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Systems Reference Library

IBM 1130 Custom Feature Description— Attachment Channel RPQ Number 831552

This manual contains programming and packaging information for the IBM 1130 attachment channel (RPQ). Channel operation and I/O operations associated with the attachment channel are described in detail. The information in this manual is not oriented to any particular control unit or I/O device that may attach to the channel.

PREFACE

This manual is intended as a reference source for programmers and operators of IBM 1130 Computing Systems with the IBM 1130 attachment channel (RPQ) and the IBM 1133 Multiplex Control Enclosure attached. The material presented assumes a thorough knowledge of the IBM 1130 system.

The programmer or operator should be familiar with the following publications:

IBM 1130 Functional Characteristics, Form A26-5881.

IBM 1130 Computing System Installation Manual - Physical Planning, Form A26-5914.

In addition, it is necessary to be familiar with the SRL publications applicable to the control unit and I/O devices connected to the attachment channel.

First Edition (October 1968)

Significant changes or additions to the specifications contained in this publication are continually being made. When using this publication in connection with the operation of IBM equipment, check the latest SRL Newsletter for revisions or contact the local IBM branch office.

The illustrations in this manual have a code number in the lower corner. This is a publishing control number and is not related to the subject matter.

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INTRODUCTION

The attachment channel, hereafter called the selector channel, provides a means for attaching certain IBM System/360 input/output devices and their associated control units to the IBM 1130 Computing System. The selector channel attaches to the 1131 central processing unit (CPU) via the IBM 1133 Multiplex Control Enclosure.

The selector channel is implemented by solid logic technology (SLT) components located within the 1133. Circuitry for the selector channel is provided by RPQ* 831552.

A maximum of eight control units may be attached to the selector channel. The number of I/O devices that may be included depends on the number of devices sharing each attached control unit. If a maximum complement of eight control units is attached, the number of I/O devices is limited by program addressing facilities to 32 per control unit.

The maximum data rate transfer between the control unit and selector channel is dependent upon the type of control unit attached, overlapping of CPU operations, and higher priority cycle steal requests. The maximum instantaneous data rates are:

1. 166 kilobyte cycles per second (KBC) for CPU's with a 3.6-microsecond core storage cycle.
2. 270 KBC for CPU's with a 2.2-microsecond core storage cycle.

These rates are based on worst case with the following conditions:

1. A machine cycle has just been initiated when a cycle steal request occurs.

2. No higher priority cycle steal devices are making demands upon the system.
3. The control unit does not contain a data buffer.
4. Data chaining is not occurring.

Note: Some I/O devices have a large deviation between their nominal data rate and their maximum data rate. For example, the IBM 2415 is nominally a 15-KBC device; however, the maximum rate is 35 KBC.

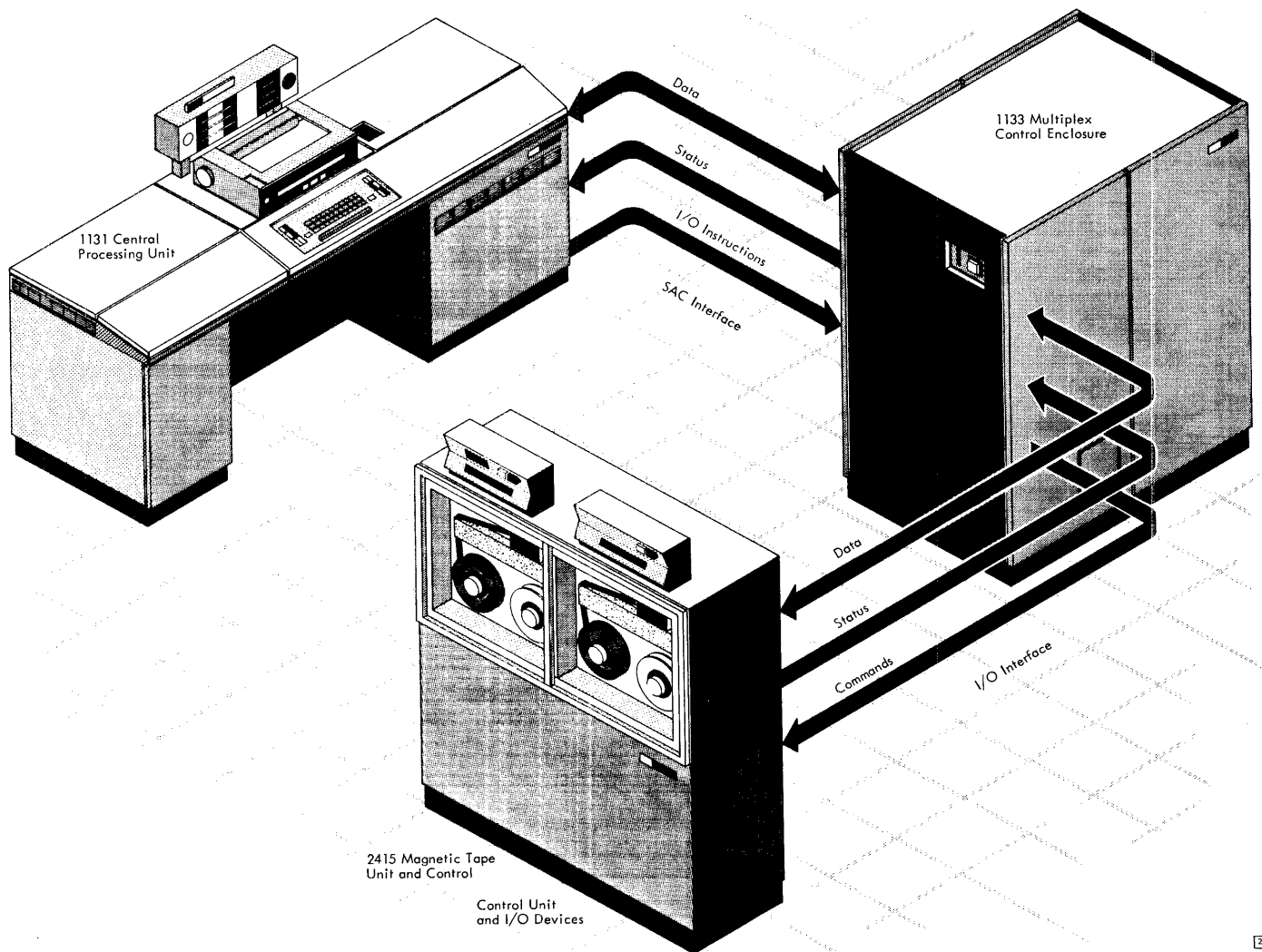
The functions of the selector channel are to provide a standard form of control for I/O devices that attach to it, and to direct the flow of information between the I/O devices and main storage.

The selector channel communicates with the attached control units over the I/O interface (Figure 1). The I/O interface provides an information format and signal sequence common to all control units. The interface consists of signal lines that connect one or more control units to the channel. Except for signals used to establish selection control, all signals provided by the channel are available to all control units. At any one time however, only one control unit can be logically connected to the channel.

The control unit decodes commands received from the channel, interprets them for the particular I/O device, and provides a signal sequence for executing the operation. The control unit may be housed separately or, as in the case of the IBM 2415, may be physically and logically integral with the I/O device.

Attachments such as the IBM 2415 Magnetic Tape Unit and Control add new dimensions of performance, flexibility, and versatility to the 1130 Computing System.

*Request Price Quotation



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Figure 1. Selector Channel Data Flow

IA (Indirect Address): IA = 0 specifies direct address. IA=1 specifies indirect address as derived by standard effective address generation used for 1130 instructions. Refer to the System Reference Library publication IBM 1130 Functional Characteristics, Form A26-5881.

Modifiers: Not used.

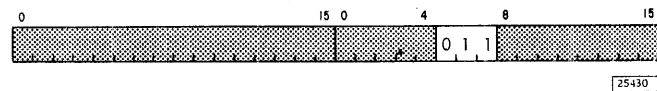
Address: When IA=0, these 16 bits specify the address of the IOCC. If IA=1, the IOCC is at the location specified by the effective address derived by indirect addressing and/or EA modification.

INPUT/OUTPUT CONTROL COMMAND (IOCC)

The IOCC defines the operation to be performed by the selector channel. It is fetched from a location specified by the effective address generated by the completion of a successful XIO instruction.

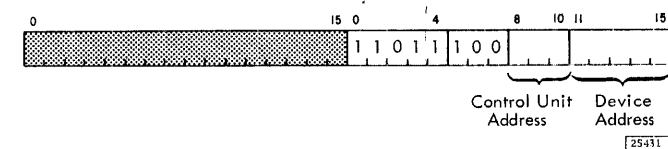
The IOCC consists of two consecutive 16-bit words designated as EA and EA+1. Standard 1130 programming procedures require that the first word (EA) of the IOCC be located at an even address. The format and bit designations pertaining to selector channel operation are shown in Figure 2.

Sense Interrupt

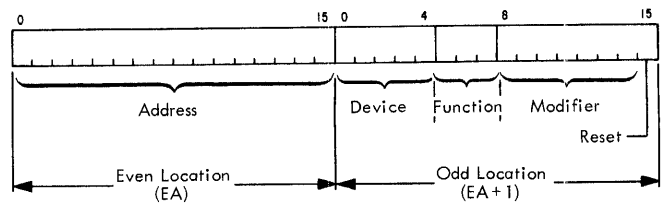


This instruction (function code 011) directs the selector channel to place a 1 in bit position 12 of the accumulator if the selector channel is requesting an interrupt. If the selector channel is not requesting an interrupt, bit 12 in the accumulator is 0.

Halt I/O



This instruction (function code 100) causes the execution of the current I/O operation at the addressed



Address - Use of this 16-bit field depends on the command specified.
 Area - The Selector Channel is assigned area 27 (11011).
 Function Code (Command) - The Selector Channel will respond to the following commands:
 Sense Interrupt (011)
 Halt I/O (100)
 Sense Device (111)
 Start I/O (101)
 Modifiers - Use of this 8-bit field depends on command specified.

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Figure 2. Input/Output Control Command

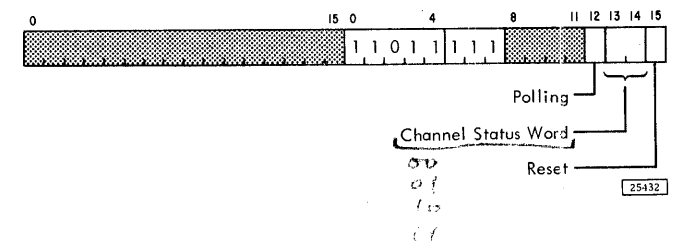
selector channel to be terminated. If the channel is not busy, modifier bits 8 to 15 identify the control unit and I/O device to which the Halt I/O applies.

When the channel is available (not busy), and the control unit is working (busy), the addressed device is selected and signaled to terminate the current operation. Halt I/O does not affect the state of the control unit when both channel and control unit are available.

If a Halt I/O is issued when the channel is executing a data transfer, the data transfer is terminated and the device performing the operation is immediately disconnected from the channel. In this case, modifier bits 8 to 15 are ignored.

The termination of channel operation as a result of a Halt I/O causes the channel and control unit to be placed in the interruption pending state. When the channel is in either the interruption pending state or available, and the control unit is in the interruption pending state, execution of a Halt I/O does not affect the state of either the channel or control unit.

Sense Device

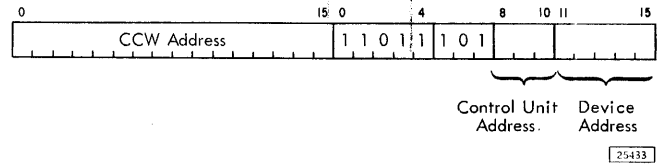


This instruction (function code 111) directs the selector channel to make its current indicator status available for automatic placement into the 1131 accumulator. Modifier bits 13 and 14 specify which of the four words comprising the channel status word (see "Channel Status Word") is to be interrogated.

Modifier bits 12 on (1) suppresses polling. Polling is reinitiated following the completion of a Start I/O operation or after the execution of another Sense Device with modifier bit 12 set to 0.

Modifier bit 15 on (1) causes the selector channel status, with the exception of the unit status pending bit, to be reset after interrogation. The unit status pending bit will be reset when unit address-status (word 2 of the channel status word) is interrogated with modifier bit 15 of the IOCC on. When modifier bit 15 is 0, the program may interrogate the selector channel with no effect on the status indicators.

Start I/O



This instruction (function code 101) initiates I/O operations. Bits 0 to 15 of the IOCC contain the address of a channel command word which will subsequently instruct the control unit or I/O device to perform a specific operation. Modifier bits 8 to 15 contain the address of the control unit and device to which the command applies.

I/O OPERATIONS

FUNCTIONAL DESCRIPTION

All I/O operations are initiated by a Start I/O instruction. If the channel facilities are available, the Start I/O is accepted and the selector channel fetches the first channel command word. The channel command word (CCW) contains information that directs the control unit and I/O device to perform specific operations.

The I/O operation to be executed is determined by an eight-bit command code in the CCW (bits 8 to 15 in CCW word 2). The basic commands are common to all types of devices that attach to the channel. Modifier bits within the command code are used to specify device-dependent conditions for the execution of operations peculiar to a particular device. The command code may direct the I/O device to initiate mechanical motion at the device, or it may initiate a data transfer to or from the device.

Facilities are provided for the channel to initiate either command or data chaining with a single Start I/O instruction.

Termination of an I/O operation normally is indicated by two conditions: channel end and device end. The channel end condition indicates that the I/O device has received or provided all information associated with the operation and no longer needs channel facilities. Device end indicates that the I/O device has terminated the execution of the operation. Device end can occur concurrently with channel end or later.

The conditions signaling the termination of I/O operations are brought to the attention of the program by I/O interruptions or by programmed interrogation of the I/O device. In either case, these conditions cause storing of the channel status word (CSW). The channel status word contains the present status of the selector channel, control unit, and I/O device as well as the conditions under which an I/O operation was executed or terminated. Using a Sense Device instruction, the program can interrogate the CSW to determine the availability of the channel, control unit, and device, and to identify conditions which caused the termination of an operation.

CHANNEL COMMAND WORD

The channel command word contains information that directs the control unit and I/O device to perform specific operations. The CCW consists of three 16-bit words that are located in any three adjacent main storage locations. The three words are designated as follows:

1. Byte count.
2. Flags and command codes.
3. Storage address.

Byte Count

The byte count (Figure 3) specifies the length of the input or output data field. The maximum length (number of bytes) that can be specified is determined by the size of the main storage in the 1131.

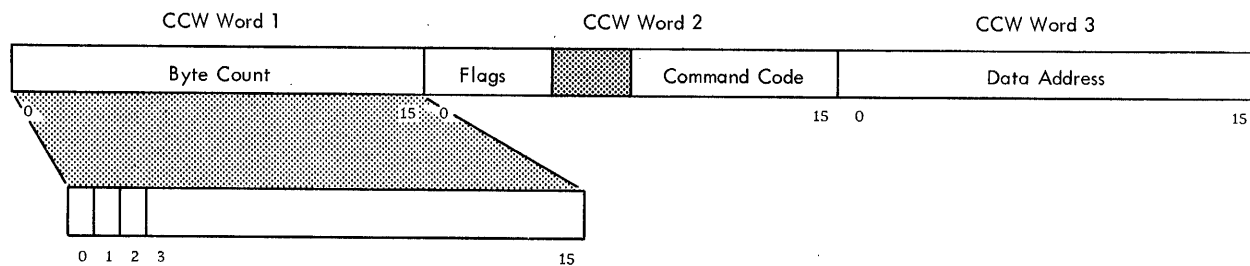
One 1131 word (16 bits) equals two bytes of data (8 bits/byte). Therefore, an 1131 with 3k storage (8192 words) would contain 16,384 bytes, a 16k storage (16,384 words) 32,768 bytes, and so on.

Flags and Command Codes

CCW word 2 (Figure 4) is essentially divided into two parts: flags and command codes. The flag bits (0 to 4) indicate certain conditions to the program and control chaining of commands and data. The command code bits (8 to 15) specify the operation to be performed by the control unit and I/O device.

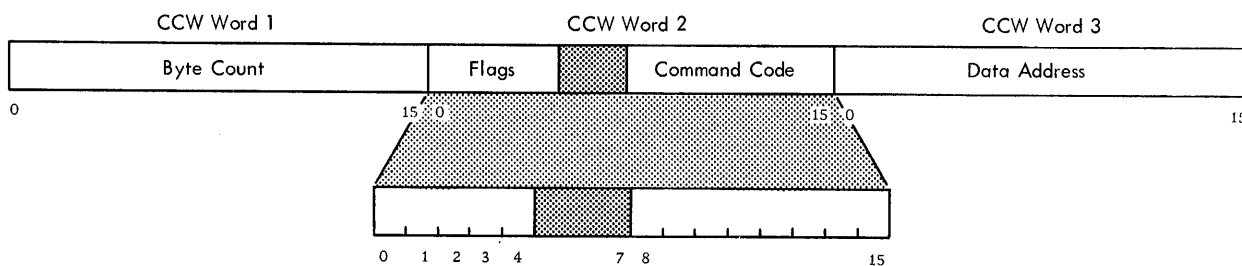
Flags

Chain Data (CD): Bit 0 on (1) specifies chaining of data. When data chaining is specified, the selector channel automatically fetches the next CCW when the byte count defined by the current CCW goes to 0. The new CCW designates a new storage area which data can be placed into or taken from. The command code in the new CCW will be ignored, unless it specifies Transfer in Channel.



Bit	Indication	
0	Used only for 32k main storage	
1	Used only for 16k and 32k main storage	
2	Used only for 8k, 16k, and 32k main storage	
3-15	Used with bits 0-2 (if applicable) and specifies the number of 8-bit bytes in the input or output data field	25434

Figure 3. Byte Count (CCW Word 1)



Bit	Indication								
0	CD - Specifies data chaining								
1	CC - Specifies command chaining								
2	SLI - Suppress length indication								
3	PCI - Program control interruption								
4	Skip								
5-7	Not used								
8	0	0	0	0	0	0	0	0	Test I/O
M	M	M	M	M	M	1	0	0	Read
M	M	M	M	1	1	0	0	0	Read Backward
M	M	M	M	M	M	0	1	0	Write
M	M	M	M	M	M	1	1	0	Control
M	M	M	M	0	1	0	0	0	Sense
X	X	X	X	1	0	0	0	0	Transfer in Channel

M = Modifier
X = Bit Ignored

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Figure 4. Flags and Command Code (CCW Word 2)

Chain Command (CC): Bit 1 on (1) specifies command chaining. When command chaining is specified, the selector channel fetches a new CCW specifying a new I/O operation on completion of the current CCW. The new CCW is automatically executed when the I/O device has completed the current operation and signaled device end to the channel. Command chaining cannot be used in conjunction with data chaining.

Suppress Length Indication (SLI): Bit 2 determines whether an incorrect length condition is to be indicated to the program. When this bit is on (1) and the CD bit is 0 in the last CCW used, the incorrect length indication is suppressed. When both the CC bit and the SLI bit are on (1), command chaining takes place regardless of the presence of an incorrect length indication. Absence of the SLI bit or the presence of the CD bit causes the program to be notified if an incorrect length indication occurs. This bit must be on when performing a write function to a control unit or an incorrect length indication will occur.

Program Control Interruption (PCI): Bit 3 on (1) causes the selector channel to generate an interrupt condition upon fetching the CCW.

Skip: Bit 4 on (1) specifies suppression of data transfer to main storage during a read, read backward, or sense operation. Skip is used only in conjunction with data chaining.

Command Code

The command code in the CCW specifies to the channel and I/O devices the operation to be performed. The two low-order bits (14 and 15) of the command code identify the operation of the selector channel. If these bits are 00, the four low-order bits (12-15) identify the operation. The high-order bit positions contain modifier bits which specify to the device how the operation is to be executed.

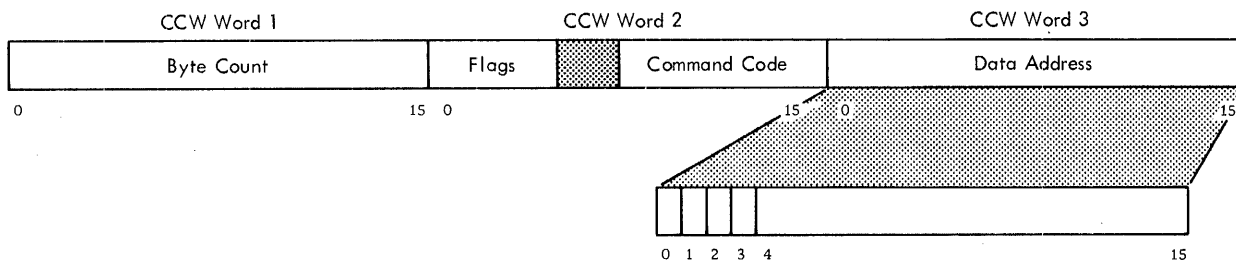
The bit configurations for commands which are common to all I/O units that attach to the channel are shown in Figure 4. See "Channel Commands" for a detailed explanation of each command code.

The meaning of the modifier bits depends on the type of I/O device attached to the channel. The Systems Reference Library publication for the particular device contains the exact function of the modifier bits for that device.

Data Address

For read or write operations, bits 0 to 15 of the data address (Figure 5) specify the address of the first byte in an input or output data field. If the command code specifies a Transfer in Channel command, the data address contains the address of a new CCW.

A data address which is outside the limits of available storage results in a program check condition.



Bit	Indication
0	Not Used
1	Used only for 32k main storage
2	Used only for 16k and 32k main storage
3	Used only for 8k, 16k, and 32k main storage
4-15	Used with bits 0-3 (if applicable) and specify the address of the first byte of data in an input or output data field. For Transfer in Channel commands, contains the address of a new CCW

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Figure 5. Data Address (CCW Word 3)

Command Chaining

Facilities are provided for the program to initiate a chain of operations with a single Start I/O instruction. This method of operation is called command chaining and is initiated by turning on the chain command bit (bit 1 of CCW word 2). If command chaining is specified, the selector channel fetches a new CCW, specifying a new I/O operation upon receipt of the device end signal for the current operation.

Chaining takes place only between CCW's located in successive three-word locations in main storage. It proceeds in an ascending order of addresses; that is, the address of the new CCW is obtained by adding 3 to the address of the current CCW. Two chains of CCW's located in noncontiguous main storage areas can be coupled for chaining purposes by a Transfer in Channel command. (See "Channel Commands".)

All CCW's in a chain apply to the I/O device specified by the modifier bits of the original Start I/O instruction.

Command chaining takes place and the new operation is initiated only if no unusual conditions have been detected in the current operation. Occurrence of a unit check, unit exception, control unit end, busy, or incorrect length (when the SLI bit is 0) cause the chain of operations to be terminated. The new CCW in this case is not fetched and the status associated with the current operation causes the CSW to be stored via program interruption.

An exception to sequential chaining of CCW's occurs when the I/O device presents the status modifier condition with the device end signal. (See "Unit Address - Status.") The combination of status modifier and device end bits causes the channel to fetch and chain to a CCW whose main storage location is 6 addresses higher than that of the current CCW.

Programming Note: Command chaining makes it possible for the program to transfer multiple blocks of data by means of a single Start I/O. In conjunction with the status modifier condition, command chaining also permits the channel to modify the normal sequence of operations in response to signals provided by the I/O device.

The time required to perform command chaining functions is 14.4 microseconds for CPU's with 3.6-microsecond core storage cycle speeds, and 8.8 microseconds for CPU's with 2.2 microsecond core storage cycle speeds. These speeds are based on worst-case conditions and the assumption that no higher priority cycle steal requests or Transfer in Channel commands have occurred.

During the execution of a chain of operations, the CSW pertains to the last operation that the channel executed or attempted to initiate. Information concerning the preceding operations is not preserved and is not made available to the program.

Command chaining cannot be used in conjunction with data chaining.

Data Chaining

Data transferred between main storage and the I/O device may be chained. Data chaining permits blocks of data to be transferred to or from noncontiguous areas of storage. When data chaining is specified (bit 0 of CCW word 2 on), the selector channel fetches a new CCW, specifying a new storage location, upon completion of data transfer for the current CCW. Unless the command code specifies transfer in channel, the content of the command code field of the new CCW is ignored.

Data chaining may be used to rearrange information as it is transferred between main storage and an I/O device. It may also be used in conjunction with the skipping function (see "Skip") to enable the program to place selected portions of a block of data into main storage.

Data chaining is considered to occur immediately after the last byte of data designated by the current CCW has been transferred to main storage or accepted by the I/O device. The new CCW then takes over control of the operation and replaces the pertinent information in the subchannel.

Programming Note: If the device sends channel end after exhausting the count of the current CCW, but before transferring any data to or from the storage area designated by the new CCW, the CSW associated with the termination identifies the new CCW.

If programming errors are detected in the new CCW or during its fetching, a program check condition is generated and the device is signaled to terminate the operation when it attempts to transfer data designated by the new CCW.

If the device signals channel end before transferring any data designated by the new CCW, incorrect length is indicated in the CSW associated with the termination.

Unless the address of the new CCW is invalid or programming errors are detected in an intervening transfer in channel command, the content of the CSW pertains to the new CCW.

An address exceeding the addressing capacity of the CPU is detected immediately upon fetching the CCW and indicated with a program check bit in the CSW.

The selector channel requires the same time to perform data chaining functions as command chaining functions. The assumptions made are the same. (See "Command Chaining.")

Self-Describing Blocks

When a channel program data chains to a CCW placed in main storage by the CCW specifying data chaining, the input block is said to be self-describing. A self-describing block contains one or more CCW's that specify storage locations and counts for subsequent data in the same input block.

Programming Note: Use of self-describing blocks is equivalent to use of unchecked data. An I/O data transfer malfunction that affects the validity of a block of information is signaled only at the completion of data transfer. The error condition normally does not prematurely terminate or otherwise affect the execution of the operation. Thus, there is no assurance that a CCW read as valid data is valid until the operation is completed. If the CCW thus read is in error, use of the CCW in the current operation may cause subsequent data to be placed in wrong locations in main storage with resultant destruction of its contents. If the error was such as to cause subsequent command chaining, it is possible to inadvertently chain to a write command. The result could be destruction of information on the I/O device.

Skip

Skipping suppresses transfer of information to main storage during read, read backward, and sense operations. Skipping is initiated by setting the skip flag (bit 4 of CCW word 2) to 1.

The skip function is used only in conjunction with data chaining and affects only the handling of information by the channel. The operation at the I/O device proceeds normally, and information is transferred to the channel. The channel keeps updating the count but does not place the data in main storage. If the chain command or chain data flag is 1, a new CCW is obtained when the count reaches 0. In the case of data chaining, normal operation is resumed if the skip flag in the new CCW is 0.

Even though data is not transferred to main storage, the initial data address in the CCW cannot exceed the addressing capacity of the CPU.

Programming Note: Skipping, when combined with data chaining, permits the program to place selected portions of a block of data into main storage from

an I/O device. Skipping should not be used by itself; it should only be used in conjunction with data chaining.

CHANNEL STATUS WORD

As previously stated, all I/O operations utilizing the selector channel are initiated by a Start I/O instruction. The operation specified by the Start I/O is initiated only when the selector channel, control unit, and I/O device are available. Conditions indicating the availability of the channel, control unit, and I/O device are contained in the channel status word (CSW). The CSW is formed, or parts of it replaced, in the process of I/O interruptions and during the execution of IOCC's.

The CSW consists of four 16-bit words.

1. Selector channel status.
2. Unit address - status.
3. Command address.
4. Count.

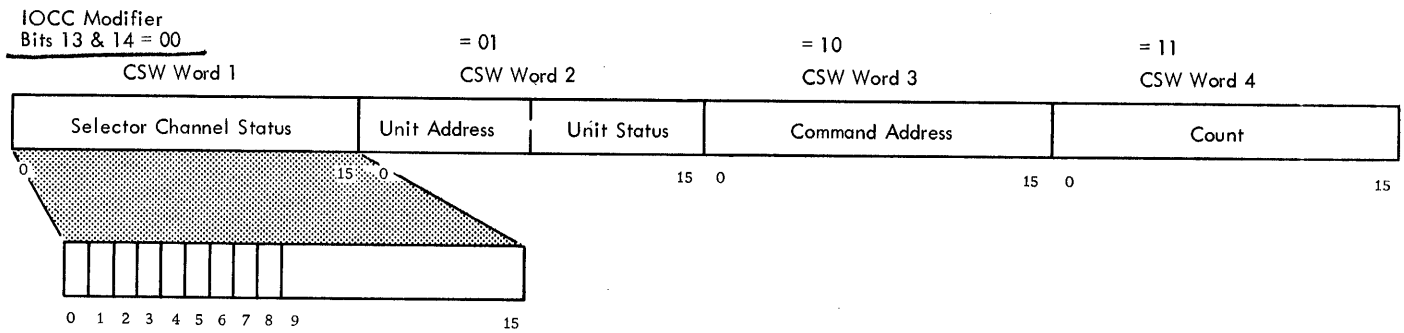
An IOCC instruction with a Sense Device function code is used to transfer each word into the accumulator. Which word of the CSW that will be transferred is determined by the setting of modifier bits 13 and 14 of the IOCC.

Selector Channel Status (CSW Word 1)

An IOCC Sense Device instruction with modifier bits 13 and 14 set to 00 causes the selector channel status portion of the CSW to be placed into the accumulator. The significance of each bit of CSW word 1 is shown in Figure 6.

Selector channel status is updated as it occurs and may be sensed by the program at any time. Whether a bit will be on (1) or off (0) in CSW word 1 is determined by conditions existing at the channel, control unit, or I/O device as a result of processing an I/O instruction.

Not Operational, Bit 0: Not operational occurs when a control unit fails to recognize a unit address specified by an IOCC. This bit is turned on (1) when the addressed control unit is not attached to the system. On multidevice control units, this bit is also set when the device portion of the unit address exceeds the number that the control unit is designed to handle. This condition causes an interrupt when it is detected by the channel. This bit is reset by modifier bit 15 on (1).



Bit	Indication	Program Interrupted
0	Not Operational	Yes
1	Unit Status Pending	Yes
2	Program Control Interrupt	Yes
3	Program Check	Yes
4	Channel Data Check	No
5	Interface Control Check	No
6	Incorrect Length	No
7	Adapter Busy	No
8	Unit Operational	No
9-15	Not Used	

Note: Bits 0, 2, and 3 will only be reset if modifier bit 15 of the Sense Device IOCC is on (1). Bit 1 can only be reset if a Sense Device with modifier bits 13, 14, and 15 set to 011 is executed. (Sense Device specifying CSW word 2 with the reset bit on)

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Figure 6. Selector Channel Status (CSW Word 1)

Unit Status Pending, Bit 1: Unit status pending occurs when a control unit or an I/O device has presented its ending status, stacked status, busy status, or unusual condition status to the channel. The channel is waiting for a Sense Device operation to interrogate this status and end the unit-status-pending condition. This condition causes an interrupt when it is detected by the channel and can only be reset by a Sense Device (CSW word 2) with modifier bit 15 on.

Program Control Interrupt, Bit 2: Program control interrupt is on (1) when the channel has fetched a CCW containing a PCI flag. This bit is reset by modifier bit 15 on (1) in the IOCC.

Program Check, Bit 3: A program check is caused by any of the following conditions.

1. Invalid function code in the IOCC. When area code 27 (selector channel) is being used, only the following function codes are correct: 011, 111, 100, and 101.

2. Invalid CCW address; that is, the address of the CCW exceeds the storage capacity of the 1131.
3. An 1131 memory parity error occurred while fetching the CCW or the CCW address.

The program check condition inhibits cycle stealing and causes a program interrupt. The program check bit is reset by modifier bit 15 on (1) in the IOCC.

Channel Data Check, Bit 4: Channel data check indicates that the channel has detected a parity error in the information transferred during a read or sense operation to the storage area designated by the CCW. The byte of data causing the data check is stored in main storage and the channel places 0's in the remaining storage locations. The current operation continues until the count as specified in the CCW is exhausted. If command chaining is in effect at the time of the data check, the following command will not be executed. The program is interrupted when the I/O device presents channel end.

Interface Control Check, Bit 5: This bit on indicates the channel has detected an invalid signal on the I/O

interface. This check indicates a malfunction in the I/O device caused by either of the following conditions.

1. A device responded with an address other than the address specified by the channel during initiation of an operation.
2. An "in" tag signal from a device occurred simultaneously with another "in" tag signal.

Detection of an interface control check by the channel causes the current operation to be immediately terminated.

Incorrect Length, Bit 6: Incorrect length occurs when the number of bytes, as designated by the byte count in the CCW, contained in the storage area assigned for the I/O operation is not equal to the number of bytes requested or offered by the I/O device. Incorrect length is indicated for one of the following reasons.

1. Long block on input: During a read, read backward, or sense operation, the I/O device attempted to transfer one or more bytes to main storage after the assigned storage area was filled. The extra bytes have not been placed in main storage, and the CSW count is 0. The fact that the CSW count equals 0 will be indicated by a hexadecimal 0001 in the accumulator when word 4 of the CSW is sensed.
2. Short block on input: The number of bytes transferred during a read, read backward, or sense operation is insufficient to fill the storage area designated by the byte count in the CCW. When word 4 of the CSW is sensed, a negative number 1 less than the number of storage positions left to fill will be indicated in the accumulator. For example, if the accumulator contains FFFB (-5), six storage positions (three 1131 words) remain to be filled.
3. Short block on output: The I/O device terminated a write or control operation before all information contained in the assigned storage area was transferred to the I/O device. The count in the CSW is not 0. A negative number, 1 less than the storage area left to transfer, will be indicated in the accumulator when the byte count (word 4 of the CSW) is sensed. See the example in "Short block on input."
4. Long block on output: During a write or control operation, the I/O device requested another byte from the channel after the CCW count went to 0. The byte is not provided and the device is signaled to send its ending status. The CSW count

will be 0 as indicated by a hexadecimal 0001 in the accumulator when the byte count (word 4 of the CSW) is sensed.

Presence of the incorrect length condition suppresses command chaining if the SLI bit is not on in the CCW being processed.

Adapter Busy, Bit 7: Adapter busy occurs when the selector channel is executing a previous IOCC instruction or servicing a control unit or I/O device request. An IOCC with a Start I/O function code will be ignored if this bit is on (1). IOCC's specifying either Halt I/O or Sense Device functions may be executed when the adapter busy bit is on or off.

Unit Operational, Bit 8: Unit operational occurs when the channel is executing a Start I/O instruction. Unit operational indicates that the selected I/O device was not busy and has initiated data transfer as specified by the command code in the CCW. This bit is set only by commands requiring data transfer. Test I/O and immediate control commands will not set this bit. If this bit is not set within a certain time (as specified by the control unit) following the IOCC instruction, the channel is unable to perform any further operations.

Unit Address-Status (CSW Word 2)

An IOCC Sense Device instruction with modifier bits 13 and 14 set to 01 will place the unit address-status portion of the CSW into the accumulator. The significance of the bits in CSW word 2 are shown in Figure 7.

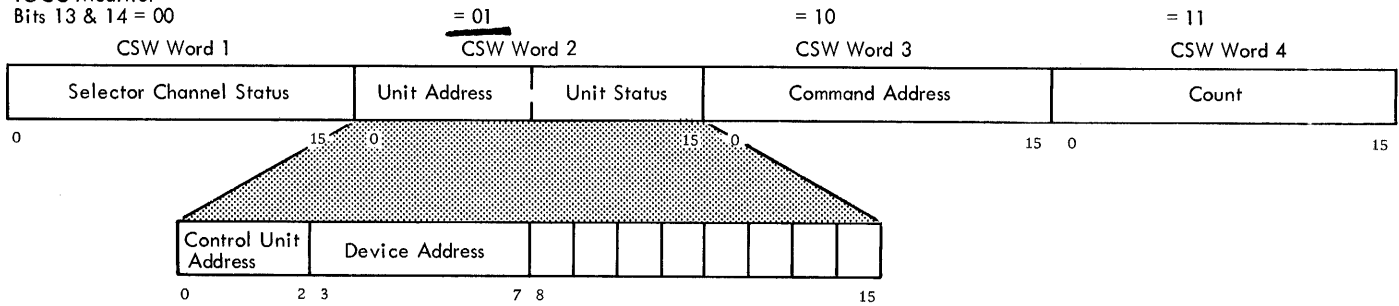
Unit address-status (CSW word 2) is only valid when the unit status pending bit (bit 1 of CSW word 1) is on.

The first eight bits (unit address) of the second word of the CSW identify the control unit and I/O device specified in the last I/O operation executed or rejected. Bits 0 to 2 contain the address of the control unit, and bits 3 to 7 contain the address of the I/O device.

The last eight bits (unit status) of the second word of the CSW identify the conditions detected in the control unit and the I/O device. The unit status conditions are sent over the I/O interface from the control unit or I/O device. The channel does not modify these bits, and they appear in the CSW as received from the interface.

Attention, Bit 8: Attention is generated when the I/O device detects an asynchronous condition that is significant to the program. The condition is interpreted by the program and is not associated with the initiation, execution, or termination of an I/O operation.

IOCC Modifier
Bits 13 & 14 = 00



Bit	Indication
0-7	Identifies the control unit and I/O device specified in the last I/O operation executed or rejected
8	Attention
9	Status Modifier
10	Control Unit End
11	Busy
12	Channel End
13	Device End
14	Unit Check
15	Unit Exception

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Figure 7. Unit Address - Status (CSW Word 2)

The I/O device can signal the attention condition to the channel only when no operation is in progress at the I/O device, control unit, or channel. Attention can be indicated with device end upon completion of an operation, and it can be presented to the channel during the initiation of a new I/O operation.

When the I/O device signals attention during the initiation of an operation, the operation is not started. Attention accompanying device end causes command chaining to be suppressed.

Some devices, such as the IBM 2415 Magnetic Tape Unit and Control, do not use the attention bit.

Status Modifier, Bit 9: Status modifier is generated by the I/O device when the normal sequence of commands has to be modified or when the control unit, during initial selection sequence, detects that it cannot execute the command or instructions as specified.

When the status modifier bit appears in the CSW with the busy bit, it indicates that the busy condition pertains to the control unit associated with the addressed I/O device. The control unit appears busy when it is executing a type of operation, or is in a state, that precludes the acceptance of any command. A typical example is the Backspace File command, which causes the control unit to remain busy after it has signaled channel end.

Once the execution of a command has been initiated, the status modifier indication can occur only with device end. If command chaining is specified in the current CCW when device end and status modifier are indicated, the channel will fetch and chain to the CCW whose main storage location is 6 higher than that of the current CCW. Since the next CCW in a chain is normally taken from a storage location three storage locations higher than the current CCW, the status modifier condition effectively provides a branching capability for the program.

Control Unit End, Bit 10: The control unit end condition is provided only by control units shared by I/O devices, and only when one or both of the following conditions occur:

1. The control unit was interrogated while executing an operation. The control unit is considered to be interrogated when, during a previous initial selection sequence, the control unit responded with busy and status modifier in the status byte.
2. The control unit detected an unusual condition while busy and after channel end was accepted by the channel.

If the control unit remains busy executing an operation after signaling channel end, but is not interrogated by the program and does not detect any unusual conditions, control unit end will not be generated.

When the busy state of the control unit is temporary, control unit end is included with busy and status modifier in response to interrogation, even though the control unit is not yet free. The busy condition is considered temporary if its duration is less than 2 milliseconds.

The I/O device address associated with the control unit end is determined as follows:

1. If control unit end is to be presented with channel end and/or device end, the address of the selected device is used.
2. If a control unit end is generated without channel end or device end, and the status is presented during a control-unit-initiated selection sequence, the I/O device address may be any legitimate address associated with the control unit. (A legitimate address is any address the control unit is capable of recognizing regardless of whether the I/O device is actually attached.)
3. If control unit end is to be presented during an initial selection sequence, the device address will be the same as the device address specified for the operation.

A pending control unit end causes the control unit to appear busy, and new instructions or commands will not be initiated.

Busy, Bit 11: Busy can occur only during an initial selection sequence. It indicates that the I/O device or the control unit cannot execute the command because a previously initiated operation is being executed or because status conditions exist. (An operation is being executed from the time initial status is accepted until device end is accepted.) Status conditions, if any, accompany the busy indication.

If the busy condition applies to the control unit, the busy bit will be accompanied by status modifier.

Channel End, Bit 12: Channel end is caused by the completion of the portion of an I/O operation involving transfer of data, if any, or control information, between the I/O device and the channel.

The exact time during an I/O operation when channel end is generated depends on the operation and the type of device. Channel end is usually generated after the control information is transferred to the control unit. For operations such as writing, channel end is generated when the block of data has

been written. Operations that do not involve data transfer can provide channel end during the initial selection sequence.

When command chaining is specified, only the channel end of the last operation of the chain is made available to the program. The channel end condition, however, is not made available to the program when a chain of commands is prematurely terminated because of an unusual condition indicated with control unit end or device end.

Each I/O operation causes only one channel end signal to be generated. The channel end condition is not generated unless the operation is initiated.

Device End, Bit 13: Device end is caused by the completion of an I/O operation at the device or by manually changing the device from a not ready state to a ready state. The device end condition indicates that the I/O device has completed the current operation.

The device end condition associated with I/O operations can occur simultaneously with the channel end condition or later. In the case of data transfer operations, the device terminates the operation at the time channel end is generated, and both channel end and device end occur together. For control operations, device end is generated at the completion of the operation at the device.

When command chaining is specified, receipt of the device end signal, in the absence of any unusual conditions, causes the channel to initiate a new I/O operation.

Each I/O operation causes only one device end condition. The device end condition is not generated unless the operation is initiated.

Unit Check, Bit 14: Unit check indicates that the I/O device or control unit requires programming or manual intervention. Unit check does not necessarily indicate an error condition. The conditions causing a unit check are detailed by information available to a sense command, which would normally follow the acceptance of unit check status. The unit check bit provides a summary indication of the conditions identified by sense data.

The unit check condition is generated when an error is detected during execution of a command, or during some activity associated with an I/O operation. Unless the error condition pertains to the activity initiated by a command and is of immediate significance to the program, the condition does not cause the program to be altered after device end is cleared.

When the device is not executing an operation and does not have a pending interruption condition,

Count (CSW Word 4)

An IOCC Sense Device instruction with modifier bits 13 and 14 set to 11 will place the count portion of the CSW into the accumulator. The significance of the bits in CSW word 4 is shown in Figure 9.

The count may only be sensed when the adapter busy bit (bit 7 of CSW word 1) is 0, or the unit status pending bit (bit 1 of CSW word 1) is 1, or when no channel-initiated operation is in progress. If the count is sensed at any other time, the information contained in the count is unpredictable.

The count is expressed in 2's complement form plus 1. For example, a byte count of 0007 hexadecimal is expressed as FFFA.

The count is not reset by modifier bit 15 of the IOCC.

Summary

The content of the CSW represents the present status of the channel, control unit, and I/O device.

The selector channel status is updated as it occurs and may be sensed by the program at any time. Except for the unit status pending bit, the channel status bits which caused the program to be interrupted are reset when the selector channel status is sensed by the 1131 program. The unit status pending bit is reset when unit address-status is sensed by the program.

The unit address-status identifies the control unit and I/O device specified in the last I/O operation executed or rejected and identifies the conditions detected in the control unit and device. Unit address-status may only be sensed when the unit status pending bit is 1.

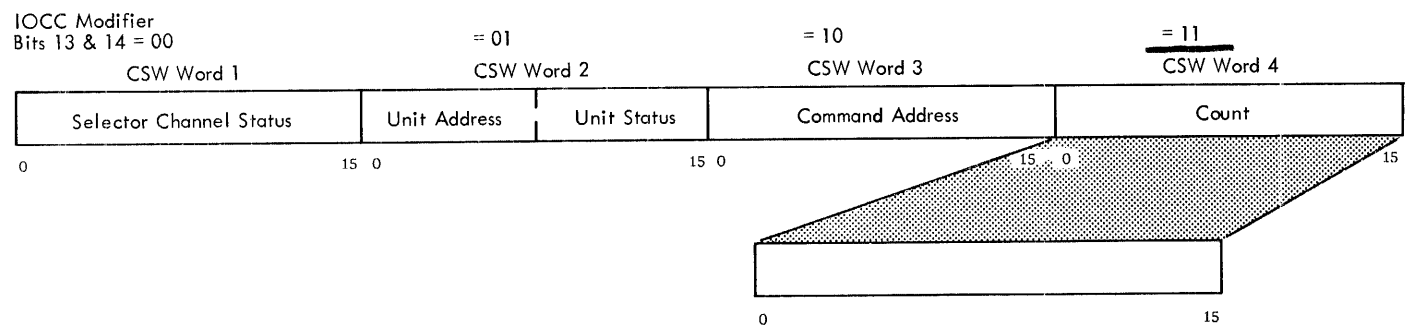
The command address may be sensed by the program at any time and will contain an address 3 higher than the address of the CCW being executed or just completed.

The count can only be sensed when the adapter busy bit is a 0, the status pending bit is a 1, or no channel-initiated operation is in progress. The byte count will be the count presently in the channel byte counter register.

The CSW during the execution of a chain of operations pertains to the last operation the channel executed or attempted to initiate. Information concerning the preceding operations is not preserved and is not made available to the program.

When an unusual condition causes command chaining to be suppressed, the premature termination of the chain is not explicitly indicated in the CSW. A CSW associated with a termination due to an unusual condition occurring at channel end time contains the channel end and identifies the unusual condition. When the device signals the unusual condition with control unit end or device end, the channel end condition is not made available to the program, and the channel provides the current unit address, command address, and count, as well as the unusual indication, with the control unit end or device end bits in the CSW. The command address and count pertain to the operation that was executed.

When the execution of a chain of commands is terminated by an error detected during initiation of a new operation, the command address and count pertain to the rejected command. Termination of a command at initiation time can occur because of attention, unit check, unit exception, program check, or equipment malfunctioning.



Bit 0-15 Indication Forms the residual count for the last CCW used. The count is expressed in two's complement form plus one

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Figure 9. Count (CSW Word 4)

A CSW associated with conditions occurring after the operation of the channel has been terminated contains an updated unit address, unit status, and channel status. The command address and count may be meaningless except when the conditions are cleared by an IOCC and the command address is updated. The count field is updated only on data transfer instructions that have been executed.

INITIATION OF SELECTOR CHANNEL OPERATIONS

The operation specified by a Start I/O instruction is initiated only when the selector channel, control unit, and I/O device are in the available state. The 1131 program must interrogate the channel status to determine that the channel is not busy before initiating a Start I/O operation. If a Start I/O is attempted while the channel is busy, the Start I/O is ignored by the channel. No indication will be given to the program that the instruction was ignored. If the channel is available, the Start I/O is accepted by the channel and the status of the control unit and I/O device are examined.

If the channel is available and either the control unit or I/O device is busy, the control unit presents the busy status to the channel, and the device command is not executed. The channel interrupts the program with the unit status pending bit in the CSW. The program must then execute a Sense Device with modifier bits 13 and 14 set to 01 to obtain the unit status. The status pending bit will not be reset until the unit address-status (CSW word 2) is sensed with modifier bit 15 on.

If the channel is available, and either the control unit addressed or the I/O device addressed is not operational, the address will not be recognized during initial selection. In this case, the channel will interrupt the program with the not operational bit in the CSW.

If the channel, control unit, and I/O device are available, the operation specified by the Start I/O is executed.

TERMINATION OF SELECTOR CHANNEL OPERATIONS

Normally, an I/O operation at the channel lasts until the device signals channel end. The channel end condition can be signaled during the sequence initiating the operation or later. When the channel detects equipment malfunctioning or a system reset

is performed, the channel disconnects the device without receiving channel end.

Termination at Operation Initiation

A data transfer operation is initiated at the I/O device only when no programming or equipment errors are detected by the channel, and the device responds with zero status during the initiation of the command. When the channel detects, or the device signals any unusual condition during the initiation of an operation, and channel end is off, the command is rejected.

If a command is rejected during the execution of a Start I/O, the device is not started, no interrupt conditions are generated, and the channel is not tied up beyond the initiation sequence. The conditions that precluded the initiation are detailed in the channel status and unit address-status portion of the CSW.

Unless the command was rejected because the I/O device was not operational or busy, the device is immediately available for the initiation of another operation.

When an unusual condition causes a command to be rejected during initiation of an I/O operation by command chaining, an interruption condition is generated and the device is not available until the condition is cleared. The unusual conditions are indicated to the program by means of the corresponding status bits in the CSW. The new operation of the I/O device is not started.

Termination Without Data Transfer

Immediate Operations

Instead of accepting or rejecting a command, the I/O device can signal the channel end condition immediately upon receipt of the command code. An I/O operation causing the channel end to be signaled during the initiation sequence is called an "immediate operation."

If command chaining is not specified, receipt of channel end causes the unit status pending bit to be set in the CSW. (The CSW also contains the channel end bit and any other indications provided by the channel or I/O device.) Unit status pending causes the channel to interrupt the program. The I/O operation, however, is initiated and the channel immediately made available to the program. If channel end is not accompanied by device end the device remains busy. Device end, when subsequently provided by the device, causes an interruption condition to be generated.

When command chaining is specified after an immediate operation and no unusual conditions have been detected during the execution of the command, no interruption condition is generated. The subsequent commands in the chain are handled normally, and the channel end condition for the last operation in the chain causes the program to be interrupted.

Program check or incorrect length will not be set, and command chaining will not be suppressed because of the contents of the CCW byte count field for immediate command operations.

Pending Interruption

When a Start I/O operation addresses an I/O device containing a pending interruption due to device end or attention, or a control unit containing a pending channel end or control unit end for the device, the channel status and unit address-status portions of the CSW are set. The unit status field contains the busy bit, identifies the interruption condition, and may contain other bits provided by the control unit or I/O device. The interruption condition in the unit status is cleared and the unit status pending bit is set in the channel status field. The remainder of the channel status field contains 0's. The unit status pending bit on causes the channel to interrupt the program.

The operation is not initiated and the channel is not tied up beyond the initiation sequence. The channel and device are immediately available for the initiation of another operation.

Device or Control Unit Busy

When a start I/O operation addresses an I/O device or control unit that is busy, or a control unit which has a pending channel end or control unit end for a device other than the one addressed, the channel status and unit address-status portion of the CSW are set. The CSW unit status field contains the busy bit, or if the control unit is busy, the busy and status modifier bits. The channel status field contains 0's, except for the unit status pending bit, which will cause a program interruption.

The operation is not initiated and the channel is not tied up beyond the initiation sequence after unit status is sensed.

Termination with Data Transfer

For operations involving data transfer, either the channel or I/O device can control the timing of the channel end condition. If command chaining is not specified or chaining is suppressed because of

unusual conditions, the channel end condition causes operation at the channel to be terminated. The status bits in the associated CSW indicate channel end and unusual conditions, if any.

The I/O device can signal channel end any time after the initiation of the operation. Channel end may occur prior to any actual data transfer.

The channel signals the device to terminate data transfer whenever any of the following conditions occur:

1. The storage areas specified for the operation are exhausted or filled. This condition occurs when the channel has stepped the count in the last CCW associated with the operation to 0. A count of 0 indicates that the channel has transferred all information specified by the program.
2. A program check condition is detected. This condition is due to errors and causes premature termination of the operation.
3. An IOCC with a function code specifying Halt I/O is executed by the program. Execution of Halt I/O automatically disconnects the device from the channel.

The I/O device can control the duration of an operation and the timing of channel end by blocking of data. On certain operations for which blocks are defined (such as reading on magnetic tape), the device does not supply the channel end condition until the end of the block is reached, regardless of whether the device has been previously signaled to terminate data transfer.

The channel suppresses initiation of an I/O operation when the data address of the first CCW associated with the operation exceeds the addressing capacity of main storage. When the initial data address is invalid, no data is transferred during the operation, and the device is signaled to terminate the operation. I/O devices, such as the IBM 2415, request the first byte of data before any mechanical motion is started at the device. If the initial data address is invalid, the operation is terminated before the recording medium has been advanced. However, since the operation has been initiated, the device provides channel end. Whether a block at the device is advanced depends on the type of I/O device and is specified in the Systems Reference Library publication for the device.

If command chaining is specified, the device executing the operation remains connected to the channel until the last command of the chain has been executed. Any unusual conditions cause command chaining to be suppressed and a terminating condition generated. The unusual conditions can be

detected by the channel or the I/O device. When the channel is aware of the unusual conditions by the time the channel end signal for the operation is received, the chain is terminated as if the operation in which the unusual condition occurred were the last operation in the chain.

Termination with Halt I/O

Initiation of a Halt I/O instruction terminates the current I/O operation at the addressed selector channel, control unit, or I/O device. If the channel is not busy, modifier bits 8 to 15 of the IOCC identify the control unit and I/O device to which the Halt I/O applies.

When the channel is available, and the control unit is busy, the addressed device is signaled to terminate the current operation. Halt I/O does not affect the state of the control unit when both channel and control unit are available.

If Halt I/O is issued when the channel is executing a data transfer, the data transfer is terminated and the device performing the operation is immediately disconnected from the channel. In this case, modifier bits 8 to 15 of the IOCC are ignored.

The termination of an operation as a result of a Halt I/O causes the channel and control unit to be placed in the interruption pending state. When the channel is in the interruption pending state or available, and the control unit is in the interruption pending state, execution of Halt I/O does not affect the state of either the channel or control unit.

The CSW set during Halt I/O pertains only to the execution of Halt I/O. It does not describe under what conditions the I/O operation at the addressed device is terminated. If the addressed device has been selected and signaled to terminate the current operation, the CSW contains 0's in the unit status field unless an equipment error is detected. If an equipment error is detected, the status bits in the CSW identify the error condition. The state of the channel and the progress of the I/O operation are unpredictable.

When Halt I/O causes a data transfer operation to be terminated, the control unit associated with the operation remains busy until the data handling portion of the operation in the control unit is terminated. Termination of data handling in the control unit is signaled by channel end. Channel end may occur at the normal time or earlier or later, depending upon the operation and type of device.

If the control unit is shared, all devices attached to the control unit appear busy until the channel end is accepted by the 1131. The I/O device executing the terminated operation remains busy

until termination of the operation. At this time the device signals the channel with device end. If blocks of data at the device are defined, such as reading on magnetic tape, the recording medium is advanced to the beginning of the next block.

CHANNEL COMMANDS

After the successful execution of a Start I/O, the selector channel continues the I/O operation initiated by the IOCC in cycle steal mode. The selector channel fetches the first CCW and, if so directed, fetches the next CCW when the first CCW operation is completed.

Each channel command word contains an eight-bit command code (bits 8 to 15 of CCW word 2) that identifies to the channel and I/O device the operation to be performed. The two low-order bits (14 and 15) of the command code identify the operation to the channel. If these bits are 00, the four low-order bits (12 to 15) identify the operation. The high-order bits are modifier bits. These bits expand the basic operation (designated by the low-order bits) at the control unit and/or I/O device level.

The basic commands are common to all devices that attach to the channel. They are; Read, Read Backward, Write, Control, and Test I/O. The modifier bits associated with the basic commands may cause, for example, the device to initiate mechanical motion or set conditions such as recording density or parity.

The modifier bits are peculiar to particular control units and I/O devices. The actual modifier codes and their function are described in detail in the Systems Reference Library publication for the particular control unit and/or I/O device.

The Transfer in Channel command is used to chain CCW's not located in adjacent three-word main storage locations. This command does not initiate any I/O operation at the channel, and the I/O device is not signaled that the command is executed.

The command code assignment is shown in Figure 10.

Test I/O

This command code causes the addressed device to place its present status onto the selector channel input bus. The selector channel interrupts the program when the status is available.

Read

The Read command code causes data to be transferred from an I/O device to main storage. The

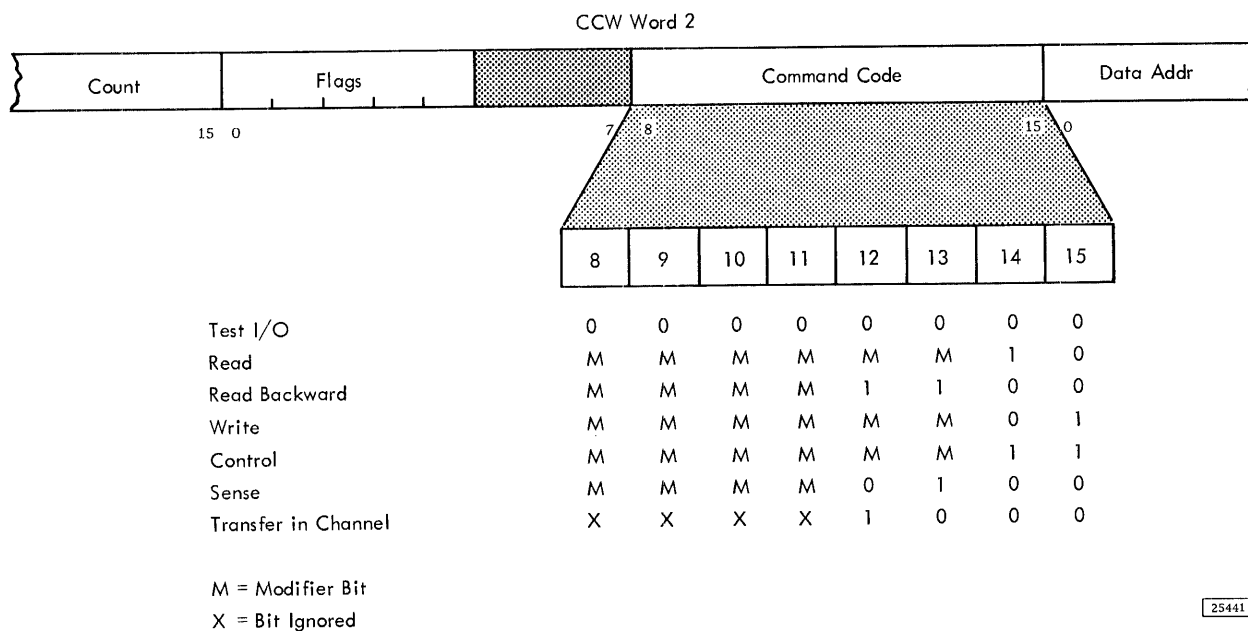


Figure 10. Command Code Assignment

data will be read from the I/O device specified in the modifier field of the IOCC.

The data address of the CCW specifies the left-most main storage location of the field where the data will be stored. Data is placed in main storage in an ascending order of addresses, two bytes per storage location.

The length of the input data field is specified in the byte count (word 1) of the CCW. The length of the field specified by the byte count is restricted by the size of main storage in the 1131.

Data transfer continues until the specified number of bytes have been transferred or until the I/O device terminates the operation. If the byte count is odd, the last byte will be placed in bits 0-7 of the last word. Bits 8-15 will be 0's.

Read Backward

This command is used on I/O devices that are designed to move the actual recording medium (such as the magnetic tape on the IBM 2415 Tape Unit and Control) in the opposite direction to that of a read operation. This operation proceeds the same as a read, and data is placed in main storage in an ascending order of addresses as it is received.

Write

The Write command code causes data to be transferred from main storage to an I/O device. The data will be transferred to the device specified in the modifier field of the IOCC.

The data address of the CCW specifies the left-most main storage location from which the output data will be transferred. The data must have been placed in main storage in an ascending order of addresses, two bytes per word.

The length of the output data field is specified in the byte count of the CCW. The length of the field specified by the byte count is restricted by the size of main storage in the 1131.

Data transfer continues until the specified number of bytes have been transferred or until the I/O device terminates the operation. If the byte count is odd, the last byte will be transferred from bits 0-7 of the last storage location addressed. Bits 8-15 will be ignored and not sent over the selector channel to the I/O device. A wrong length indication will occur on this operation if the command is not accompanied by a SLI flag in the CCW.

Control

Control operations in general initiate mechanical motion at the specified I/O device and do not involve transfer of data to or from the CPU. Since no data transfer is involved, the control unit responds with channel end as soon as the command is accepted. The I/O device signals device end after it has completed the operation specified by the command (Rewind, Rewind and Unload, etc.). The two low-order bits of the command code (11) identify the operation as a control. The modifier bits received by the control unit are decoded to determine which of several possible functions are to be performed.

If a control command is issued with the six modifier bits all 0, the command is treated as a no-operation (No-Op). The no operation causes the control unit and I/O device to respond with channel end and device end without causing any action at the device.

The function of the modifier bits in the control command varies with the I/O devices attached to the selector channel. The functions of the modifier bits are explained in the Systems Reference Library publication pertaining to the I/O device.

Sense

The Sense command code provides the system with information concerning unusual conditions detected in the last operation performed by an I/O device, and the current status of the device that executed the operation. The modifier bits in the IOCC specify the device to which the sense command applies.

The number of sense bytes needed for sense information is variable. Normally, as in the case of the IBM 2415 Magnetic Tape Unit and Control, only two sense bytes are significant to the I/O device and are used for programming information. Any bytes following those used for programming information contain diagnostic information and may extend to as many bytes as needed.

The information provided by the sense command is more detailed than that supplied by the unit status byte (CSW word 2). It may describe reasons for a unit check condition, indicate the addressed device is in the not ready state, or, in the case of magnetic tape units, indicate the tape is positioned beyond the end of tape mark or is in the file protected state.

The sense data is placed in main storage two bytes per word in an ascending order of addresses, beginning at the address specified in the data address portion of the CCW. If the byte count is odd, the last byte transferred will be placed in bits 0-7 of the last addressed main storage location. Bits 8-15 will be 0's.

The sense information pertaining to the last I/O operation is reset by the next command addressed to the control unit, provided it is not another sense command.

The first six bits of the first sense byte are common to all I/O devices requiring this type of information. These six bits are designated as follows:

- Bit 0 -- Command Reject
- Bit 1 -- Intervention Required
- Bit 3 -- Bus Out Check
- Bit 4 -- Equipment Check
- Bit 5 -- Data Check
- Bit 6 -- Overrun

Execution of a sense command cannot cause the command reject, intervention required, data check, or overrun bits to be turned on. However, if the control unit detects an equipment error or invalid parity in the sense command code, the equipment check or bus out check bits are turned on, and unit check is sent with channel end.

A description of the first six bits and their reasons for being turned on follows. The meanings of the remaining sense bytes are peculiar to the type of device and are specified in the SRL publication for the particular device.

Command Reject, Bit 0: This bit on (1) indicates the device has detected a programming error. The programming error could be caused by either of the following conditions:

1. The device has received a command it is not designed to execute.
2. The device cannot execute the specified command because of its present state, such as a Write command to a file-protected tape.

Intervention Required, Bit 1: This bit on (1) indicates the last operation could not be executed because of a condition requiring some type of intervention at the I/O device. If the device is not ready, is in the test mode, or not attached to the control unit, intervention required will be indicated in the sense data.

Bus Out Check, Bit 2: This bit on (1) indicates that the I/O device or the control unit has received a command code or a data byte with invalid (even) parity. Parity errors on command codes and control information cause the operation to be immediately terminated. During a write operation, bus out check indicates that incorrect data has been recorded on the device. Data parity errors do not cause the operation to be terminated prematurely.

Equipment Check, Bit 3: This bit on (1) indicates that there is a malfunction in either the control unit or the addressed I/O device. Parity errors caused by defective circuits or mechanical malfunctions cause the equipment check bit to be turned on in response to a sense command. These errors will be detected by either the control unit or the I/O device.

Data Check, Bit 4: This bit on (1) indicates that the control unit or I/O device has detected a data error other than those included in the bus out check. Data check identifies errors associated with the recording medium. A typical example is detecting invalid parity on data recorded on magnetic tape.

On an input operation, data check indicates that incorrect data may have been placed in main storage. (The control unit forces correct parity on data sent to the channel.) During writing, data check indicates that incorrect data may have been recorded at the I/O device. Data errors on reading or writing do not cause the operation to be terminated prematurely.

Overrun, Bit 5: This bit on (1) indicates that the channel has failed to respond in time to a request for service from the device. Overrun can occur when data is transferred to or from a nonbuffered control unit operating with a synchronous medium, and the total activity initiated by the program exceeds the capability of the channel.

On an output operation, overrun indicates that data recorded on the device may be involved. In these cases, data overrun stops data transfer and the operation is terminated.

The overrun bit is also turned on when command chaining is specified, and the device receives the new command too late to act upon the area specified by the command.

Transfer in Channel

Normally the next CCW in a chain of commands is located at an address three storage locations higher than the current CCW. The purpose of the Transfer in Channel (TIC) command is to provide a branching capability to a CCW not located in the next adjacent three-word location. The data address field of the CCW specifying transfer in channel will designate the main storage location of the next CCW.

The TIC command does not initiate any I/O operation at the channel, and the I/O device is not signaled that the command is executed.

The TIC is considered as an unconditional branch and will be executed regardless of the state of command and data chaining flags. That is, transfer in channel can occur with command or data chaining specified or without either being specified.

PACKAGING

RPQ 831551 is a prerequisite for the selector channel. The SLT hardware required for the selector channel is located within the 1133.

Two serpent connectors (Figure 11) mounted within the 1133 to accommodate the standard System/360 external cables from the first control unit attached. A connector (P/N 523269) is mounted within the 1133 to accommodate the standard power control cable (P/N 5351178) from a control unit.

METERING

The 1133 metering remains the same. Refer to IBM 1130 Functional Characteristics, Form A26-5881.

ENVIRONMENTAL CONDITIONS

The 1133 environmental conditions specifications are not affected by addition of this feature. Refer to IBM 1130 Computing System Installation Manual -- Physical Planning, Form A26-5914.

POWER REQUIREMENTS

The 1133 electrical power requirements are not affected by addition of this feature. Refer to IBM 1130 Computing System Installation Manual -- Physical Planning, Form A26-5914.

HEAT OUTPUT PER HOUR

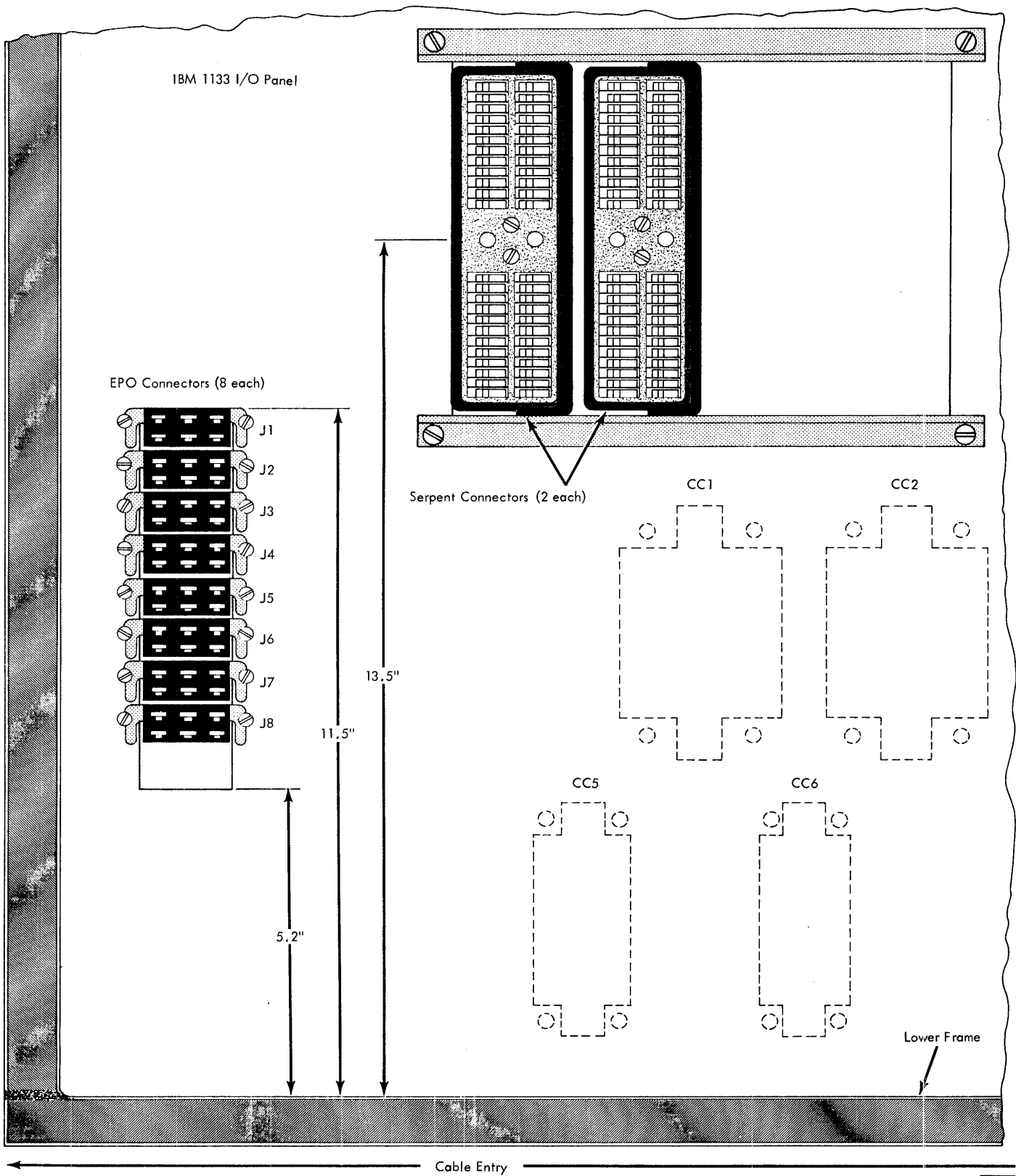
This feature adds 700 BTU/hr to the rating for the 1133. Refer to IBM 1130 Computing System Installation Manual -- Physical Planning, Form A26-5914.

EXTERNAL CABLES

One emergency power off (EPO) cable (P/N 5351178) and two channel signal cables (P/N 5353920) must be ordered for each control unit attached to the channel. (See Figure 12.)

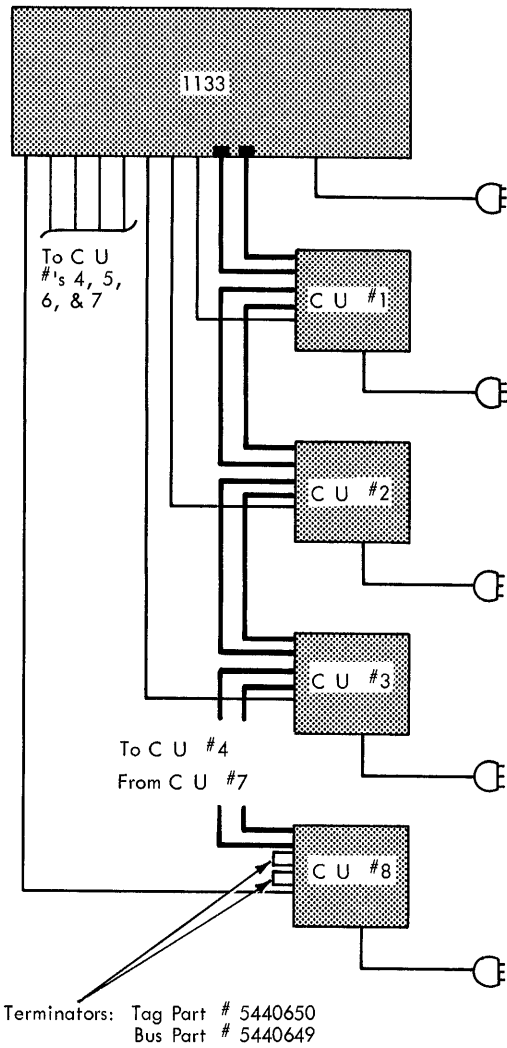
TERMINATION

Two terminators are supplied for the last control unit attached to the channel: tag terminator P/N 5440650 and bus terminator P/N 5440649.



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Figure 11. I/O Connections for IBM 1130 Attachment Channel



— Channel Signal Cables
 Part # 5353920
 Requirement - 2 per control unit
 Maximum Accumulated length - 100 feet*.
 (Unless otherwise specified on the cable order form, the cables supplied will be 25 feet.)

— Emergency Power Off (EPO) Cables
 Part # 5351178
 Requirement - 1 per control unit (Unless otherwise specified on the cable order form, the cables supplied will be 25 feet)

*Certain control units may have a more limiting restriction on cable length. Refer to the specifications for the particular control unit attached to the channel.

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Figure 12. External Cabling for IBM 1130 Attachment Channel

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Termination See Also: Selector Channel Operations

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Tag Terminator 23
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Unit Address-Status (CSW Word 2)

Attention, Bit 8 12
Busy, Bit 11 14

Unit Address-Status (continued)

Channel End, Bit 12 14
Control Unit End, Bit 10 13
Device End, Bit 13 14
Status Modifier, Bit 9 13
Unit Check, Bit 14 14
Unit Exception, Bit 15

Write Command 20



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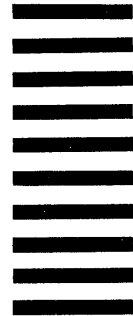
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