RKV11-D
disk drive controller
user's manual

EK-RKV11-OP-001

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PREFACE

This manual provides the user with information on the RKV11-D Disk Driver Controller. Discussions in the manual deal with general descriptions of the RKV11-D controller. Detailed descriptions are found in the RKV11-D Disk Driver Controller Maintenance Manual—available on microfiche. For detailed coverage of the RK05 disk drive, refer to the RK05 Disk Drive Maintenance Manual (EK-RK5JF-MM-001).

Although control signals and data are transferred between the RKV11-D controller and the LSI-11 bus, it is beyond the scope of this manual to cover the operation of the bus itself. Detailed information regarding the LSI-11 bus may be found in the Microcomputer Handbook (EB-07948-53).

Occasional reference is made to engineering drawings not contained in this manual. These drawings are in the RKV11-D Moving Head Disk Driver Controller Engineering Drawings Manual; a copy is supplied with each RKV11-D controller. That manual contains current RKV11-D prints, updated to the time the equipment is shipped.

CHAPTER 1
GENERAL DESCRIPTION

1.1 INTRODUCTION

The RKV11-D is a controller for RK05 mass memories capable of communicating with up to eight daisy-chained disk drives (Figure 1-1). The system is block-oriented but is capable of transferring from 1 to 2^{16} consecutive data words without reinitiation or processor intervention. These data transfers occur on the LSI-11 bus at the Direct Memory Access (DMA) level of communication.

For simplicity and clarity, the illustrations and descriptions contained in this manual are representative of a system utilizing only RK05J disk drives. RK05F drives, however, may also be used on the RKV11-D controller. The RK05F is a nonremovable media disk drive. It is essentially identical to the RK05J except that it has twice the storage capacity (achieved by doubling the track density).

The RK05F was designed to appear to the RKV11-D as if two "logical" RK05J drives were connected to it. This design feature permits RK05J and RK05F drives to co-exist on the controller in any PDP-11 computer system. The RK05F utilizes two consecutive drive positions on the Drive bus instead of the single position utilized by an RK05J. The first of the two "logical" consecutive drive positions must always be an even number (i.e., 0-1, 2-3, 4-5, or 6-7).

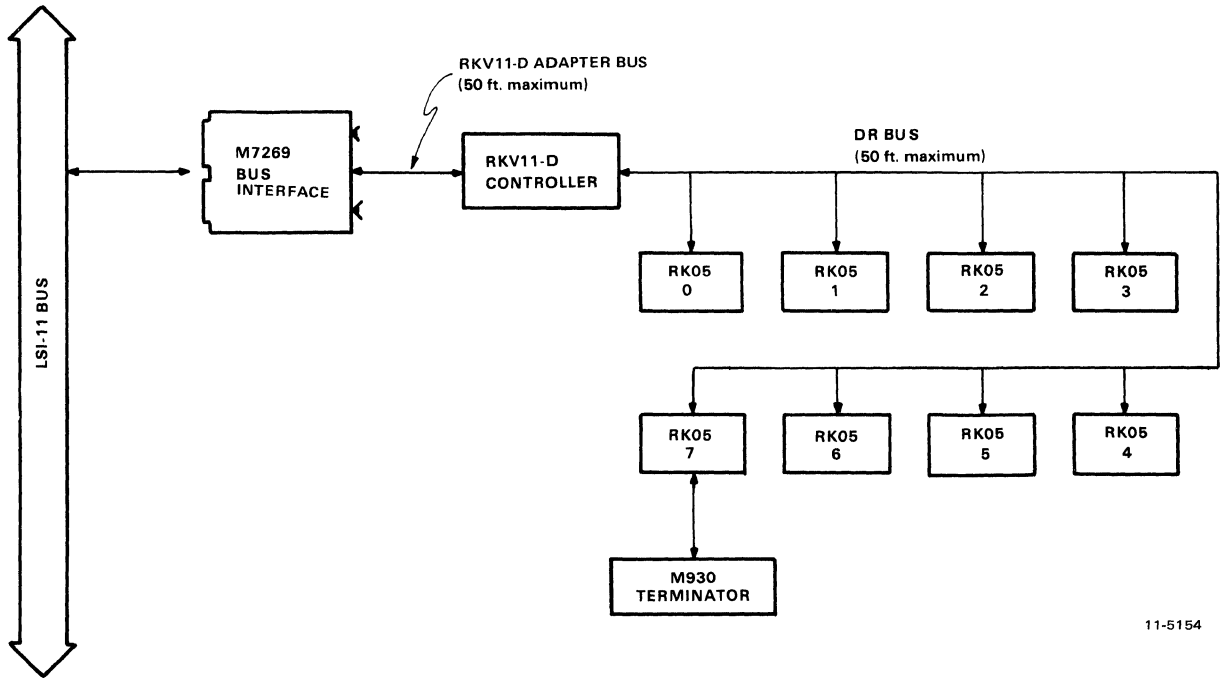


Figure 1-1 RKV11-D Disk Drive System

1.2 FUNCTIONAL DESCRIPTION

The RKV11-D controller and the RK05 disk drive form the disk drive system, which interfaces with a PDP-11/03 processor via the LSI-11 bus. The RKV11-D is implemented on five functional modules (M7254, M7255, M7256, M7268, and M7269) and interfaces with the RK05 disk drive via a drive bus (DR BUS) as shown in Figure 1-2.

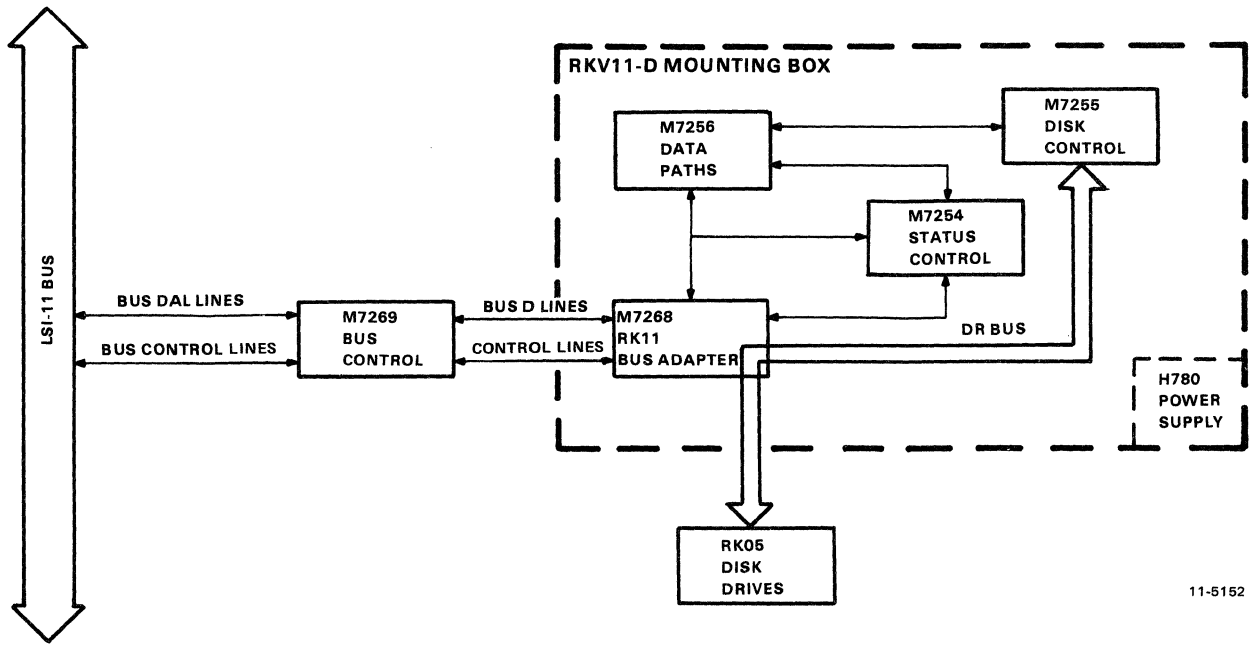


Figure 1-2 RKV11-D Controller, Functional Block Diagram

1.2.1 Disk Drives

The RK05 is a moving head disk drive that uses RK03-KA disk cartridges for data storage. Data is stored on both sides of the disk by a pair of movable heads, which are always positioned over opposing surfaces of the same cylinder. Each side of the disk contains 203_{10} tracks, each of which contains 12_{10} sectors capable of storing 400_8 or 256_{10} data words.

The sector format consists of 15_8 words of preamble terminating in a sync bit followed by a one-word header, 400_8 data words, a one-word checksum, and one word of postamble. A sector pulse indicates the beginning of each sector. The index pulse occurs during the last sector, and the sector following the index pulse is sector 0.

The DR BUS has up to eight disk drives connected in daisy-chain fashion, each of which can be write protected either by an RKV11-D controller Write Lock function or by manual intervention.

On a disk cartridge, the upper surface is defined as surface 0 and is active when RKDA 04 (SUR) is clear. If a data transfer requires an overflow from surface 0, SUR is set automatically, and surface 1 (the lower surface of the cartridge) is activated at sector 0. If a data transfer requires an overflow from surface 1, the RKV11-D automatically moves the disk drive heads to the next cylinder, checks the header word to verify head positioning, and resumes the data transfer at sector 0 of surface 0. Attempting this cross-cylinder operation from surface 1 of the last cylinder will result in an error condition (RKER 14-OVR).

For more detailed information on the disk drive operation and the related power supply, refer to the RK05 Disk Drive Maintenance Manual (EK-RK5JF-MM-001)—available on microfiche. That manual also contains a complete description of the DR BUS lines.

1.2.2 RKV11-D Controller

The RKV11-D is divided into five major functional units, as shown in Figure 1-2. The Status Control module initiates the programmable RKV11-D functions and monitors logic status conditions. The Disk Control module monitors disk drive status conditions and controls all disk drive functions. The Data Paths module transfers parallel data to and from the LSI-11 bus and serial data to and from the disk drives. The RK11 Bus Adapter module serves as a connection point for the DR BUS, passing the bus from the M7255 module to the RK05. The M7268 also adapts the three RK11-D modules to communicate with the RKV11-D Bus Control module (M7269). The Bus Control module interfaces the RKV11-D with the LSI-11 bus for address selection and controls DMA data transfers and interrupt sequences. The Bus Control module is located in the PDP-11/03 processor and connects to the Adapter module via the Adapter bus.

The RKV11-D contains seven 16-bit programmable hardware registers, addressed from the LSI-11, that provide the software interface for the RKV11-D and the LSI-11 bus. Table 1-1 lists these registers and their addresses.

Table 1-1 RKV11-D Registers

Name	Abbreviation	Address
Drive Status Register	RKDS	177400
Error Register	RKER	177402
Control Status Register	RKCS	177404
Word Count Register	RKWC	177406
Bus Address Register (Current Memory Address)	RKBA	177410
Disk Address Register	RKDA	177412
Data Buffer Register	RKDB	177416

Through software control, the RKV11-D can perform four control functions (Control Reset, Seek, Drive Reset, and Write Lock) and four data transfer functions (Write, Read, Write Check, and Read Check). The Hardware Poll feature (see section 4.3.4 of RKV11-D Maintenance Manual, EK-RKV11-MM-001) enables more than one disk drive to perform multiple Seek or Drive Reset functions simultaneously. The RKV11-D also initiates an interrupt sequence on the LSI-11 bus in response to any of six interrupt conditions described in Paragraph 3.4.

The data transfer functions (Read, Write, Read Check, and Write Check) all begin with an automatic "implied" Seek operation. This allows the user of a single disk drive system to ignore the Seek function completely and initiate data transfer functions directly. The hardware poll logic is initiated only for Seek and Drive Reset functions and not for the "implied" Seek portion of data transfer functions.

1.2.2.1 Control Reset – The Control Reset function initializes all internal registers and flip-flops and clears all of the bits of the seven programmable registers except RKCS 07 (READY), which it sets, and RKDS 00 through 11, which are not affected. Disk drive operation is only affected indirectly, as a result of RKV11-D logic being cleared.

Control Reset serves as an effective "abort," because it terminates all controller action; however, care should be taken during a Write operation as the abort does not occur until completion of the current sector. If a Control Reset function is used to abort a function in process to allow a high-priority user access to a disk drive, that drive must first be checked for head motion (indicated by RKDS 06—Read/Write/Seek Ready). If the function is initiated before the heads have stopped, a hard error results; after which a Drive Reset function must be performed on that drive before it can be used again.

1.2.2.2 Seek Function – For a Seek function, the RKV11-D directs the selected disk drive to move its head mechanism to the cylinder address specified by RKDA 05-12. When this portion of a Seek has been initiated, the controller returns to the Ready state (RKCS 07). If the specified cylinder address is greater than 312_8, the function is aborted and bit 06 (Nonexistent Cylinder) of the RKER is set. RKCS 06 (IDE) then determines the program reaction.

The selected disk drive completes the Seek function by moving its head mechanism to the desired cylinder, whereupon RKDS 06 (R/W/S RDY) is set. The time required to initiate a Seek function is normally 1 μs but may range up to 3.3 ms if an attempt is made to abort a Write function. Head movement may take up to a maximum of 80 ms.

1.2.2.3 Drive Reset Function – For a Drive Reset function, the controller directs the selected disk drive to move its head mechanism to cylinder address 000 and reset all active error status lines. To the controller, the Drive Reset function is the same as a Seek function, even to the manner in which the hardware poll logic is used; however, a Drive Reset function can take much longer than a Seek function to execute. The time required to complete a Drive Reset function depends on the physical position of the head mechanism at the time the function is initiated and therefore may take a maximum of two seconds.

1.2.2.4 Write Lock Function – The Write Lock function write-protects a selected disk drive until the condition is overridden by operation of the corresponding WT PROT (write protect) switch on the disk drive (refer to RK05 Disk Drive Maintenance Manual, EK-RK5JF-MM-001). The disk drive is automatically write-enabled when power is first applied or when the disk drive RUN/LOAD switch is set to RUN.

1.2.2.5 Write Function – For a Write function, the controller automatically performs an "implied" Seek operation. When that is completed, the next header word is read and checked for correct cylinder identification (cylinder address). If the header is correct, the controller begins the Write operation when the Sector Counter (RKDA 00-03) equals the Sector Address (RKDS 00-03), hereafter referred to as SC = SA (RKDS 04).

A preamble consisting of 15 words of zeros is written, followed by a sync bit. Then the header word is rewritten automatically, followed immediately by the data words for the sector. As the data words pass through the controller, a one-word checksum word is calculated and automatically written after the last sector data word, followed by one word of zeros for the postamble. If the cylinder address is incorrect, the controller makes 16 attempts to establish the correct cylinder address before the function is aborted, setting RKER 12 (Seek Error). (Compatibility with the RK11-C, which makes only one attempt, may be achieved by cutting a jumper on the Status Control module.)

An RKWC overflow at any time from the start of the Write function stops the DMA data transfers and sets RKCS 07 (RDY) at the end of the current sector. If the RKWC has not overflowed at the end of a given sector, the function is continued at the next contiguous sector; however, if the last sector of the disk cartridge is transferred without RKWC having overflowed, then RKER 14 (OVR) is set.

1.2.2.6 Read Function – For a Read function, the controller automatically performs an "implied" Seek operation. When that is completed, the controller waits for SC = SA then reads and checks the header word. If the cylinder address is correct, the controller continues reading the sector, and DMA transfers the data words onto the LSI-11 bus. If the cylinder address is initially incorrect, the controller makes 16 attempts (jumper selectable to one, as previously noted) to establish the correct cylinder address before the function is aborted, setting RKER 12. As the data words of a sector pass through the controller, a one-word checksum word is calculated and compared with the checksum read from the disk drive. If there is a discrepancy between the two checksums, RKER 01 (Checksum Error) is set, and the controller reaction is determined by RKCS 06 (IDE) and RKCS 08 (SSE). An RKWC overflow at any time from the start of the Read function stops the DMA data transfers and sets RKCS 07 (RDY) at the end of the current sector. If the RKWC has not overflowed at the end of the given sector, the function is continued at the next sector.

1.2.2.7 Write Check Function – The Write Check function is used to compare the contents of memory to the contents of a continuous block of data on a disk cartridge. The controller automatically performs an "implied" Seek operation, just as for a Write function and then reads and checks the next header word. If the cylinder address is correct, the controller waits for SC = SA then begins reading the rest of the sector (data and checksum) while performing DMA transfers for each data word. Each data word from the disk drive is compared, bit by bit, with memory data from the LSI-11 bus. The disk drive checksum, in turn, is compared with the checksum calculated by the controller. If any bit is found to be in error, RKER 00 (Write Check Error) is set. Controller reaction is then determined by RKCS 06 (IDE) and RKCS 08 (SSE). The Write Check function may be performed on a short sector (less than 256 data words) as long as the number of words write-checked is equal to the number of words previously written into the sector.

1.2.2.8 Read Check Function – The Read Check function is identical to a normal Read function, except that no DMA data transfers occur. Only the checksum is calculated and compared with the checksum read from the disk drive. This function enables the program to know beforehand if a given block of data is readable and error free. Because the Read Check is essentially a parity check, it must be performed on a whole-sector basis only.

1.2.2.9 Hardware Poll – The controller is capable of permitting any or all disk drives to perform a Seek or Drive Reset function simultaneously. The hardware poll feature in the disk control module identifies the logical disk drive in RKDS 13-15 (DRIVE IDENT) for any disk drive that has completed a Seek or Drive Reset function. This poll causes an interrupt if RKCS 06 (IDE) is set, the controller is in the Ready state (RKCS 07 set), and the controller is not already attempting to initiate an interrupt from some other function. If two or more disk drives complete a Seek or Drive Reset function simultaneously, the controller interrupts once for each disk drive and identifies each in turn to the RKDS. In this situation, the processor interrupt level must be raised in order to shut off interrupts, or else a second interrupt will occur immediately after the first—causing the interrupt service routine to be interrupted. Similarly, back-to-back interrupts will also result from directing the heads to a cylinder at which they are already positioned—with the first interrupt coming from the initiation of a Seek function and the second coming from notification from the hardware poll that the heads are already at the desired address.

1.3 PHYSICAL DESCRIPTION

The RKV11-D controller utilizes six modules: M7254, M7255, M7256, M7268, M7269, and M930. The M930 is a bus terminator and is installed on the last RK05 disk drive in the system. The M7269 module is located in the PDP-11/03 processor box. The remaining four modules are in the RKV11-D box, which is 381.00 mm deep, 88.90 mm high, and 482.60 mm long (15.00 in × 3.50 in × 19.00 in). The RKV11-D box is hard-mounted in the cabinet and also contains an H780 power supply. Detailed cabling and module utilization information can be found in unit assembly drawing D-UA-RKV11-D-O.

An RKV11 disk drive system consists of the controller, the RK05 disk drives, and the necessary cabling. The LSI-11 bus connects the RKV11-D Bus Control module and the PDP-11/03 processor. The Drive bus (DR BUS) connects the controller and the disk drives in a daisy-chain manner. To be compatible with the RKV11-D, each RK05 disk drive requires an M7700, Revision J or later, and a back panel, Revision A or later. The M7700 card of each disk drive contains a rotary switch that defines the logical disk DR BUS position. The first disk drive on the DR BUS is normally switched to position 1 and is designated disk drive 0 and so on through disk drive 7. This configuration may be varied as DR BUS length allows. The maximum length of DR BUS is 1524 cm (50 ft). For more information on the disk drive and disk drive system, refer to the RK05 Disk Drive Maintenance Manual (EK-RK5JF-MM-001).

1.4 SPECIFICATIONS

Table 1-2 specifies the RKV11-D parameters in the areas of environmental limits, logic format, timing format, and power requirements and sets forth model designations.

Table 1-2 Specifications

Category	Parameters
Environmental Limits	
DIGITAL Class A Environment:	
Temperature	15°C to 32°C (60°F to 90°F)
Relative Humidity	20% to 80% (no condensation)
Engineering Specifications:	
Temperature	5°C to 50°C (41°F to 122°F)
Relative Humidity	10% to 95% (no condensation)
Input Voltage:	
RKV11-DA	100-127 V rms, 50 ± 1 Hz or 60 ± 1 Hz
RKV11-DB	200-254 V rms, 50 ± 1 Hz or 60 ± 1 Hz
Input Power:	
RKV11-D	140 W maximum
M7269	+5 V @ 1.8 A maximum (9 W)
Format	
Drive Format:	1 disk cartridge/disk drive 203 cylinders/disk drive 2 disk surfaces/disk drive 2 tracks/cylinder 12 sectors/track
Data Word Format:	16-bit data word $256_{10} = 400_8$ data words/sector $3072_{10} = 6000_8$ data words/track $623,616_{10}$ data words/surface $1,247,232_{10}$ data words/disk drive Bit density – approximately 2200 bpi
Recording Method:	Double frequency
Data Transfer Path:	LSI-11 bus DMA

1.5 RELATED DOCUMENTS

These documents pertain to the RKV11-D controller: RK05 Disk Drive Maintenance Manual (EK-RK5JF-MM-001); Microcomputer Handbook (EB-07948-53).

CHAPTER 2
INSTALLATION

2.1 INTRODUCTION

The RKV11-D controller system configuration depends on the number of disk drives used in a particular disk drive system. Each RKV11-D can control up to eight disk drives. Each cabinet contains the power controls for the associated disk drives and all the necessary cabling. For details regarding disk drive installation, refer to RK05 Disk Drive Maintenance Manual (EK-RK5JF-MM-001).

2.2 POWER REQUIREMENTS

The RKV11-D controller has a +5 V power supply positioned in its mounting box. Table 2-1 lists power specifications.

Table 2-1 Power Specifications

RKV11-D Box	
Input voltage:	
RKV11-DA	100–127 V rms, 50 ± 1 Hz or 60 ± 1 Hz
RKV11-DB	200–254 V rms, 50 ± 1 Hz or 60 ± 1 Hz
Input power	140 W maximum
Output power (to RKV11-D modules)	+5 V ± 3%
Output protection	Current is limited to 1.2 times maximum normal rating +5 V is limited to +6.3 V
Output ripple	Less than 150 mV p-p
Line protection	115 V input – 5 A fast blow fuse 230 V input – 2.5 A fast blow fuse
Console	DC ON indicator (under bezel)
Rear panel controls	AC ON/OFF power switch
Backplane signals received from power supply	BPOK H (BUS AC LO L) BDCOK H (BUS DC LO L)
Cooling	Two self-contained fans provide 30 ft^3/min at 200 linear ft/min air flow
M7269 input power	+5 V @ 1.8 A maximum

2.3 CABLING REQUIREMENTS

There is no physical LSI-11 bus between the RKV11-D box and the LSI-11 central processor. Two 120 ohm, 40 conductor flat cables (BC05-L) called the Adapter bus connect the M7268 module in the RKV11-D box to the M7629 module in the LSI-11 box. Both modules contain the mechanical connection points and logic to control this bus.

The DRive BUS connects the RKV11-D to the RK05 disk drives in the system. The cable between the first disk drive and the RKV11-D box consists of a pair of 120 ohm, 40 conductor flat cables (7009026-02). Cabling between each of the RK05s is supplied with each disk drive (BC11-A). The disk control logic on the M7255 module connects through the RKV11-D back panel to the M7268 module which makes the physical connection to the DR BUS (the M7268 itself contains no disk control logic).

2.4 RKV11-D OPTION CONFIGURATIONS

All jumpers are the same as on the RK11-D. For details refer to the Field Maintenance Print Set (MP00223). However, no bus interrupt priority jumper plug is required on the M7254.

2.5 INSTALLATION PROCEDURE

The RKV11-D subsystem can be mounted easily in any 48.260 cm (19 in) rack. The RKV11-D ships in two containers: the small one is shipped inside the larger one. The larger container holds the RKV11-D box and the mounting hardware kit necessary to put the RKV11-D into the cabinet. The kit contains all necessary screws, nuts, and mounting brackets.

The small container holds two modules, two cables, and a module/cable assembly for connection to an LSI-11 system. For module and cable utilization descriptions, refer to the RKV11-D unit assembly drawing (D-UA-RKV11-D-O).

A standard 48.260 cm (19 in) rack has a pattern of holes spaced 1.270 cm and 1.588 cm (1/2 in and 5/8 in). The pattern repeats itself every 4.4450 cm (1-3/4 in) (Figure 2-1).

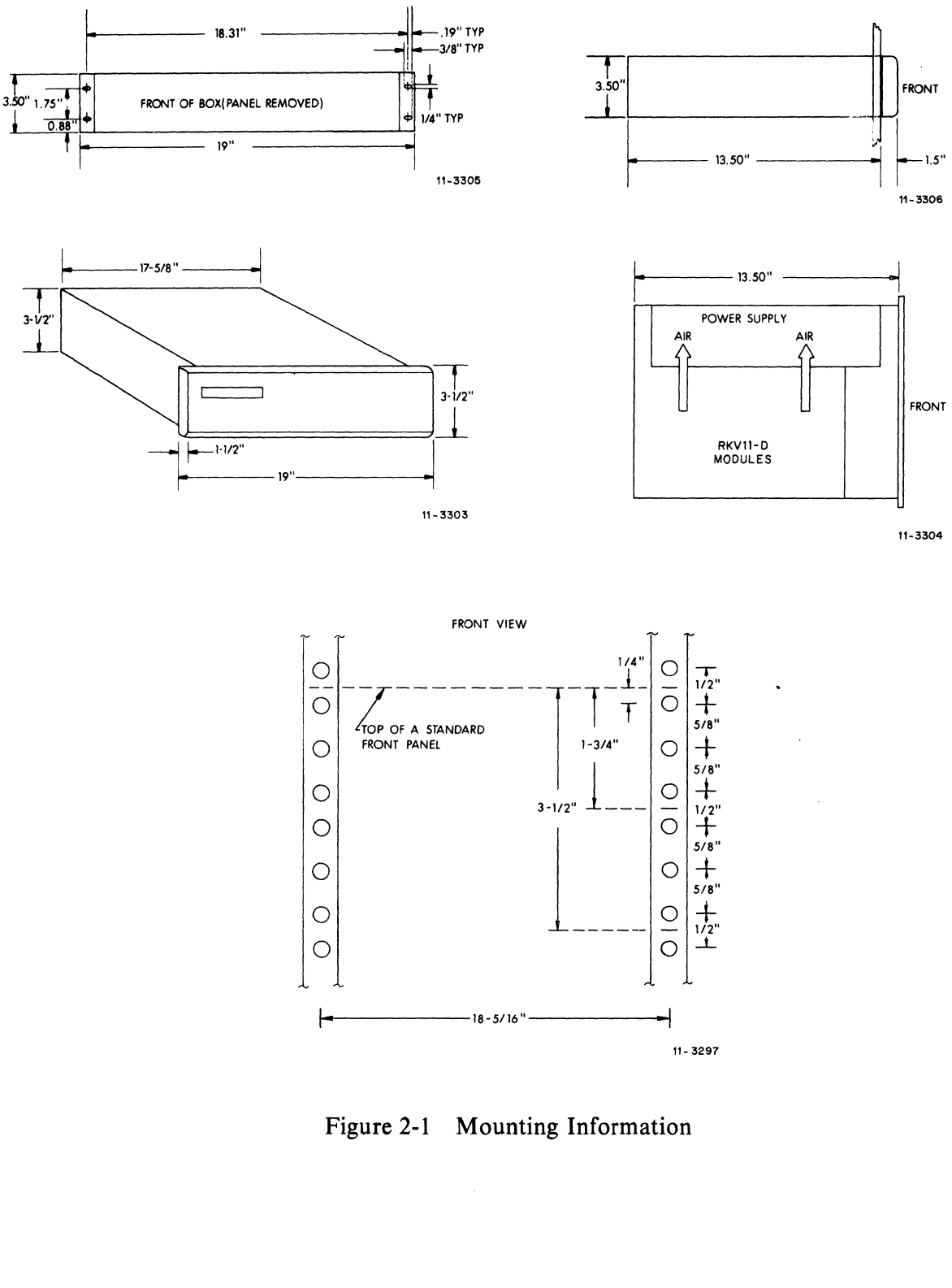


Figure 2-1 Mounting Information

2.6 INSTALLATION TESTING

To ensure that the RKV11-D system is properly installed and operational, installation testing is performed by running the diagnostic programs listed in Table 2-2. If performance of these tests fails to reveal errors, assume that the RKV11-D is operational and that it has been correctly installed. These diagnostics are supplied with the RKV11-D. Instructions and descriptions regarding their use are supplied to each field office on microfiche. Hard copies are available through the Software Distribution Center, Digital Equipment Corporation, Maynard, MA 01754.

Table 2-2 Diagnostic Programs

Title	Number
RK11 Performance Exercisor	MD-11-DZRKH-F-PB
RK11 Utility Package	MD-11-DZRKI-D-PB
RK11 Basic Logic Test I	MD-11-DZRKJ-D-PB
RK11 Basic Logic Test II	MD-11-DZRKK-D-PB
RK11/RK05 Dynamic Test	MD-11-DZRKL-D-PB

2.6.1 Procedure

Use a scratch pack to ensure that the RK05 can be safely powered-up and that the heads can be successfully loaded. All RK05s should be properly installed and adjusted prior to testing the RKV11-D. The "oscillating seek" program may be used to assist in performing a head alignment. Refer to Toggle Routines, Paragraph 2.6.1.1.

Diagnostics may be loaded into the LSI-11 from the RKDP pack if available. If not available or if the RKV11-D requires repair, then the diagnostics may be loaded into the LSI-11 via a PRS01 paper tape reader.

If the system contains an REV11 bootstrap module, the RKDP pack may be booted upon the application of power to the system. If the system does not contain an REV11 bootstrap or if the bootstrap is defective, the "boot" routine may be used to boot the RKDP pack. See Toggle Routines, Paragraph 2.6.1.1.

To be acceptable, the RKV11-D must run error free (use a scratch pack):

Two passes	RK11 Basic Logic Test I
Two passes	RK11 Basic Logic Test II
One pass	RK11 Performance Exercisor.

All customer system software should also be verified as a part of installation testing.

2.6.1.1 Toggle Routines – These routines aid installation and maintenance testing. They are loaded into the LSI-11 using the hardware ODT microcode, allowing the use of the operator console instead of the traditional console switch panel normally associated with larger PDP-11 central processors. The hardware ODT microcode automatically begins execution when the LSI-11 is halted, either under program control or by momentary assertion of the HALT switch mounted on the LSI-11 processor box. A detailed description of hardware ODT commands is contained in the Microcomputer Handbook (EB-07948-53).

Oscillating Seek Program – This program aids in checking servo signals and performing head alignment. Load the program into memory using the hardware ODT feature and select the desired drive, cylinder, and surface addresses. The program will then cause the drive to seek back and forth between the cylinder addresses contained in the high and low bytes of R0. If both bytes of R0 contain the same cylinder address, the drive will stay at that cylinder.

Equivalent Track Addresses

Decimal	Octal
0	0
4	4
64	100
85	125
105	151
125	175
202	312

```
;R0 = two cylinder addresses, one in each byte
;R1 = 177404 (RKCS address)
;R2 = drive number in bits 15, 14, 13; surface number in bit 4; all others are zero.

001000  000005  START:  RESET
001002  010003  LOOP:   MOV     R0, R3          ; R3=cylinder address
001004  042703          BIC     #377,R3         ; mask for single address
001006  000377
001010  000241          CLC
001012  006003          ROR     R3
001014  006003          ROR     R3              ; position address
001016  006003          ROR     R3
001020  010361          MOV     R3,6(R1)        ; load cylinder address
001022  000006
001024  050261          BIS     R2,6(R1)        ; load drive, surface address
001026  000006
001030  012711          MOV     #11,(R1)        ; load SEEK & GO
001032  000011
001034  105711  1$:     TSTB    (R1)
001036  100376          BPL     1$              ; await ready
001040  032737          BIT     #100,RKDS       ; await R/W/S RDY
001042  000100
001044  177400
001046  001774  2$:     BEQ     2$
001050  000300          SWAB    R0              ; position second address
001052  000753          BR      LOOP
```

RK Boot Program – Use this program to boot an operating system from any RK05 when the system does not contain a hardware bootstrap module or contains a defective bootstrap module.

```
;R0 = drive number in bits 15, 14, 13; all others are zero.
;R1 = 177404 (= RKCS Address)

001000    000005    START:    RESET
001002    010061              MOV       R0,6(R1)      ; load RKDA
001004    000006
001006    012761              MOV       #-256,2(R1)   ; load RKWC = -256
001010    177400
001012    000002
001014    012711              MOV       #5,(R1)       ; load READ & GO
001016    000005
001020    105711    1$:       TSTB      (R1)          ; test ready
001022    100376              BPL       1$            ; await ready
001024    005007              CLR       PC            ; force PC to absolute zero
```

Format Program – This program allows the user to format an unformatted disk on any disk pack in the system. Any information formerly contained on the disk is lost, and the entire disk is filled with the contents of memory address 000000. When the program halts, check the contents of the RKER register (177402). It will contain 000100 if the format was successfully completed. If this register contains any other data, the format did not complete successfully.

```
;R0 = drive number in bits 15, 14, 13; all others are zero.
;R1 = 177404 (= RKCS)

001000    000005    START:    RESET
001002    010061              MOV       R0,6(R1)      ; RKDA = drive number
001004    000006
001006    005161    LOOP:     COM       2(R1)         ; RKWC = -1
001010    000002
001012    012711              MOV       #6003,(R1)    ; load write format, IBA + GO
001014    006003
001016    105711              TSTB      (R1)          ; ready?
001020    100376    1$:       BPL       1$            ; await ready
001022    005711              TST       (R1)          ; error?
001024    100370              BPL       LOOP          ; if not, LOOP
001026    000000              HALT
```

CHAPTER 3
PROGRAMMING CONSIDERATIONS

3.1 INTRODUCTION

This chapter discusses the software interface for the RKV11-D controller, including device registers and their addresses, the interrupt process, timing considerations, and data format.

3.2 DEVICE REGISTERS AND ADDRESSES

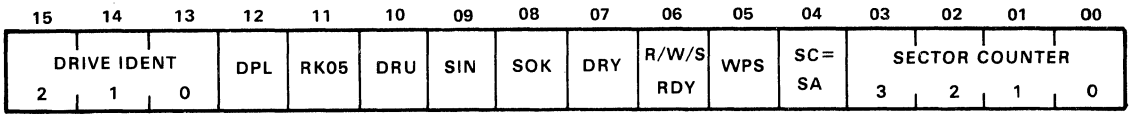
All RKV11-D software control is accomplished by seven device registers. These registers are assigned memory addresses and can be read or written into (except as noted), using instructions that refer to the respective register addresses. The seven device registers, their bit assignments, and their memory addresses are presented on the following pages. Unassigned and write-only bits are always read as zeros. Any attempt to manipulate unassigned or read-only bits has no effect on the bit (except as noted). The INIT signal refers to the initialization signal issued by the processor.

3.2.1 Drive Status Register (RKDS)

Address = 177400

NOTE

This register is a read-only register and contains the selected drive status and current sector address.



CP-3137

Bit	Designation	Description and Operation
00-03	Sector Counter (SC)	These four bits are the current sector address of the selected drive. Sector address 00 is defined as the sector following the sector that contains the index pulse.
04	Sector Counter Equals Sector Address (SC = SA)	Indicates that the disk heads are positioned over the disk address currently held in the Sector Address Register.
05	Write Protect Status (WPS)	Sets when the selected disk is in the write-protected mode.

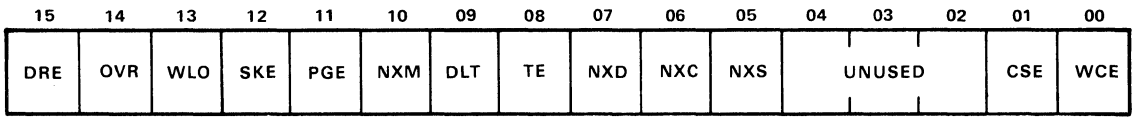
Bit	Designation	Description and Operation
06	Read/Write/Seek Ready (R/W/S RDY)	Indicates that the selected drive head mechanism is not in motion and that the drive is ready to accept a new function.
07	Drive Ready (DRY)	Indicates that the selected disk drive complies with the following conditions: a. The drive is properly supplied with power. b. The drive is loaded with a disk cartridge. c. The disk drive door is closed. d. The LOAD/RUN switch is set to RUN. e. The disk is rotating at a proper speed. f. The heads are loaded properly. g. The disk is not in a DRU (bit 10 of RKDS) condition.
08	Sector Counter OK (SOK)	Indicates that the Sector Counter operating in the selected drive is not in the process of changing and is ready for examination. If this bit is not set, the Sector Counter is not ready for examination, and a second attempt should be made.
09	Seek Incomplete (SIN)	Indicates that due to some unusual condition, a Seek function cannot be completed. Can be accompanied by RKER 15 (Drive Error). Cleared by a Drive Reset function.
10	Drive Unsafe (DRU)	Indicates that an unusual condition has occurred in the disk drive, and it is unable to properly perform any operations. Reset by setting the RUN/LOAD switch to LOAD. If—when the switch is returned to run—the condition recurs, an inoperative drive can be assumed, and corrective maintenance procedures should begin. Can be accompanied by RKER 15 (Drive Error).
11	RK05 Disk on Line (RK05)	Always set, to identify the selected disk drive as RK05.
12	Drive Power Low (DPL)	Sets when an attempt is made to initiate a new function or if a function is actively in process when the control senses a loss of power to one of the disk drives. Can be accompanied by RKER 15 (Drive Error). Reset by a BUS INIT or a Control Reset function.

Bit	Designation	Description and Operation
13-15	Identification of Drive (ID)	If an interrupt occurs as the result of a hardware poll operation, these bits will contain the binary representation of the logical drive number that caused the interrupt.

3.2.2 Error Register (RKER)

Address = 177402

NOTE
This is a read-only register.



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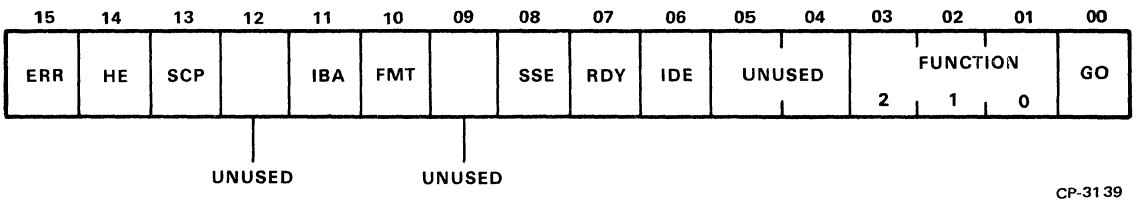
Bit	Designation	Description and Operation
00	Write Check Error (WCE)	Indicates that an error was encountered during a Write Check function as a result of a faulty bit comparison between disk data and memory data. Clears upon the initiation of a new function. This is a soft error condition.
01	Checksum Error (CSE)	Sets while performing a Read Check or a Read function as a result of a faulty recalculation of the checksum. Cleared upon the initiation of any new function. This is a soft error condition.
02-04	Unused	

The remaining bits of the RKER are all hard errors and are cleared only by a BUS INIT or a control reset function.

05	Nonexistent Sector (NXS)	Indicates that an attempt was made to initiate a transfer to a sector address greater than 13_8.
06	Nonexistent Cylinder (NXC)	Indicates that an attempt was made to initiate a transfer to a cylinder address greater than 312_8.
07	Nonexistent Disk (NXD)	Indicates that an attempt was made to initiate a function on a nonexistent drive.
08	Timing Error (TE)	Indicates that a loss of timing pulses for at least 5 μs has been detected.
09	Data Late (DLT)	Sets during a Write or Write Check function when the multibuffer file is empty, and the operation is not yet complete. Sets during a Read function when the multibuffer file is filled, and the operation is not yet complete.

Bit	Designation	Description and Operation
10	Nonexistent Memory (NXM)	Sets if memory does not respond with a RPLY within 20 μs of the time when the RKV11-D becomes bus master during a DMA sequence. Because of the speed of the RK05 disk drive, it is possible that NXM will be accompanied by RKER 09 (Data Late).
11	Programming Error (PGE)	Indicates that RKCS 10 (Format) was set while initiating a function other than Read or Write.
12	Seek Error (SKE)	Sets if the disk head mechanism is not properly positioned while executing a normal Read, Write, Read Check, or Write Check function. The control checks 16 times before flagging this error. A simple jumper change will force the control to check just once.
13	Write Lockout Violation (WLO)	Sets if an attempt is made to write on a disk that is currently write-protected.
14	Overrun (OVR)	Indicates that, during a Read, Write, Read Check, or Write Check function, operations on sector 13_8, surface 1, of cylinder address 312_8 were finished; and the RKWC has not yet overflowed. This is essentially an attempt to overflow out of a disk drive.
15	Drive Error (DRE)	Sets if a function is either initiated or in process, and a. One of the drives in the system senses a loss of either ac or dc power; or b. The selected drive is not ready or is in some error condition.

3.2.3 Control Status Register (RKCS)
Address = 177404



Bit	Designation	Description and Operation
00	GO (Write Only)	This bit can be loaded by the operator and causes the control to carry out the function contained in bits 01-03 of the RKCS (Function). Remains set until the control actually begins to respond to GO, which may take from 1 μs to 3.3 ms, depending on the current operation of the selected disk drive (to protect the format structure of the sector).
01-03	Function (Read/Write)	The Function register or function bits are loaded with the binary representation of the function to be performed by the control when a GO command is initiated. These bits are loaded by the program and cleared by BUS INIT. A description of each of the eight functions is given in Paragraph 1.2.2. The binary codings are as follows:

Bit 2	Bit 1	Bit 0	Operation
0	0	0	Control Reset
0	0	1	Write
0	1	0	Read
0	1	1	Write Check
1	0	0	Seek
1	0	1	Read Check
1	1	0	Drive Reset
1	1	1	Write Lock

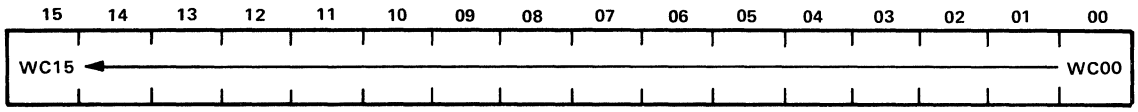
04, 05	Unused	NOTE: The RK11-D uses these bits as extended address bits. Since the 11/03 BUS structure has no provision for extended addressing, no connection is made to the bus from these bits on the RKV11-D. They will respond as two unused READ/WRITE bits in the status register; but like the RK11-D, they will increment should the RKBA overflow.

Bit	Designation	Description and Operation
06	Interrupt on Done Enable (IDE) (Read/Write)	When set, causes the control to issue a bus request and interrupt to vector address 220 if: a. A function has completed activity. b. A hard error is encountered. c. A soft error is encountered and bit 08 of the RKCS (SSE) is set. d. RKCS 07 (RDY) is set, and GO is not set.
07	Control Ready (RDY) (Read Only)	Indicates that the control is ready to perform a function. Set by INIT, a hard error condition, or by the termination of a function. Cleared by GO being set.
08	Stop on Soft Error (SSE) (Read/Write)	If a soft error is encountered when this bit is set: a. All control action will stop at the end of the current sector if RKCS 06 (IDE) is reset, or b. All control action will stop, and a bus request will occur at the end of the current sector if RKCS 06 (IDE) is set.
09	Unused	
10	Format (FMT) (Read/Write)	FMT is under program control and must be used only in conjunction with normal Read and Write functions. Used to format a new disk pack or to reformat any sector erased due to control or drive failure. Alters the normal Write operation, under which the header is rewritten each time the associated sector is rewritten, in that the head positioner is not checked for proper positioning before the Write. Alters the normal Read operation in that only one word, the header word, is transferred to memory per sector. For example, a three-word Read function in format mode will transfer header words from three consecutive sectors to three consecutive memory locations for software checking.
11	Inhibit Incrementing the RKBA (IBA) (Read/Write)	Inhibits the RKBA from incrementing during a normal transfer function. This allows data transfers to occur to or from the same memory location throughout the entire transfer operation.

Bit	Designation	Description and Operation
12	Unused	
13	Search Complete (SCP) (Read Only)	Indicates that the previous interrupt was the result of some previous Seek or Drive Reset function. Cleared at the initiation of any new function.
14	Hard Error (HE) (Read Only)	Sets when any of RKER 05-15 are set. Stops all control action, and processor reaction is dictated by RKCS 06 (IDE)—until cleared, along with RKER 05-15, by INIT or a Control Reset function.
15	Error (ERR) (Read Only)	Sets when any bit of the RKER sets. Processor reaction is dictated by RKCS 06 and RKCS 08 (IDE and SSE). Cleared if all bits in the RKER are cleared.

3.2.4 Word Count Register (RKWC)

Address = 177406



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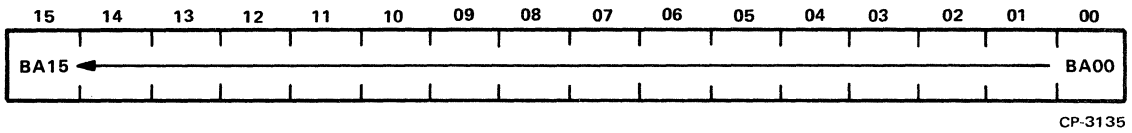
Bit	Designation	Description and Operation
00-15	WC00-WC15 (Read/Write)	The bits in this register contain the 2's complement of the total number of words to be affected or transferred by a given function. The register increments by one after each word transfer. When the register overflows (all WC bits go to zero), the transfer is complete and RKV11-D operation is terminated at the end of the present disk sector. However, only the number of words specified in the RKWC are transferred.

3.2.5 Current Bus Address Register (RKBA)
Address = 177410

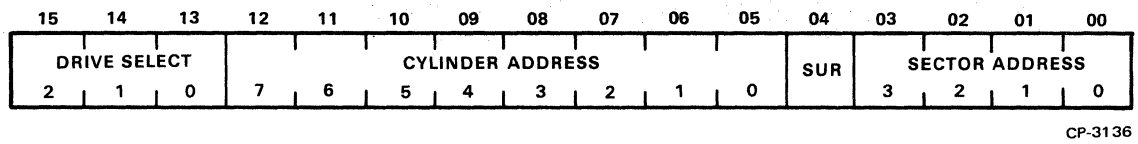


Bit	Designation	Description and Operation
00-15	BA00-BA15 (Read/Write)	The bits in this register contain the bus address to or from which data will be transferred. The register is incremented by two at the end of each transfer.

3.2.6 Disk Address Register (RKDA)
Address = 177412

NOTE

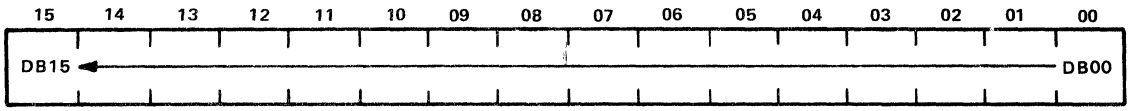
This register will not respond to commands while the controller is busy. Therefore, RKDA bits are loaded from the bus data lines only in the Control Ready (RDY - bit 07 of the RKCS) state and are cleared by BUS INIT and Control Reset. The RKDA is incremented automatically at the end of each disk sector.



Bit	Designation	Description and Operation
00-03	Sector Address (SA)	Binary representation of the disk sector to be addressed for the next function. The largest valid address (or number) for the sector address is 13_8.
04	Surface (SUR)	When active, enables the lower disk head so that operation is performed on the lower surface; when inactive, enables the upper disk head.
05-12	Cylinder Address (CYL ADDR)	Binary representation of the cylinder address currently being selected. The largest valid address or number for the cylinder address is 312_8.
13-15	Drive Select (DR SEL)	Binary representation of the logical drive number currently being selected.

3.2.7 Data Buffer Register (RKDB)

Address = 177416



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Bit	Designation	Description and Operation
00-15	DB00-DB15 (Read Only)	The bits of this register work as a general data handler in that all information transferred between the control and the disk drive must pass through this register. Loaded from the bus only while the RKV11-D is bus master during a DMA sequence.

NOTE
Address 177414 is unused.

3.3 DATA FORMAT

Data is stored on the disk cartridge in groups of 12 sectors per track. Each of the 12 disk sectors contains 256_{10} words and is defined by physical sector marks. These sector marks generate a sector pulse that is passed from the disk drive to the controller. Another similar physical disk mark, called an index mark, defines the starting point for the sequence of sectors. The sector which follows a sector containing the index mark is defined as sector 0. All of the sectors are formatted identically in five parts: preamble (terminated with a sync bit), header, data, checksum, and postamble.

PREAMBLE	SYNC BIT	HEADER	DATA	CHECKSUM	POSTAMBLE
15_8 WORDS OF ZEROES	"1"	CYLINDER ADDRESS (1 WORD)	256_{10} (400_8) WORDS	SECTOR CHECKSUM (1 WORD)	1 WORD OF ZEROES

CP-3133

The preamble and postamble areas of a sector serve as boundaries before and after the information major states (header, data, and checksum) to ensure compatibility between disk drives. (Refer to the *RK05 Disk Drive Maintenance Manual, EK-RK5JF-MM-001.*)

The preamble consists of 15_8 words of zeros, adequate to guarantee that RD GATE will turn on during a known zero data field under all conditions. The disk drive head then waits for the first "1" to occur (sync bit) and begins to read with the header word. During a Write function, the sync bit is automatically written by hardware following the 15_8 words of zeros.

The header area of a sector consists of a single word containing the cylinder address from RKDA 05–12. Before a data transfer function is performed, the header word is read and checked against the cylinder address portion of the RKDA to ensure that the disk drive heads are positioned at the proper cylinder. The Write function always rewrites the header on the disk, using the cylinder address portion of the RKDA. The sector format for a raw (unformatted) cartridge is written under program control in conjunction with RKCS 10 (FMT) (refer to Paragraph 3.2.3).

The data area consists of 256_{10} data words. These words, like all of the words in each area of the sector, are 16 bits long.

The checksum area of a sector consists of a single word that is the checksum of all 256 data words. For a Write function, the controller calculates a checksum and writes it on the disk cartridge following the last data word. This checksum is compared by the controller to the checksum that it calculates whenever a Write Check, Read, or Read Check function is performed within a given sector.

Short portions (less than 256 data words) of a sector may be read or written as long as this short sector is the last sector of the data transfer. When a short sector is written, the remainder of the sector is automatically written with zeros. The Write Check function may be performed on a short sector as long as the number of words write checked is equal to the number of words previously written into the sector. Because the Read Check function is essentially a parity check, it must be performed on a whole-sector basis only.

3.4 PROGRAM INTERRUPTS

A program interrupt is initiated by an interrupt request, which can only occur if RKCS 06 (IDE) is set. Six hardware conditions can generate an interrupt request to the processor:

1. The occurrence of a hard error condition RKCS 14 (HE).

2. The presence of a soft error condition RKCS 08 (SSE) is set and either RKER 00 (WCE) or RKER 01 (CSE).

3. Completion of transfer of the designated number of words.

4. The acceptance (Address Acknowledge) of a Seek or Drive Reset function by the selected disk drive, freeing the controller for hardware polling or a new function.

5. The initiation of a Write Lock function on a disk drive, indicating that the controller is free to perform a new function.

6. The completion of hardware polling (RKCS 13 - SCP), indicating that the disk drive in the DRIVE ID bits of the RKDS has completed a Seek or Drive Reset function (RKDS 06 - R/W/S RDY).

The interrupt request level of the RKV11-D controller is determined by the physical position of the controller on the LSI-11 bus. The DMA device closest to the LSI-11 processor is usually the Memory Refresh module REV11 (DIGITAL Part No. M9400-YA), and, like all DMA devices, the RKV11-D controller must be connected to the LSI-11 bus after the REV11.

Because of the format structure of the RKV11-D, any interruption of the Write function cannot be tolerated until the end of the current sector, as it would result in what would be essentially an unformatted disk cartridge. As a result, outside intervention is inhibited until the current sector is completed, including Control Reset functions and processor initialize (BUS INIT) signals. This means that such functions as Control Reset, Seek, and Write Lock, which take only a few microseconds to initiate, can take as long as 3.3 ms if initiated during a Write function. For this reason, Seek, Drive Reset, and Write Lock functions cause an interrupt as soon as the function is initiated, provided that RKCS 06 (IDE) is set.

3.5 TIMING CONSIDERATIONS

RKV11-D timing is a consideration in the performance of overlapping Seek or Drive Reset functions, because these functions can be initiated on free disk drives while previous Seek or Drive Reset functions are in process on other disk drives. Thus, up to eight disk drives can be performing a Seek or Drive Reset function simultaneously. The hardware poll logic of the disk control module generates an interrupt when a disk drive has completed the Seek or Drive Reset function (RKDS 06 – R/W/S RDY set). When a Seek or Drive Reset function has been initiated on the disk drive (Address Acknowledge), an interrupt request occurs if RKCS 06 (IDE) is set. This process normally requires 1 μs but may range up to 3.3 ms, if an attempt is made to abort a Write function. Head movement, however, may take as long as 80 ms, after which a second interrupt (RKCS 13 – Search Complete) occurs (if IDE is set). In the interval between these two events, the selected disk drive is busy moving its heads, but the controller is free to perform any RKV11-D function on any other available disk drive. Once a disk drive has begun moving its head mechanism, only a Drive Reset function can stop it. An attempt to perform any other function on a disk drive whose heads are in motion results in a hard error condition.

The data transfer functions (Read, Write, Read Check, and Write Check) all begin with an automatic "implied" Seek. This allows the user of a single disk drive system to ignore the Seek function completely and initiate data transfer functions directly. The hardware poll logic is initiated only for Seek and Drive Reset functions and not for the "implied" Seek portion of data transfer functions.

3.6 POWER FAIL

An RKV11-D system contains a number of power supplies, each with its own circuitry for detection of a power failure:

1. The central processor and other computer-related supplies
2. The RKV11-D box
3. The RK05 disk drives.

If the power to the entire system is interrupted, a variety of events can occur depending on which of the system supplies first senses a power loss, the worst of which is the abortion of the function currently in process in the RKV11-D. Also, if a Write function was in process at the time of the failure, the sector being written at the time of the power loss may contain erroneous but readable data. All of the RK05 drives will unload their heads, and no data or format on any disk drive will be lost.

If one or more of the computer-related supplies should malfunction, the program being executed is interrupted and a power down sequence occurs in the computer. The result is the same as a system power failure except that the RK05 disk drives do not unload their heads. No data or format on any disk drive will be lost.

If the RKV11-D power supply malfunctions, the result is the same as a system power failure except that the computer and its parts will continue to operate. Because no dc power is available to the RKV11-D, no interrupt or error condition will occur to notify the computer that a failure has occurred. In most cases the RKV11-D controls the system disk, and this sort of malfunction would "hang" the software in the computer. The same unreportable error occurs if any of the computer-related power supplies has a similar malfunction.

An RKV11-D power supply malfunction is easily identified both physically and logically. Physically the "DC ON" LED on the power supply console will extinguish, and all the disk drives will unload their heads. Logically, all RKV11-D addressable registers contain all zeros.

If any of the RK05 disk drives senses a loss of ac or dc power, no new functions can be initiated. If an ac power loss is sensed and a function is in progress, the current sector will finish properly, and the next sector pulse will unload the heads—setting bit 15 RKER (DRE). If a malfunction occurs and a dc power loss occurs, the function is aborted; and—if writing—the sector being written may be logically damaged and in need of reformatting before it can be used again. Bit 15 RKER (DRE) and bit 12 RKDS (DPL) are set.

Reader's Comme

RKV11-D Disk Drive Controller
User's Manual
EK-RKV11-OP-001

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