Systems

IBM System/370 Special Feature Description: Channel-to-Channel Adapter

IBM

Preface

This publication provides a functional description of the System/370 channel-to-channel adapter. The System/370 and System/360 channel-to-channel adapters are similar in function and in operation. This manual describes all of the. System/370 adapter functions that are also provided by the System/360 adapter as described in the *IBM System/360 Special Feature Channel-to-Channel Adapter*, GA22-6892, plus unique System/370 extensions. Reference information is included which pertains to the adapter's use, operation, and the commands and status data required for assembly language programming.

The reader should possess a basic knowledge of data processing systems and, specifically, the IBM System/370. Such information can be found, for example, in the *Introduction to IBM Data Processing Systems*, GC20-1684, the *IBM System/360 Principles of Operation*, GA22-6821 and the *IBM System/370 Principles of Operation*, GA22-7000.

This manual is directed to the user who needs a description of the adapter's function and operation, as well as to the systems programmer, systems engineer, or maintenance personnel who need reference information in the writing and maintenance of assembly language programs for the channel-to-channel adapter.

Glossary

Adapter Compatibility—The capability of the System/370 channel-to-channel adapter to operate in compatibility mode and thereby to properly respond to programs written for the System/360 channel-to-channel adapter.

Compatibility Mode—That adapter mode of operation which permits the use of programs written for the System/360 channel-to-channel adapter.

Extended Mode—That adapter mode of operation provided for System/370 operation which adds new commands and functions to the System/360 adapter function.

High-speed Data Mode—That data transmission mode of adapter operation utilized when two block multiplexer channels are interconnected and the adapter has been wired to make use of this above-normal rate of data transmission during adapter operations.

Latch—A unit of circuitry which may be used to store a bit of information (0,1) that controls the performance of a function. For example, the state of the inhibit compatibility latch controls the operating mode of the adapter.

Select-out—An electronic signal utilized by the System/360 and System/370 I/O interface in the performance of I/O device selection by a channel. The channel must select (address) a connected device before requesting the performance of an operation by that device.

The channel-to-channel adapter is a special feature available on many System/360 and System/370 models that include integrated channels and on the standalone IBM 2860 Selector Channel which is utilized by the larger IBM systems. The function of the channel-to-channel adapter is fundamentally the same in both System/360 and System/370, however, additional capability has been added to the System/370 channel-to-channel adapter, (hereafter referred to as the adapter). This manual applies only to the System/370 adapter; for information on the System/360 adapter see *IBM System/360 Special Feature Channel-to-Channel Adapter*, GA22-6892.

System/360s may connect an installed channel-to-channel adapter to a System/370 channel and continue to utilize the existing program. When a System/370 installed adapter connects to a System/360 channel, provision is made through a compatibility mode of operation to use either the existing System/360 program or the System/370 program. (See "Mode of Operation.") System/370s using the IBM 2860 Selector Channel can install only the System/360 adapter; the adapter cannot be installed in the 2870 byte multiplexer or 2880 block multiplexer channels. However, because the adapter connects two channels by means of the standard channel to control unit I/O interface, it can connect the system in which it is installed to any other channel on any model of the System/360 or System/370. For more information on the I/O interface, see *IBM System/360 and System/370 I/O Interface–Channel to Control Unit, Original Equipment Manufacturers' Information*, GA22-6974.

The channel-to-channel adapter provides the data path and the synchronization for a data transfer between two channels. Normally, the adapter is used to connect two channels associated with different processing units, thus establishing a loosely coupled multiprocessing (MP) system. (*Note:* Only the selector or block multiplexer channels can be utilized by the adapter to connect two channels within the same System/370 Model 145 system.)

The adapter makes each channel appear as a control unit to the other channel (at least one control unit position on each of the connected channels is required). The adapter is selected and responds in the same fashion as any control unit, and, in essentially the same manner as a control unit, it accepts and decodes commands from the channel. However, the adapter differs from a control unit in that it does not use these commands to operate and control input/output devices; instead, it uses them to open a path between the two channels it connects and then synchronizes the operations performed between the two channels.

The two channels connected by the adapter are designated channel X and channel Y. The channel X designation is applied to the channel of the system in which the adapter is physically located and powered. When channel X power is off, the adapter is disabled; however, channel Y may continue to operate with its other control units.

UNIT CHARACTERISTICS

I/O Interface Operation

The adapter operates in burst mode. Once data transfer begins, a logical connection between the channels is established for the duration of the operation. Data transmission proceeds at a byte rate established by the speed of the slower channel.

Mode of Operation

The adapter on System/370 models that include integrated channels has two modes of operation: compatibility mode and extended mode.

Compatibility Mode

When the host system (X) is powered up, the adapter assumes the compatibility mode. In this mode the adapter uses the same commands as the System/360 channel-to-channel adapter to permit system operation utilizing existing System/360 programs.

Extended Mode

In this mode the adapter provides several new features that are not available in the System/360 adapter nor in the compatibility mode. These features include:
1. The unit check status bit.
2. The unit exception status bit.
3. An attention interruption condition that is mandatory and must be cleared either by the receiving channel via a test I/O (TIO), a start I/O (SIO), or an I/O interruption; or by a halt I/O (HIO), halt device (HDV), or system reset from either side. This means that the first command to be accepted by the adapter (from channel X, for example) causes an attention interruption condition to channel Y. No operation with the adapter can be performed by channel Y until that attention interruption condition is recognized and cleared by channel Y, even if a second SIO (from channel Y) issues a command which matches with the first command (for example, a read X to a write Y.)

4. A halt I/O or halt device instruction, and an interface disconnect, selective reset or system reset, which sets the associated side of the adapter to not ready and sets the intervention required sense bit. Any SIO, other than a sense adapter-state command, causes the adapter to become ready and a device end interruption to be generated on the other side of the adapter.

5. New commands: Modified no-operation, sense adapter-state, and write end-of-file.

High-Speed Data Mode

The data transfer rate of the adapter may be increased by operating the adapter in high-speed data mode. The adapter is plugwired at installation time by the service personnel to run in this optional mode, with the restriction that channels X and Y must implement the data-in and data-out tag lines in the I/O interface, that is, channels X and Y must be block multiplexer channels. Otherwise, the high-speed data mode cannot be used. (See "Wrong Length Record" under "Programming Notes.")

COMMANDS

Figure 1 shows the commands that are accepted by the adapter.

Basic Command	Bit Position							
	0	1	2	3	4	5	6	7
Test I/O (Note 1)	—	—	—	—	0	0	0	0
Write	0	M	M	M	M	M	0	1
Write End-of-File (Note 2)	1	—	—	—	—	—	0	1
Read	M	M	M	M	M	M	1	0
No-operation	—	0	—	—	—	0	1	1
Control	M	M	M	M	M	1	1	1
Sense Adapter State (Note 3)	—	—	—	0	0	1	0	0
Modified No-operation (Disable Compatibility)	1	1	—	—	—	0	1	1
Modified No-operation (Enable Compatibility)	0	1	—	—	—	0	1	1
Sense Command Byte	—	—	—	1	0	1	0	0
Read Backward	M	M	M	M	1	1	0	0

Notes:
1. The test I/O command is generated only when the test I/O instruction is addressed to the adapter; the all-zero command is invalid in a channel command word (CCW).
2. In compatibility mode, this command decodes as a normal write command.
3. In compatibility mode, this command decodes and operates like the sense command-byte command.
4. "—" indicates that the bit may be either 1 or 0; the state of the bit is irrelevant.
5. "M" indicates that the bit is a modifier bit and may be either 1 or 0; the modifier bits are made available to the programmer by use of the sense command-byte command.

Figure 1. Valid Adapter Commands

Data Flow

The adapter has two nine-bit (eight data bits plus parity) buffer registers, one for each side of the adapter. These buffers do not have a common input; an error detected on one side of the adapter will not necessarily make the adapter unavailable to both sides (both channels). The adapter also has two command registers. During a sense command-byte operation, the command byte from one side is sent to main storage of the other side. The programmer can, therefore, inspect the command issued by the other channel and he can also use the modifier bits in any way he chooses.

Status Byte

The adapter uses six of the eight available status byte bits defined in *IBM System/360 Principles of Operation*, GA22-6821. (For additional information, see "Operations.")

Bit	Indication
0	Attention
1	Not used
2	Not used
3	Busy
4	Channel end
5	Device end
6	Unit check*
7	Unit exception*

* Not used in compatibility mode

Sense Byte

The adapter uses seven of the eight available sense byte bits to indicate to the channel the cause of a unit check condition presented at status time. The sense bits are reset by any command issued to the adapter except test I/O, no-operation, write end-of-file and sense adapter state. The sense bits are not available to the program in compatibility mode because the sense adapter state command cannot be executed in this mode.

Bit	Indication
0	Not used
1	Intervention required
2	Buffer data check (other side of adapter)
3	Equipment check
4	Selection check (other side of adapter)
5	Control sequence check (other side of adapter)
6	Status generation check (other side of adapter)
7	Interface disconnect*

* Normally produced by execution of HIO or HDV instruction.

Sense Bit Definitions

Intervention Required: The other side of the adapter is not ready because of a system reset, selective reset, or interface disconnect.

Buffer Data Check: Incorrect parity was detected during data transfer; the error was detected at the data buffer on this side of the adapter.

Equipment Check: This side of the adapter detected a logic error. Four possible error conditions may be detected by either side of the adapter: selection check, control sequence check, status generation check, and command check (incorrect command code parity).

Selection Check: The adapter is selected but the select-out line is propagated at the same time.

Control Sequence Check: An adapter control sequence did not occur in the proper order; this is a logic error.

Status Generation Check: The adapter generated a status byte with incorrect parity.
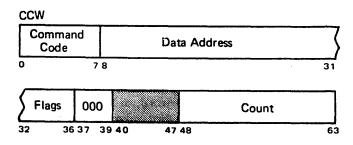
Interface Disconnect or Selective Reset: A selective reset, or interface disconnect (normally the result of a HIO or HDV instruction) has been issued to the other side of the adapter.

OPERATIONS

General Sequences

All adapter data transfer operations are initiated by a start I/O instruction. Note that some models execute start I/O fast release (SIOF) as start I/O; the results of the instruction execution are the same. Successful execution of the start I/O instruction causes the channel to fetch a channel address word (CAW) from main storage. The CAW specifies the location in main storage where the channel program begins, that is the address of the first byte of the first channel command word (CCW).

Channel Command Word

CCW

Command Code	Data Address
0 7	8 31

Flags	000		Count
32 36	37 39	40 47	48 63

The CCW specifies all the information necessary for an operation to be executed. For a complete description of the CCW, see the *IBM System/360 Principles of Operation,* GA22-6821.

The CCW fields that are of special significance to adapter operations include:

Command Code: This field specifies the operation to be performed, and is sent to the adapter upon the initiation of the operation.

Flags: Bit 32 is the chain-data flag and bit 33 the chain-command flag. When bit 32 is set to 0 and bit 33 is set to 1, command chaining is specified. In adapter operations, command chaining may be performed by one of the two channels or by both simultaneously. Note, however, that operations performed using the adapter occur functionally in pairs. If a channel issues commands in an illogical sequence, the out-of-sequence command is not accepted. For example, if both channels are chaining and channel X initiates a read operation but channel Y answers with a control command, the control command is rejected with attention and busy status. The adapter disconnects from channel Y but remains connected to channel X until channel Y sends a correct response, or a halt I/O instruction, or system reset or IPL is issued.

Bit 34 is the suppress-length-indication (SLI) flag. It controls whether an incorrect length condition is to be indicated to the program. In order to perform command chaining, it is always necessary to include the SLI flag in one of the CCWs. If the byte counts in the CCWs of each side are equal, the adapter always causes an incorrect length condition in the channel performing the write operation. If the SLI flag is not present, this condition inhibits command chaining. See "Programming Notes."

Operation Sequences

When a channel issues a command to the adapter, the adapter responds by sending to the channel a status byte indicating the status of the adapter. If the adapter is available and the operation is an "immediate" one, that is, one not requiring a data transfer, the adapter responds with a status byte indicating that the command will be executed and the channel is free for the next operation (condition code 1). However, if the operation is one that requires data transfer, the adapter responds with a status byte indicating that the command has been accepted, the operation is proceeding, and the channel is not free (condition code 0). If the adapter is not available condition code 3 is set. (See "Online and Offline Modes.")

The type of command determines which adapter operation ensues after the command is decoded. For example, a no-operation command causes the adapter to return a status byte containing channel end and device end and to disconnect from the channel immediately after accepting the command. Certain other commands issued by a channel to the adapter can be executed only if the other channel to which the adapter is connected issues an appropriate command. For example, a read or read backward operation issued by one channel can be executed by the adapter only after a write command has been issued to the adapter by the other channel. Likewise, a write command issued as the initial part of an operation requires an accompanying read command.

When the adapter decodes from one channel a command that requires an appropriate command from the other channel, the adapter signals the other channel (via an attention interruption) that an operation is waiting in the adapter. The other channel program responds with a sense command, which causes the adapter to transmit (to the channel issuing that command) the command byte issued by the initiating channel. The other channel's CPU program then examines the byte to determine what command should be issued in response to the adapter, and proceeds to issue that command. Only after both commands have been accepted by the adapter does the adapter operation continue to completion.

During I/O interruptions and during execution of start I/O, test I/O, halt I/O, and halt device, the unit status byte, under certain conditions, is stored as bits 32-39 of the channel status word (CSW). The CSW is stored at location 64 (40 hex) in main storage. The conditions under which the unit status byte is stored are described in *IBM System/360 Principles of Operation*, GA22-6821.

Ready and Not Read Conditions (Not Used in Compatibility Mode)

The adapter can be made not ready, that is, unavailable to one or both channels for command execution. An interface disconnect, a selective or system reset, or an equipment check from channel X creates a not ready condition on the X side of the adapter. While the X side is not ready, any command (other than sense adapter state) issued by channel Y is rejected with a unit check indicated in the initial status. Any command (except test I/O or sense adapter state) issued by channel X makes the X side of the adapter ready. The not ready to ready transition causes a device-end interruption to channel Y to indicate that the X side is ready and available for operation.

Both sides of the adapter perform the same functions. In the preceding explanation and in the remainder of the manual, "X" and "Y" may be interchanged to show the operation for either side of the adapter.

Specific Commands

Control

The control command provides for communicating control information between the channels. To serve this purpose, the five modifier bits of the command may be coded as desired. Proper use of the control command can eliminate situations in which a channel is kept busy with a command issued to the adapter while waiting for the proper command response (for example, an X read waiting for a Y write.)

When the control command is issued to the adapter, it is always an immediate command. In response, a sense command-byte command must be issued by the other channel to free the adapter and return it to the idle state. A control command from one channel may, however, receive a busy response because the other channel has previously issued a command.

Control Issued to an Idle Adapter: If channel X issues the control command, the complete command byte is set into the channel X command register of the adapter which sends channel end with initial status to free channel X. A control immediate latch is set on the X side, and an attention interruption is presented to channel Y. Channel Y, when free, can accept the attention as defined in *IBM System/360 Principles of Operation*, GA22-6821.

To free the adapter, a sense command-byte command must be issued by channel Y. At the termination of the sense command-byte command from channel Y, a device end for channel X is generated by the adapter.

Control Issued to a Busy Adapter: A control command issued by channel X receives busy status for the following reasons:
1. A previously issued control command by channel X has not been cleared. The response is the busy bit alone.
2. A previously issued control command by channel X was cleared with a channel Y sense command-byte command, but device end has not yet been accepted by channel X. The adapter responds with busy and device end. This clears the device end and leaves the adapter idle.
3. The control command is issued by channel X after channel Y has issued a command. The response is 'busy' and 'attention.' The 'attention', after being presented, no longer brings up the interface request-in tag to try to interrupt the CPU. If channel X subsequently issues another command, other than sense command-byte, or a matching command, the response is again 'busy' and 'attention'.

Control Issued to a Not Ready Adapter (Not Used in Compatibility Mode): When the Y side is not ready, a control command from channel X to the adapter receives unit check status.

Sense Adapter State (Not Used in Compatibility Mode)

This command is used to interrogate the adapter to determine the cause of a unit check. The sense byte is sent as data to the channel. The definition of the sense bits sent to the channel is listed under "Significant Sense Bit Combinations." Channel end and device end are presented as final status.

The sense adapter-state command receives a busy response if there is an outstanding control command at the adapter.

Significant Sense Bit Combinations:

1. All sense bits off indicates that the other side is ready. This is the normal condition.
2. Bit 1 on (intervention required) and bit 7 off (interface disconnect or selective reset) indicates that the other side is not ready due to a system reset on that side.
3. Bit 1 on and bit 7 on indicates that the other side is not ready due to a halt I/O, halt device, or selective reset.
4. Bit 3 on (equipment check) indicates a hardware failure on this side of the adapter. Bits 4, 5, and 6 must be interrogated to determine if the other side of the adapter is also in error. An all-zeros condition indicates that the side executing the sense command has the only error.
5. Bit 2 on (buffer data check) indicates that the data buffer on this side of the adapter detected incorrect parity. The operation is not stopped, but unit check is presented with the final status.

Sense Command-Byte

The sense command-byte command is used by one system to examine the command byte of the other system. If the adapter is idle when the sense command is performed, the data byte contains all zeros. For the data byte to contain the command byte of the other system, one of the following commands must have been issued by the other (Y) channel:

Channel Y Previously Issued	Sense Data							
	0	1	2	3	4	5	6	7
Adapter Idle	0	0	0	0	0	0	0	0
Control	-	-	-	-	-	1	1	1
Read Backward	-	-	-	-	1	1	0	0
Read	-	-	-	-	-	-	1	0
Write	0	-	-	-	-	-	0	1

The only exception is encountered when channel X issues a sense command-byte command to the adapter before a previous control command from channel X has been cleared. If the control command has not been answered by a sense command from channel Y, then the X sense command receives a busy response. If the X control command has been answered, but device end has not been accepted or has been stacked by channel X, then the X sense command receives both busy and device end in the initial status byte. This clears the device end.

Read and Read Backward

The adapter does not recognize the difference between a read and a read backward command. In both cases, the primary function of the adapter is to transmit data bytes to the initiating channel. It is the function of the channel to place the data bytes in main storage in the proper order.

Read Issued to an Idle Adapter: When a read or read backwards command is issued to an idle adapter, the issuing channel (X, for example) receives an all-zeros initial status, and then the operation is delayed while waiting for channel Y to respond with a write command. An attention interruption is immediately sent to channel Y indicating that an operation is waiting. The complete read command is stored in the adapter's X command register and is available to the Y side by means of the sense command-byte command.

Read Issued to a Busy Adapter: There are three responses to a read command issued by channel X.
1. If a previously issued X control command has not been cleared (the X control command is still valid), the adapter responds to initial selection with busy status.
2. If there is outstanding status information stored in the X side of the adapter, the response includes 'busy' in the status. This status could be channel end and device end from a previous operation that was stopped with a halt I/O. It could also be device end from a previous X control command that was cleared by a Y sense command-byte command but that had not been accepted by channel X; or the status may be a device end produced by the Y side going from the not ready to the ready state.
3. If channel Y has previously issued a read, read backward, or control command, then busy and attention status is the response to the X read command. If the attention was not previously accepted by channel X, the X read command clears attention as an interrupting condition, although it still appears as a response to another X read command until the previously issued read command by channel Y is satisfied by an X write command. (A Y write is only satisfied by an X read, and a Y control is only satisfied by an X sense command-byte command, etc).

Read When EOF is Issued (Not Used in Compatibility Mode): If end-of-file is set on the X side of the adapter by a previously issued Y write EOF command, an X read is rejected with the unit exception bit presented in the initial status byte.

Write

The adapter accepts data from the writing (initiating) channel and transmits the data to the reading (non-

initiating) channel. A write command might be issued to either an idle or a busy adapter. In either case, the response is the same as if a read command had been issued. See "Read Issued to an Idle Adapter" and "Read Issued to a Busy Adapter."

If a read command is issued by channel Y before a write command is issued by channel X, and if the attention status on the X side has been accepted, both operations are performed. See also "Adapter Compatibility." In compatibility mode, channel X receives a zero status in response to its command whether attention is accepted or not. The adapter requests a data byte from channel X and transmits it to channel Y. This operation continues until either channel signals 'stop'. If the operation is stopped by the reading channel, one more byte of data than is required is sent to the adapter by the writing channel. (Two more bytes are required if operating in high-speed data mode.)

Write End-of-File (Not Used in Compatibility Mode)

The write EOF command is used to signal to a read or read backward command on the other side of the adapter that no more data is to be sent. This command is especially useful when trying to stop an operation where individual writes are being issued to chained reads. The write EOF command sets an EOF latch in the other side of the adapter to indicate that no more data will be transmitted and to break the read chaining.

When channel X issues a write EOF, a pending read on channel Y receives channel end, device end, and unit exception ending status before any data has been transferred, but after a zero initial status is sent to channel Y. If the write EOF is issued before the read and initial status are presented, the unit exception bit is presented alone and the read command is rejected.

The write EOF command is treated on the writing side as a no-operation command in that channel end and device end are returned in the initial selection status and the adapter is available for more commands.

Because a write EOF is only meant to terminate a read (or read backwards), the EOF condition is reset if any command other than read is issued on the other side. In this case, the EOF condition is never indicated and is lost.

If after a write EOF is issued, another command such as control is given on the same channel and before a read is issued on the other channel, the attention interruption condition is kept pending until after unit exception is sent in response to the read command.

Write EOF commands are not stackable, that is, if three write EOF commands are issued by channel X, then channel Y issues two read commands, only the first read command receives a unit exception.

An interface disconnect, selective or system reset on either side of the adapter resets the EOF condition.

No-operation

The no-operation command in the adapter is always an immediate command. It has no effect on the adapter except for clearing an end-of-file (EOF) condition if that condition existed before the execution of the no-operation command. The response that is sent to the channel if this command is issued to an adapter that is busy or has an outstanding status is the same as that stated for read command.

If channel X issues a no-operation command to an idle adapter, channel X receives a status response containing channel end and device end, and the adapter remains free to the channel.

Modified No-operation

The response of the channel-to-channel adapter to the modified no-operation command is the same as the response to a no-operation command except for the setting or resetting of the extended mode condition.

The adapter is normally in compatibility mode (System/360 adapter-type operation). The issuing of a modified no-operation (disable compatibility, op code C3), sets the inhibit compatibility latch on that side of the adapter. Inhibit compatibility being set by either or both sides of the adapter forces the adapter into extended mode (noncompatibility mode). A system reset, selective reset or a modified no-operation (enable compatibility op code 43 (hex)) resets the inhibit compatibility latch for that side of the adapter, but does not put the adapter back in compatibility mode unless the inhibit compatibility latch on the other side is also reset.

Test I/O

A test I/O instruction (adapter command) may be used by the programmer to determine the status of the adapter any time the channel is free. The status received indicates the condition of the adapter as follows:
1. A zero status indicates that the adapter is idle.
2. A busy bit indicates that the adapter is busy with a control command which has not been cleared.
3. If channel Y has previously issued a read, read backward, write or control that is still in the adapter, and an X test I/O command is issued, the adapter responds with attention status to channel X.
4. A device end status response to an X test I/O command indicates that a previously issued X control command has been cleared or that the other side went from the not ready to the ready state. This clears the device end status.
5. A channel end and device end response indicates that a previously issued command was stopped by an interface disconnect.

The meaning of the above status conditions is not changed when presented as an interruption.

Attention: A start I/O (other than a sense, write EOF, or a no-operation on either side) generates an attention interruption on the opposite side if there was not an outstanding command already on the opposite side. This attention interruption alerts the program that the adapter has an active I/O operation on the other side which is awaiting a response. After the 'attention' is recognized by the channel, this side can issue a sense command-byte command to determine what command is active. This is a typical sequence of events.

If two systems are operating so that a start I/O is active on channel X and a second start I/O (using a matched command) is issued to channel Y before the attention is accepted by channel Y, the following occurs depending on the mode:

1. Compatibility mode—the attention interruption is not presented but is reset because of the matched commands, and the operation proceeds.
2. Extended mode—the attention interruption to channel Y, if not previously cleared by channel Y, is given in response to the channel Y start I/O, even if the commands match. If the channel Y start I/O is issued again (assuming a match) the operation proceeds.

Halt I/O / Halt Device

The execution of a HIO or HDV instruction causes an interface disconnect. The interface disconnect condition in extended mode stops the adapter data transfer and makes the adapter not ready. When the adapter recognizes the interface disconnect condition, its response to the halting channel is immediate. The adapter drops all in-tag lines, sets channel end and device end if the reset occurred after initial status time and waits for a chance to send the status to the halting channel. If the other channel is operating with the adapter, it receives channel end, device end, and unit check. If this channel issues a sense adapter state command to ascertain the cause of the unit check, it receives a data byte with bits 1 and 7 on. Bit 1 on indicates intervention required (adapter is not ready) and bit 7 on indicates that an interface disconnect or selective reset caused the not ready condition.

The interface disconnect sequence in compatibility mode causes a channel end and/or device end interruption to the channel that issues the HIO even if the halt occurs before the adapter has an active command. A halt I/O or halt device command terminates any operation in effect on either side of the adapter.

System or Selective Reset

A system or selective reset is handled like an interface disconnect, except that no channel end or device end is sent to the issuing channel and the inhibit compatibility latch on the side of the system reset is reset. When the adapter is powered up, both the X and Y sides receive an automatic reset which puts the adapter in compatibility mode.

A system or selective reset causes the adapter to become not ready only if one inhibit compatibility latch is still on; this holds the adapter in extended mode. In order to make the adapter ready again, it is necessary to issue a read, read backward, write, write end-of-file, control, or no-operation command to the adapter. For example, if channel X issues a system reset, the X side is not ready until channel X issues one of the commands just mentioned. All of the channel Y commands except sense adapter state are rejected with unit check as long as the X side remains not ready. When an X command makes the X side ready, a device end interruption occurs on channel Y indicating the adapter is ready.

When a device end is pending or stacked and the adapter is made ready on the other side, the ready device end is saved. After the pending device end is cleared, the adapter interrupts with the ready device end. When the adapter has a pending or stacked device end and a saved ready device end interruption, and the adapter is made not ready, the saved device end is reset and only the pending or stacked device end occurs. The state of the X adapter ready latch has no effect on commands issued by channel X. The X ready latch only affects channel Y commands.

System Adapter-Control

Online and Offline Modes

The adapter provides an I/O interface switch, located on the operator's console, to allow the adapter to be logically removed from the Y system. Once the adapter has been removed (disabled), it will be unavailable to the Y side. An unavailable adapter does not respond to its address if selection is attempted but always propagates select-out. (*Note:* In some System/370 models, the I/O interface switch may logically disconnect both the X and the Y systems.)

A green indicator labeled I/O INTF DSBLD indicates that the adapter is offline. This indicator is lit only if the following conditions are satisfied on both sides of the adapter at the same time:

1. Neither interface is operating with a channel (both operational-in tags are down).
2. Neither interface is chaining commands.
3. Neither interface has pending or stacked status of any type.
4. Neither adapter side has a control command outstanding.

With the I/O interface switch set to DSBL and all of the above conditions satisfied simultaneously, the indicator lights (indicating that the adapter is then unavailable to the channel Y side). The adapter remains in this condition until the switch is moved to ENBL. (See Figure 2.)

I/O Interface Lever Switch

Position	Operation	Information
Enable	System power-on sequence is complete. I/O interface disabled indicator is on. Move lever to enable position. I/O interface disabled indicator status is off.	Adapter is available to program.
Disable	Operator message specifying removal of adapter from use must be sent to both systems. Move lever to disable position. I/O interface disabled indicator status is on.	Adapter is disabled when the lever is in disable position and the disabled indicator is on.

I/O Interface Disabled Indicator

Title	Status	Information
I/O INTF DSBLD	On	The adapter is not ready and the I/O interface lever switch is in the disable position.
	Off	The adapter is enabled and available but ready status is a program function.

Figure 2. Adapter Controls on Operator Console

Power-off and Power-on Procedures

To turn off power, proceed as follows:
1. Send to both systems operator messages that specify removal of the adapter from use.
2. Move the I/O interface switch to DSBL.
3. Wait for the I/O INTF DSBLD indicator (green) to light.
4. Depress the power-off pushbutton.

The reversal of the above procedure is used for power on:
1. Depress the power-on pushbutton.
2. I/O INTF DSBLD indicator should come on.
3. Move the I/O interface switch to ENBL. The I/O INTF DSBLD indicator should go out.

Initial Program Loading (IPL)

During the initial program loading operation, a system reset pulse precedes the selection of the adapter. (See also "Adapter Compatibility.") The reset pulse causes the adapter to become not ready; any other outstanding operation on the other side of the adapter is terminated with channel end and device end sent to a read or write operation and device end sent to a control operation. Another device end is presented because the adapter on the IPL side went from not ready to ready and then attention status is presented because of the IPL read command. The Y side of the adapter must respond with a write command after 'attention' is accepted in order to complete the IPL.

PROGRAMMING NOTES

The following information is elaborated upon to explain operations that are peculiar to the adapter.

Adapter Compatibility

In order to operate the adapter on System/370 models that include integrated channels and use programs originally written for the channel-to-channel adapter previously announced for the System/360, some of the functions provided for the adapter must be disabled. Two inhibit compatibility latches are provided, one for each side of the adapter. An inhibit compatibility latch is set by a modified no-operation command (11---011). When either or both inhibit compatibility latches are set, the adapter is in extended mode.

An inhibit compatibility latch is reset by system reset, selective reset, or by another modified no-operation command (01---011). When *both* inhibit compatibility latches are reset, the adapter is in compatibility mode and can operate with System/360 adapter programs. The following conditions become effective in *compatibility mode*:

The Write End-of-File Command is Deleted—If the command for write end-of-file (1XXXXX01) is presented to the adapter, it will be decoded as a standard write (0MMMMM01).

The Sense Adapter-State Command is Deleted—If the command for sense adapter state (XXX00100) is presented to the adapter, it is decoded as a sense command-byte command (XXX10100).

The Unit Check and Unit Exception Status Bits are Deleted—The latches used to present these bits are inhibited in compatibility mode.

The Ready Latches for Both Sides of the Adapter are Forced to the On State and They are Not Allowed to Reset—This means that a not ready to ready device end is not presented.

The Sense Bits are Never Presented to the Channel Because there is No Sense Adapter-State Command—The sense bits do not stop adapter operation but they do turn on and are displayed at the X CPU console.

The Interface Disconnect Sequence Changes—Channel end and device end bits are presented to the halting channel even when the halt occurs before initial status time.

A Read-Write Match is Always Performed—The attention status does not have to be cleared before the match is performed.

Command Chaining

Command chaining may be performed by channel X, channel Y, and/or both simultaneously; however, it must be remembered that all operations performed by the channel-to-channel adapter occur in pairs. Therefore, an illogical sequence of commands may send a status of busy and attention to the last channel issuing a command. For example, if both channels are chaining and a Y read command is matched by a control command from channel X, channel X receives 'attention' which causes channel X to disconnect from the adapter. Channel Y remains connected to the adapter until a correct response is received from channel X; in this case a write or a write end-of-file command. Because the sense commands do not require a reply, they should not be chained in answer to a chain of control commands. When channel X issues a write, read, or chained control command to the adapter, the busy condition remains active until a proper response is received from channel Y or until either channel issues a halt I/O or reset.

Halt I/O or Halt Device

The halt I/O or halt device instruction causes a channel end and device end to be sent to the channel that issued the halt only if initial status was accepted before the adapter was halted. (See "Adapter Compatibility.") The channel end and device end status is sent to the channel as an interruption or in response to a test I/O or start I/O instruction. If an interface disconnect is issued after a control immediate type command is received, the normal initial status for that command is sent to the channel.

Attention

If the adapter has a pending attention interruption, a test I/O clears the attention as an interruption condition although it does not reset the attention status bit. Any subsequent test I/O receives the attention status until a match· between the channel commands occur. (For example, a write on one channel to a read on the other.) When the attention bit is a 1 in the adapter status byte and the adapter receives a matching command, the attention bit is reset and subsequently the adapter executes the operation. Under the same condition, if a mismatch occurs, a condition code of 01 is set with busy and attention stored in the unit status of the CSW. A pending or stacked attention on one side of the adapter is reset by an interface disconnect issued to either side of the adapter. Zero status may be presented to the channel under these conditions.

Wrong Length Record

A wrong length record indication can occur under the following conditions at the end of the operation.

Read on Channel X to Write on Channel Y	Wrong Length Record Indicated on	
	Ch X	Ch Y
1. X count equal to Y count	No	Yes
2. X count greater than Y count	Yes	Yes
3. X count less than Y count	Yes	Yes
4. X count equal to Y count less one (compatibility mode)	Yes	No
5. X count equal to Y count less two (high-speed data mode)	Yes	No

Note: When running with high-speed data mode plugged, the adapter prefetches two bytes of data from the writing channel before the reading channel can stop data transfer. (Figure 3 presents a summary of adapter status responses.)

Channel X Issues Control Command Followed by Y Sense Command	Status For Channel X After: Channel Y Issues				And Channel X Issues
	Read	Write	Control	Write EOF	
Busy, Device End (Adapter Idle)	Busy, Attention	Y-GO*-X Reset Attention	Busy, Attention	Unit Exception	Read
Same as Above	X-GO*-Y, Reset Attention	Busy, Attention	Same as Above	Reset X EOF; Attention to Y	Write
Same as Above	Busy, Attention	Same as Above	Same as Above	Reset X EOF; Attention to Y. Channel End to X	Control
Same as Above	Chan End, Device End to Both Sides. Unit Exception to Y	Same as Above	Same as Above	Reset X EOF; Set Y EOF; Channel End, Device End to X	Write EOF
Device End (Adapter Idle)	Attention	Attention	Attention	Reset X EOF; Zero Status to X (Adapter Idle)	Test I/O
Busy, Device End (Adapter Idle)	Busy, Attention	Busy, Attention	Busy, Attention	Reset X EOF; Channel End, Device End to X	No-operation
Busy, Device End	Force Zero Initial Status; Y Command Byte to X	Force Zero Initial Status; Y Command Byte to X	Y Command Byte to X; Reset Attention. Device End Interruption to Y	Reset X EOF; Zero Command Byte to X	Sense Command Byte
Busy, Device End (Adapter Idle)	Busy, Attention	Busy, Attention	Busy, Attention	Reset X EOF; Sense Bits to X	Sense Adapter State

* GO = Data is transferred.

Note: The response given to the channel when the adapter has an outstanding control command (no Y sense command to an X control command) is always 'busy', presented as initial status.

Figure 3. Adapter Status Response Summary

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Channel-to-Channel Adapter

Order No. GA22-6983-0

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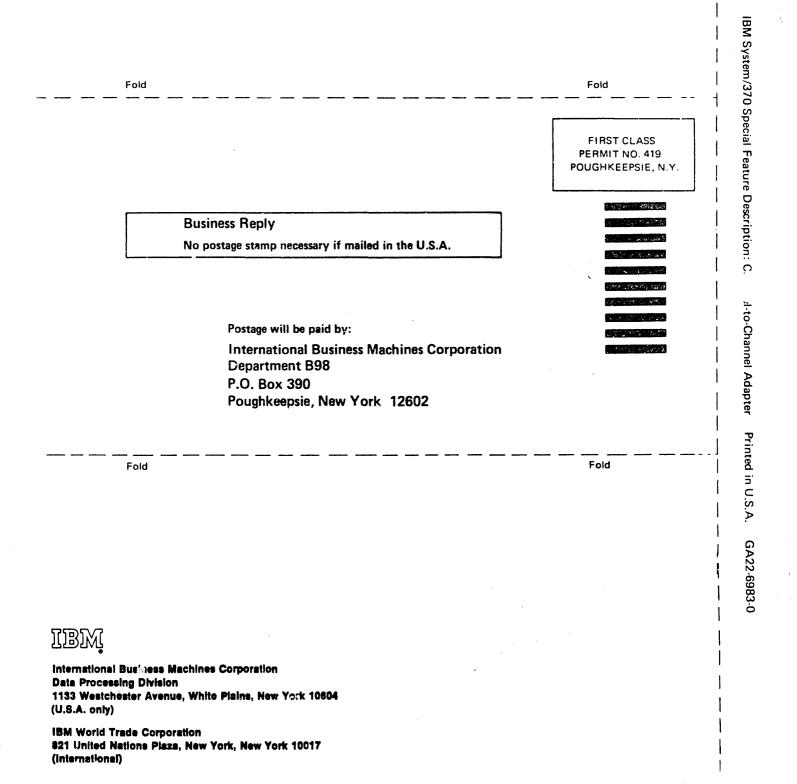What is your occupation? _____

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