers, condition codes, service interrupts, check condition records, etc. The microprocessor also performs data correction for all fields when handling a data transfer operation. In addition, it maintains disk drive usage logs and transmits these logs to the channel during channel operations.

The microprocessor control storage retains SP microcode and data. The control storage has an overall addressing capacity of 128K words. Microcode instructions are accessed from ROM or read/write memory according to the function being performed and whether the expansion RAM has been enabled. At power-on, the maximum amount of addressable ROM is available and the code is loaded into expansion RAM. After power-up diagnostics have completed, the control storage may be switched (under microcode control) to provide execution from RAM through the entire address range.

4.1.3 Read/Write Unit Function

The read/write unit is a multifunctional logic group that performs a variety of tasks; these tasks center around the preparation and receipt of data for the disk drive. The following description covers the main tasks executed during read/write unit processing.

- The read/write unit aids the device interface in controlling data format for the disk drive. As stated, the device interface transfers data, commands, and status/sense information to and from the addressed drive. The read/write unit receives instructions on handling interface information from the microprocessor in the form of control registers. The read/write unit employs Direct Memory Access (DMA) to transfer data in and out of the unit without the aid of microprocessor program control. The microprocessor only intervenes when generating control information prior to each data transfer, when an exceptional condition occurs, or when an operation is successfully completed.
- The read/write unit serializes and deserializes data. Data transfers between the SP and the selected drive occur in bit-serial form. During a write transfer, the read/write unit converts data bytes from the channel into serial format and transfers the data bit by bit to the drive. Conversely, during a read, the read/write unit converts bit-by-bit data from the drive into a byte (parallel) format and transfers the data to the channel. In both instances, the transfer of data through the read/write unit must be synchronized with the rate at which it is being read from or written to the disk drive.
- The read/write unit performs defect skipping functions and gap counter processing. For the user's reference, defect skipping is defined as a method of logically avoiding faulty areas of the media. Gap processing involves the construction of interrecord and intrarecord gaps — fields which separate record from record and field from field on the disk drive track.
- The read/write unit handles the error detection operation. The read/write unit's logic generates twelve error correction code (ECC) bytes that reflect the content of each field of data transferred to the drive during a write transfer. These ECC bytes are appended to the associated Data field at the time that the field is written on the disk. When the field is read from the disk, the ECC circuits check the field data and the appended ECC bytes. The ECC circuits note any data errors detected during this read check and generate corrective information. The SP processor is notified when an error is detected; the SP then retrieves the information generated by the ECC circuits for the appropriate corrective action. The data is then corrected in the SP buffers.

- The read/write unit generates and checks a two-byte error detection code (EDC). The purpose of the EDC is to ensure that data is accurately transferred within the SP. For write operations, the channel interface function generates the code and the read/write unit checks the code against the data. Conversely, for a read operation, the read/write unit produces the code and the channel interface function performs the data verification.

4.1.4 Volume Level Selection Enhanced (VLSE) Function

The VLSE feature is an integral part of the cluster control unit function and allows the four storage paths to access any four separate volumes simultaneously, thus lowering the number of delays resulting from device busy conditions. Under the VLSE feature, each SP communicates volume status of the other SPs during volume selection and deselection. This measure ensures that each SP maintains complete, up-to-date information for all volumes in the string. Additionally, each of the four storage paths stores channel path information for each device. This information allows dynamic reconnection to any available member of the channel path group. To organize this information, the VLSE feature utilizes a buffer memory array within each SP; the array stores information on the volumes, channels, and path groups. All communication between the four storage paths is structured in distinct communication packages. Each package consists of a 16-bit command word accompanied by the number of words required to complete the command function. Different packages regulate volume access, keep volume data current, maintain channel path information, and perform interface diagnostics. The interface hardware manages requests for simultaneous transmissions by means of a tie-breaker circuit. The hardware is capable of stacking multiple packages in its First-In-First-Out (FIFO) circuitry.

4.1.5 Buffer Function

The buffer group transfers data to the SP interfaces. The buffers for each interface line store data that is fed to the interface. The buffers consist of a series of registers that maintain pointer locations, data transfer initialization, transfer counts, and parity checks; these registers control and sequence data flow during a transfer operation.

4.1.6 Device Interface

The device interface functions as the communications path between the storage path and the attached disk modules. The interface consists of a group of registers, inbound data lines (Device Bus In), outbound data lines (Device Bus Out), and control lines. Bus In and Bus Out are 9-bit lines (8 bits of data, 1 bit for parity) which transfer read/write commands and information between the storage path and the disk drive. These lines are accompanied by lines (Tag) that transmit control, selection, response, and status information.

Storage path/drive control communication is carried out over the Device Tag Bus, Device Bus Out, and Device Bus In lines. The storage path can send the drive 23 orders for execution. Drive response, when required, is in byte format on Device Bus In.

4.2 Disk Module Functional Description

The following paragraphs define the five basic functional groups that constitute 3890-2 logic; these groups consist of the device interface function, the drive control function, the servo function, the read/write control function, and the read detector function. This discussion covers the logic on a function-by-function basis.

4.2.1 Device Interface Function

The device interface function allows two-way communication between the SP and the individual volumes; this function also performs rotational position sensing during SP disconnect loops and executes autopadding functions. In a general sense, the device interface function translates the Bus and Tag data issued by the SP into a form that the drive can process. The device interface function utilizes both a microsequencer and microcontroller. The microsequencer receives Tag commands and determines whether a given command requires immediate execution. Those commands which entail straightforward, rapid execution are then converted into an equivalent drive command (if necessary) and forwarded directly to the drive. Commands of this type include Set Head Address Register, Reset Attention, etc. If the microsequencer establishes that the command in question is more complex, it forwards the command to the microcontroller which converts the commands and transmits them to the drive. Among the commands that do not require instant processing are various sense commands (Sense Target, Sense Device Type, etc.) and control commands (Set Target, Seek-To-Cylinder, etc.). In addition to handling nonimmediate commands, the microcontroller transmits Bus information associated with these commands. Read/write data, on the other hand, is transferred directly to the drive.

4.2.2 Drive Control Function

The drive control function manages various drive operations and commands. The drive control logic stores the functional code which performs power-up/down sequences, servo-rezero sequences, and Tag command execution. In addition, this function stores diagnostic code executed by the storage path, host, or diagnostic monitor. Supporting the drive control function is the circuitry used for timing sequences and accessing operations. This circuitry furnishes the cylinder address registers, the target address register, various status registers, and servo calibration constants. The drive control logic also manages the access register, servo difference counter/register, and Bus In multiplexer which gathers sequence and servo status for the storage path. As another of its tasks, the drive control function provides check logic that flags sequence, access, and sector noncompare problems for the storage path.

4.2.3 Servo Function

The servo function responds to translated orders by moving the servo head to a relative cylinder address specified by the SP. The relative cylinder address is defined in terms of the difference between the current cylinder address and the target cylinder address. The servo function manages the VCM which extends and retracts the servo head and mechanically linked read/write heads until they are positioned as necessary for completion of an operation. This series of operations transfers information from the servo surface to the servo logic via the servo head. The servo logic uses the information to control servo velocity during seeks and thus maintain precise alignment of the servo head and mechanically linked read/write heads.

4.2.4 Read/Write Control Function

The read/write control function develops and controls read/write operations for the drive; this function channels digital read/write data from the selected drive port to the actuator and vice versa. The read/write control function includes logic that generates read and write signals. It also detects Index and inner/outer guardband patterns from the servo surface. The read/write control function selects the correct head to execute the read/write operation. In addition, this function monitors the read/write circuitry for error conditions. Upon detecting an error, the logic terminates the read/write operation and notifies the SP of the type of error that occurred. As another of its tasks, the read/write control function maintains status information which will be transferred to the SP over the Bus In drivers when requested.

4.2.5 Read Detector Function

The read detector function receives preamplified analog signals from the actuator for head operation. When the logic gate transfers digital write data to this function, the read detector transforms the data it receives into transition data which is subsequently converted to head current switching on the head arm assembly. Raw analog read data is received from the head preamplifier, buffered, filtered, and recovered to form digital read data. In addition, the read detector function includes safety circuits which provide check conditions for chip selection, multichip selection, write transitions, write current, open head, and shorted head to ground.

Section 5
Subsystem Maintenance

5.1 Maintenance Philosophy

The maintenance philosophy for the 3890-2 subsystem represents significant advances in efficiency and convenience. The majority of CE troubleshooting is performed via a Portable Maintenance Terminal (PMT). When diagnosing a subsystem unit, all higher or equal level units are 100% available to the customer for data operations. This approach allows the CE to keep the number of components dedicated to a test session at a minimum. Thus, as many components as possible remain available to the host system. In addition to PMT testing, the CE may review a variety of drive specific problems via the drive diagnostic panel. This diagnostic panel is a field tool that plugs into each drive, and allows the CE to select a variety of drive-level diagnostics. Utilizing this method, the CE is able to isolate drive faults with minimal disruption of the normal 3890 disk module job flow. The following paragraphs describe the Portable Maintenance Terminal and drive diagnostic panel, as well as the various test programs available for the 3890-2 subsystem.

5.2 Portable Maintenance Terminal (PMT) Testing

The Portable Maintenance Terminal (PMT) is a portable CE control/display panel. The PMT furnishes a keyboard and display for command entry and test monitoring. As illustrated in Figure 5-1, the PMT includes a display, a character keyboard, four shift keys, and four shift status indicators. The display is formatted to provide one line of 16 characters. The keyboard is composed of 24 keys and produces 128 ASCII characters and codes. Twenty of the keys are defined as character keys and four keys are defined as shift keys. Each character key is capable of transmitting any one of the four characters printed on the key. The single exception is the CTRL key which does not transmit characters, but rather, has a special conversion function that adds formatting potential. Selection of a particular character from a character key is a process of the shift keys which define which of the four characters on a given key will be transmitted. The shift status indicators illuminate when a particular shift key is activated by the operator. The Portable Maintenance Terminal may be attached to any SP or the PSU via a PMT interface.

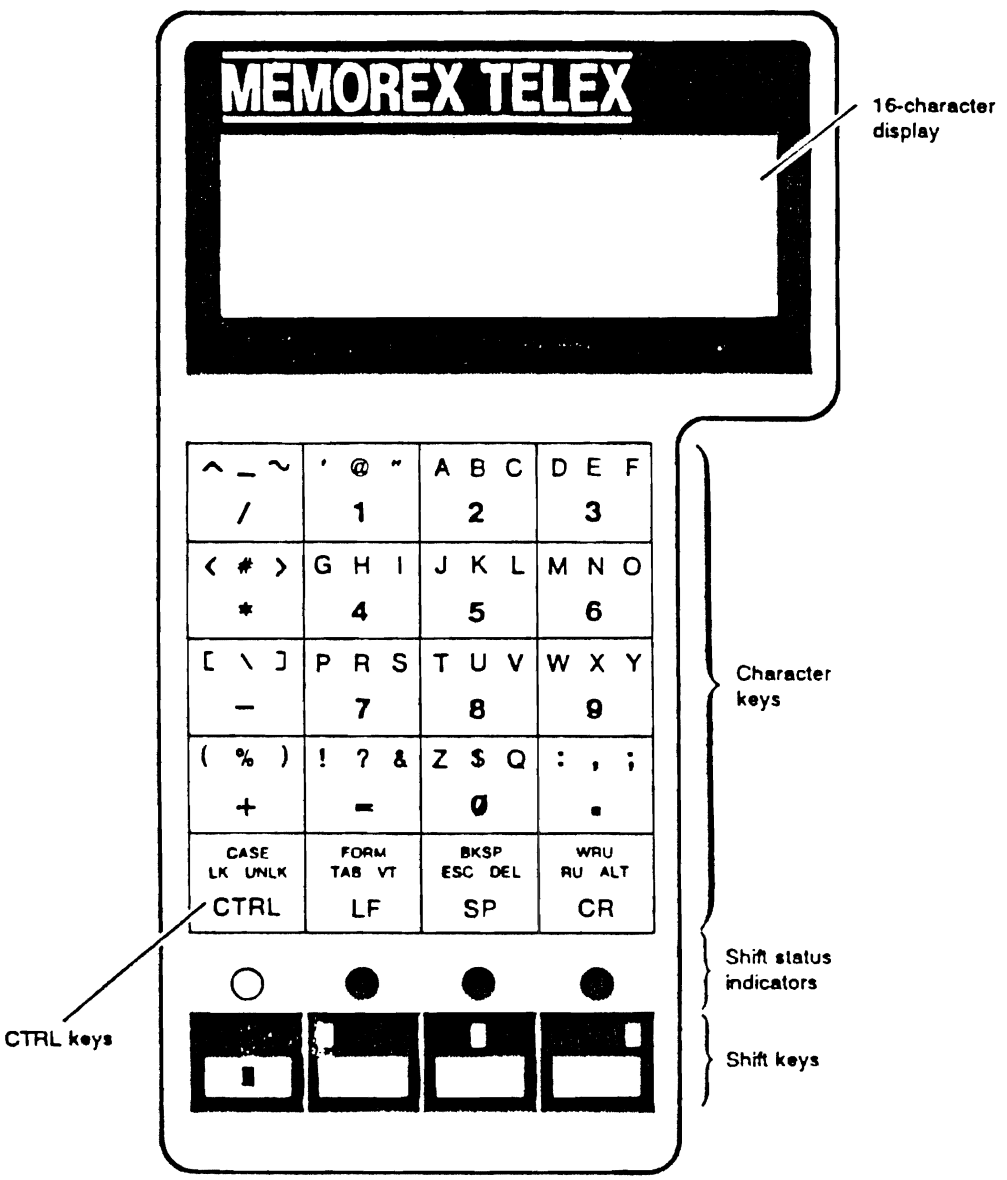


Figure 5-1. Portable Maintenance Terminal (PMT)

5.3 Drive Diagnostic Panel

Like the PMT, the drive diagnostic panel is a portable field tool. The panel is equipped with a 24-pad keyboard, LED display, and 5-position fault code display as shown in Figure 5-2. When the CE wishes to exercise certain drive functions or execute diagnostic tests, the diagnostic panel may be plugged into a receptacle on the drive. The CE may then enter any of the three test modes furnished by the panel. The first of these, status mode, allows the CE to review the operation of the drive while the unit is online and performing normal user jobs. The second mode, seek test mode, permits the CE to vary the individual drive offline to the SP; the CE may then execute various seek exercises against the drive. The CE may specify whether errors from the session are to be logged or disregarded. The third mode, log review mode, allows the CE to review the number and type of errors encountered while the other two modes were active. While testing, the CE observes the LED display and fault code display to determine the current status of the unit and whether the drive experienced any faults.

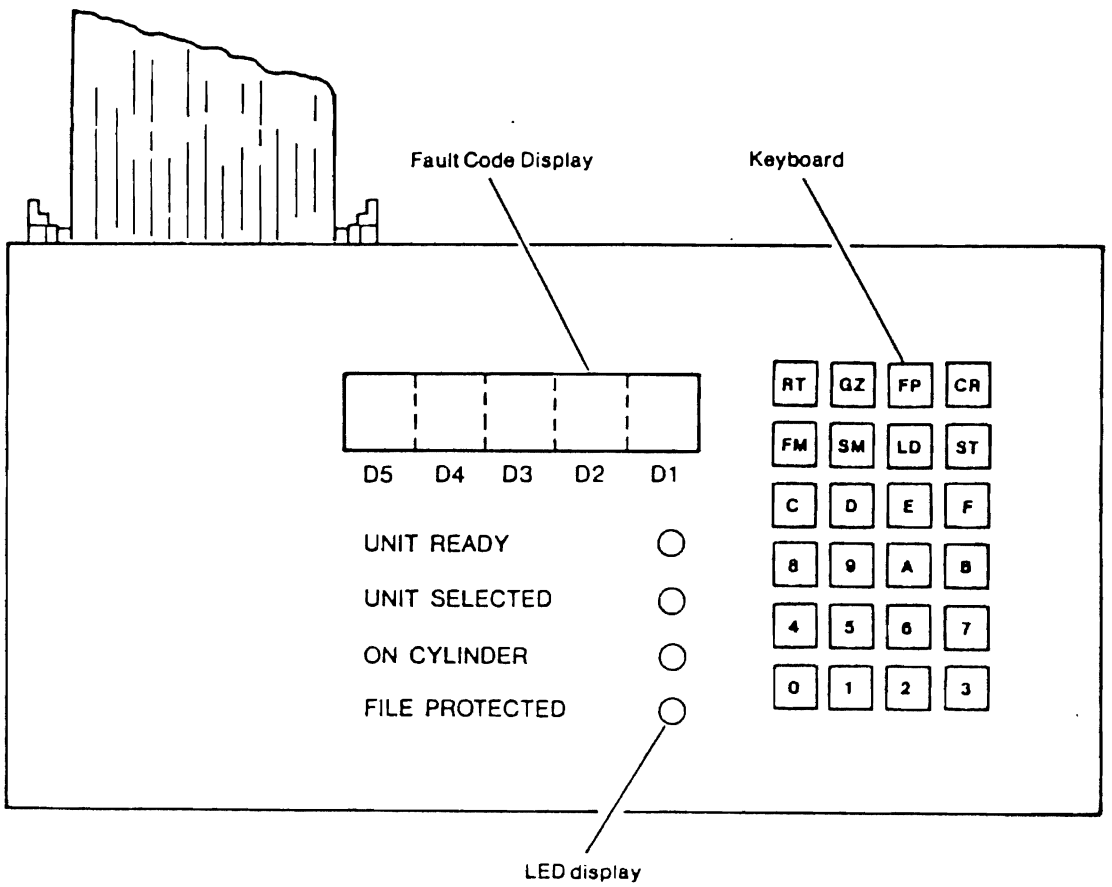


Figure 5-2. Drive Diagnostic Panel

5.4 Subsystem Microdiagnostics

The diagnostic routines available for the subsystem provide extensive test capabilities. Microdiagnostic testing for all devices may be performed at the SP level with the use of a Portable Maintenance Terminal (PMT). Microdiagnostic testing for the drive and SP includes the following categories: power-up tests, channel interface tests, external register tests, RAM tests, buffer tests, ECC tests, seek tests, read tests, write tests, servo tests, PCB tests, drive interface tests, media surface analysis tests, and drive selection tests.

5.5 Other Test Packages

Additional test packages for the subsystem include both CPU-executed and diagnostic-type programs. Among these programs are the Fault Isolation Diagnostic System (FIDS) and programs focusing on media evaluation.

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