Honeywell

REMOVABLE DISK SUBSYSTEMS PROGRAMMING MANUAL

SYSTEM 700

SUBJECT:

Functional Characteristics and Programming and Operating Procedures for the System 700 Removable Disk Subsystems.

SPECIAL INSTRUCTIONS:

This revision completely supersedes the edition dated January 1972. Since this edition of the manual has been extensively revised and rewritten, marginal change bars and asterisks have not been used. The Type 4623 Removable Disk Subsystem has been deleted from this new revision and the Types 4710, 4740, 4741, 4742, and 4743 Removable Disk Subsystems have been added.

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PREFACE

This manual describes programming considerations for the Types 4710, 4740, 4741, and 4742 10-Surface, Single-Spindle Removable Disk Subsystems and the Types 4720 and 4743 20-Surface, Single-Spindle Removable Disk Subsystems. These devices are used in System 700 installations. They share the same control unit design and are programmed in a similar manner.

The first section is an introduction to System 700 Removable Disk Subsystems. The second section provides a functional description. Section III includes the necessary programming information. Sections IV and V cover controls and indicators. Operating procedures and programming examples are provided in Section VI.

It is assumed that the reader has a basic familiarity with System 700 assembly language programming and has read the System 700 Programmers' Reference Manual, Order Number AC72, and the OS/700 Systems Manual, Order Number AG02.

File No.: 1903

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SECTION I
SYSTEM 700 REMOVABLE DISK SUBSYSTEMS

The System 700 Removable Disk Subsystems provide users with a wide choice in the selection of needed storage capacities and speeds. Removable disk subsystems available for System 700 configurations are the Types 4710, 4720, 4740, 4741, 4742 and 4743. Figure 1-1 illustrates a typical disk pack drive.

The System 700 Removable Disk Subsystems have data storage capacities ranging from 1.1 million 16-bit words (2 million bytes) to 30.0 million 16-bit words (60 million bytes).

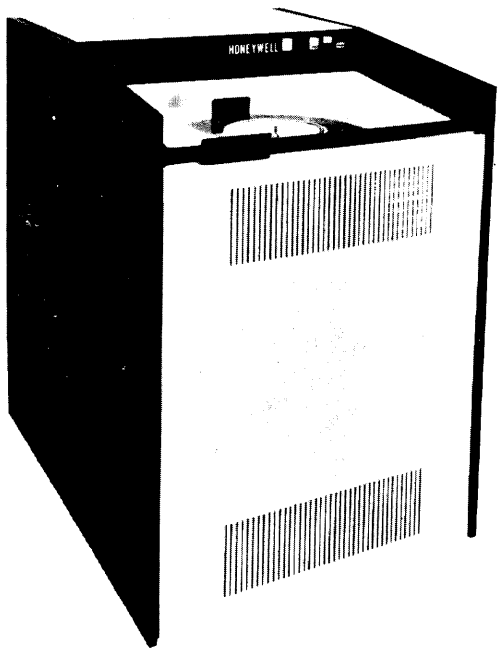


Figure 1-1. System 700 Single-Spindle Removable Disk Subsystem

TEN-SURFACE REMOVABLE DISK SUBSYSTEMS

The Types 4710, 4740, 4741, and 4742 are 10-surface removable disk subsystems that use the M4005 disk pack. The Type 4710 subsystem has a basic capacity of 1.1 million words and is expandable to 7.5 million words via Features 4715, 4716, and 4717. The Type 4740 subsystem has a basic capacity of 1.1 million words and is expandable to 4.4 million words via the addition of up to three Type 4750 disk drives. The Type 4741 subsystem has a basic

capacity of 1.8 million words and is expandable to 7.5 million words via the addition of up to three Type 4751 disk drives. The Type 4742 subsystem has a basic capacity of 3.7 million words and is expandable to 15.0 million words via the addition of up to three Type 4752 disk drives.

TWENTY-SURFACE REMOVABLE DISK SUBSYSTEMS

The Types 4720 and 4743 are 20-surface removable disk subsystems that use the M4007 disk pack. The Type 4720 subsystem has a basic capacity of 7.5 million words and is expandable to 30.0 million words via the addition of up to three Type 4721 drives. The Type 4743 subsystem has a basic capacity of 7.5 million words and is expandable to 30.0 million words via the addition of up to three Type 4753 disk drives.

OPERATIONAL CHARACTERISTICS

Each disk pack drive has an access mechanism consisting of 5 or 10 arms, with a pair of read/write heads mounted on the end of each arm. All arms move linearly and simultaneously in a horizontal direction to gain access to the recording tracks. In multidrive systems, while one drive is performing either a read or write operation, the other drives are capable of performing seek operations.

The track-to-track positioning time, of great importance in sequential processing, is 20 milliseconds (minimum) for all of the subsystems. The maximum seek time for the Types 4710 and 4720 is 110 milliseconds and for the Types 4740, 4741, 4742, and 4743 is 135 milliseconds. Average latency time, rotational delay, is 12.5 milliseconds and common to all subsystems.

The recording medium is a removable disk pack containing 6- or 11-disks each. A disk pack is mounted on a single-spindle that rotates at 2400 revolutions per minute. The 6-disk pack (M4005) provides 10 recording surfaces; the 11-disk pack (M4007) provides 20 recording surfaces.

ERROR CHECKING

The validity of recorded information is ensured by the insertion of a 16-bit "check word" in each record. This check character is automatically calculated by the control during a write operation. When reading is performed, the check character is recalculated by the control and compared to the recorded check character. If the codes are not identical, bits are set in the status word that can be tested by the program.

FEATURES

Some of the outstanding capabilities available with the System 700 removable disk subsystems are outlined below:

- Removable disk packs allow disk drives to operate with different packs as on-line systems requirements change.
- Direct seek is standard. This permits track-to-track head movement without returning to the base position.
- A seek-complete interrupt prevents loss of processing time during the seek operation.
- Up to four disk pack drives can be connected, permitting modular expansion of the system.
- Variable track formats permit the storage of records of variable length.
- A write-lockout capability protects the areas of bulk storage.
- Central-processor-finished indication permits on-line disk pack removal in multidrive systems.

SECTION II
FUNCTIONAL DESCRIPTION

The information described herein covers the operational and physical characteristics of the disk drives, including head movement operations, record format, multiplexer channels, and interrupt operations.

SEEK OPERATIONS

Seek operations move the head assembly to a specific track on the disk pack. Upon execution of a seek command, a control word is sent to the control unit, which specifies the unit, direction, and track number. The head assembly begins to move as directed, increasing its speed rapidly.

The completion of a seek command causes the control to generate an interrupt signal that is sent to the common interrupt line to inform the processor that the spindle is ready on the desired track.

When used in a multidrive system, access time can be minimized by allowing simultaneous seek operations on all units. An interrupt will be generated for each spindle as its operation is completed.

READ/WRITE OPERATIONS

Read/write operations are initiated by a pair of control words that are transferred to the control to designate the desired spindle head and record address. Since the disk pack drive is designed to permit the storage of records of variable length, a format-generation procedure is required to place record addresses on the track as needed. This is accomplished by means of a subroutine. Once the format of a track has been set, it can be changed only by regenerating the format for the entire track.

An Output Control Pulse (OCP) command is executed to select the multiplexer mode of data transfer. This is followed by a normal setup procedure in which two control words are transferred to the direct interface, prescribing the appropriate address and number of words to be transferred. Thereafter, the data is directed between the memory and the specified spindle, while the memory is shared by both the central processor and the direct interface.

The action is identical regardless of the direction of the data transfer. When the required number of words have been transferred, an interrupt signal is generated and sent to the processor. This interrupt can be enabled or disabled under program control.

The following OCP instructions require the use of setup words. See Section III for these instructions with their associated setup word(s).

- Seek Track Zero
- Direct Seek
- Read Current Address
- Central Processor Finished
- Write Track Format
- Read/Write Record

STORAGE CAPACITY

The storage capacity of a disk pack depends on the format chosen for the tracks. Each track can be formatted for 1 to 103 records. The maximum capacity of a track is 1891 words in 1 record. The 16.5-word overhead and the timing tolerance (5% gap) associated with each record reduces the net storage capacity as more records are formatted.

Table 2-1 shows the comparative storage capacities of the various subsystems.

NOTE: The Type 4710 and 4720 subsystems have a faster access time than the rest.

DISK DRIVE ASSEMBLY

The 10 or 20 read/write heads of the access mechanism are oriented in a vertical line (see Figure 2-1). For this reason, at any position, 10 or 20 tracks are available for reading or writing. Each disk surface (see Figure 2-2) has 200 recording tracks (the corresponding tracks on each surface together constitute a "cylinder"). The drive detects the beginning of all tracks by sensing one physical index mark on the disk pack hub. Each track is divided into records in a format defined by the user. The fields within a record are described further on.

Table 2-1. Comparative Characteristics of System 700 Removable Disk Subsystems

Capacity (MW) \ Type	4710	4720	4740	4741	4742	4743
1.1	BASIC		BASIC			
1.8	with feature 4715			BASIC		
2.2			with (1) 4750			
3.3			with (2) 4750			
3.7	with features 4715 and 4716			with (1) 4751	BASIC	
4.4			with (3) 4750			
5.4				with (2) 4751		
7.5	with features 4715, 4716, 4717	BASIC		with (3) 4751	with (1) 4752	BASIC
11.1					with (2) 4752	
15.0		with (1) 4720			with (3) 4752	with (1) 4753
22.5		with (2) 4720				with (2) 4753
30.0		with (3) 4720				with (3) 4753

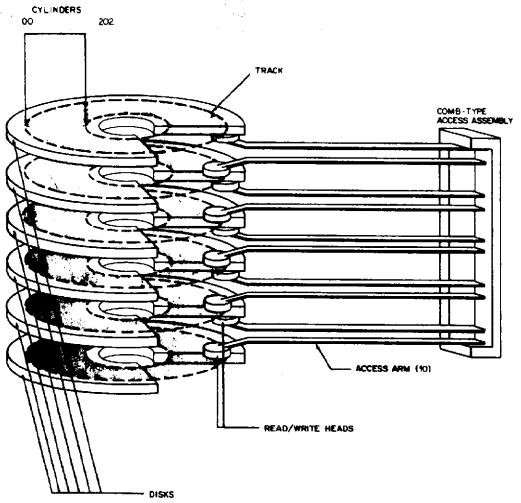


Figure 2-1. Disk Drive Assembly (10-surface)

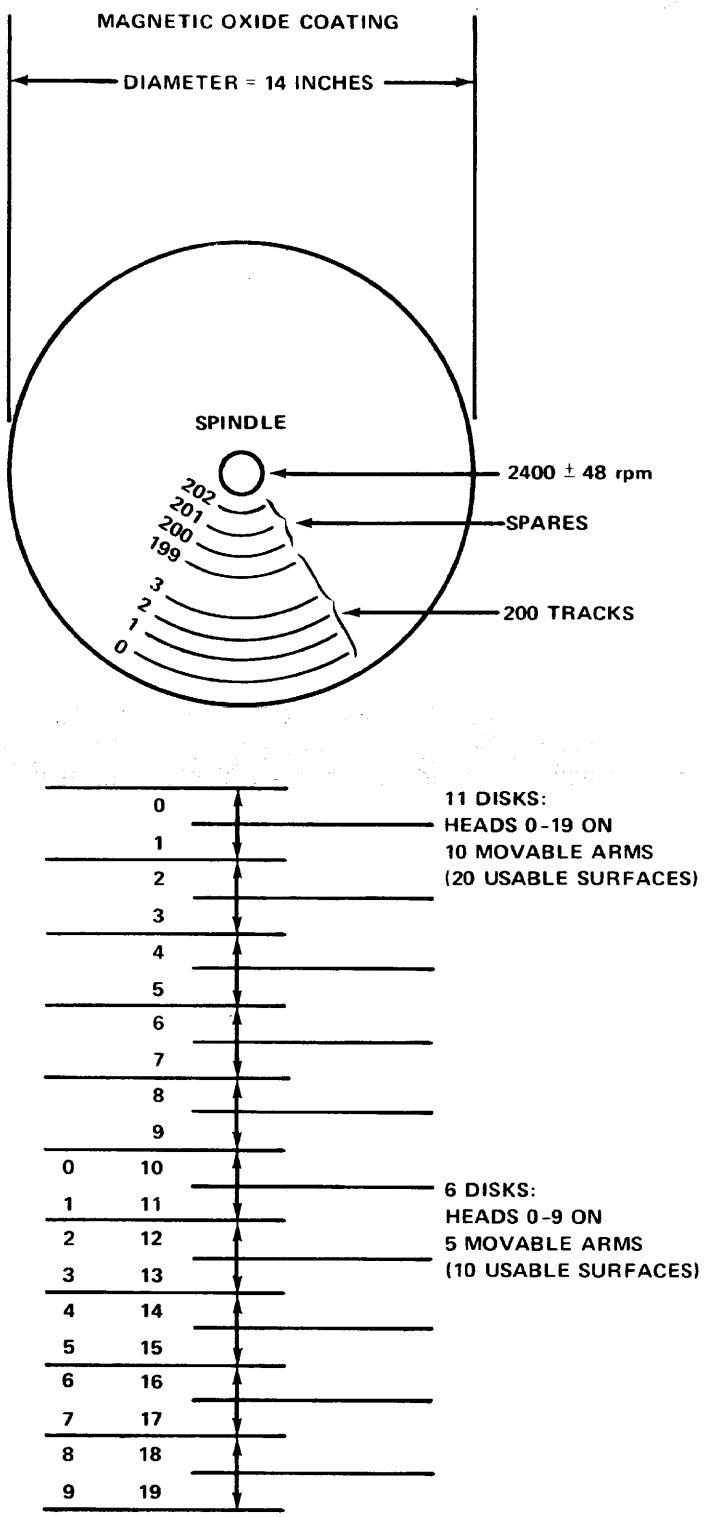


Figure 2-2. Physical Organization of M4005 and M4007 Disk Packs

TRACK FORMAT AND GAP

Figure 2-3 shows the track format. Information is recorded on the disk in a serial bit stream.

Field A is a 64-bit field which allows for jitter in detection of the index mark. This field is recorded only before the first record of the track. Fields B, E, and K are 64-bit fields which allow for the distance between the erase head and the read/write head. Fields C, F, and J are special fields also used internally. Field D is the address, which is a 24-bit field with the first 8 bits ignored; the remaining 16 bits contain a program-assigned address for each record. Field G contains the data of the record. Field H is a 16-bit record checksum for field G. Field L is a gap field which must be at least 5% of the total length of fields B through K:

$$L = 16\,[0.05(G + 16.5)] = 0.80G + 13.2$$

where L is the length of field L in bits, G is the length of field G in words, and 16.5 is the length in words of fields B through K, except G. If the frequency tolerance exceeds 0.5 Hz, increase the gap proportionally. For example, with a tolerance of 1.0 Hz, increase the gap to 10%.

$$\frac{5\%}{0.5\ \text{Hz}} = \frac{\text{Gap}}{1.0\ \text{Hz}}$$

To access sequential records within the same rotation, take into account time T between the end-of-busy for the first record (which allows the next OCP to be sent) and the output of the second setup word, as follows:

$$L = 16\,[0.05(G + 16.5) + 0.078T + 1.75]$$
$$= 0.80G + 41.2 + 1.25\%$$

where T is in microseconds. The minimum time T between the initiating OCP and the output of the second setup word is 55 μs.

OPERATING DESCRIPTION

The disk control unit (DCU) is interfaced with a Type 716 Central Processor (CP) via a Type 3010 Data Multiplex Control (DMC) Adapter. A maximum of four disk pack drives can be connected to and controlled by the DCU (except Type 4710).

Type 3010 DMC, which is not supplied as a part of a disk subsystem, is required for operation with a Type 716 Central Processor. The adapter portion provides the logic necessary for System 700 to Model 516 I/O conversions, making the DMC of System 700 program-compatible with the 516 DMC, the 316 Standard DMC, and the 316 High-Speed DMC. The DMC portion provides eight DMC channels, of which one channel is assigned to the DCU. Therefore, existing 516/316 software, which utilizes a DMC channel between 1 and 8, can be used without program modification.

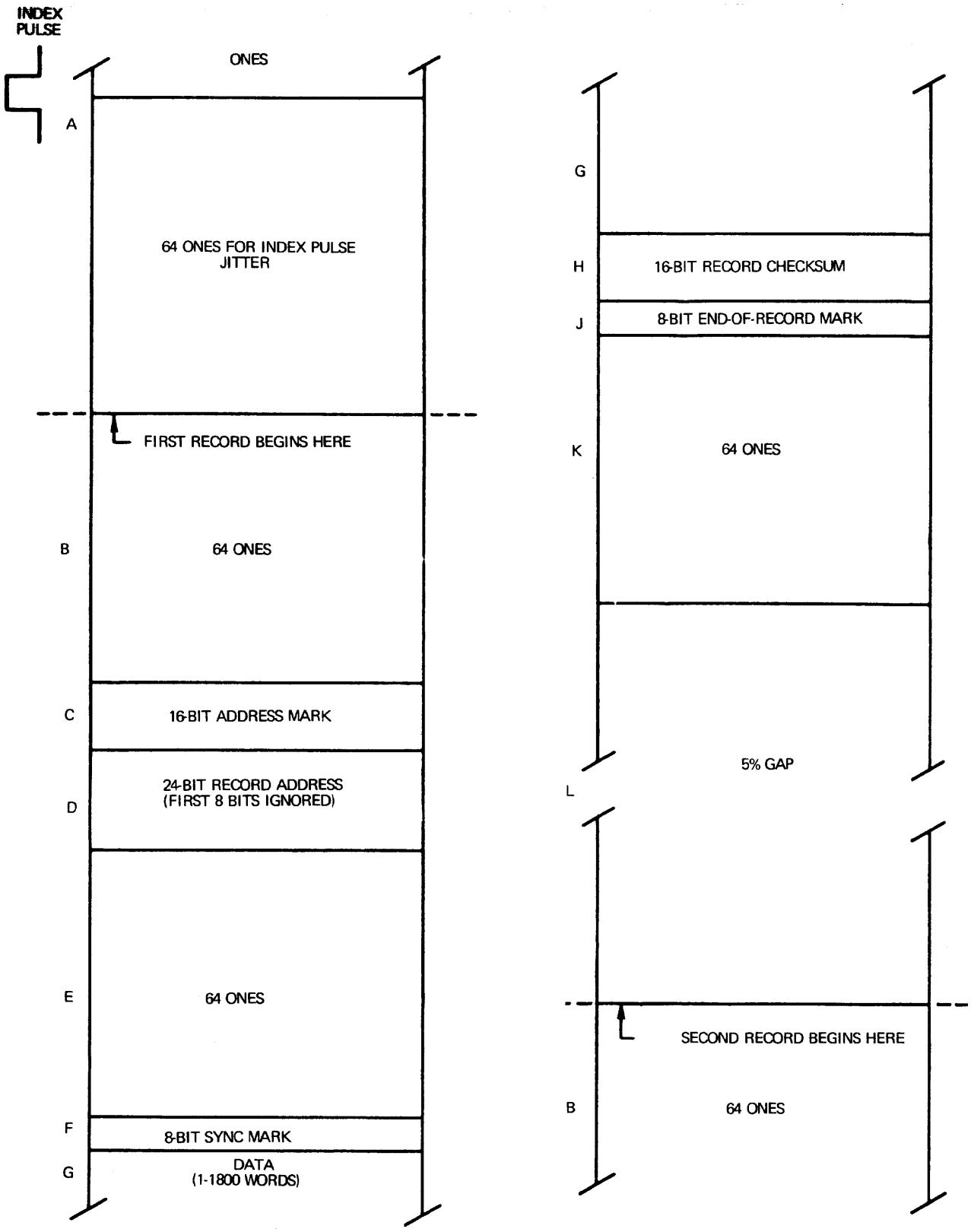


Figure 2-3. Disk Track Format

Although the subsystems can be operated via the I/O bus, Honeywell neither supports nor recommends such operation.

The timing of disk rotation, bit transfer, and head travel is shown in Table 2-2. The timing of specific data input and output operations is discussed under Programming Information.

Table 2-2. Timing for Basic Disk Functions

Characteristics \ Type	4710/4720	4740/4741/4742/4743
Rotational speed	2352-2448 rpm	
Time for one revolution	25 ms (nominal)	
Average rotational latency (time lapse for required data to move under head)	12.5 ms	
Word transfer time	12.8 µs	
Word data aperture	12 µs	
Maximum head travel time:		
Minimum	20 ms	20 ms
Average	55 ms	75 ms
Maximum	110 ms	135 ms

PHYSICAL CHARACTERISTICS

Physical Dimensions:

Width	Depth	Height
24"	33"	39"

Power Requirements: Input voltage, 208 Vac ± 10%, three-phase, five wire, 60 Hz.

Power Consumption: 1.4 KVA

Heat Dissipation: 3000 Btu/hr

Environment: Temperature — 60 to 90° F

Relative Humidity — 10 to 80%

Weight: 500 pounds

SECTION III
PROGRAMMING CONSIDERATIONS

All programmed operations are performed by the control in response to specified peripheral instructions. The precise operation to be performed is specified by the instruction word (and setup word if needed); the operation code varies according to the function that is involved.

The control decodes and transfers data as well as responding to commands from the central processor and informs the processor of disk status. The control is programmed through five basic types of instructions. These instructions are listed in Table 3-1.

Table 3-1. Basic Data Transfer Instructions

Instruction	Function
OCP	Output Control Pulse – transfers control pulse to disk control to perform specific functions.
SKS	Skip If Set – directly tests various conditions of the control or device.
INA	Input Status Word – used to transfer status from the disk control to the A register in the Central Processor.
OTA	Output Setup Word – used to transfer setup from the A register in the Central Processor to the disk control.
SMK	Set Interrupt Mask – used to control interrupt processing.

A summary of each of the specific instructions is listed in Table 3-2.

HARDWARE STATUS WORD

The programmer can obtain detailed information about the state of important elements within the controller by checking the hardware status word. The hardware status word can be read via the I/O bus or the DMC, following the instruction sequence presented later in this section.

Figure 3-1 shows the format of the hardware status word. In Figure 3-1, the indicated condition is true when the associated bit is set.

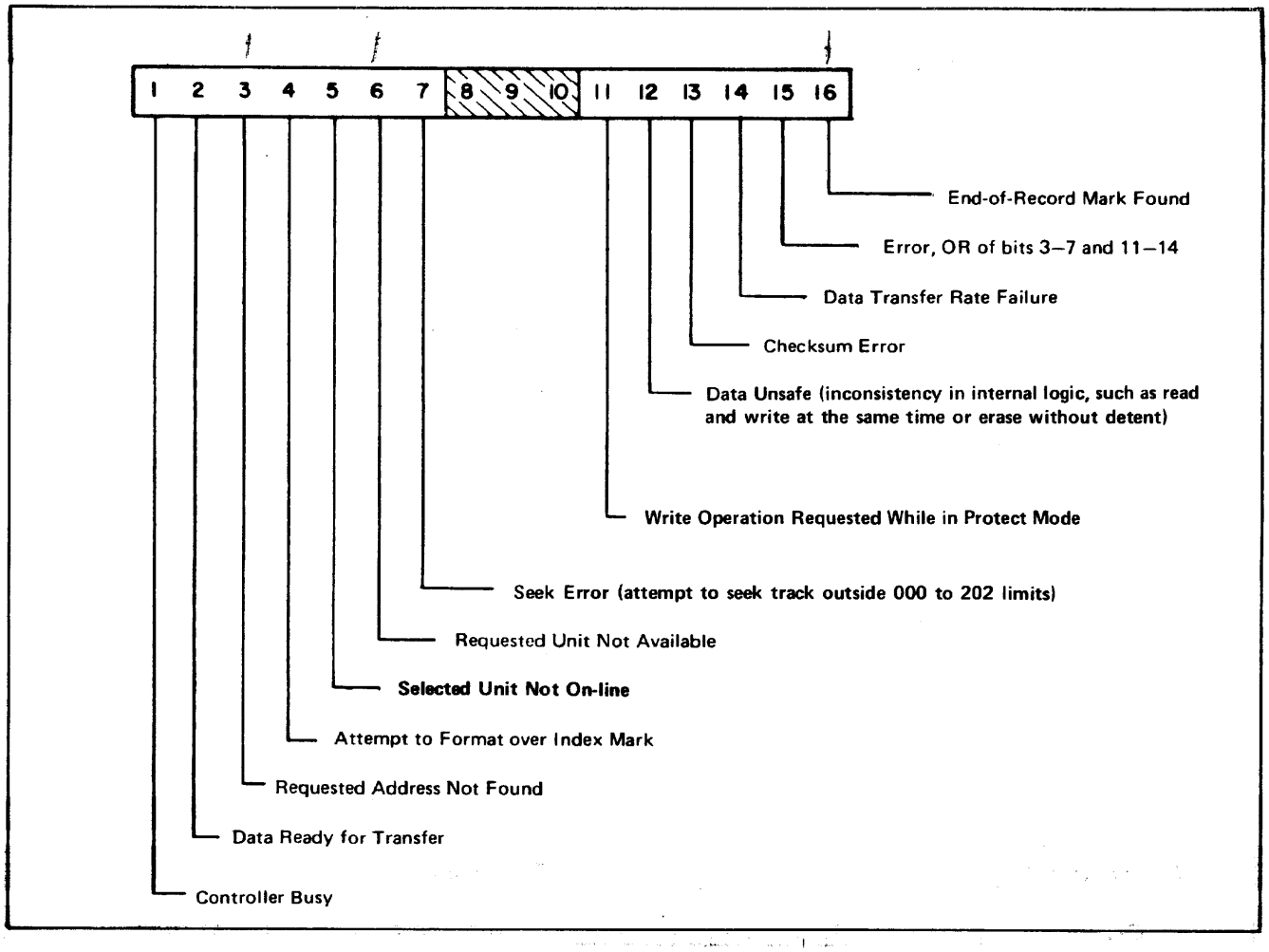


Figure 3-1. Status Word Format

SETUP WORDS

Six of the OCP instructions require one or two setup words, which transfer information necessary for the particular operation. Figure 3-2 shows these six OCP's and the formats of the corresponding setup words.

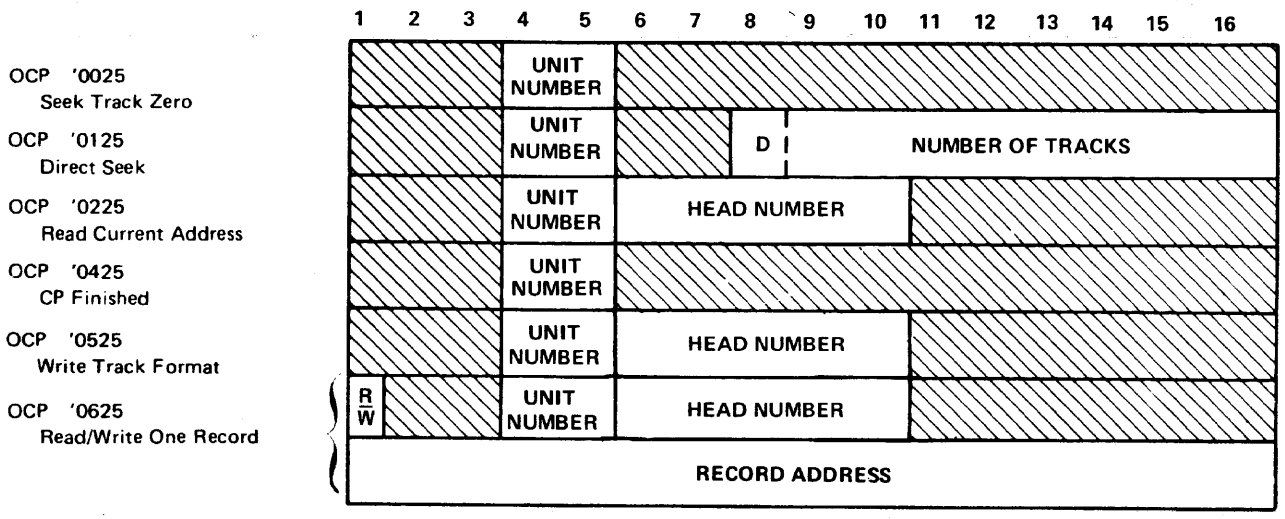
UNIT NUMBER ASSIGNMENT

Each disk drive is assigned a number from 0 to 3 at its installation, and each drive should be labeled with its appropriate number.

DEVICE ADDRESS

The standard device address (the two least significant octal digits of the instruction) for the removable disk subsystem is '25.[1]

[1] Apostrophe indicates octal code.



NOTE

D = Direction. 0 means toward hub; 1 means toward rim.

R/W = Read or Write. 0 means read; 1 means write.

Shaded bits not used.

Figure 3-2. Instructions with Required Setup Words

DEVICE INTERRUPT NUMBER

The removable disk subsystem interrupts through location '63.

CHECKSUM

As data is written on the disk, the controller accumulates a checkword. The checkword is formed by exclusively ORing all data words into a register. At the end of an n-word transfer, the checkword is a 16-bit even-parity checksum, which is written on the disk as word n+1.

When data is read from the disk and passes back through the controller, the hardware recomputes the checksum. Word n+1 is included in the computation. If the result is nonzero, the checksum error bit in the status word is set. A programmer can examine the checkword by requesting an n+1 word read operation.

INTERRUPT REQUESTS

Certain conditions cause hardware interrupt requests. These conditions are listed under Acknowledge Interrupt, OCP '1425, in this section.

DMC DEDICATED LOCATIONS

Each DMC channel is assigned two consecutive memory locations. The starting address of the data transfer is stored in the first location and the terminal address is stored in the second location. The dedicated addresses are between 00020_8 and 00021_8 for DMC channel 1, and 00036_8 and 00037_8 for DMC channel 8.

More information on DMC operation is contained in the System 700 Programmers' Reference Manual, Order No. AC72.

ACCESS TO DMC DEDICATED LOCATIONS

A program that utilizes the 316 high-speed DMC is guaranteed access to the DMC dedicated locations only when the disk control unit is not busy. More information on this subject is presented in the 316/516 Programmers' Reference Manual, Order No. BX47.

GENERAL INSTRUCTION SEQUENCES

The instruction complement for the System 700 Removable Disk Subsystems is given in Table 3-2. Tables 3-3 through 3-7 give appropriate instruction sequences for common operations.

Table 3-2. Summary of Instructions

Instruction	Function
OCP '0025	Seek track zero
OCP '0125	Direct seek
OCP '0225	Read current address
OCP '0425	CP finished
OCP '0525	Write track format
OCP '0625	Read or write one record
OCP '1025	Stop transfer
OCP '1125	Read status word
OCP '1325	Enable DMC mode
OCP '1425	Acknowledge interrupt
OCP '1725	Enable I/O bus mode
INA 'X025[a]	Input from disk to A-register if ready
OTA '0025	Output contents of A-register to disk if ready
SKS '0025	Skip if ready

[a]The address of the removable disk subsystem control unit is 25. X in INA 'X025 can be either 1 or 0: 1 means clear the A-register before input; 0 means input without first clearing.

Table 3-2 (cont). Summary of Instruction

Instruction	Function
SKS '0125	Skip if not interrupting
SKS '0225	Skip if operational
SKS '0325	Skip if no error
SKS '0425	Skip if not busy
SKS '1125	Skip if unit 1 not seeking
SKS '1225	Skip if unit 2 not seeking
SKS '1325	Skip if unit 3 not seeking
SKS '1425	Skip if unit 4 not seeking
SMK '0020	Set interrupt mask (bit 4)

Seek, Seek Track Zero

Before information can be transferred to or from a record, the head must be positioned on the proper track. Two instructions perform this function: one is an absolute seek to cylinder 000; the other moves the head a specified number of cylinders in either direction from the current position. The programmer is expected to keep track of the current head position within his program. Table 3-3 shows the sequence of operations required for the seek operations.

Table 3-3. Seek and Seek Track Zero Instruction Sequence

Step	I/O Bus & DMC
1	Test control unit busy indicator
2	Test if drive seeking
3	Execute seek instruction
4	Output setup word
5	Handle seek complete interrupt request

CP Finished

Execution of the CP Finished instruction causes the selected unit to seek track zero, power down, and flash the CP FINISHED indicator. The flashing continues until the operator presses CP FINISHED. The sequence of operations required for a CP Finished instruction is shown in Table 3-4.

Table 3-4. CP Finished Instruction Sequence

Step	I/O Bus and DMC
1	Test control unit busy indicator
2	Execute CP finished instruction
3	Output setup word

Read Current Address

Disks are often formatted so that the address of each record identifies the track, head, and unit. By reading the address of the next record formatted under such a system, a programmer can determine the track location and relative rotational position of the heads on the disk. Table 3-5 shows the sequence of operations required for reading the current address.

Table 3-5. Read Current Address Instruction Sequence

Step	I/O Bus	DMC
1	Test control unit busy indicator	Test control unit busy indicator
2		Set up DMC for one-word input transfer
3	Enable transfer via I/O bus	Enable transfer via DMC
4	Execute read current address instruction	Execute read current address instruction
5	Output setup word	Output setup word
6	INA current address	(Enter DMC)
7	Return to DMC mode	(End-of-range)

Write Track Format

Table 3-6 shows the sequence of operations required for writing a track format. Formatting takes place in the following order (after the setup word):

1. Record address.
2. Data for every word in the record (may be blank or filler).
3. End-of-range.
4. Five percent gap word (whose value is the number of bit cells in the gap field).
5. Repetition of steps 1 through 4 for each record.
6. End-of-range, acknowledge interrupt, and stop transfer after the last record (which writes a gap to the track origin).

The 5% gap word related to the previous record must be output as the first word of the block being output for the present record.

Because of timing constraints, the CP must be dedicated exclusively to formatting. Time-sharing or multiprogramming is not possible, since time is not available to handle interrupts.

Table 3-6. Write Track Format Instruction Sequence

Step	DMC
1	Test control unit busy indicator
2	Set up DMC for n+1 word output[a]
3	Enable transfer via DMC
4	Execute write track format instruction
5	Output setup word
6	(Enter DMC)
7	(End-of-range)
8	Reinitialize DMC for n+2 word output[b]
9	(Enter DMC)
10	Repeat steps 6 through 9 for each record
11	Reinitialize DMC for 1-word output[c]

[a] For the first DMC transfer, word 1 should be the record address and the remaining n words should be data.

[b] For subsequent DMC transfers, word 1 should be the 5% gap word for the preceding record, word 2 should be the record address, and the remaining n words should be data.

[c] The last DMC transfer should be the 5% gap word for the previous record. Setup must be accomplished within 60μs, and a subsequent interrupt request must be followed by stop transfer and acknowledge (clear)interrupts commands. The drive will write gap until it detects track origin.

If the programmer has ensured that enough space remains on the disk for a gap for the final record (he may include 64-bit field A), he need not transfer the 5% gap for the final record. If the last gap word is not transmitted or if timing requirements are not satisfied, the drive writes gap to track origin and sets the data transfer rate-failure bit in the status word.

Read or Write One Record

The sequence of instructions for these two operations is almost identical. The data words, preceded by two setup words, are transferred between the computer and the disk. The address is read but not modified. The record checksum is written or read and compared, but it is not transferred to the computer unless a read has been specified for more words than the record contains. Table 3-7 shows the sequence of operations required for reading or writing one record.

Table 3-7. Read or Write One Record Instruction Sequence

Step	DMC
1	Test control unit busy indicator
2	Set up DMC for n-word input or output
3	Enable transfer via DMC
4	Execute read/write one record instruction
5	Output first setup word
6	Output second setup word[a]
7	(Enter DMC)
8	(End-of-range)

[a]The time of second setup word is critical only if sequential access within the same rotation is desired (see Track Format and Gap, p. 2-5).

In an under-range read, the controller transfers the specified number of words to memory and discards the remainder of the record. The controller becomes not busy shortly after the end-of-record mark is detected. The checksum is handled as in a normal read.

An over-range read, which inputs the checksum word (often useful for error recovery), terminates at the end-of-record mark. The checksum error bit (bit 13 in the status word) is valid as in a normal read. An under-range write causes no problems.

An over-range write reduces the gap field correspondingly for up to four words over the original format. If more than four words are written beyond the format, the next record (and format) is destroyed. The current record is readable under most circumstances.

Read Status Word

The sequence in Table 3-8 shows the order of instructions to read the contents of the status register. With DMC it is easiest to code this operation using the I/O bus as shown below, although DMC is perfectly acceptable.

Table 3-8. Read Status Word Instruction Sequence

Step	I/O Bus
1	Test control unit busy indicator
2	Enable I/O bus
3	Execute read status word instruction
4	Input status word
5	Enable DMC

INSTRUCTION DESCRIPTIONS

Seek Track Zero (OCP '0025)

This instruction and its associated setup word cause the heads on the selected unit to move to track 000. The disk control unit busy indicator is set for 50 μs after the setup word is output; the seeking indicator of the selected unit is set for 20 to 110 ms for the Types 4710/4720 or 20 to 135 ms for the Types 4740/4741/4742/4743 after the setup word is output (see **Table 2-2).**

More than one disk drive may be seeking at a time. When the heads reach track zero, the controller generates an interrupt request (which can be delayed until the controller becomes not busy). This instruction is ignored if issued while the disk control unit busy indicator is set. A seek track zero instruction executed with the heads already on track zero is processed in the same way as a seek track zero from any other position.

Direct Seek (OCP '0125)

This instruction and its associated setup word cause the heads on the selected unit to move the number of tracks specified by bits 9 through 16 of the setup word and in the direction specified by bit 8 of the setup word, where 0 means toward the center of the disk (higher track numbers) and 1 means toward the outside of the disk (lower track numbers). If the disk control unit detects a 0 in the difference field (bits 9 through 16), it sends no orders to the disk drive, sets the seek error bit in the status word, and generates an interrupt request. The disk control unit busy indicator is set for 50 μs after the setup word is output; the selected unit seeking

indicator is set for 20 to 110 ms for the Types 4710/4720 or 20 to 135 ms for the Types 4740/4741/4742/4743 after the setup word is output. This instruction is ignored if issued while the disk control unit busy indicator is set.

The programmer can code several units to seek concurrently with successive OCP seeks and setup words. He must test for controller busy between OCPs. If several units are seeking, the programmer can either acknowledge interrupts as they occur, or wait until all units have finished seeking and then clear all interrupt requests with one acknowledge interrupt. An interrupt request will be delayed until the controller becomes not busy (e.g., if a data transfer follows a seek). A seek directed to a nonexistent track results in a seek to zero and a seek error in the status word.

Read Current Address (OCP '0225)

This instruction and its associated setup word cause the next address encountered on the selected track by the selected head to become available on the input bus. The disk control unit busy indicator is set from the time the setup word is output until the address becomes available to the central processor. Then the ready indicator is set, the busy indicator is reset, and an interrupt request is generated. This OCP has no effect if issued while the DCU is busy.

CP Finished (OCP '0425)

Execution of this instruction and its associated setup word cycles down the unit, starts the CP FINISHED indicator flashing, and illuminates STOP. A programmer may code this operation to signal the operator that a certain disk is no longer needed by the executing program. The DCU busy indicator remains set for 50 μs after the setup word OTA. No interrupt request is generated.

Write Track Format (OCP '0525)

This instruction and its associated setup word cause the selected head on the selected unit to detect the track origin and write a new format on the track. In addition, data may be written in the newly formatted records. The address, the data, and the gap size are under program control. If the output transfer rate is not maintained by the computer, the disk control unit aborts the operation, writes gap to the track origin, and sets the data-transfer rate-failure bit in the status word. The DCU is busy from the time of the order-initiation OCP until formatting terminates at track origin. Refer to Track Format and Gap on p. 2-5 for information on how to format to access sequential records on a track.

Read or Write One Record (OCP '0625)

This instruction and its two associated setup words cause the selected head on the selected disk drive to read or write one record at the specified record address on the current cylinder. Bit 1 of the first setup word must be 0 for read and 1 for write.

READ

The unit reads until one of the following conditions occurs:

1. End-of-record is sensed.
2. The computer fails to maintain the necessary input transfer rate.
3. Two index pulses are tallied.
4. The stop transfer instruction (OCP '1025) is executed or DMC end-of-range occurs. Data transfer will cease, but the disk control unit continues reading to the end of the record. When a stop transfer instruction is executed during a read operation, the last data word transferred before the instruction takes effect is interpreted as a checksum. The checksum error bit in the status word may be set. This feature is useful in test programs.

The control unit busy indicator is set from the time the OCP is issued until the read is completed in one of the four ways listed above.

If the program specifies a larger number of words (range) to be read than the record contains, the record checksum is transferred to the central processor as if it were data, and the end-of-record is sensed before the next word is transferred. If, at the end of the read operation, the checking logic indicates an error, the checksum error bit in the status word is set.

WRITE

Data is written into the addressed record until one of the following conditions occurs:

1. The stop transfer instruction (OCP '1025) is executed or DMC end-of-range occurs.
2. The computer fails to maintain the necessary output transfer rate.
3. Two index pulses are tallied.

When condition 1 or 2 is encountered, the word being written is finished, and the checksum record is written along with the end-of-record mark and the field of ones (fields H, J, and K of Figure 2-3). When condition 3 occurs, the operation is terminated immediately.

The programmer should make sure that the record written is no larger than allowed by the record format. If it is too long by four words or less, the 5% gap is diminished, but the following record will not be affected. If it is more than four words too long, the following records are destroyed.

The controller is busy from the time the OCP is issued until 1, 2, or 3 above terminates the operation. The read/write operation may be requested when one or more units are seeking and will be executed either immediately or when the appropriate seek is complete. Any pending interrupt request is delayed until the operation is complete, i.e., until the controller becomes not busy.

Stop Transfer (OCP '1025)

This instruction, which does not require a setup word, stops track formatting if issued immediately after the DCU has received the last data word. If this OCP is not issued within 50 μs of end-of-range for the last record formatted, the data-transfer rate-failure bit in the status word is set. Execution of a stop transfer instruction forces the controller to not busy. In this way, a programmer can clear a busy hangup which may result from an OCP with no setup word transfer or a hardware fault. If issued during a read operation, this instruction forces a diagnostic checksum (see Read on previous page).

Read Status Word (OCP '1125)

This instruction causes the status word to be the next data-like word transferred via I/O bus or DMC. To make the transfer via I/O bus, code INA '0025 or '1025 after the OCP. For DMC transfers, initialize the channel before issuing the OCP. Before issuing OCP '1125 while the DCU is busy, delay 50 ms (two revolutions) to allow completion of any transfer in progress. Reading the status word does not alter the state of the controller other than to clear the status request. See Figure 3-1 for the status word format.

Enable Data Transfer Via DMC (OCP '1325)

Enable Data Transfer Via I/O Bus (OCP '1725)

OCP '1325 (or '1725), which does not require a setup word, enables the disk control unit to use the DMC (or I/O bus) exclusively. It does not initiate an order to any of the disk drives.

Pressing MASTER CLEAR initializes the system for DMC transfers. To initialize the system for I/O bus transfers, execute OCP '1725 before executing the OCP which implies the data transfer (e.g., OCP '0625, Read One Record). Transfers are enabled via the I/O bus until OCP '1325 is executed or the computer is MASTER CLEARed.

Acknowledge Interrupt (OCP '1425)

This instruction, which does not require a setup word, does not initiate any orders to the disk drives but does reset (clear) an interrupt request if one is present. The following situations cause interrupts if allowed:

1. The disk control unit goes from busy to not busy, except for the 50 μs busy at the beginning of a seek, CP finished, or read status word instruction. Any OCP, except read status word, addressed to the disk control unit resets this interrupt request.

2. A seek operation is completed. If this happens when the disk control unit is busy, the interrupt is delayed until the control unit goes to not busy. If a direct seek is requested and its setup word specifies a difference of zero tracks, this interrupt request is generated immediately. Only OCP '1425 resets this interrupt request.

3. A disk drive error (bit 5, 6, 7, 11, or 12 in the status word) is detected. The operation is terminated and an interrupt request is generated at the end of the 50 μs order process interval.

4. End-of-range is reached in write track format operations with DMC mode set. The interrupt signals the program to reinitialize the DMC within the time constraints. It may be cleared by OCP '1425 during the format operation, or by OCP '1425 or OCP '1025 at the end of the format operation.

Input From Disk to A-Register if Ready (INA '0025)

If the disk control unit has a data word ready for transfer, this instruction ORs the word from the DCU into the A-register and skips the next instruction. At the completion of the instruction, data ready and status request are reset. If data is not ready, INA '0025 is treated as an NOP. To maintain the data transfer rate, INA must be executed within 12 μs of the time data becomes ready (time constraints do not apply for status and address transfers).

Clear A-Register and Input from Disk to A-Register if Ready (INA '1025)

This instruction performs a function similar to that above, except that the A-register is cleared before the data is ORed in.

Output to Removable Disk Subsystem if Ready (OTA '0025)

If the data ready indicator is set, this instruction outputs data (usually a setup word) to the removable disk subsystem, resets data ready, and skips the next instruction. If data ready is reset, the instruction is treated as an NOP. The timing requirements for disk data are the same as for INA '0025 and '1025. The timing of setup words is noncritical.

Set Interrupt Mask (Bit 4) (SMK '0020)

The state of the standard interrupt mask for the removable disk subsystem is made equal to bit 4 of the A-register (which must contain the entire mask word) by executing SMK '0020.

Skip if Ready (SKS '0025)

The data ready indicator is used on both read and write operations to signal that another word may be transferred to or from the disk control unit. SKS '0025 tests this indicator. This instruction is not generally useful.

Skip if Not Interrupting (SKS '0125)

This instruction skips if the disk control is not generating an interrupt request. Interrupt conditions are listed under OCP '1425.

Skip if Operational (SKS '0225)

This instruction skips if the DCU is not busy and if no error bits in the status word are set. It skips if the previous data transfer was completed satisfactorily or a seek operation started without error.

Skip if No Error (SKS '0325)

This instruction skips if no error bit is set in the status word (bits 3-7 and 11-14).

Skip if Not Busy (SKS '0425)

This instruction tests the disk control unit busy indicator and skips if the controller is not busy. The control unit is busy for the duration of a read, write, or write format operation, and for 50 μs after the beginning of a seek. See the relevant OCP descriptions for specific information about busy conditions.

Skip if Unit Not Seeking (SKS 'XX25)

These instructions test the seek indicator of each disk drive. Since the indicator is set near the end of the 50-μs seek cycle, a valid indication of unit seeking can be obtained only after the DCU has gone not busy (see Table 3-2).

SECTION IV
CONTROLS AND INDICATORS

MAIN CONTROL PANEL

The main control panel on each disk subsystem contains four push-button indicator/switches used by the operator during on-line operation. See Figure 4-1 for a view of the panel and below that for a description of the controls and indicators.

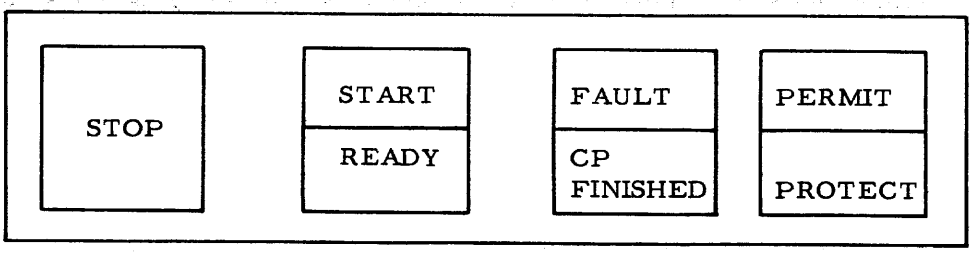


Figure 4-1. Main Control Panel

START/READY – To start up the disk, apply power to the unit (if not on), load the disk pack, close the cover, and press START. The indicator will illuminate, the disk will rotate, and the heads will seek to track zero. In about 25 seconds the READY indicator will light. During this cycle-up sequence a set of brushes will wipe all recording surfaces and then retract.

STOP – Press STOP to remove power from the spindle drive motor and brake the spindle. The START light will go out, STOP will illuminate, and the heads will retract. In about 15 seconds the disk will stop rotating and will release the cover lock solenoid.

FAULT/CP FINISHED – The FAULT indicator lights upon detection of any of the following conditions:

1. Selection of more than one head.
2. Improper combination of read, write, and erase heads or drivers (e.g., both read and erase).
3. Attempt to read, write, or erase with head not directly on track.
4. Improper rotating speed.

Pressing FAULT clears the indicator. If the condition reappears, the indicator lights again. Clearing a recurrent fault may be attempted by stopping the unit and then restarting it with the START switch.

OCP '0425 controls the CP FINISHED indicator. The programmer can program this indicator to flash as a signal to the operator that the program is finished with the current disk pack. The command also causes the unit to cycle down. Push CP FINISHED to turn off the indicator.

PERMIT/PROTECT – The permit state allows writing or formatting on a disk. Since the unit cycles up (i.e., starts) in the protect state, press PERMIT before attempting either of these operations.

POWER

The main circuit breaker at the front of the disk drive (see Figure 5-1) controls power to the unit except for the main motor. Controller logic is powered from the computer. The main motor is controlled by the START pushbutton and interlocked with the plastic cover.

SECTION V

OPERATING PROCEDURES

The operating and disk-handling procedures for the System 700 Removable Disk Subsystems are presented in this section.

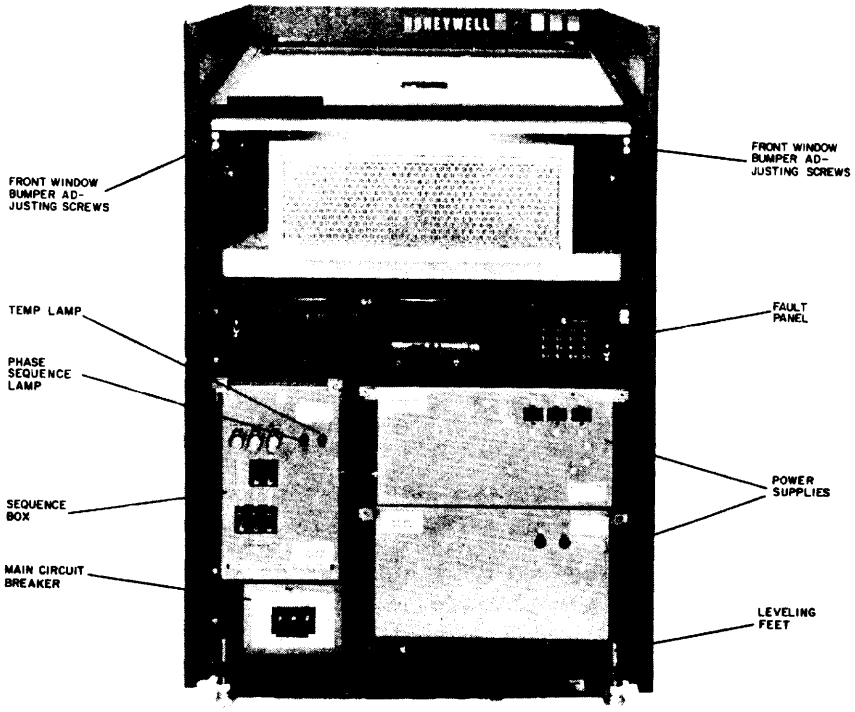


Figure 5-1. Front View without Cover

INITIAL STARTING PROCEDURE

To initially start any disk pack drive, perform the following procedures:

1. Open the front door(s) of the disk drive(s).
2. Set the main circuit breaker switch(es) (see Figure 5-1) to the ON position. The main circuit breaker applies AC and DC voltages to the drive(s) and illuminates the STOP and the PROTECT indicator(s).
3. Close the front door(s) of the disk drive(s).
4. Load a disk pack(s).

LOADING PROCEDURE

A disk pack can be loaded if the spindle is completely stopped and the heads are fully retracted.

To load a disk pack after the required conditions have been met, perform the following steps:

1. Slide the glass access cover back into the provided storage space.

NOTE: The glass access cover that permits entry into the disk pack area can be opened only when machine power is applied. When power is off or the drive is in the start or run mode, the cover lock prevents entry into the disk pack area.

2. Unscrew the knob on the bottom cover of the disk pack canister, and remove the bottom cover.
3. Place the disk pack on the spindle. Turn the top cover clockwise until it comes to a full stop and the disk pack is firmly engaged on the spindle.
4. Lift the top canister cover from the disk pack. If positioned properly, the disk pack will remain on the spindle.

NOTE: The pack-in-place switch prevents the drive from operating if the disk pack is improperly mounted on the spindle.

5. Slide the glass access cover forward until it is engaged.
6. Select the proper state for the PROTECT/PERMIT push-button indicator.

STARTING PROCEDURE

After all of the previously mentioned conditions have been met (i.e., Loading Procedure), perform the following:

To start the drive, press the START push button. When the START push button is pressed, the glass access cover locks, the STOP indicator is extinguished, the spindle and disk pack rotates, and the START indicator is illuminated. The READY indicator is illuminated when the heads are loaded. The drive is on-line and ready to be addressed.

UNLOADING PROCEDURE

Prior to unloading a disk pack, the spindle must be completely stopped, the heads fully retracted, and the STOP indicator illuminated. To accomplish this, perform the following:

1. Press the STOP push button. This causes the heads to unload and after 10 seconds the spindle rotation ceases. The STOP indicator is illuminated and the glass access cover unlocks.
2. Slide the glass access cover back into the provided storage space.
3. Place the top canister cover of the disk pack over the disk pack.
4. Rotate the disk pack cover counterclockwise until the cover pins are engaged. Two full turns are necessary to join the disk pack to the canister.
5. Lift the disk pack and canister cover off the spindle.

6. Attach the bottom canister cover to the disk pack.

7. Slide the glass access cover forward until it is engaged.

STOP PROCEDURE

To stop a disk drive, press the STOP push button. To completely power down the drive, press STOP, wait until the spindle stops rotating, and then trip the main circuit breaker.

RESTART PROCEDURES

FAULT Indicator Illuminated

When a fault occurs, the drive enters the protect mode and illuminates both the FAULT and PROTECT indicators. To reset and run in the protect state, press the FAULT push button. To reset and run in the permit state, perform the following:

1. Press the FAULT push button.
2. Press the PROTECT/PERMIT push button. The PROTECT indicator will be extinguished and the PERMIT indicator illuminated.

NOTE: If the FAULT indicator continues to light, a service call should be made.

CP FINISHED Indicator Flashing

"CP FINISHED" is a program-controlled stop that places the drive in the stop mode, extinguishes the START and READY indicators, and causes the CP FINISHED indicator to flash on and off. To restart perform the following:

1. Refer to the local program operating procedures.
2. Press the flashing CP FINISHED indicator.
3. Press the START push-button indicator. Normal operation will commence.

Unexpected Power-Down

If the disk pack drive powers down unexpectedly and extinguishes all indicators, check the following:

1. Main circuit breaker — reset tripped circuit breaker and perform the start procedure.
2. Other — notify Honeywell Field Service.

CLEANING DISK PACKS

Dust or dirt on the disk pack recording surfaces may cause read or write errors as well as permanent damage to the surfaces and the read/write heads. Honeywell disk pack drives are equipped with nylon cleaning brushes to ensure optimum performance. Manual cleaning on Honeywell drives equipped with brushes is not usually necessary; brushes clean the packs during each cycle-up.

If a specific pack continually causes read errors after write operations, however, cycle up the unit five times. The brushes will clean the error-causing disk pack during the cycle-up process. If read errors persist and the record or format was written on another drive, this may be the cause of the error. If errors persist and the drive used for writing and reading is the same and otherwise satisfactory, take the error-causing track out of service and assign one of the spare tracks. If spare tracks are not available, remove the pack from service, as the entire surface may be degraded.

Check the disk pack filter on the bottom of each pack and change it when necessary. Filters can be ordered through your local Honeywell Field Service Office.

Honeywell disk packs are impervious to 91% isopropyl alcohol (2-propanol); other solvents, however, may cause damage.

SECTION VI
EXAMPLES

Three examples are included in this section. Each example assumes that a routine named ERR is available to handle errors indicated by the hardware status word. The ERR routine, which must be coded to serve the specific requirements of the user, is not presented.

The techniques in the sample programs apply to the 10-surface disk as well as the 20-surface disk, though the examples cite device characteristics specific to the 20-surface disk. To adapt these examples for the 10-surface disk, addressing must be limited to a surface between 0 and 9.

WRITE TRACK ZERO

Figure 6-1 is an example of a program for returning the heads of disk drive number 4 to track 000 on a DMC system. This program waits for the busy indicator to be reset before returning.

```
SEEK  DAC    **          ENTRY POINT
      SKS    '0425       TEST BUSY INDICATOR
      JMP    *-1         DELAY UNTIL NOT BUSY
      SKS    '1425       IS UNIT 4 SEEKING?
      JMP    *-1         DELAY UNTIL NOT SEEKING
      OCP    '0025       RETURN TO TRACK ZERO
      LDA    ='20000     SETUP WORD FOR UNIT 4
      OTA    '0025       OUTPUT SETUP WORD
      JMP    *-1         DELAY IF NOT READY
      SKS    '0425       TEST BUSY INDICATOR
      JMP    *-1         DELAY UNTIL NOT BUSY
      SKS    '0325       ERROR?
      JMP    ERR         YES, PROCESS IT
      JMP*   SEEK        EXIT
```

Figure 6-1. Seek Track Zero Example

WRITE TRACK FORMAT

Figure 6-2 is an example of a program that formats track 3 (the fourth track) on the current cylinder into 25 records of 40 words each. Records in this example are assigned sequential decimal numbers 1 through 25. The contents of buffer BUF are written as data in each record. Since BUF is not initialized, the programmer does not know in advance what data (or pseudo-data) will be written.

The program uses a DMC channel and formats on disk drive 1, head 3 (second drive, fourth head). The 5% gap is not long enough to allow immediate sequential access.

This sample program does not allow interrupts but does mask on interrupt requests which can be tested with SKS '0125. The test determines when the DMC reached end-of-range. The controller will cause an interrupt request within two revolutions, regardless of error conditions.

```
FRMT DAC    **              ENTRY POINT
     INH                    INTERRUPTS NOT WANTED
     SKS    '0425           TEST BUSY INDICATOR
     JMP    *-1             DELAY UNTIL NOT BUSY
     OCP    '1325           ENABLE IN DMC MODE
     LDA    ADST            STARTING TRACK ADDRESS
     STA    BUF             STORE IN BUFFER
     LDA    BIAD            ADDRESS OF TRACK ADDRESS
     STA*   STRT            STORE IN DMC START LOCATION
     LDA    BFND            DMC END ADDRESS
     STA*   END             STORE IN DMC END LOCATION
     LDA    ='10000         MASK BIT
     SMK    '0020           SET MASK BIT
     OCP    '0525           WRITE TRACK FORMAT
     LDA    ='4300          SETUP WORD FOR UNIT 1, HEAD 3
     OTA    '0025           OUTPUT SETUP WORD
     JMP    *-1             DELAY UNTIL READY
*            NOW DMC STARTS
     LDA    =-25            NUMBER OF RECORDS
     STA    RCNT            STORE IN COUNTER
     SKP                    SKIP OVER INTERRUPT ACKNOWLEDGE
REC  OCP    '1425           MUST ACKNOWLEDGE INTERRUPT REQUEST
     SKS    '0125           IS DISC REQUESTING INTERRUPT?
     SKP                    YES, RESET DMC
     JMP    *-2             NO, DELAY UNTIL IT IS
*
     IRS    BUF             INCREMENT TRACK ADDRESS
     LDA    BFAD            DMC START IS 5% GAP WORD
     STA*   STRT            STORE IN DMC START LOCATION
*            DMC CAN BECOME ACTIVE AGAIN
     IRS    RCNT            UPDATE RECORD COUNT
     JMP    REC             NOT DONE, DO ANOTHER RECORD
*
```

Figure 6-2. Write Track Format Example (Sheet 1 of 2)

```
        STA*  END          SET DMC FOR 1-WORD TRANSFER
        OCP   '1425        ACKNOWLEDGE INTERRUPT
        SKS   '0125        WAIT FOR INTERRUPT REQUEST
        SKP                EXIT WHEN REQUEST ARRIVES
        JMP   *-2          LOOP WHILE WAITING
        SKS   '0425        TEST BUSY INDICATOR WHILE WRITING
*                            GAP TO TRACK ORIGIN
        JST   TERR         ERROR TEST IF BUSY
        OCP   '1425        ACKNOWLEDGE INTERRUPT
        JMP*  FRMT         RETURN
*
TERR    DAC   *            ENTRY TO ERROR TEST LOOP
        SKS   '0325        ERROR?
        JMP   ERR          YES, PROCESS IT
        STA   TEMP         NO, SAVE A AND
        LDA   TERR         LOAD RETURN POINTER
        SUB   =2           DECREMENT RETURN POINTER
        STA   TERR         RESTORE POINTER
        LDA   TEMP         RESTORE A REGISTER
        JMP*  TERR         RETURN TO CALLING PROGRAM
*
GAP1    DEC   46           NUMBER OF BITS IN 5% GAP
BUF     BSS   41           STORAGE FOR ADDRESS FOLLOWED
*                            BY 40 DATA WORDS
ADST    OCT   1            ADDRESS OF FIRST RECORD
RCNT    OCT   0            STORE RECORD COUNTER HERE
BIAD    DAC   BUF          FIRST DMC START
BFAD    DAC   GAP1         SUBSEQUENT DMC STARTS
BFND    DAC   ADST-1       DMC ENDING ADDRESS
STRT    OCT   20           DMC CHANNEL 1 START ADDRESS
END     OCT   21           DMC CHANNEL 1 END ADDRESS
TEMP    BSZ   1            STORAGE FOR A REGISTER IN TERR
```

Figure 6-2. Write Track Format Example (Sheet 2 of 2)

WRITE ONE RECORD ON DMC

The sample program in Figure 6-3 may be used to write a 4-word record on cylinder 139, surface 9, at address '26.

In Figure 6-3, the transfer of data is performed via DMC channel 1. Therefore, the starting and ending addresses of the data buffer are stored in locations '20 and '21, respectively. The two setup words are transferred to the controller via the I/O bus (OTA '0025) and the transfers are performed.

```
WRIT DAC    **                  ENTRY POINT
     INH                        INTERRUPTS NOT WANTED
     SKS    '0425               TEST CONTROLLER BUSY INDICATOR
     JMP    *-1                 DELAY UNTIL NOT BUSY
     LDA    BUFB                BUFFER ADDRESS
     SSP                        RESET FLAG FOR OUTPUT
     STA*   STRT                STORE IN DMC STARTING ADDRESS
     LDA    BFND                END-OF-BUFFER ADDRESS
     STA*   END                 STORE IN DMC ENDING ADDRESS
     OCP    '0625               READ OR WRITE
     LDA    ='1100              FIRST SETUP WORD
     SSM                        SET FLAG FOR OUTPUT
     OTA    '0025               OUTPUT FIRST SETUP WORD
     JMP    *-1                 DELAY UNTIL READY
     LDA    WADR                SECOND SETUP WORD
     OTA    '0025               OUTPUT SECOND SETUP WORD
     JMP    *-1                 DELAY UNTIL READY
*         DMC BEGINS WRITING
     LDA    ='10000             MASK BIT
     SMK    '0020               SET MASK BIT
     SKS    '0125               TEST FOR END-OF-RANGE INTERRUPT REQUEST
     SKP                        YES, SKIP TO EXIT ROUTINE
     JMP    *-2                 NO, DELAY UNTIL END-OF-RANGE OCCURS
     SKS    '0425               TEST BUSY INDICATOR
     JST    TERR                ERROR TEST IF BUSY
     OCP    '1425               ACKNOWLEDGE INTERRUPT
     HLT
*
TERR DAC    **                  ENTRY TO ERROR TEST LOOP
     SKS    '0325               TEST FOR ERRORS
     HLT
     STA    TEMP                NO, SAVE A AND
     LDA    TERR                LOAD RETURN POINTER
     SUB    =2                  DECREMENT RETURN POINTER
     STA    TERR                RESTORE POINTER
     LDA    TEMP                RESTORE A REGISTER
     JMP*   TERR
*
BUFB DAC    BUF                 BUFFER ADDRESS
BFND DAC    BUF+3               END-OF-BUFFER ADDRESS
STRT OCT    20                  DMC STARTING ADDRESS
END  OCT    21                  DMC ENDING ADDRESS
WADR OCT    26                  WRITE ADDRESS
TEMP BSZ    1                   STORAGE FOR A REGISTER IN TERR
BUF  OCT    75                  DATA BUFFER
     OCT    100
     OCT    100
     OCT    150
```

Figure 6-3. Write One Record on DMC Example

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