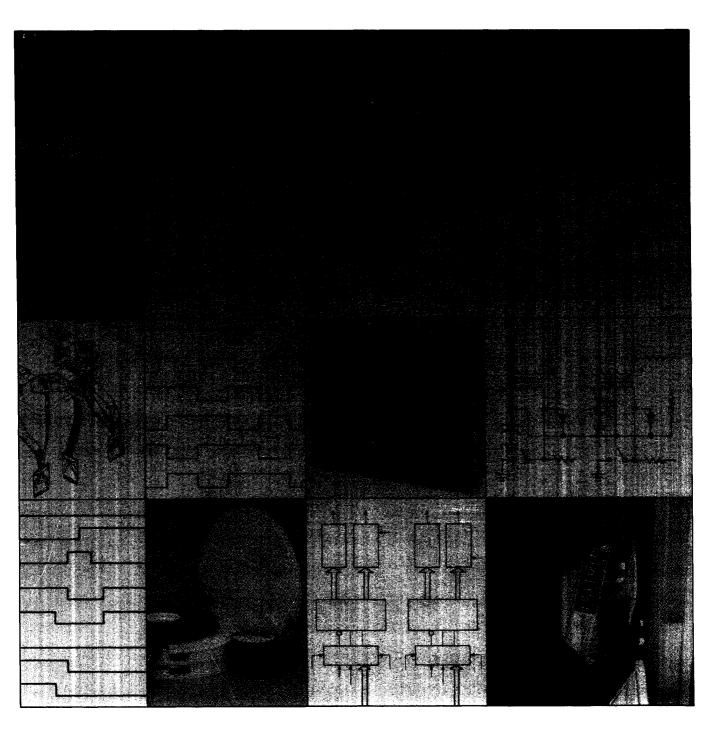
digital

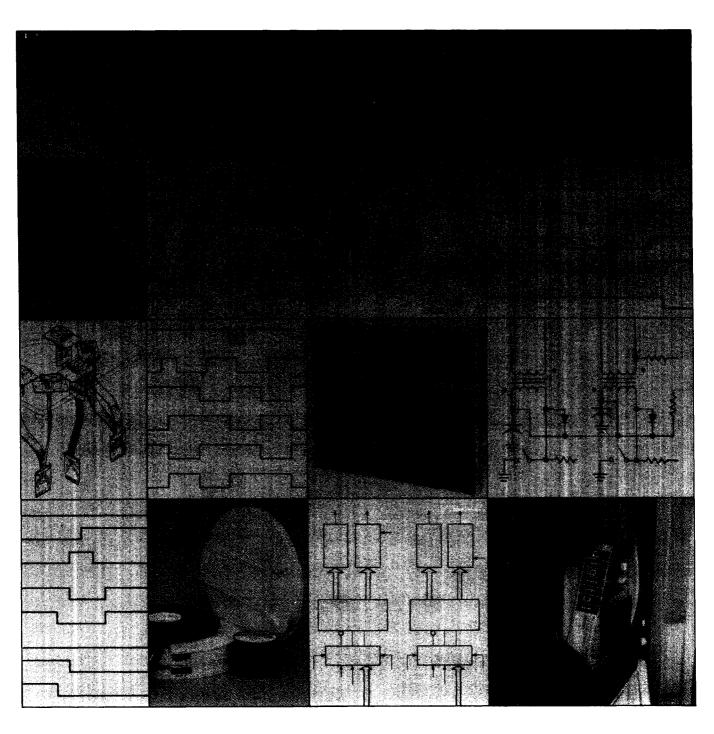
RK05 disk drive user's manual



-digital equipment corporation -maynard, massachusetts –

digital

RK05 disk drive user's manual



-digital equipment corporation • maynard, massachusetts –

RK05 disk drive user's manual

EK-RK05-OP-001

Copyright © 1976 by Digital Equipment Corporation

The material in this manual is for informational purposes and is subject to change without notice.

Digital Equipment Corporation assumes no responsibility for any errors which may appear in this manual.

Printed in U.S.A.

The following are trademarks of Digital Equipment Corporation, Maynard, Massachusetts:

DEC DECtape PDP
DECCOMM DECUS RSTS
DECsystem-10 DIGITAL TYPESET-8
DECSYSTEM-20 MASSBUS TYPESET-11
UNIBUS

CONTENTS

	Pag	e
CHAPTER 1	GENERAL INFORMATION	
1.1	INTRODUCTION	1
1.2	WARRANTY	1
1.3	SPECIFICATIONS	1
1.4	50/60 Hz POWER OPTION	-1
1.5	MAJOR ASSEMBLIES AND SYSTEMS	1
1.5.1	Controls and Indicators	4
1.5.2	Spindle and Drive	4
1.5.3	Linear Positioner	4
1.5.4	Cartridge-Handling System	4
1.5.5	Logic Assembly	.4
1.5.6	Air System	4
1.5.7	Power Supply	4
1.5.8	Read/Write Heads	4
CHAPTER 2	INSTALLATION	
2.1	UNPACKING AND INSPECTION	-1
2.2	MECHANICAL INSTALLATION AND CHECKOUT 2-	
2.3	CARTRIDGE HANDLING PRACTICES AND PRECAUTIONS	
2.4	CARTRIDGE PACKING AND SHIPPING	_
2.5	NORMAL OPERATING PROCEDURES	
2.5.1	Cartridge Loading	,
2.5.2	Cartridge Unloading	
2.3.2	Cartridge Officading	-,
CHAPTER 3	INTERFACE	
3.1	GENERAL	_
3.2	INPUT INTERFACE LINES	-1
3.2.1	RK11-D 3	-1
3.2.2	Select (4 lines)	-1
3.2.3	Cylinder Address (8 lines)	-1
3.2.4	Strobe	_
3.2.5	Title Dollott	3
3.2.6	Write Protect Set	3-3
3.2.7	Will Data and Clock	3
3.2.8	Write Gate	3-3
3.2.9	Restore (RTZ)	3-3
3.2.10	Read Gate	3-3
3.3	OUTPUT INTERFACE LINES	3-3
3.3.1	File Ready (Drive Ready)	3-3
3.3.2	Read, Write, or Seek Ready/On Cylinder	3-3
3.3.3		3-3
3.3.4		3-3
3.3.5		3-3
3.3.6	- · · · · · · · · · · · · · · · · · · ·	3-3
3.3.7		3-3
3.3.8		3-4
3.3.9		3-4

CONTENTS (Cont)

		Page
3.3.10	Sector Address (4 lines)	. 3-4
3.3.11	Sector Pulse	
3.3.12	Index Pulse	. 3-4
3.3.13	AC Low	
3.3.14	DC Low	. 3-4
3.3.15	High Density/RK05 L	. 3-4
APPENDIX A	THE RK05-TA OFF-LINE TESTER	
	ILLUSTRATIONS	
Figure No.	Title	Page
1-1	Location of Major Assemblies and Systems	. 1-3
1-2	Controls and Indicators	
1-3	Spindle and Drive System	. 1-7
1-4	Linear Positioner	. 1-7
1-5	Cartridge Handling System	. 1-8
1-6	Air System	
1-7	Head Loading	
1-8	Relationship of Disk Head, Disk, and Contaminants	
2-1	Shipping Bracket and Shipping Strap Location	
2-2	RK11C or RK11D Interface Cable Installation	
2-3	Chassis Slide Mounting	
2-4	RK8/E Interface Cable Installation	
3-1	Controller/RK05 Disk Drive Interface Lines and Pin Assignments	. 3-2
	TABLES	
Table No.	Title	Page
1-1	Performance Specifications	. 1-2
1-2	Controls and Indicators	. I-5

CHAPTER 1 GENERAL INFORMATION

1.1 INTRODUCTION

The RK05 Disk Drive, which is designed and manufactured by Digital Equipment Corporation, is a self-contained, random-access, data storage device that is especially well suited for use in small or medium-size computer systems, data acquisition systems, terminals, and other storage applications. Operational power for this device is provided by a power supply located within the drive cabinet. The RK05 is available in four models, each of which operates on a different power line.

This compact, lightweight drive uses a high-density, single-disk, 12-sector or 16-sector cartridge as its storage medium. Two movable heads, one flying above the rotating disk surface and one below, can read or record up to 406 data tracks at 1500 rpm. The double-frequency, nonreturn-to-zero (NRZ) recording method used in this drive can store up to 25 million bits of on-line data. Data formatting is governed entirely by the operating system.

With the address select logic contained in each drive, up to eight RK05 Disk Drives (depending on the type of system) can be "daisy-chained" and operated from a single controller bus.

1.2 WARRANTY

"Removable media involve use, handling and maintenance which are beyond DEC's direct control. DEC disclaims responsibility for performance of the Equipment when operated with media not meeting DEC specifications or with media not maintained in accordance with procedures approved by DEC. DEC shall not be liable for damages to the Equipment or to media resulting from such operation."

1.3 SPECIFICATIONS

Table 1-1 lists the performance specifications of the RK05 Disk Drive for the 12-sector cartridge. Wherever applicable, a second specification pertaining to a 16-sector cartridge is also listed.

1.4 50/60 Hz POWER OPTION

The RK05 Disk Drive is available in the following four power models:

RK05-AA
 95 to 130 Vac @ 60 Hz

RK05-AB 190 to 260 Vac @ 60 Hz

RK05-BA 95 to 130 Vac @ 50 Hz

• RK05-BB 190 to 260 Vac @ 50 Hz

Each model is shipped with a complete set of drawings. To change from 50 to 60 Hz operation requires a different spindle drive pulley, and the motor must be moved.

1.5 MAJOR ASSEMBLIES AND SYSTEMS

The RK05 Disk Drive is composed of the following major assemblies and systems:

- Controls and Indicators
- Spindle and Drive System
- Linear Positioner
- Cartridge Handling System
- Logic Assembly
- Air System
- Power Supply
- Read/Write Heads

Figure 1-1 illustrates the locations, and the subsequent paragraphs describe the functions of each of the major assemblies and systems.

Table 1-1
Performance Specifications

retionnal	nce Specifications		
Characteristic	Specification		
Storage Medium			
Type	Single disk magnetic cartridge		
Disk Diameter	14 in.		
Magnetic Heads			
Number	Two		
Recording Density and Format			
Density	2200 bpi max.		
Tracks	406 (200 plus 3 spares on each side of the disk)		
Cylinders	203 (two tracks each)		
Sectors (records)	4872 (12 per revolution)/6496 (16 per revolution		
Bit Capacities (unformatted)*			
Per Disk	25 million		
Per Inch	2040 (max. at inner track)		
Per Cylinder	115,200		
Per Track	57,600		
Per Sector	4,800/3,844		
Access Times			
Disk Rotation	1500 ± 30 rpm		
Average Latency	20 ms (half rotation)		
Head Positioning	10 ms – for adjacent tracks		
(including settling time)	50 ms — average 85 ms — for 200 track movement		
District 6			
Bit Transfer* Transfer Code	Double frequency moneytyrm to goes recording		
Transfer Code Transfer Rate	Double frequency, nonreturn-to-zero recording 1.44M bits per sec		
Electrical Requirements			
Voltage	115/230 Vac @ 50/60 Hz ± .05 Hz		
Power	250 VA		
Starting Current	Power only: 1.8 A		
	Start spindle: 10 A (for 2 sec)		
Model Designation			
RK05-AA	95 to 130 Vac @ 60 ± 0.5 Hz		
RK05-AB	190 to 260 Vac @ 60 ± 0.5 Hz		
RK05-BA	95 to 130 Vac @ 50 ± 0.5 Hz		
RK05-BB	190 to 260 Vac @ 50 ± 0.5 Hz		
Environment			
Ambient Temperature	50° to 110° F (10° to 43° C nominal)		
Relative Humidity	8% to 80% (no condensation)		
Barometric Pressure	10,000 ft (3,000 meters) max.		
Temperature, Change Rate	10° F (6° C) per hr		
Temperature, Interchangeable Range	30° F (17° C)		
Dimensions and Weight			
Width	19 in. (48 cm)		
Depth	26-1/2 in. (67 cm)		
Height	10-1/2 in. (27 cm)		
Weight	110 lb (50 kg)		

^{*}Some RK11-D systems record at 1.54M bits/sec which increases the bit density and capacity accordingly.

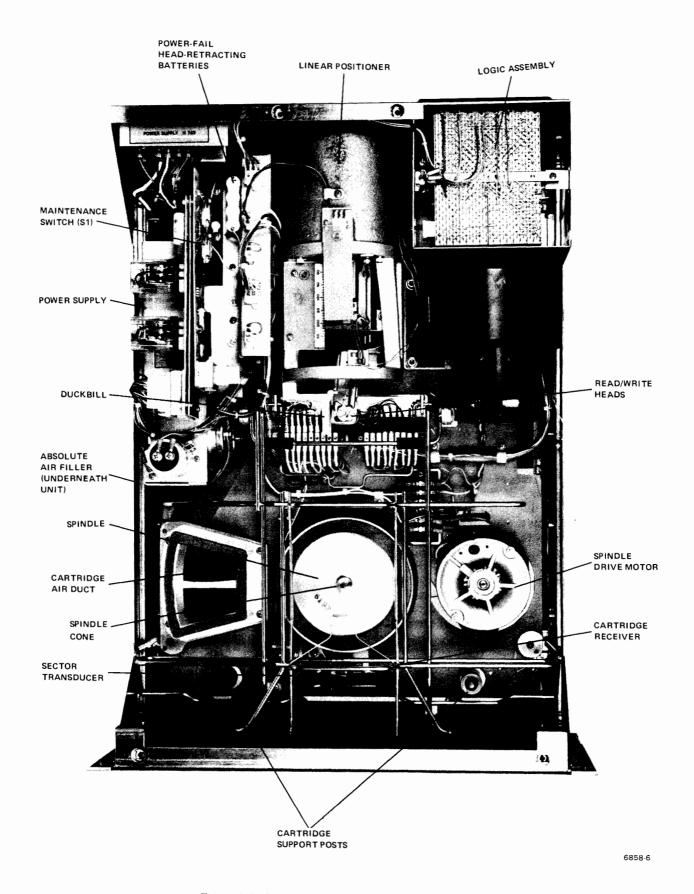


Figure 1-1 Location of Major Assemblies and Systems

1.5.1 Controls and Indicators

The controls and indicators (Figure 1-2) required for normal operation are located on the front of the drive cabinet. Table 1-2 describes the function of each control or indicator.

1.5.2 Spindle and Drive

The spindle and drive system (Figure 1-3) is composed of the spindle, spindle drive motor, and the recording disk. A 50/60 Hz, split-phase ac motor transfers torque (via the drive belt) to the spindle drive pulley. Belt tension is maintained by a tension spring anchored to the baseplate.

The spindle speed is electronically tested by a circuit that measures the INDEX PULSE interval. When the interval increases to approximately 45 ms, indicating an unsafe speed, the drive is cycled down. If the RUN/LOAD switch is placed in the LOAD position, ac power is removed from the motor and the spindle coasts to a halt.

1.5.3 Linear Positioner

The linear positioner (Figure 1-1) consists of the linear motor, the carriage, the read/write heads, and the linear positioner transducer. To move the read/write heads across the recording disk, dc current is applied to the bobbin-wound armature (Figure 1-4) of the linear motor. The resulting magnetic field reacts with a permanent magnet in the motor housing to either pull the armature into or force it out of the permanent magnetic field, depending upon the polarity of the current applied to the armature. This motion is transferred to the carriage, which is fastened to the armature. As a result, the read/write heads, which are attached to the carriage, move across the surface of the disk.

Any carriage movement is detected by the linear positioner transducer, which is located on the underside of the carriage. The transducer output is used with the control logic to determine the cylinder position of the heads, and in the servo logic to govern the speed of carriage travel.

1.5.4 Cartridge-Handling System

The cartridge-handling system (Figure 1-5a) consists of a cartridge receiver, two receiver lifting cams, an access door opener, a duckbill, and two cartridge support posts. During normal operation, the plastic cartridge is located *only* by the duckbill and support posts. The cartridge receiver merely *guides* the cartridge into position to be picked up by the duckbill and support posts, allowing the recording disk to rotate freely on the spindle. The rotating spindle drives the disk by magnetic coupling at the disk hub.

As the drive front door is opened, the lifting cams rotate to elevate the receiver to a slanted position and the magnetic coupling at the disk hub is released. When the disk cartridge is inserted into the receiver (Figure 1-5b), the access door opener contacts the rear of the top cover, opening the access door to allow entry of the read/write heads.

As the drive front door is closed, the cartridge is lowered to the operating position, and the magnetic coupling again engages the disk hub. When the cartridge is in the operating position, the plastic case depresses the cartridge-on switch and removes the no-cartridge interlock condition. The cartridge receiver should *not* hold the cartridge tightly.

1.5.5 Logic Assembly

The logic assembly (Figure 1-1), located in the right rear portion of the disk drive, holds eight printed circuit cards. Three of these cards contain the system logic and the read/write circuits. Two cards contain the positioner servo logic. One card is the cable connector that interfaces the electronics with the positioner and other chassis-mounted components, while the remaining two cards contain the interface cables and terminators.

1.5.6 Air System

The air system (Figure 1-6) consists of the prefilter, blower, absolute filter, plenum chamber, and the cartridge air duct. As the blower rotates, unfiltered air is drawn through the prefilter, where it is purged of large dust particles. The prefiltered air is then circulated through the logic assembly and into the plenum. From there, the air passes through the absolute filter (where minute contamination is removed), up the cartridge air duct, and into the disk cartridge. Cooling air from the absolute filter is also shunted, by the plenum, through the linear positioner. Exhaust air exits through the front grill of the drive.

1.5.7 Power Supply

The power supply (Figure 1-1), located in the left rear portion of the disk drive, furnishes all the dc voltages for the drive. The power supply can operate with a 115 V or 230 V, 50 or 60 Hz line voltage input.

1.5.8 Read/Write Heads

There are two ramp-loaded read/write heads in the RK05 Disk Drive. One head functions on the top surface of the recording disk and the other on the bottom. The heads are mounted on suspension arms that rest, when the heads are unloaded, on a plastic cam block of the duckbill (Figure 1-7). Flat cantilever springs connect the suspension arms to the head-support tailpieces. When the drive is placed in the RUN mode, the positioner moves the heads forward toward cylinder zero. When the entire head slider pad has passed the edge of the disk, a ramp on the suspension arm slides down the edge of the plastic cam block, thereby moving (loading) the heads close to the disk surface. When loaded, the heads "fly" 80 to 100 microinches from the disk surface (Figure 1-8). A film of air (air bearing) between the disk and the head acts as a force away from the disk, while the cantilever spring is a counterbalancing force toward the disk. Thus, as long as the disk rotation remains constant the heads remain at a relatively constant distance away from the disk surface.

Table 1-2 Controls and Indicators

Controls and Indicators	Description		
RUN/LOAD	Placing this switch in the RUN position (providing that all interlocks are safe):		
(rocker switch)	a. locks the drive front door		
	b. accelerates the disk to operating speed		
	c. loads the read/write heads		
	d. lights the RDY indicator.		
	Placing this switch in the LOAD position:		
	a. unloads the read/write heads		
į	b. stops the disk rotation		
	c. unlocks the drive front door when the disk has stopped		
	d. lights the LOAD indicator.		
	CAUTION Do not switch to the LOAD position during a write operation; this results in erroneous data being recorded.		
WT PROT (rocker switch — spring-loaded off)	Placing this momentary contact switch in the WT PROT posistion lights the W PROT indicator and prevents a write operation; it also turns off the FAUL indicator, if that is lit. Depressing this switch in the WT PROT position a second time turns off the W PROT indicator and allows a write operation.		
PWR (indicator) RDY	Lights when operating power is present. Goes off when operating power is removed.		
(indicator)	Lights when:		
	a. the disk is rotating at the correct operating speed.		
	 b. the heads are loaded. c. no other conditions are present (all interlocks safe) to prevent a seek, read, or write operation. 		
	Goes off when the RUN/LOAD switch is set to LOAD.		
ON CYL	Lights when:		
(indicator)	a. the drive is in the Ready condition.		
	b. a seek or restore operation is not being performed.		
	c. the read/write heads are positioned and settled.		
	Goes off during a seek or restore operation.		

Table 1-2 (Cont)
Controls and Indicators

Controls and Indicators	Description			
FAULT (indicator) WT PROT	Lights when: a. erase or write current is present without a WRITE GATE. b. the linear positioner transducer lamp is inoperative. Goes off when the WT PROT switch is pressed, or when the drive is recycled through a RUN/LOAD sequence. Lights when:			
(indicator)	 a. the WT PROT switch is pressed. b. the operating system sends a Write Protect command. Goes off when the WT PROT switch is pressed a second time, or when the drive is recycled through a RUN/LOAD sequence. 			
LOAD (indicator)	Lights when the read/write heads are fully retracted and the spindle has stopped rotating.			
WT (indicator)	Lights when a write operation occurs. Goes off when the write operation terminates.			
RD (indicator)	Lights when a read operation occurs. Goes off when the read operation terminates.			

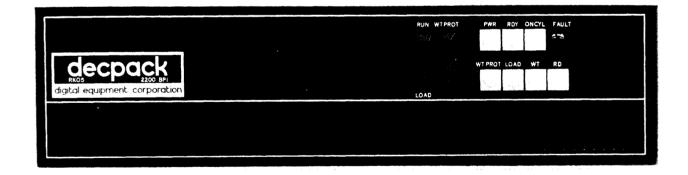


Figure 1-2 Controls and Indicators

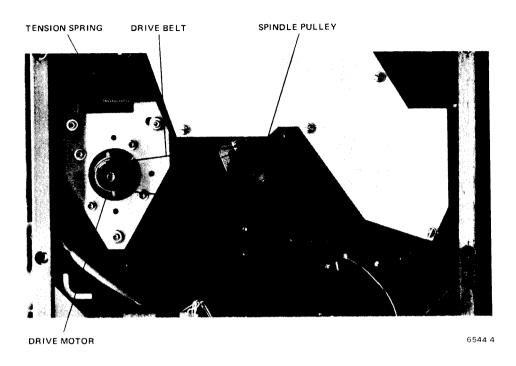


Figure 1-3 Spindle and Drive System

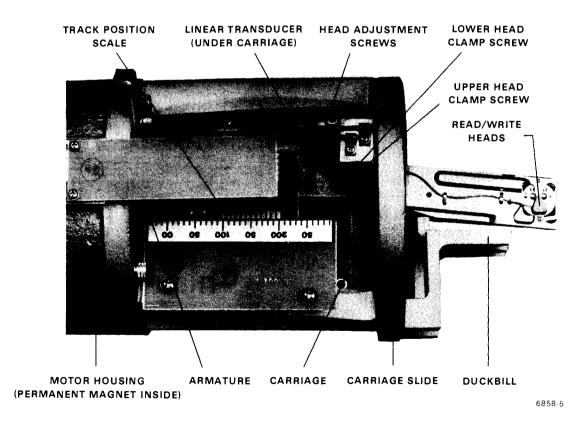
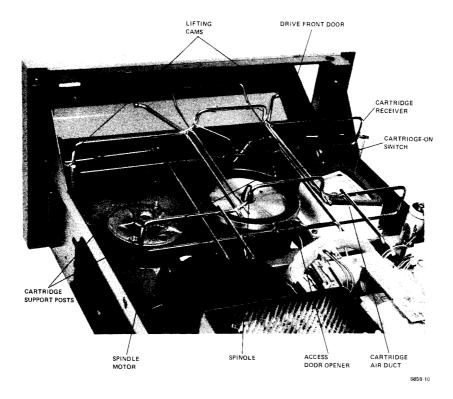
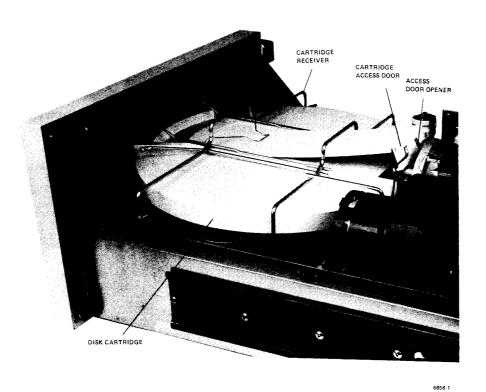


Figure 1-4 Linear Positioner



a. Cartridge Removed



b. Cartridge Inserted

Figure 1-5 Cartridge Handling System

1-8

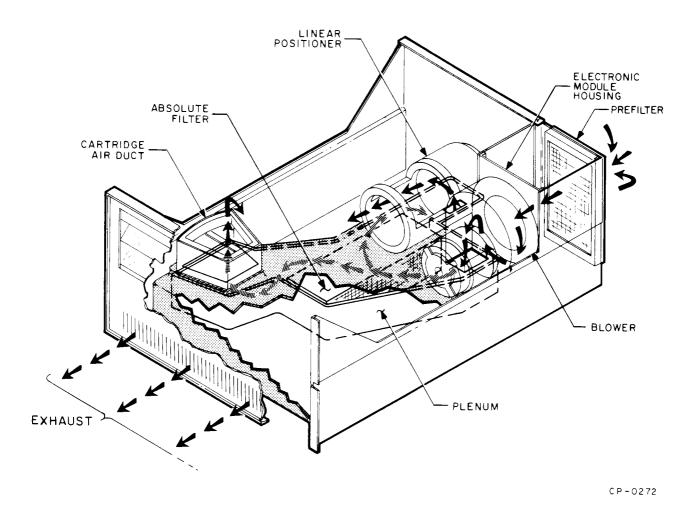


Figure 1-6 Air System

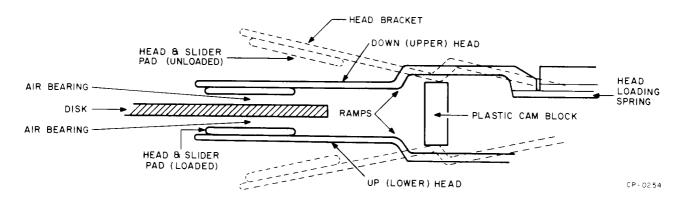


Figure 1-7 Head Loading

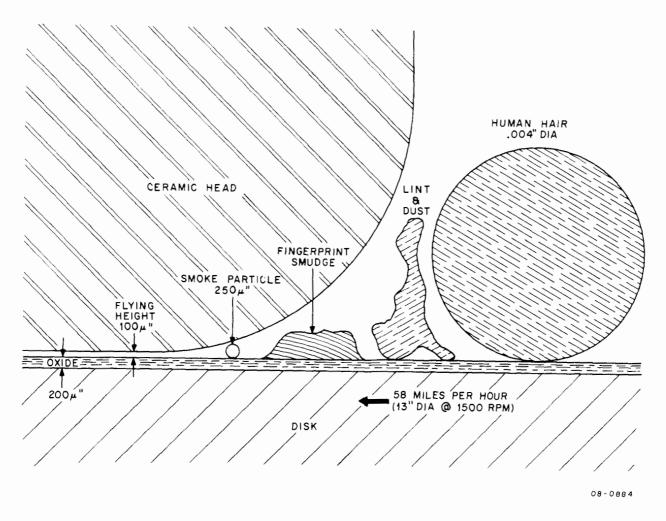


Figure 1-8 Relationship of Disk Head, Disk, and Contaminants

The DOWN (UPPER) HEAD is so-called by convention throughout the computer industry because it faces down; the UP (LOWER) HEAD faces up. These designations were created to describe heads loaded onto a multisurface (10 or 20) cartridge.

The recording device (read/write head) is a coil-wound ferrite core with an air gap. As current flows through the

coil, the induced flux magnetizes the surface of the disk passing under the gap. During a write operation, when the current direction in the coil is reversed, a flux reversal is recorded on the disk. During a read operation, the previously-recorded flux pattern on the disk induces current in the head. Any flux reversal on the recording surface produces a pulse.

CHAPTER 2 INSTALLATION

2.1 UNPACKING AND INSPECTION

The RK05 Disk Drive can be shipped in a rack as an integral part of a system or in a separate container. If the drive is shipped in a rack, the rack should be positioned in the final installation location and unpacked as follows:

- Remove the shipping brackets from the drive by removing the snap-on bezel beneath the lowest drive.
- Remove the screws attaching the shipping bracket and latch molding to both sides of the drive.

CAUTION

Do not use the drive front door handle to pull the drive out from the rack.

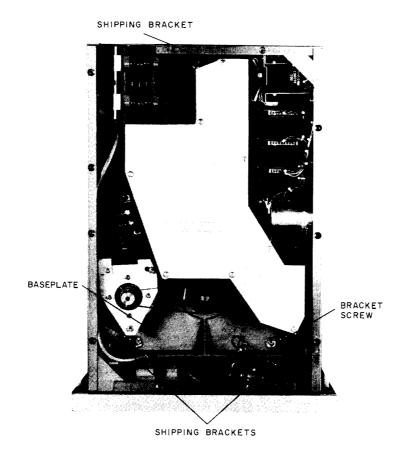
- Slide the drive out about 3 inches from the rack and pull the shipping brackets out from the sides of the drive. Attach the latch molding back onto the drive with the shipping bracket screws.
- 4. Slide the lowest drive out far enough to gain access to the shipping brackets on the drive directly above it and remove the screws from these two shipping brackets.
- 5. Repeat Steps 3 and 4 for each drive in the rack.
- 6. Remove the drive bottom cover and remove the screws that attach the three internal shipping brackets to the baseplate (Figure 2-la).

CAUTION

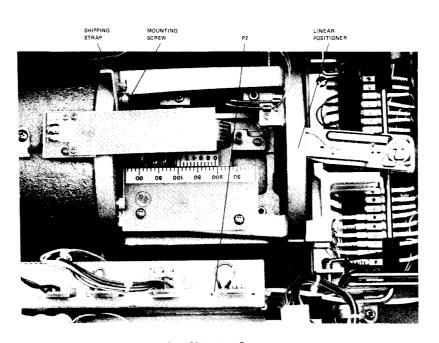
Do not operate drive with shipping brackets attached.

- 7. If RK05 drives are "daisy-chained" with RK03 drives in a multidrive installation, arrange the RK05s consecutively at the controller end of the bus to avoid interruption of the AC LOW and DC LOW interface lines, which are not carried by the RK03s. If this arrangement is not possible, all RK05s that are separated on the bus by RK03s must be connected by separate cables between their J06 connections (Figure 2-2).
- 8. Remove the drive top cover and remove the mounting screw and shipping strap from the linear positioner (Figure 2-1b). Turn the shipping strap upward and replace it on the linear positioner, making sure it is tightly secured.
- 9. Retain all packing material for possible reshipment. Inspect the drive for possible damage. Report any damage to the carrier and to Digital Equipment Corporation.
- 10. In the case of RK05 Disk Drive relocation or reshipment, replace the shipping brackets and shipping strap in the shipping position; repeat this unpacking and inspection procedure when the drive is reinstalled.

If the drive is shipped in a separate container, use care while unpacking it. Do not drop the drive or subject it to unreasonable impact.



a. Shipping Brackets



b. Shipping Strap

Figure 2-1 Shipping Bracket and Shipping Strap Locations

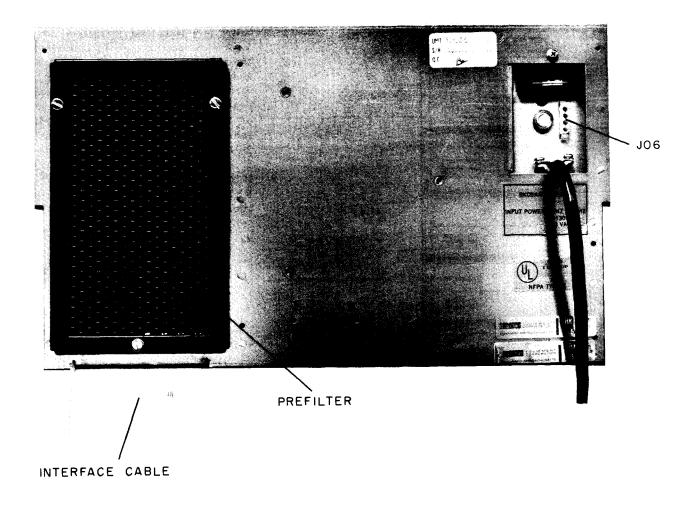


Figure 2-2 RK11C or RK11D Interface Cable Installation

2.2 MECHANICAL INSTALLATION AND CHECKOUT If the RK05 Disk Drive is to be installed in an existing rack, the chassis slides should first be installed in the rack (Figure 2-3). The disk drive should be mounted on the chassis slides as follows: (If necessary, refer to the RK05 Option Configuration Dwg. No. D-OC-RK05-0-15 for detailed mechanical specifications of a multidrive installation.)

- Install cabinet stabilizers before mounting the drive, unless the weight of the rack is sufficient to prevent tipping when the drive is fully extended.
- 2. Pull the chassis slides out until they lock in the extended position.

- Slide the drive onto the chassis slides until it locks.
- 4. Remove the drive bottom cover and remove the screws that attach the three internal shipping brackets to the baseplate (Figure 2-1a).
- 5. Remove the drive top cover and remove the mounting screw and shipping strap from the linear positioner (Figure 2-1b). Turn the shipping strap upward and replace it on the linear positioner. Pull the heads forward as far as possible without going off the ramp (Figure 1-7) and confirm that the batteries (Figure 1-1) return the heads to the home position.

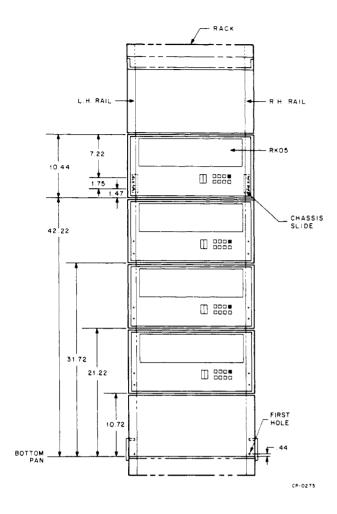


Figure 2-3 Chassis Slide Mounting

- 6. Inspect P2 (Figure 2-1) and the spindle pulley to ensure that the drive is configured properly for the input power to be used. If P2 contains two jumpers, the supply is configured for 115 Vac operation. If P2 contains only one jumper, the supply is configured for 230 Vac. The operating frequency is stamped on the spindle pulley.
- 7. Check the logic assembly to ensure that no pins are bent or broken, and then plug the interface cable card into card position 7 or 8 of the logic assembly. If there is only one drive in the system, or if this is the last drive of the daisy-chain, ensure that an M930 terminator card (Dwg. No. RK05-0-2) is in the unused interface card position.

- 8. If RK05 drives are daisy-chained with RK03 drives in a multidrive installation, arrange the RK05s consecutively at the controller end of the bus to avoid interruption of the AC LOW and DC LOW interface lines, which are not carried by the RK03s. If this arrangement is not possible, connect all RK05s that are separated on the bus by RK03s by means of separate cables between their J06 connections (Figure 2-2).
- If the drive is to be connected to other than an RK11-C or RK11-D controller, install the interface cables as follows:
 - a. Remove the prefilter and frame.
 - b. Route the interface cables through the prefilter opening and reinstall the filter and frame so that the cables fit into the slot on the side of the frame (Figure 2-4).
 - c. Route the cables over the prefilter and fold them as indicated in Figure 2-4.
 - d. Place the cable retaining bracket over the fold in the cables and fasten the bracket to the chassis.
- 10. If the drive is to be connected to an RK11-C or RK11-D controller, install the interface cables either as described in Step 9, above, (which is preferable) or as follows:
 - a. Fold the interface cables and route them through the slot just below the prefilter at the rear of the drive cabinet (Figure 2-4).
 - Hold the cables in position and replace the bottom cover.
- 11. To avoid random errors, confirm that the grounding strap is firmly in place between the base plate and the chassis, and that brushes are mounted securely and in the proper plane. Confirm that all connectors are securely in place.
- 12. Configure the M7700 select switch to address a valid drive (Paragraph 3.2.2).
- 13. Plug the power cord into the switched ac line receptacle.

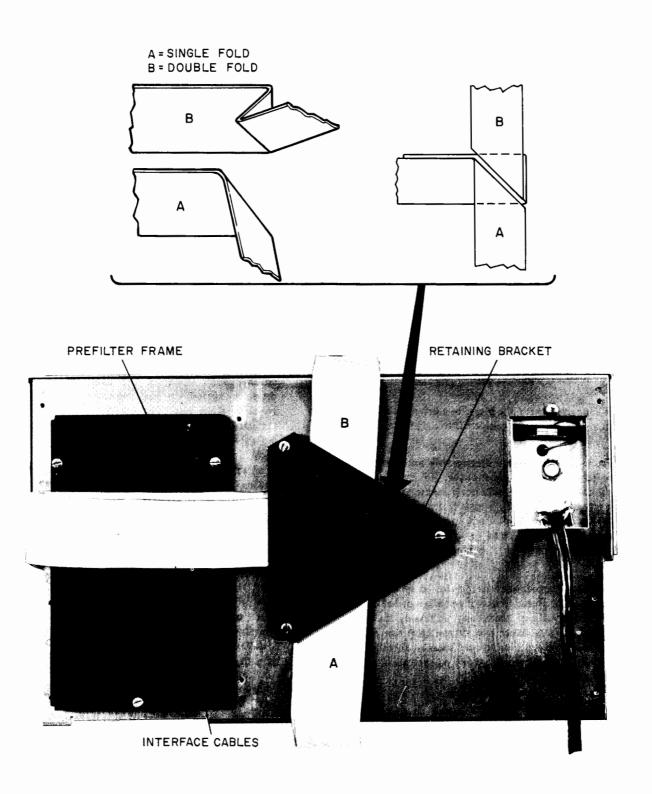


Figure 2-4 RK8/E Interface Cable Installation

- 14. Turn the processor keyswitch ON to apply power to the drive.
- Check that the spindle is clean, and that the heads are not bent or dirty.

2.3 CARTRIDGE HANDLING PRACTICES AND PRECAUTIONS

To obtain maximum performance and high reliability from the RK05 Disk Drive, the following precautions and cartridge-handling practices must be observed:

- 1. Store cartridges in a clean, dry area away from direct sunlight. Do not expose cartridges to heat. They may be stored on edge or stacked; however, stacks of more than 3 or 4 cartridges should be avoided. Do not place heavy items on the plastic cartridge cases. Do not store cartridges on top of computer cabinets or in places where dirt can be blown by fans into cartridge interiors.
- 2. Whenever a cartridge is not in a drive, enclose it in a plastic bag to exclude dust or dirt.
- 3. Professional cartridge disassembly and cleaning is required every six months; however, disks should be cleaned whenever they are excessively dirty, or when a high transient error rate is encountered. In such instances, a disk-cleaning service, listed by Digital Equipment Corporation, should be contacted at once.
- 4. Place stiff cardboard or plastic labels only in the molded frame at the front edge of the disk cartridge without using any adhesives. Labels placed on any other part of the cartridge may interfere with the drive operation or introduce contamination into the drive or the interior of the cartridge.
- 5. Allow the temperature of the cartridge to become stabilized with the room temperature before using the cartridge. If cartridges are exposed to outside temperature extremes, or if the temperature differential between drive and cartridge exceeds 20°F, a two-hour stabilization period is necessary.

- 6. Although cartridges recorded on RK03s and RK05s are fully interchangeable, allow them to stabilize before new data is recorded on them. Data interchangeability between drives is only guaranteed if the temperature difference does not exceed 30° F (17° C), even though a specific drive/cartridge combination may operate over a temperature range of 50° to 110° F (10° to 43° C).
- 7. Keep the spindle hub clean and free from nicks and burrs to ensure reliable cartridge operation. Because the hub is slightly magnetic, do not expose it to metal chips that could adhere to the mounting surface. Periodically inspect the coupling hub on the bottom of the disk cartridge for dirt, metal chips, plastic chips in cone, etc.
- 8. A sustained tinging, scratching, or rumbling sound (not to be confused with spindle ground brushes) that is the result of head-to-disk contact may occur if the cartridge is not properly seated on the spindle, if excessive contamination has built up in the interior of the cartridge, or if the cartridge or the drive is defective. If this sound is heard, shut down the drive immediately to avoid damage to the read/write heads. Remove the disk cartridge and examine the heads for damage or excessive dirt. If necessary, clean or replace the heads. Do not reuse the cartridge without first checking it for surface damage.

CAUTION

NEVER CYCLE A BAD CARTRIDGE THROUGH AN INSTALLATION OF SEVERAL DRIVES. This practice can ruin all the read/write heads or contaminate all drives in a multidrive installation, which will, in turn, damage all other cartridges run in these drives.

9. Always keep the front door of the drive closed and keep all covers on to prevent unnecessary entry of atmospheric dirt or dust.

2.4 CARTRIDGE PACKING AND SHIPPING

Data recorded on disk cartridges may be degraded by exposure to any sort of small magnet brought into intimate contact with the disk surface. If cartridges are to be shipped in the cargo hold of an aircraft, precautions are necessary against possible exposure to magnetic sources. Because physical separation from the magnetic source is the best

protection against accidental erasure of a cartridge, cartridges should be packed at least three inches within the box. This amount of separation should be adequate to protect against any magnetic sources likely to be encountered during transportation, making it generally unnecessary to ship cartridges in specially shielded boxes.

2.5 NORMAL OPERATING PROCEDURES

All drives in a multidrive system must have operating power applied even when the drive is not in use. In addition, unused drives should be left write-enabled, and with the RUN/LOAD switch in the LOAD position.

IMPORTANT: ON EARLIER MODEL RK05 DISK DRIVES EQUIPPED WITH A POWER ON/OFF SWITCH, DO NOT USE THE ON/OFF SWITCH DURING SYSTEM OPERATION TO REMOVE OPERATING POWER FROM AN INDIVIDUAL DRIVE.

Because the DC LOW interface signal is common to all drives in a multidrive system, a power loss in any one drive disables all the drives in the system. If the drive power is controlled by a processor keyswitch, all drive ON/OFF switches should be left ON; however, all RUN/LOAD switches should be set to LOAD before system power is removed.

2.5.1 Cartridge Loading

The procedure for cartridge loading is as follows:

 Set the RUN LOAD switch on all drives to LOAD and observe that the LOAD indicator lights.

CAUTION

If the LOAD indicator is not lit, the drive front door is locked. In this case, do not attempt to force the front door open.

- 2. Open the front door of the drive and gently insert a clean, operable disk cartridge fully into the cartridge receiver. DO NOT TWIST OR FORCE THE CARTRIDGE DURING INSERTION!
- Close the front door of the drive and set the RUN/LOAD switch to RUN.
- 4. Wait for the RDY and ON CYL indicators to light, the drive is now ready to perform seek, read, or write operations.

2.5.2 Cartridge Unloading

The procedure for cartridge unloading is as follows:

- Set the RUN/LOAD switch to LOAD and observe that the RDY indicator goes out. After approximately 30 seconds, the LOAD indicator will light.
- 2. Open the drive front door and gently withdraw the disk cartridge.
- 3. If another cartridge is not loaded, close the drive front door to prevent unnecessary entry of atmospheric dirt or dust.
- 4. Store the cartridge in a clean plastic bag.

			•

CHAPTER 3 INTERFACE

3.1 GENERAL

The flexibility achieved with the address select logic and the eight-position address select switch permits the RK05 Disk Drive to be connected to a variety of computer systems. In the RK11-C and RK8/E systems, up to four drives can be serially connected to a single bus; in the RK11-D system, up to eight drives can be serially connected.

Interface cable connection of the RK05 Disk Drive is made to card position 7 or 8 of the electronic module. These card positions are parallel-wired so that several drives may be daisy-chained in a multidrive configuration; that is, card position 7 or 8 of the first drive is connected to card position 7 or 8 of the succeeding drive, etc. (By convention, card position 7 is used for input signals; card position 8 is used for output signals.) If there is only one drive in the system, an M930 terminator card must be installed in the unused interface card position; if there is more than one drive in the system, only the last drive on the bus must have the M930 terminator card in the unused interface card position. The interface signal levels are determined by the M930 terminator card. An assertion, or logic 1, is approximately +0.5 Vdc, and a negation, or logic 0, is approximately +3.5 Vdc.

Figure 3-1 illustrates and the following paragraphs describe the function of each interface line. The signals listed, being bus signals, operate according to negative logic; they are asserted low. Appendix A contains a glossary of RK05 backplane connections.

3.2 INPUT INTERFACE LINES

3.2.1 RK11-D

This line (BUS RK11-D L) transmits a signal that configures the address select logic to operate with a particular controller type. A logical 0 on this line indicates that the controller is not an RK11-D (thus, the controller is either an RK11-C or an RK8/E, both of which control only four drives on a single bus), while a logical 1 indicates that the controller is an RK11-D.

3.2.2 Select (4 lines)

BUS SEL DR 0/A/E, 1/B/F, 2/C/H, and 3/D/J L operate in conjunction with the RK11-D interface line and an eight-position address select switch on the M7700 card to determine the drive address assignment and selection by one of the following two methods:

- a. With a logical 0 on the RK11-D line, the M7700 selection circuit is configured to decode the four selection lines as a linear set. In a particular drive, only one of the four lines is internally connected (via positions 0 through 3 of the address select switch) to the drive control logic. To select a drive, the controller places a logical 1 on the desired select line. This line remains at logical 1 throughout the entire data transfer or control operation.
- b. With a logical 1 on the RK11-D line, the M7700 selection is configured to decode the four selection lines as a binary-encoded set. To select a drive, the controller places a 3-bit binary code, which corresponds to the drive address, on these select lines. This binary code is then translated by a three-line-to-eight-line decoder to activate only one of the eight address select switch positions.

3.2.3 Cylinder Address (8 lines)

BUS CYL ADD 0 L through BUS CYL ADD 7 L determine the cylinder position of the read/write heads. In order to move the heads to a desired cylinder, the controller places a corresponding 8-bit binary code on the lines (valid codes=0 through 202₁₀). These lines are gated by the Strobe signal to position the heads at the selected cylinder. The binary code remains on the lines until either the Address Acknowledged or the Address Invalid signal is returned from the drive (Paragraph 3.3.3).

3.2.4 Strobe

BUS STROBE L transmits a signal that gates the Cylinder Address or Restore line. The controller places a logical 1 on the Strobe line, only after the Cylinder Address or the Restore signals are fully settled on their respective lines.

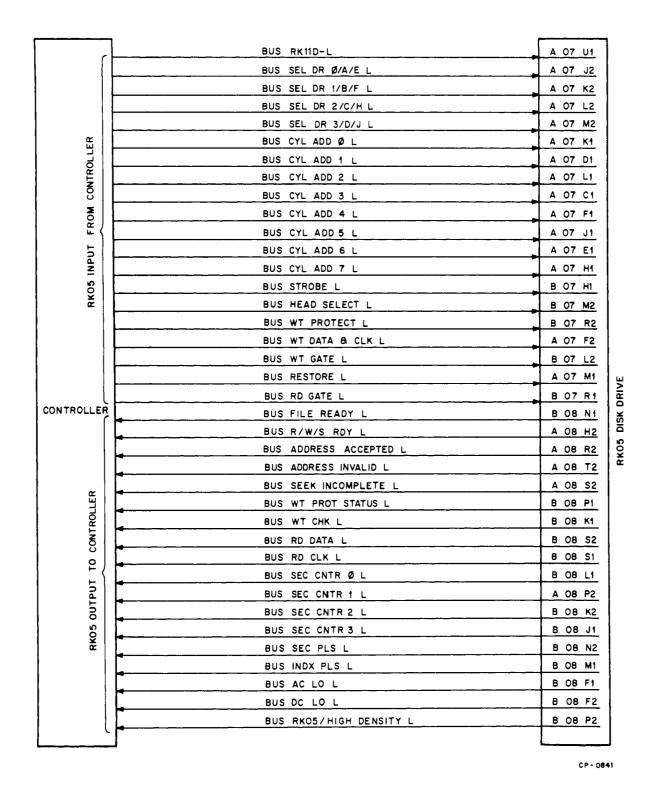


Figure 3-1 Controller/RK05 Disk Drive Interface Lines and Pin Assignments

3-2

The Strobe line remains at logical 1 until either the Address Acknowledged or the Address Invalid signal is returned from the drive.

3.2.5 Head Select

BUS SEL UPPER HD L transmits a signal that determines which of the two read/write heads is to be selected. The controller places a logical 1 on this line to select the upper head, and a logical 0 to select the lower head. Either signal remains on the line throughout the entire read or write operation.

3.2.6 Write Protect Set

BUS WT PROTECT L transmits a signal that disables the drive write amplifiers to prevent a write operation. The controller places a logical 1 on this line to set the Write Protect flip-flop and inhibit the write capability of the drive. The Write Protect flip-flop is also set if the WT PROT indicator is off and the operator presses the WT PROT switch (Paragraph 1.4.1).

3.2.7 Write Data and Clock

BUS WT DATA & CLK L transmits multiplexed data and clock pulses to the disk drive.

3.2.8 Write Gate

BUS WT GATE L transmits a signal to simultaneously turn on both the write and erase current in the selected write head. The controller places a logical 1 on this line 1 μ s prior to transmitting the write data. This line remains at logical 1 throughout the data transmission time.

3.2.9 Restore (RTZ)

BUS RESTORE L transmits a signal to position the read/write heads at cylinder zero. The controller places a logical 1 on this line prior to issuing the Strobe (BUS STROBE L) signal. About 2 μ s after this signal is issued, the drive returns an Address Acknowledged signal, clears the address register, and moves the heads to cylinder zero. The Restore line remains at logical 1 until the Address Acknowledged signal is received by the controller.

3.2.10 Read Gate

BUS RD GATE L transmits a signal that allows data to be read from the drive. The controller places a logical 1 on this line to enable the Read Clock and Read Data output lines. This line remains at logical 1 throughout the entire read operation.

3.3 OUTPUT INTERFACE LINES

3.3.1 File Ready (Drive Ready)

BUS FILE RDY L transmits a logical 1 to indicate the following conditions:

- a. Drive operating power is correct.
- b. A disk cartridge is properly loaded.

- c. The drive front door is closed.
- d. RUN/LOAD switch is in the RUN position.
- e. Spindle is rotating at the correct speed.
- f. Read/write heads are loaded.
- g. Write Check is false.

3.3.2 Read, Write, or Seek Ready/On Cylinder

BUS R/W/S RDY L transmits a logical 1 to indicate that the drive is in the File Ready condition (Paragraph 3.3.1) and is not performing a seek operation.

3.3.3 Address Accepted

BUS ADDRESS ACCEPTED L transmits a 5- μ s negative pulse to indicate that the drive has accepted a Seek command with a valid address and the command execution has begun. The negative pulse is generated about 2 μ s after receipt of the Strobe signal, even if there is no change from the present address.

3.3.4 Address Invalid (Logic Address Interlock)

BUS LOG ADD INT L transmits a 5- μ s negative pulse to indicate that the drive has received a nonexecutable Seek command with a cylinder address greater than 202. For this case, the Seek command is suppressed in the drive and the heads are not moved. The pulse generation time is the same as for the Address Acknowledged signal.

3.3.5 Seek Incomplete

BUS SIN L transmits a logical 1 to indicate that some malfunction in the drive did not allow the seek operation to be completed. This line remains low until a Restore command is received or the operator sets the RUN/LOAD switch to LOAD and then back to RUN.

3.3.6 Write Protect Status

BUS WT PROT STATUS L transmits a logical 1 to indicate that the write capability of the drive is inhibited (write protected). When this line is at logical 1, the WT PROT indicator on the drive control panel lights (Paragraph 1.4.1).

3.3.7 Write Check

BUS WT CHK L transmits a logical 1 to indicate the following conditions:

- a. Erase or write current without a WRITE GATE.
- b. Inoperative linear positioner transducer lamp.

When the Write Check signal is at a logical 1, all external commands to the drive are suppressed and the FAULT indicator on the drive control panel lights. If the fault condition is temporary, the operator may turn off the FAULT indicator by pressing the WT PROT switch. This

action, however, causes the WT PROT indicator to light; the WT PROT switch must be pressed a second time to turn off the WT PROT indicator (Paragraph 1.4.1).

3.3.8 Read Data

BUS RD DATA transmits read data only (160-ns pulses).

3.3.9 Read Clock

BUS RD CLK L transmits read clock pulses only (160-ns pulses).

3.3.10 Sector Address (4 lines)

BUS SEC CNTR 0 through 3 L indicate which sector is passing under the read/write heads. The sector address is a 4-bit binary code derived from the Sector Address counter.

3.3.11 Sector Pulse

BUS SEC PLS L transmits a $2-\mu s$ negative pulse each time a sector slot passes the sector transducer. The index slot (unique slot) is suppressed in this line and is transmitted on a separate Index Pulse line.

3.3.12 Index Pulse

BUS INDX PLS L transmits a single 2- μ s negative pulse for each revolution of the disk. The Index Pulse occurs 600 μ s

after the last sector pulse and is generated each time the index slot (unique slot) is detected by the sector transducer.

3.3.13 AC Low

BUS AC LO L transmits a logical 1 when there is a loss (for more than 45 ms) of the 30 Vac within the drive. When AC Low occurs, the drive finishes reading/writing the current sector, then initiates a normal head-retract and unload cycle. If a total power loss occurs before the heads are completely retracted, the safety relay is de-energized to retract the heads under battery power (emergency retract).

3.3.14 DC Low

BUS DC LO L transmits a logical 1 when the ±15 Vdc within the drive drops to 12 Vdc or below. When DC Low is generated, the safety relay is de-energized to retract the heads under battery power (emergency retract). Since the RUN gate of each drive is connected to the DC Low bus, a DC Low signal from any one drive in a multidrive system disables all the drives in the system.

3.3.15 High Density/RK05 L

BUS RK05 L transmits a logical 1 (indicating high density only) whenever the drive is selected. (All RK05s are high density.)

APPENDIX A THE RK05-TA OFF-LINE TESTER

A.1 MOVE FUNCTIONS

- 1. STEP incrementing cylinder seek to limit and a high speed return.
- 2. ALT (Alternate) an incrementing seek from the cylinder address selected.
- 3. OSC oscillate between 0 and the cylinder address selected (not affected by FOR/REV).
- 4. RAND random cylinder seek.
- 5. Drive Selector selects the drive number selected on the M7700 module in the RK05.
- 6. RUN enables all move functions.
- 7. RTZ forces a zero recalibrate.
- 8. FOR/REV selects the initial drive motion in step and alternate.
- 9. Cylinder Address selects any cylinder address from 0 to 202₁₀.

INDICATORS

- 1. Address invalid cylinder address set up to an illegal address; i.e., > 202.
- 2. Seek incomplete excess time to perform the seek.
- 3. Power on indicates power is applied to the drive.

A.2 WRITE FUNCTIONS

- 1. *Write sector selects a sector (from sectors 0 through 9 only) to write on and simulates a write data. "All" simulates a write all. Note: the unit cannot read to check headers.
- 2. Head select selects or enables either the upper or lower head. Only one head can be selected at a time; thus only one surface is written on.
- 3. *Write button causes a write one-shot to write or erase on the sector selected (or the track, if "All" is selected).
- 4. *Constant write when set, writes continuously on the sector selected; the write button need not be pressed.
- 5. *DC erase when ON, enables erase on a sector (or sectors) when the WRITE button is pressed; when OFF, enables writing on a sector (sectors) when the WRITE button is pressed.
- 6. Data bits sets a 4-bit data pattern to be written on the sector selected.

A.3 CONNECTING THE RK05-T OFF-LINE TESTER

- 1. Disconnect the ac line cord.
 - a. Remove the interface cable from the RK05.
 - b. Check the RK05 and the tester to ensure that a M930 Terminator module is present in one of them (slot 7 or 8 of the RK05, or slot 2 of the RK05-TA Off-Line Tester).
 - c. Connect a BC11-A cable from slot 1 or 2 of the tester to slot 7 or 8 in the RK05.
 - d. Disconnect connector J1 in the RK05 (logic voltage connector).
 - e. Plug one end of the tester power cable into the tester.
 - f. Check for proper keying of the pins and plug the male connector of the power cable into the female connector of J1.
 - g. Connect the remaining connector to the plug leading to the logic block of the RK05.
 - h. Reconnect the ac line cord.
 - i. Toggle RTZ to initialize and clear all error conditions and proceed with testing.

^{*}After the RK05-T has been used to perform write or erase operations, the disk will have to be reformatted.

Reader's Comments

RK05 DISK DRIVE USER'S MANUAL EK-RK05-OP-001

Your comments and suggestions will help us in our continuous effort to improve the quality and usefulness of our publications.

· -			ete, accurate, well organized, well
	useful?		
What faults do you find	d with the manual?		
Does this manual satisf	y the need you think it wa	s intended to satisfy?	
Does it satisfy your ne	eds?	Why?	
Would you please indic	cate any factual errors you	have found.	
Please describe your pe	osition.		
Name		Organization	
Street		Department	
City	State		7in or Country

	Fold Here	
	Total Nete	
	— — Do Not Tear - Fold Here and Staple — —	
		FIRST CLASS PERMIT NO. 33 MAYNARD, MASS.
BUSINESS REPLY MAIL NO POSTAGE STAMP NI	ECESSARY IF MAILED IN THE UNITED STATES	
Postage will be paid by:		
	Digital Equipment Corporation Technical Documentation Department Maynard, Massachusetts 01754	

DIGITAL EQUIPMENT CORPORATION digital WORLDWIDE SALES AND SERVICE

MAIN OFFICE AND PLANT

Maynard, Massachusetts, U.S.A. 01754 • Telephone, From Metroporton Euston, 648-8600 • Elsewhere (617)-897-5111 TWX: 110-347-0212 Cable, DIGITAL MAYN Telex, 94-8467

DOMESTIC

MID-ATLANTIC (cont.) NORTHEAST NORTHEAST

REGIONAL OFFICE:
225 Wyman Street, Waltham, Mass. 02154
Telephone: (617)-690-0330/0310 Dataphone. 617-890-3012 or 3013 Princeton
U.S. Route 1. Princeton, New Jersey 08540
Telephone (609)-452-2940
Dataphone 609-452-2940 CONNECTICUT Meriden 240 Pomeroy Avel, Meriden Conn 06540 Telephone (203)-237-8441/7466 Dataphone 203-237-8205 Fairfield 1275 Post Road, Fairfield, Conn. 06430 Telephone, (203)-255-5991 Telephone, (200)≮30-399-NEW YORK Rochester 136 Allens Croek Road, Rochester, New York Telaphone (716)-461-1700 Dataphone 716-244-1880 Syracuse 6700 Thompson Road Syracuse, New York 13211
Telephone (315)-437-1593/7085 Dataphone 315-454-4152 MASSACHUSETTS
Marlborough
One Iron Way
Martborough Mass. 01752
Terephone (6*7)-481-7400 Terex. 710 347-0348 MID-ATLANTIC REGIONAL OFFICE: U.S. Route 1, Princeton, New Jersey 08540 Telephone: (609)-452-2940 FLORIDA FLORIDA Orlando Suite 130, 7001 Lake Ellenor Drive, Orlando, Florida 32809 Telephone: (305)-851-4450 Dataphone: 305-859-2380

GEORGIA
Atlanta
2815 Clearview Place Suite 100
Atlanta, Georgia 03040
Telephone (404)-451-7411 Dataphone, 305-859-2360 NEW JERSEY
Fairfield
253 Passaic Ave Fairfield New Jersey 27006
Tolephone (201)-227-9280 Dataphone 201-227-9280 Metuchen
95 Main Street, Metuchen New Jersey 08840
Telephone: (201):549-4100/2000 Dataphone 201-548-0144

NEW YORK Long island 1 Hurtington Quadrangle Suite 1507 Huntington Station New York 11746 Telephone (516):564-4131 (212):995-6095 Dataphone 1516:293-569 Dataphone 516-293-5693 Manhattan 810 /In Ave , 22nd Floor New York, N.Y. 10019 Telephone: (212)-582-1300 PENNSYLVANIA Philadelphia Digital Hall 1740 Walton Road, Blue Bell Pennsylvania 19422 Telephone (215)-825-4200 Knoxville 5311 Kingston Pike, Suite 21E Knoxville, Tennesser 37919 Telephone (615)-588-6571 Dataphone 615-584-0571 WASHINGTON D.C. Lanham 30 Office Building 4900 Princess Garden Parkway, Lanham, Maryland Telephone (301)-459-7900 Datophone 301-459-7900 X53 CENTRAL
 CENTRAL
 REGIONAL OFFICE

 *850 Frontage Road, Northbrook, Illinois 60052

 Telephone (312):498-2500
 Datashone 312-498-2500

 Ex. 78
 | INDIANA | Ex. 78 | Ex. 78 | Indianapolis | 21 Beachway | Drive | Suite | G | Indianapolis | Indiana 46224 | Telephone | (3/7)-243-8341 | Dataphone: 317-247-1212 | Dataphone | 317-247-1212 | Indiana | 317-247-1212 | Indi ILLINOIS Chicago 1850 Frontage Road Northbrook, Illinois 60062 | Dataphone: 312-498-2500 LOUISIANA New Orleans
3100 Ridgelake Drive, Suite 108
Metairie Louisiana 70002
Telephone (504)-837-0257 Dataphone: 504-833-2800

CENTRAL (cont.) MISSOURI TEXAS INTERNATIONAL

WEGIONAL OFFICE. 310 Socuet Way Sunnyvale, California 94086 Telephone (408):735:9200 Dataphone, 408-735-1820 ARIZONA Phoenix 4358 East Broadway Road, Phoenix Arizona 85040 Telephone (602)-268-3488 — Dataphone 602-268-7371 2377 Green eid Post Stuffs 189 Southfield Michigan 48075 Datephone 313-557-3063 MINNESOTA CALIFORNIA Minneapolis 8030 Cedar Ave. South, Minneapolis, Minnesota 55420 Telephone. (812):854-6582-3-4-5. Dataphone: 612-854-1410 Santa Ana 2110 S. Anne Street, Santa Ana, California 92704 Telephone: (714)-979-2460 — Dataphone: 714-979-7850 Leighbne (143):974-260 Dataphone 714-979-7690 5154 Mission Gorge Road Suite 110 San Diego California Telephone (114):280-7830/7870 Dataphone 714-280-7825 San Francisco 1400 Terra Be'la Mountain Visw, California 94040 Telephone (145):884-8500 Dataphone 415-884-1436 Kansas City 12401 East 43rd Street, Independence Missouri 64055 Telephone (816):252-2300 Dataphone 816-461-3100 Telephone (515):2222300 Datephone Brown 1300 St. Louis Suite 113, 115 Progress Parkway Maryland Heights, Missouri 63043 Telephone (314):878-4310 Dataphone 816-461-3100 Telephone (415)-635-5453/7830 Dataphone 415-562 2160 West Los Angeles | California 90025 Telephone (213)-479-3791/4318 Dataphone 213-478-5626 Telephone (216)-946-8494
Dasphone: 216-946-8494
Dasphone: 216-946-8494
Dasphone: 216-946-8494
Dataphone: 216-946-8474
Dataphone: 513-298-4724
OKLAHOMA
Tulsa
Sil40 S. Winston
Winston St. Bldg. Suite 4
Tulsa, Oklahoma 74135
Dataphone: 518-749-2714
PENNSYLVANIA
PITSDURANIA NEW MEXICO Albuquerque 10200 Menual N.E., Albuquerque, New Mexico 87112 Talaphone (505):296:5411/5428 Dataphone 505:294:2330 Pittsburgh 490 Penn Center Boulevard, Pittsburgh, Pennsylvania 15235 Telephone (412)-243-9404 Dataphone 412-824-9730 OREGON Portland Suite 186 5319 S.W. Westgate Drive, Portland, Oregon 97221 Telephone (503)-297-3761/3765 Dallas Dallas Diagnorii Suite 513
Plaza North Suite 513
Plaza North Suite 513
Dataphone (214)-620-2051
Dataphone 214-620-2061 UTAH Salt take City 429 Lewn Date Drive, Salt Lake City, Utah 84115 Telephone (801)487/4869 Ditabhore 801-487-0538 WASHINGTON WASHING ON Bellevue, 1940 N. E. Bellevue, Redmond Road, Suite 111 Bellevue, Washington 98005 Telephone (206):545-4058/455-5404 Dataphone 206:747-3754 WISCONSIN Milwaukee 8531 West Capitol Drive Milwaukee, Wisconsin 53222 Telephone (414)-463-9110 Dataphone: 414-463-9115

EUROPEAN HEADQUARTERS
Digital Equipment Corporation International Europe
81 route de l'Arra
1211 Geneva 26. Switzerland
Telephone: 42 79 50 Telex: 22 683

Telephone: 42 79 50 Telex: 22 683

FRANCE

Digital Equipment France
Centre Site — Ordex L 225

94533 Rung s France
Telephone 657-73-33 Telex: 26640

GRENOBLE
Digital Equipment France
Tour Mannion Mannion
38'00 Openation France
Telephone (76)-97-95-01 Telex: 212-32892

GERMAN FEDERAL REPUBLIC

MUNICH 8 Muenchen 13, Wallensteinplatz 2 Telephone 0811-35031 Telex 524-226 COLOGNE 5 Koe'n 41 Aachener Strasse 3'1 Telephone 0221-44-40-95 Tolex 888-2269 Telegram Flip Chip Koe'n FRANKFURT 6078 Neu-Isenburg 2 Am Forstaus Gravebruch 5-7 Telephane: 06102:5526 Telex: 41-75-82

Teinshane 06102-5258 Telex: 41:76-82 #ANNOVER 3 3 Hannover, Podbielskisstresse 102 Telephone 051: 69-70-95 Telex: 522-952 571:717GAR7 D-7301 Kempert Stuttgart Marco-Pato Strasse 1 Telephone 10711-45-70-85 Talex: 841-722-393

AUSTRIA Digital Educioment Corporation Ges m.b.H. VIENNA Mariahilferstrosse 136, 1150 Vienna 15. Austria Telephone 85.51.86

UNITED KINGDOM

UNITED KINGDOM
DIENT SADUMENT CO. LID
U.K. HEADQULARTERS
FOURTHIN FLOWERS
FOURTHIN FOURTH
FEEDOM CO. 197349 58355
FEEDOM CO. 1 BRISTOL Fish Ponds Boad Fish Ponds Bristol England BS163HQ Teraphone Bristol 651-431 Bilton House - Uxbridge Road, Ealing, London W.5. Telephone - 01-579-2334 - Telex - 22371 Telephone 01-579-2334 Telex 2237 EDINBURGH Shiel House, Craigshill Tivingston West Lothian, Scotland Telephone 32705 Telex 727113

Telegoner SZ00 Intel 72:103

LONDON
Management Hause
43 Parker 57: Halbarn London
WC 28 581 Envision
Telegoner Disdo-2014/087 Tele 27:50
MANCHESTER
Andole House
Cleater Roud Szetlora Manchester M32-9BH
Telegoner (06) 985-7011 Teles 686666

UNITED KINGDOM (cont.)

READING Fountain House, Butts Centre Reading RG1 7QN England Telephone (9734)-583555 Telex 8483278 NETHERLANDS

THE HAGUE Six Winston Churchillian 370 Rijswijk/The Hague, Netherlands Telephone: 94 9220 Telex 32533

BELGIUM
Digital Equipment N.V /S A
BRUSSELS
108 Rue D'Arlon
1040 Brussels, Belgium
Telephone 02-139256
Telex 25297

SWEDEN
Digital Equipment AB
STOCKHOLM
Englundrivagen 7, 171 41 Solna, Sweden
Telephone 98 13 90 Telex 170 50
Cable Digital Stockholm

NORWAY
Digital Equipment Corp. A/S
05L0
05L0
Torinheimsvelen 47
Q8lo 5, Norway
Telephone 02/68 34 40
Telex 19079 DEC N DENMARK

Digital Equipment Aktiebolag COPENHAGEN

Hellerupveg 66 2906 Helferup, Denmark

FINLAND

Orgital Equipment AB HELSINKI

SWITZERLAND
Digital Equipment Corporation S A
GENEVA
20 Quai Ernost Ansermet
Baile Postale 21, 1211 Ceneva 8, Switzerland
Tolleanone No. 022 20 40 20 and 20 58 92 and 20 68 93
Talex 28 92 07

ZURICH
Distrial Equipment Corp. AG
Schiffhauserstr. 315
CH 8050, Zurich. Switzerland
Telephone. 01:48:41.91. Telex. 56059

ITALY Digital Equipment Sip A

Digital Equipment Sip A MilLAN Corso Gribbith 49 10121 Milland, Italy Telephone (02):879-051/2/3/4/5 Telex 843-33615

Digital Equipment Corporation Ltd MADRID MADRID Atmo ingenieros S.A., Enrique Larreta 12, Magrid 16, Telephone, 215, 35, 43, Telex, 27249 BARCELONA Atao Ingonieros S.A. Granduxer 76, Barcelona 6 Telephone, 221, 44,66

ISRAEL
DEC Systems Computers Ltd.
FEL AVIV.
Street
Tel Aviv. Israel
Telsphone (20) 443114/440763
Telsphone (20) 443114/440763
Telsphone (20) 443114/440763

CANADA
Digital Equipment of Canada, Ltd
CANADIAN HEADQUARTERS
P O Box 1500
Ottawa Ontano, Canada
K2Y 8K8
Telephone (6/3)-592-5111
TWX 610-562-8732 TORONTO
2550 Goldenridge Road Mississauga, Ontario
Telephone (416)-270-9400 TWX 610-492-7118 MONTRAL 9045 Cote De Liesse Dorval, Quenco Canada H9P 2M9 Telephone (514):636-9393 Telex 610-422-4124 CALGARY/Edmonton

CALGARY/Edmonton

Suite 140, 5940 Fisher Road S E

Calgary, Alberta, Canada

Talephone (403) 435-4881

TWX: 403-255-7408 VANCOUVER VANCOUVER Suite 202 644 S.W. Marine Dr. Vancouver British Columbia Canada V6P 5Y1 Telephone (604):325-3231 Telex 610-929-2006

CENTRAL INTERNATIONAL SALES
REGIONAL OFFICE
146 Main St. (617) 897-5111
From Metrapolitan Boston, 846-8600
TWX 170-347-0217-0212
Cable D-0117AL MAYN
Telex 94-8457

AUSTRALIA

 AUSTRALIA
 Digital Equipment Australia Pty
 Ltd

 AOELA/IDE
 8 Montross Avenue
 5 Montross Avenue

 Norwood
 8 South Australia 5067

 Terephone
 (08) 42 1339
 Telex
 750-82825

CANBERRA 27 Collie St Fyshwick A C T 2609 Australia Telephone (062)-959073

MELBOURNE 65 Park Street South Melbourne Victoria 3205 Australia Telephone (03):699-2888 Telex 790-30700 PERTH 643 Murray Street West Pictric Western Australia 5005 Telephone (935)-21-4993 Telex 790-92140

SYDNEY
P O Box 491, Crows Nest
N S W Austral a 2065
Telephone (02) 439-2555 Telex 790-20740

NEW ZEALAND
This Faultment Corporation Ltd. Digital Egypment Corporation Ltd. AUCKLAND Hiton House 430 Queen Street Box 2471 Auckland New Zenfand Telephone 75533

JAPAN
Digital Equipment Corporation International
Kowa Building No. 16 — Annex, First Floor
9:20 Aksaska 1-Chome
Minatokki, Tokyo 107 Japan
Telephone 586:2771 Telex J-25478
Bikei Trading Co. Ltd. (sales only)
Kozatok Sakan Bidg
No. 18:4 Nari-sembashi 1-Chome
Minatokki Chowa Sakan S

PUERTO RICO
Digital Equipment Corporation De Pilerto Rico
407 del Parque Street
Santurce, Puerto Rico 00012
Telephone (809)-123-8068/87 Telev 385-9356

ARGENTINA
BUENOS AIRES
Coasin S A
Virrey del Pino 4071, Buenos Aires
Telephone 52:3185 Telex 012:2284

BRAZIL

RIO DE IANEIRO — GB

Ambries S A

Ambries S A

Ruo Cesta, 104 2 n 3 anderes ZC - 29

Ruo Cesta, 104 2 n 3 anderes ZC - 29

Ruo De Janeiro — GB

Telephone Telephone 264-7406/09617/023
SÃO PAULO
Ambriex S A.
Rua Tup: 535
Sao Paulo — SP
Telephone 52-7806/1870, 51-0912 PORTO ALEGRE — RS Pua Coronel V cente 421/101 Porto Alegre — RS Telephone 24-741

CHILE SANT/AGO

SANTIAGU
Coasin Chile Ltda (sales only)
Casilla 14588 Correo 15
Telephone 396713 Cable COACHIL

INDIA
BOMBAY
Historion Computers Pvt. Ltd
69/A L. Jagmohandas Marg
Bombay 6 (WB) India
Felectione 36: 515 36:5344 Telex 011-2594 Plenty
Caste TEX-Miss.

MEXICO MEXICO CITY
Mexitek, S.A.
Eugenia 405 Deptos 1
Apdo. Postal 12-1012
Mexico 12 D.F.
Telephone (905) 536-99-10

PHILIPPINES

MANILA Stanford Computer Corporation P.O. Box 1608 416 Dasmarinas St., Manila Telephone, 49-88-96 Telex, 742-0352

VENEZUELA

CARACAS Coss.r C A Apartado 50939 Sabana Grande No. 1, Caracas 105 Yelephone 72,8862, 72,9637 Cable INSTRUVEN

DIGITAL EQUIPMENT CORPORATION digital WORLDWIDE SALES AND SERVICE

MAIN OFFICE AND PLANT

Maynard, Massachusetts, U.S.A. 01754 * Telephone: From Metropolitin Eustin 546-8600 * Eisewhere (617)-897-5111 TWX: 710-347-0212 Cable - DIGITAL MAYN Telex 94-8457

DOMESTIC

NORTHEAST REGIONAL OFFICE: 235 Wyman Street, Waltham, Mass 02154 Telephone: (617)-890-0330 03:0 Dataphone: 617-890-3012 or 3013 Fairfield 1275 Post Road, Fairfield, Conn. 06430 Telephone. (203):255-5991 Rephane (concaras)
NEW YORK
Rachester
130 Allens Croek Road Rochester New York
Telsphone (716):461-1700 Dataphone 716-244-1680 Syracuse
6700 Thompson Road: Syracuse, New York 13211
Telephone: (315)-437-1593/1765 Distaphone: 315-454-4152 Teledonace (315):437/1937/1985 Dataphone 31 MASSACHUSETTS Mariborough One Iron Way Mariborough Mass 01752 Telephone (617):481-7400 Telex 710.347-0348 MID-ATLANTIC REGIONAL OFFICE U.S. Route 1, Princeton, New Jersey 08540 Telephone (609)-452-2340 FLORIDA

- LUNIUM Orlando St, ta 130, 7001 Lake Ellenor Drive, Orlando, Florida 32809 Telephone (305)-851-4450 Dataphone 305-859-2360 GEORGIA Atlanta 2815 Clearview Place, Suitc 100 Atlanta, Georgie 03040 Telephone (404):451-7411 Dataphone 305-859-2360

Telephone (40)4-451-7411 Dataphone 305-859-2390 NORTH CAROLINA Durham/Chapel Hill Executive Park 3700 Chapel Hill Blod Durham North Carolina 27797 Telephone (919)-489-3347 Dataphone 919-499-7832 NEW JERSEY Partiald 253 Passaic Ave Fairfield New Jersey 07006 Telephone (201)-227-9280 Dataphone 201-227-9280 Metuchen 95 Main Street, Metichen New Jersey 98840 Telephone (201)-549-4100/2000 Dataphone 201 548-0144

EUROPEAN HEADQUARTERS
Digital Equipment Corporation International Europe
81 route de l'Aire
121* Geneva 26 Switzerland
Telephone 42 79 50 Telex 22 883

FRANCE
Digital Equipment France
Centre Silic — Cidex L 225
94533 Rungis, France
Telephone 687-23-33 Telex 26840

Interporting Barry 3.3 new 25640 GRPNOBLE Digital Equipment France Tour Mangin 88100 Grenoble France Telephone (76) 87-96 0° Telex 212 32882

GERMAN FEDERAL REPUBLIC

Digital Equipment GmbH MUNICH 8 Muenchen 13, Wallensteinplatz 2 Telephone 0811-35031 Telex 524-226 COLOGNE 5 Kostn 41 Aachener Strause 31) Telephone 0221-44-40-95 Telex 898-2269 Telegram Flip Chip Koe'n

FRANKFURT 6078 Neu-Isenburg 2 Am Forstaus Gravebruch 5-7 Telephone 06102-5526 Telex 41-76-82 HANNOVER

MANNOVER
3 Hannover, Podhielaki straisse 102
Telephone: 051: 68-70:95
Tellev: 922:952
STUTTGART
D-7391 Kameral: Stuttgart
Marco-Poi-Strasse
Telephone: 07771-947-0-65
Teles-me: 07771-947-0-65
Teles-me: 07771-947-0-65
Teles-me: 07771-947-0-65

AUSTHIA
Digital Equipment Corporation Ges m.b.H.
VIENNA
Maniahilferstrasse 136, 1150 Vienna 15. Austria
Telephone, 85,51,86

UNITED KINGDOM

UNITED KINGDOM

Digital Equipment Co. Ltd

U.K. HEADQUARTERS
Fourtain House Butts Centre
Reading PG1 70 N. England
Telephone (2034) 883555 Telev. 8483278
BRMINGHAM
Maney Butdings
29/31 8 mingsham Rt., Sutton Colof etc.
Warey Cestive: England
Telephone (201-356-550) Telev. 337-660
BRISTOIL BRISTOL Fish Ponds Bond Fish Ponds Bristel England BS163HO Telephone Bristol 651-431

EALING Bilton House Uxbridge Road, Ealing, London W.S. Telephone (01-579-2334) Telex 22371

Telephone 0.159-2034 Telex 2231

EOI/NEUROH

EOI/NEUROH

West Loh an Scotland

Telephone 39795 Talex 777113

LONDON

LONDON 11 House

LONDON 11 House

LONDON 11 House

LONDON 11 House

LONDON 12 House

LONDON 1

Arndale House Chester Bond Streeford Munchester M32 98H Teleprone (061):865-7011 Telex 668668

MID-ATLANTIC (cont.) Princeton U.S. Route 1, Princeton New Jersey 08540 Telephone (609)-452-2940 Dataphone 609-452-2940

NEW YORK New Funni Long Island 1 Huntington Quadrangle Suite 1507 Huntington Station New York 1746 Telephone (516):694-4131 (212):895-8095 Dataphone 516-293-5693 Manhattan 810 /tr. Avel, 22nd Floor New York, N.Y. 10019 Telephone (212)-582-1300

PENNSYLVANIA Philadelphia Digital Hall 1740 Walton Road, Blue Be'll Pennsylvania 19422 Telephone (215)-825-4200

Knaxville 6311 Kingstor Pike, Suite 21E Knoxville, Tennesser 37919 Telephone (615):588-6571 Dataphone 615-584-0571

WASHINGTON D.C. Lanham 30 Office Building 4900 Princess Garden Parkway, Lanham, Maryland Telephone (301)-459-7900 Dataphone 301-459 7900 X53

CENTRAL
PEGIONAL OFFICE
1850 Frontage Road, Northbrook, Illinois 60062
Telephone (312) 498-2500 Dataphone 117-498-2500
Ex. 78

ILLINOIS Chicago 1850 Frontage Road Narthbrook, Illinois 60062 | Dataphone: 312-498-2500

LOUISIANA New Orleans 3100 Ridgelake Drive Suite 108 Metalire Louisiann 70002 Telephone (504) 837-0257 Dataphone 504-833-2800

CENTRAL (cont.)

CENTHAL (cont.)
MICHIGAN
Ann Arbor
230 Huron View Boulevard, Ann Arbor, Michigan 48103
Telephone (313)-761-1150
Detroit
Detroit
23777 Greenfield Road

2017 Gleen Ros John St. 1992 Southfield Michigan 48075 Dataphone 313-557-3063 MINNESOTA Minneapol s 8030 Cedar Avel South, Minneapolis, Minnesota 55420 Telephonel (612)-854-6562 3-4-5 Dataphonel 612-854-1410 MISSOURI

MISSOURI Kansas City 1240: East 43rd Street, Independence Missouri 64055 Telephone (816)-252-2300 Dataphone: 816-461-3100

Tulsa 3140 S. Winston Winston Sq. Bldg. Suite 4, Tulsa, Oklahoma 74135 Telephone. (918):749-4476 — Dataphone. 918-749-2714 PENNSYLVANIA

Pittsburgh 400 Penn Genter Boulevard, Pittsburgh, Pennsylvania 15235 Telephone (412)-243-9404 Dataphone: 412-824-9730 TEXAS

| Fanu | Dailas | Dailas | Plaza North | Suite 513 | Plaza North | Suite 513 | 2880 | LBJ Freeway | Dailas | Texas 75234 | Telephone (214)-620-2051 | Dataphone | 214-620-2061 | HOUSTON

HOUSTON 6856 Horwood Drive Monterey Park Houston, Texas 77036 Telephone (73)3777-3471 Dataphone: 713-777-1071 WISCOMSIN Milwakee 8331 West Capitol Drive Milwakee Wisconsin 53222 Telephone (4/4)463-3115 Dataphone 414-463-3115

##EG/ONAL OFFICE: 310 Sequel Way: Sunnyvale California 94085 Telephone (408)-735-9200 Dataphone 408-735-1820

ARIZONA Phoenix 4358 East Broadway Road Phoenix, Arizona 85040 Telephone (602):268,3488 — Dataphone 602-268-7371

CALIFORNIA Santa Ana 2110 S. Anne Street, Santa Ana, California **92704** Telephone (714)-979-2460 Dataphone 714-**979**-7**85**0 Telephone (714):979-2660 Dataphone 714-979-7850 San Diego 5154 Mission Gorce Bond 5154 Mission Gorce Bond Suite 110 San Diego. California Telephone (714):280-7850/7970 Dataphone 714-280-7825 San Francesci 1400 Terra Bella Mounto n View, California 94040 Telephone (415):884-6200 Dataphone 415-984-1436

Oakiand
785 Edgewater Drive, Oakland, California 94621
Telephone (4/5):695-5453/7830
Dataphone: 415-562-2160
West Los Angeles
1510 Corner Avenue, Los Angeles, California 90025
Telephone (2(3):4/9-379-74318
Dataphone 213-478-5626 Telephone (203)479-39 74316 Desaphone 213-476 COLCRADO 7901 E. Bellevue Avenue Sulte S. Englewood, Colorado 80110 Telephone (303)-770-6930 Dataphone 303-770-6828

NEW MEXICO NEW MEXICO Albuquerque 10200 Menust N.E., Albuquerque New Mexico 87112 Telephone (505):296:5411/5428 Dataphone 505:294:2330

OREGON
Portland
Suite 188
5319 S W Westgate Drive Portland Oregon 97221
Telephone (503)-297-3761/3765

UTAH Saft Lake City 429 Lewn Date Or ve. Saft Lake City, Utah 84115 Telephone (801)487-4669 Detachere 801-467-6636

WASHINGTON Believice 13401 N.E. Bellevic, Redmond Road, Suite 111
Bellevic, Washington 98005
Telephone (206):545-4058/455-5404 Dataphone 206-747-3754

INTERNATIONAL

UNITED KINGDOM (cont.) ISRAEL READ:NG Fountain Housei, Butts Centre Reading RG1 7QN England Telephone (0734)-583555 Telek 8483278

NETHERLANDS Digital Equipment N V.
THE HAGUE
Sir Winston Churchillian 370
Rijswijk/The Mague, Netherlands
Telephone 94 9220 Telex 32533

BELGIUM
Digital Equipment NIV /S.A.
BRUSSELS
108 Pile D'Arton
1043 Brussels, Belgium
Telephone 02-139256. Telex 25297

SWEDEN

Digital Equipment AB STOCKHOLM Englundavagen 7: 171:41 Salna, Sweden Tefershone: 98:13:90 Talex: 170:50 Cable: Digital Stockholm

NORWAY Equipment Corp. A/S. Digital Equipment Corp. A/S OSLO Trondheimsveren 47 Oslo 5. Norway Telephone: 02/68/34/40 Telex. 19079 DEC N

DENMAHK
Digital Equipment Aktiebolag
COPENHAGEN
Hellerupveg 66
7905 Helferup, Denmark

HELSINKI Titismaantie 6 SF-00710 Helsink, 71 Telephone: (090) 370133 Cable: Digital Helsink

SWITZERLAND
Digital Equipment Corporation S A
GENEVA
20. Quest Excest Absorbed 20, Ques Ernest Ansermet Boite Postale 23, 1211 Geneva 8, Switzerland Tellenbrons No. 072 70 40 20 and 20 18 93 and 20 68 93 Tellen 28 90 01 ZURICH Digital Equipment Corp. AG Schaffbauserstr. 315

CHIRDS Zurich Switzerland Telephone 01.46.41.91 Telex 16010 ITALY Die tall Equipment Sip A Unit tall Equipment 5 p.A.
MILAN
Cursu Geribaidi 49, 10121 Milliano, Italiy
Telephone (02):879-051/2/3/4/5 Telex 843-33615

SPAIN
Digital Equipment Corporation Ltd
MADRID
Abute Ingenieros S.A., Enrique Larreta 12, Madrid 16, Telephone 215, 25, 43, Telex, 27249

BARCELONA Attiral Ingonieros S.A. Granduxer 76. Barcelona 6. Telephone, 221,44,66

DEC Systems Computers Ltd.
TEL AVIV.
Suite 103. Southern Habakuk Street
Tel Aviv. Israel
Telaphone 103, 443114/440783
Telex: 922-33-3163

CANADA
Dig tal Equipment of Canada, Ltd.
CANAD(AN HEADQUARTERS
P O Box 11500
Ottawa, Ontario Canada
K24 8K8
Telephone (613):592:5111 TWX 610-562-8732

TORONTO 2550 Goldenridge Road, Mississauga Ontario Telephone (418):270.9400 TWX: 610.492-7118

CALGARY/Edmonton
CALGARY/Edmonton
Sture 140, 6940 Fisher Road S.E.
Calgary, Alberta, Canada
Tolephone (403) 435-4881
TWX: 403-255-7408

VANCOLVER Suite 202 644 S W. Manico Dr., Vancouver But sh Columbia, Canada V66 SY1 Telephone (604)-335-3231 Telex 810-929-2006

GENERAL INTERNATIONAL SALES
REGIONAL OFFICE
486 Main Street Manand Massachusetts 01754
*elephore (617) 891-5111
From Metrapolitan Boston, 846-8600
TWX 710 947-0217/2012
Table 94-8457
Table 94-8457

AUSTRALIA

Digital Ecoopment Australia Ptv. Ltd. ADELAIDE 6 Montrose Avenue Norwood South Australia 5067 Terephone (08) 42 1339 Telex. 790-82625 BRISBANI 133 Le cohardt Strect Spring Hill Brisbane Operinshird Australia 4000 Le ephade (072) 793038 Teller 790-40616

CANBERRA 27 Cottle St Fyshwick A C T 2609 Australia Telephone (062)-959073

MELBOURNE 63 Park Street Sorts Melbouxie Victoria 3205 Australia Talephone (C3) 699-2888 Telei 790-30100

SYDNEY
P O Box 491 Crows Nest
N S W Anstratio 2069
Telephone 702: 439.7%50 Telephone 702: 439.7%50 Telephone

NEW ZEALAND
THE Resument Corporation Etd. Digital Equipment Corporation Ltd.
AUCKLAND
Hilton Holisin 430 Queen Street Box 2471
Auckland New Zealand
Telephone 75533

JAPAN
Dig fall Equipment Corporation International
Kowa Building No. 16 — Annex, First Floor
9/20 Assake L-Chome
Minato-Ku, Toxyo 107: Japan
Telephone S86-277: Telex 1-26428
Rikes Trading Co. List (sales only)
Kotano-Kajikan Bildig
No. 18.14 Nish-sh-mhashi 1: Chome
Minato-Ku, Toxyo Japan
Telephone: 5915248 — Yelex 781-4208

PUERTO RICO
Digital Equipment Conporation De Puerto Rico
407 del Parque Street
Santince Pierto Rico 09912
Terephone (809):723-8768/67
Talex 385-9056

ARGENTINA BUENOS AIRES BUENOS AIRES Coasin S A Virrey del Pino 4071, Buenos Aires Telephone 52-3185 - Telek 012-2284

Telephone SA A Company SA A Company SA Compa Telephone 264-7406/0461/7625 SAO PAULO Ambriex S.A. Pua Tup , 535 Sao Paulo — SP Telephone 52-7806/1870 51-0912

PORTO ALEGRE — RS Rua Coronel V cente 421/10! Porto Alegre — PS Telephone 24.741

Coasin Chile Ltda (sales only)
Casilla 14586 Correo 15
Telephone 396213 Cable COACHIL

INDIA BOMBAY hindston Computers Pvt. Ltd 69/A. L. Tagmichandas Marg. Bombav-6 (WB) India Teleptonia 38/451 38/5344 Telex 011-2594 Plenty Cable TEKHIND

MEXICO MEXICO CITY Mexitok S.A. Eugenia 408 Deptos 1 Apdo. Postal 12:1012 Mexico 12: D.F. Telephone (903) 596.09:10

PHILIPPINES MANILA Stanford Computer Corporation P.O. Box 1608 416 Dasmarinas St. Manila Telephone 49:68:96 Telex 742:0352

VENEZUELA VENEZUELA CARACAS Coasin. C.A Apartido 50939 Sabana Grande No. 1. Caracas 105 Telephone 72-8662 72-9637 Cable INSTRUVEN