PRODUCT SPECIFICATION

FOR

CARTRIDGE MODULE DRIVE

MODEL 9448

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TABLE OF CONTENTS

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

1.0 SCOPE

This document describes the Model 9448 Cartridge Model Drive (CMD) which is a member of Control Data Corporation's Module Drive family of disk products. Contained in this document are descriptions of the functional and physical characteristics of the 9448 CMD. The interface description, however, is contained in a separate specification (refer to paragraph 2.1).

2.0 APPLICABLE SPECIFICATIONS, STANDARDS and DOCUMENTATION

2.1 SPECIFICATIONS

Specification No.	Title
64712400	Flat Cable Interface Specification for SMD, MMD and CMD.
76204375	M1204 Disk Cartridge Product Specification

2.2 STANDARDS

The 9448 CMD is designed to meet CDC standards for equipment safety, reliability, maintainability, EMI, and EMC. These include or surpass the requirements of UL and CSA.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE , MODEL 9448

2.3   DOCUMENTATION

The following documentation is available as support documentation for the 9448 CMD.

Publication No.   Title

75888415   CMD Hardware Maintenance Manual

3.0   GENERAL DESCRIPTION

The 9448 CMD is a member of Control Data Corporation's Module Drive family of Random Access Rotating Disk Mass Memory Devices. In addition to the CMD the Module Drive family also includes the Storage Module Drive (SMD) and the Mini Module Drive (MMD).

The Cartridge Module Drive (CMD) is a rack mounted unit which features both fixed (i.e. not operator removeable) and removeable media and is available in any of three capacity ranges as shown in Figure 1.

*CAPACITY

PRODUCT	REMOVEABLE	FIXED	TOTAL
9448-32	16 MB	16 MB	32 MB
9448-64	16 MB	48 MB	64 MB
9448-96	16 MB	80 MB	96 MB

* Unformatted using 808 cylinders.

Figure 1. CMD Capacity Ranges, Fixed and
            Removeable Configurations

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

3.0   -contd.

The CMD utilizes the CDC M1204 Front Loading Cartridge as removeable inter-changeable media storage. M1204 cartridges written on one CMD can be read and/or updated on another CMD provided that the recording formats employed by the CMD's host systems are compatible with each other.

The CMD unit consists of a cartridge receiver; spindle, drive motor and braking system, fixed media, read/write and servo heads; voice coil positioner and track following servo; a logic chassis containing read/write, microprocessor, I/O, servo and drive control electronics; a filtered air supply and a DC power supply.

A hinged front door provides access for installation and removal of the front load cartridge. A removable cover provides access to the electronics, heads, actuator and power supply.

4.0   PERFORMANCE SUMMARY

The performance characteristics of the various models of the 9448 CMD are summarized in Figure 3.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448
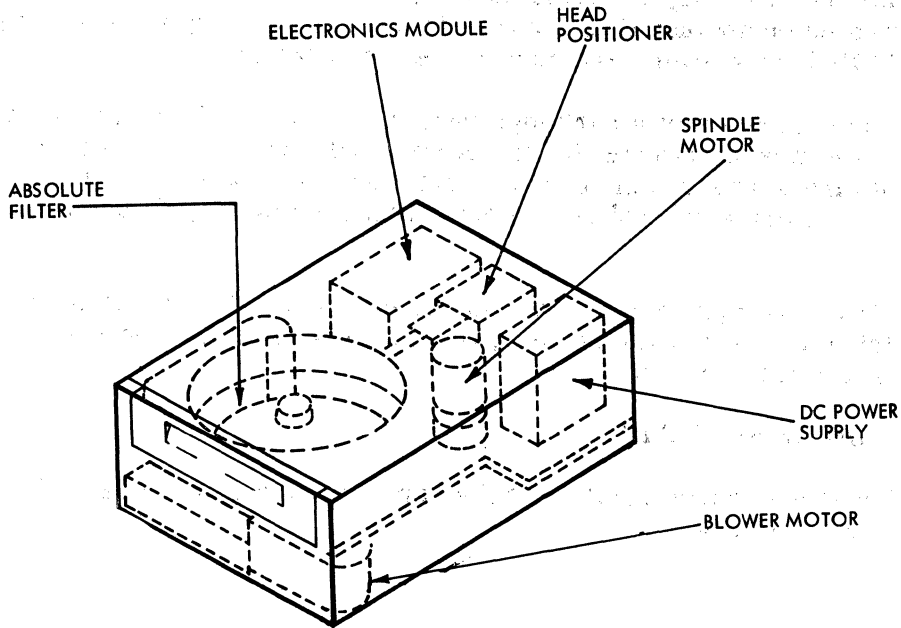
Figure 2. 9448 CMD Major Components

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

	9448-32	9448-64	9448-96
Capacity △1			
Removeable Cart.	16 MB	16 MB	16 MB
Fixed Pack	16 MB	48 MB	80 MB
Total	32 MB	64 MB	96 MB

Removeable Cartridge
Useable Cylinders △2

CDC M1204
808

Data Heads			
Cartridge	1	1	1
Fixed Pack	1	3	5
Total	2	4	6

Servo Heads			
Cartridge	1	1	1
Fixed Pack	1	1	1
Total	2	2	2

Unformatted Track
Capacity

20,160 Bytes

Recording

Mode   MFM
bpi   6038 bpi Nominal Inner Track
tpi   384

RPM   3600 (+2.5%; -4.0%) Rev/Min
Data Transfer Rate   9.67 Mhz (Nominal)

Maximum Latency △3   17.4 msec
Average Latency △4   8.33 msec

Positioning Times △5

Single Cylinder   6 msec
Average   30 msec
Maximum (822 Cylinders)   55 msec

Figure 3.   CMD Performance Summary
(Sheet 1 of 2)

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

NOTES

⚠1 Unformatted capacity is stated in millions of Bytes for Convenience. (Actual Unformatted capacity, of any Data Surface, based upon 808 tracks and 20,160 8 bit bytes per track would be 16,289,280 bytes)

⚠2 There are 823 tracks on each data surface. At the time of shipment from the point of manufacture each CMD fixed pack will contain 808 usable tracks plus not less than 8 usable spare tracks on each data surface. (See paragraph 6.5.1 for further definition & explanation)

⚠3 Based on minimum Disk Speed of 3456 Revs per min.

⚠4 Based on nominal disk speed.

⚠5 See paragraph 6.1.1 for further clarification.

Figure 3. CMD Performance Summary. (Sheet 2 of 2)

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

5.0   MAJOR CMD ASSEMBLIES & COMPONENTS

Refer to Figure 2 for approximate Component locations.

5.1   HEAD POSITIONER

Head positioning is performed using a closed-loop proportional Servo System with both acceleration and velocity feedback. The carriage is driven by a Voice-Coil Linear Actuator utilizing positioning information recorded on the dedicated Servo Surface of either the Cartridge or Fixed Pack. The appropriate servo surface is selected prior to the start of a new positioner movement (or seek).

5.2   DECK & SPINDLE

The CMD employs a rigid cast-aluminum deck. An AC induction motor and precision spindle are attached to this rigid deck to insure positive registration and seating of the cartridge to the spindle. The Head Positioner Assembly is also mounted directly to the deck assembly.

5.3   AIR SUPPLY & FILTERING

A direct drive blower provides cooling air to the CMD. The Air Supply to the cartridge receiver and to the fixed pack is filtered by a 0.3 micron absolute filter. To maintain the cleanliness of the fixed pack and receiver areas, the blower assembly operates whenever AC is present in the CMD.

5.4   CARTRIDGE RECEIVER

A front loading cartridge receiver is employed to load the CDC 1204 cartridge into the CMD and to register it correctly onto the spindle. The design of this receiver together with the design of the CDC 1204 cartridge is such that it combines the front loading convenience of older technology cartridge drives (i.e. 2315 types) with the desireable features of the TOP Loading cartridge drives (i.e. 5440 types) in regard to the method by by which the rotating disk is loaded/unloaded on the disk spindle.

5.5   POWER SUPPLY

The power supply assembly provides all of the DC voltages required to operate the CMD.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

5.6 ELECTRONICS MODULE

The electronics module contains the majority of the electronics components needed to interface the CMD with its host control unit and to operate the CMD. The majority of the logic employed in the CMD has been implemented using low power Schottky circuits while ECL components are used in critical timing areas of design such as in the read/write circuits. The CMD also employes a microprocessor and standard microprocessor building blocks. The microprocessor is utilized within the CMD for a variety of tasks such as coarse seek control, spindle start/stop and internal event monitoring.

Figure 6 contains a block diagram of the CMD and Figure 7 illustrates the Electronics Module and its printed circuit card contents.

5.7 OPERATOR CONTROL PANEL

The operator control panel is located on the front of the CMD as shown in Figure 1. This panel is illustrated in Figure 4, the function of the various controls and indicators are described in Figure 5.

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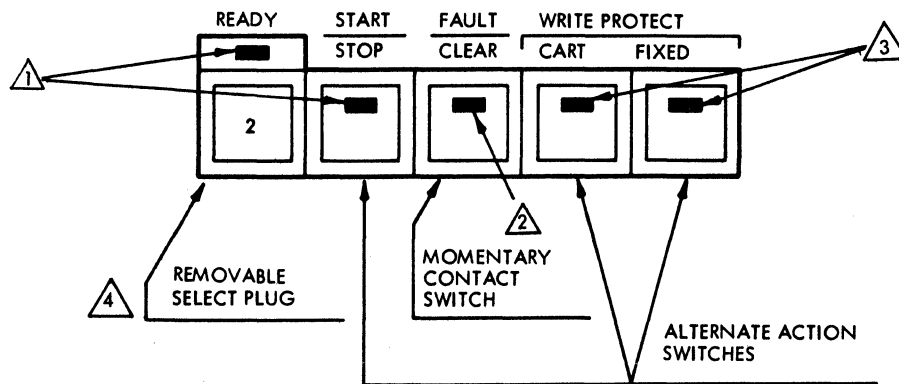
NOTES:

⚠1 GREEN INDICATOR

⚠2 RED INDICATOR

⚠3 AMBER INDICATOR

⚠4 CMD ACCESSORY

(Z098a)

Figure 4. CMD Operator Panel

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

CONTROL OR INDICATOR NAME	TYPE LIGHT	TYPE SWITCH	TYPE PLUG	FUNCTION
SELECT			X	Assigns the SELECT number (00-07) to the CMD. Plug also provides quick visual recognition of assigned SELECT number.
READY	X			Indicates Unit Ready Status; i.e. disks are up to speed, heads are loaded and no fault requiring manual unit event exists within the CMD. Additionally the READY light will blink throughout the spindle start or stop sequence and will be off in a stop sequence after the spindle has stopped.
START/STOP		X		This alternate action switch is used to start and stop the spindle. The spindle can only be started when a cartridge is in place.
	X			This indicator is illuminated when the START/STOP switch is in the start position (depressed).
FAULT	X			This indicator will be illuminated when any fault condition is present.
		X		This momentary closure switch is used to clear fault conditions (Refer to paragraph 14.4.).
WRITE PROTECT CART or FIXED		X		These alternate action switches are used to write protect the fixed pack or the cartridge. Depressing a switch disables the appropriate write driver circuits within the CMD.
	X			These indicators are illuminated when either of the WRITE protect switches are in the WRITE PROTECT mode.

Figure 5. CMD Operator Panel Controls & Indicators

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

5.8   FIXED PACK

The CMD also contains a fixed (i.e. not removeable or data interchangeable) pack which provides 16 mbytes of fixed capacity in the standard 9448-32 CMD configuration.

The fixed pack module is not readily visible within the CMD since it is located under the deck plate of the cartridge receiver mechanism. This module contains three magnetic disks on which servo information and data are recorded. In the 9448-32 configuration only the middle disk is used while the higher capacity models also employs one or both of the two remaining disks.

6.0   PERFORMANCE CHARACTERISTICS

6.1   ACCESS TO DATA

6.1.1   Head Positioner Movement

Head positioner movement (often referred to as a physical seek) involves the physical movement of the head positioners carriage assembly from one location to another. Such an operation is typified by a movement, for example, of the carriage from cylinder 200 to cylinder 225. In such an operation head positioning time is measured from the receipt, in the CMD, of the interface command containing the cylinder address 225 until the completion of the operation as signaled by the generation of an "on cylinder" indication by the CMD's I/O interface.

DISTANCE	AVERAGE MAXIMUM TIME
A. Cylinder zero to Cylinder 822	55.0 msec.
B. Cylinder zero to Cylinder 410	45.0 msec.
C. Single Cylinder (any two adjacent cylinders)	6.0 msec.
D. Average (sum of all possible movements ÷ by number of movements)	30.0 msec.
E. Zero distance seek when executing a volume change without a change in cylinder address	4.0 msec.

(Refer to Figure 9 for a profile of CMD Seek performance.)

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448
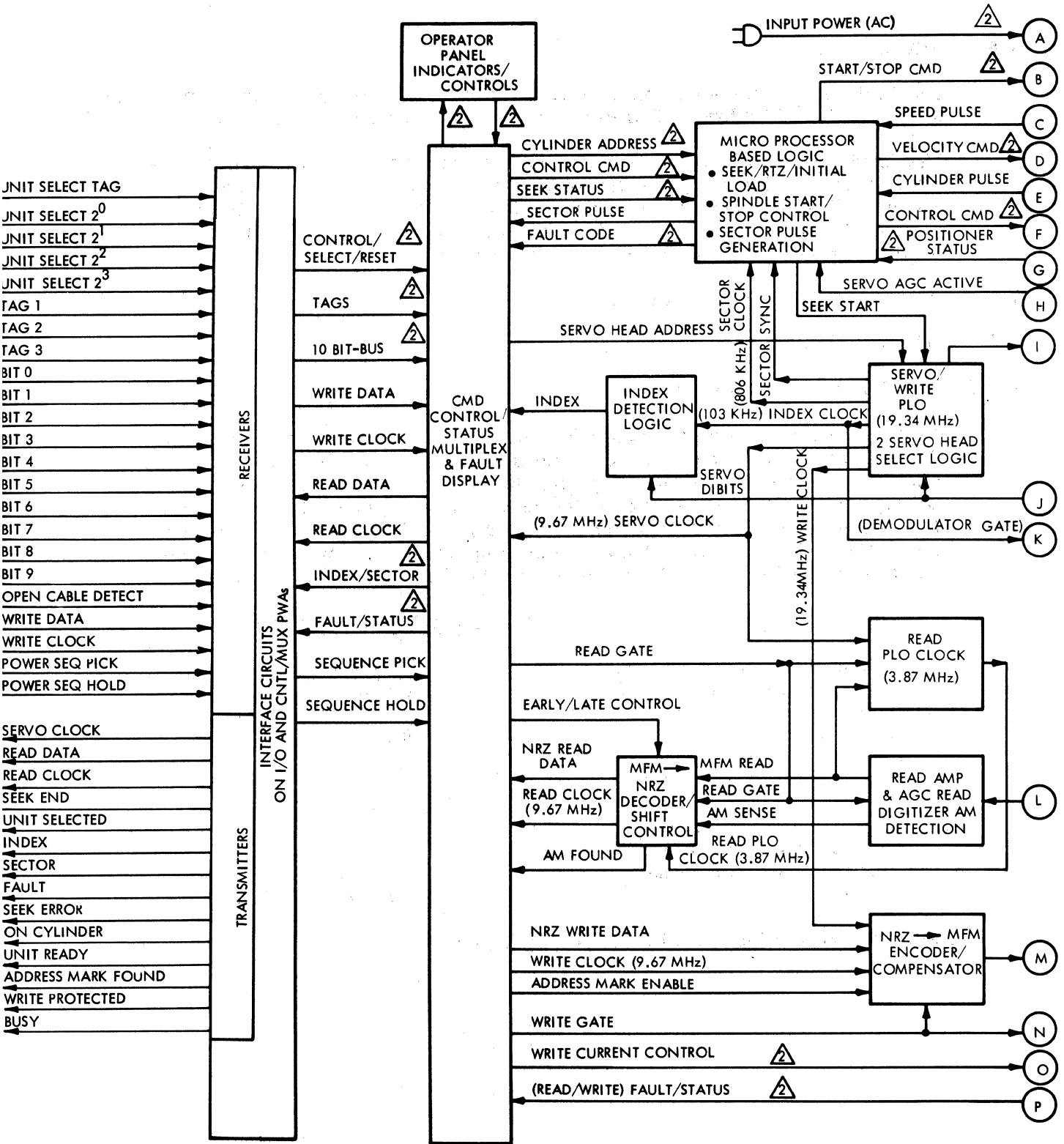
⚠ DENOTES MULTIPLE LINES

Figure 6. Block Diagram - 9448 CMD (Sheet 1 of 2)

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448
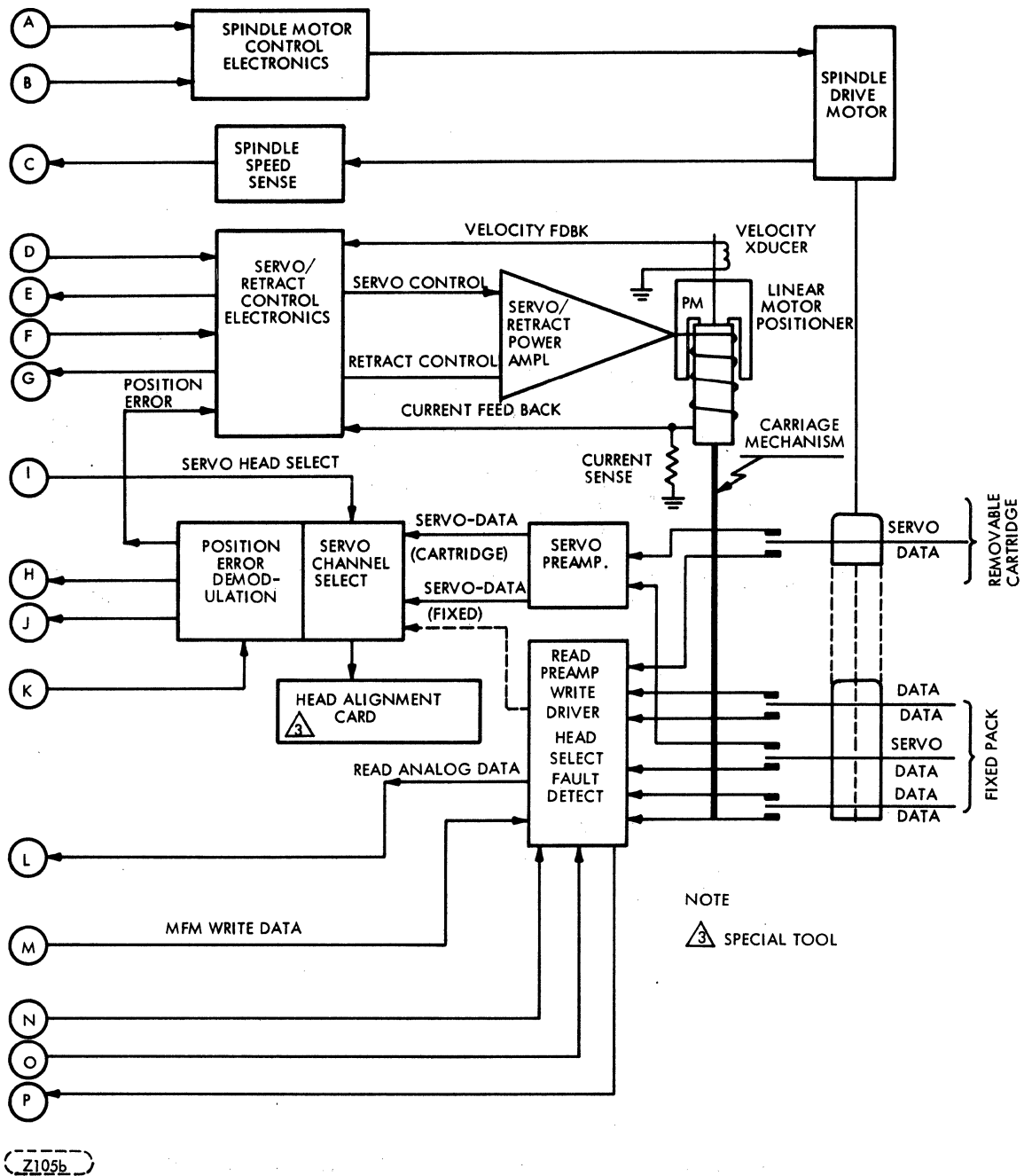
Figure 6. Block Diagram – 9448 CMD (Sheet 2 of 2)

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

ELECTRONICS MODULE

Z096b
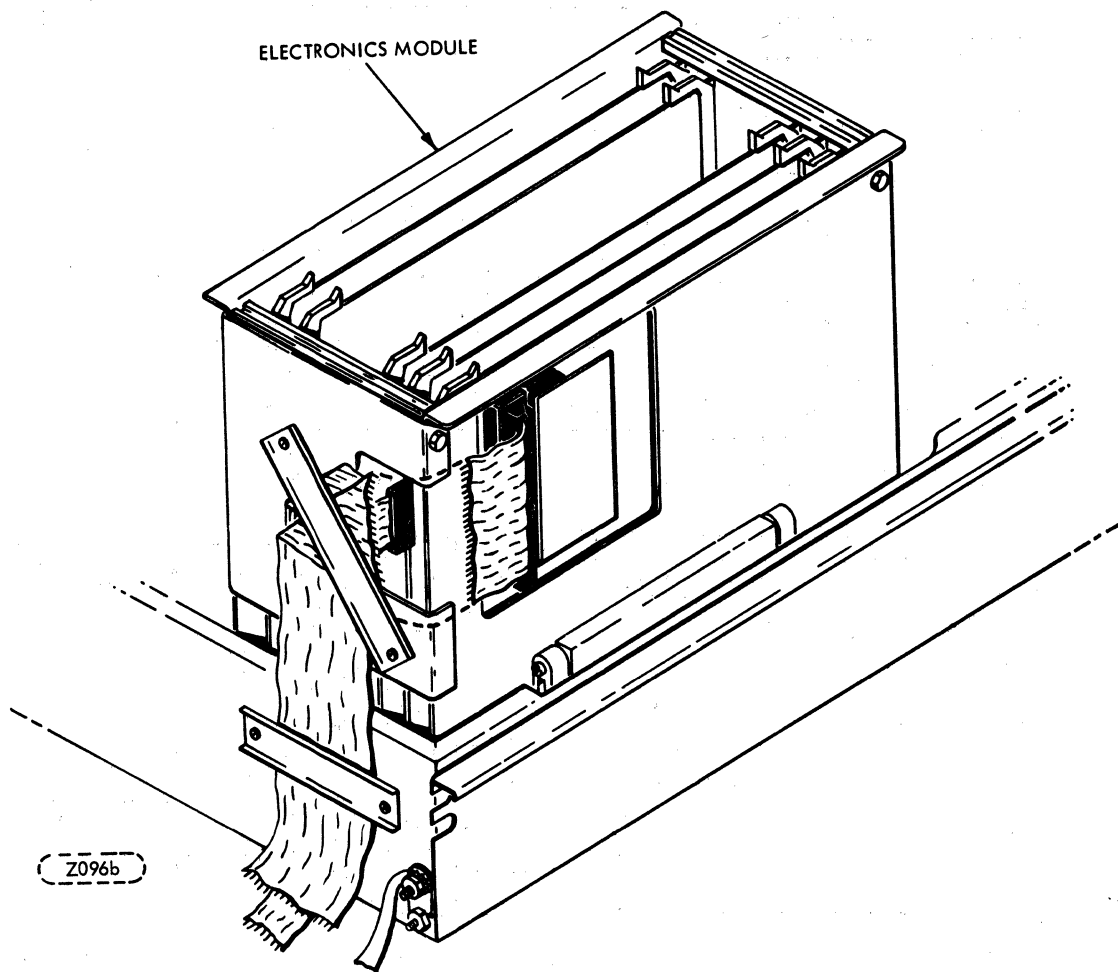
Figure 7. CMD Electronic Module (illustrated with
I/O Cabling installed.)

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

6.1.2   Spindle Speed and Latency

The spindle speed is 3600 +2.5 -4.0% r/min. The speed tolerance includes motor performance, pulley tolerances and the mains voltage and frequency variation specified. This does not include other variables which affect data transfer rates, (see paragraph 6.3).

The average latency time is 8.33 ms, based on a nominal disk speed of 3600 r/min.

The maximum latency time is 17.36 ms, based on a minimum disk speed of 3456 r/min (3600-4.0%).

Latency time is defined as the time required to reach a particular sector after positioning is complete.

6.1.3   Read Initialization Time

Between the deselection of one head and the selection of another head, there is a 5.0 us delay within the CMD due to circuit characteristics. The time from the initiation of a head change until data can be read with a selected head without error, is 24 us, maximum (5.0 us for head selection, and 10 us for read amplifier stabilization and 9.0 us for phase lock synchronization).

6.1.4   Write-To-Read Switching

Assuming that head selection has stabilized and a Write operation is in progress the required time interval between the end of the Write operation (Write Gate) and the initiation of a read operation (Read Gate) is 10.0 usec (minimum).

6.1.5   Read-To-Write Switching

Assuming that head selection has stabilized and a read operation is in progress, the required interval between the end of the Read Operation (Read Gate) and the initiation of a Write operation (Write Gate) is 0.3 usec (minimum).

6.1.6   Volume Addressing and Switching

The CMD contains two media volumes, the cartridge (removeable volume) and the fixed pack (fixed volume), each containing its own servo surface as illustrated in Figure 8. When read/write operations are to be directed from one volume to the other, the head positioning system switches from one servo surface to the other and achieves track following on the new servo surface. This process imposes certain restrictions on use of the CMD during the transition.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

6.1.6   -contd.

The method of addressing a new volume and the operating characteristics relative to volume control are as follows:

Addressing a new volume requires a two-command sequence: As described in interface specification 64712400. Briefly this sequence involves:

A. Volume - selection to set-up the conditions for the volume change including the head to be used after the volume change. AND:

B. Seek command which causes the transition from one volume to another to occur.
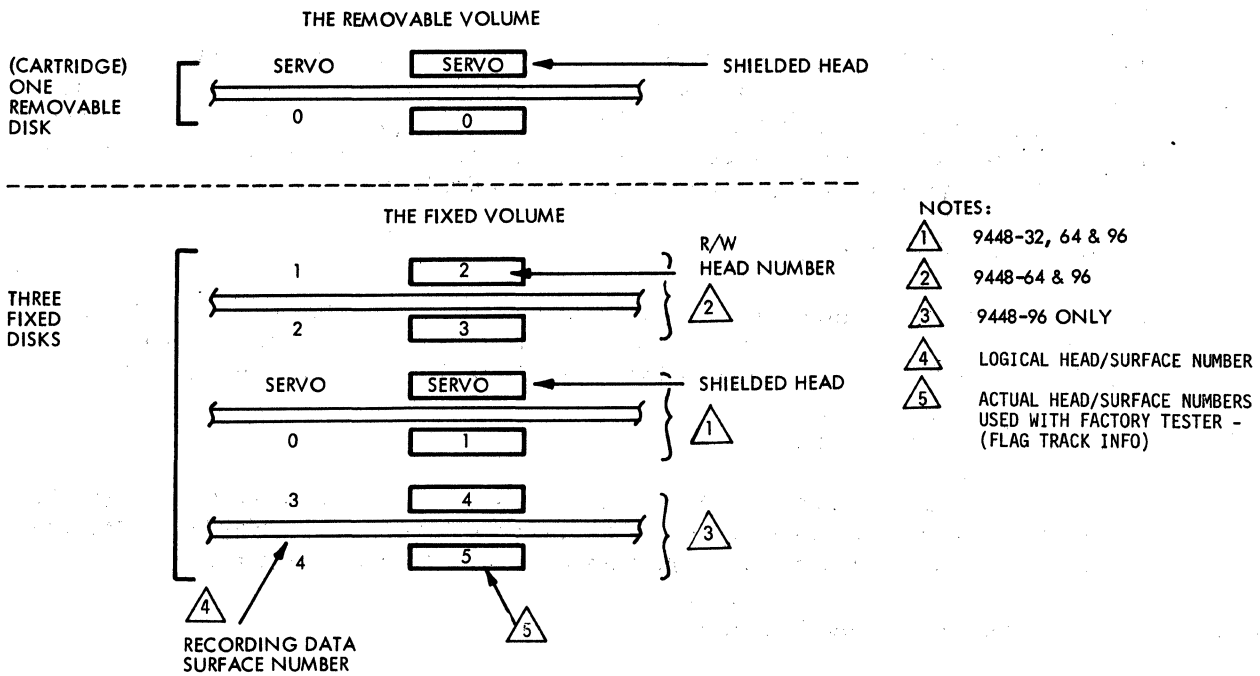
Figure 8. CMD Fixed & Removeable Volumes

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

6.1.6   -contd.

This may place some restrictions on the system employing the CMD which may not be obvious to the system designer:

1. After a volume-select command, servo track-following continues with the old volume until a seek command is received. The next seek command causes the servo circuits to be switched from the old volume to the new volume.

2. The volume-select command may be sent at any time prior to the seek command, however the CMD read/write head register is also loaded from bus out during the volume-select command, selecting the new read/write data head.

3. The volume select command should therefore not be issued until Read/Write operation on old volume is completed. The volume select command can be re-issued to select the original volume and a valid head address if continuation of the Read/Write operation becomes necessary.

4. The volume-select command should contain the head address for the new volume.

5. If the head address for the new volume is not known when the volume-select command is sent then any valid head address for the new volume should be sent with the volume-select command. Head address=zero is recommended because it is valid for both volumes.

6. If an invalid head address is sent with the volume-select command then a no head selected fault will occur.

7. Upon receipt of the first seek command after a volume-select command:

   a. Servo clock will be undefined while the servo clock is rephased to signals from the new volume.

   b. Index and sector pulses will be inhibited.

   c. Responses (a & b) occur only when the new volume is different than the old volume and are not produced by redundant volume addressing.

   d. The seek will be initiated. Seek duration will be as given in Section 6.1. Repositioning does not occur in the event of redundant volume addressing when the seek is to the present cylinder address.

8. The CMD self-initializes upon power-up and selects the cartridge volume, head 0.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

6.1.6   -contd.

9. The volume selection is retained, it is not necessary to command a volume
prior to every read/write operation to the same volume. However the
volume change bit must remain valid for the selected volume.

10. RTZ causes an automatic change to the cartridge volume, head 0.

11. A 25 microsecond delay should be added after ON-CYLINDER becomes active
and before the next seek command, when the seek command is part of
one of the following sequences:

   a. repetitive zero track seeks without volume change,
   b. repetitive single track seeks without a read or write operation.
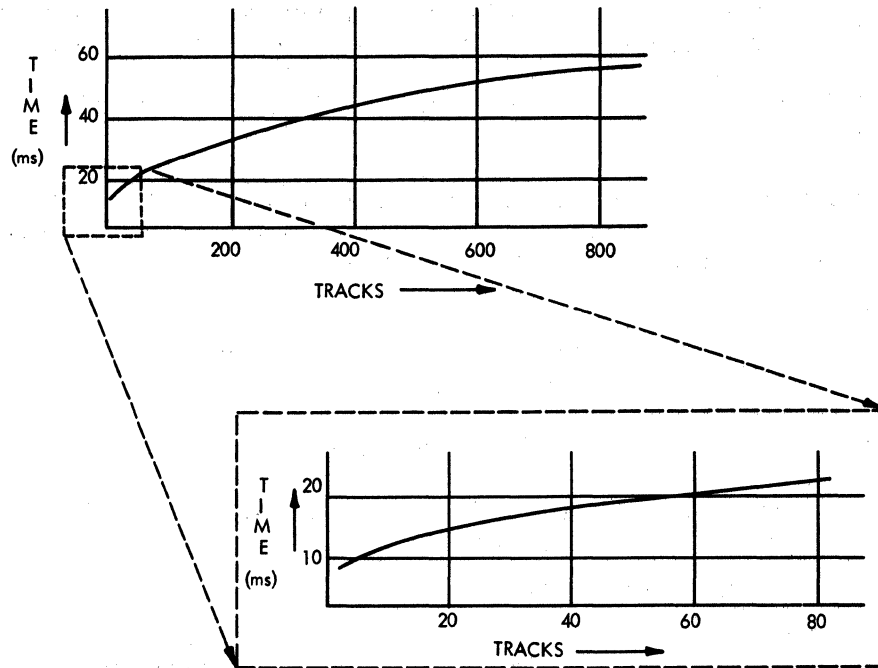
Figure 9. CMD Typical Seek Profile

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

6.2 START/STOP TIME

Assuming that a CMD cartridge has been correctly inserted into the CMD and that the front door is closed and locked the time for the CMD to come into the Ready State after the START/STOP switch has been depressed is 45 seconds typical, (70 seconds maximum).

The time to completely stop the rotating disk after the START/STOP switch is switched off in 30 seconds typical (35 seconds maximum). If AC power is lost the spin down time of the disk is 180 seconds typical.

6.3 DATA TRANSFER RATES

The serial data transfer rate is 9,676,800 bits/sec (1.2096 mega bytes/sec.). The range of transfer rate variations on a bytes/sec basis for read/write operations is +4.0% to -5.5%. This range includes the effects of all factors effecting spindle speed variations and dynamic jitter on a byte-to-byte basis. Data on the interface is NRZ while the CMD internally converts this information to MFM for reading and writing.

6.4 ERROR RATES

The error rates stated in this specification assume:

a. that the CMD is adjusted to specification;
b. that a CDC 1204 CMD Cartridge is employed on the CMD;
c. that a data format will be employed that fulfills the data format requirements of the CMD as outlined in interface specification 64712400;
d. that errors caused by media defects or CMD equipment failures are excluded.

6.4.1 Read Errors

Prior to the determination or measurement of Read Error rates:

a. The data which is to be used for a measurement of read error rates must be verified as being written correctly on the media;

b. All media defect induced errors must be excluded from error rate calculations. (see paragraph 6.5).

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

6.4.1.1 Recoverable and Unrecoverable Read Errors

A recoverable read error is one that can be re-read correctly in 27 or less retries. These retries must include three attempts to read at each combination of data strobe and carriage offset.

The recoverable read error rate for any read operation shall be less than one error in 10^{10} bits read.

An unrecoverable read error is one which cannot be recovered after 27 retries to read the record. These retries must include three retries at each combination of strobes and carriage offsets.

The unrecoverable read error rate shall be less than one bit in 10^{12} bits read.

6.4.1.2 Environmental Factors

When operating at low effective data transfer rate, e.g., random access of single short records, the effective error rate may be expected to exceed the above limits due to external environmental interference. The resulting recoverable read error rate shall be no more than one error in eight hours of operation.

6.4.2 Write Errors

Write errors can occur as a result of the following: write data not being presented correctly, media defects, or equipment malfunction. As such, write errors are not predictable as a function of the number of bits passed.

For the case of an unrecoverable write error occurring because of a CMD equipment malfunction, the error is classified as a failure affecting MTBF. Unrecoverable write errors are those which cannot be corrected within three attempts at writing the record with a write verify after each attempt.

6.4.3 Seek Errors

A seek error is defined as a condition where the CMD fails to position to the correct cylinder as indicated by the information on the I/O. There shall be no more than one recoverable seek error of this type in 10^6 physical seek operations. Nonrecoverable seek errors are classified as failures for MTBF calculations.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

6.5 MEDIA DEFECTS

Media defects are characterized as being either correctable or uncorrectable based upon the type of data error condition they can create. While the defects in the media cannot be corrected it is possible to correct the data errors they create by using the appropriate error correction code in the recorded data pattern.

In the CMD by definition, a correctable media induced error is one that is equal to or less than 11 bits in length (i.e. the total span of the media defect cannot exceed 11 bits). Similiarly an uncorrectable media induced error is one that is greater than 11 bits in length.

6.5.1 Fixed Pack Media

The CMD fixed pack will be tested and certified in the CMD prior to shipment of the CMD from the factory. This certification process will only test and certify the fixed pack configuration present in the particular CMD at the time of its manufacture. Those fixed pack data surfaces which are not used in the particular CMD confguration will be untested and therefore are not certified. This certification process will determine the types and location of the media defects present in the CMD fixed pack prior to shipment. This information will be supplied to CMD customers for use in flagging and reallocating the tracks on the CMD fixed pack.

The CMD fixed pack will:

a. have neither correctable nor uncorrectable errors in cylinder 0 or cylinder 822. (i.e. tracks 0 and 822 of all fixed pack data surfaces used in the particular CMD's configuration);

b. have not more than 2 uncorrectable error tracks on any fixed pack data surface;

c. have not more than 6 correctable error tracks on any fixed pack data surface; and;

d. have not more than a total of 7 error tracks (i.e. combination of b & c) on any fixed pack data surface.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

6.5.2   Cartridge Media

The physical media employed in CDC's M1204 Cartridge is the same disk media used in the CMD's fixed pack and is subject to similiar concerns insofar as media defects are conceived.

The technical characteristics of the cartridge are contained in the cartridge product specification (specification 76204375 for the CDC M1204 Cartridge) and that specification must be used for birding cartridge specifications. However a review of this specification will reveal that:

a. Cylinders 0 and 822 of the cartridge are free of both correctable and uncorrectable errors &;

b. Not more than 6 tracks on the cartridge will contain correctable errors.

6.5.3   Error Correction Codes (ECC)

In order to obtain optimum performance with the CMD it is recommended that an error correction code (capable of correction errors which may span a total of 11 bits) be employed by all CMD customers.

6.5.4   Recommended Systems Utilization of the CMD Fixed Pack & Removeable Cartridge

All statements regarding CMD storage capacity are based upon the utilization of 808 active tracks per data surface. At the time of shipment from the factory, the CMD will contain not less than 8 additional good data tracks on each CMD data surface. These 8 additional tracks are considered to be spare tracks which should be used or made active when one or more of the originally active 808 tracks begin to exhibit unacceptable data error rate characteristics. When such a condition develops the unacceptable error track should be deallocated (i.e. made inactive) and its task should be reassigned to one of the spare tracks.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

7.0   CMD/CONTROL UNIT INTERFACE

The detailed description of the CMD's Control Unit interface is described in CDC specification 64712400. The information regarding this interface contained in this product specification has been included solely for the convenience of the user of this CMD product specification. In the event that there are descrepancies between the information contained in this section and the referenced interface specification the Interface specification is to be considered the governing information source.

7.1   CMD SYSTEMS CONFIGURATIONS

The CMD interface will support its use in either "Star" or "Daisy Chain" configurations as illustrated in Figure 10.

7.2   I/O CABLING

Two signal cables are used to interface the CMD. The first cable is referred to as the "A" cable and contains those signal lines illustrated in Figure 11. The "A" cable may be connected in either a "Star" or Daisy Chain configuration as illustrated in Figure 10.

The second signal cable used is known as the "B" cable and it contains those signal lines illustrated in Figure 12.

The I/O connectors for the A &B cables are located on CMD printed circuit cards in the Electronics Module as illustrated in Figure 13.

7.3   CMD TAG & BUS DECODE

The input bus lines on the "A" cable (illustrated in Figure 11) are multipurpose and are used to input cylinder addresses, head addresses and control functions. These bus lines are used with the A cable TAG Lines as illustrated in Figure 14.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

STAR SYSTEM CONFIGURATION

DAISY CHAIN SYSTEM CONFIGURATION
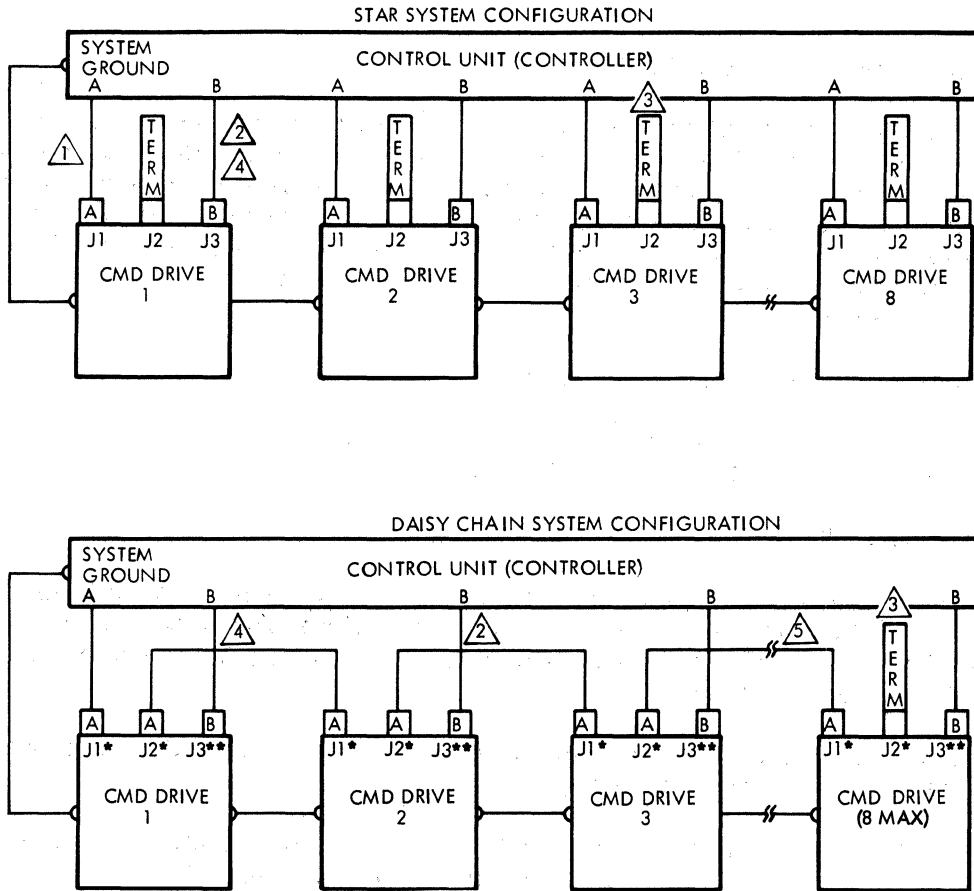
NOTES

⚠1 MAXIMUM INDIVIDUAL A CABLE LENGTHS = 100 FEET

⚠2 MAXIMUM INDIVIDUAL B CABLE LENGTHS = 50 FEET

⚠3 TERMINATION OF "A" CABLE LINES ARE REQUIRED AT CONTROLLER AND THE LAST UNIT OF THE DAISY CHAIN OR EACH UNIT IN A STAR.

⚠4 TERMINATION OF "B" CABLE RECEIVER LINES ARE REQUIRED AT THE CONTROLLER AND ARE ON THE RECEIVER CARDS OF THE CMD.

⚠5 MAXIMUM CUMULATIVE A CABLE LENGTH PER CONTROLLER IN DAISY CHAIN CONFIGURATION = 100 FEET.

(Z095b)

Figure 10. CMD Systems Configurations

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

CONTROLLER	"A" CABLE		DRIVE

Signal	Note	LO, HI
UNIT SELECT TAG		22, 52
UNIT SELECT 2^0		23, 53
UNIT SELECT 2^1		24, 54
UNIT SELECT 2^2		26, 56
UNIT SELECT 2^3		27, 57
TAG 1	2	1, 31
TAG 2	2	2, 32
TAG 3	2	3, 33
BIT 0	2	4, 34
BIT 1	2	5, 35
BIT 2	2	6, 36
BIT 3	2	7, 37
BIT 4	2	8, 38
BIT 5	2	9, 39
BIT 6	2	10, 40
BIT 7	2	11, 41
BIT 8	2	12, 42
BIT 9	2	13, 43
OPEN CABLE DETECTOR		14, 44
INDEX	2	18, 48
SECTOR	2	25, 55
FAULT	2	15, 45
SEEK ERROR	2	16, 46
ON CYLINDER	2	17, 47
UNIT READY	2	19, 49
ADDRESS MARK FOUND	2	20, 50
WRITE PROTECTED	2	28, 58
POWER SEQUENCE PICK		29
POWER SEQUENCE HOLD		59
	1	21, 51
NOT USED (SPARE)		30, 60

} ONE TWISTED PAIR

NOTE: 60 POSITION
28 AWG, 30 PAIR, TWISTED-STRAIGHT FLAT CABLE
MAXIMUM LENGTH - 100 FT

⚠1 RESERVED

⚠2 GATED BY UNIT SELECTED

(XX020a)

Figure 11.   CMD "A" Cable

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

Figure 12. CMD "B" Cable

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448
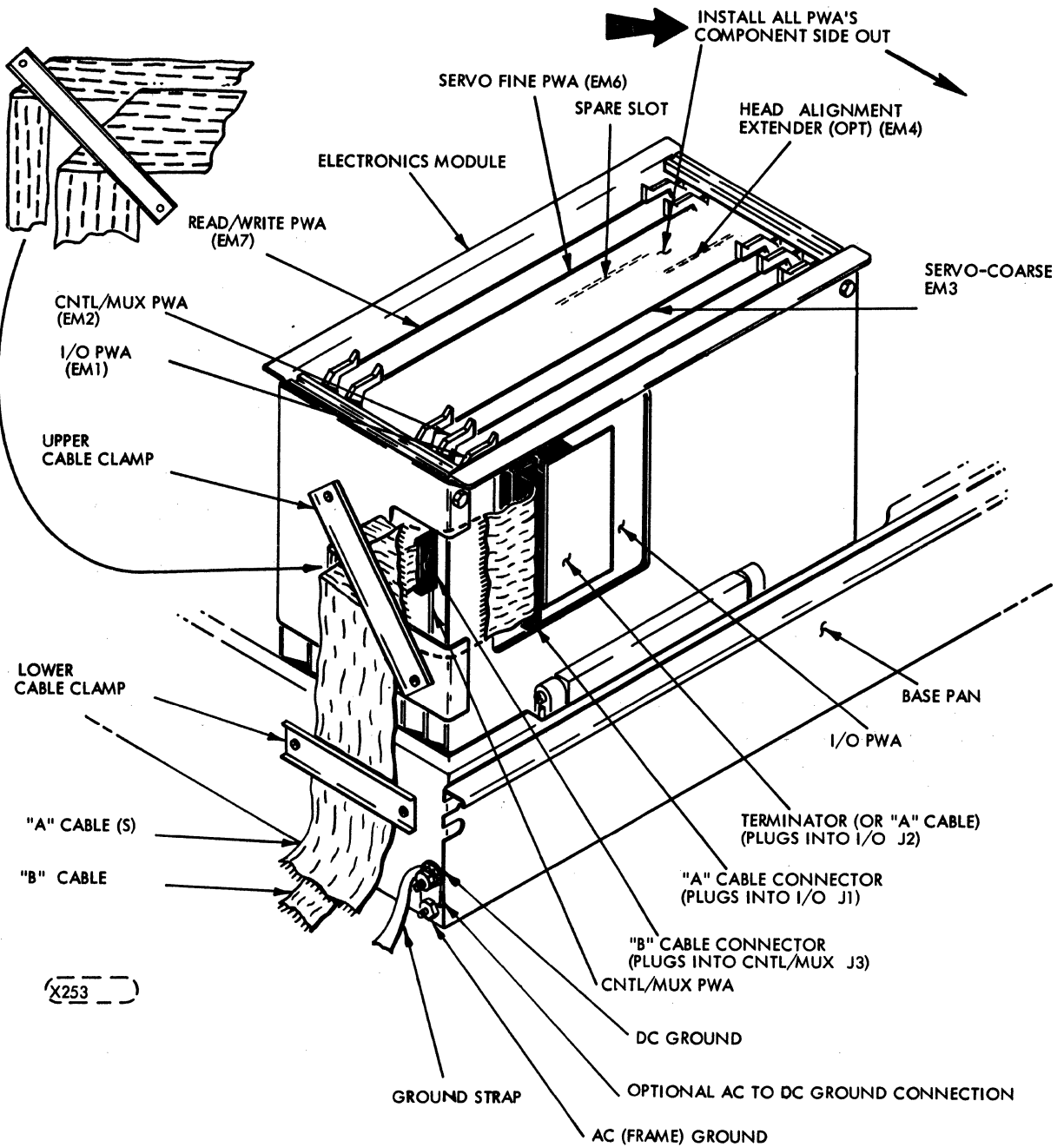
Figure 13. CMD A &B Cable I/O Connectors

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

BUS LINE	TAG 1 CYLINDER ADDRESS	TAG 2 HEAD/VOLUME SELECT	TAG 3 CONTROL SELECT
Bit 0	2^0	2^0	WRITE GATE
1	2^1	2^1	READ GATE
2	2^2	2^2	SERVO OFFSET PLUS
3	2^3		SERVO OFFSET MINUS
4	2^4	2^4 △1	FAULT CLEAR
5	2^3		AM ENABLE
6	2^6		RTZ
7	2^7		DATA STROBE EARLY
8	2^8		DATA STROBE LATE
Bit 9			

△1 This BIT is volume address which is stored in a bistable within the CMD. The stored volume address and "TAG 1" result in a volume select if the cylinder address is valid. A zero denotes the removable cartridge and a one denotes the fixed disks.

Figure 14. CMD TAG & BUS Line Decode

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

8.0   CMD ENVIRONMENTAL REQUIREMENTS

8.1   TEMPERATURE

8.1.1   Operating Temperature (Inlet Air)

Since the CMD is designed to be housed in a rack or cabinet and will, in many instances, reside in these housings together with other equipment; the impact of the heat generated by these other equipments and the air-flow thru the housing must be taken into consideration when specifying the operating temperature environment of the CMD.

In order to maintain proper air flow thru the CMD and to maintain internal CMD temperatures within reasonable and safe limits, the following requirements must be observed:

a. The maximum temperature of the CMD's exhaust air must not exceed 57.2°C (135.0°F) as measured at the 4th opening in the rear of the CMD's top cover. The location for making such a measurement is illustrated in Figure 15.

b. A minimum clearance of 32mm (1¼ in.) must be provided at the rear of the MCD. This is the CMD's air exhaust area which must be maintained at an air pressure level that does not exceed 0.03 inches of water (7.47 Pascal) positive pressure relative to the air entry into the CMD's mechanical interface in Figure 15 of this product specification.

Operating in a housing environment which satisfy's these needs the operating temperature specification is as follows:

a. Temperature range = 10.0°C (50.0°F) to 35.0°C (95.0°F)
b. Altitude restrictions, maximum temperature must be reduced 1.0°C per 1000 ft of altitude.
c. Temperature gradient = 10°C (18°F).

In the event that it becomes necessary to use a CMD Cartridge which has not been allowed to stabilize at the ambient CMD input temperature for at least one hour or; a cartridge which was exposed to temperatures below 16°C immediately prior to the stabilization period then the following procedures must be employed:

a. the cartridge must be visually inspected or examined to insure that condensation is not present on any part of cartridge and;

b. the cartridge must be allowed to spin on the CMD for a perod of not less than five minutes prior to attempting to read or write on that cartridge.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

REAR OF DEVICE

(XX258d)

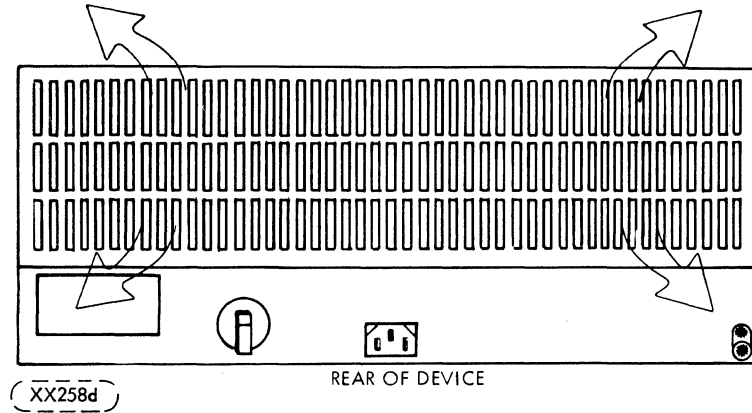Figure 15. CMD Exhaust Air Temperature Measurement

8.1.2   Transit Temperatures

-40.4°C (-40°F) to 70.0°C (158°F) with a maximum gradient of 20°C (36°F) per hour. This specification assumes that the CMD is packaged in the shipping container designed by MPI for use with the CMD.

8.1.3   Storage Temperature

-10°C (+14°F) to 50.0°C (122°F) with a maximum gradient of 15.0°C (27°F) per hour.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

8.2   RELATIVE HUMIDITY

8.2.1   Operating

20% to 80% RH (providing there is no condensation) with a maximum gradient of 10% per hour.

8.2.2   Transit (as packed for shipment)

5% to 95% (providing there is no condensation).

8.2.3   Storage

10% to 90% (providing there is no condensation).

8.3   ALTITUDE (actual or effective)

980 ft. (300 m) below sea level to 6500 ft (1982 m) above sea level.

8.4   VIBRATION AND SHOCK

8.4.1   Operating

Equipment, as normally installed and positioned, shall meet the full specified performance while subject to the following vibration and shock conditions injected from the floor in a vertical direction.

1. Continuous vibration as indicated in Figure 15, "Operating" Curve A.

2. Intermittent shocks of up to 2 g and not exceeding 10 ms in duration. No shock is to be repeated more often than two per second.

8.4.2   Transit (as packed for shipment)

Equipment in its normal upright position shall withstand the conditions of vibration and shock injected from the floor in the three major mutually perpendicular axes.

1. Vibration, as shown in Figure 16, Curve C, "Non-Operating, Packaged."

2. Shocks of up to 5 g not exceeding 10 ms in duration. The time between consecutive shocks cannot be less than five seconds.

3. Figure 17 illustrates typical and acceptable test method.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

ACCELERATION IN "G" UNITS

CURVE B
(NON-OPERATING
UNPACKAGED)

DISPLACEMENT IN INCHES

CURVE C
(NON-OPERATING
PACKAGED)

VELOCITY
(IN./SEC)

FREQUENCY (HZ)

CURVE A
(OPERATING)
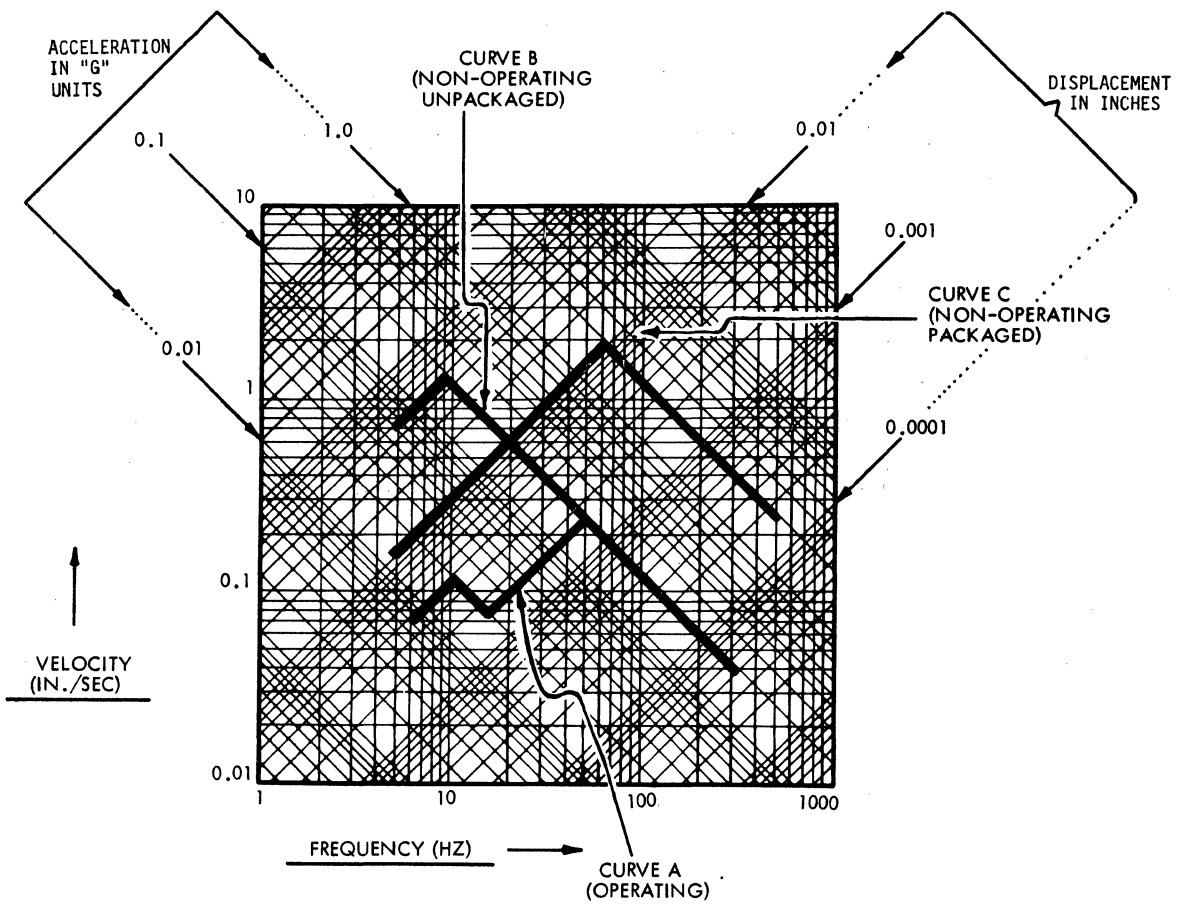
Z097b

Figure 16. Vibration Levels

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

UNIT IN UNCRATED CONDITION

SPEED: APPROX.
300 MM/SEC (11.81 IN/SEC)

1" PLATE   1" PLATE

CONCRETE

4 SHOCKS:
2   ROLLING OFF PLATE
2   ROLLING ONTO PLATE

UNIT IN CRATED CONDITION

6"   6"

A   B   A   B

FREE DROP

CONCRETE

2 DROPS FROM TIPPED POSITION
(ONE ON EACH END)
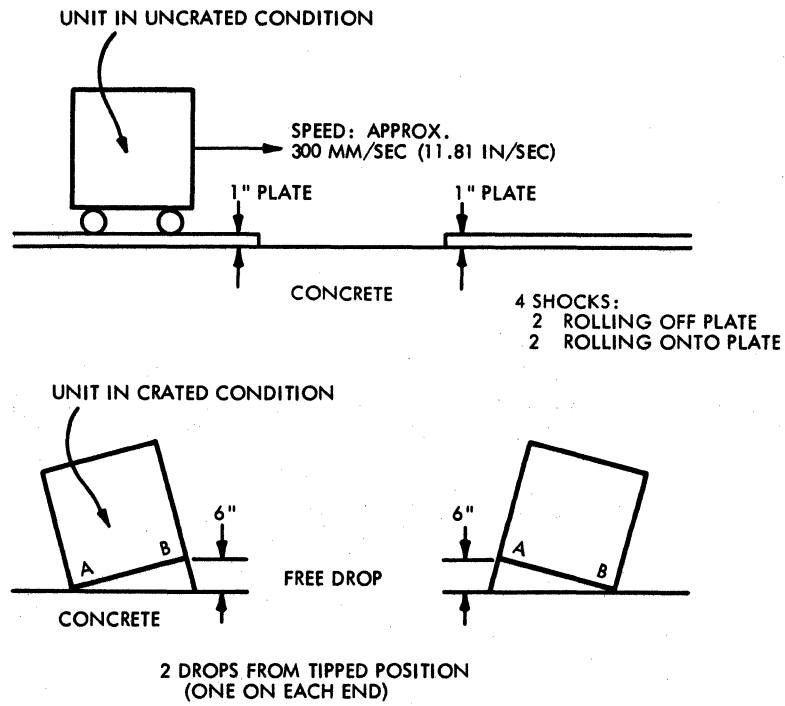
X393b

Figure 17.   Transit Shock

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

8.5   AIR CLEANLINESS

The CMD is designed for operation in working Range #3 of CDC Standard 1.03.205. This describes, what is considered to be, a typical office environment as it relates to air contamination. In this environment the CMD will operate with the following levels of contamination:

a. Particle sizes greater than 1.0 microns-concentration of 4×10^7 particles per cubic meter.

b. Particle sizes greater than 1.5 microns-concentration of 4×10^6 particles per cubic meter.

c. Particle sizes greater than 5.0 microns-concentration of 4×10^5 particles per cubic meter.

8.6   AC POWER REQUIREMENTS

The AC input or primary power voltage & frequency requirements for the standard 120 VAC/60 Hz CMD are shown in Figure 18 under CMD power configuration #1. Figure 18 also lists the voltage and frequency requirements of CMD power configurations 2 thru 6.

Figures 19, 20 and 21 illustrate the start-up and run currents for the various CMD power configurations. All CMD's described use single phase AC power.

POWER CONFIGURATION	VOLTAGE INPUT	TOLERANCE	FREQUENCY INPUT	TOLERANCE
1	120VAC	+8, -18VAC	60Hz	+0.6, -1.0Hz
2	100VAC	+7, -10VAC	60Hz	+0.6, -1.0Hz
3	120VAC	+7, -16VAC	50Hz	+0.5, -1.0Hz
4	220VAC	+15, -29VAC	50Hz	+0.5, -1.0Hz
5	230VAC	+15, -31VAC	50Hz	+0.5, -1.0Hz
6	240VAC	+16, -32VAC	50Hz	+0.5, -1.0Hz

Figure 18. CMD Input Voltage & Frequency Requirements

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448
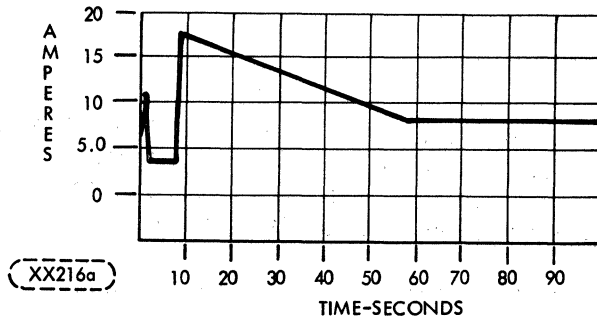
Figure 19. Start Up Current (100/120V, 60 Hz; 120V, 50 Hz
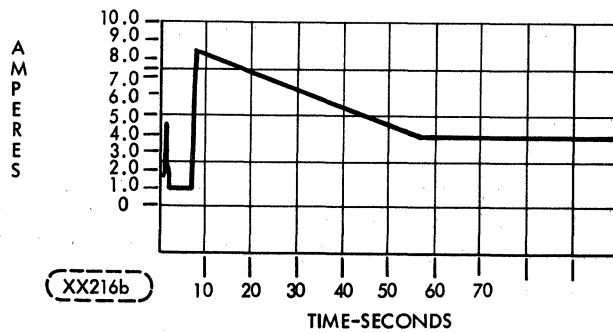
Figure 20. Start Up Current (220/230/240V, 50 Hz)

UNIT STATUS	LINE CURRENT (MAXIMUM)		CONSUMPTION		POWER FACTOR	AC POWER (VAC - Hz)
	START	RUN	KW	BTU/HR		
Disks and Carriage in Motion	15.0	8.2	0.95			100 - 60 120 - 60 120 - 50
	7.5	4.0	0.95			220 - 50 230 - 50 240 - 50
Disks not in motion (standby)		2.0	0.25			100 - 60 120 - 60 120 - 50
		1.0	0.25			220 - 50 230 - 50 240 - 50

Figure 20. CMD Start-Up and Run Currents

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

9.0   CMD MECHANICAL INTERFACE

This section contains information which will be needed by those CMD customers who plan to house the CMD in a rack or cabinet of their own design. Figures 22 and 23 contains illustrations of the standard CMD configuration and its important dimensions. While this illustration is considered to be self explanitory, the OEMs attention to the following items of cabinet or rack design will help insure that the CMD is properly interfaced and integrated into your cabinet or rack design.

a. Air Exhaust: That cabinet or rack area immediately adjacent to the CMD's air exhaust must be maintained at a pressure which does not exceed 0.03 inches of water (i.e. positive pressure relative to the air entry thru the front of the CMD). Reference paragraph 8.1.1 of this specification and Figure 22.

b. Basepan Clearance: The clearance area (noted in Figure 21) immediately below the bottom of the CMD's base pan must be observed. This clearance requirement would be of particular interest to CMD customers planning to mount the CMD on a plate or similar fixture rather than mount it using slides.

c. Maintenance Access: As noted in paragraph 14.3, the CMD is designed such that access to the device for the purposes of maintenance can be accomplished from the front of the unit. The information contained in Figure 22 provides the clearance information the CMD will require when it is in the maintenance position.

9.1   CMD SLIDES

The slides illustrated in Figures 24 and 25 are part of the RACK MOUNT SLIDE and MOUNTING KIT described in paragraph 12.1 (Accessories). These slides and the mounting kit are not part of the standard CMD configuration but are available as an accessory for use with the CMD.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE – MODEL 9448

Figure 22. CMD Mechanical Interface (Part-1)
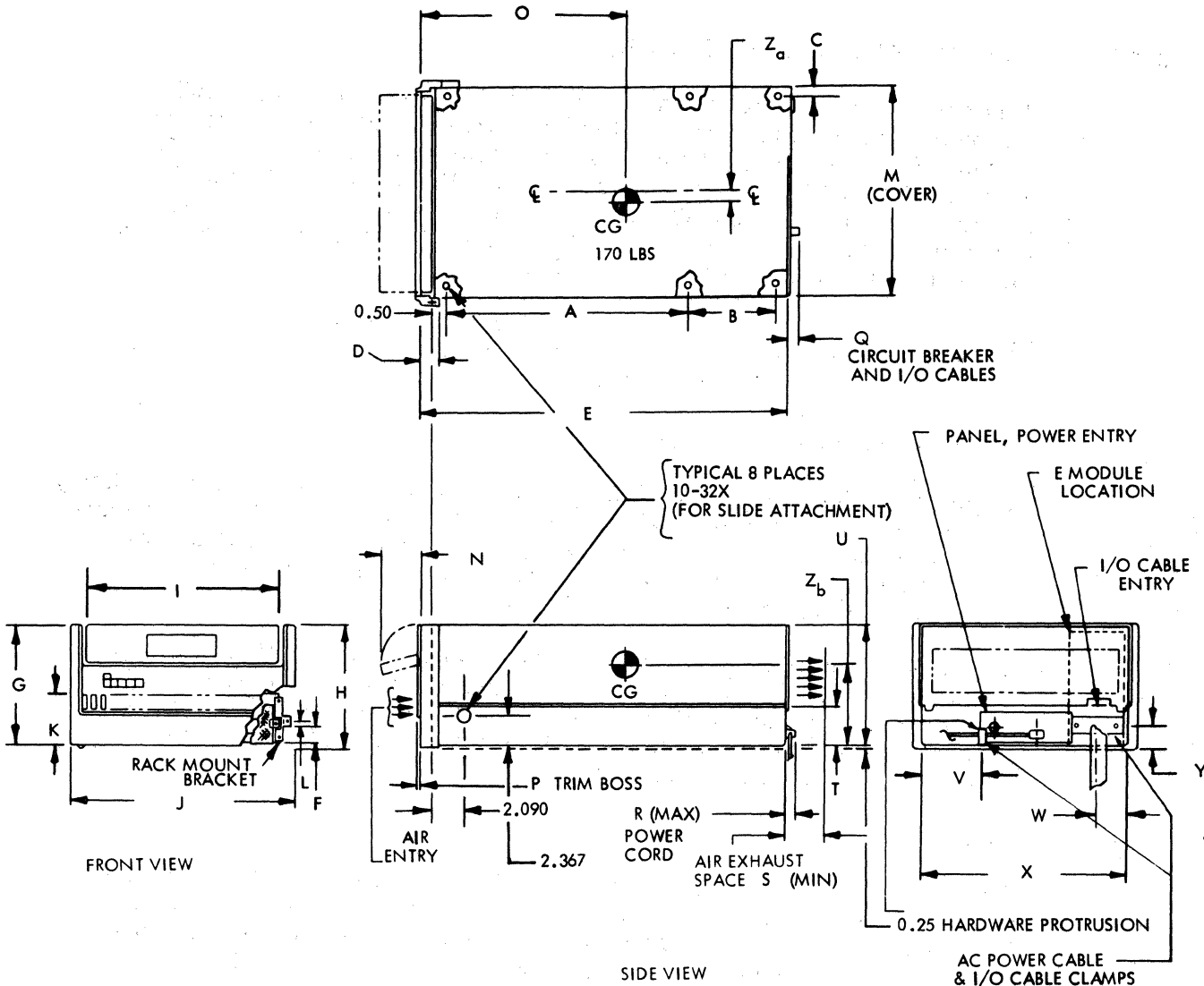
DIMENSION	INCHES	MILLIMETERS
A	17.76	451.1
B	10.0	254.0
C	0.36	9.1
D	2.50	63.5
E	30.50	774.7
F	1.38	35.0
G	10.34	262.6
H	10.34	262.7
I	16.62	422.0
J	18.94	481.1
K	4.4	111.8
L	0.38	9.65
M	17.50	444.5

DIMENSION	INCHES	MILLIMETERS
N	4.25	108.0
O	17.25	438.2
P	0.38	9.7
Q	0.56	14.2
R	1.38 max	35.1 max
S	1.25 min	31.7 min
T	3.38	85.9
U	10.15	257.8
V	5.5	139.7
W	2.80	71.1
X	16.70	424.2
Y	1.7	43.5
Z_a	0.90	0.23
Z_b	2.50	63.5

Z099a

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE – MODEL 9448

NOTE:
* FRONT PANEL MUST BE REMOVED &
  "E" MODULE MUST BE IN MAINTENANCE.
  POSITION TO RAISE THE BASE ASSEMBLY.

VIEW A
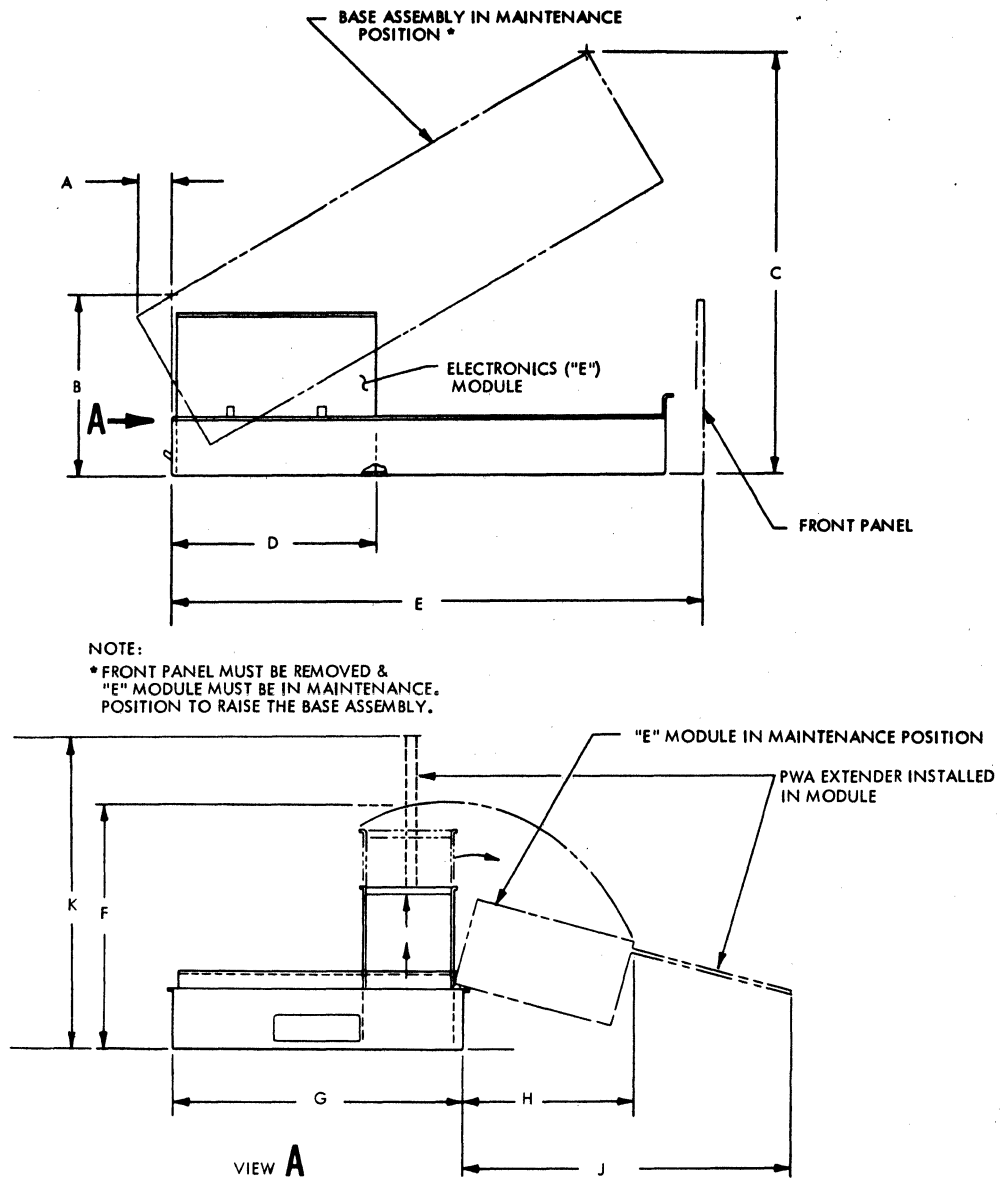
DIMENSION	INCHES	MILLIMETERS	REMARKS
A	1.50 MAX	38.1	
B	8.00 MAX	203.2	
C	24.00	609.6	"E" MODULE RAISED TO MAINTENANCE POSITION
D	12.50	317.5	
E	30.50 REF	774.7	
F	14.20	360.7	
G	16.70 REF	424.2	
H	9.25 MAX	234.9	
J	18.00	457.2	WITH BOARD EXTENSION
K	18.25	463.6	WITH BOARD EXTENSION

Z106a

Figure 23. CMD Mechanical Interface (Part 2)

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE – MODEL 9448
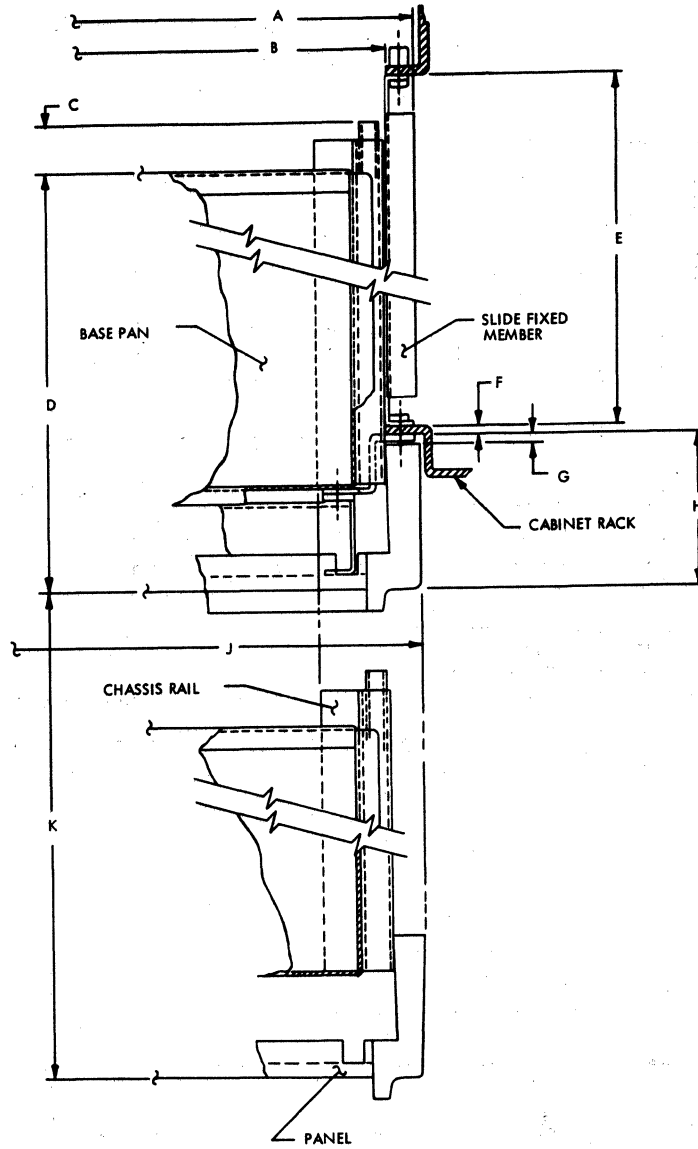
DIMENSION	INCHES	MILLIMETERS	REMARKS
A	18.82	478.0	MIN ALLOWABLE CABINET CLEARANCE FOR FIXED SLIDE MEMBER
B	17.75	450.9	MIN ALLOWABLE CABINET OPENING FRONT AND REAR
C	1.18	30.0	
D	30.41	772.0	CASE
E	27.50 thru 33.75	698.5 thru 857.25	SLIDE ADJUSTMENT LIMITS
F	0.12	3.1	REFERENCE
G	0.12	3.1	
H	2.62	66.6	
J	18.94	468.4	MAXIMUM
K	32.00	812.8	TRAVEL MAINTENANCE POSITION

Z100a

Figure 24. CMD Rack Mounting Slides (Part 1)

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE – MODEL 9448
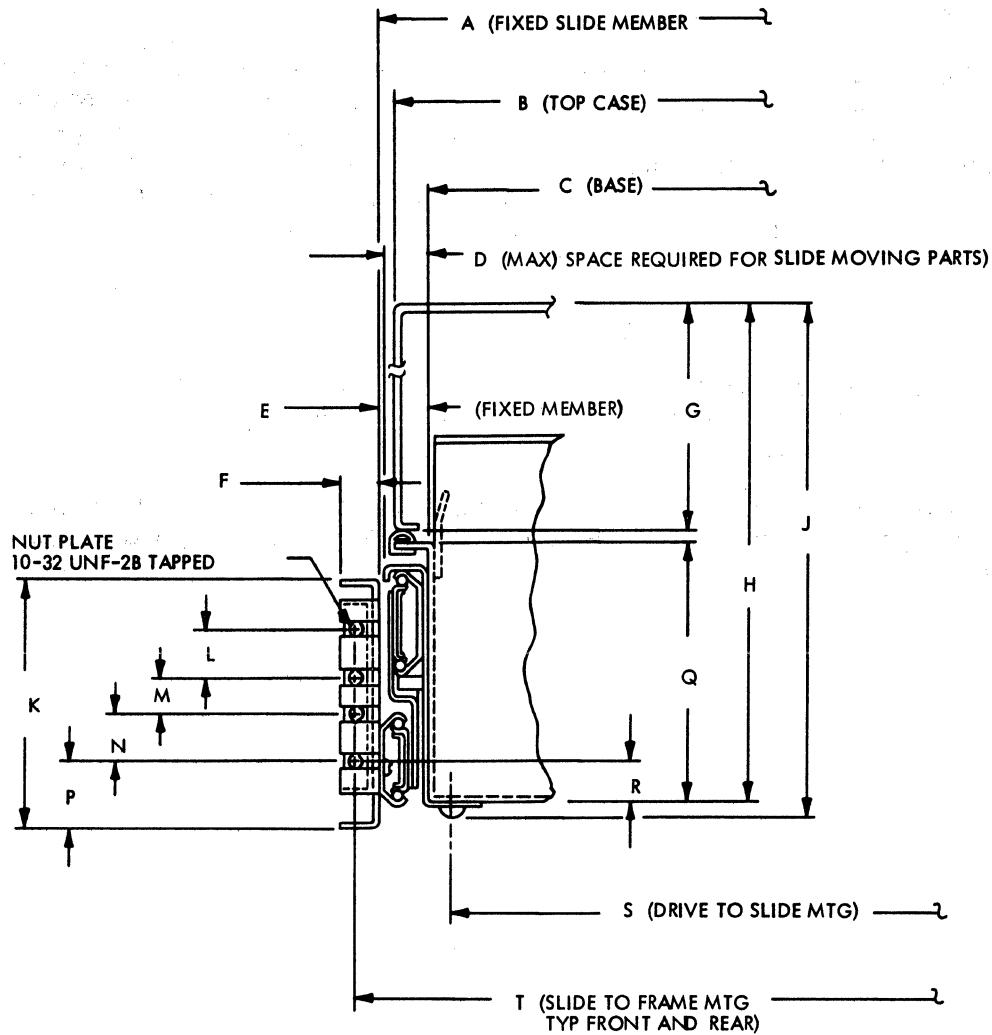
VIEW C
FRONT PANEL REMOVED

DIMENSION	INCHES	MILLIMETERS	DIMENSION	INCHES	MILLIMETERS
A	17.82	452.6	L	0.625	15.9
B	17.50	444.5	M	0.500	12.7
C	16.70	424.2	N	0.625	15.9
D	0.52	13.2	P	0.88	22.4
E	0.56	14.2	Q	3.38	85.9
F	0.50	12.7	R	0.63	16.0
G	6.66	169.2	S	15.98	405.9
H	10.15 REF	257.8	T	18.312	465.1
J	10.34 REF	262.6			
K	3.24	82.3			

(XX207a)

Figure 25. CMD Rack Mounting Slides (Part 2)

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

10.0   STANDARD CONFIGURATION

The STANDARD CMD Configuration is that of a unit suitable for mounting in a customer supplied "Industry Standard" 19 inch RETMA rack as shown in Figure 26. The standard unit (9448-32) has a total unformatted storage capacity of 32 Mbytes utilizing a *CDC1204 removable disk cartridge and a 16 Mbyte fixed pack. The standard unit is configured for use with a 64 sector format, operates at 3600 r/min, contains a dynamic spindle brake and utilizes 60 Hz/120 VAC input power.

*NOTE

The referenced CDC 1204 Cartridge is not a part of the standard CMD shipping configuration and must be purchased separately.

Additionally, the standard CMD configuration will be painted as illustrated in Figure 26, and equipped with a Control Data Corporation logo and front panel.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

CDC LIGHT GREY

CDC LOGO
CDC BLUE

OPERATOR PANEL
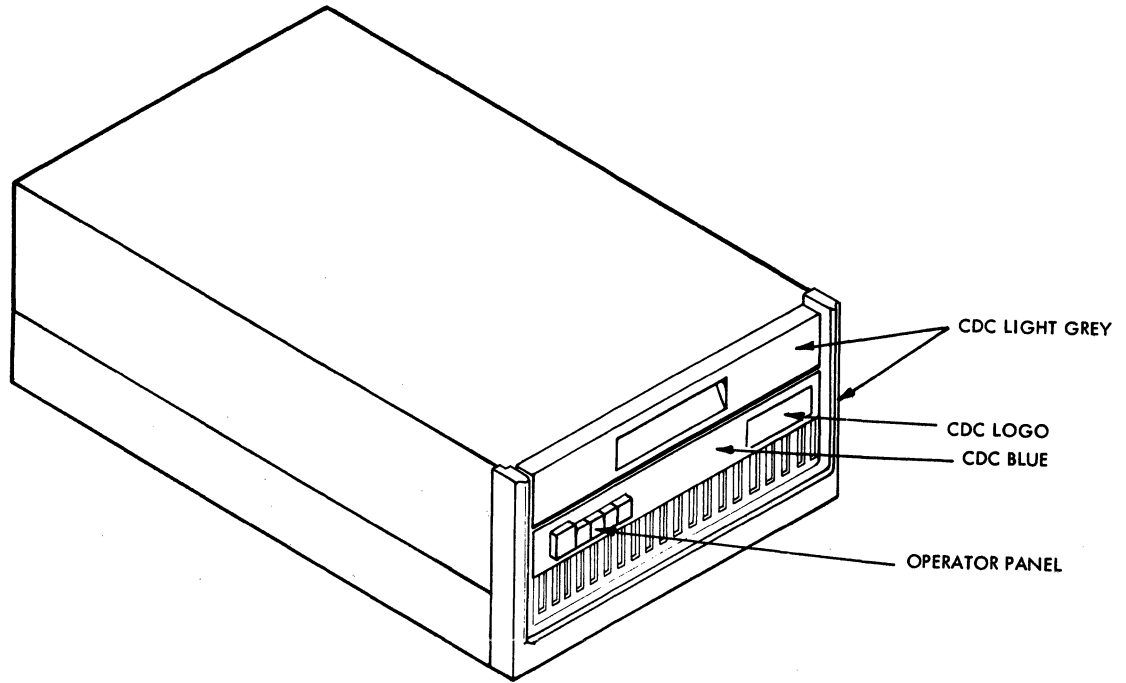
HEIGHT	10.5 In. (264mm)
WIDTH	19.0 In. (483mm) Max. (Panel)
	17.25 In. (438mm) (Cover)
LENGTH	31.75 in (806mm). Includes 1.25 in. (30mm) cable and switch clearance.
WEIGHT	170 lb (77.1 kg)

Z105a

Figure 26. Rack Mount CMD Unit

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

11.0   CUSTOMER SELECTABLE OPTIONS

Various options are available for inclusion in the CMD or for use with the CMD.

11.1   INCREASED FIXED DISK CAPACITY

a.   9448-64 which utilized a 48 Mbyte fixed pack with three 16 Mbyte data surfaces.

b.   9448-96 which utilizes a 80 Mbyte fixed pack with five 16 Mbyte data surfaces.

11.2   INPUT POWER OPTIONS

The standard CMD unit is configured for operation with 120 VAC/60 Hz input power. Other CMD configurations may be ordered for use with the various input power options listed in paragraph 8.6.

Kits of varing degrees of complexity are also available which can be employed to convert a CMD to operate with different input power options. However the preferred ordering method is to order CMDs configured to the specific input power requirement.

11.3   QUIETIZED UNIT

A rack mount CMD configuration may be ordered in which the CMD substantially betters the noise power emission standards listed in CDC Corporate Standards. In the quietized CMD, emission levels are maintained at (typically) 6.7 bels and 6.8 bels in the idle and operating mode respectively.

11.4   SYSTEMS ATTACHMENT AND INTERGRATION OPTIONS

A number of interface options are available which may reduce systems software and/or control unit complexity. These options may be greatest value to those systems using a single disk unit which employs both fixed and removable media for the first time. Contact your CDC/OEM salesperson for further information regarding these options.

11.5   UNIVERSAL CABINET

A universal cabinet is available for use in mounting CMDs (either single or dual units) and/or other members of the CDC Module Drive family. Consult your CDC/OEM salesperson for further information regarding this universal cabinet.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

12.0   CMD ACCESSORIES AND SPECIAL TOOLS

12.1   ACCESSORIES

The following accessories are available for use with the CMD.

	DESCRIPTION	CDC PART NUMBER	NOTES
a.	Select Plug(s)	943988XX	1
b.	Select Plug Set #1	75896141	2
c.	Select Plug Set #2	75896140	3
d.	CDC 1204 Disk Cartridge (DATA)	M1204	4
e.	Rack Mount Slides and Mounting Hardware Kit	75897340	5
f.	Flat to Round Cable Adapter Kit	77622712 through 77626722	6

NOTES:

△1   a.   XX in part number indicates numeric designation (00 thru 07) visible on face of plug.
         b.   One plug must be mounted in every CMD.
         c.   One plug is supplied with each CMD. Plug supplied will be 00 unless ordered differently.

△2   Set contains three plugs (01 thru 03), 1 ea 94398801, -02 and -03.

△3   Set contains seven plugs (01 thru 07), 1 ea 94398801, -02, -03, . . . -07.

△4   None supplied, must be ordered separately, each CMD will require a minimum of one data cartridge.

△5   None Supplied, must be ordered separately.

△6   None Supplied, must be ordered separately according to list below.

KIT PART NO. *	CABLE LENGTH
7 7622712	5 feet
13	6 feet
14	8 feet
15	10 feet
16	15 feet
17	20 feet
18	25 feet
19	30 feet
20	40 feet
21	50 feet
22	4 feet

* Kit contains one "A" cable, one "B" cable plus mounting hardware.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

12.2   SPECIAL TOOLS

The following special tools may be ordered for use with the 9448 CMD.

	DESCRIPTION	CDC PART NUMBER	NOTES
a.	CE Alignment Cartridge	76204400	⚠1
b.	TB216-A Field Testor	9967	⚠2 ⚠1
c.	Head Alignment Kit	75899096	⚠3
d.	Head Alignment Extender PWA	75886001 *	⚠3 ⚠1
e.	Alignment PWA	54226509 *	⚠4
f.	8 Pin Cable	77612337 *	⚠3 ⚠1
g.	2 Pin Cable	75882394 *	⚠3 ⚠1
h.	PWA Extender	75882560 or 77643160	⚠5
i.	Head Adjustment Tool	75893963	⚠1
j.	Jumper Connector	77612622	
k.	Torque Wrench	12218425	⚠1
l.	Torque Wrench Bit	87016704	⚠1

NOTES:

⚠1 Required to align 9448 CMD cartridge heads.

⚠2 FTU includes head alignment capability however items marked with Note 1   must be ordered as FTU accessories for head alignment capability.

⚠3 Kit contains all items marked with Asterisk, in addition kit contains the head alignment meter (73576400) and alignment procedure 77614917.

⚠4 Included with TB216-A FTU

⚠5 Interchangeable

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

13.0   RELIABILITY AND MAINTAINABILITY

13.1   CORRECTIVE MAINTENANCE PHILOSOPHY

In the CMD, the corrective maintenance philosophy is to isolate the failure to an optimum replaceable unit (ORU) and the replacement of same. For example, if a failure is isolated to a complex assembly such as a printed circuit card then the ORU is the printed circuit card and it must be replaced. (Printed circuit card component troubleshooting and component replacement is considered to be a factory or depot level operation and to repair PWA's in the field may invalidate CMD warranty.)

Similarly fault or failure isolation procedures which identify other complex assemblies such as spindle motors must treat these assemblies as the ORU.

The CMD field maintenance manual has been prepared assuming that this philosophy will be employed by the CMD customer. It should be noted that any and all alignment and/or adjustment procedures contained in the CMD Field Maintenance Manual are considered to be within the competence of a adequately trained maintenance individual.

13.2   MEAN TIME BETWEEN FAILURES (MTBF)

Following an initial period of 200 hours, the Mean Time Between Failure shall exceed 2600 hours for units manufactured in the first year of production and 3200 hours for units manufactured in the second year. For units manufactured after the second year, the MTBF shall exceed 4000 hours. The following expression defines MTBF:

$\triangle 1$

$$MTBF = \frac{\text{Operating Hours}}{\text{No. of Equipment Failures}}$$

$\triangle 1$ Power on hours.

Equipment failures means any stoppage or substandard performance of the equipment because of equipment malfunction, excluding stoppages or substandard performance caused by operator error, adverse environment, power failure, controller failure, cable failure, or other failure not caused by the equipment. A mutually agreeable field reliability test plan will establish the basis for reliability measurement.

For the purpose of this specification, equipment failures are defined as those failures necessitating repairs, adjustments or replacements on an unscheduled basis. Essentially, the term equipment failure implies that emergency maintenance is required because of the hardware failure.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

13.3   MEAN TIME TO REPAIR (MTTR)

The mean time to repair the CMD shall not exceed 1.5 hours. MTTR is defined as the time for an adequately trained, competent and properly supported service individual to diagnose and correct a typical CMD malfunction.

13.4   PREVENTIVE MAINTENANCE REQUIREMENTS

CMD routine scheduled preventive maintenance requirements shall not exceed one-half hour per 1000 power-on hours. This maintenance shall be performed by a suitably trained and competent individual. The schedule and procedures employed for preventive maintenance shall be based upon the schedules and procedures recommended by Magnetic Peripherals Inc. in the CMD Maintenance Manual.

The maximum interval for scheduled preventative maintenance is 3000 power-on hours or 6 months whichever occurs first.

For the purposes of this specification, the stated CMD preventive maintenance requirements are based upon operation of the CMD in an environment that conforms to the CMD environmental requirements as stated in Section 8 of this Product Specification. Operating the CMD, for example, in an environment which does not meet the CMD air cleanliness requirement of Section 8.5 of this specification will undoubtedly increase the CMD's preventive maintenance needs beyond that which is outlined in this paragraph (i.e. par. 13.4) due to the need to replace air filters at more frequent than anticipated intervals.

13.5   SERVICE LIFE

The CMD is designed and constructed to provide a useful life of five years or 20,000 hours without overhaul by the CMD manufacturer at the manufacturer's overhaul facility. Repair or replacement of major components will be permitted within the service life of the CMD.

13.6   INSTALLATION

The CMD is designed, manufactured and tested for use with a "Plug-in and Play" installation philosophy. Basically this philosophy permits the OEM to minimize the effort (i.e. time of highly trained personnel) required to successfully integrate a CMD into the OEM's system.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

13.6 -contd.

The recommended procedure (which is included in the CMD Maintenance Manual) consists basically of the following:

  a. Unpacking;
  b. Inspection for shipping damage;
  c. Verification that all pluggable components are properly seated;
  d. Positioning of unit (or mounting in cabinet) and leveling same;
  e. Cabling;
  f. Power-up;
  g. Confidence testing in host system.

This recommended procedure does not contain any device level functional checks or adjustments (such as head alignment). Systems confidence testing is recommended instead.

13.7 SERVICE TOOLS

In addition to the tools which are normally found in the typical service tool box, there are a number of special tools available for use with the CMD. These tools are outlined in paragraph 12.2 of this specification.

13.8 SPARE PARTS

Control Data will provide CMD spare parts to the OEM or to the OEM's customer through its Customer Engineering Material (CEMATL) organization. These parts are readily available both in the U.S. and in Europe and can usually be obtained anywhere in the free world. Your CDC/OEM representative can arrange to provide more information on this subject should you require it.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

14.0   CMD MAINTENANCE FEATURES

In addition to the special tools which are available for use with the CMD, the CMD contains a number of maintenance features as part of the standard CMD configuration. These features, which are described in detail in the CMD's maintenance manual, are summarized in the paragraphs that follow.

14.1   CONTROL/MUX FAULT INDICATORS

The CMD's CONTROL/MUX is a PWA or printed circuit card located in the CMD's ELECTRONICS MODULE. This PWA, which is illustrated in Figure 27, is normally only accessible to equipment service personnel due to the fact that the electronics module is not visible unless the CMD's top cover is absent.

There are seven LEDs located on the edge of the PWA as illustrated in Figure 27. These LED indicators together with switches located on the CONTROL/ MUX and other CMD PWA's are used for multiple purposes by the service person servicing the CMDs. These LEDs will be employed by a properly trained and competent service person as follows:

a.   To check and/or adjust the CMD's head positioner assembly's electronic circuits to obtain correct positioner velocity.

b.   To display and describe those CMD detected fault conditions which resulted in the operation of the FAULT light on the CMDs OPERATOR PANEL.

c.   To display and describe a wide variety of CMD internal conditions which are monitored by the CMD's micro-processor and stored in its memory.

14.2   CMD HEAD POSITIONER ASSEMBLY VELOCITY CHECK AND/OR ADJUSTMENT

In the CMD a check or adjustment of the velocity of the CMD's head positioner is accomplished without the use of any test equipment such as 'scopes, meters or testors. To accomplish this adjustment in the CMD the customer engineer employs the LEDs located on the CONTROL/MUX PWA as an indicator.

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448
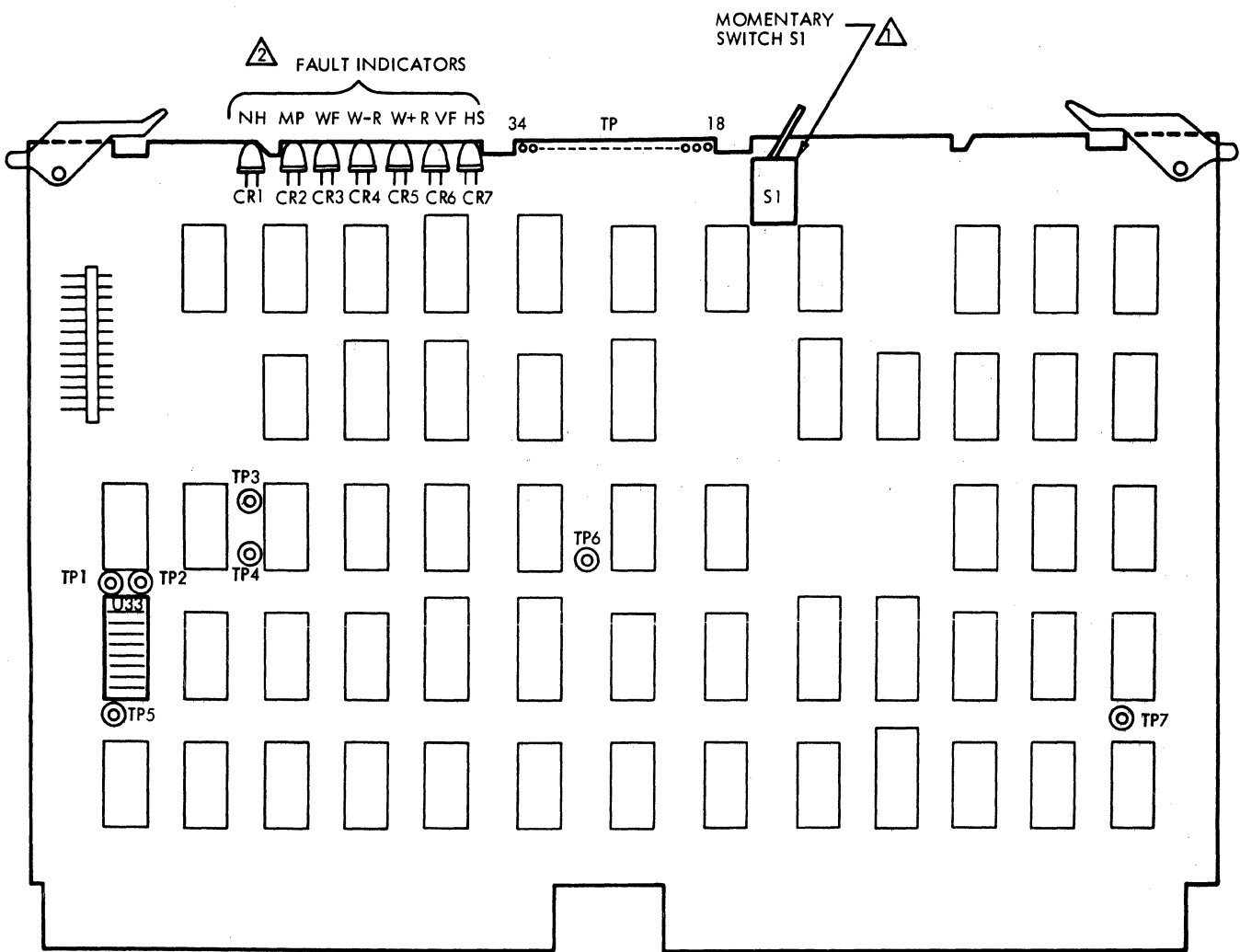
Figure 27. Control/Mux PWA and Fault Indicators

PRODUCT SPECIFICATION FOR CARTRIDGE MODULE DRIVE, MODEL 9448

14.3   MAINTENANCE ACCESS TO CMD COMPONENTS

If the CMD is mounted on slides in a rack, maintenance access to all CMD
components can be accomplished when the CMD is fully extended forward
position.   The majority of the CMD's components can be accessed by removing
the CMD's top cover.   Some components can only be accessed when the CMD's
base deck is in the raised position as shown in Figure 23.

14.4   CMD MAINTENANCE SWITCHES

The CMD is equipped with several switches located on printed circuit cards
in the electronics module.   These switches are normally only accessable to
service personnel because of their location.   These switches can be employed
by a properly trained and competent service individual to enable the CMD
to perform some service operations without the need for CMD connection
to a field testor or to the host systems control unit.