File No. 1800-19
Form A26-3626-0

Systems Reference Library

IBM 2310 Disk Storage Drive, Models A1, A2, and A3 Original Equipment Manufacturers' Information

This publication provides definitions and functional descriptions of the interface lines for the 2310 Disk Storage Drive. It also contains specifications, timings, and cable information.

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CONTENTS

The 2310 Disk Storage provides random access storage for the 1800 System. Three models of the 2310 are available:

Model A1 is a free-standing unit which contains a single Disk Storage Drive and Adapter.
Model A2 is a free-standing unit containing two Disk Storage Drives and Adapters.
Model A3 is a free-standing unit containing three Disk Storage Drives and Adapters.

All models are attached through an 1800 System Data Channel. When the Model A2 or A3 units are used, the drives can be attached to more than one 1800 System Data Channel.

FUNCTIONAL DESCRIPTION, 2310 DISK DRIVE MECHANISM

The 2310 recording medium is an oxide coated disk in an interchangeable cartridge (IBM 2315 Disk Cartridge). A separate magnetic head is provided for each surface of the disk. Each magnetic head performs the read and write functions for the associated disk surface. The two magnetic heads are positioned over the data tracks by a stepping actuator. Each positioning of the magnetic heads selects one of the 203 possible recording cylinders on the disk. (A cylinder consists of two tracks, one on each side of the disk.) Three cylinders on the disk are reserved for system use (replacement and diagnostics) and the remaining 200 cylinders are available to the customer.

The tracks are further divided into 4 sectors to permit block handling of data. Each sector contains a maximum of 321 words. This means that up to 321 words can be stored in a sector. A data word is composed of 16 data bits and four additional bits for checking and spacing.

An incremental track to track motion is employed for all magnetic head movement in the 2310. The magnetic actuator moves the carriage one or two tracks, as determined by the actuator pulses received from the adapter. Forward and backward movement of the carriage is also controlled by the adapter. The drive mechanism characteristics are listed in Table 1. The functional characteristics of the disk drive are listed in Table 2.

FUNCTIONAL DESCRIPTION, 2310 ADAPTER

The adapter circuits for the disk drive are located in the 2310 enclosure. The adapter synchronizes and controls all data transfers between the 2310 and the 1801 or 1802 Processor-Controller (P-C). Commands from the P-C are received by the adapter, decoded, and relayed to the disk drive.

The selection of the 2310 is accomplished via the Execute I/O Instruction (XIO, Figure 1) and the I/O Control Command (IOCC, Figure 2). The XIO selects the two IOCC words for the disk drive. The first IOCC word for an Initialize Read or Write determines the address in core storage to which or from which the data transfers are to be made. The second IOCC word is decoded by the adapter and determines the type of function that the adapter is to perform. (For additional information, refer to the IBM Systems Reference Library, IBM 1800 Data Acquisition and Control System Reference Manual (Form A26-5918) and IBM 1801 and 1802 Processor Controllers Original Equipment Manufacturers' Information (Form A26-3591).

The Area code portion of the second IOCC word designates which disk drive is to be used. Any one of the following five Function codes can be used to determine the operation of the 2310:

Initialize Read (110): This XIO command refers to the control word and address word shown in IOCC Formats A and B of Figure 2. The control word contains the area number, which is customer assigned, the function code, and the modifier. The 3 low order bits (bits 13, 14, and 15) of the modifier contain the address of the sector to be read (000-111). Bit 8 of the modifier determines if the read function is read to core storage (Format A). The table into which the data is read begins at the sector word count address plus one and occupies as many words in ascending sequence as indicated by the sector word count. For example, if the command address word contains 1000, the sector word count is found at that location. If the word count is N, then the table occupies locations 1001 through 1000 plus N. The difference between read to core storage and read check is that read to core storage causes the read data to be stored in the specified table area, whereas read check simply passes the data through the attachment data register

Table 1. Drive Mechanism Characteristics

Dimensions (single drive device)	Height 11.50" Width 16.37" Depth 22.41"
Weight (each drive device)	85 pounds
Primary power requirement	208/230 vac, single phase
DC input supply voltages from adapter	-3v +3v +6v +48v
Operating environment	50 to 110°F, 8% to 80% RH (85°F max. wet bulb)
Cooling	Forced room air, ambient at installed location
CFM	70 (each drive)
Mounting	Cast aluminum base plate (each drive)
Connecting cables from adapter	One signal, one ac, dc power
Disk rotational speed/Sector capacity	1500 RPM counterclockwise/321 20-bit words
Time for trailing edge of sector pulse to sync field	250 μs ± 15%
Length of sync field	One 20-bit word
Total capacity of disk (203 track) cylinders	521,304 20-bit words
Customer usable portion of disk (200 track cylinders)	513,600 20-bit words

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and checks it for modulo 4 errors. A separate XIO (Initialize Read) command must be given for each sector to be read. At the end of the operation, an Operation Complete interrupt occurs.

The Operation Complete interrupt occurs after the word count has been reduced to zero. If a sector mark is encountered prior to the word count becoming zero, an error indicator is set when the Operation Complete interrupt occurs. An error indicator is also set if a modulo 4 error is detected in the data.

Initialize Write (101): This XIO command refers to the control word and address word shown in IOCC Format C of Figure 2. The data table is specified in the same manner as for Initialize Read. The sector address is specified by bits 13, 14, and 15. For each word written, a modulo 4 bit count is generated by the adapter. This means that up to 3 check bits are written at the end of a word to make the total number of bits in the word divisible by 4. If an erroneous count is generated, an error interrupt is set. The Operation Complete interrupt is described under Initialize Read. This command always writes a full sector. After the word count has gone to zero, an Operation Complete interrupt is given and zeros are written in the remainder of the sector.

Control (100): This XIO command control refers to the control word and address word shown in IOCC Format D of Figure 2. When bit 13 of the control word is a zero, the carriage steps forward toward

NOTE: The illustrations in this manual have a code number in the lower corner. This is a publishing control number and is unrelated to the subject matter.

Table 2. Functional Characteristics

Capacity	
Track	27,100 Bits Max.
Cylinder	54,200 Bits Max.
Disk	11 Million Bits Max.
Recording Technology	
Track Density	100 TPI
Bit Density	1080 BPI Inside Track
Medium	Interchangeable Single Disk
Recording Band	2.0 Inches
Disk Diameter	14 Inches
Coding	Double Frequency
Bit Frequency	720 KC
Access Mechanism	
Actuator	Voice Coil Motor
Detent	Electromechanical
Access Motion Time	
Single Step	15 MS
Average Random*	500 MS
Maximum*	1500 MS
Head Settling Time**	20 MS Max.
Rotational Characteristics	
Rotational Period	40 MS

NOTE: * Access times shown assume the use of the two-step moves whenever possible. If only single-step moves are used, the Average Random Access Time will be 1000 ms and the Maximum will be 3000 ms.

** Head settling time is provided following the last access motion to allow mechanical vibrations in the head to settle out before reading or writing information.

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the center of the disk. If bit 13 of the control word is a one, the carriage is stepped backward toward the outer edge, or home position, of the disk. The address word specifies the number of tracks to be stepped (up to 199). The range of the address word is ±202. If the address word is zero, no carriage movement occurs and the Operation Complete interrupt is not given. There must be a 20 msec delay between consecutive access operations. This is accomplished by placing an initialized read back check operation with a word count of zero between the access operations.

Sense Device (111): This command uses the control word portion of the IOCC as shown in IOCC Format E of Figure 2. It causes the current 2310 status word to be read into the accumulator. In addition, all the indicators except write select error are reset if modifier bit 15 is a one.

Sense Interrupt (011): This command, following an interrupt from the 2310, causes the 2310 to transfer its status word to the P-C Accumulator where this status word becomes the interrupt level status word.

C.E. Mode (000): This command uses the control word portion of the IOCC as shown in IOCC Format F of Figure 2. The device area code is given with a function code of 000 and bit 15 of the modifier is set (one). The 2310 is removed from the C.E. Mode by repeating the C.E. Mode XIO instruction with bit 15 of the modifier cleared (zero). When in the C.E. Mode, the 2310 is not available to the P-C for normal operational data transfers. The 2310 in the C.E. Mode is under the control of a diagnostic program which checks the operation of the 2310. The 2310 status word is shown in Table 3.

The status word reserves Bits 0 through 9, 11 and 12 for the various status conditions of the 2310. Bits 14 and 15 record the next sectors which can be read from or written into.

When the 2310 has completed a read, read-check, or write operation, or when the carriage has moved the requested number of tracks, an Operation Complete interrupt is sent to the P-C and status bit 1 is set. This interrupt informs the P-C that the

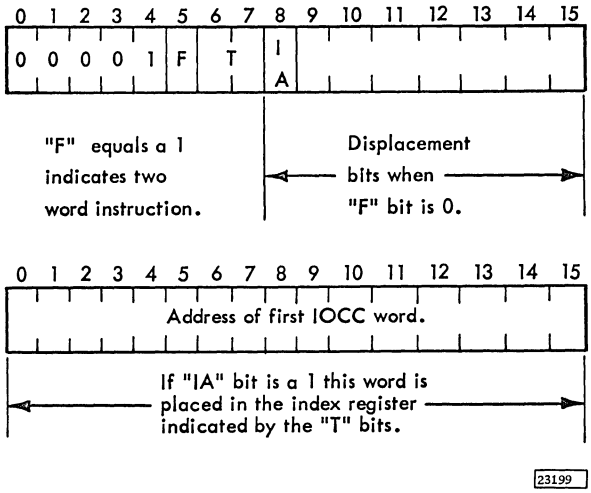
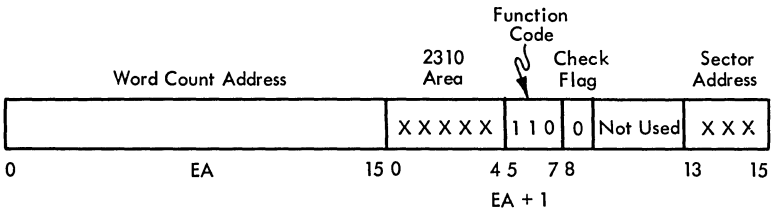
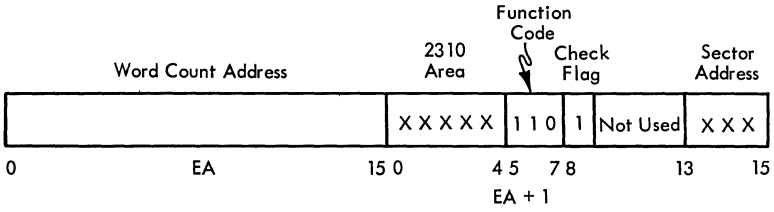


Figure 1. XIO Instruction Format

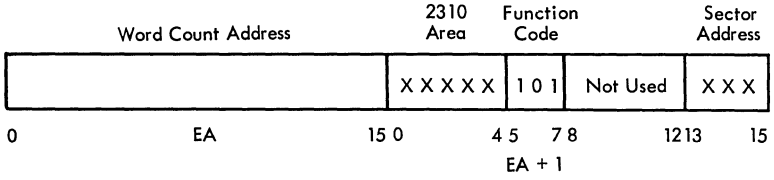
A. Initialize Read



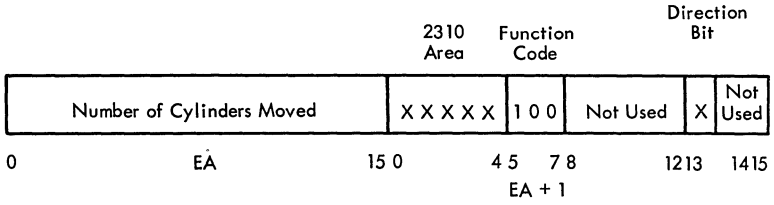
B. Initialize Read Check



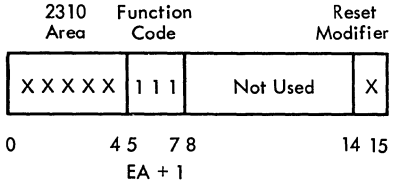
C. Initialize Write



D. Control



E. Sense Device



F. C.E. Mode

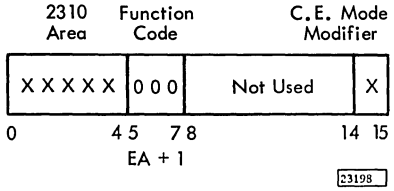


Figure 2. IOCC Formats

Table 3. 2310 Status Word Format

Bit	Definition
0	Any Error
1	Operation Complete
2	Disk Not Ready
3	Disk Busy (R/W or Control)
4	Carriage Home
5	Parity Check Error
6	Storage Protect Error
7	Data Error
8	Write Select Error
9	Data Overrun
10	Not Used
11	C.E. Not Ready
12	C.E. Busy
13	Not Used
14-15	Sector Counts

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2310 has completed the XIO instruction. At this time, the P-C, if programmed to do so, can generate an XIO-Sense-Device instruction to check the status register in the 2310. If the Any Error status indicator (status bit 0) is on, the program checks the remaining status bits for one or more of the following status conditions:

- Data Error: This status bit (bit 7) indicates a modulo four error or the detection of a sector pulse prior to the completion of the read or write operation.

- Write Select Error: This status bit (bit 8) indicates that both heads were selected during a write operation. This status places the 2310 in the not ready status and can be reset only by stopping and restarting the disk drive motor.

- Data Overrun: This status bit (bit 9) indicates that the channel failed to transfer the previous word to or from core storage before the disk required service for the next word.

- Parity Check Error: This status bit (bit 5) indicates that a data transfer to or from the P-C register did not have correct parity.

- Storage Protect Error: This status bit (bit 6) indicates that the file attempted to read into a memory location previously defined as a Storage Protected Area.

In addition to setting the Operation Complete status and the 5 Any Error status conditions, the 2310 sets status bits for the following conditions:

- Disk Not Ready: This status bit (bit 2) is turned on when the file is busy. This status is generated when the disk control is in the C. E. Mode, or when the disk file is not mechanically or electrically ready. In the latter two cases, operator intervention is required to reset the status bit.

- Disk Busy: This status bit (bit 3) is turned on when the file is executing a prior XIO command. It is never active while the file is in the C. E. Mode.

- Carriage Home: This status bit (bit 4) is turned on when the carriage is in the Home Position (track 00).

- C. E. Not Ready: This status bit (bit 11) indicates that the disk drive control is either busy or not ready when the 2310 is in the C. E. Mode.

- C. E. Busy: This status bit (bit 12) indicates the disk drive control is busy when the 2310 is in the C. E. Mode.

- Sector Counts: These bits (14 and 15) identify the pair of sectors which are next available for reading or writing.

RELATED LITERATURE

The IBM 1800 Data Acquisition and Control System Bibliography (Form A26-5931) lists the Systems Reference Library publications that are available for the 1800 System. The following Field Engineering publication is available:

IBM Field Engineering Manual of Instruction, 2310 Disk Storage Drive (Form 227-5985).

PRIMARY POWER

The 2310 receives single phase 208 vac and 115 vac power from the controlling or host device (1801 or 1802 Processor-Controller). Figure 3 illustrates the power cable connector. Table 4 lists the voltages and pin assignments for the power connector.

Secondary Power

Power supplies within the 2310 provide the following d-c voltage outputs.

Voltage	Max. Current
+6	8.0
-3	8.0
+3	8.0
+48	6.0

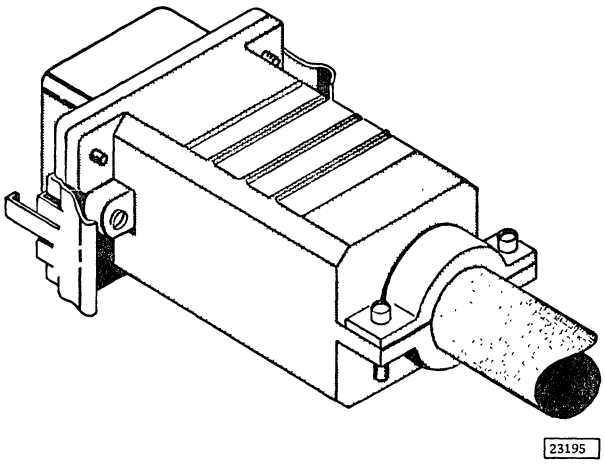

Figure 3. 2310 Power Cable Connector

SIGNAL INTERFACE

IBM Serpentine type signal connectors (Figure 4) are used on the 2310 signal cables and signal interface. The I/O Channel Interface lines and pin assignments are listed at the sides of the cable connectors illustrated in Figure 5.

Timings for the I/O Channel Control and XIO Instruction are shown in Figures 6 and 7.

CABLES

Table 5 lists all the I/O cables for the 1800 System. Cable groups 30 and 31 in the table are for the 2310.

Table 4. Power Connector Pin Assignment

Pin Number	Voltage	Phase
A1	208	3
A2	208	1
A3	---	-
A4	Frame Ground	-
B1	115 ac	-
B2	115 ac	-
B3	---	-
B4	---	-

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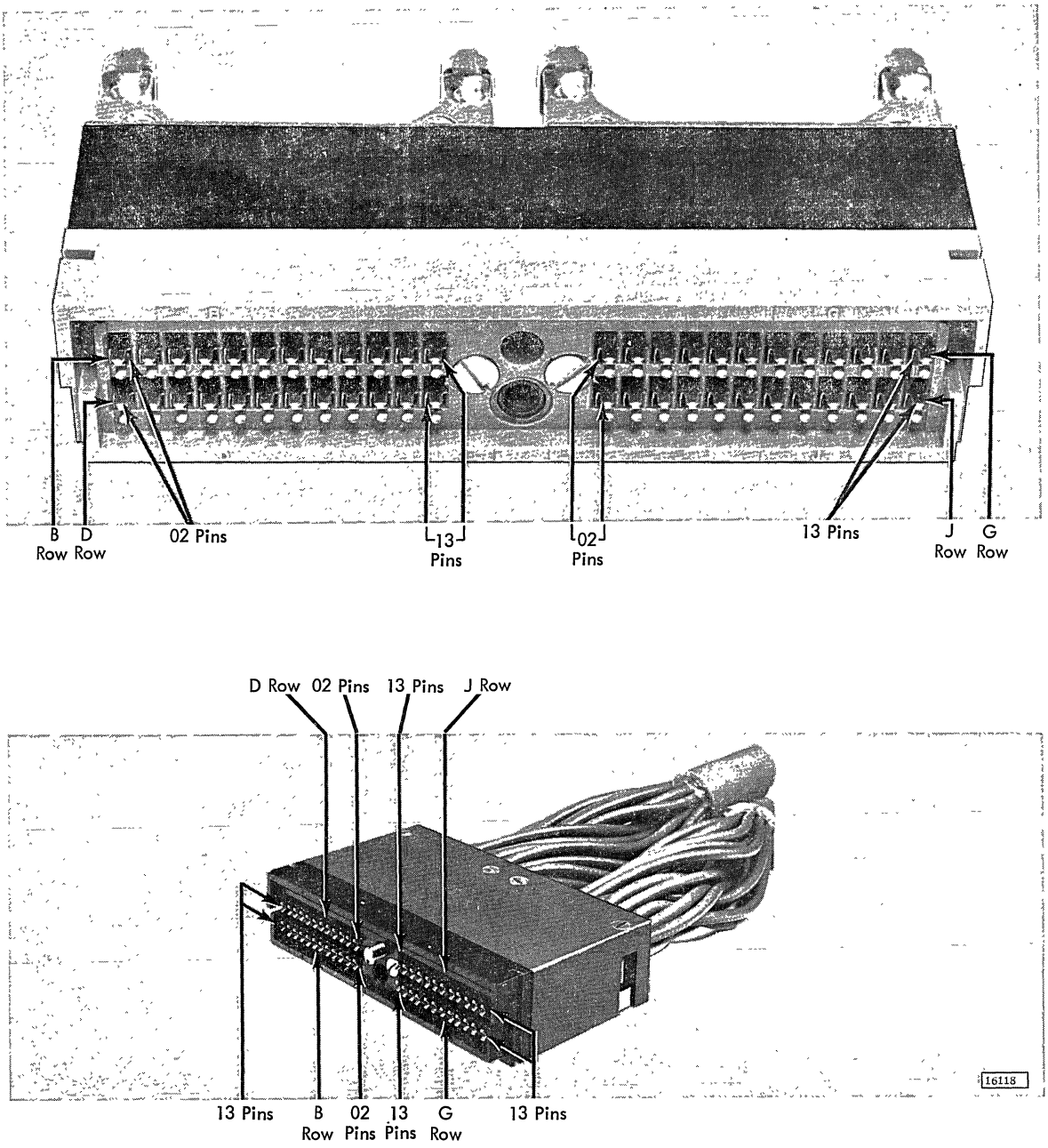
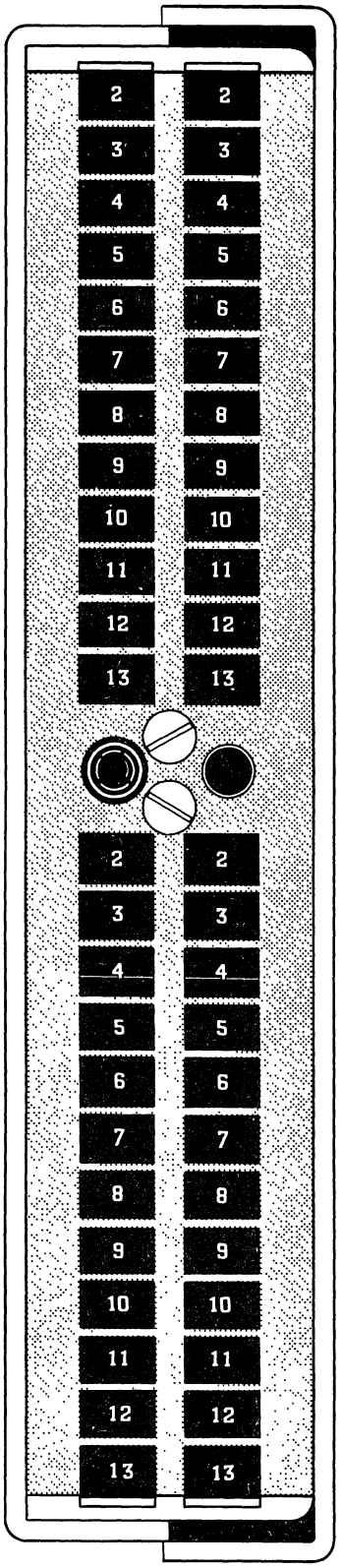


Figure 4. Signal Connector

B	
Out Bus Bit 0	•
Out Bus Bit 1	•
Out Bus Bit 2	•
Out Bus Bit 3	•
Out Bus Bit 4	•
Out Bus Bit 5	•
Out Bus Bit 6	•
Out Bus Bit 7	•
Out Bus Bit 8	•
Out Bus 9	•

G	
In Bus Bit 0	•
In Bus Bit 1	•
In Bus Bit 2	•
In Bus Bit 3	•
In Bus Bit 4	•
In Bus Bit 5	•
In Bus Bit 6	•
In Bus Bit 7	•
In Bus Bit 8	•
In Bus Bit 9	•



D	
•	Out Bus Bit 10
•	Out Bus Bit 11
•	Out Bus Bit 12
•	Out Bus Bit 13
•	Out Bus Bit 14
O	Ground
•	Out Bus Bit 15
•	Time Pulse A
•	Time Pulse B
•	Parity Left Byte
•	Parity Right Byte

J	
•	In Bus Bit 10
•	In Bus Bit 11
•	In Bus Bit 12
•	In Bus Bit 13
•	In Bus Bit 14
O	Ground
•	In Bus Bit 15
•	XIO Data Cycle
•	XIO Control Cycle
•	Parity Error - CAR Check
•	Storage Protect Violation

• Signal (Standard SLT)
O Ground Shield

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Figure 5a. I/O Channel Interface Pin Assignments, Connector P3

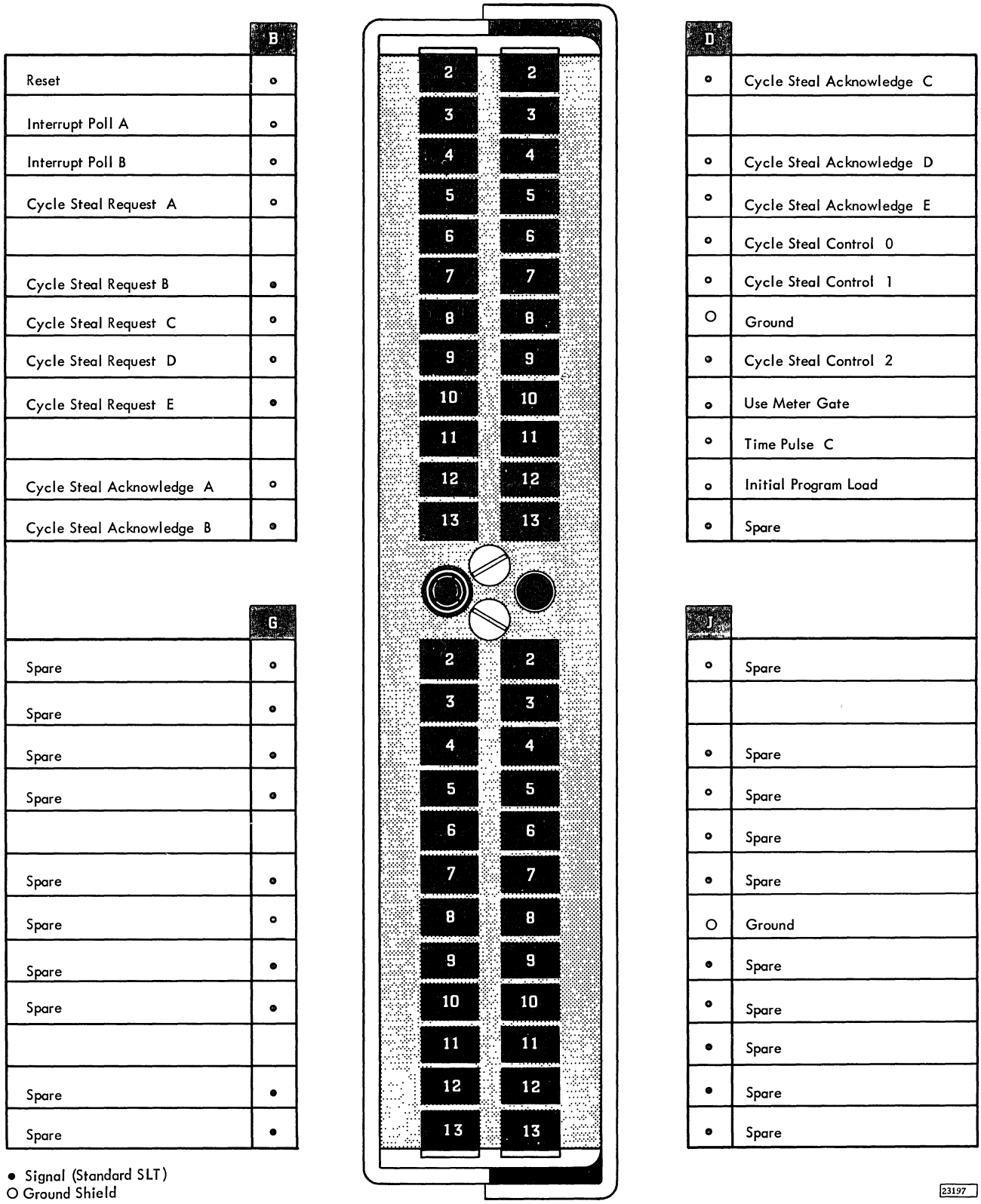
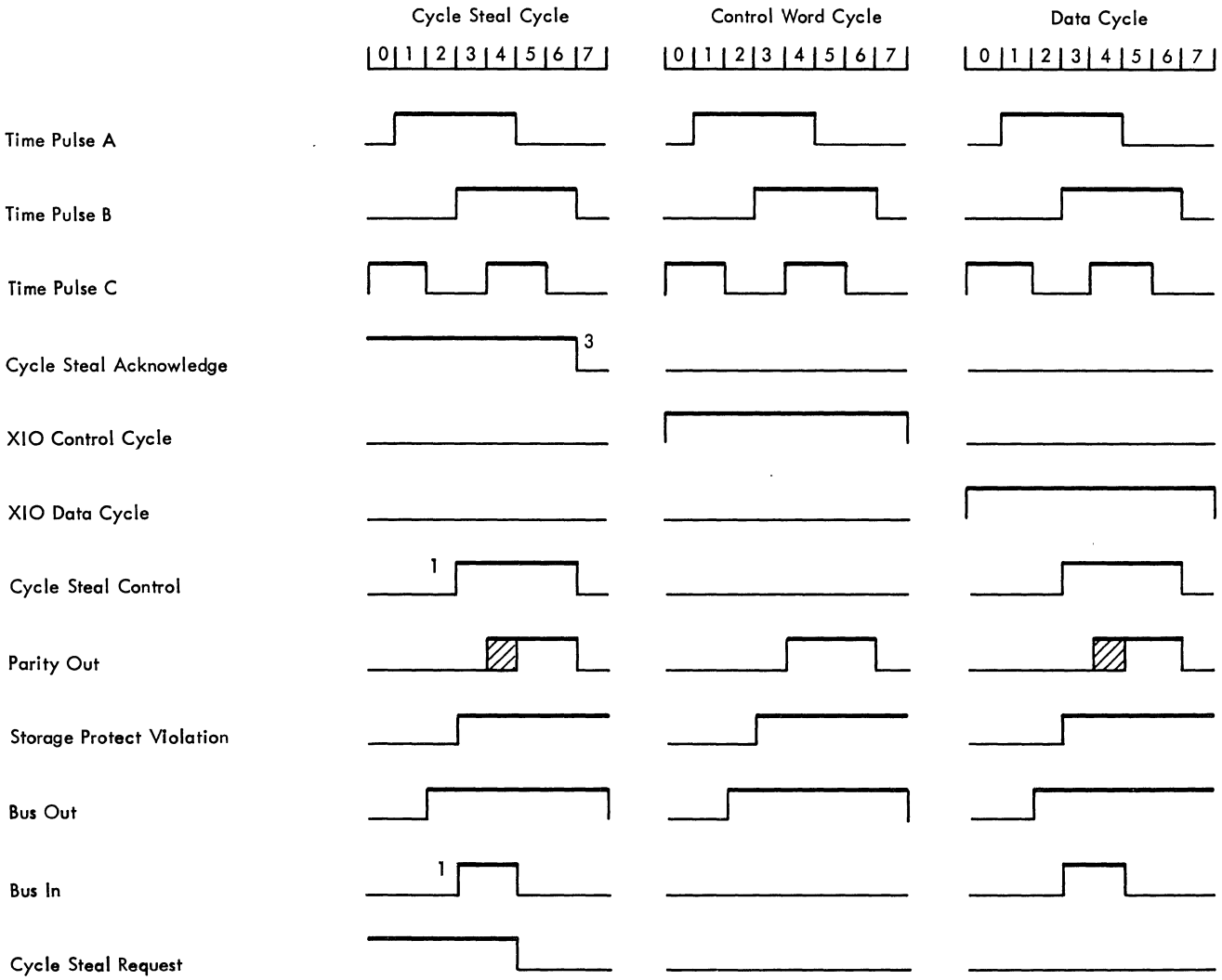


Figure 5b. I/O Channel Interface Pin Assignments, Connector P4



NOTES
1. Minimum Required Width at CPU. Maximum Allowed Width is Such as to be Included Within Selected Cycle.
2. Timing Pulses Occur as Long as T or X Clock Runs.
3. This Signal is Undefined During X7 and T7 Time.
4. All Rise and Fall Times are Subject to ±100nsec Skew.

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Figure 6. I/O Channel Control Timing

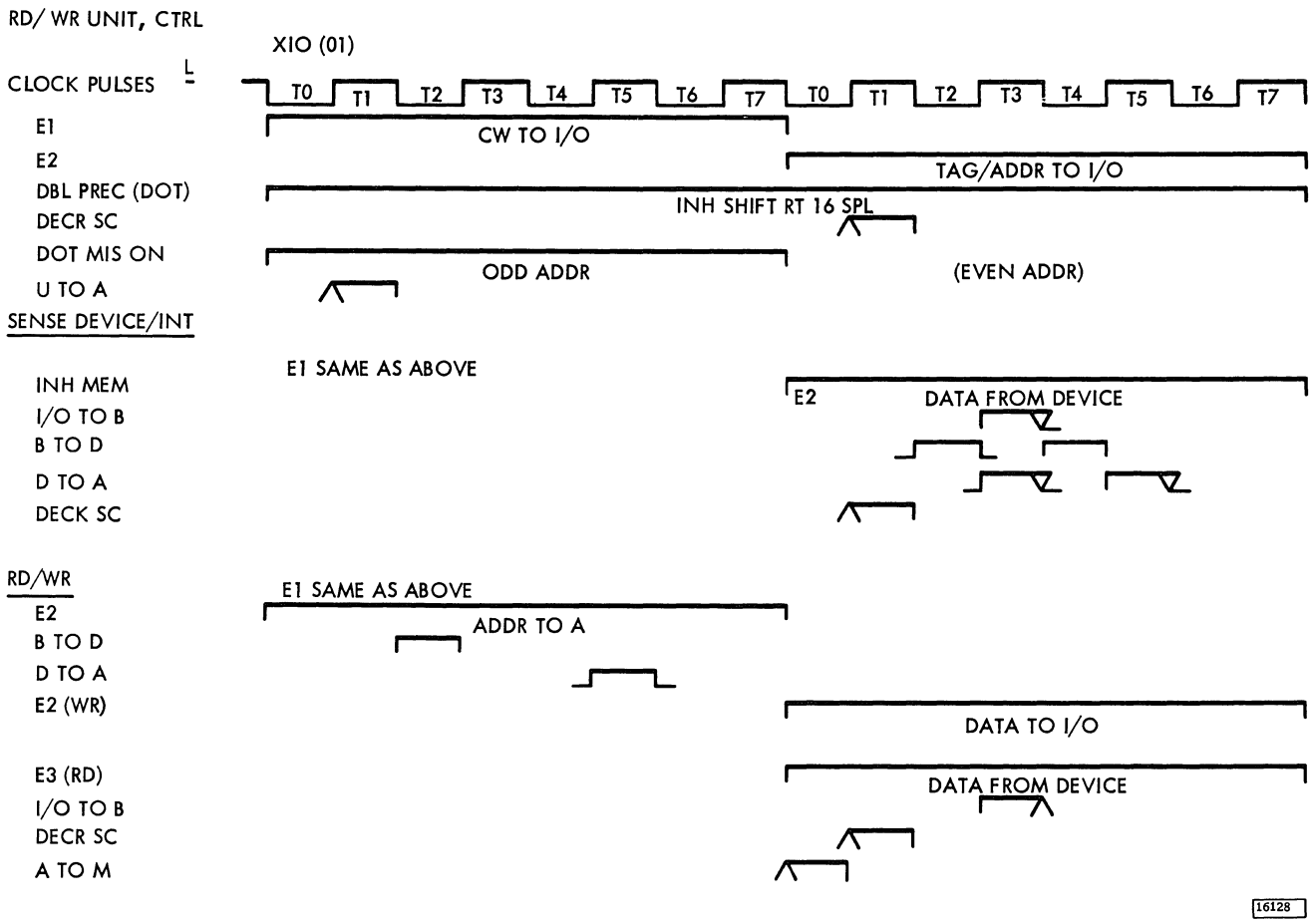

Figure 7. XIO Instruction Timing

Table 5. 1800 System Cables

CABLE GROUP NUMBER	CABLE QTY.	KEY NO.	(CABLE) PART NUMBER	MAX. X LENGTH	"FROM" UNIT	ENTRY LOCATION	"TO" UNIT	FUNCTION	FEATURE CODES
1	1	1	2196099	14 Fixed	Power Outlet	A	1801/2	Power	
2	1	2	2196099	100	1826-1	A	1801/2	Power 208v, 110v, and 24 vdc	
3	2	3a	2195952	100	1826-1	B	1801/2	Signal Process Interrupt	1st 5710
		3b	2195952	100	1826-1	B	1801/2	Signal Process Interrupt	
4	1	4	2195952	100	1826-1	B	1801/2	Signal Dig. Input	1st 3262 or 5861
5	1	5	2195952	100	1826-1	B	1801/2	Signal Dig. Output	1st 3295
6	2	6a	2195952	100	1826-1	B	1801/2	Sig. AI Expand	1237
		6b	2195952	100	1826-1	B	1801/2	Sig. AI Expand	(1 only)
8	1	8	2196097	100	1828-1	A	1801/2	Power 115-24v and 208v	
9	1	9	2195952	100	1828-1	B	1801/2	Signal Analog Out	
20	1	20	2196095	20	1627	A	1801/2	Power and signal	
21	2	21a	2196101	50	1816	B	1801/2	Signal	
		21b	2196102	50	1816	B	1801/2	Signal	
22	1	22	2196101	Note 1	1053	B	1801/2	Signal	
23	1	23	2196093	20	1054	A	1801/2	Power and Signal	1054
24	1	24	648548	20	1055	B	1801/2	Signal and Signal	1055
25	1	25	2196094	20 Fixed	1442	A	1801/2	Power AC-DC	
26	1	26	648549	20 Fixed	1442	B	1801/2	Signal	
27	1	27	2159004	25	1443	A	1801/2	Pwr. Sequence	
28	1	28	2196104	25	1443	B	1801/2	Signal	
29	1	29	2162477	14 Fixed	1443		Power Outlet	Power 208v	
30		30	2196096	20	2310	A	1801/2	Power 208v	
31	2	31a	2195952	20	2310	B	1801/2	Signal	
		31b	2195952	20	2310	B	1801/2	Signal	
33	1	32	1166293	Fixed-8'	1053		Wall Rect	Power 115V	
32	1	33	1166293	Fixed-8'	1816		Wall Rect	Power 155V	
121	1	121	535098	100 (Note 2)	2401/2402	B	1802	Power	
122	1	122	5318935	200 (Note 2)	2401/2402	A	1802	Signal	
109	1	109	535098	Note 2	2nd 2401		1st 2401	Power	
110	1	110	5356175	Note 2	2nd 2401		1st 2401	Signal	

Note 1: This cable can be a maximum of 2,000 feet. Cable in excess of 8 feet, however, is an extra cost item to the customer.

Note 2: The combined "X" length of cable groups 121 and 109 (2401 power), and 122 and 110 (2401 signal) is a maximum of 100 feet when two 2401 tape drives are used.

5356195 Cable terminators for 2401/2402 are part of the 1802 shipping group.

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GENERAL

The signal lines between the cable connector interface and the adapters within the 2310 consist or flat transmission cables and printed wire. Transmission lines to the 2310 can be driven by single or multiple drivers and can feed single or multiple receivers. All transmission lines must terminate with their characteristic impedance.

Single Driver and Receiver

When a transmission line is supplied by a single driver and feeds a single receiver, the driver and receiver must be located at the extreme ends of the lines. Drivers and receivers can be located beyond the line terminator, provided that the distance between the terminator and the end-of-line driver or receiver is less than 6 inches.

Multiple Drivers and Receivers

Transmission lines can be driven by a maximum of eight drivers, and can supply a maximum of eight receivers. Any combination of drivers and receivers, up to the maximum of eight drivers and eight receivers, can be dot ORed to the transmission line.

Multiple receivers on a line should not be less than 3 feet apart. However, no minimum spacing requirements have been set for the distance between drivers, between an end-of-line terminator and a driver, or between and end-of-line terminator and a receiver. If a line with multiple drivers and/or receivers is not terminated at the extreme end, the terminator must be within 6 inches of the end-of-line driver or receiver.

GENERAL ELECTRICAL CONSIDERATIONS

Current Flow

The direction of current flow (conventional) is minus if it is flowing into a component or plus if flowing out of it.

Voltage Levels

The positive level on a line denotes a logical zero and the more negative level denotes a logical one. See Specific Electrical Requirements — Receiver, Driver.

Impedance

Lines must have a characteristic impedance of 95 ohms, plus or minus 10 ohms. Lines must terminate at each end (except as noted above) with their characteristic impedance.

Noise

The maximum noise coupled onto any signal line within a cable due to any combination of changes external to that line must not exceed 300 millivolts.

Fault Conditions

The signal line may be grounded with no damage to drivers, receivers, or terminators.

Loss of power at either end does not cause any damage.

Loss of power at any terminator may cause random errors in information transmission.

Loss of power at both terminators results in generation of logical ones, irrespective of information input.

Line operation is unaffected where power is off in any driver or receiver unit.

SPECIFIC ELECTRICAL REQUIREMENTS

Receiver

The output must be interpreted as a logical one for the more negative line signal, and as a logical zero for either a plus line signal or an open input.

Receivers must not require a switching level more positive than +2.52 volts for a logical zero or more negative than +1.42 volts for a logical one.

Receivers must not be damaged by a most positive direct current up level of 3.4 volts or most negative direct current down level of 0 volts.

Receiver input must not require positive current greater than 0.35 milliampere at the most positive up level of 3.4 v. Positive current required must not be greater than that taken by a 15.4K ohm resistor network connected to a 6.24-v supply. Input impedance of each receiver should be made as high as possible, but never lower than 4.0K.

Terminator

The terminator is viewed as a two-terminal network consisting of resistors and power supplies, and must meet the following requirements.

The terminal connected to the signal line must present an open-circuit voltage between +2.88 volts and +3.4 volts. Impedance between the terminals must not be less than 90 ohms nor greater than 105 ohms. Current is measured at the terminal that is connected to the cable and must not be greater than 22.8 milliamperes flowing out of the component at +1.12 volts. One terminal of the terminator is connected to ground, the other to the signal line.

Driver

To transmit a logical zero, voltage source drivers must pull less than 100 microamperes from the line.

To transmit a logical one, the driver conducts. The driver must be capable of accepting +56.0 microamperes from a 0.33-v source when in the conducting state.

If the driver output is open-circuited when conducting, the voltage must not fall below 0.00 v.

Cable

Cable length is limited by a maximum cable resistance of 26 ohms, including contact resistance. A maximum of 0.25 ohm contact resistance per control unit or channel is allowed, including connections to and from the external cables. The cable may consist of any combination of flat cable, coaxial cable, and printed wire within the above limitation. The maximum allowable internal cable resistance offered by any control unit or channel on the interface is 1.5 ohms. The measurement of this value is made between the external connector pins.

The characteristic impedance ranges from 82 to 102 ohms.

Connectors

The maximum coupled noise due to connectors in each control unit, including to and from external cables, is 250 millivolts.

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The customer is responsible for the design, procurement, installation, repair, and service of the alteration or attachment. In the event that an alteration or attachment causes interference with the installation of an engineering change which is considered necessary to effect an improvement in the operation or maintenance of an IBM machine, the customer will be required to eliminate such interference.

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