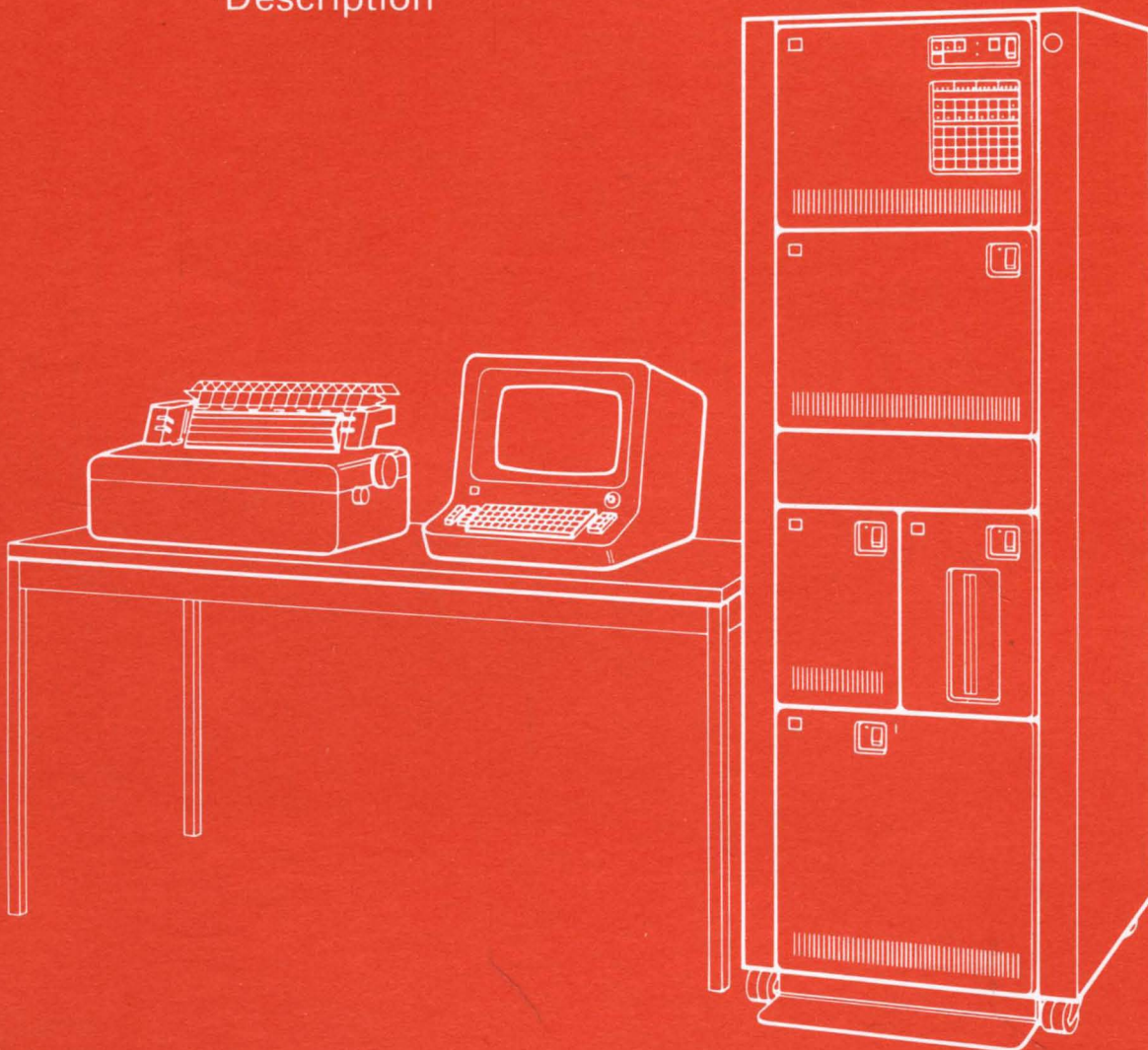




GA34-0031-0

Series/1

Customer Direct Program
Control Adapter Features
Description



DPC ADAPTER DESCRIPTION



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DPC ADAPTER DESCRIPTION

First Edition (November 1976)

Changes are periodically made to the information herein; any such changes will be reported in subsequent revisions or Technical Newsletters.

Text for this manual has been prepared with the IBM Magnetic Tape Selectric® Composer.

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Preface	v
Prerequisite Publications	v
Related Publications	v
Customer Direct Program Control Adapter Feature	1
Commands	1
Addressing	2
Condition Codes Reported During the Operate I/O Instruction	2
Adapter-Directed Commands	3
Read Adapter Status Word	3
Read Diagnostic Data	4
Prepare	4
Set Diagnostic Mode	4
Bit 0 = 0	4
Bit 0 = 1	5
Reset Diagnostic Mode	5
Device-Directed Commands	6
Read ID	6
Device Reset	6
Designer-Defined Device-Directed Commands	6
Read Data	6
Read Status	6
Write Data	6
Write Control	6
Interrupt Presentation and Status Words	6
Interrupt Condition Codes	6
Interrupt Information Byte	7
Interrupt Status Byte	7
Status After Power On Transitions and Resets	7



This publication describes the purpose of and the command and interrupt structure for the Customer Direct Program Control Adapter. The manual is designed for use by programmers who program in assembler language, but who require knowledge of machine language.

This manual consists of a single chapter containing an introduction to the Customer Direct Program Control Adapter and the description of the applicable commands. This manual will be revised in the future to discuss other user adapter features.

This manual is directly related to the *IBM Series/1 Model 3 4953 Processor and Processor Features Description* and the *IBM Series/1 Model 5 4955 Processor and Processor Features Description* manuals. Knowledge of either of these two publications is assumed.

Prerequisite Publications

IBM Series/1 Model 3 4953 Processor and Processor Features Description, GA34-0022

IBM Series/1 Model 5 4955 Processor and Processor Features Description, GA34-0021

Related Publications

IBM Series/1 System Summary, GA34-0035

IBM Series/1 User's Attachment Manual, GA34-0033

IBM Series/1 Physical Planning Manual, GA34-0029



Customer Direct Program Control Adapter Feature

The direct program control adapter feature card provides a convenient means of attaching I/O devices and subsystems to a Series/1. The adapter is designed to perform direct program control (DPC) functions only; cycle steal operations cannot be performed. The feature card can be configured to accommodate 4, 8, or 16 I/O device addresses. The adapter allows for interrupt vectoring of 16 interrupt sources.

User attachment is through three top-card connectors. There are 75 signal lines. These include: 18 data bus out, 18 data bus in, 16 interrupt request in, 3 function bits, 4 modifier bits, 4 device address bits, and 12 control and response lines. The data flow is always 16 bits without parity option or 18 bits with parity option (2 parity bits).

This manual provides a functional description and programming information for the Customer Direct Program Control Adapter feature. For publications containing other kinds of information, refer to the preface of this manual.

COMMANDS

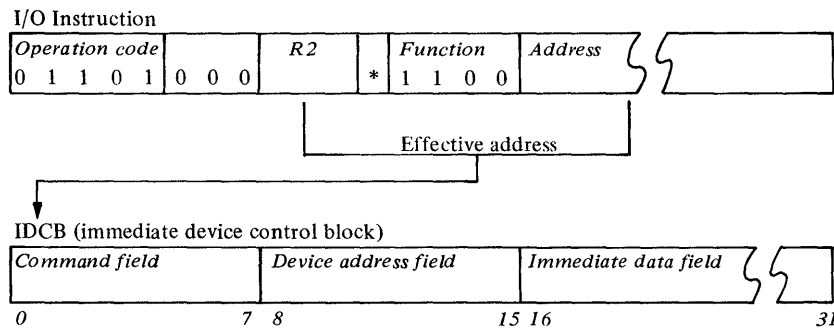
The Customer Direct Program Control Adapter feature is connected to the processor through the I/O channel. Direct Program Control (DPC) commands are used for all I/O operations; that is, cycle steal mode is *not* implemented. The Operate I/O instruction (IO) is executed for each command.

The Operate I/O instruction generates an effective address that points to an immediate device control block (IDCB). The IDCB contains a command field, a device address field, and an immediate data field. Refer to Chapter 7 of *IBM Series/1 Model 5 4955 Processor and Processor Features Description*, GA34-0021, or Chapter 6 of *IBM Series/1 Model 3 4953 Processor and Processor Features Description*, GA34-0022, for additional information about I/O operations.

Commands to the Customer Direct Program Control Adapter are of two kinds: adapter directed and device directed.

Adapter-directed commands are specifically defined by IBM. These commands perform specific actions using only the adapter. They must use the function and modifier codes specified.

Device-directed commands are defined by the customer. Because IBM does not know what device will be attached to the feature card, we can define the commands only in a general way that specifies whether information will be transferred from the processor to the device or from the device to the processor. For specific information about device-directed commands, consult the designer of the device and its adapter circuits.



*Indirect addressing bit

Addressing

The Customer Direct Program Control Adapter can be configured for 4, 8, or 16 device addresses by field-installable jumpers.

The first four (high-order) bits of the device address field of the IDCB are defined by field installable connectors on the feature card. The next two bits are defined by field installable connectors only if the feature card is configured for four or eight devices. The low-order bits that are not used to address the adapter card are used for device addressing within the domain established by the feature card address.

Condition Codes Reported During the Operate I/O Instruction

The following table is a summary of the condition code values that can be reported when the Operate I/O instruction is executed.

Command	Condition code values							
	CC0	CC1	CC2	CC3	CC4	CC5	CC6	CC7
0X Read Data	X	X	X	X	X	X	X	X
1X Read Data	X	X	X	X	X	X	X	X
20 Read ID	X					X		X
2X Read Status	X	X	X	X	X	X	X	X
2E Read Adapter Status Word	X					X		X
2F Read Adapter Diagnostic Data	X					X		X
4X Write Data	X	X	X	X	X	X	X	X
60 Prepare	X					X		X
61 Set Diagnostic Mode	X					X		X
62 Reset Diagnostic Mode	X					X		X
6X Write Control	X	X	X	X	X	X	X	X

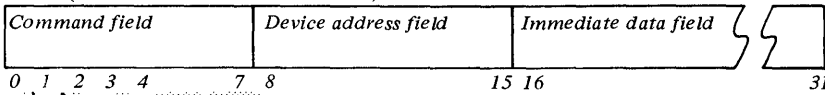
Legend:

- CC0 = Device not attached
- CC1 = Busy
- CC2 = Busy after reset
- CC3 = Command reject
- CC4 = Operator intervention required
- CC5 = Interface data check
- CC6 = Controller busy
- CC7 = Satisfactory

Adapter-Directed Commands

The adapter feature card executes the adapter-directed commands shown in the following illustration.

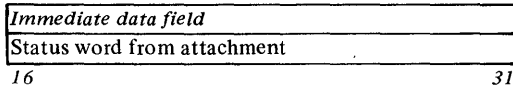
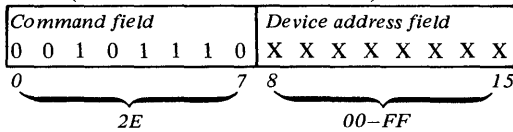
IDCB (immediate device control block)



Chan	R/W	Function	Modifier	Hex	Specific command
0	0	10	1110	2E	Read status word
0	0	10	1111	2F	Read diagnostic data
0	1	10	0000	60	Prepare
0	1	10	0001	61	Set diagnostic mode
0	1	10	0010	62	Reset diagnostic mode

READ ADAPTER STATUS WORD

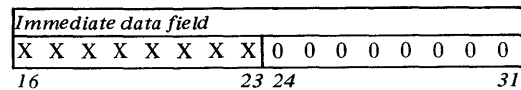
IDCB (immediate device control block)



The read adapter status word command transfers the 16 bits of the adapter status word to the immediate data field of the IDCB. The output parity error bit and the input parity error bit are reset. (These two bits are also reset by the successful execution of any other I/O command.)

If condition code 5 (interface data check) is reported, the status word in the IDCB data field is not valid.

After the Read Adapter Status Word command is executed, the status word bits in the second word of the IDCB have the following meaning:



- Diagnostic Interrupt Masking—Interrupts from the attached devices are masked during external diagnostic mode.
- Four device addresses.
- Eight device addresses.
- Parity option selected.
- Input parity error—parity error was detected between an I/O device and the attachment feature during a device directed output command.
- Output parity error—parity error was detected between the channel and the attachment feature during a device directed output command.
- External diagnostic mode.
- Local diagnostic mode.

READ DIAGNOSTIC DATA

IDCB (immediate device control block)

Command field								Device address field							
0	0	1	0	1	1	1	1	X	X	X	X	X	X	X	X
0 7								8 15							
2F								00-FF							

Immediate data field															
Data from diagnostic register															
16 31															

The Read Diagnostic Data command transfers the 16 bits of the diagnostic register into the immediate data field of the IDCB. The diagnostic register is not reset.

If condition code 5 (interface data check) is reported, the data in the IDCB is not valid.

If the adapter is not in diagnostic mode, execution of this command will transfer all zeros to the IDCB immediate data field.

PREPARE

IDCB (immediate device control block)

Command field								Device address field							
0	1	1	0	0	0	0	0	X	X	X	X	X	X	X	X
0 7								8 15							
60								00-FF							

Immediate data field															
Zeros															
Level															
I															
16 26 27 30 31															

Execution of this command prepares the Customer Direct Program Control Adapter feature to interrupt on the level defined in the immediate data field of the IDCB. All devices are prepared to the same level and are enabled by the same I-bit. Previous prepare commands are overridden.

If condition code 5 (interface data check) is reported, the command is not executed.

SET DIAGNOSTIC MODE

IDCB (immediate device control block)

Command field								Device address field							
0	1	1	0	0	0	0	1	X	X	X	X	X	X	X	X
0 7								8 15							
61								00-FF							

Immediate data field																
X	Zeros														X	X
16 17 29 30 31																

Execution of this command sets the adapter into diagnostic mode and resets the diagnostic register. Diagnostic mode provides wrap-back to the diagnostic register of the adapter control and data lines available to the devices attached. It also controls generation of interrupts. The particular diagnostic functions performed are controlled by the bits in the immediate data field of the IDCB.

Bit 0 = 0

When bit 0 of the immediate data field is 0, the command is directed to the adapter feature card. This is called local diagnostic mode. When the adapter is in local diagnostic mode, output parity error (OPE) and input parity error (IPE) bits in the status word will always be zero, all interrupts from the attached I/O devices are masked, data from the I/O devices is ignored, and the data and control lines from the adapter to the I/O devices are inactive. Any subsequent device-directed commands are responded to by the adapter. Within these parameters further responses are controlled by bits 14 and 15 of the immediate data field.

Bits 14 and 15 = 00

This will cause the adapter to initiate an attention interrupt. The interrupt information byte (IIB) presented will be all zeros and the device address will be DDDD0000 (when configured for 16 devices), DDDDD000 (when configured for 8 devices), or DDDDD000 (when configured for 4 devices), where the Ds are higher order bits of the jumpered device address on the adapter feature card. After the interrupt is serviced by the channel, the interrupt request will be reset. If an additional interrupt request is desired, another set diagnostic mode command with the same data format must be issued.

Bits 14 and 15 = 01

This will cause the adapter to load data into the diagnostic register during any subsequent device-directed command. The data loaded depends on the type of device-directed command.

Write or Control Command. The command will load the immediate data field of the IDCB into the adapter diagnostic register. The contents of the diagnostic register can be read by issuing a read diagnostic data command. If an interface parity error is detected, condition code 5 (interface data check) will be returned, the command will not be executed in the adapter, and the data in the diagnostic register will not be changed.

Read or Read Status Command. The command will load all zeros in the immediate data field of the IDCB and set all zeros in the diagnostic register. If condition code 5 (interface data check) is reported, the data in the IDCB is not valid and the data in the adapter diagnostic register is not changed.

Bits 14 and 15 = 10

This will load the adapter lines between the adapter and the I/O devices into the diagnostic register during any subsequent device-directed command. Under this mode of operation the data in the diagnostic register has the following format:

Zero	Attachment function	Attachment modifier	Device address
16	20 21	24 25	27 28 31

The attachment function, modifier, and device address are control lines between the adapter feature card and the attached devices. The attachment function and modifier bits are equivalent to bits 1 through 7 of the command field in the IDCB.

The data loaded in the diagnostic register depends on the type of subsequent device-directed command.

Write or Write Control Command. This will load the adapter control lines previously stated into the diagnostic register. The content of the diagnostic register can be read by issuing a read diagnostic data command.

If an interface parity error is detected, condition code 5 (interface data check) will be returned, the command will not be executed, and the data in the adapter diagnostic register will not be changed.

Read or Read Status Command. This will load all zeros in the immediate data field of the IDCB and the adapter control lines stated previously will be loaded into the adapter diagnostic register. The content of the diagnostic register can be read by issuing a read diagnostic data command.

If an interface parity error is detected, condition code 5 (interface data check) will be reported, the data in the immediate data field of the IDCB is not valid, and the data in the adapter diagnostic register is not changed.

Bits 14 and 15 = 11

The control lines described in "Bits 14 and 15 = 01" and in "Bits 14 and 15 = 10" are logically ANDed for any subsequent device-directed command. The result is loaded into the diagnostic register. The contents of the diagnostic register will depend on the kind of subsequent device-directed command.

Write or Write Control Command. This will load the data resulting from the AND into the adapter diagnostic register. The content of the diagnostic register can be read by issuing a read diagnostic data command.

If an interface parity error is detected, condition code 5 (interface data check) will be returned, the command will not be executed by the adapter, and the data in the diagnostic register is not changed.

Read or Read Status Command. This will load all zeros in the immediate data field of the IDCB and all zeros in the adapter diagnostic register. The content of the diagnostic register can be read by issuing a read diagnostic data command.

If an interface parity error is detected, condition code 5 (interface data check) will be reported, the data in the immediate data field is not valid, and the data in the diagnostic register is not changed.

Bit 0 = 1

When bit 0 of the immediate data field of a set diagnostic mode command equals 1, it sets external diagnostic mode in the Customer Direct Program Control Adapter feature card. In external diagnostic mode, device-directed commands are passed to the devices, the control and data lines between the adapter and the devices function normally, and the data received from the I/O devices will be set in the diagnostic register.

Bits 14 and 15 of the immediate data field of the set diagnostic mode IDCB provide variables for the external diagnostic mode. When bit 14 is on, all I/O devices attached to the adapter feature must reset. Bit 15 is a diagnostic mode modifier.

The functions of commands under external diagnostic mode is defined by the designer of the I/O devices attached to the feature card. Consult his literature for precise definitions.

RESET DIAGNOSTIC MODE

IDCB (immediate device control block)

Command field	Device address field
0 1 1 0 0 0 1 0	X X X X X X X X
0 7	8 15
62	00-FF

Immediate data field
Zeros
16 31

Execution of this command will reset the adapter diagnostic mode and diagnostic register. The immediate data field of the IDCB is not used, but parity is checked.

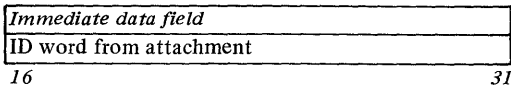
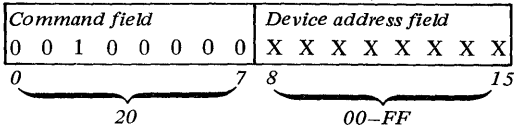
If condition code 5 (interface data check) is reported, the command will not be executed. If the adapter is not in diagnostic mode, the command will be accepted, but no resetting will be performed.

Device-Directed Commands

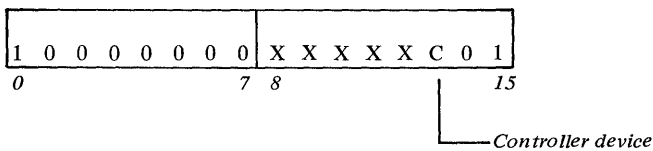
IBM defines two device-directed commands: read ID and device reset. All other commands are defined by the I/O device designer.

READ ID

IDCB (immediate device control block)

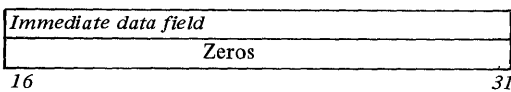
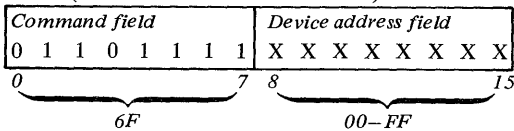


This command transfers the ID word from the device and adapter to the immediate data field of the IDCB. The contents of the ID word are:



DEVICE RESET

IDCB (immediate device control block)



This command causes the addressed device to reset. Any pending interrupts will be cleared.

DESIGNER-DEFINED DEVICE-DIRECTED COMMANDS

The following designer-defined commands are available for use with the Customer Direct Program Control Adapter feature, except for those combinations of XXXX that result in IBM-defined commands. Any bit patterns for the command field of the IDCB not specified here or as IBM-defined commands are reserved and must not be used.

Command field	Command type
0000 xxxx	Read data
0001 xxxx	Read data
0010 xxxx	Read status
0100 xxxx	Write data
0101 xxxx	Write data
0110 xxxx	Write control

Read Data

A device-directed command of this form transfers 16 bits of data from the addressed device to the immediate data field of the IDCB.

Read Status

This device-directed command transfers 16 bits of status from the addressed device to the immediate data field of the IDCB.

Write Data

Device-directed commands of this kind transfer 16 bits of data from the immediate data field of the IDCB to the addressed device.

Write Control

This device-directed command initiates a control action in the addressed device. A word transfer from the immediate data field of the IDCB may or may not accompany a control command.

INTERRUPT PRESENTATION AND STATUS WORDS

The devices attached to the Customer Direct Program Control Adapter feature may be designed as interrupting devices. Interrupting devices are capable of executing commands which initiate operations that continue beyond the execution of the Operate I/O instruction. These devices interrupt the processor upon termination of the operation specified by the initiating command.

When the device presents an interrupt, it also presents a condition code that specifies the general cause of the interrupt and may present an interrupt status byte that specifies the exact cause of the interrupt.

Interrupt Condition Codes

When the device presents an interrupt, it also presents one of the following condition codes. See the documentation supplied by the designer of the device for any required information not presented in the following explanations.

CC0—Controller End. This condition code is reported by a controller after it has successfully reported condition code 6 (controller busy) to an I/O instruction. Controller end signifies that the controller is free to accept I/O commands for devices which it controls. The device address reported with the controller end interrupt is the lowest numerical value of the group of devices controlled by that controller domain. The IIB will be zero.

CC1—Reserved. This condition code should never be reported by a device attached to this feature.

CC2—Exception Interrupt. This condition code is reported by the device when an error or exception condition is associated with the interrupt. The condition is described in the interrupt status byte and in device dependent status words, if required.

CC3—Device End. This condition code is reported by the device when no error, exception, or attention conditions occurred during the I/O operation.

CC4—Attention. This condition code is reported by the device only when the interrupt was caused by an external event rather than execution of an I/O command. If the event has a singular meaning, no further status recording is required.

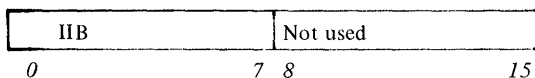
CC5—Reserved. This condition code should never be reported by this feature.

CC6—Attention and Exception. This condition code is reported by the device when an attention condition occurs at the same time as an exception condition.

CC7—Attention and Device End. This condition code is reported when an attention condition occurs at the same time as device end.

Interrupt Information Byte

Each interrupting device may implement an interrupt information byte (IIB). The IIB is used to record status that cannot be indicated to the program via condition codes. The meaning of each bit in the IIB depends on the device. For information on the meaning of the IIB, see the documentation supplied by the designer of the device. The IIB has the following format:



Interrupt Status Byte

The interrupt status byte (ISB) is a special format of the IIB and is presented only when interrupt condition codes 2 and 6 are reported. Unless the condition code presentation of 2 or 6 is singular in meaning, the ISB will never be zero.

Bits in the ISB are normally set as a result of status errors which occur in an operation that was initiated by a command but which cannot be indicated to the program via a condition code. After the device has recognized that its interrupt request has been taken by the processor, the ISB is reset.

The ISB for devices has the following format:

Bit 0	Device dependent status available
Bit 1	Delayed command reject
Bits 2–7	Device dependent

STATUS AFTER POWER ON TRANSITIONS AND RESETS

- *Halt I/O Command or Machine Check Reset.* The diagnostic mode, the diagnostic register, and the status word are reset.
- *System Reset.* The diagnostic mode, the diagnostic register, the prepare register, and the status word are reset.
- *Power On Reset.* The diagnostic mode, the diagnostic register, the prepare register, and the status word are reset.

Consult the documentation supplied by the designer of the device for reset conditions that apply to each device attached to this feature.



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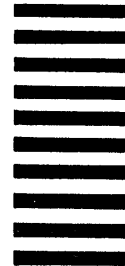
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