AA61658-00

SERIES 6000
PERIPHERAL DEVICE
PROGRAMMING CONSIDERATIONS

March, 1973

Datacraft Corporation

1200 N. W. 70th Street P. O. Box 23550 Fort Lauderdale, Florida 33307 (305) 974-1700

CONTENTS

INTRODUCTION

SCOPE

This manual contains programming considerations pertaining to peripheral devices. The information presented describes the peripheral device response to program instructions and the conditions under which a device generates a priority interrupt. This information is necessary for the user who must write device handlers which must operate in his custom system. The information is of limited use to those users whose requirements are met using the standard device handlers supplied with the various operating systems.

GENERAL

There are three models of Datacraft computers. These are the DC 6024/1, the DC 6024/3 and the DC 6024/5. Table 1 contains a summary of the features of the different models.

All three models of the computer are software compatible in almost all areas. The systems use the same peripheral devices in almost all cases. In those instances where a feature and/or device is unique to a particular model, it will be clearly stated.

Table 1. Major Characteristics

CHARACTERISTIC	MODEL		
	6024/1	6024/3	6024/5
Cycle Time	600 nanosec	1 microsec	1 microsec
Basic Memory Size	8K words	8K words	4K words
Expansion Increment	8K	8K	4K or 8K
Maximum Memory	65K	65K	65K
Registers (24-bit)	5 (I, J, K, E, A)	5 (I, J, K, E, A)	5 (I, J, K E, A)
Condition Register	4-bit (C)	4-bit (C)	4-bit (C)
Index Registers	I, J, K	I, J, K	I, J, K
Main Arithmetic Register	A	A	A
Arithmetic Extension	E	E	E
Double Precision Instructions	10	10	10
Hardware Multiply	Yes	Yes	Yes
Divide	Yes	Yes	Yes
Square Root	Yes	Yes	Yes

Table 1. Major Characteristics (Cont'd.)

CHARACTERISTIC	MODEL		
	6024/1	6024/3	6024/5
Basic Priority Interrupt	4	4	4
Maximum	72	24	24
Executive Traps	8 Optional	8 Optional	7 Optional
Floating Point Hardware	Optional	Optional	No
Hardware Bootstrap	Optional 4 devices	Optional 4 devices	Optional 4 devices
Direct Memory Access	Optional 24-bit	Optional 24-bit	Optional 24-bit
Maximum I/O Channels	14	14	14
Devices per Channel	16	16	16

GENERAL I/O INFORMATION

All peripheral devices respond to the Output Command Word (OCW) and Input Status Word (ISW) instructions. The command word has up to eight bits depending on the device. The status word has up to eight bits, again depending on the device characteristics.

Every peripheral device except the discs has up to two interrupt lines. The interrupt logic is controlled by bits 0, 1 and 2 of the command word. Table 2 shows the bit configurations which select and enable/disable the interrupts.

Table 2. Device Interrupt Control

Bit 2	Bit 1	Bit 0	Function Performed
Select Output/ Trouble Interrupt	Select Input Interrupt	Interrupt Control	
0	0	0	No Action
0	0	1	No Action
0	1	0	Disable Input Interrupt
0	1	1	Enable Input Interrupt
1	0	0	Disable Output/Trouble Interrupt
1	0	1	Enable Output/Trouble Interrupt
1	1	0	Disable Both Interrupts
1	1	1	Enable Both Interrupts

It must be clearly understood that the command word interrupt bits control the enabling and disabling of the peripheral device interrupt logic and have no effect at all on the computer's interrupt structure; the CPU interrupt structure is controlled by the execution of priority interrupt control instructions, not by I/O instructions to a peripheral device.

CHANNEL/UNIT ASSIGNMENTS

The channel/unit assignments given in the device descriptions are those used for the system at the Datacraft Computer Center. Generally speaking, the assignments are made for a particular system configuration and can be considered as arbitrarily chosen and arbitrarily changeable numbers.

The channel/unit select bits of the I/O instruction are shown in Figure 1.

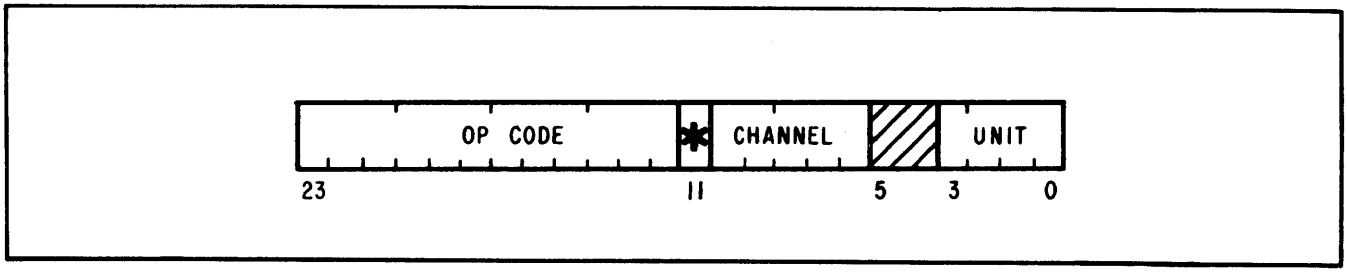

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Figure 1. I/O Instruction Format

A simple way to construct the octal channel/unit code is:

1. Determine the channel number (octal).
2. Multiply channel number by 100_8.
3. Add the octal unit number to the product.

Example: Channel 6_8, unit 12_8

```
'6 . '100 =   '600
        +      12
          ------
          '612

OCW           '612    Channel 6/ unit 12
ISW           '612
etc.
```

Figure 2 is a chart showing the command and status word formats for each peripheral device.

DATA WORD FORMATS

All Datacraft peripheral devices transfer data from bits 0 to n of the device or CPU register. Bit 0 is always the least significant bit. Devices which operate on an 8-bit channel transfer data via bits 0-7. Devices which operate on a 24-bit channel transfer data via bits 0-11 (card readers and punches) or bits 0 - 23 (disc and magnetic tape units).

PROGRAMMING EXAMPLES

The programming examples shown are coded in a straightforward manner with no attempt to optimize the coding used. This approach makes it easier to see the steps required to program a device handler.

None of the examples have extensive error recovery routines, however the requirement for the routine is stated in the example. The user generally has a recovery procedure which he will implement.

The examples which illustrate interrupt handling end with a "BUC *" instruction. This is a practical procedure to use in examples, but it is rarely practical in actual applications.

DESCRIPTION FORMATS

The device descriptions all follow the same general outline and format. There are seven major paragraphs in each description. The headings of the paragraphs are:

1. Device

   (Names the device and gives the model numbers available)

2. General

   (Briefly states the purpose of the device and what type channel is required for the device)

3. Program-Controlled Operation

   (States the standard channel/unit assignments and lists the I/O instructions applicable to the device)

4. Command Word Format

   (Shows the command bits and defines their functions)

5. Status Word Format

   (Shows the status bits and defines their use)

6. Programming Examples

7. Summary of Specifications

PERIPHERAL DEVICE		23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
TELETYPE: MODELS 6001-1 6001-2 6001-3 6001-51	COMMAND WORD																		CLEAR INPUT BUFFER	DISABLE INPUT	ENABLE KEYBOARD	ENABLE READER	SELECT OUTPUT INTERRUPT	SELECT INPUT INTERRUPT	INTERRUPT CONTROL
	STATUS WORD																				KEYBOARD ENABLED	READER ENABLED	OUTPUT BUFFER EMPTY	INPUT BUFFER FULL	UNIT ON-LINE
PAPER TAPE READER: MODELS 6002-10 6002-20	COMMAND WORD																		CLEAR INPUT BUFFER	DISABLE READER	0	ENABLE READER	0	SELECT INPUT INTERRUPT	INTERRUPT CONTROL
	STATUS WORD																			GATE OPEN	0	READER ENABLED	0	INPUT BUFFER FULL	UNIT ON-LINE
PAPER TAPE READER: MODELS 6003-30 6003-32	COMMAND WORD																	FORWARD (0) REVERSE (1)	CLEAR INPUT BUFFER	DISABLE READER	0	ENABLE READER	0	SELECT INPUT INTERRUPT	INTERRUPT CONTROL
	STATUS WORD																				FORWARD/ REVERSE SELECTED	READER ENABLED	0	INPUT BUFFER FULL	UNIT ON-LINE
PAPER TAPE PUNCH: MODEL 6003-1	COMMAND WORD																		CLEAR OUTPUT BUFFER	0	DISABLE PUNCH (POWER-OFF)	ENABLE PUNCH (POWER-ON)	SELECT OUTPUT INTERRUPT	0	INTERRUPT CONTROL
	STATUS WORD																			TAPE LOW	0	0	OUTPUT BUFFER EMPTY	0	UNIT ON (POWER ON)
PAPER TAPE PUNCH: MODELS 6003-30 6003-34	COMMAND WORD																	FORWARD (0) REVERSE (1)	0	0	0	0	SELECT OUTPUT INTERRUPT	0	INTERRUPT CONTROL
	STATUS WORD																			TAPE LOW	TAPE HANDLING ERROR	0	OUTPUT BUFFER EMPTY	0	UNIT ON-LINE
CARD READER: MODELS 3010 3020 3030	COMMAND WORD																				EJECT CARD	FEED CARD	SELECT TROUBLE INTERRUPT	SELECT INPUT INTERRUPT	INTERRUPT CONTROL
	STATUS WORD																		COMMAND BUFFER FULL	NON-PICK	0	HOPPER CHECK	READER TROUBLE	INPUT BUFFER FULL	UNIT ON-LINE
CARTRIDGE DISC: MODELS 5201 5210	COMMAND WORD	0 0 0 RESTORE 0 0 1 SEEK 0 1 0 WRITE EOF 0 1 1 EXPANDED STATUS 1 0 0 READ 1 1 0 WRITE 1 1 1 WRITE DATA/EOF			DRIVE ADDRESS		DISC SELECT	CYLINDER ADDRESS									0	0	HEAD ADDRESS	0	SECTOR ADDRESS					
	STATUS WORD										CYLINDER ADDRESS ERROR	HEAD ADDRESS ERROR	SECTOR ADDRESS ERROR	NO SYNC PATTERN	INVALID SECTOR ADDRESS	0	SEEK ERROR	BUSY (1) READY (0)	0	END OF FILE	CHECKSUM ERROR	EXPANDED STATUS ACTIVE	FILE UNSAFE	READ ONLY	SELECTED DRIVE ON-LINE
LINE PRINTER: MODELS 4005 4006	COMMAND WORD																	PAPER FEED MODE	VERTICAL FORMAT CONTROL	UNCONDI-TIONAL TOP-OF-FORM	PRINT AND FILL COMMAND	RESET BUFFER	SELECT TROUBLE INTERRUPT	SELECT READY INTERRUPT	INTERRUPT CONTROL
	STATUS WORD																					BUSY	SLEWING/ DATA	PRINTING/ DATA	UNIT ON-LINE
LINE PRINTER: MODEL 4010	COMMAND WORD																	VFC SELECT	VFC MODE	0	PRINT	CLEAR PRINT BUFFER	SELECT TROUBLE INTERRUPT	SELECT READY INTERRUPT	INTERRUPT CONTROL
	STATUS WORD																						TROUBLE	BUSY	UNIT ON-LINE
LINE PRINTER: MODEL 4020	COMMAND WORD																				RESET CONTROLLER BUFFER	MODE SELECT	SELECT TROUBLE INTERRUPT	SELECT READY INTERRUPT	INTERRUPT CONTROL
	STATUS WORD																					INTERFACE VERIFICA-TION	TROUBLE CONDITION	PRINTER READY	UNIT ON-LINE
MOVING HEAD DISC: MODELS 5100 5110 5112 5114	COMMAND WORD	0 0 SEEK 0 1 0 1 WRITE EOF 1 0 1 0 READ 1 1 1 1 WRITE * 0 0 RESTORE 0 1 0 PRESENT EXPANDED STATUS 1			DRIVE ADDRESS			CYLINDER ADDRESS								1	1	TRACK ADDRESS			SECTOR ADDRESS				
	STATUS WORD										CYLINDER ADDRESS MISMATCH	TRACK ADDRESS MISMATCH	SECTOR ADDRESS MISMATCH	NO SECTOR SYNC PATTERN	INVALID SECTOR ADDRESS	CYLINDER MISMATCH FROM DRIVE	SEEK ERROR	BUSY/ READY	READ/ WRITE UNDER-FLOW	END OF FILE	RFAD CHECKSUM ERROR	EXPANDED STATUS ACTIVE	DRIVE UNSAFE	READ ONLY	DRIVE ON-LINE
FIXED HEAD DISC: MODELS 5300 72008, H	COMMAND WORD	0 0 NO OPERATION 0 1 0 0 WRITE EOF 1 1 1 1 READ 0 1 1 1 WRITE 1 1 0 PRESENT SECTOR STATUS 0		0 1	UNIT ADDRESS UNIT ADDRESS			HEAD ADDRESS									SECTOR ADDRESS										
	STATUS WORD																	BUSY	INVALID SECTOR ADDRESS	END OF FILE	CHECKSUM ERROR	SECTOR ADDRESS ERROR	HEAD ADDRESS ERROR	READ ONLY	DRIVE ON-LINE
CARD PUNCH: MODELS 3170 3172	COMMAND WORD																		CLEAR PUNCH MEMORY	SKIP	PUNCH FEED	PUNCH OFF-LINE	SELECT READY INTERRUPT	0	INTERRUPT CONTROL
	STATUS WORD																				PUNCH READY	PUNCH ON-LINE	BUFFER READY	TROUBLE	CONTROLLER ON-LINE
MAGNETIC TAPE TRANSPORT: MODELS 6007 6008 6009 6010	COMMAND WORD	ABC CONTROL								EDIT	PARITY	DENSITY SELECT		CHARACTERS PER WORD		OPERATION CODE				TRANSPORT ADDRESS			SELECT TROUBLE INTERRUPT	SELECT READY INTERRUPT	INTERRUPT CONTROL
	STATUS WORD																	BUSY	LOAD POINT	END OF FILE	END OF TAPE	READ OVERFLOW	TROUBLE	FILE PROTECTED	ON-LINE
		23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

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Figure 2. Standard Command and Status Word Formats

Each page of the description has a heading in the upper right hand corner of the page which has the format:

Device Name
Sheet____of____

The descriptions are, for the most part, self-contained. Any references to other devices are references to programming examples.

1. KEYBOARD/PRINTER

Model 6001-1	(ASR-33)
Model 6001-2	(ASR-35)
Model 6001-3	(KSR-35)
Model 6001-510	(ASR-33)

2. GENERAL

The various keyboard/printers provide basic, low-speed data input and output functions for the computer.

The Model 6001-510 is used with the DC 6024/5 computer only. All other models may be used with any DC 6024 computer.

All models operate from an 8-bit I/O channel.

3. PROGRAM CONTROLLED OPERATION

The standard channel/unit assignment is channel Ø, unit Ø.

The keyboard/printers respond to the following I/O instructions:

OCW
ODW
IDW
ISW

4. COMMAND WORD FORMAT

The command word format is shown in Figure 1. Note that the print function requires no command word output.

When the interrupts are selected and enabled, an input interrupt will occur when a character has been read from the keyboard or reader. An output interrupt will occur when a character has been printed.

Note that each condition indicates a "ready" status; i.e., the device is ready to accept another character or ready to give another character.

5. STATUS WORD FORMAT

The status word format is shown in Figure 2.

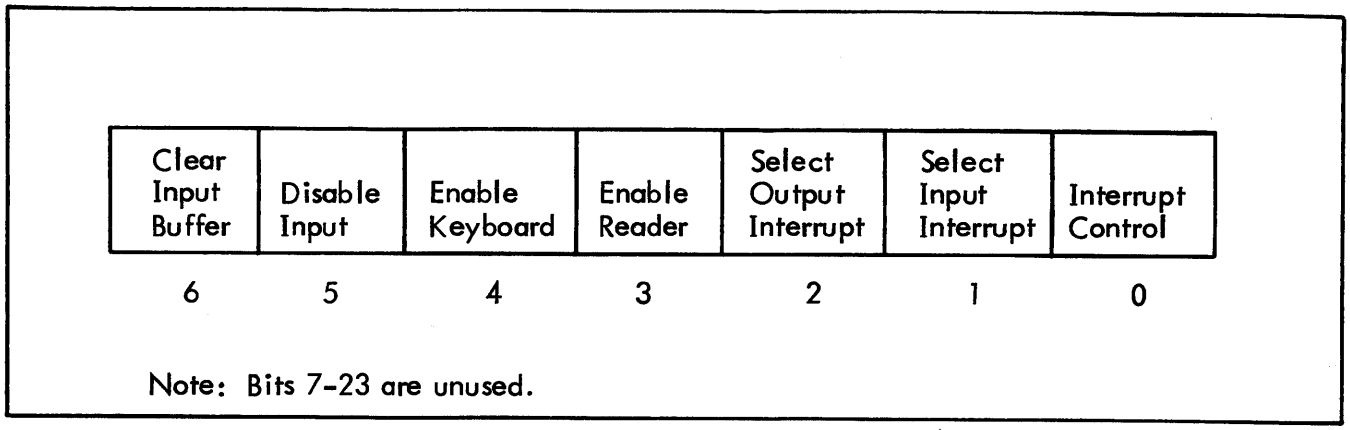

Figure 1. Keyboard Printer Command Word

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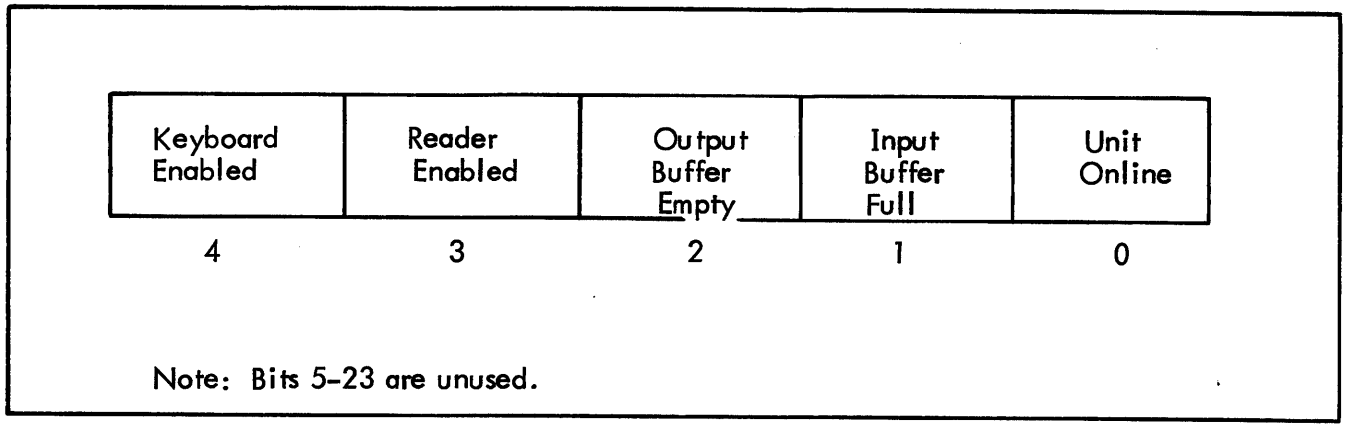

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Figure 2. Keyboard Printer Status Word

The "Keyboard Enabled" status and the "Reader Enabled" status are mutually exclusive.

6. EXAMPLES

The following examples illustarte various combinations of I/O instructions to the device.

Example 1: Enable Keyboard and Enable Input Interrupt

```
TOA    '23
OCW    Ø
BNZ    *-1
```

Example 2: Enable Reader, Disable Input Interrupt

```
TOA    '12
OCW    Ø
BNZ    *-1
```

Example 3: Enable Keyboard, clear Input Buffer, Disable Interrupts, get a character and print it.

```
TOA    '126
OCW    Ø
BNZ    *-1
IDW    Ø          GET A CHARACTER
BNZ    *-1
ODW    Ø          PRINT IT
BNZ    *-1
BUC    *-4        DO IT SOME MORE
```

7. SUMMARY OF SPECIFICATIONS

Models 6001-1, 6001-2 and 6001-51 can be used in both on-line and off-line operations. In the on-line mode, the units operate in conjunction with the computer under program control. The off-line mode allows the paper tape reader and punch to duplicate an existing tape or the keyboard and paper tape punch may be employed to prepare a tape. A facility for monitoring the tape preparation is provided by the typing unit.

The Teletypewriter is character oriented and operates with characters containing up to eight bits. A character generated by the paper tape reader or keyboard is loaded into the input data buffer prior to transfer to the computer. A character generated by the computer is loaded into the output data buffer and subsequently operates the typewriter's typing unit and paper tape punch. Both input and output characters are right justified in the 24-bit data word.

For input operations, the paper tape reader and keyboard function as separate and mutually exclusive devices. When executing output data transfers, the computer regards the typing unit and paper tape punch as a single device. The typing unit and paper tape punch function simultaneously, unless the punch is manually turned off. All data characters will be punched regardless of whether it is a printable character or a control character. All printing, punching and carriage control functions are initiated by a data character.

The major operating characteristics of the ASR-33, ASR-35, and KSR-33 Teletypewriter are:

Typing Unit

Number of printable characters	63
Number of characters per line	72
Operating Speed	10 characters/second
Vertical Spacing	6 lines/inch

Typing Unit (Cont'd.)

Horizontal Spacing	10 characters/inch
Page Required	Standard roll, 8 1/2 inches wide, five inches in diameter

Paper Tape Punch

Levels	8
Operating Speed	10 characters/second
Bits per character	8-bits (ASCII code) 7-bits + parity
Tape packing density	10 characters' inch

Paper Tape Reader (ASR Models Only)

Operating Speed	10 characters/second (OFF-LINE operation) 20 characters/second (ASR-33) 10 characters/second (ASR-35) (ON-LINE operation)
Tape	1-inch wide paper or mylar
Tape leader	3-inch minimum

The character set is shown in Table 1.

Table 1. Character Set

Symbol or Function	Octal Code	Symbol or Function	Octal Code	Symbol or Function	Octal Code
A	301	O	317	1	261
B	302	P	320	2	262
C	303	Q	321	3	263
D	304	R	322	4	264
E	305	S	323	5	265
F	306	T	324	6	266
G	307	U	325	7	267
H	310	V	326	8	270
I	311	W	327	9	271
J	312	X	330		
K	313	Y	331	@	300
L	314	Z	332	[	333
M	315			\	334
N	316	0	260	]	335

Table 1. Character Set (Cont'd)

Symbol or Function	Octal Code	Symbol or Function	Octal Code	Symbol or Function	Octal Code
↑	336	(	250	<	274
←	337	)	251	=	275
SPACE	240	*	252	>	276
!	241	+	253	?	277
"	242	,	254	Carriage Return*	215
#	243	-	255	Line Feed*	212
$	244	.	256	Bell*	207
%	245	/	257	Delete*	377
&	246	:	272		
'	247	;	273	*Does not produce a printed character.	

1. PAPER TAPE READERS

Model 6002-10 (Digitronics 2540) 300 cps.

Model 6002-20 (Digitronics 2540) 600 cps

2. GENERAL

The paper tape readers provide medium-speed data input functions for the computer. The paper tape readers operate from an 8-bit I/O channel.

3. PROGRAM-CONTROLLED OPERATION

The standard channel/unit assignment is channel 1, unit Ø.

The paper tape reader responds to the following I/O instructions:

OCW
IDW
ISW

4. COMMAND WORD FORMAT

The command word format is shown in Figure 1.

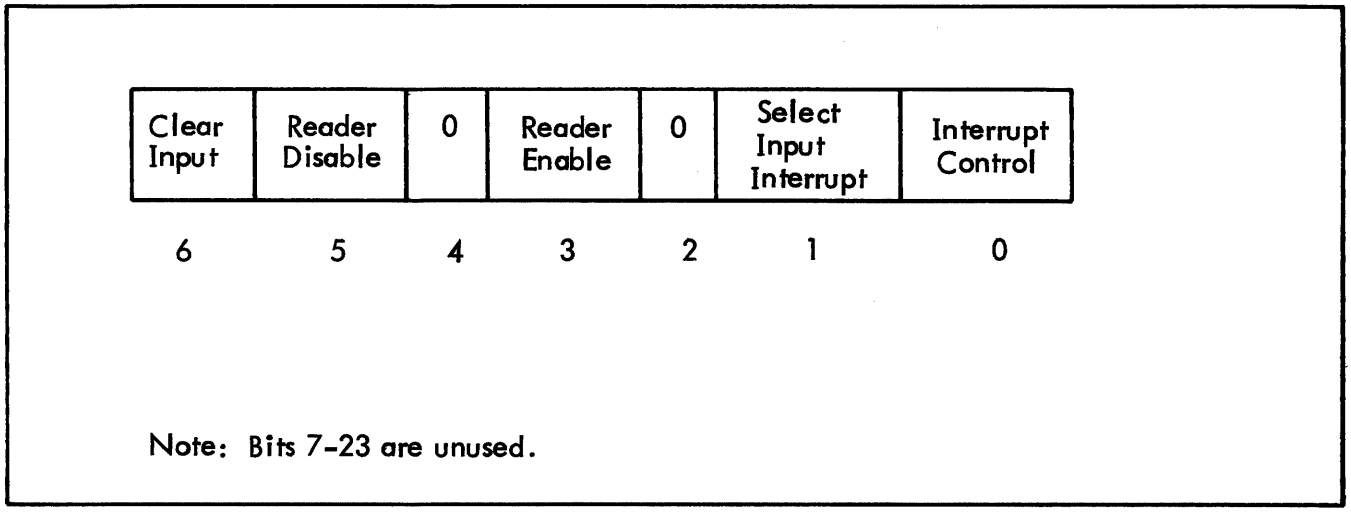

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Figure 1. Paper Tape Reader Command Word

When the interrupt is selected and enabled, an interrupt will occur when a character has been read.

When the reader is enabled, the condition of the input buffer determines whether or not a character is read. If the buffer is empty, the tape advances one frame and a character is read into the buffer. When the buffer is cleared, e.g., by an IDW instruction, the tape will again advance and read a character.

In order to prevent the tape from advancing after reading a character, a Reader Disable command must be issued within 400 microseconds of the last IDW instruction execution to prevent tape motion.

5. STATUS WORD FORMAT

The status word format is shown in Figure 2.

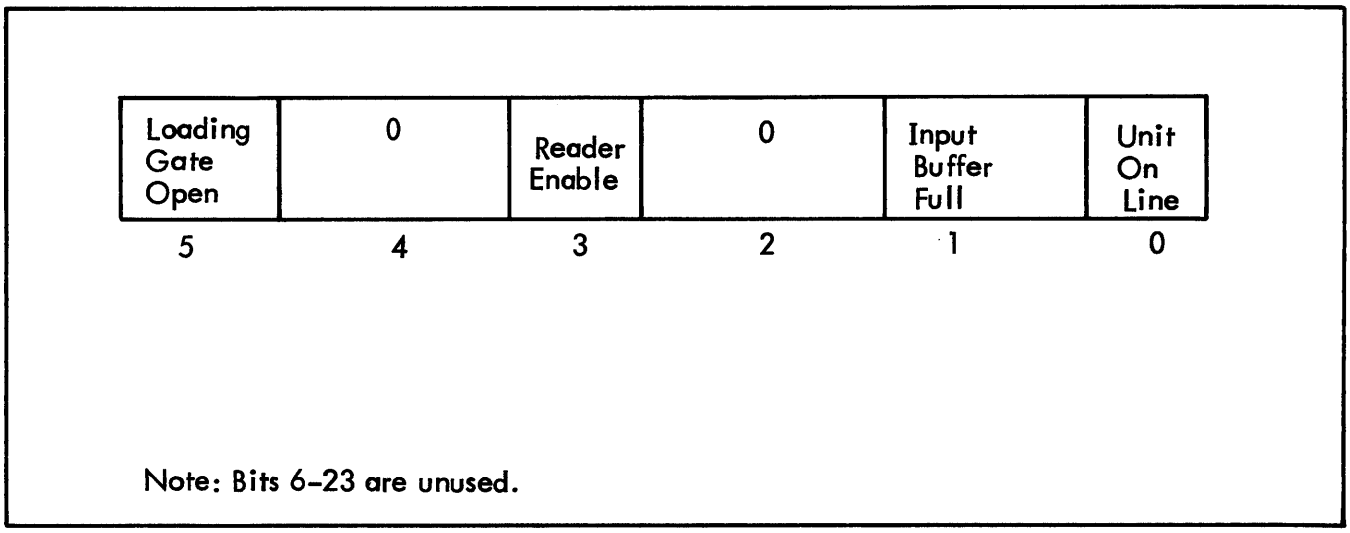

Figure 2. Paper Tape Reader Status Word

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6. EXAMPLES

The following examples illustrate various combinations of I/O instructions to the device.

Example 1: Clear input buffer, enable interrupt

```
TOA     '103
OCW     '100
BNZ     *-1
```

Example 2: Read one character and stop, no interrupt operation.

```
TOA     '112
OCW     '100
BNZ     *-1
IDW     '100
TAI
TOA     '40
OCW     '100
BNZ     *-1
```

Example 3: Read a record of up to 72 characters, pack 3 c/w. End-of-record is a carriage return character ('215). First character of record may have a Line-Feed character ('212). If less than 72 characters are read, insert blanks in remainder of word and/or buffer. Non-interrupt operation.

LABEL 1	OPERATION 9	OPERAND AND COMMENTS 15	
*EXAMPLE	3	PAPER TAPE READER	
	TNI	24	WORD COUNT
	TOA	'111	INITIAL SETUP
	OCW	'100	
	BNZ	*-1	
	TNJ	3	CHARACTER COUNT
SHIFT	LLA	8	
	IDW*	'100	GET CHARACTER, MERGE
	BNZ	*-1	
	COB	0	IS THIS LEADER?
	BOZ	*-3	YES, IGNORE IT
	TME	BUC	NO, FIRST CHARACTER
	TEM	*-3	REPLACE COB WITH BUC A
A	COB	'212	IS IT A LINE FEED?
	BOZ	SHIFT+1	YES, IGNORE IT
	COB	'215	IS IT A CARRIAGE RETURN?
	BOZ	END	YES
	BWJ	SHIFT	NO, COUNT IT
	TAM	BUFF+24,I	SAVE 3 CHARACTERS
	BWI	SHIFT-1	COUNT THE WORD
* IF THE WORD COUNT GOES TO 0 THE NEXT CHARACTER SHOULD BE			
* THE CARRIAGE RETURN. THIS EXAMPLE ASSUMES THE CR IS THERE.			
* FOR AN OPERATIONAL VERSION OF THIS PROGRAM, A TEST AND ERROR			
* SEQUENCE SHOULD BE INSERTED.			
	IDW	'100	GET CR
	BNZ	*-1	
	BUC	DONE	
END	TOB	'40	REPLACE CR WITH BLANK
	AOJ	1	MODIFY CHARACTER COUNT
	BOZ	SAVE	
	LLA	8	
	TOB	'40	FILL WORD WITH BLANKS
	BWJ	*-2	
SAVE	TAM	BUFF+24,I	SAVE LAST 3 CHARACTERS
	AOI	1	MODIFY WORD COUNT
	BOZ	DONE	
	TMA	="###"	
	TAM	BUFF+24,I	FILL REST OF BUFFER WITH BLANKS
	BWI	*-1	
DONE	TOA	'40	DISABLE READER
	OCW	'100	
	BNZ	*-1	
	TMA	COB	
	TAM	A-4	RE-INSERT COB 0
*			
* END OF INPUT -		- - -	
*			
BUC	BUC	A	
COB	COB	0	
BUFF	BLOK	24	
	END		

Note that, with minor changes, this example will work on the Keyboard/Printer or on the Paper Tape Reader Models 2005, 2015 and 2020.

7. SUMMARY OF SPECIFICATIONS

The paper tape reader operates with 8-bit characters. A character, generated by reading and perforated tape, is read into the input data buffer. The 8-bit character is subsequently transferred to the computer via the input/output channel. Each character is right justified in the 24-bit data word.

The Model 6002 Paper Tape Reader major operating characteristics are as follows:

Drive	Unindirectional
Operating Speed	300 characters/second (Model 6002-10) 600 characters/second (Model 6002-20)
Tape	Paper, Paper-Mylar, aluminized mylar or solid mylar; 0025 to .005 inch thick.

1. PAPER TAPE PUNCH

Model 6003-1 (Teletype Model BRPE)

2. GENERAL

The paper tape punch provides high-speed paper tape output. The punch operates at 110 characters per second.

The paper tape punch operates from an 8-bit I/O channel.

3. PROGRAM-CONTROLLED OPERATION

The standard channel/unit assignment for the paper tape punch is channel 1, unit 1.

The punch responds to the following I/O instructions:

OCW
ODW
ISW

4. COMMAND WORD FORMAT

The command word format is shown in Figure 1.

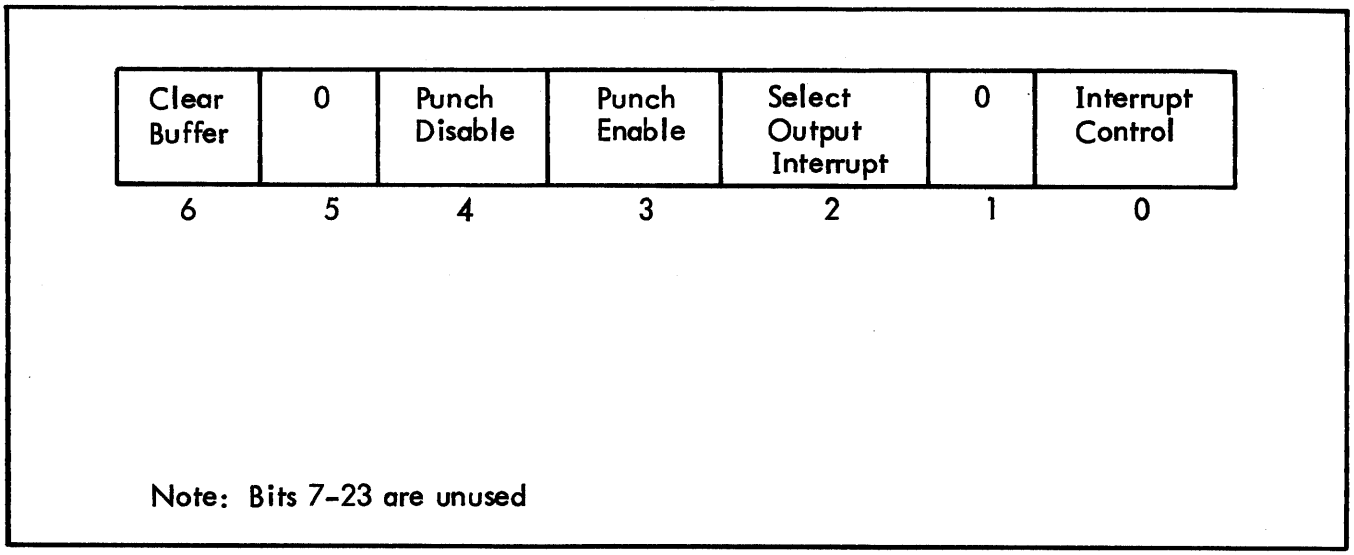

Figure 1. Paper Tape Punch Command Word MI1162-373

When the interrupt is selected and enabled, an interrupt will occur when the device has punched the character in the buffer, ie., when the buffer is clear.

5. STATUS WORD FORMAT

The status word format is shown in Figure 2.

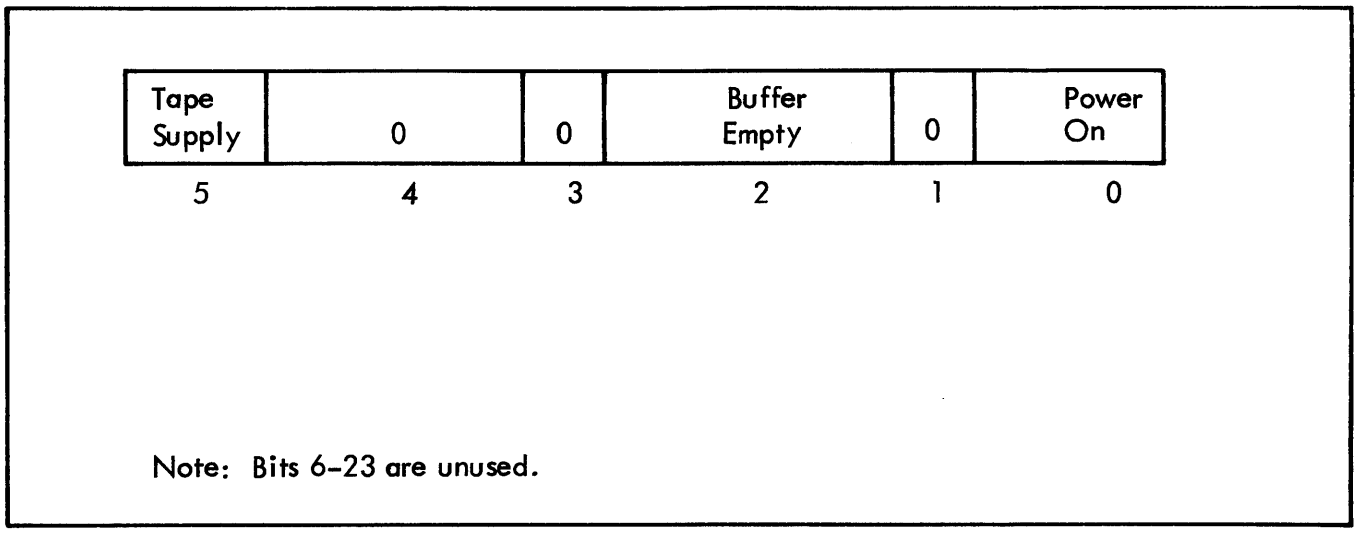

Figure 2. Paper Tape Reader Status Word

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6. EXAMPLES

The following examples illustrate various combinations of I/O instructions to the device.

Example 1: Clear buffer, enable punch, enable interrupt (Note that an interrupt will occur immediately because the buffer was cleared).

```
TOA    '115
OCW    '101
BNZ    *-1
```

Example 2: Clear buffer, enable punch, disable interrupt, punch 3 characters, disable punch.

```
TOA    '114
OCW    '101
BNZ    *-1
TMA    WORD
TNI    3
LRA    8
ODW    '101
BNZ    *-1
BWI    *-3
TOA    '20
OCW    '101
BNZ    *-1
```

7. SUMMARY OF SPECIFICATIONS

The major operating characteristics of the paper tape punch are as follows:

Punching Speed	110 Characters/Second
Tape Levels	5, 6, 7, or 8 with in-line feed holes and 6 with advanced feed hole.
Tape	5 level (11/16 inch), 6 and 7 level (7/8 inch), and 8 level (1 inch)

1. PAPER TAPE SYSTEM

Model 2015 (Remex Reader and Punch)

2. GENERAL

The Model 2015 Paper Tape System provides medium-speed input-output capability via paper tape for the 6024/5 computer. The reader and punch are bidirectional. The Reader operates at 300 characters per second and the punch operates at 75 characters per second. The system operates from an 8-bit I/O channel.

3. PROGRAM CONTROLLED OPERATION

The paper tape system responds to the following I/O instructions:

OCW
ODW
IDW
ISW

The paper tape reader's channel/unit assignment is channel 1, unit 0 and the punch is assigned to channel 1, unit 1.

4. COMMAND WORD FORMAT

The command word formats for the reader and the punch are shown in Figure 1.

When the input interrupt is selected and enabled, an interrupt will occur when a character has been read.

When the reader is enabled the condition of the input buffer determines whether or not a character is read. If the buffer is empty, the tape advances one frame and a character is read. When the buffer is cleared by a command e.g., IDW 100, the tape will then advance and read the next character.

In order to prevent the tape from advancing after reading a character, a Reader Disable command must be issued within 400 microseconds after the read command.

When the output interrupt is selected and enabled an interrupt occurs when the unit is ready to accept a character for punching, i.e., when the buffer is empty.

5. STATUS WORD FORMAT

The status word format for the reader and for the punch is shown in Figure 2.

Forward (0) Reverse(1)	Clear Buffer	Disable Reader	0	Enable Reader	0	Select Input Interrupt	Interrupt Control
7	6	5	4	3	2	1	0

Note: Bits 8-23 are unused.

a. Reader Command Word

Forward (0) Reverse (1)	0	0	0	0	Select Output Interrupt	0	Interrupt Control
7	6	5	4	3	2	1	0

Note: Bits 8-23 are unused.

Figure 1. Command Words

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Direction (0 = Forward)	Reader Enabled	0	Input Buffer Full	Reader System On
4	3	2	1	0

Note: Bits 5-23 are unused.

a. Reader Status Word

Tape Low	Tape Handling Error	0	Output Buffer Empty	0	Punch System On
5	4	3	2	1	0

Note: Bits 6-23 are unused

Figure 2: Status Words

MI1165-373

6. EXAMPLES

Refer to the Paper Tape Reader description for reader programming examples. The programming considerations for this model Reader are the same as those of the Model 6002 Readers.

Refer to the Paper Tape Punch description for punch programming examples. The only changes in the examples given are to delete the Clear Buffer bit and the punch enable/disable functions, since the Remex unit does not respond to those commands.

7. SUMMARY OF SPECIFICATIONS

The major operating characteristics of the Model 2015 Paper Tape System are as follows:

Reader Speed	Up to 300 characters per second
Punch Speed	Up to 75 characters per second
Mounting	18" rack. Usually installed in the 6024/5 cabinet.

1. CARD READERS

Model 3010 (Documation M-200, 300 cards per minute)

Model 3020 (Documation M-600, 600 cards per minute)

Model 3030 (Documation M-1000, 1000 cards per minute)

2. GENERAL

The card readers provide low, medium and high-speed punched card data input to the DC 6024 computers. The punched cards are 80-column, 12-row standard cards.

The card readers operate from a 24-bit I/O channel. An ABC channel can also be used, although it is not done on standard systems.

3. PROGRAM-CONTROLLED OPERATION

The standard channel/unit assignment for the card reader is channel 4, unit Ø.

The card reader responds to the following I/O channel instructions.

OCW
IDW
ISW

4. COMMAND WORD FORMAT

The command word format for the card reader is shown in Figure 1.

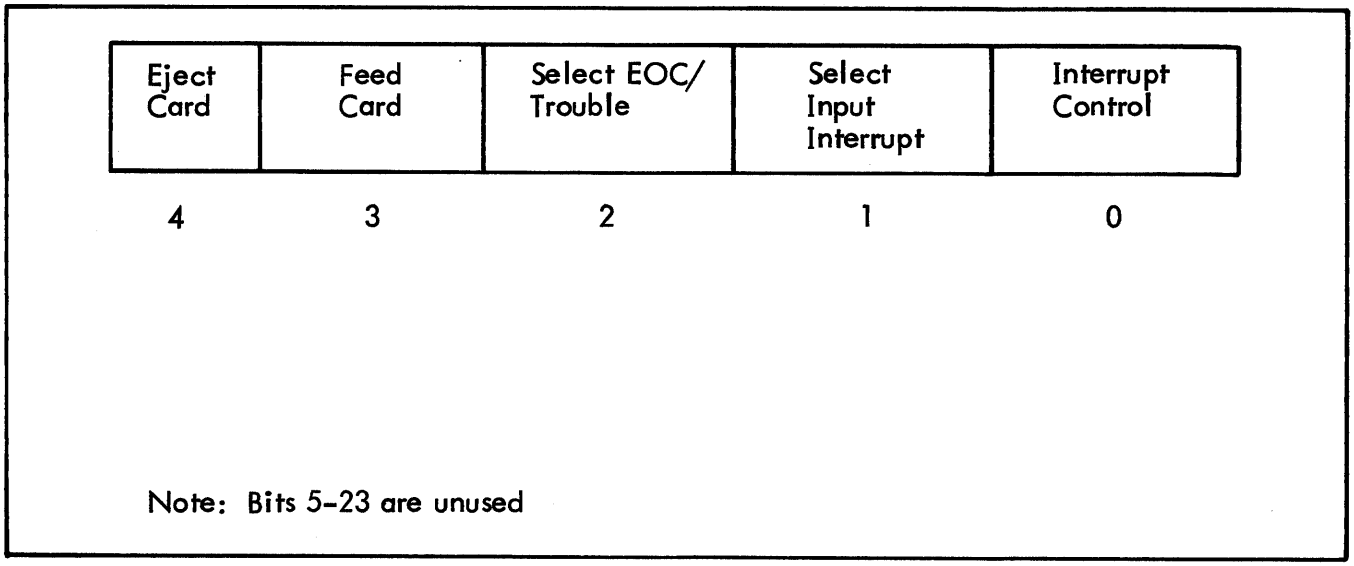

Figure 1. Card Reader Command Word

The Card Readers generate a 12-bit character by sensing the presence of holes in each of the 12 rows of each column of a punched card. Each row in a card column corresponds to a specific bit in the computer word. Table 1 illustrates the relationship between card row and computer bit. Also shown in the examples are several data characters, their octal presentation and the corresponding binary word. Each "1" in the binary word represents a punched hold in the card. Comparing the "1s" in a binary word to the corresponding card row will determine which row(s) in a column will contain a punched hole.

Table 1. Data Character Bit Sequence

Computer Word Bit	11	10	9	8	7	6	5	4	3	2	1	0
Corresponding Card Row	12	11	0	1	2	3	4	5	6	7	8	9
Character A (4400_8)	1	0	0	1	0	0	0	0	0	0	0	0
Character Z (1001_8)	0	0	1	0	0	0	0	0	0	0	0	1
Character + (4012_8)	1	0	0	0	0	0	0	0	0	0	1	0
Character @ (0042_8)	0	0	0	0	0	0	1	0	0	0	1	0

Each time a card column is read, a character is generated and loaded into the input data buffer. The character is subsequently transferred to the computer as the least signifcant half (Bit 0-11) of the 24-bit data word.

When the input interrupt is selected and enabled an interrupt will occur each time a character is read. Note particularly that the interrupt occurs because a character has been read by the reader and not because the buffer is full as happens in the paper tape readers. The program must input the column prior to the arrival of the next column, or data will be lost.

An End-of-Card (EOC) interrupt is available and occurs on the same level as the input interrupt, however, the EOC interrupt is selected by setting bit 2 (Select Trouble Interrupt). If the input and EOC interrupts are active, then a total of 81 interrupts occur when reading a card, assuming a full 80-columns are read and no errors occur.

The Trouble Interrupt occurs when there is a read error (light current or dark current) or a card jam. The Trouble interrupt is on the same level as the input interrupt, i.e. The EOC, input and Trouble interrupts are ORed together on the same interrupt line.

The Eject Card command inhibits the remainder of the card data from entering the buffer and thereby prevents any more input interrupts. The EOC interrupt is not inhibited by the Eject command.

5. STATUS WORD FORMAT

The status word format is shown in Figure 2.

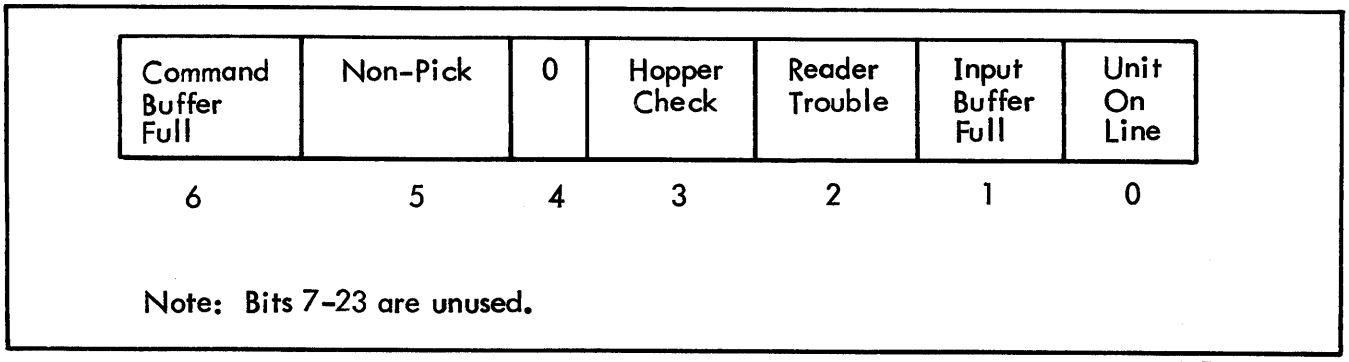

Figure 2. Card Reader Status Word MI1167-373

The Hopper Check indicates the input hopper is empty or the Stacker is full.

The Non-Pick bit indicates a pick failure or a stacker problem.

The Command Buffer Full bit indicates that a Feed Command is pending.

6. EXAMPLES

The following examples illustrate various combinations of I/O instructions to the device.

Example 1: Disable interrupts, feed a card, read 20 columns and eject the card.

This example uses the status word for testing the buffer. This was done because of the other tests requiring status input.

Example 2: Read a Card, pack 2 characters per word. Use interrupts. Assume Group 1, Level 10 is the card reader input/trouble interrupt. Note that the initialization routine clears the buffer. This can be avoided by changing the interrupt routine so that the previous contents of the buffer are shifted prior to the tests, e.g.

```
        TMA*    BUFFAD
        LLA     12
        IDW*    400
        BNZ     *-1
        TAM*    BUFFAD
        CZM     FLAG        IS THE FLAG SET?
        BOZ     SETF        NO
        TZM     FLAG        YES, RESET IT
        AUM     BUFFAD      MODIFY ADDRESS
        TMA     SAVEA
        BRL*    CARDPI
SETF    TFM     FLAG        SET FLAG
        BUC     *-3
```

With this method, reading less than 80 columns leaves the remaining words in the buffer in their prior condition.

LABEL	OPERATION	OPERAND AND COMMENTS
* EXAMPLE 1		CARD READER
	TOA	'16
	OCW	'4ØØ
	BNZ	*-1
	TNI	2Ø SET UP COLUMN COUNT
LOOP	ISW	'4ØØ
	BNZ	*-1
	QBB	B5 B3 B2 ANY PROBLEMS?
	BNZ	ERROR YES
	QBB	B6 HAS CARD FEED STARTED?
	BNZ	LOOP NO, WAIT FOR IT
	QBB	B1 IS THERE A CHARACTER IN THE BUFFER?
	BOZ	LOOP NO
	IDW	'4ØØ YES
	BNZ	*-1
	TAM	BUF+2Ø,I SAVE IT
	BWI	LOOP
	TOA	'2Ø EJECT THE CARD
	OCW	'4ØØ
	BNZ	*-1
* END OF INPUT		
	HLT	
* ERROR HANDLING AND RECOVERY ROUTINE SHOULD		
* BE INSERTED HERE		
ERROR	NOP	
	BUC	LOOP-4 RESTART
*		
BUF	BLOK	2Ø
	END	

LABEL 1	OPERATION 9	OPERAND AND COMMENTS 15	
*EXAMPLE	Z	CARD READER	
*SET UP DEDICATED		LOCATION FOR GROUP 1, LEVEL 10 PI	
	AORG	'102	
	BSL	CARDPI	
*INITIALIZE			
	AORG	'200	
EXAMP2	TOA	'17	
	OCW	'400	
	BNZ	*-1	
	TOA	'2000	
	UDI		
	UAI		ARM PI
	UEI		ENABLE IT
	TLO	BUF	
	TKM	BUFFAD	SAVE BUFFER ADDRESS
	TZA		
	TAM	FLAG	CLEAR SHIFT FLAG
	TNI	40	
	TAM	BUF+40,I	CLEAR BUFFER
	BWI	*-1	
	BUC	*	WAIT FOR PI
*			
CARDPI	NOP		
	TAM	SAVEA	
	ISW	'400	
	BNZ	*-1	
	QBB	B5B3B2	ANY PROBLEMS
	BNZ	ERROR	YES
	QBB	B1	CHARACTER INTERRUPT?
	BOZ	EOC	NO, MUST BE END OF CARD
	TMA*	BUFFAD	GET PREVIOUS CHARACTER
	CZM	FLAG	SHIFT REQUIRED?
	BOZ	SETF	NO, FLAG NOT SET
	LLA	12	YES
	TZM	FLAG	RESET FLAG
	BUC	*+2	
SETF	TFM	FLAG	SET FLAG
	IDW*	'400	GET THE NEW CHARACTER
	BNZ	*-1	
	TAM*	BUFFAD	SAVE IT.
	CZM	FLAG	
	BNZ	*+2	
	AUM	BUFFAD	FLAG IS RESET, MOVE ADDRESS POINTER
	TMA	SAVEA	
	BRL*	CARDPI	
EOC	TOA	'2000	
	UDI		DISABLE LEVEL
	BRI*	CARDPI	
* ERROR ROUTINE		SHOULD BE INSERTED HERE	
ERROR	***	0	
*			
SAVEA	BLOK	1	
BUF	BLOK	40	
BUFFAD	DAC	BUF	
	END		

7. SUMMARY OF SPECIFICATIONS

The major operating characteristics of the Models 3010, 3020, and 3030 Card Readers are listed below. Differences among the three models are identified.

Reading Speed (Cards per minute)	300 cards nominal (Model 3010) 600 cards nominal (Model 3020) 1,000 cards nominal (Model 3030)
Card Characteristics	Standard 80-Column cards (per EIA Std. R5292)
Supply Hopper Capacity	550 Cards (Model 3010) 1,000 Cards (Model 3020 and 3030) (can be replenished during operation)
Stacker Capacity	550 Cards (Model 3010) 1,000 Cards (Model 3020 and 3030)
Read Sensing	Photoelectric

1. LINE PRINTERS, LOW SPEED

Model 4005 (Potter LP3000, 135 lpm)

Model 4006 (Potter LP3300, 300 lpm)

2. GENERAL

These line printers provide low-speed printed output for the DC 6024 computers. The Model 4005 operates at 135 lines per minute and the Model 4006 operates at 300 lines per minute.

The printers operate from an 8-bit I/O channel.

3. PROGRAM-CONTROLLED OPERATION

The standard channel/unit assignment for the printer is channel 3, unit 0.

The printer responds to the following I/O instructions:

OCW
ODW
ISW

4. COMMAND WORD FORMAT

The command word formats for the printer are shown in Figures 1 and 2. The command word operates in one of two modes determined by bit 7. When bit 7 is a zero, the command mode is in effect. When bit 7 is a one, the Vertical Format Control (VFC) mode is in effect. The VFC mode permits program controlled selection of one of four channels on the control tape in he printer or an "advance n lines" function.

When the Ready interrupt is selected and enabled, an interrupt occurs when:

1. The printer is ready to accept an ODW or OCW, if the last command issued was not a VFC command, i.e., after a print/advance is completed.

2. The printer is slewing and is ready to accept data, i.e., after paper motion has started the printer buffer is available for filling and printing or the printer is able to accept another VFC mode command.

The printer buffer is automatically cleared after each print command. An automatic print cycle occurs when the buffer is full, i.e., has 132 characters in it.

If the TOP OF FORM command is issued, no other data transfers may take place until paper motion is completed, therefore it is recommended that a VFC mode command be used to set TOP-OF-FORM. The printer handler in all Datacraft software systems does not use the TOF command.

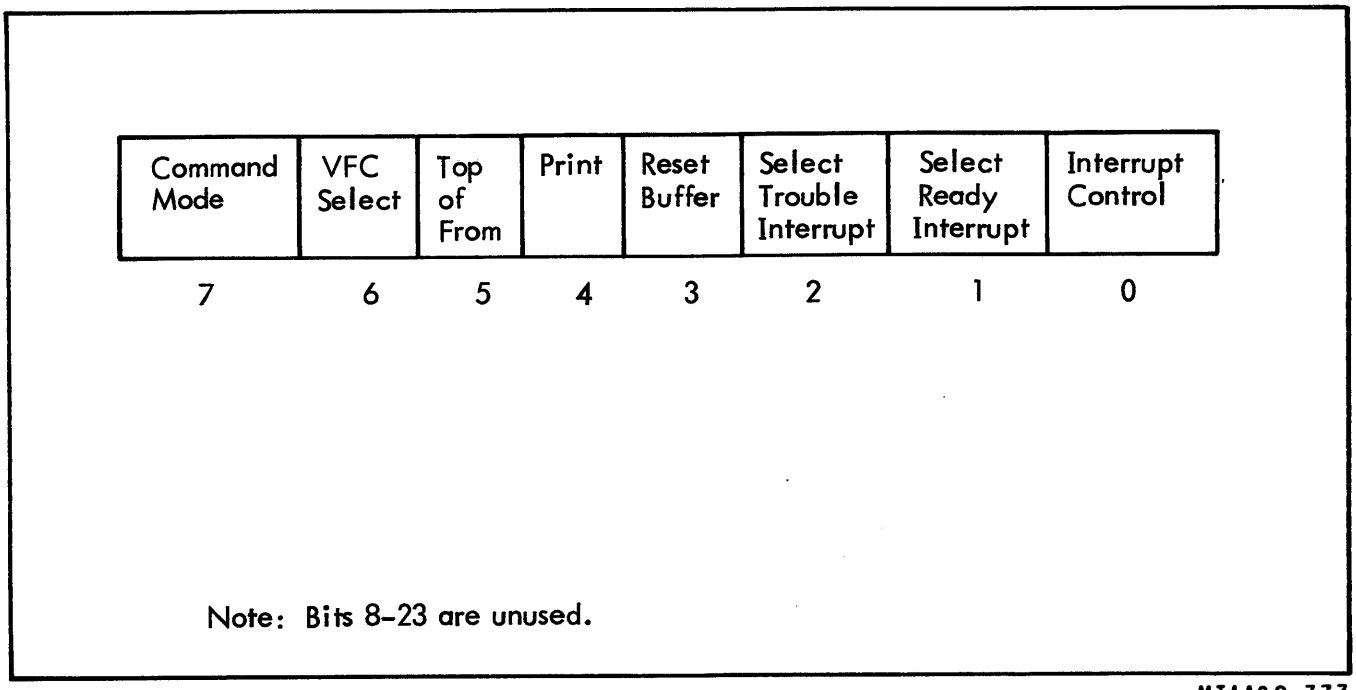

Figure 1. Line Printer Command Word – Command Mode

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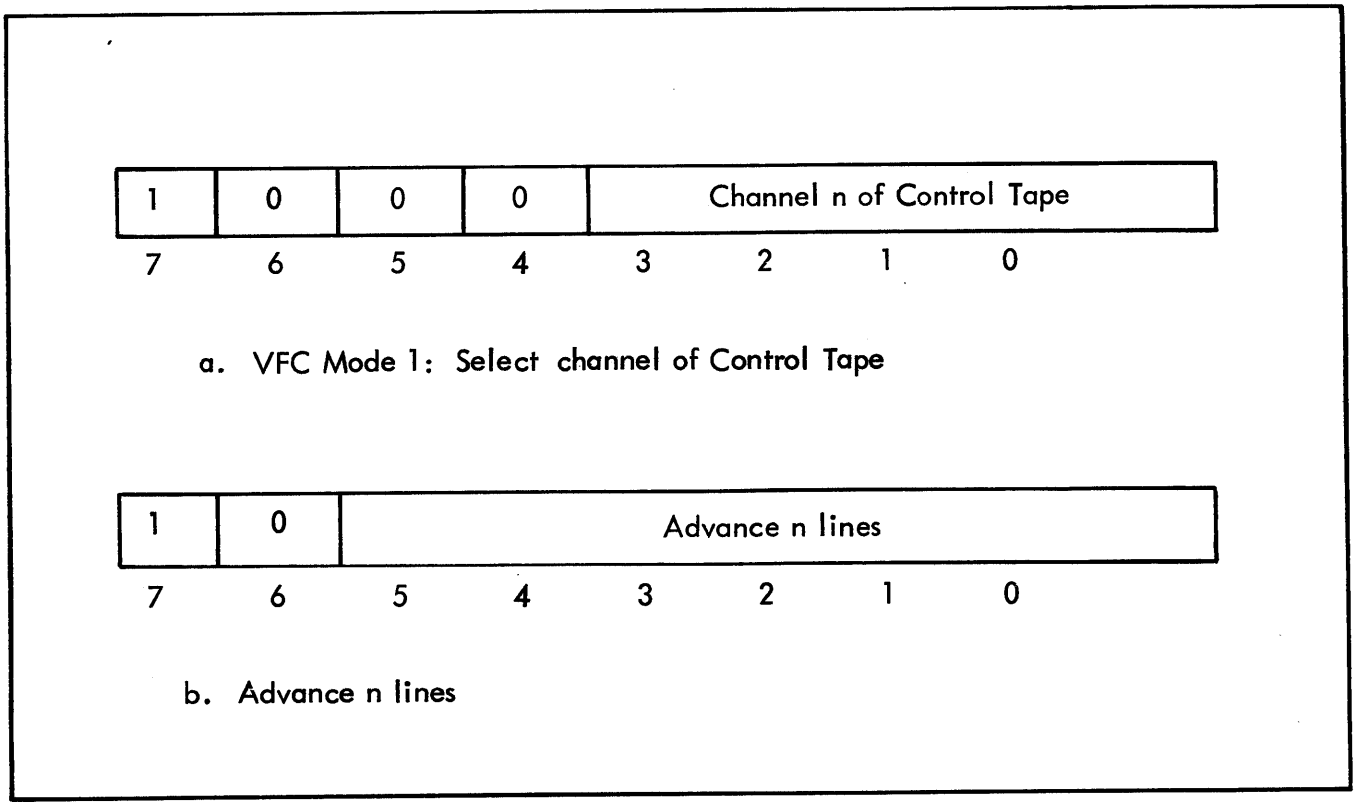


Figure 2. Line Printer Command Word – VFC Mode

MI1169-373

When the trouble interrupt is selected and enabled, an interrupt occurs when the yoke is open or a low paper or no paper condition exists.

5. STATUS WORD FORMAT

The status word format is shown in Figure 3.

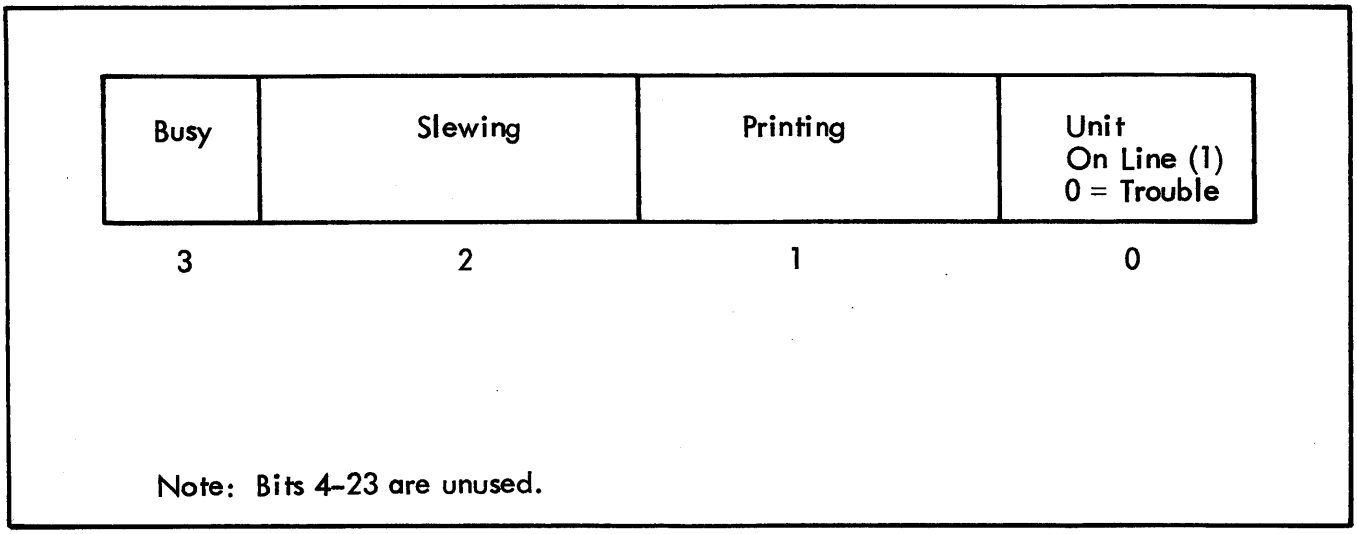


Figure 3. Line Printer Status Word

MI1170-373

6. EXAMPLES

The following example illustrates the use of I/O instructions for the printer.

Example: Move paper to Top of form, fill the buffer and print a line. Use interrupts. Assume group 1, level 10 interrupt.

7. SUMMARY OF SPECIFICATIONS

The major operating characteristics of the Models 4005 and 4006 are:

Printing Speed	135 lines per minute (Model 4005) 3001 lines per minute (Model 4006)
Characters	64 (ASCII)
Bits per Character	6
Characters per Line	132
Paper Width	4-20 inches
Character Set	

```
*EXAMPLE  1     POTTER PRINTER
LP        EQIV  '300
          AORG  '102
          BSL   PRINT
          AORG  '200
          TOA   '2000
          UDI
          UAI
          UEI
          TOA   '201        VFC MODE - SELECT CHANNEL 1
          OCW   LP
          BNZ   *-1
          TOA   '13         CLEAR BUFFER, SELECT INTERRUPT
          OCW   LP
          BNZ   *-1
          BUC   *           WAIT FOR READY INTERRUPT
*
PRINT     NOP
          TAM   SAVEA
          TIM   SAVEI
          TOA   '2000
          UII               GO TO PERMISSIVE MODE
          TNI   132
          ISW   LP
          BNZ   *-1
          QBB   B1          TROUBLE?
          BOZ   ERROR       YES
          TMA   BUF+132,I
          ODW   LP          FILL PRINT BUFFER
          BNZ   *-1
          BWI   *-3
          TOA   B10
          UEI
          TOA   '20         PRINT-NEXT INTERRUPT OCCURS WHEN
          OCW   LP          PRINT IS COMPLETE, I.E., AFTER
          BNZ   *-1         PAPER ADVANCES.
          BRL*  PRINT
ERROR     NOP               ERROR ROUTINE
          BUC   *-1

SAVEA     NOP
SAVEI     NOP
BUF       BLOK  132
          END
```

Octal Code	Character	Octal Code	Character
0	@	40	Blank
1	A	41	!
2	B	42	"Quote
3	C	43	#
4	D	44	$
5	E	45	%
6	F	46	&Ampersand
7	G	47	' Apostrophe
10	H	50	(
11	I	51	)
12	J	52	*
13	K	53	+
14	L	54	,Comma
15	M	55	-Dash
16	N	56	.Period
17	O	57	/
20	P	60	0
21	Q	61	1
22	R	62	2
23	S	63	3
24	T	64	4
25	U	65	5
26	V	66	6
27	W	67	7
30	X	70	8
31	Y	71	9
32	Z	72	:
33	[	73	;
34	\	74	<
35	]	75	=
36	^	76	>
37	_Underline	77	?

1. LINE PRINTER

Model 4010 (Data Printer V-132-C, 600 lpm)

2. GENERAL

The Model 4010 Line printer provides high-quality, high-speed printed output for the DC 6024 computers. The line printer operates at a nominal 600 lines per minute. The output line consists of 132 characters.

The unit operates from an 8-bit I/O channel.

3. PROGRAM-CONTROLLED OPERATION

The standard channel/unit assignment for the printer is channel 3, unit 0.

The device responds to the following I/O instructions:

OCW
ODW
ISW

4. COMMAND WORD FORMAT

The command word formats are shown in Figures 1 and 2. The command word operates in one of two modes determined by bit 7. When bit 7 is a zero, the command mode is in effect.

CAUTION

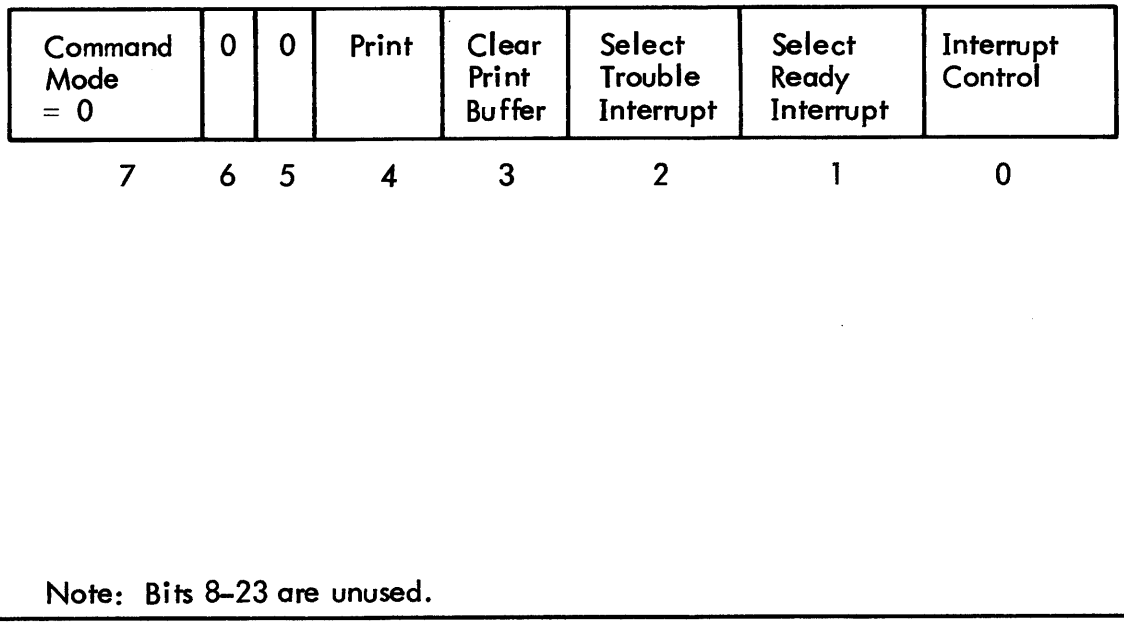
IF THE SELECTED CHANNEL OF THE CONTROL TAPE IS UNPUNCHED, A PAPER RUNAWAY RESULTS. POWER MUST BE TURNED OFF TO STOP THE RUNAWAY CONDITION.

When the Ready interrupt is selected and enabled an interrupt will occur when the printer has completed a print command, a clear buffer command or a VFC command.

No interrupt is available on a per character basis while filling the buffer because the buffer will accept data at a 500 KHz rate.

When the Trouble Interrupt is selected and enabled are interrupt occurs under the following conditions:

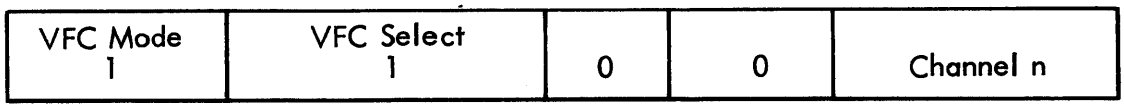
1. Yoke Open
2. Paper Low
3. Paper Out



Note: Bits 8–23 are unused.

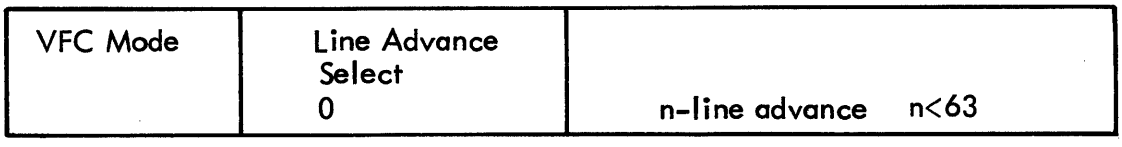
Figure 1. Line Printer Command Word - Command Mode

MI1171-373



Note: If "n" is greater than 8 (10_8) a one-line advance is done. If "n" = 0, channel 1 is selected.

a. Advance per channel n of control tape



b. Advance n lines.

Note: Bits 8–23 are unused.

Figure 2. Line Printer Command Word - VFC Mode

MI1172-373

Top-of-Form is effective by VFC Mode 1 selecting channel 1 of the control tape.

CAUTION

THE LINE BUFFER HOLDS 132 CHARACTERS. IF THE PROGRAM OUTPUTS MORE THAN 132 CHARACTERS, THE CHANNEL WILL LOCK UP IN THE ODW - BNZ LOOP. AN OCW* WILL REGAIN CONTROL OF THE CHANNEL.

5. STATUS WORD FORMAT

The status word format for the line printer is shown in Figure 3.

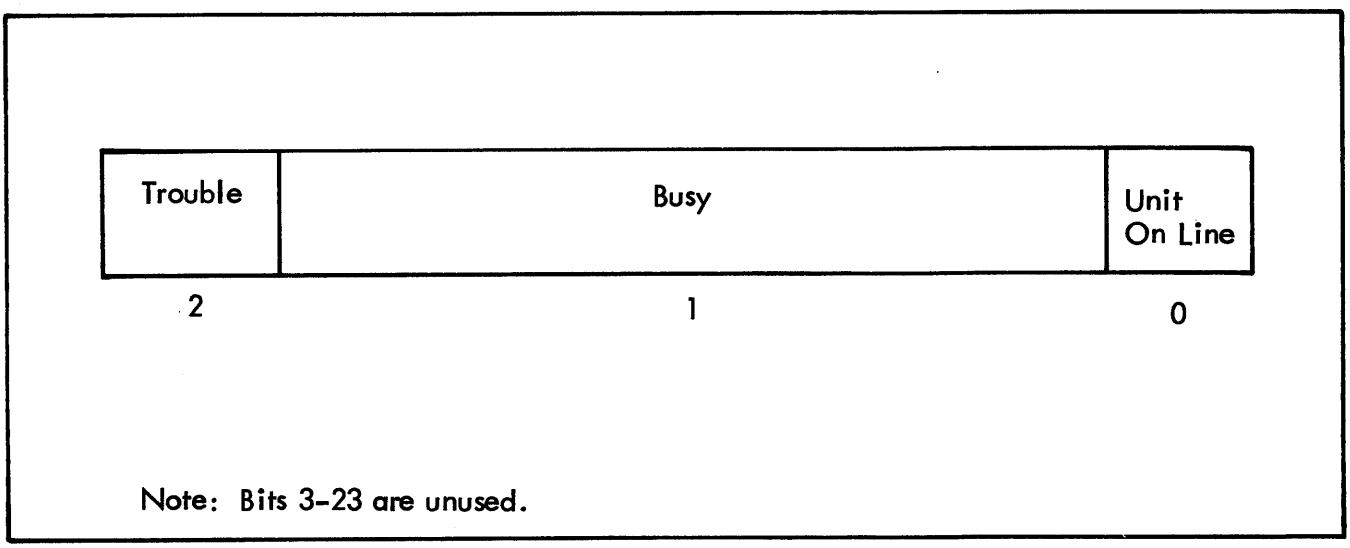


Figure 3. Line Printer Status Word MI1173-373

6. EXAMPLES

The following examples illustrate the use of the I/O instructions for the device.

Example 1: Move paper to top of form, clear buffer and disable interrupts.

```
TOA     '16
OCW     '3ØØ
BNZ     *-1
TOA     '301        TOP OF FORM
OCW     '3ØØ
BNZ     *-1
ISW     '3ØØ
BNZ     *-1
QBB     B1          TOF COMPLETE?
BNZ     *-3         NO
```

Example 2: Fill buffer, print a line. The characters are packed one per word in core.

```
        TOA     '16
        OCW     '300
        BNZ     *-1
        TNI     132
        TMB     BUF +132, I     FILL PRINTER BUFFER
        ODW     '300
        BNZ     *-1
        BWI     *-3
        TOA     '201            ADVANCE 1 LINE
        OCW     '300
        BNZ     *-1
        TOA     '20             PRINT
        OCW     '300
        BNZ     *-1
*
BUF     BLOK    132
```

7. SUMMARY OF SPECIFICATIONS

The major operating characteristics of the Model 4010 Line Printer are as follows:

Printing Speed	600 lines per minute
Characters	64
Bits per Character	6
Characters per Line	132
Paper Width	4-20 inches
Character Set	

Octal Code	Character	Octal Code	Character
0	@	40	Blank
1	A	41	!
2	B	42	"Quote
3	C	43	#
4	D	44	$
5	E	45	%
6	F	46	&Ampersand
7	G	47	' Apostrophe
10	H	50	(
11	I	51	)
12	J	52	*
13	K	53	+
14	L	54	,Comma
15	M	55	-Dash
16	N	56	.Period
17	O	57	/
20	P	60	0
21	Q	61	1
22	R	62	2
23	S	63	3
24	T	64	4
25	U	65	5
26	V	66	6
27	W	67	7
30	X	70	8
31	Y	71	9
32	Z	72	:
33	[	73	;
34	\	74	<
35	]	75	=
36	^	76	>
37	_Underline	77	?

1. MOVING HEAD DISCS - DISC PACK

Model 5110	(7 Megabyte, ISS701D)
Model 5112	(28 Megabyte, ISS714D)
Model 5114	(56 Megabyte, ISS715D)

2. GENERAL

The 5100 series discs provide high-speed data transfer and large storage capability for the DC 6024 computers. Data is transferred via an ABC channel (24-bit). The controller provides automatic stepping of sector, head and track when records exceed a given boundary.

3. PROGRAM-CONTROLLED OPERATION

The standard channel/unit assignment for the disc is channel 5, unit 1. The device responds to the following I/O instructions.

OCW
ODW
IDW
OAW
IAW
} ABC Commands

Each controller will handle up to eight drives. The drive number is specified in the command word.

Although this design employs a fixed size sector, the read/write concept is on a record basis. Data words are transferred to or from a disc, starting at a specified cylinder/track/sector and continuing until the specified number of words have been transmitted. When a sector is depleted or filled, the next sequential sector within the track is automatically selected by the controller, and transfer is continued without loss of a revolution.

After the last sector of a track is completed, sector 0 of the next track within a cylinder is selected. Likewise, after sector i of track j of cylinder k is filled, sector 0 of track 0 of cylinder k + 1 is selected. There will be a seek delay when changing cylinders, but there are no delays when addressing sequential sectors on a track or when addressing sequential tracks within a cylinder.

In the write mode, the remainder of a partially filled sector is zeroed for proper check-sum computation. In the read mode, if an EOF sector is detected, the input is terminated.

4. COMMAND WORD FORMAT

There are six commands used with the disc system. These are:

1. Restore
2. Seek
3. Read

4. Write
5. Write End-of-File (EOF)
6. Present Expanded Status

Figure 1 shows the formats for these commands. The command words are referred to as Format 1 commands and Format 2 commands for the sake of convenience.

In general, the disc controller is busy performing some function or it is ready. If an error condition occurs, the controller will set appropriate status bits and become Ready. Any time the controller changes from Busy to Ready, an interrupt signal is transmitted to the mainframe. THERE ARE NO DEVICE COMMAND BITS TO ENABLE OR DISABLE THIS INTERRUPT; IT MUST BE CONTROLLED AT THE CPU LEVEL. The recommended approach to handling the disc is via the Disc Ready interrupt as opposed to an ABC word count complete, to ensure that the status conditions are valid upon entry into the interrupt service routine.

If the word count is not exhausted when an EOF is detected, the ABC is not released and the program must issue the appropriate commands to terminate the ABC operation. On the DC 6024/1 and DC 6024/3 this is done via an OAW to the channel. The DC 6024/5 ABC requires an OCW command with the override bit set, i.e., an OCW* to the channel/unit to terminate the ABC operation.

The WRITE Command writes data starting at the specified location and continues until the word count is exhausted. The interrupt occurs when the operation is complete.

The SEEK command causes the read/write head assembly on the specified drive to move to the designated cylinder. The interrupt will occur when the seek is completed, i.e., when the head is on-cylinder.

The WRITE, EOF command writes an EOF sector (112 words) at the specified location. The interrupt will occur on completion of the write operation.

The Read command reads data starting at the specified location and continuing until the word count is exhausted or an EOF sector is read. If an EOF sector is read the Read operation is terminated and the EOF status bit is set. The interrupt occurs at the End of the Read operation.

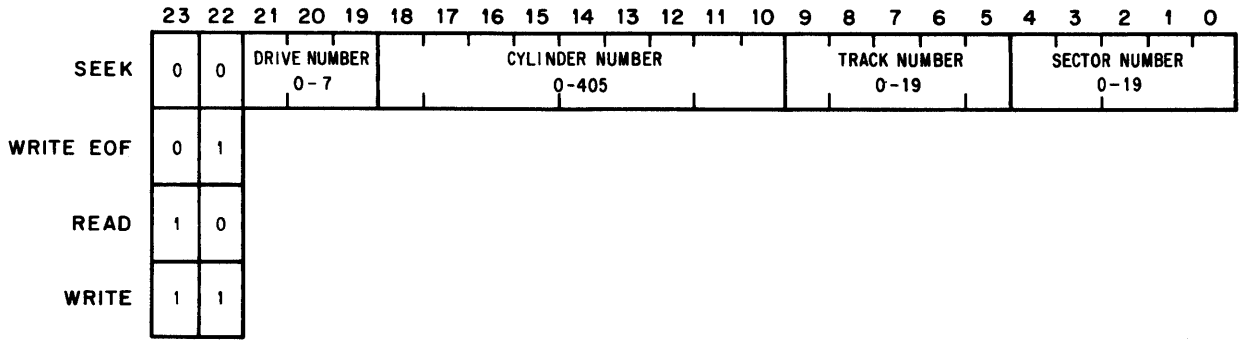
The RESTORE Command causes the head to return to cylinder 0. The interrupt occurs when the operation is complete.

The PRESENT EXPANDED STATUS Command causes the expanded status word to be placed on the data lines for input via an IDW instruction. The expanded status bits are input to the A-Register in bits 8-14. No interrupt will occur.

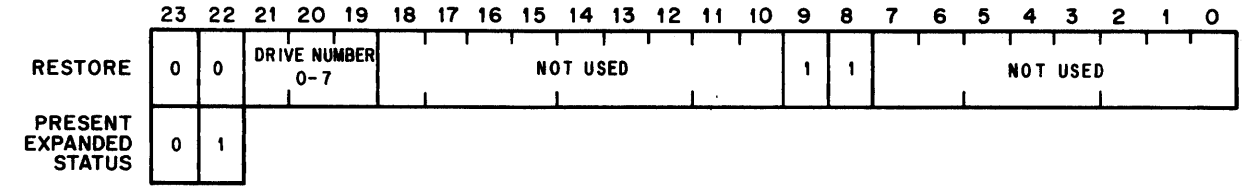
5. STATUS WORD FORMAT

There are two status words associated with the disc. One is an 8-bit word obtained via the ISW instruction. The other is an expanded status word obtained via an IDW instruction following an OCW specifying expanded status.

Figures 2 and 3 show the normal and expanded status words.



a. Format 1 Commands

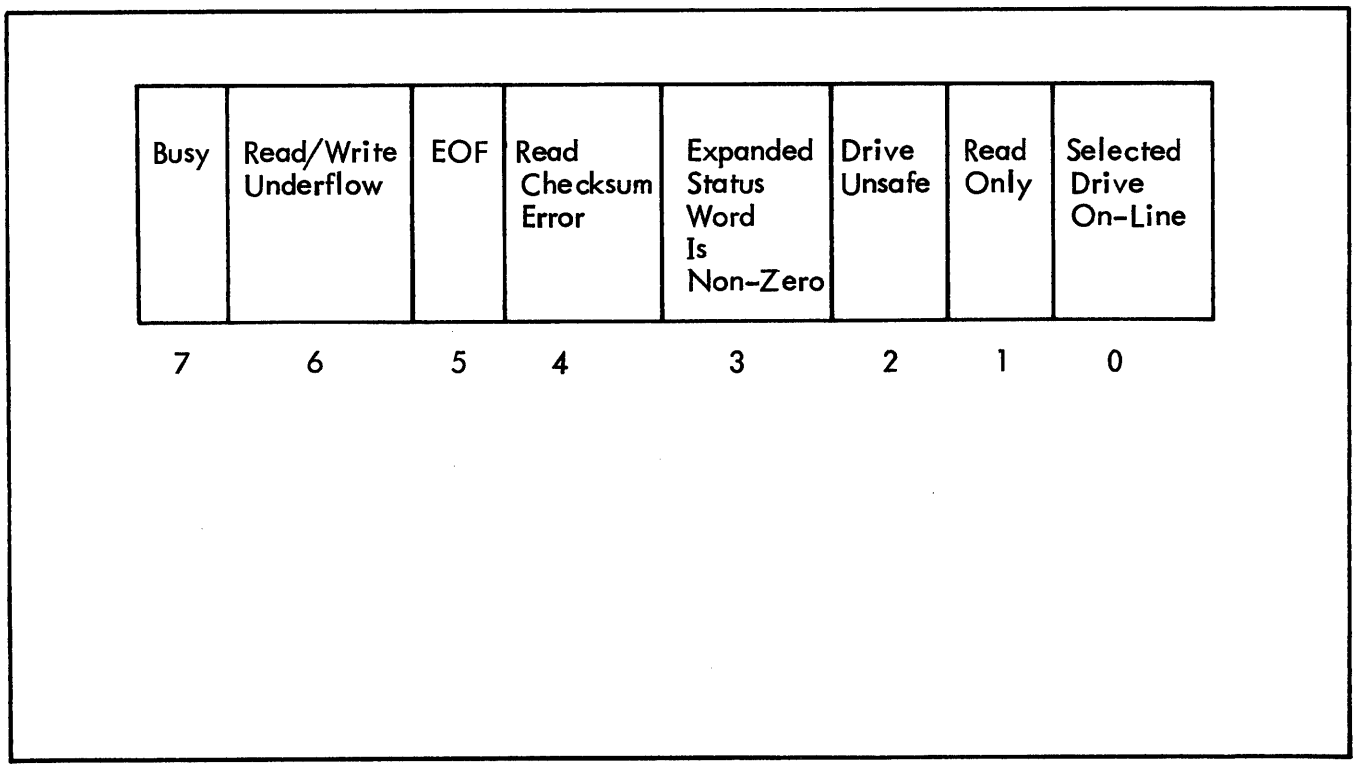


NOTE: Format 2 is selected by selecting a track number equal to or greater than 24 (30_8).

b. Format 2 Commands

MI1174-373

Figure 1. Moving Head Disc Command Word



MI1175-373

Figure 2. Normal Status Word

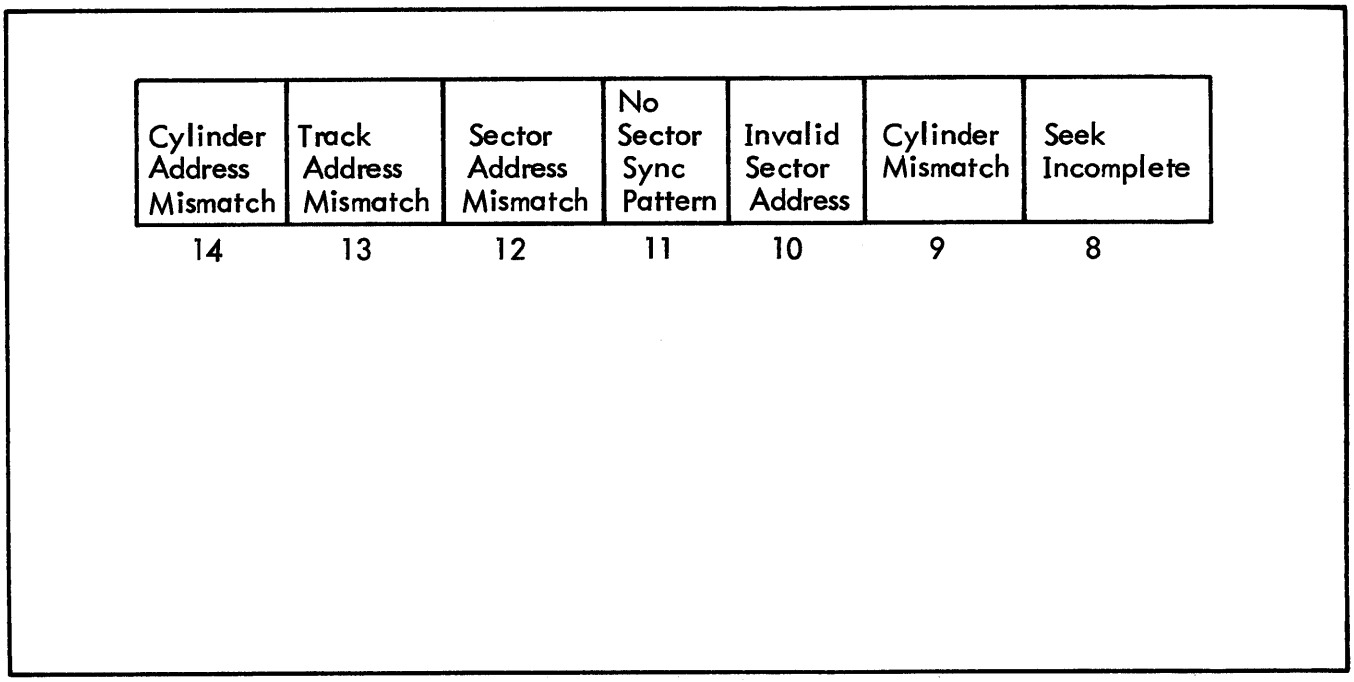


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Figure 3. Expanded Status Word

The Drive Unsafe status indicates a drive malfunction. Some of the possible problems are:

1. Velocity Unsafe
2. DC Write unsafe
3. AC Write unsafe
4. AC Voltage unsafe
5. Temperature unsafe
6. Pack speed unsafe

The Read/Write underflow status occurs when less than a full sector is read or written. This status bit is not used in Datacraft standard software since transfers are on a record, rather than a sector, basis.

The Seek incomplete status indicates that the head failed to reach the selected cylinder within 100 ms of the seek command.

The Cylinder Mismatch status means that the selected cylinder and the cylinder on which the head stopped are not the same.

The invalid Sector Address status indicates that the specified sector address cannot be found, e.g., a sector address of 21 will cause this error.

The No Sector Sync Pattern indicates a malfunction of the drive's Read and Write circuits or that the sector being read has not been previously written with compatible write circuitry.

The Sector, track and Cylinder Address Mismatch status bits are set when the specified address and the address actually read do not coincide.

6. EXAMPLES

The example illustrates the use of the I/O instructions for the disc.

Example: Issue a Restore command, write a 300-Word record, starting at cylinder 7, track 5, sector 7; Write EOF. Assume Group 1, Level 10 interrupt. The ABC is used.

Note that the routine does not read the data after writing a check for errors. This procedure is not recommended for critical data. Also note that the interrupt is disabled after issuing the EOF command, so no indication of completion is given. Prior to using the disc for another operation, status must be checked to see if the disc is ready.

7. SUMMARY OF SPECIFICATIONS

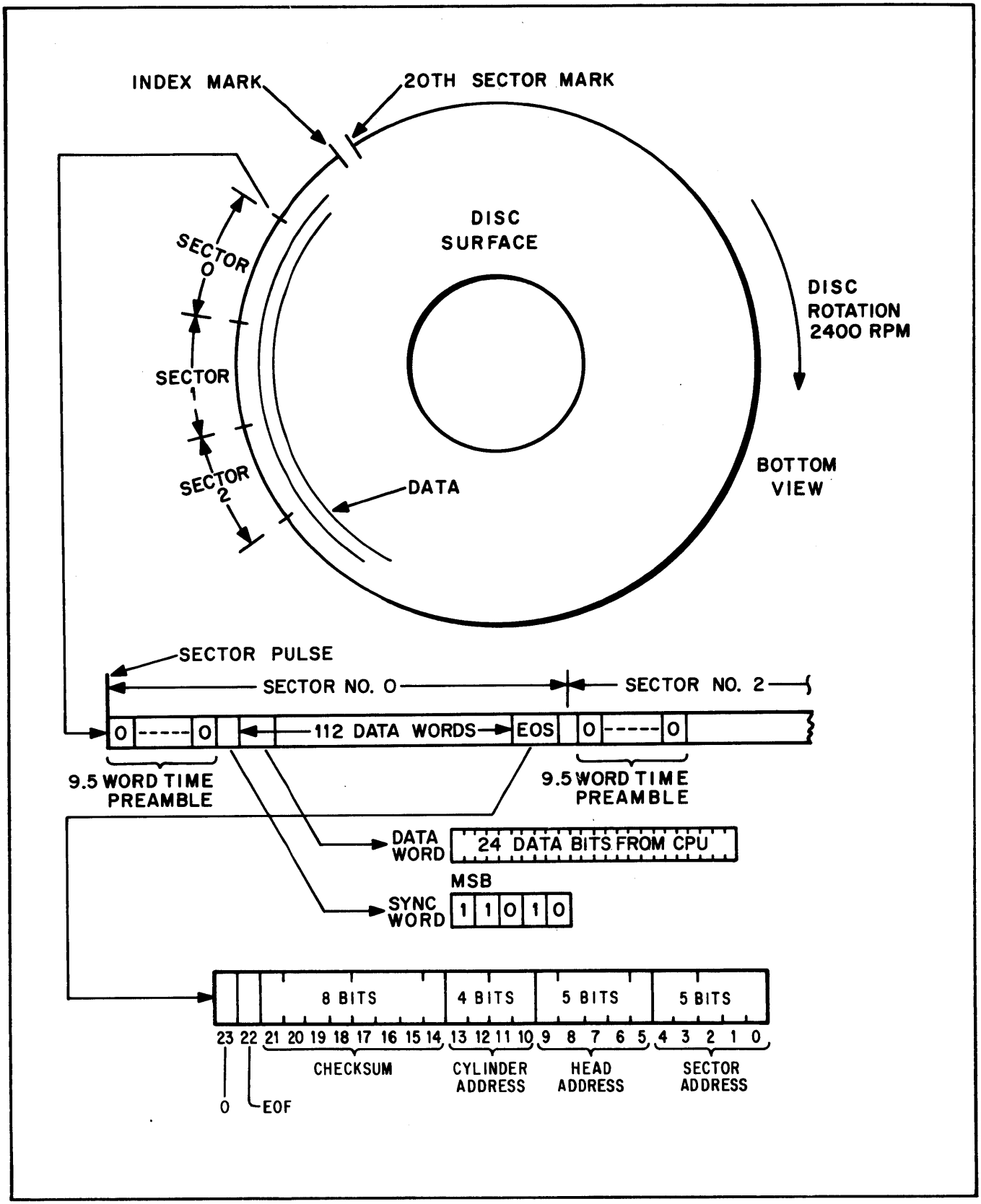
The main differences in the disc storage systems relate to the physical characteristics of the respective models of disc drives. The major characteristics of each, model are shown in Table 1.

```
*EXAMPLE 1          MOVING-HEAD DISC
DISC      EQIV      '500
CHAN      EQIV      5
          AORG      '100
          BSL       DISCPI
          AORG      '200
          TOA       '2000
          UD1
          UA1
          UE1
          ISW       DISC
          BNZ       *-1
          QBB       B3B2B1          TROUBLE?
          BNZ       ERROR           YES
          TMA       RESTORE         RESTORE COMMAND
          OCW       DISC
          BNZ       *-1
          TZM       FLAG            CLEAR EOF FLAG
          BUC       *               WAIT FOR PI
*
DISCPI    NOP
          TAM       SAVEA
          ISW       DISC
          BNZ       *-1
          QBB       B3B2            TROUBLE?
          BNZ       ERROR           YES
          CZM       FLAG            TIME TO WRITE EOF?
          BNZ       EOF             YES
          TFM       FLAG            SET EOF FLAG
          TMA       PLIST
          OAW       CHAN            SET UP ABC
          BNZ       *-1
          TMA       WRITE
          OCW       DISC            START ABC
          BNZ       *-1
          TMA       SAVEA
          BRL*      DISCPI
EOF       TMA       WEOF
          OCW       DISC            WRITE EOF
          BNZ       *-1
          TOA       '2000
          UD1
          BUC       EOF-2
PLIST     DATA      3000
          DAC       FLAG+1
          FORM      5,9,5,5
RESTORE   DATA      /0,0,30,0/
WRITE     DATA      /30,7,5,7/
WEOF      DATA      /10,7,5,7/
FLAG      NOP
          BLOK      3000
ERROR     QBB       B0
          BOZ       *               TO OFF-LINE ROUTINE
          QBB       B1
          BNZ       *               TO READ-ONLY ROUTINE
          QBB       B2
          BNZ       *               TO FILE UNSAFE ROUTINE
          TMA       EXPSTAT
          OCW       DISC            EXPANDED STATUS COMMAND
          BNZ       *-1
          IDW       DISC
          BNZ       *-1
          NOP
          BUC       *               RETURN
EXPSTAT   DATA      /10,0,30,0/
SAVEA     HLT
          END
```

Table 1. Disc Drive Characteristics, Moving Head Disc Storage System

Specification	Model 5110	Model 5112	Model 5114
Byte Capacity/Pack	6,820,800	27,283,200	54,566,400
Bytes/Word	3	3	3
Words/Sector	112	112	112
Sectors/Track	10	20	20
Tracks/Cylinder	10	20	20
Cylinders/Disc Unit	203	203	406
Recording Discs	6	11	11
Data Transfer Rate (Bytes/Second)	150,000	300,000	270,000
One Cylinder Seek Time	10ms	10ms	7.5ms
Average Seek Time	30ms	32ms	29ms
Maximum Seek Times	60ms	60ms	55ms

The Disc Format is shown in Figure 4.



MI1155-273A

Figure 4. Disc Format, Moving Head Disc

1. CARTRIDGE DISC

Model 5202 (CDC9425, 2.75 Megabyte)

Model 5204 (CDC9425 with fixed disc, 5.5 megabyte)

2. GENERAL

The 5200 series disc drives provide medium speed data transfer and moderate storage capability for the DC6024 computers. Data is transferred via an ABC Channel (24-bits). The Model 5201 has a removable cartridge. The Model 5210 has a removable cartridge and a fixed disc.

Automatic stepping of sector, track and cylinder is provided by the controller.

3. PROGRAM CONTROLLED OPERATION

The standard channel/unit assignment for the disc is channel 5, unit 1. The device responds to the following I/O instructions:

OCW
ODW
IDW
ISW
OAW
IAW } ABC Commands

Each controller will handle up to 4 drives. The drive number is specified in the Command word.

Although this design employs a fixed size sector of 112 words, the Read/Write concept is on a record basis. Data words are transferred to or from a disc, starting at the specified cylinder/track/sector and continuing until the specified number of words has been transmitted. Sector/Head and Cylinder spillovers are automatically handled by the controller.

There are no interrupt control bits in the command word. The assigned interrupt must be controlled in the program by the usual Arm/Disarm and Enable/Inhibit instructions. In general, the interrupt will occur after this completion of an operation or when a fault condition occurs.

Each sector is comprised of 112 data words and one End-of-Sector (EOS) word. The EOS word is not part of the data transfer. Figure 1 shows the EOS word format.

The last sector (19) of head 1 of the last cylinder (203) is only usable as an EOF Sector.

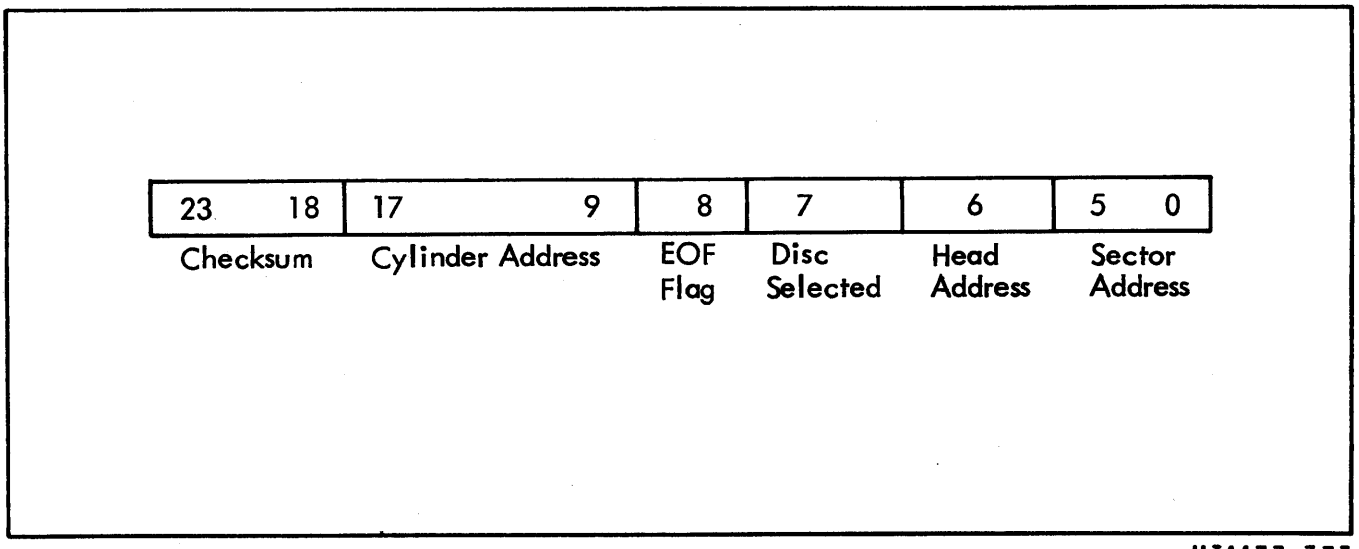


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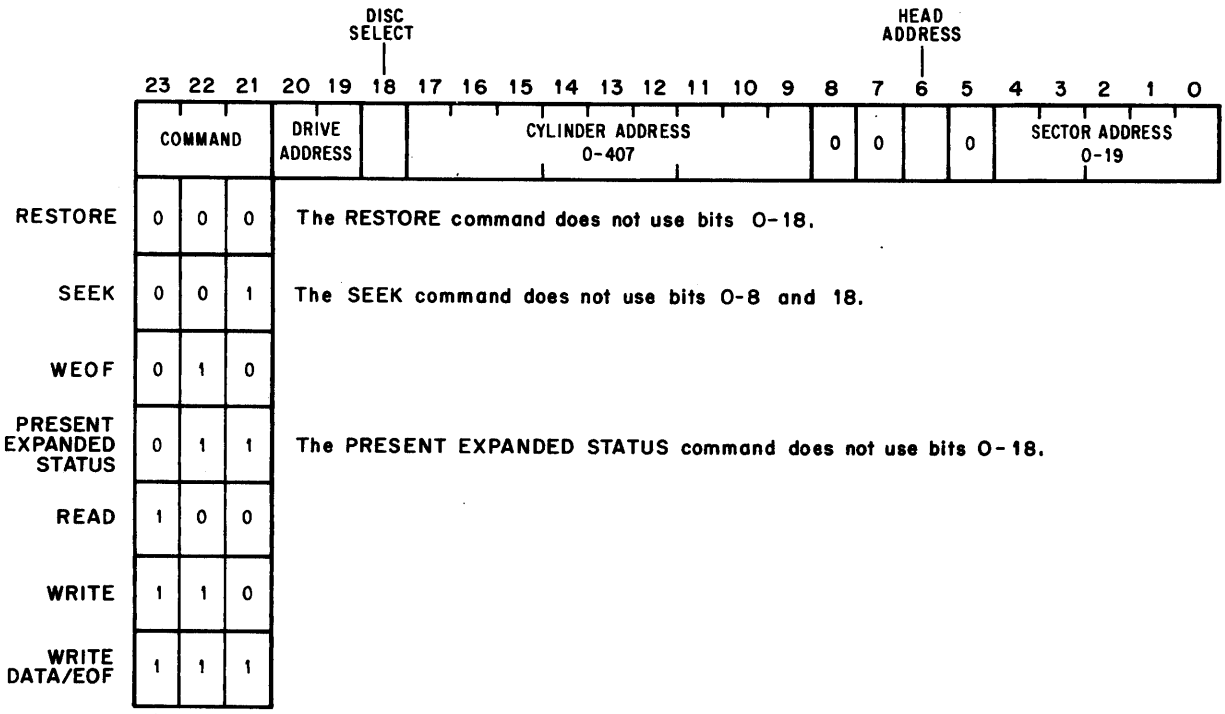
Figure 1. EOS Word Format

4. COMMAND WORD FORMAT

There are seven command words used with the disc system. These are

1. Restore
2. Seek
3. Read
4. Write
5. Write End-of-File (EOF)
6. Write Data/EOF
7. Present Expanded Status

Figure 2 shows the formats for these commands. Datacraft standard software does not use the WRITE DATA/EOF command.



MI1178-373

Figure 2. Command Word Format

The RESTORE command causes the head to return to cylinder 0. This command can be used to establish an initial head position and should be used when access errors are detected. An interrupt occurs when the command execution is completed.

The SEEK command positions the head on the specified cylinder. An interrupt occurs when the command execution is completed.

The READ command starts a data input transfer via the ABC, starting at the specified location and continuing until the word count is complete or an End-of-File is detected. If an EOF is detected, the transfer is terminated but the ABC Channel is still busy. On the DC6024/1 and DC6024/3 computers an OAW with the override bit set, i.e., an OAW* , will release the channel. The DC6024/5 ABC channel can be released with an OCW* command to the channel/unit.

The interrupt will occur where the transfer terminates because of either condition.

The WRITE command starts a data output transfer via the ABC which continues until the word count is complete. An interrupt will occur at the completion of the transfer.

The WRITE EOF command causes the controller to write a sector of zeros at the specified location. Bit-8 of the EOS word is set to indicate the EOF condition. An interrupt will occur at the completion of the command

The WRITE DATA/EOF command operates the same as a WRITE command followed by a WRITE EOF command. The only difference is a possible reduction of access time. An interrupt occurs when the operation is completed.

The PRESENT EXPANDED STATUS (PES) commands causes the controller to put the expanded status bits on the data lines. The PES command must be followed by an IDW instruction prior to issuing another command. No interrupt occurs when this command is executed.

5. STATUS WORD FORMAT

The status word format is shown in Figure 3. The Expanded Status Word format is shown in Figure 4.

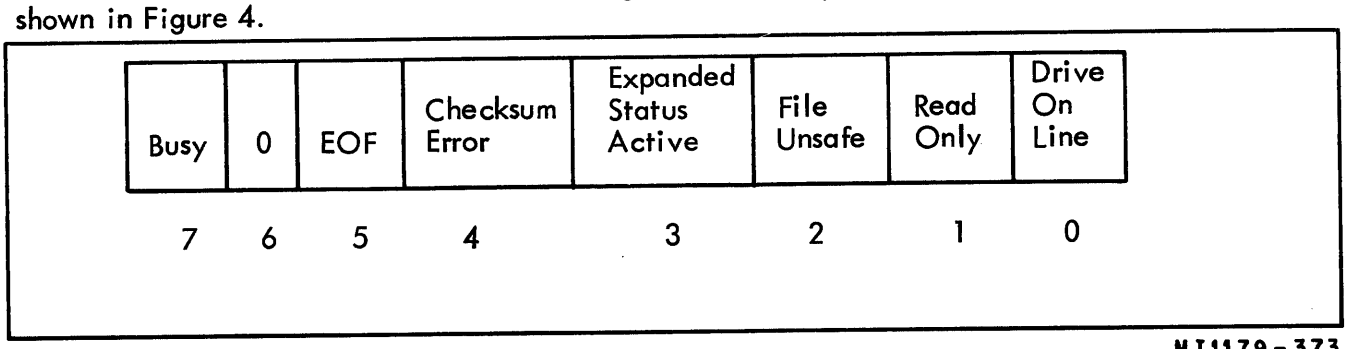


Figure 3. Status Word

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When a trouble condition occurs, bit 3 is set, bit 7 is reset, the current transfer is terminated and an interrupt occurs.

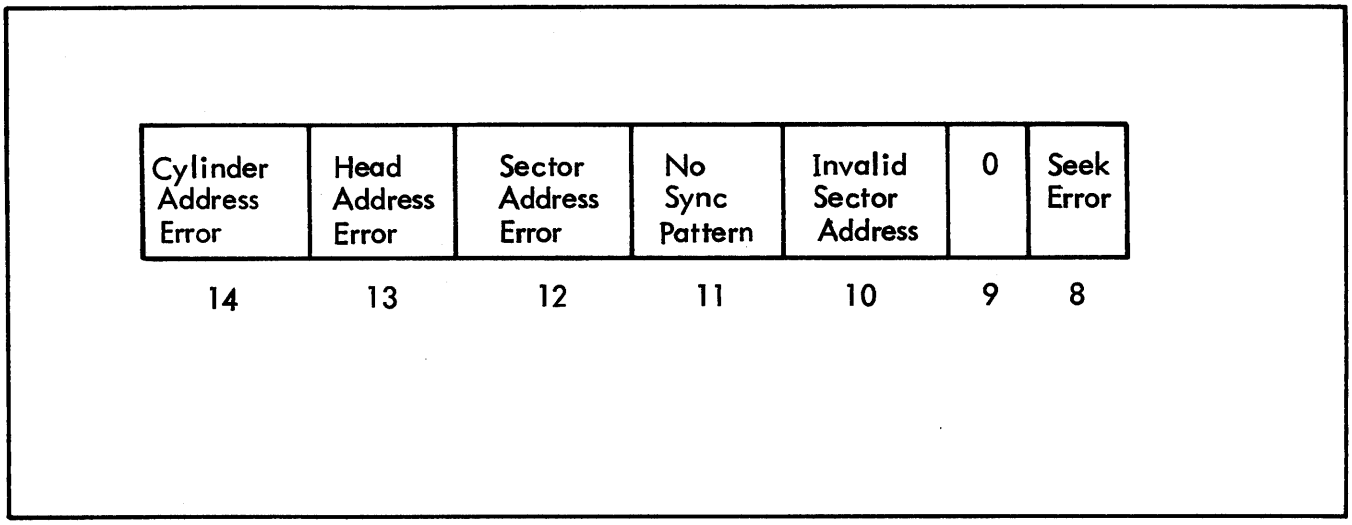

Figure 4. Expanded Status Word

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The invalid Sector address status occurs when the sector number specified is greater than 19.

The sync pattern error occurs when a sector is read which has not been written with compatible circuitry, or when the read/write circuits are faulty.

6. EXAMPLES

The following example illustrates the use of the I/O instructions for the Cartridge Disc System.

Example: Assumed Disc is Model 5204 (with fixed disc and removable cartridge). Read a 228 word record from the fixed disc starting at head 1, cylinder 4, sector 12. The interrupt level is group 1, level 10. The example assumes that the drive is on-line and trouble free. Good programming practice dictates a status check prior to any data transfer attempts.

LABEL	OPERATION	OPERAND AND COMMENTS
*EXAMPLE	1	CARTRIDGE DISC
	AORG	'1Øz
	BSL	DISCPI
	AORG	'2ØØ
	TMA	RESTORE
	OCW	'5ØØ SET DISC TO CYLINDER Ø---
	BNZ	*-1 PI WILL OCCUR WHEN DONE
	TOA	'2ØØØ
	UD1	
	UA1	
	TZM	FLAG
	UE1	
	BUC	* WAIT FOR PI
*		
DISCPI	NOP	
	TAM	SAVEA
	CZM	FLAG RESTORE COMPLETE OR READ COMPLETE PI ?
	BNZ	DONE READ COMPLETE
	TFM	FLAG
	TMA	PLIST
	OAW	5 SET UP ABC
	BNZ	*-1
	TMA	READ
	OCW	DISC START ABC
	BNZ	*-1
	TMA	SAVEA
	BRL*	DISCPI
DONE	TOA	'2ØØØ
	UD1	
	BUC	DONE-2
	FORM	3,3,9,3,6
RESTORE	DATA	Ø
READ	DATA	/4,Ø,4,1,12/
FLAG	NOP	
SAVEA	NOP	
PLIST	DATA	228
	DAC	*+1
	BLOK	228
	END	

7. SUMMARY OF SPECIFICATIONS

The major characteristics of the Model 5201 and Model 5204 disc system are as follows:

	Model 5201	Model 5204
Cylinder Disc	1 Removable 204	1 Removable, 1 Fixed 204
Capacity	913,920 24-bit words	1,827,840 24-bit words
Seek Time		
Min.	10ms	10ms
Max.	70ms	70ms
Ave.	35ms	35ms
Latency Time		
Max.	25ms	25ms
Ave.	12.5ms	12.5ms
Access Time		
Max.	105ms	105ms
Ave.	47.5ms	47.5ms
Transfer Rate (nominal with sector/track spillover)	89,600 words per second	89,600 words per second

1. CARD PUNCH

Model 3170 (Univac 1701-04)

Model 3172 (Univac 1710-04)

2. GENERAL

The Model 3170 and Model 3172 Card Punches provide low-speed punched card output for the DC6024 computers. Both models operate at 35 cards per minute and each has a keypunch and verifier. The Model 3172 has an interpreter.

Both models operate from a 24-bit I/O channel.

3. PROGRAM-CONTROLLED OPERATION

The standard channel/unit assignment for the card punch is channel 4, unit 1. The card punch responds to the following I/O instructions:

OCW
ODW
ISW

The card punch has an input buffer and an output buffer. The input buffer accepts data from the CPU. When a Punch command is issued, the data is transferred from the input buffer to the output buffer and the contents of the output buffer are then punched on the card. When the data is transferred to the output buffer, the input buffer can be refilled concurrent with the punching of the card. Another Punch command will not be accepted until the unit finishes the current card and positions a new card in the station.

4. COMMAND WORD FORMAT

The command word format is shown in Figure 1.

Clear Punch Memory	Skip	Punch-Feed	Select Off-Line Mode	Select Ready Interrupt	0	Interrupt Control
6	5	4	3	2	1	0

Note: Bits 7-23 are unused

Figure 1. Card Punch Command Word

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The Ready interrupt is triggered, if enabled, each time the input buffer changes from a busy to a ready state, or when a trouble condition occurs. The ready condition occurs following a Clear Memory command; following each output data word; following a skip complete; following the transfer complete caused by a punch feed command, i.e., when the data has been moved from the input buffer to the output buffer. A trouble interrupt is not triggered if a card jam occurs between the punch station and the stacker.

The input buffer retains its previous contents after a punch-feed command. A fill sequence replaces the appropriate column with the new data. If, for example, a full 80 columns of data are punched, the input buffer still retains that data and if 30 columns are output to refill the buffer, only the first 30 columns are replaced. It is therefore necessary to output a Skip command, or to always transmit 80 characters of data. The Skip command fills the buffer from its present position to column 80 with blanks, i.e., no bits.

The Clear Punch Memory command causes the controllers to generate two skip functions in order to clear the input buffer. This command should preceed a data transfer sequence. Figure 2 shows the data transfer and punching sequence of the device.

5. STATUS WORD FORMAT

The status word format is shown in Figure 3. The trouble status occurs when:

1. The Stacker is full
2. The Hopper is empty
3. A card jam occurs
4. No card in Advance Station

When trouble occurs, the punch goes off-line , therefore the program must place the punch on-line and retransmit the last card image, i.e., the data which was to punched prior to the trouble status. The contents of the buffers are indeterminate when the device comes on-line.

6. EXAMPLES

The following example illustrates the use of the I/O instruction set for the card punch.

Example 1: Fill input buffer with 40 columns of data, enable interrupts, punch the card. Assume Group 1, level 10 interrupt with BSL CARDP in location '102. Note that the example shows no status testing, nor does it perform an initial feed command.

Card In Station	Punch On Line	Controller Ready	Trouble	Controller On Line
4	3	2	1	0

Note: Bits 5-23 are unused.

Figure 3. Card Punch Status Word

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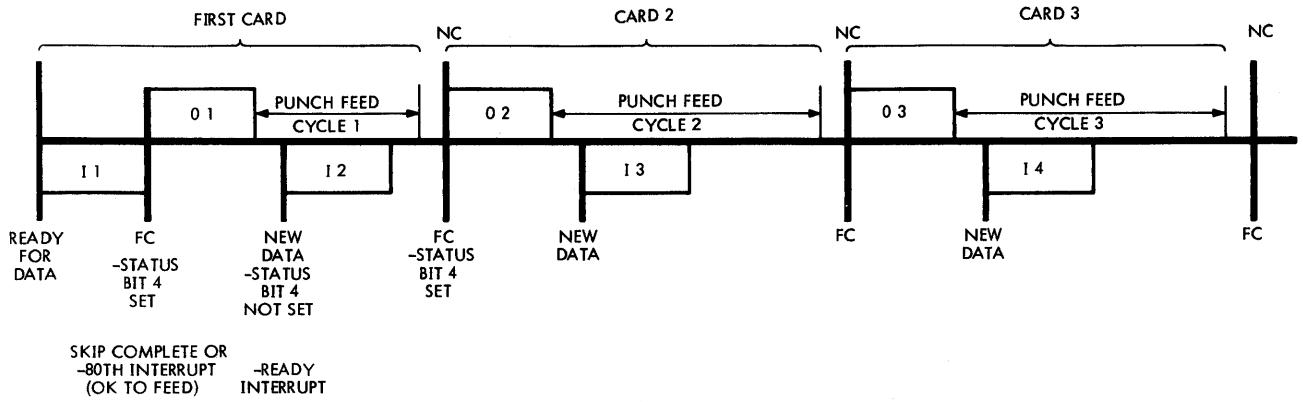

FC = Feed Command

I = Data Transfer to input punch buffer (Initiated by Controller ready, Status Bit 2).

0 = Data Transfer to output punch buffer (Initiated by Feed Command, Bit 4).

NC = New card from hopper to advance station feed completed (Status Bit 4).

NOTE: Data in input punch buffer will remain in Core Memory Storage until replaced by new data, even if Punch is turned off.

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Figure 2. Data Transfer and Punching Sequence

LABEL	OPERATION	OPERAND AND COMMENTS
*EXAMPLE	1	UNIVAC CARD PUNCH
	AORG	'1Ø2
	BSL	CARDPI
	AORG	'2ØØ
	TFM	FLAG SET A PI FLAG
	TFM	SHIFT SET SHIFT INDICATOR
	TOA	'2ØØØ
	UD1	
	UA1	
	UE1	
	TNI	4Ø
	TIM	WC WORD COUNT
	TOA	'1Ø5
	OCW	'4Ø1
	BNZ	*-1
	BUC	*
*		
CARDPI	NOP	
	TAM	SAVEA
	CZM	FLAG PUNCH COMPLETE PI ?
	BNZ	FILL NO
	TOA	'2ØØØ
	UD1	
	TMA	SAVEA
	BRL*	CARDPI
FILL	TMA*	BUFFAD GET CHARACTERS
	LRA	12 SHIFT
	TAM*	BUFFAD SAVE
	ODW	'4Ø1 PUT CHARACTER IN PUNCH BUFFER
	BNZ	*-1
	CZM	SHIFT 1ST OR 2ND CHARACTER?
	BOZ	SET 2ND
	TZM	SHIFT 1ST
	BUC	FILL-2 GO FOR 2nd
SET	TFM	SHIFT
	AUM	BUFFAD
	AUM	WC
	BNZ	FILL-2
	TZM	FLAG
	TOA	'2Ø
	OCW	'4Ø1
	BNZ	*-1
	BUC	FILL-2
FLAG	NOP	
SHIFT	NOP	
BUFFAD	NOP	
SAVEA	NOP	
BUF	BLOK	4Ø
	END	

7. SUMMARY OF SPECIFICATION

The major characteristics of the device are:

Card Type:	80 column
Punch Speed:	35 cards per minute
Input Hopper Capacity:	600 cards
Output Stacker Capacity:	600 cards
Select Stacker Capacity:	20 cards

Physical Dimension:

Height:	99.1cm (39 inches)
Width:	96.5cm (38 inches)
Depth:	100.3cm (39.5 inches)
Weight (Model 3170)	124.7Kg (275 pounds)
(Model 3172)	147.4Kg (325 poungs)

Character Set

VP AND VIP 9000 SERIES CODE CHART

SYMBOLS AND CHARACTERS	80-COLUMN CARD CODE	SYMBOLS AND CHARACTERS	80-COLUMN CARD CODE
A	12-1	8	8
B	12-2	9	9
C	12-3	0	0
D	12-4	#	3-8
E	12-5	' (APOS)	5-8
F	12-6	$	11-3-8
G	12-7	.	12-3-8
H	12-8	-11	11
I	12-9	+	12-6-8
J	11-1	—	0-5-8
K	11-2	)	11-5-8
L	11-3	¢	12-2-8
M	11-4	0-2-8	0-2-8
N	11-5	|	12-7-8
O	11-6	&-12	12
P	11-7	12-0	12-0
Q	11-8	7	0-6-8
R	11-9	:	2-8
S	0-2	;	11-6-8
T	0-3	¬	11-7-8
U	0-4	, (COMMA)	0-3-8
V	0-5	11-0	11-0
W	0-6	?	0-7-8
X	0-7	"	7-8
Y	0-8	=	6-8
Z	0-9	!	11-2-8
1	1	(	12-5-8
2	2	@	4-8
3	3	%	0-4-8
4	4	*	11-4-8
5	5	↑	12-4-8
6	6	/	0-1
7	7		