CONTROL DATA CORPORATION

SPEC	77653527
CD	0
REV	A Issue
DATE	July 1981

PRODUCT SPECIFICATION

FOR

MODEL 9454
LARK™ MICRO UNIT

MAGNETIC PERIPHERALS INC.
a subsidiary of
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1.0 SCOPE

This specification describes the Model 9454 Lark™ Micro Unit. Within this document the disk storage unit will be referred to as the Lark Micro Unit, LMU, Micro Unit, or simply as the drive. The interface will be referred to as the Micro Unit Interface (MUI). The user-defined controller which allows information transfer between the LMU and the central processing unit will be referred to as the adapter.

The LMU consists of the Micro Unit Interface, drive positioning mechanism, read/write electronics, read/write heads, and media.

The LMU is shown in Figure 1.

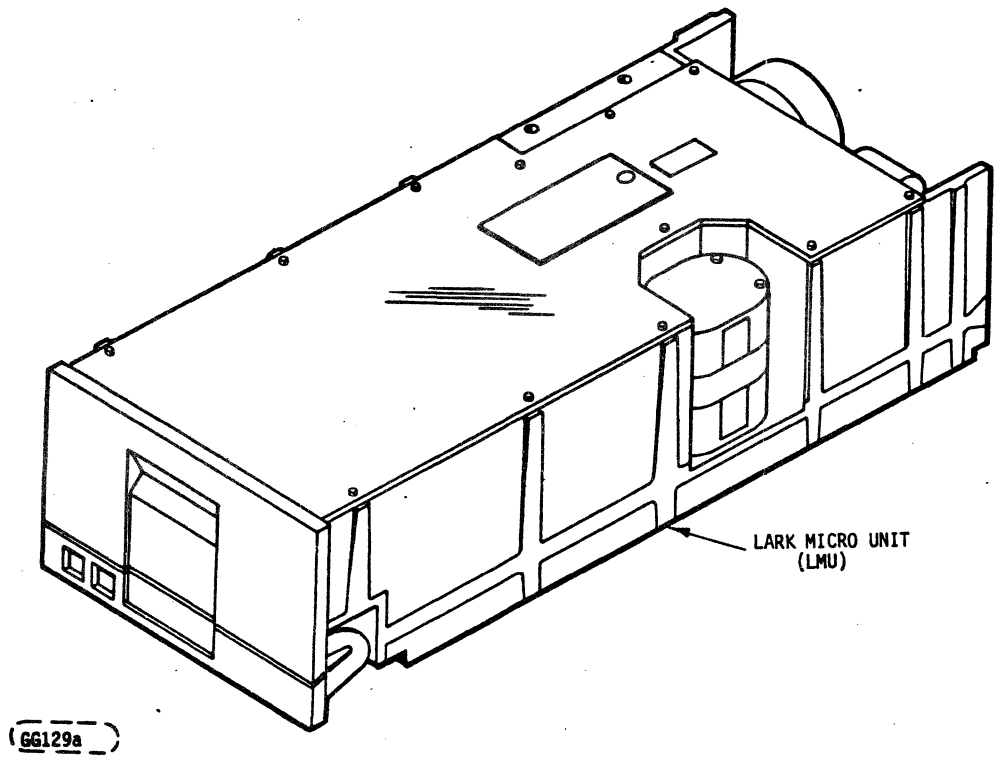


Figure 1. Lark Micro Unit

The basic configurations of the 9454 are as listed below:

PRODUCT NUMBER	VOLTAGE/ FREQUENCY	MOUNTING	NUMBER OF SECTORS
9454-32	120/60	Rack	32
9454-64	120/60	Rack	64
9454-32A	220/230/240/50	Rack	32
9454-64A	220/230/240/50	Rack	64

2.0 APPLICABLE DOCUMENTS

2.1 STANDARDS

In addition to applicable CDC corporation standards, the LMU complies with the requirements of UL 478 and CSA Standard C22.2 No. 154-1975. The LMU is a component and, as such, is not subject to standards imposed by FCC Docket 20780/FDD 8-148 Part 15 governing EMI of computing devices.

The Model 9454 LMU has been designed as a system peripheral to the highest standards of design and construction. The drive, however, must depend upon its hose equipment to receive adequate power and environment in order to provide optimum performance and compliance with applicable industry and governmental regulations. Special attention must be given in the areas of safety, power distribution, grounding, shielding, audible noise control, and temperature regulation of the device to ensure specified performance and compliance with all applicable regulations.

When evaluating systems operation under conditions of EMI the performance of the 9454 Lark Micro Unit within the system shall be considered acceptable if the device does not generate an unrecoverable error, or incur an unrecoverable condition. An unrecoverable error, or condition, is defined as one which:

1. Is not detected and corrected by the device itself;
2. Or is not capable of being detected from the error or fault status provided through the device/system interface;
3. Or is not capable of being recovered by normal device or system recovery procedures without requiring operator intervention.

2.2 DOCUMENTATION

The following documentation is available for field support of the LMU.

- Model 9454 Lark Micro Unit Interface, 77653473
- Lark Maintenance Manual, 77647815
- Operation and Installation Instructions, 77630473
- CDC Disk Cartridge Product Specification, 76192089
- Voltage Conversion Instructions. TBD

3.0 GENERAL DESCRIPTION

The Model 9454 LMU is a member of a family of low-cost, high-performance, highly reliable, random access, rotating disk mass memory devices featuring both removable and fixed media storage.

The media used on the LMU is an extension of the media used with the existing module drive family. The diameter of the disk is approximately eight inches. Its coating thickness is optimized for high density magnetic recording with densities in excess of 7000 flux reversals per inch and track densities up to 600 tracks per inch.

A dedicated servo surface is not used with the LMU for head positioning control. Instead, embedded servo information is factory written on each data surface in those areas not occupied by header or data blocks. This pre-recorded servo field is used for carriage positioning, index and sector pulse generation, and PLO reference clock.

The basic components in the LMU consists of the base casting, spindle, spindle drive motor, cartridge insertion and positioning mechanism, linear servo motor and carriage assembly with read/write heads, base PWA with microcomputer control, Read Signal Processor PWA, and Read/Write Pre-Amp PWA. A cooling fan is also provided.

These components are shown in Figure 2.

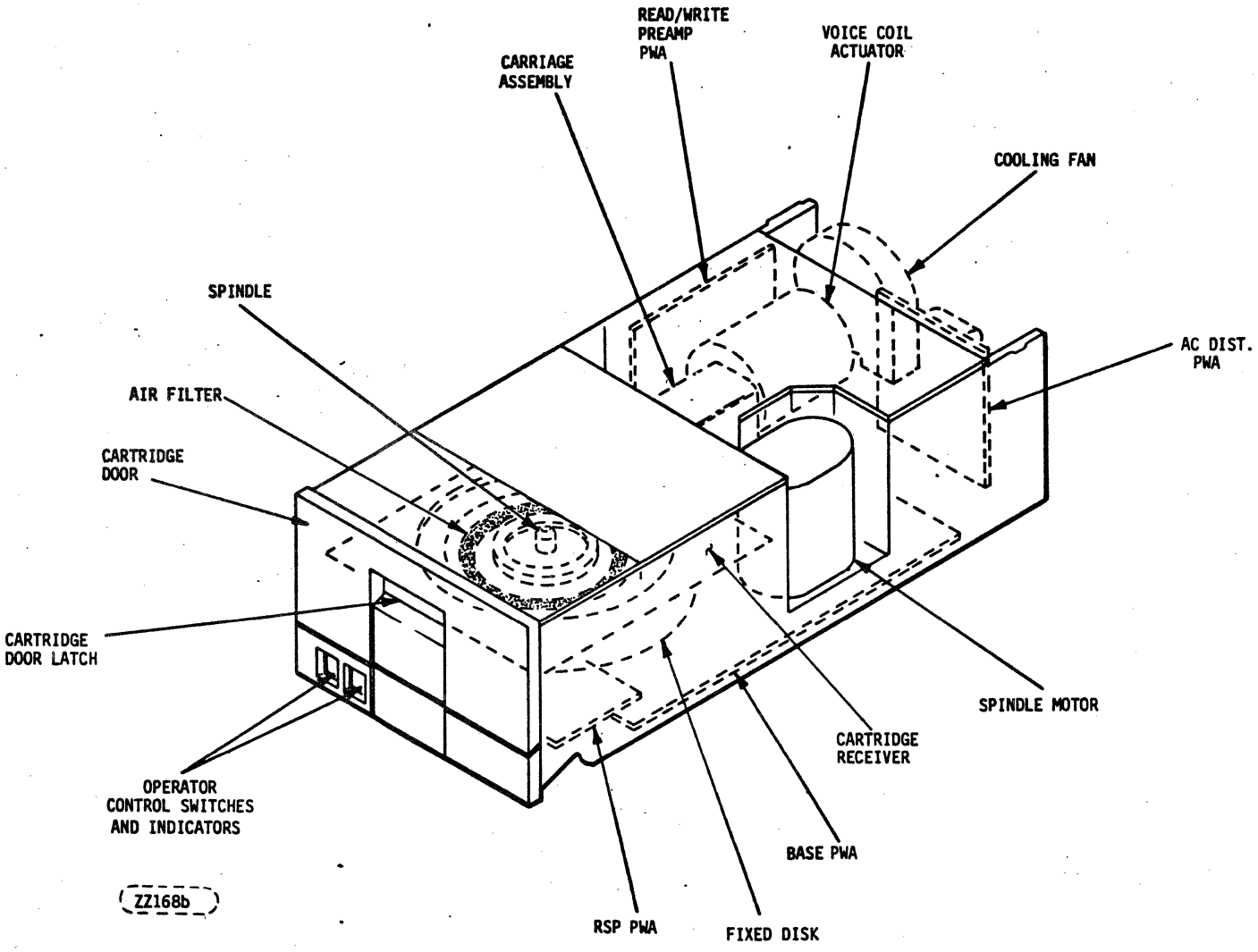


Figure 2. LMU Basic Components

The unformatted storage capacity of the LMU is 16.7 megabytes: 8.35 megabytes of storage is provided by the removable disk (cartridge) and 8.35 megabytes of stroage is provided by the fixed disk. This typically provides 13.2 MB of on-line formatted storage.

For operator convenience, the cartridge is removed and inserted via a hinged access door on the front panel that locks when the disks begin to spin. Operator controls (and indicators) consist of a START/STOP switch and a WRITE PROTECT switch for the fixed disk. The front panel and cartridge insertion are shown in Figures 9 and 13.

The LMU utilizes an asychronous bus interface which allows flexibility in the adapter design. The bus timing and protocol is controlled by a microcomputer within the LMU to also provide maximum flexibility and expandability of the interface for future produce enhancements. Bus timing requirements (that is, setup times, hold times, response times, etc.) have been defined to require minimal hardware within the adapter. These timing requirements also allow a wide range of technologies (such as MOS, LSI, TTL, and/or microcomputers) to be used to implement an adapter design.

The physical interface consists of a 40-pin command ("C") cable and a 26-pin data ("D") cable. The command cable can be daisy-chained and is based on an 8-bit bidirectional bus for command/status transfer between the adapter and the drive.

NOTE

The user must provide the daisy-chain facilities; only one command I/O connector is provided on the LMU.

A maximum of four LMU's may be daisy-chained. The data cable, which contains high frequency (9.67 MHz) read/write signals, must be radially connected. Cabling is discussed in more detail in the Lark Micro Unit Interface Specification, 77653473.

4.0 FEATURES

4.1 STANDARD FEATURES

The LMU has the following standard features:

- Removable Cartridge
- Low Power Consumption
- No Head Alignment Required
- Embedded Servo
- LSI and Microcomputer Control
- Low Audible Noise for Office Environments
- Terminators
- Operator and Installation Guide

4.2 OPTIONAL FEATURES

- Vertical Mounting

4.3 ACCESSORIES

The following accessories are available for the LMU and must be ordered and shipped separately:

- Data Cartridge #76210000 (32 and 64 Sector Operation)
- Maintenance Manual 77647815

5.0 PERFORMANCE CHARACTERISTICS

The performance characteristics of the LMU are shown in Table 1.

Table 1. Performance Characteristics

Data Capacity (Unformatted) (Note 1)		
Per Track	20,672 bytes	
Per Removable Cartridge	8.35 megabytes	Note 2
Per Fixed Disk	8.35 megabytes	Note 2
Total	16.7 megabytes	Note 2
Number of Data Heads	4	
Per Removable Cartridge	2	
Per Fixed Disk	2	
Recording Mode	2,9	
Data Interface	NRZ DATA + CLOCK	
Flux Reversal Density	6774 FRI	
Track Density	237 TPI	
Data Transfer Rate (Nominal)	9.677 MHz	
Maximum Latency	17.95 ms	
Average Latency	8.55 ms	
Positioning Times		
Average	50 ms	
Maximum	100 ms	
Head Change to Read Gate Delay	10 ms Avg. Max	

NOTE 1: Formatted capacity realized in a specific system application is generally less than the inherent capacity and may be different for the same LMU on different systems.

NOTE 2: Based on 202 primary cylinders. Does not include four spare tracks per surface.

5.1 ACCESS-TO-DATA CHARACTERISTICS

5.1.1 Positioning Times

Positioning time is defined as the time required from the receipt of a seek and/or head change command by the LMU until the drive signals the controller it is ready to perform another seek or read/write function on the new cylinder. Completion of a seek is reported by the interface with a status return. Because the LMU incorporates positioning information on each of its four data surfaces, a head change, whether to the current cylinder address or to a new one, is also considered as a positioning time.

Average seek time is determined by dividing the sum of all possible movements by the total number of movements.

The positioning times are listed below:

Maximum Positioning Time	100 ms
Average Positioning Time	50 ms
Average Maximum Adjacent Single Track Seeks Without Head Change	10 ms
Average Maximum Random Head Selection Without Seek Command	10 ms
Average Maximum Random Head Selection With One Track Adjacent Seeks	15 ms
Seek to Same Cylinder Address and Head	$\leq$2 ms
Return to Zero (Maximum)	500 ms

5.1.2 Spindle Speed and Latency

The spindle speed is 3510 +2.5, -4.8% revolutions per minute (r/min). The speed tolerance includes motor performance, belt and pulley tolerances and the mains voltage and frequency variations specified in section 7.1. This does not include other variables which affect data transfer rates.

The average latency time is 8.55 milliseconds, based on a nominal disk speed of 3510 r/min. The maximum latency time is 17.95 milliseconds based on a minimum disk speed of 3342 r/min (3510 - 4.8%).

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

5.1.3 Read Initialization Time

Read Initialization time is defined as the time required to switch from one head to another, stabilize the read circuitry, and establish phase lock oscillator synchronization subsequent to reading data. This time is 10 milliseconds average maximum assuming a head change to the current cylinder address.

5.1.4 Write-to-Read Recovery Time

Assuming a write operation is in progress the required time interval between the end of Write Gate and the initiation of Read Gate is 10 microseconds minimum.

5.1.5 Read-to-Write Recovery Time

Assuming a read operation is in progress, the required minimum time interval between the end of Read Gate and the initiation of Write Gate is 0.3 microseconds.

5.1.6 Data Capacity

The total unformatted data capacity of the LMU is 16,702,976 bytes per spindle. The total formatted data capacity using the recommended format is 13,238,272 bytes per spindle. This capacity does not include four spare tracks per surface.

Formatted capacity realized in a specific system application is generally less than the inherent capacity and may be different for the same LMU in different systems.

5.1.7 Data Transfer Rate

The nominal serial data transfer rate is 9,676,800 bits per second (1.2096 megabytes per second). The range of transfer rate variations on a byte-per-second basis for read/write operations is +4.5, -5.5% of the nominal. This range includes the effects of all factors including spindle speed variations and dynamic jitter on a byte-to-byte basis. Data on the interface is NRZ while the drive internally converts this information to a 2,9 code for reading and writing.

5.1.8 Start/Stop Time

Assuming that a cartridge has been inserted in the drive and no faults are present, the maximum time measured from actuation of start switch to Ready and On Cylinder status to adapter is 120 seconds.

The maximum stop time measured from actuation of stop switch until the cartridge can be removed is 60 seconds.

Upon a power loss, the maximum stop time is 120 seconds.

6.0 RELIABILITY SPECIFICATIONS

The following reliability specifications assume correct host/drive operational interface has been implemented, including all interface timings, power supply voltages, environmental conditions, and appropriate data-handling circuits in the host system.

Error Rates	
Soft Read Errors (Recoverable)	$\leq$1 in 10^{10} bits read
Hard Read Errors (Unrecoverable)	$\leq$1 in 10^{12} bits read
Seek Errors	$\leq$1 in 10^{6} seeks
MTBF	First Year Production - $\geq$3200 hours Second Year Production - $\geq$6000 hours Third Year On - $\geq$7500 hours
Service Life	5 years or 20,000 hours
Preventive Maintenance	None required

6.1 ERROR RATES

The error rates stated in paragraph 6.0 assume the following:

1. That the LMU is operated per specification.
2. That an approved data cartridge is employed.
3. That a data format is employed fulfilling the requirements of the LMU as outlined in the Lark Micro Unit Interface Specification, 77653473.
4. That errors caused by media defects or host system failures are excluded from error rate computations.
5. That power requirements as specified in paragraph 7.1 and system grounding requirements indicated in the installation instructions are met.

6.1.1 Read Errors

Prior to the determination or measurement of read error rates:

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

2. All media defect induced errors must be excluded from error rate calculations.

A recoverable read error is one that can be re-read correctly in nine or less retries. These retries must include three retries at normal data strobe, three retries at early data strobe, and three retries at late data strobe.

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 read correctly after nine retries to read the record.

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

6.1.2 Write Errors

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

If an unrecoverable write error occurs because of an LMU 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.

6.1.3 Seek Errors

A seek error is defined as a condition where the LMU fails to position the heads to the addressed track provided the correct cylinder address information has been presented to the drive. There shall be no more than one recoverable seek error in 10^6 physical seek operations. Unrecoverable seek errors are classified as failures for MTBF calculations.

6.1.4 Environmental Errors

When operating at low effective data transfer rate (that is, random access of single short records), the effective error rate may be expected to exceed the specified limits due to environmental interference. Excluding environmental interference, the recoverable read error rate shall be no more than one error in eight hours of operation.

6.2 RELIABILITY AND SERVICE

6.2.1 Mean Time Between Failure

Following an initial period of 200 hours, the Mean Time Between Failure (MTBF) shall exceed 3200 hours for units manufactured in the first year of production and 6000 hours for units manufactured in the second year. For units manufactured after the second year, the MTBF shall exceed 7500 hours. The following equation defines MTBF:

$$\text{MTBF} = \frac{\text{Operating Hours}}{\text{Number of Equipment Failures}}$$

"Operating Hours" means total power-on hours less any maintenance time. "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, adapter failure, cable failure, or other failure not caused by equipment. To establish a meaningful MTBF, operation hours must be greater than 7500 hours per drive and shall include field performance data from all field sites.

The term "equipment failure" implies that emergency maintenance is required because of a hardware failure.

6.2.2 Preventive Maintenance

No routine scheduled preventive maintenance shall be required provided the drive is operated in a clean office or computer room environment.

6.2.3 Service Life

The LMU shall have a useful service life of five years or 20,000 power-on hours, whichever occurs first, before requiring factory overhaul. Depot repair or replacement of major parts will be permitted during the lifetime of the drive.

6.2.4 Installation

The LMU is designed, manufactured, and tested with a "Plug-in and Play" installation philosophy. Basically, this philosophy minimizes the requirements for a highly trained personnel to integrate an LMU into the user's system.

The LMU has a factory installed top cover providing maximum protection from environmental contaminants. This cover should only be removed in a recommended maintenance facility with proper environmental control; otherwise, warranty will be void.

This does not preclude on-site replacement of components external to the sealed area such as printed circuit boards, belt, etc.

6.2.5 Service Tools

No special tools are required for site installation or site maintenance of the LMU.

7.0 PHYSICAL/ELECTRICAL SPECIFICATIONS

7.1 POWER REQUIREMENTS

The primary AC/DC voltage and current requirements are shown in Tables 2 and 3.

Table 2. Primary AC/DC Voltage Requirements

VOLTAGE (V ac)	TOLERANCE (V ac)	FREQUENCY (Hz)	TOLERANCE (Hz)
120	+8, -16	60	+0.6, -1.0
220	+15, -29	50	+0.5, -1.0
230	+16, -32	50	+0.5, -1.0
240	+16, -32	50	+0.5, -1.0

VOLTAGE (V dc)	REGULATION	MAX RIPPLE P/P	CURRENT DRAIN	
			MIN	MAX
+5	±2%	50 mV	0.05 A	2.8 A
-5.2	±2%	50 mV	0.07 A	3.5 A
+16.5	±10%	500 mV	0.1 A	1.3 A
-16.5	±10%	500 mV	0.04 A	1.3 A

NOTE 1: PEAK CURRENT FOR THE ±16.5 VOLT SUPPLIES MAY REACH 2.4 AMPERES FOR 24 MILLISECONDS DURATION FROM EITHER SUPPLY (NOT BOTH) WITH A 38 MILLISECOND MINIMUM INTERVAL BETWEEN CURRENT PULSES.

NOTE 2: THE ±5 VOLTS SHALL SHARE A DC COMMON. THE ±16.5 VOLTS SHALL SHARE A SEPARATE DC COMMON.

NOTE 3: IN REGARD TO DC POWER SEQUENCING, THE +5 V DC SUPPLY MUST NOT PRECEDE THE REMAINING DC VOLTAGES IN EXCESS OF 50 MILLISECONDS.

Two standard as-shipped voltage configurations are available for the LMU: either 120 V ac 60 Hz or 220 V ac 50 Hz. The 50 Hz configuration will function over the voltage range of 220/230/240 volts without any changes to the LMU. Field conversion of 50 Hz LMU's is possible by following the instructions contained in the Voltage Conversion Instructions, TBD.

Table 3. LMU Current/Power Requirements Under Various Conditions

DRIVE INPUTS	CURRENTS AND WATTAGE					
	ON TRACK		SEEKING		STARTING	
	NOMINAL	MAXIMUM	NOMINAL	MAXIMUM	NOMINAL	MAXIMUM
120 V ac	0.5 A (60 W)		0.5 A (60 W)		0.85 A (102 W)	
+16.5 V dc	0.4 A (6.6 W)		0.72 A (11.9 W)		---	---
-16.5 V dc	0.35 A (5.8 W)		0.67 A (11.1 W)		---	---
+5 V dc	0.91 A (4.55 W)		0.91 A (4.55 W)		---	---
-5.2 V dc	2.88 A (14.4 W)		2.88 A (14.4 W)		---	---
TOTAL WATTAGE	91.1 W		102 W		---	---

7.1.1 AC and DC Power Connectors

Refer to Figure 3 for connector locations and Table 4 for pin assignments.

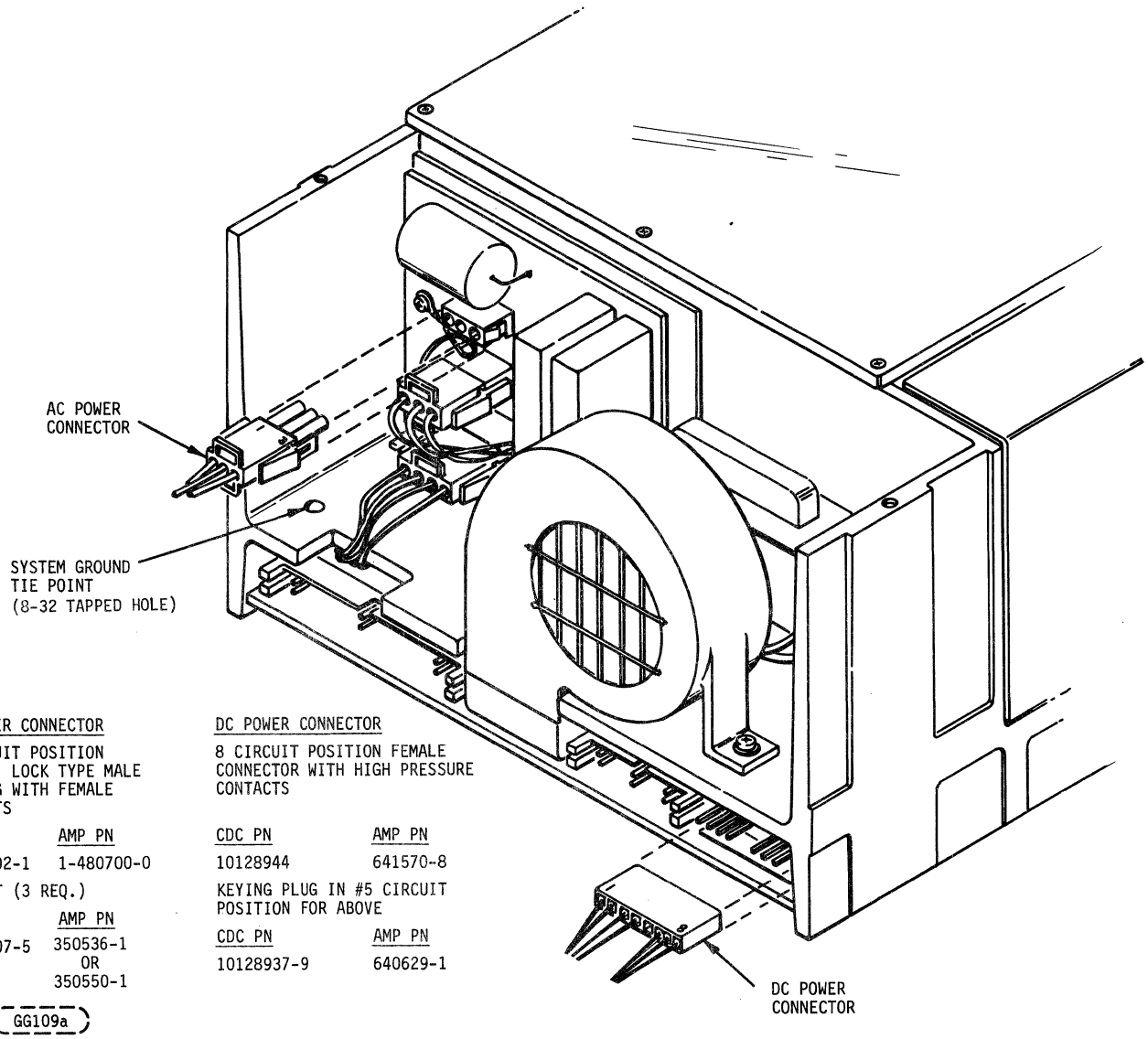


Figure 3. AC and DC Cabling

Table 4. AC/DC Pin Assignments

AC CONNECTOR	
PIN	SIGNAL
1	AC RETURN
2	SAFETY GROUND
3	AC LINE

DC CONNECTOR	
PIN	SIGNAL
1	+16.5 V
2	+5 V
3	GROUND
4	GROUND
5	KEY
6	-5.2 V
7	-5.2 V
8	-16.5 V

Figure 4 illustrates an operational profile of line currents to power supply versus time.

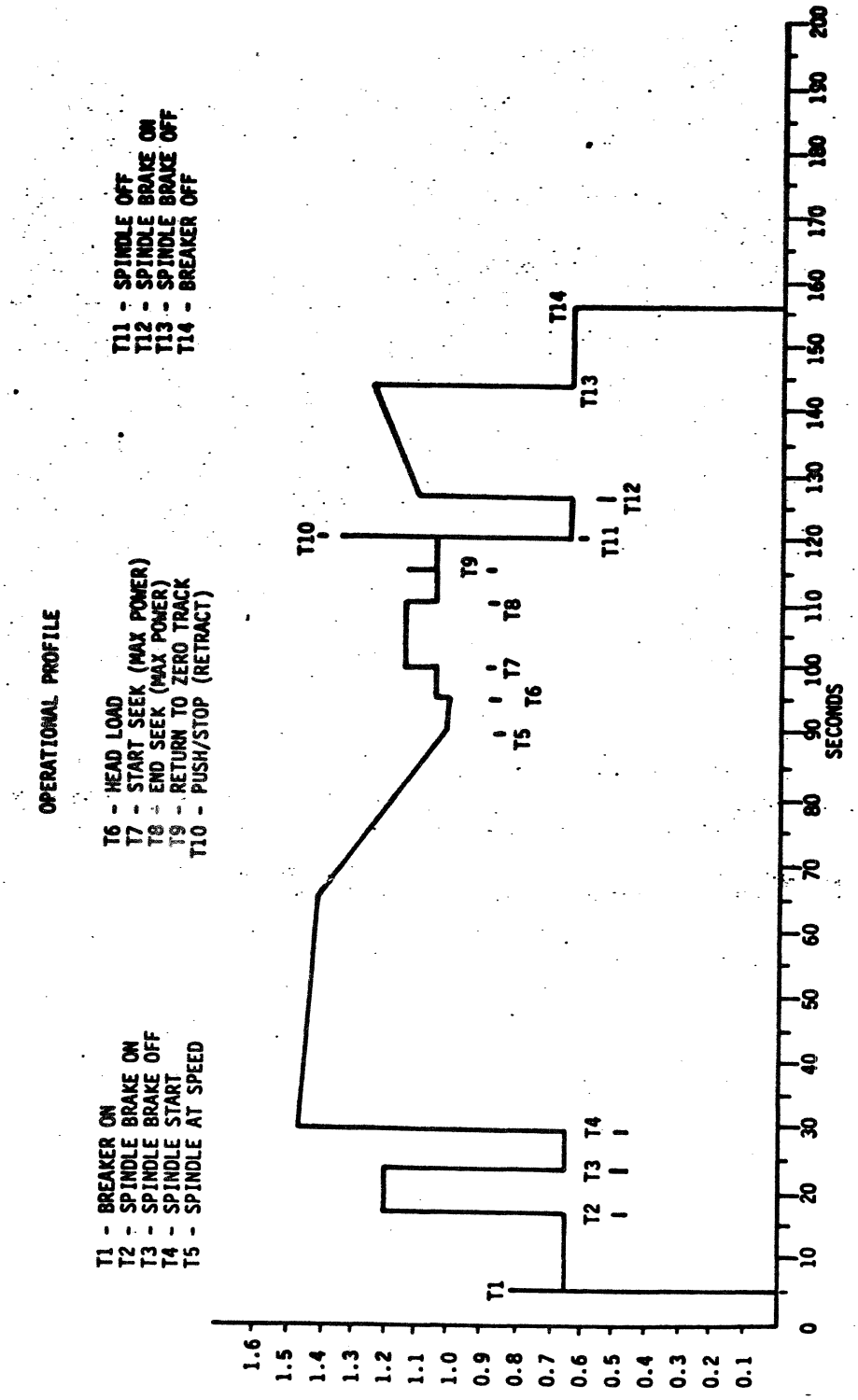


Figure 4. Operational Nominal Line Currents to Power Supply vs Time

7.1.2 Command/Data Cable Connectors

System command/data cable connectors are shown in Figure 5. Detailed connector information is contained in the Product Specification for the Micro Unit Interface, 77653473.

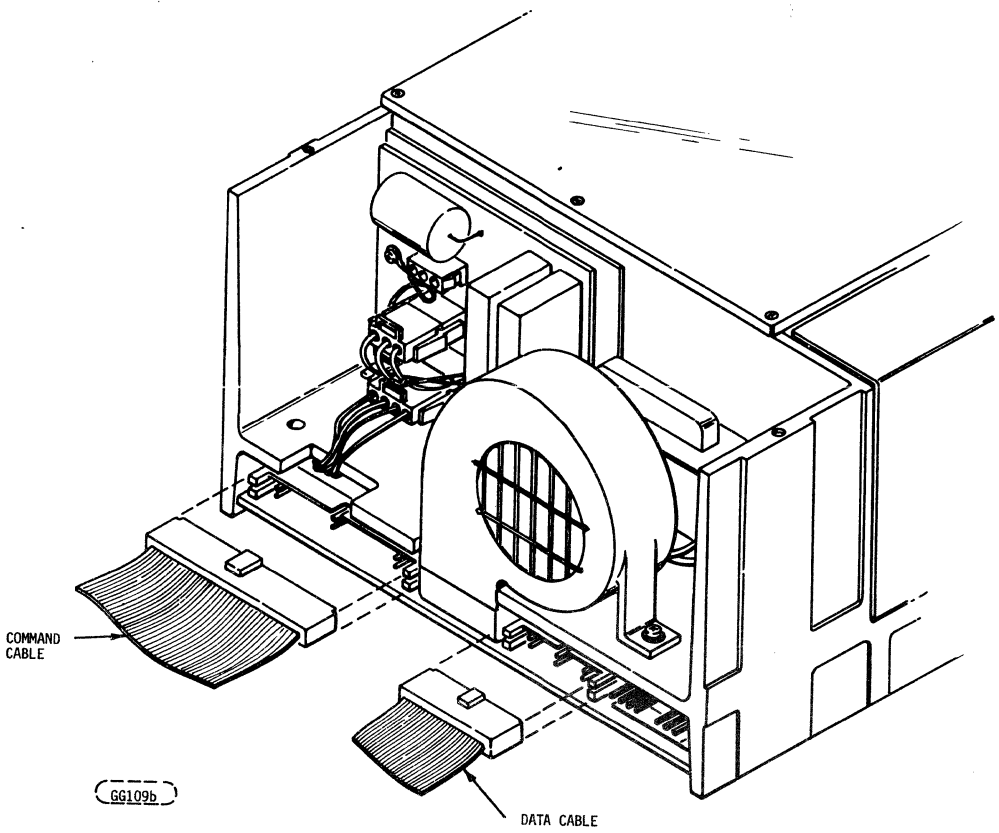
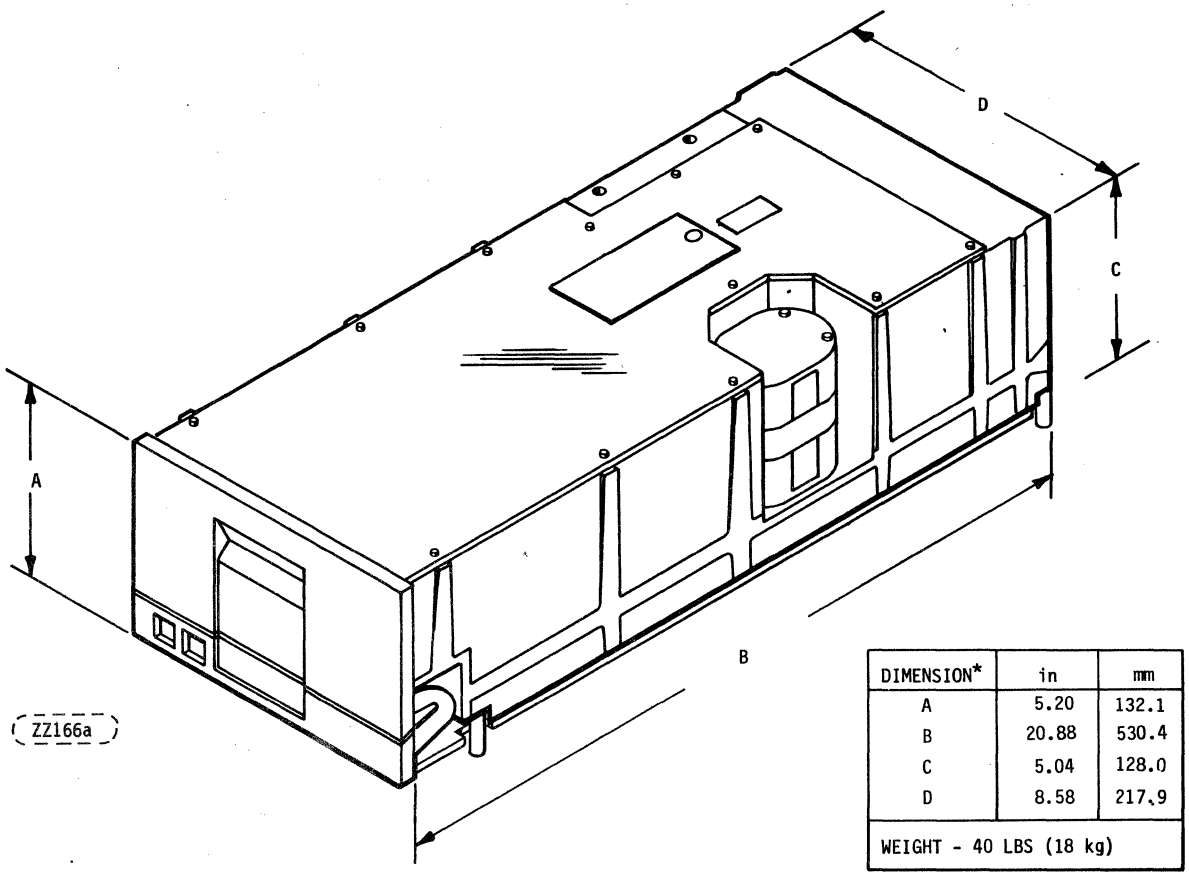


Figure 5. Command/Data Cable Connections

7.2 MECHANICAL SPECIFICATIONS

The overall dimensions of the LMU are contained in Figure 6.

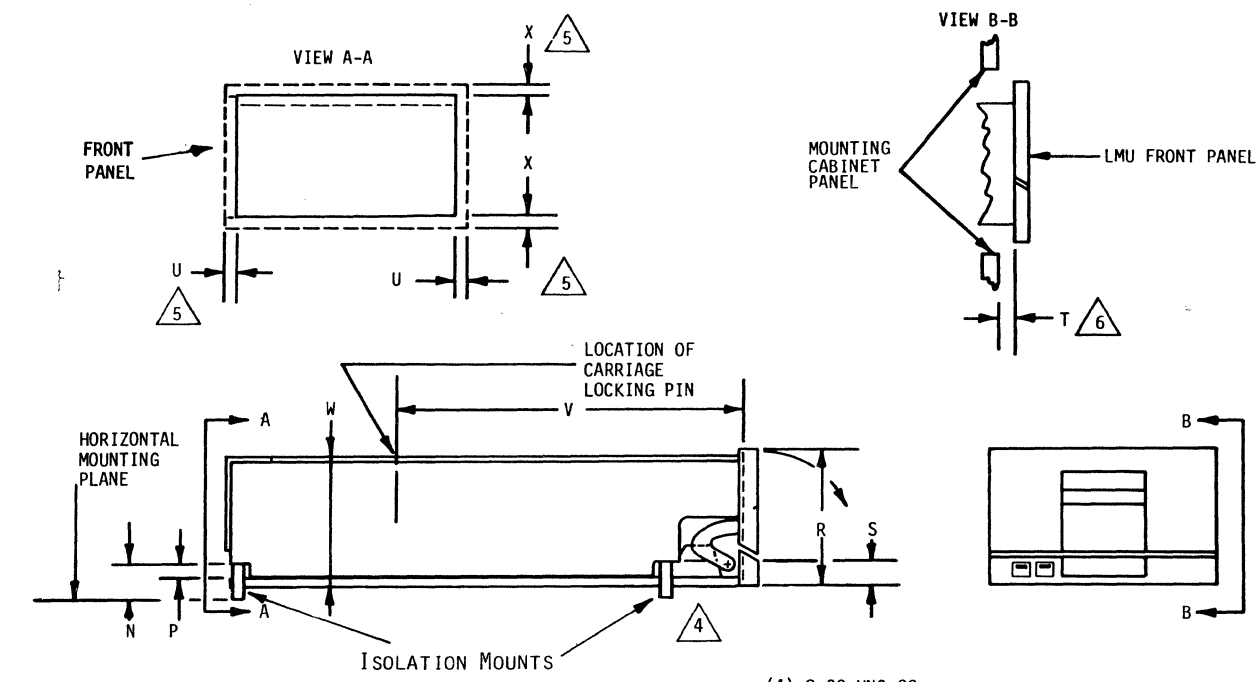


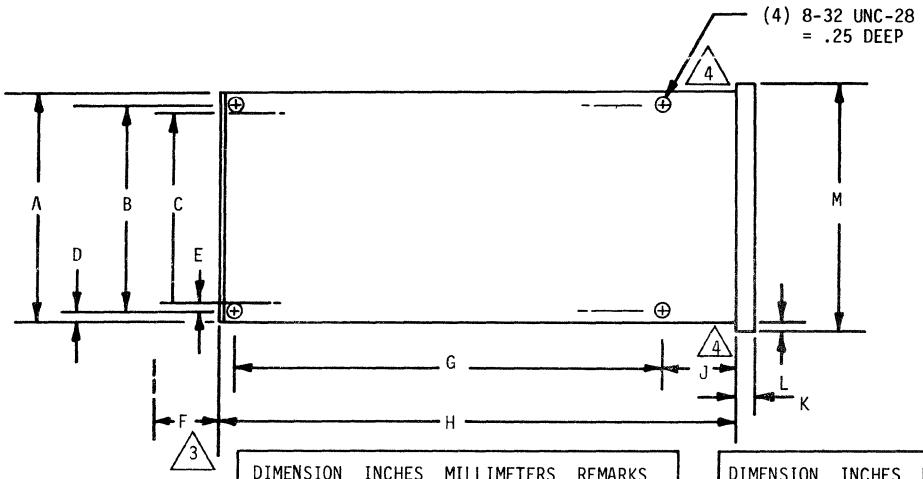
DIMENSION*	in	mm
A	5.20	132.1
B	20.88	530.4
C	5.04	128.0
D	8.58	217.9
WEIGHT - 40 LBS (18 kg)		

* MAX DIMENSIONS

Figure 6. Mechanical Dimensions

Figure 7 contains detailed mounting configuration dimensions.





DIMENSION	INCHES	MILLIMETERS	REMARKS
* A	8.58	217.9	
B	8.00	203.20	
C	7.75	196.85	
D	0.28	7.11	
E	0.13	3.30	
F	2.00	50.80	△3
G	17.55	445.77	
* H	20.88	530.4	REF
J	2.94	74.68	REF
K	0.56	14.22	
L	0.10	2.54	

DIMENSION	INCHES	MILLIMETERS	REMARKS
M	8.78	223.01	
N	0.625	15.875	FREE STATE
N	0.575	14.605	LOADED
P	0.45	11.43	
* R	5.20	132.1	
S	0.53	13.46	
T	0.03	0.76	△6
U	0.03	0.76	△5
V	12.55	318.77	
* W	5.04	128.0	MAXIMUM
X	0.125	3.175	

NOTES: 1. ALL DIMENSIONS SHOWN ARE NOMINAL UNLESS * THEN MAX.

△3. AIR ENTRY AND CABLE CLEARANCE.

△4. CLEARANCE OF 0.75 INCHES (19.1 mm) MUST BE PROVIDED AT AIR EXITS.
△5. MAINTAIN CLEARANCE BETWEEN LMU AND SURROUNDING STRUCTURE FOR RELATIVE MOTION.
△6. MAINTAIN CLEARANCE BETWEEN LMU FRONT PANEL AND FRONT SURFACE OF MOUNTING CABINET PANEL FOR RELATIVE MOTION.

GG039a

Figure 7. Mechanical Mounting Dimensions

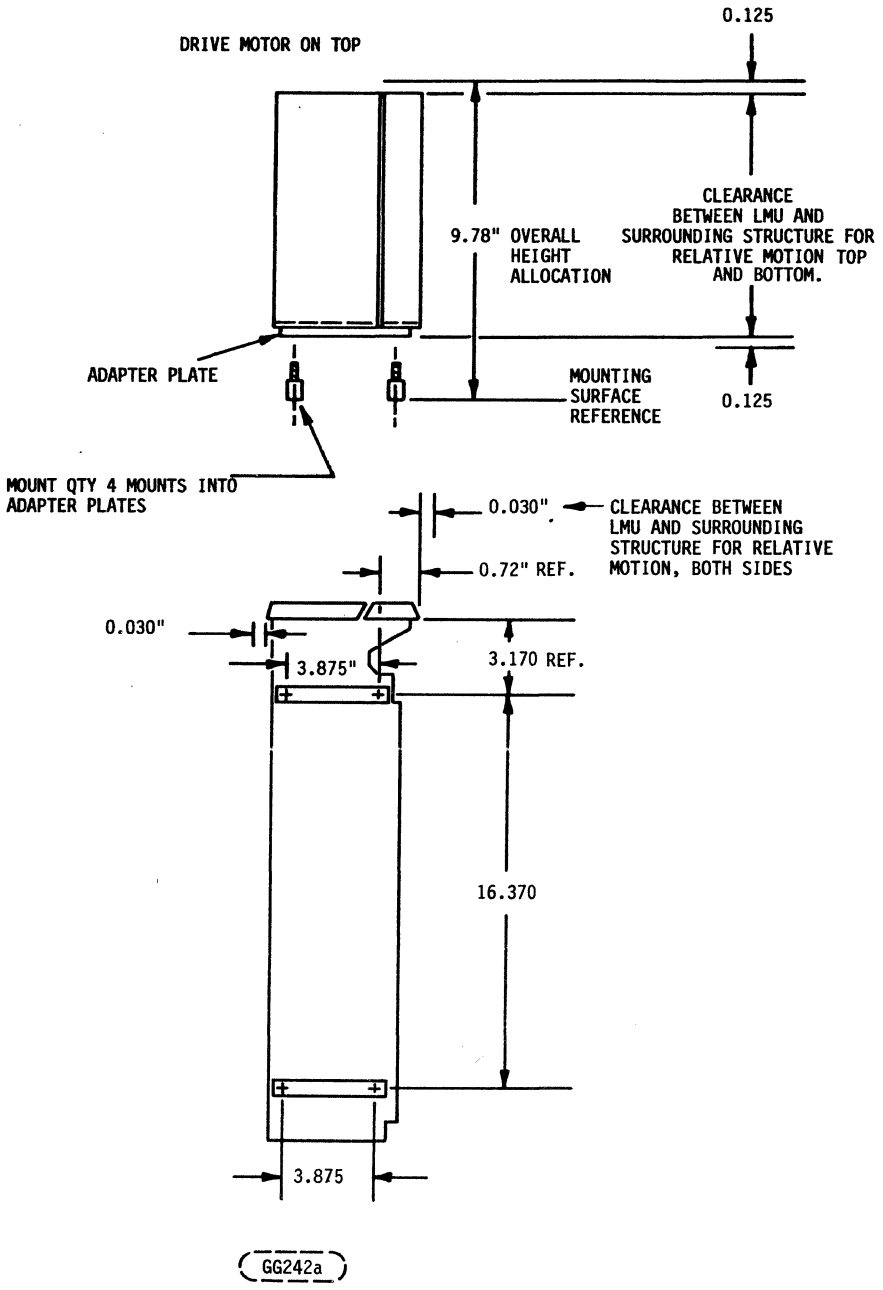


Figure 7a. Vertical Mounting Dimension

The LMU is designed for installation into a standard RETMA rack or equivalent enclosure. Two LMU's, configured horizontally, will fit within a standard 7.0 inch (177.8 mm) opening. Three drives configured vertically (spindle motor up) will fit within a standard 10.5 inch (266.8 mm) opening. Refer to Figure 8.

No slides are provided with the LMU, but provisions for mounting are found on the side of the base casting for vertical configurations and at the bottom of the base casting for horizontal configurations. The mechanical interface for mounting is accomplished via the mandatory use of shock absorbers supplied with the drive. Reference Figures 7 and 7A for details.

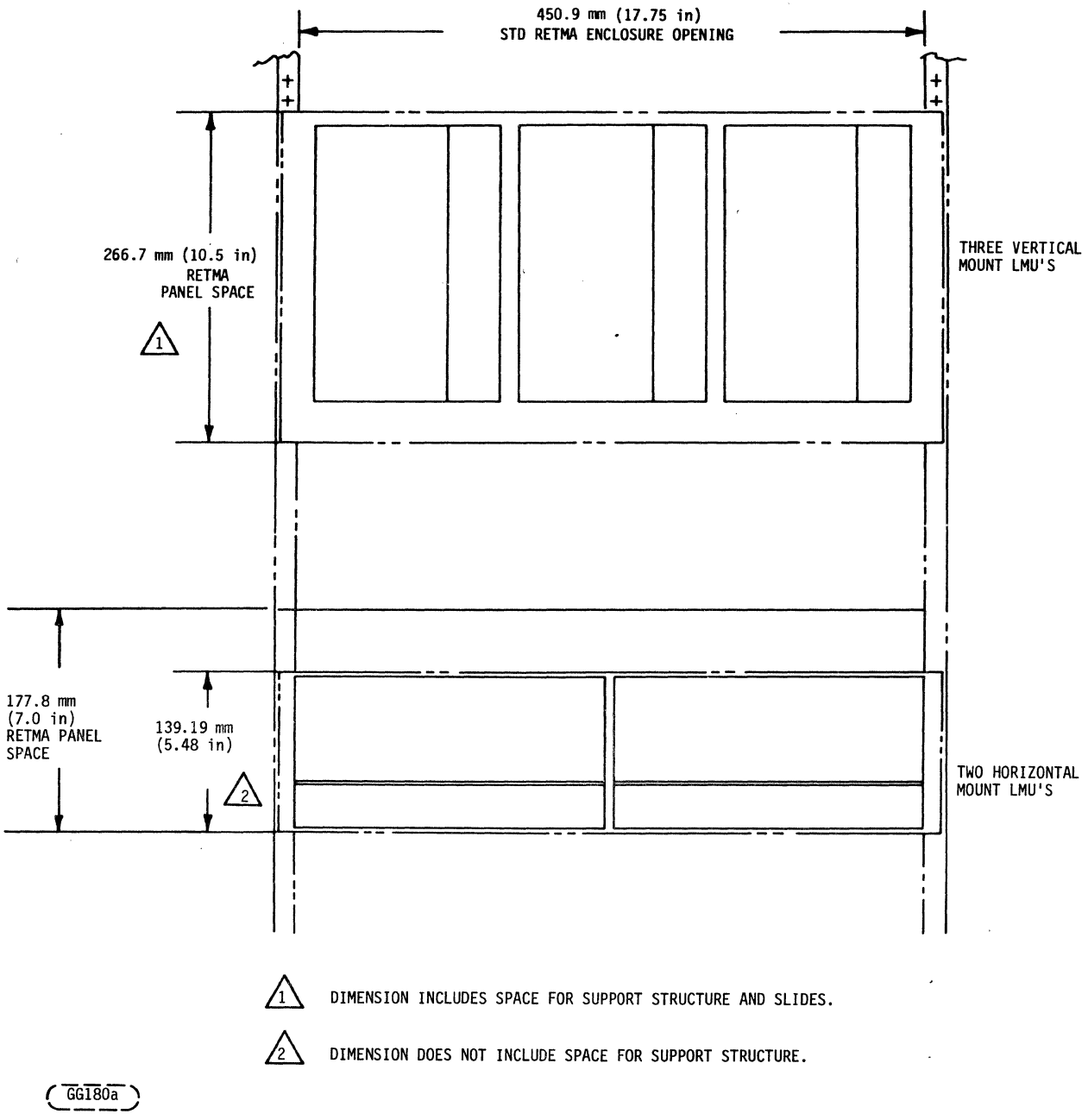


Figure 8. Typical Rack Mount Configurations

7.3 OPERATOR CONTROL PANEL

The operator control panel shown in Figure 9 contains two alternate action switches and two LED indicators as defined below.

The Ready indicator illuminates the faceplate of the Start/ Stop switch and the Fixed Write Protect indicator illuminates the faceplate of the Fixed Write Protect switch.

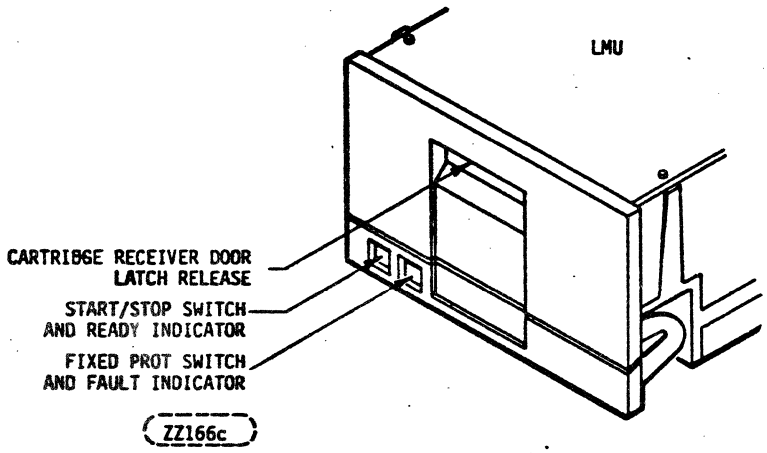


Figure 9. LMU Front Panel

Start/Stop Switch

The Start/Stop switch, when engaged, energizes the spindle motor provided that the following have been satisfied:

1. The AC circuit breaker is ON.
2. The cartridge-door-closed switch is ON.
3. The cartridge-in-place switch is ON.
4. The spindle power off bit has not been activated via an interface command.

Fixed Write Protect Switch

When the Fixed Write Protect Switch is engaged, it inhibits all write operations on the fixed volume. (The removable volume is protected via an operator changeable write protect tab which is sensed by the LMU electronics to prevent unwanted writing.) This switch also provides a means for the operator to clear device faults. When a fault condition exists, cycling the switch from its current position and then back initiates the fault reset and recovery procedure.

Ready Indicator

The Ready indicator indicates Unit Ready status whenever the spindle is up to speed and the heads are loaded. The Ready indicator blinks during the spindle start and stop procedures.

Fixed Write Protect Indicator

The Fixed Write Protect indicator indicates that the selected volume is write protected. In addition, it also provides the operator with fault status as follows:

1. Fixed Write Protect indicator blinking indicates that a fault condition has been detected.

2. Fixed Write Protect indicator blinking with the Ready indicator blinking indicates a fault causing the heads to retract.

7.4 ENVIRONMENTAL LIMITS

The LMU is intended to operate in computer room and office environments with minimal environmental control. Temperature and humidity specifications preclude condensation on any drive part.

7.4.1 Temperature

1. Operating

   50°F to 104°F (10°C to 40°C) with a maximum gradient of 18°F (10°C) per hour. The maximum temperature of 104°F (40°C) applies at altitudes between ± 983 feet (300 meters) or atmospheric pressures between ±105 kilopascals. Above this altitude, the maximum temperature is derated linearly to 95°F (35°C) at 6560 feet (2000 meters), or atmospheric pressure of 79.5 kilopascals.

2. Transit Temperatures

   -40°F to 140°F (-40.4°C to 60°C) with a maximum gradient of 36°F (20°C) per hour. This specification assumes that the drive is packaged in the shipping container designed for use with the LMU.

3. Storage Temperature

   +14°F to 122°F (-10°C to 50°C) with a maximum gradient of 27°F (15°C) per hour.

If it becomes necessary to use an LMU cartridge which has not been allowed to stabilize at the ambient drive operating room temperature for at least one hour or if the cartridge was exposed to temperatures below 61°F (16°C) immediately prior

to the stabilization period, then the following procedures must be employed:

1. The cartridge must be visually inspected or examined to ensure that condensation is not present on any part of the cartridge.

2. The cartridge must be allowed to spin on the LMU for a period of not less than five minutes prior to attempting to read or write on the cartridge.

7.4.2 Relative Humidity

1. Operating

   20% to 80% relative humidity with a maximum gradient of 10% per hour.

2. Transit (packaged in the shipping container designed for use with the LMU)

   5% to 95% relative humidity.

3. Storage

   10% to 90% relative humidity.

7.4.3 Altitude (Actual or Effective)

1. Operating

   -983 to +6560 feet (-300 to +2000 meters), sea level reference.

2. Transit (packaged in the shipping container designed for use with the LMU)

   -983 to +8200 feet (-300 to +2500 meters), sea level reference.

7.4.4 Vibration and Shock

The LMU is designed to withstand the vibration and shock conditions specified below without damage to its function, physical structure, or external appearance.

NOTE

Shock and vibration limits are measured directly at the LMU. If the drive is installed in an enclosure to which the stated shock/vibration criteria is applied, resonances may occur internally to the enclosure resulting in forces in excess of these limits at the installed drive's interface. Shock absorbers are supplied with the drive and are to be used in both the vertical and horizontal mounting configurations.

1. Operating

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

a. Continuous vibration as indicated in Figure 10, Curve A (Operating).

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

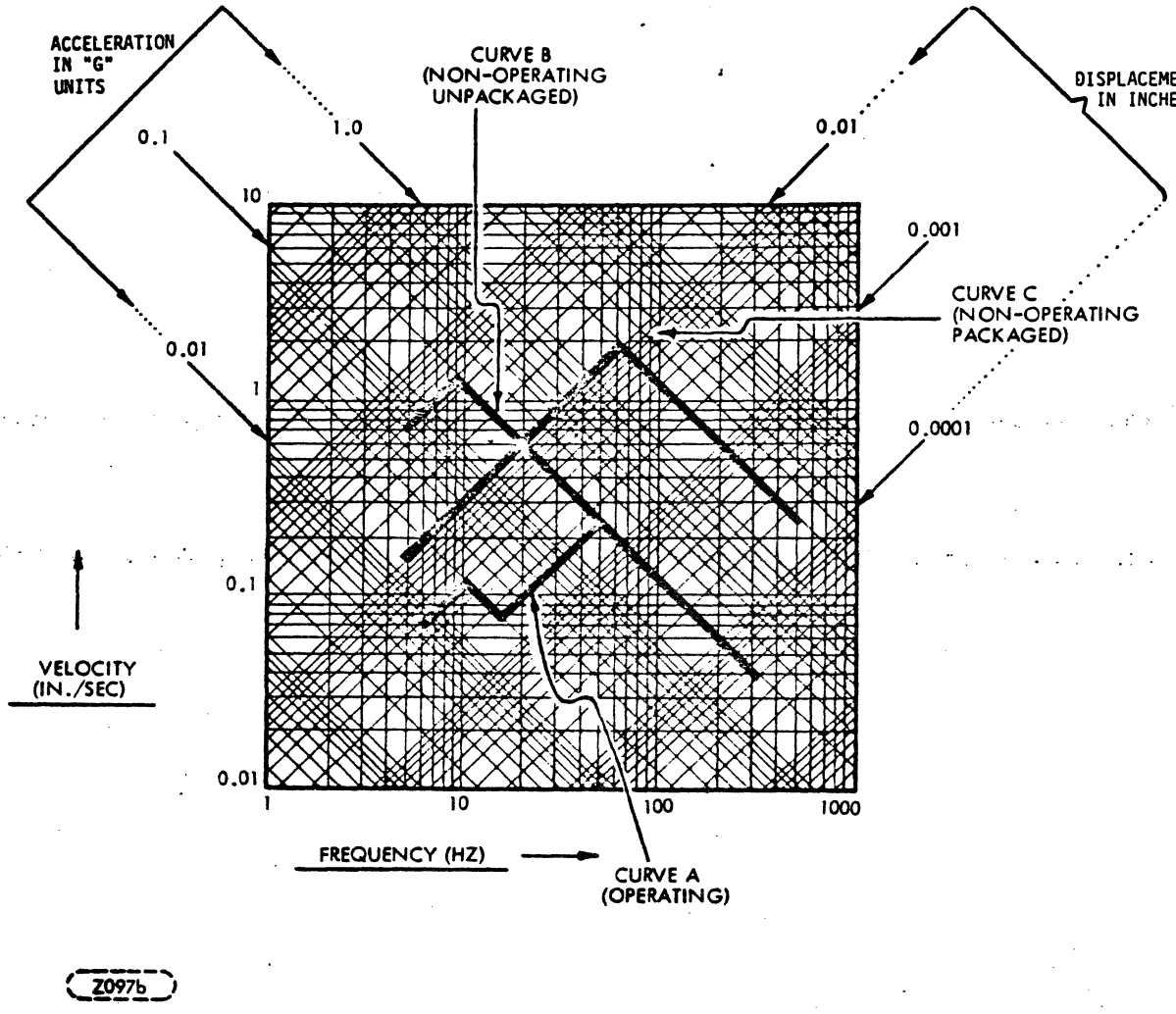


Figure 10. Vibration Levels

2. Transit

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.

a. Vibration as shown in Figure 10, Curve C (Non-Operating Packaged).

b. Shocks of up to 5 g, not exceeding 10 milliseconds in duration. The time between consecutive shocks cannot be less than 5 seconds.

The LMU is packaged for van or air freight shipment and shall withstand drop tests from 30 inches (765 mm) on all surfaces, three edges and one corner, against a concrete floor or equivalent. See Figure 11.

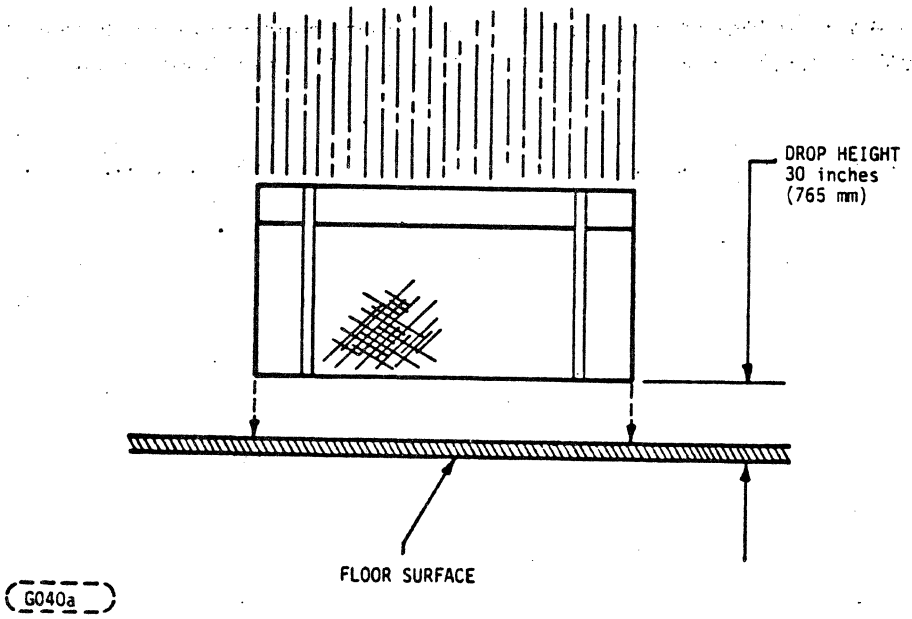


Figure 11. Flat Drop Test

7.4.5 Air Cleanliness

The LMU is designed to operate in an office environment with minimum or no environmental control. Heating is provided, but artificial cooling may not exist for the drive. Natural or forced air ventilation may be used to limit the maximum temperature. This range is considered the minimum acceptable environment for human comfort. In this environment, the LMU will operate with the following levels of contamination:

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

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

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

8.0 MEDIA/RECORDING CHARACTERISTICS

8.1 MEDIA CHARACTERISTICS

The media used on the LMU has a diameter of approximately eight inches. Its coating thickness is optimized for high density magnetic recording with densities in excess of 7000 flux reversals per inch (frpi) and track densities up to 600 tracks per inch (tpi).

A dedicated servo surface is not used with the LMU for head positioning control. Instead, embedded servo information is factory written on each data surface in those areas not occupied by header or data blocks. This pre-recorded servo field is used for carriage positioning, index and sector pulse generation, and PLO reference clock.

8.1.1 Cartridge Description

The LMU cartridge contains a single oxide-coated aluminum disk which is mounted on a self-centering hub and enclosed in a protective plastic case. The cartridge is sealed against dust. When the disk is inserted into the drive, the dust cover opens automatically for spindle and head access and closes automatically when the disk is withdrawn. An optional protective jacket can be supplied with the cartridge to provide an additional safeguard against contamination or damage resulting from handling or storage.

Cartridge interchangeability between other LMU's using the same format and sector configuration is ensured.

A write protect tab that is operator changeable prevents inadvertent overwriting of data.

A cartridge is approximately 8.5 inches (215.9 mm) square and 1 inch (25.4 mm) high. Refer to Figure 12.

Cartridge insertion is shown in Figure 13.

8.1.2 Fixed Media Description

The fixed media is a single iron-oxide coated aluminum disk attached to the spindle hub assembly. It is considered part of the basic drive and always remains within the assembly. Protection from damage and dirt is provided by housing it in a special cavity and isolating it from the cartridge receiving mechanism with a protective cover.

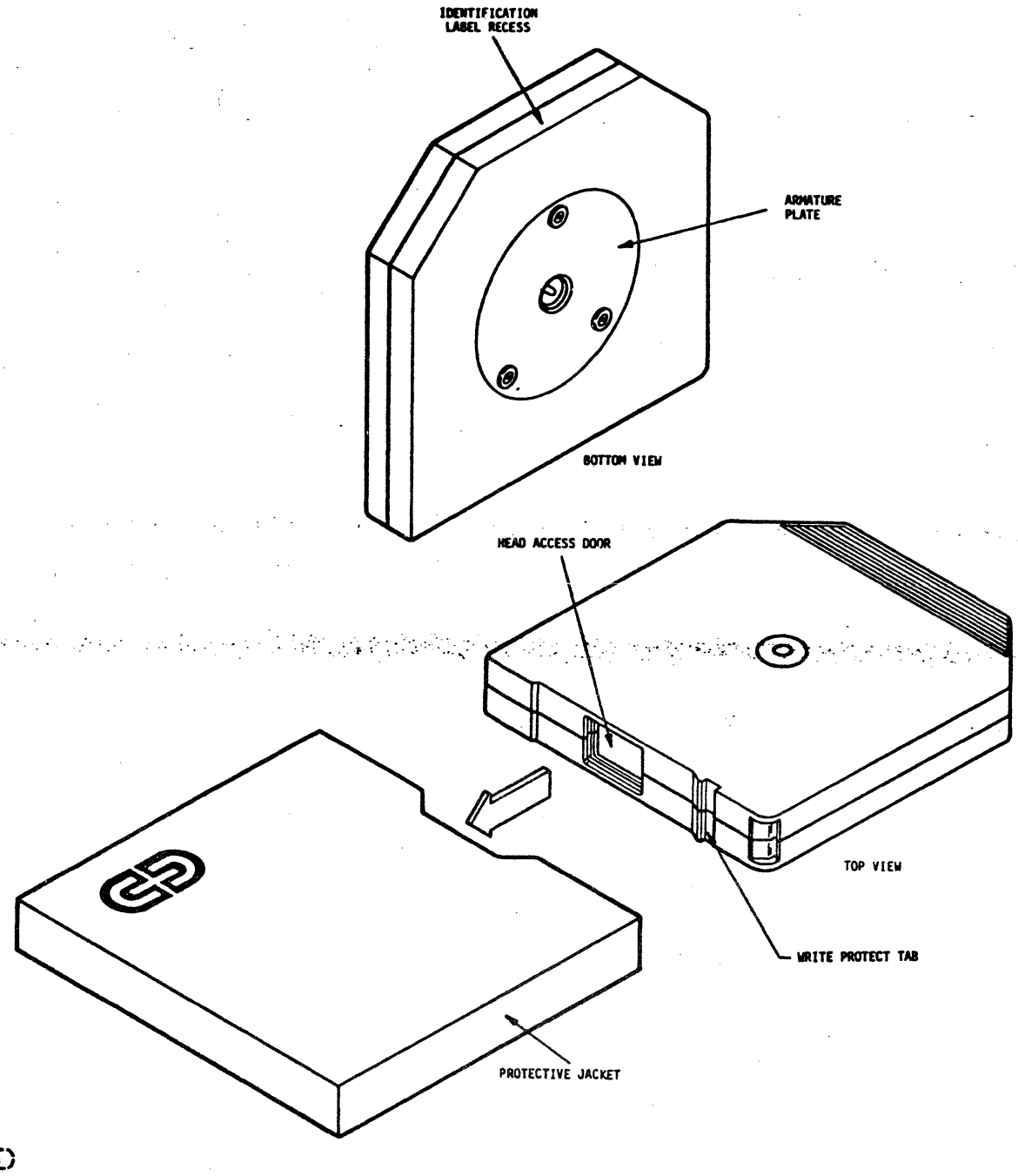


Figure 12. Removable Cartridge

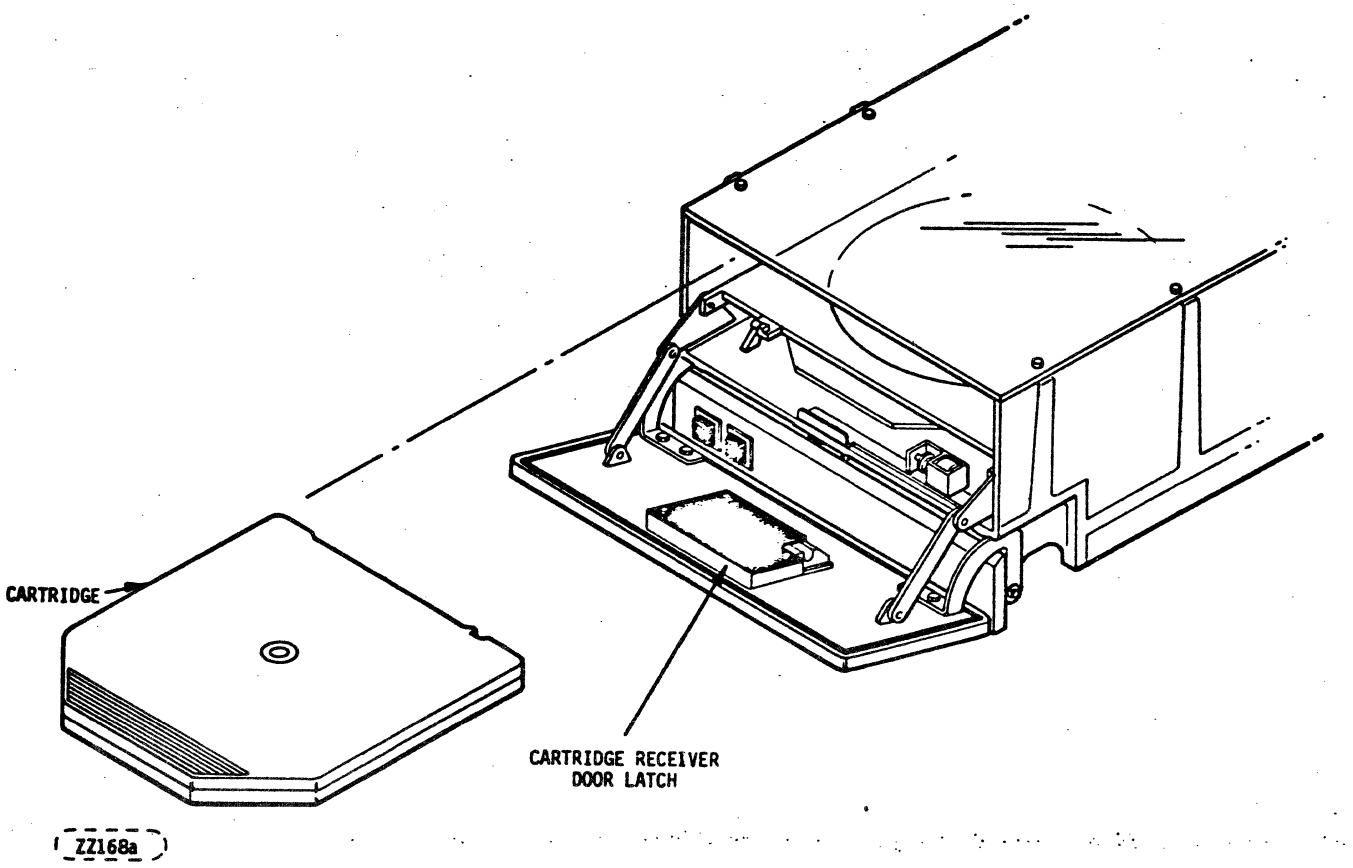


Figure 13. LMU Cartridge Insertion

It is mandatory that fixed media replacement be performed at a depot level maintenance facility or equivalent to ensure the proper environmental control.

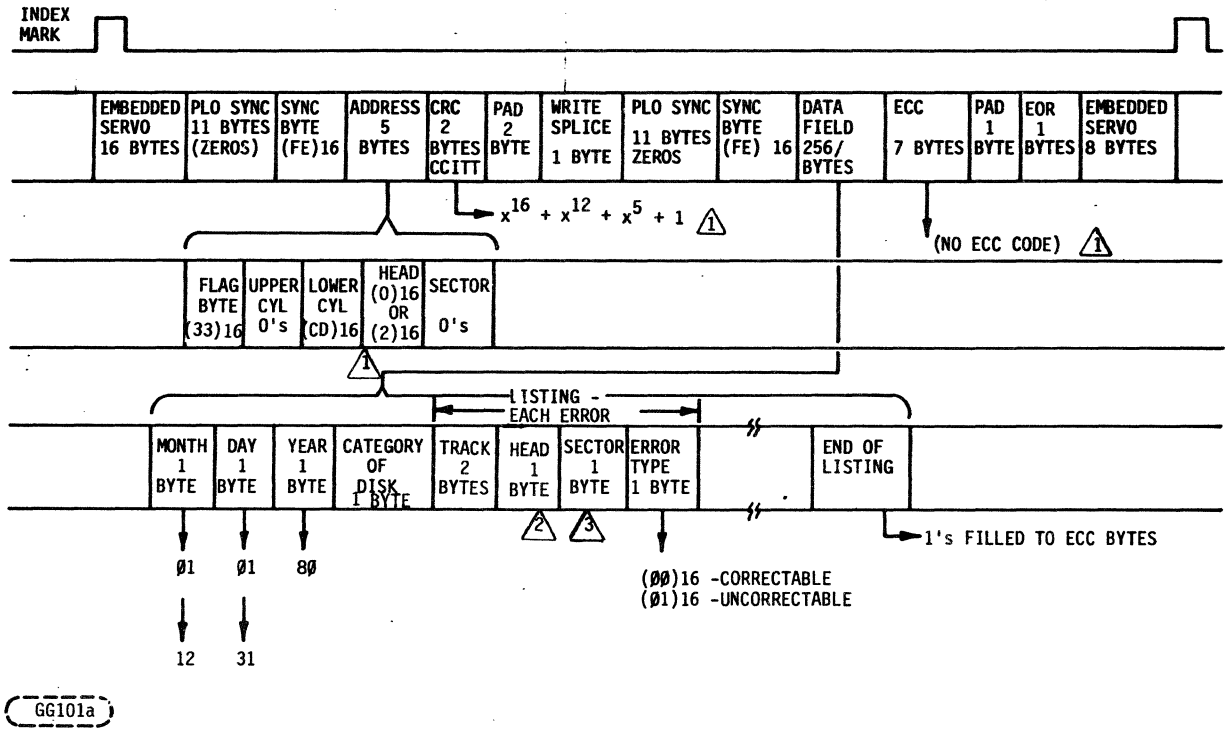
8.2 ALLOWABLE MEDIA DEFECTS

Media defects are characterized as being either correctable or uncorrectable as a function of the type and magnitude of the media flaw. Various error correction codes may be implemented to correct errors in the data read from the disk. However, the code chosen should be consistent with the media manufacturer's testing and certification methods. In the LMU, media certification is performed using the following standards:

1. An error burst of 11 bits or less is a correctable error.
2. An uncorrectable error is one greater than 11 bits in length.
3. Only one correctable error may occur in each sector or that sector must be classified as uncorrectable.

At the time of manufacture, media defect information is recorded on track 205, surface 0, sector 0 of each disk. This identifies flagged track/sector data for those users who wish to use it as a part of a system initialization and track and/or sector deallocation routine without recertification. If the user wishes to use this information, it is imperative not to write on this area of the disk until such time that it can be recovered.

Figure 14 shows the recording format for surface 0, track 205, and sector 0.



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(1) WILL CONTAIN 2 BYTE CRC CHARACTER FOLLOWED BY 5 ZERO BYTES, THE SYNC BYTE IS INCLUDED IN THE CRC CALCULATION. THE CRC GENERATOR IS INITIALIZED TO (0000)16.

(2) CARTRIDGE IS HEAD 0; FIXED DISK IS HEAD 2.

(3) ALWAYS LOGGED W A 64 SECTOR 256 BYTE DATA FIELD FORMAT. IF OPERATING W A 32 SECTOR CONFIGURATION, THE SECTOR INFORMATION OF THE ERROR LOG MAY BE INTERPRETED AS FOLLOWS TO DETERMINE DEFECTIVE SECTORS.

ERROR LOG SECTOR #	0-1-2-3-4-5-----60-61-62-63
32 SECTOR CONVERSION	0 1 2 30 31

Figure 14. Format for Surface 0, Track 205, Sector 0- Factory Flagged Track Data

8.2.1 LMU Fixed Media

The LMU fixed media will:

1. Have no media defects on cylinder 0 and 205.
2. Have no more than three correctable errors per surface.
3. Have no more than two uncorrectable errors per surface.
4. The total of items 2 and 3 above must not exceed four errors.

This permits those users who have implemented error correction codes (ECC) into their systems the use of 202 correctable tracks with two spare tracks to be used as needed.

For those users who choose not to use ECC, it is recommended that 200 tracks be used for data storage and retrieval, leaving two spare tracks that can be assigned as alternates if this becomes necessary.

8.2.2 LMU Cartridge Media

The magnetic recording surface of the LMU cartridge is the same as that of the fixed media. Media certification is performed using the same criteria. Refer to Disk Cartridge Product Specification, 76192089, for further details.

8.3 RECORDING CHARACTERISTICS

The recording system used in the LMU employs 2,9 recording code. This code yields a bits-per-inch to flux-reversals-per-inch ratio of 1.5 to 1. Data recorded on a track using this code at 6000 flux reversals per inch is effectively recording data on that track at 9000 bits per inch.

Briefly, this code operates in the following manner:

1. The NRZ serial data which is to be written on the disk is examined in a bit-field form.

2. Within the 9-bit field each 3-bit sequence is encoded into a recorded zone containing not more than two flux reversals.

3. The presence or absence of a flux reversal and their placement within the zone is a function of the specific three bits of data to be written in the zone and the contents of the two zones which are immediately adjacent to the zone being written.

8.4 DATA SECURITY

Under normal adapter input/output operation, it is not possible to write a pattern other than that on the Write Data lines. The bit pattern can only be altered when the LMU signifies an On Cylinder status, is not write protected via hardware or operator control, and Write Gate is active, but only upon specific selection of the LMU. Data is protected by inhibiting Write Gate in the following fault conditions:

1. Write Gate and Servo Write Inhibit

   This detects the condition of a missed embedded servo field which causes a write protect condition for the following data field, AND'ed with an attempt to write.

2. Write Gate and Microcomputer Write Protect

   This detects an attempt to write when write protected by the microcomputer. The microcomputer may write protect when off cylinder during seek, during command dialogue, if a fault condition exists, if Fixed or Cartridge Write Protect is active and the associated volume is selected, or when not ready.

3. Servo Write Protect Timing Fault

   This checks internal embedded servo write protect timing. This guarantees that Write Protect is toggling and correct in time with respect to Read Enable, another servo-related signal.

4. Read Gate and Write Gate

   This is a simultaneous occurrence of both Write Gate and Read Gate.

Under any of the following conditions, a Write Inhibit and an emergency retract of the heads is performed so that data is protected:

1. Loss of AC line power
2. Loss of spindle speed
3. Pre-amp faults
   a. Write Gate and no Write Data
   b. Head shorted or open
   c. Read active and DC write current
4. Servo Faults
   a. +5, -5.2, +16.5, -16.5 V dc failure
   b. Retract capacitor charge low
   c. Microcomputer detected fault

Protective features are incorporated within the LMU to prevent altering data due to abnormalities during start-up or shutdown.

9.0 ERROR RECOVERY CONSIDERATIONS

9.1 EARLY/LATE DATA STROBE

Consistent with media recording employing flux reversals in excess of 6000 flux reversals per inch, the LMU incorporates provisions to strobe the data window early or late to compensate for peak shifting due to bit crowding. This capability is controlled via an adapter command and would normally be used when a read error occurs during reading as part of program controlled error recovery routine.

9.2 ALTERNATE TRACK ASSIGNMENTS

The LMU has 206 tracks per surface. Four of these are intended to be used as spares for alternate track assignments. Alternate track assignments may become necessary due to media defects that are uncorrectable (greater than 11 bits in length) when using error correction codes (ECC). Since the probability of occurrence of error bursts greater than 11 bits is minimal as compared to single or multiple bit errors, optimum system efficiency would be realized using ECC techniques in conjunction with alternate track assignments.

9.3 ECC IMPLEMENTATION

It is recommended that the host system implement ECC (error correction codes) error correction techniques with the LMU.

A factor to consider is the 2,9 recording method used. In MFM recording, error bursts are directly proportional to the number of affected flux reversal positions; therefore, no error propagation occurs with media defects. In other words, "N" bad flux reversals on the recording surface equals "N" defective bits in the decoded data.

With the 2,9 recording method, incoming binary data passes through complex encoding circuitry and is written on the media in a coded manner (that is, three binary bits equal six possible flux reversal sites on the recorded media). Resultantly, a media defect in a current flux reversal sequence may propagate into adjacent flux reversal groups resulting in a decoded data error burst of greater length than the actual media defect.