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Section 1
General Information

1.1 Introduction

The Model 835-IEEE Interface is designed to enhance the capabilities of the Model 835 Laser Pico-Watt Digital Power Meter by allowing the transmission of data and commands over an IEEE-488 bus in computer controlled instrumentation systems. The Model 835-IEEE Interface provides all the digital logic necessary to interface the Model 835 to the bus using standard IEEE-488 (1978 standard).

1. Section 1 contains general information and guidelines for using this manual.
2. Section 2 is an overview (general descriptive, functional and use information) of the IEEE-488 (1978 Standard) Bus, with which the Newport Model 835 Laser Pico-Watt Digital Power Meter (equipped with the Model 835-IEEE Interface) is used - in a Computer Controlled Instrumentation System.
3. Section 3 contains detailed operation and use information for the Model 835 power meter, equipped with a Model 835 interface.
4. Section 4 provides theory of operation, and Section 5 contains maintenance information, for the Model 835-IEEE Interface.

1.2 Unpacking And Inspection

The Model 835-IEEE Interface was carefully inspected both mechanically and electrically before shipment. Upon receiving the Model 835-IEEE Interface, carefully check all items for any obvious signs of physical damage during shipment. Report any damage to the shipping agent immediately. Retain the original packing materials in case reshipment is necessary. The following items are shipped with every 835-IEEE Interface order:

Model 835-IEEE-488 Interface*

Installation Hardware (complete)*

Modified Rear Panel with Power Cord*

Model 835-IEEE-488 Interface Instruction Manual

Additional Accessories (as ordered)

If an additional instruction manual is required, order the manual package (Newport Corporation part number 14077-01). (The manual package includes an instruction manual and all pertinent addenda.)

*If the interface is ordered with the Model 835, the parts marked with * will be installed in the main unit.

1.3 Preparation For Use

As shipped, the Model 835 interface is set to the addressable mode, with the primary address set to 22 at the factory. For information on changing these parameters, refer to Section 3. If the Model 835-IEEE interface is to be field installed, refer to Section 5 for installation instructions.

1.4 Specifications

Model 835-IEEE Interface specifications immediately precede this section.

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1.5 Warranty Information

Warranty information is inside the front cover of this manual. For warranty service, contact your nearest Newport representative or the factory to determine the proper course of action. Newport Corporation maintains service facilities in the United States, West Germany, and England. Addresses for these facilities are on the warranty page of this manual. Direct questions on application, operation or service of your instrument to the Newport representative at any of these locations.

1.6 Manual Addenda

Information on improvements or changes to the interface, which occur after this manual is printed are on an Addendum sheet included with this manual. Review these changes before attempting to install or use the interface.

1.7 Safety Symbols, Terms, And Notes

The following safety symbols and terms are used in this manual and found on the Model 835:

The ⚠ symbol on the instrument indicates that the user is to refer to the operating instructions.

The WARNING headings in this manual explains danger that could result in personal injury or death.

The CAUTION headings emphasize hazards that could damage the instrument.

The NOTE headings highlight information or procedures especially beneficial or useful.

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Section 2
An Overview of the IEEE-488 Bus

2.1 Introduction

The IEEE-488 bus is an instrumentation data bus standardized by the Institute of Electronic and Electrical Engineers (IEEE) in 1975. The most recent revision of bus standards was made in 1978; hence the complete description for current bus standards is the IEEE-488 (1978 Standard).

This section gives a brief description of the general bus structure with an outline of bus commands. The information presented here is not intended to be an in-depth description of a very complex standard. More complete information on the IEEE-488 bus, also frequently referred to as the General Purpose Interface Bus (GPIB), is available from the IEEE and a variety of other sources.

2.2 Description

The IEEE-488 bus was designed for parallel data transfer between devices to optimize data transfer using a minimum number of bus lines. The bus has eight data lines that are used for both data and some commands. Five additional bus management lines and three handshake lines complete the bus (a total of 16 signal lines). Since it is a parallel bus, all devices connected to the bus have the same information available simultaneously. Exactly what is done with the information by each device depends on many factors, including device capabilities. Each connected device uses or reacts to the information depending on device capabilities and other factors.

For controlled operation, see a typical bus configuration in Figure 2-1. The typical system has one controller and one or more instruments to which commands are given, and in most cases, from which data is received. Generally, there are three categories that describe device operation: controller; talker; listener.

The controller does what its name implies: it controls other devices on the bus. A talker sends data, and a listener receives data. Depending on the instrument, a particular device may be a talker only, or both a talker and a listener. The Model 835, through the 835-IEEE interface, is capable of both talking and listening - but it does not have controller capability.

A system usually has only one controller (control may be passed to an appropriate device through a special command), but any number of talkers or listeners may be connected within the hardware limits of the bus. Generally, bus operation is limited to use with a maximum of 15 devices. This number may be less - if higher than normal data transfer rates are required, or if longer than normal cables are used.

Several devices may be commanded to listen at once, but only one device may be a talker at any given time. Otherwise, communications would be scrambled much like an individual trying to pick out a single conversation in a large crowd.

Before a device can talk or listen, it must be correctly addressed. Devices are selected by their primary address. To avoid confusion, the addressed device is sent a talk or listen command with its primary address. Normally, each device on the bus has a unique primary address and each may be addressed individually. The primary address of the Model 835 interface is set to 22 at the factory, but it may be changed to any other between 0 and 30 (Section 3).

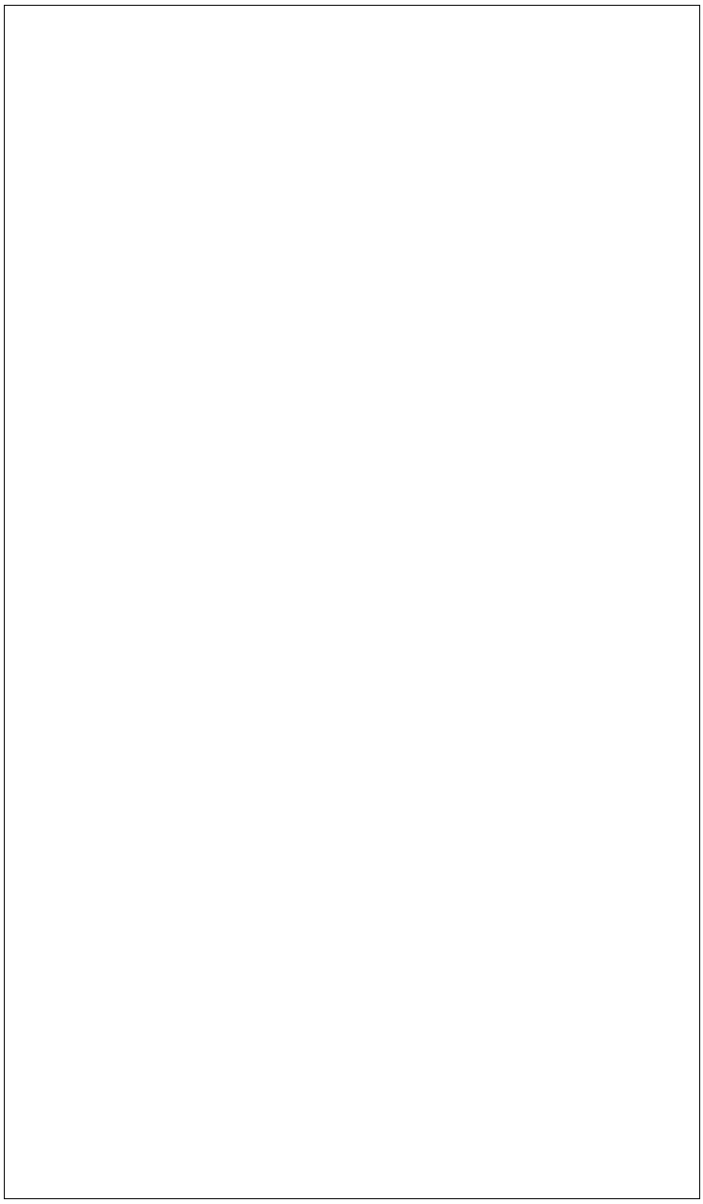
Once the device is addressed to talk or listen, designated bus transactions take place. For example, if the Model 835 is addressed and commanded to talk, it will generate and place its output data string on the bus - one byte at a time.

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The controller then reads and uses this information, and/or directs any other device(s) selected to read or use the data - at the desired device location(s) on the bus. Other bus functions and instrumentation may be controlled by special bus commands (paragraph 2.3).

IEEE-488 Bus Lines

The signal lines on the IEEE-488 bus are grouped into three general categories. The data lines handle bus information, while the handshake and bus management lines ensure proper bus operation and correct data transfer. Each of the bus lines operate in an inverted state (low is true). The purpose of these lines (shown in Figure 2-1) are described in the following paragraphs.



2.3.2 Handshake Lines

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2.3.1 Bus Management Lines

Five bus management signal lines transfer specific single-line bus commands, which ensures orderly transfer of data between devices. These lines transfer only the single-line commands described in paragraph 2.4.

1. ATN (Attention)-The attention line is an important management line. The state of the ATN line indicates whether information to be on the data bus is data or a command (paragraph 2.4).
2. IFC (Interface Clear)-Setting the IFC line true (low) causes a bus interface clear status by sending the IFC command.
3. REN (Remote Enable)-Setting the REN line sends the REN command. This sets up instruments on the bus for remote operation.
4. EOI (End or Identify)-The EOI line is used to terminate a multi-byte transfer sequence.
5. SRQ (Service Request)-The SRQ line is set low by a device on the bus, when that device requires service from the controller.

Figure 2-1. Typical IEEE-448 Bus Configuration

This ensures reliable data transfer regardless of the transfer rate. Generally, data transfer occurs at a rate determined by the slowest active device on the bus.

One of the handshake lines is controlled by the data source, while the remaining two lines are controlled by accepting devices. The three bus handshake lines are:

1. DAV (Data Valid)-The talker (source) controls the state of the DAV line.
2. NRFD (Not Ready For Data)-The listener (acceptor) controls the state of the NRFD line.
3. NDAC (Not Data Accepted)-The listener (acceptor) also controls the NDAC line.

The complete handshake sequence for one data byte is shown in Figure 2-2. Handshake can occur once data is high, indicating that all devices on the bus are ready for data. At the same time NDAC should be low from the previous byte transfer. If these conditions are not met, the source must then wait until NRFD and NDAC lines have the correct status. Because of the possibility of a bus hang up, some controllers have time-out routines to display error messages, if the handshake sequence stops for any reason.

Once the NRFD and NDAC lines are properly set, the source sets the DAV line low, indicating that data on the bus is now valid. The NRFD line then goes low and the NDAC line goes high once all devices on the bus have accepted the data. Each device releases the NDAC line at its own rate, but the NDAC line does not go high until the slowest device has accepted the data.

After the NDAC line goes high, the source then sets the DAV line high to indicate that the data on the bus is no longer valid. At this point, the NDAC line returns to its low state. Finally, the NRFD line is released by each of the devices at their own rates, until the NRFD line finally goes high when the slowest device is ready - and the bus is set to repeat the sequence with the next byte of data.

The sequence described is used to transfer both data and multiline commands. The state of the ATN lines determines whether the data bus contains data or commands (paragraph 2.4).

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Figure 2-2. Handshake Sequence For One Data Byte



2.3.3 Data Lines

The IEEE-488 bus has eight data lines that allow data to be transmitted and received in a bit-parallel, byte-serial manner. These eight lines use the convention D101 through D108 instead on the usual D0 through D7 binary terminology. The data lines are bidirectional, and like the bus management and handshake signal lines, low is true.

2.4 Bus Commands

Hardware aspects of the bus are important, but the interface can transfer data correctly only with appropriate commands to control communications between the various instruments on the bus. This section briefly describes the purpose of the bus commands, which are grouped into the following three general categories:

1. Uniline commands: Sent by setting the associated bus line low.
2. Multiline commands: General bus commands sent when the ATN line is low.
3. Device-Dependent commands: Special commands that depend on device configurations; sent when ATN is high.

These commands are summarized in Table 2-1. (Only commands that affect Model 835 operation are covered in this section.)

2.4.1 Uniline Commands

Uniline commands are sent by setting the named command associated bus line low. The ATN, IFC and REN commands are sent only by the system controller. The SRQ command is generated and sent by an external device on the bus. The EOI command may be sent by either the controller or an external device. Following is a brief description of each command:

1. REN (Remote Enable)-When the controller sends the REN command, the instrument is set up for remote operation before transfer of information over the bus.
2. EOI (End Or Identity)-The EOI command is transmitted by setting the EOI

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sequence.

3. IFC (Interface Clear)-The IFC command is sent by setting the IFC line low; it clears the bus interface.
4. ATN (Attention)-The controller sets the ATN line low when sending multiline commands. Device-dependent commands are sent with ATN high. (The ATN line must remain high while a device transmits its data string.)
5. SRQ (Service Request)-The SRQ line is set low by an external device when it requires service from the controller. A serial polling sequence (described in paragraph 3.4.7) must be used to determine which device has requested service.

2.4.2 Universal Commands (Multiline)

Table 2-1. IEEE-488 Bus Command Summary

Command Type	Command	**State of** ATN Line*	Comments
Uniline	REN (Remote Enable)	X	Set up for remote operation.
	EOI (End or Identify)	X	Sent by setting EOI low.
	IFC (Interface Clear)	X	Clears Interface.
	ATN (Attention)	Low	Defines data bus contents.
	SRQ (Service Request)	X	Controlled by external device
Multiline			
Universal	DCL (Device Clear)	Low	Returns device to default conditions.
	LLO (Local Lockout)	Low	Disables most front panel controls.
	SPE (Serial Poll Enable)	Low	Enables serial polling.
	SPD (Serial Poll Disable)	Low	Disables serial polling.
Addressed	SDC (Selective Device Clear)	Low	Returns unit to default conditions
	GTL (Go to Local)	Low	Returns to local control.
	GET (Group Execute Trigger)	Low	Triggers device for reading.
Unaddressed	UNL (Unlisten)	Low	Removes all listeners from bus.
	UNT (Untalk)	Low	Removes all talkers from bus.
Device-dependent**		High	Programs Model 835 for various modes.

* X = Don't Care

** For complete description refer to Section 3.

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Universal commands are multiline commands that require no addressing. All instrumentation equipped to implement the command complies when the command is transmitted over the bus. (Like all multiline commands, the universal commands are sent with ATN low.)

1. DCL (Device Clear)-After DCL is sent, all instrumentation equipped to implement the command reverts to some known state (all devices so equipped).
2. LLO (Local Lockout) - After LLO is sent, all instrumentation equipped to implement the command will disable front panel controls. The Model 835 disables all front panel controls except POWER, ZOOM and OFFSET.
3. SPE (Serial Poll Enable)-The SPE command is the first step in the serial polling sequence (used to determine which instrument has requested service).
4. SPD (Serial Poll Disable)-The SPD comand is sent by the controller to remove all instrumentation on the bus from the serial poll mode. The Model 835 then no longer places status bytes on the bus when addressed to talk (after the SPD command is sent).

2.4.3 Addressed Commands

Each of these commands must be preceded by a listen command coded for the device's primary address, before the instrument will respond. Only the addressed device responds to each of these commands:

1. SDC (Selective Device Clear)-The SDC command performs essentially the same function as the DCL command (paragraph 2.4.2), except that only the addressed device responds.
2. GTL (Go to Local)-The GTL command changes instruments from the remote to local mode of operation.
3. GET (Group Execute Trigger)-The GET command triggers devices to perform some acton that depends on device configuration.

2.4.4 Unaddressed Commands

Two unaddressed commands from the controller remove all talkers and listeners from the bus simultaneously. No addressing is required to implement these commands.

1. UNL (Unlisten)-All listeners are removed from the bus at once when the UNL command is sent on the bus.
2. UNT (Untalk)-The controller sends the UNT command to remove any talkers from the bus.

2.4.5 Device-Dependent Commands

The meaning of the device-dependent commands is determined by instrument configuraton. Generally, these commands are sent as one or more ASCII characters and tell the device to perform a specific function. For complete information on using these commands with the Model 835, refer to Section 3. The IEEE-488 bus treats device-dependent commands as data since the ATN line is high when commands are transmitted.

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Command Codes

Each bus command contains a unique code that is transmitted over the bus as 7 bit ASCII data. This section briefly explains the code groups, which are summarized in Figure 2-3. (Every command is sent with ATN low.)

1. Addressed Command Group (ACG)-Addressed commands are listed in column 0(B) in the table. Column 0(A) lists the corresponding ASCII codes.
2. Universal Command Group (UCG)-Columns 1(A) and 1(B) list the Universal commands and the corresponding ASCII codes.
3. Listen Addressed Group (LAG)-Columns 2(A) and 3(A) list the ASCII codes corresponding to the primary address listed in columns 2(B) and 3(B). For example, if the primary address of the instrument is set to eight, the LAG byte corresponds to the ASCII "(" character.
4. Talk Address Group (TAG) - TAG primary address values and the corresponding ASCII characters are listed in columns 4(A) through 5(B).

The preceding address groups are all grouped together to form the Primary Command Group (PCG). The bus also has another group of commands, called the Secondary Command Group (SCG). These are listed in Figure 2-3, at the end of this section, for informational purposes only. The Model 835 does not respond to these commands, but other devices may have secondary addressing capability.

Note

Commands are normally transmitted with the 7 bit code listed in the table. For most devices, the condition of D7(D108) is unimportant, as shown by the "Don't Care" indication in the table. Some devices, however, may require that D7 is at a specific logic state before the commands are recognized.

Hexadecimal and decimal values for each of the commands or command groups are listed in Table 2-2. Each value in the table assumes that D7 is set to 0.

Table 2-2. Hexadecimal and Decimal Command Codes

Command	Hex Value*	Decimal Value
GTL	01	1
SDC	04	4
GET	08	8
LLO	11	17
DCL	14	20
SPE	18	24
SPD	19	25
LAG	20-3F	32-63
TAG	40-5F	64-95
UNL	3F	63
UNT	5F	95

*Values shown with $D_7 = 0$

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2.6 Command Sequence

The correct command sequence must be sent by the controller before an instrument will respond as intended. The universal commands, such as DCL, require only that ATN be set low before the command is sent. Other commands require that the device be addressed to listen first. This section briefly describes the bus sequence for several types of commands.

2.6.1 Addressed Command Sequence

Before a device responds to one of these commands, it must receive a LAG command containing its primary address. Table 2-3 shows a typical sequence for the SDC command. (The example in the table assumes that the instrument has a factory set primary address of 22.)

Note

A UNL command is transmitted before the LAG SDC sequence. (This is generally done to remove all other listeners from the bus first, so that only the addressed device responds.)

Table 2-3. Typical Addressed Command Sequence

Step	Command	ATN	Data Bus		
			ASCII	Hex	Decimal
1	UNL	Set low	?	3F	63
2	LAG*	Stays low	6	36	54
3	SDC	Stays low	EOT	04	4
4	Returns high				

*Assumes primary address = 22.

2.6.2 Universal Command Sequence

Universal commands are sent by setting ATN low and then placing the command on the bus. For example, the following is placed on the bus to give the DCL command:

ATN*DCL

Note

Both the ATN and DCL commands are on the bus simultaneously. Also, addressing is not necessary.

2.6.3 Device-Dependent Command Sequence

Device-dependent commands are transmitted with ATN high. However, the device must be addressed to listen first - before the commands are transmitted. Table 2-4 shows the command sequence for the following:

D1X

This command, which sets up the Model 835 for the LOG function, is described in detail in Section 3.

Figure 2-3. Command Codes

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Table 2-4. Typical Device-Dependent Command Sequence

Step	Command	ATN	Data Bus		
			ASCII	Hex	Decimal
1	UNL	Set low	?	3F	63
2	LAG*	Stays low	6	36	54
3	Data	Set high	D	44	68
4	Data	Stays high	1	31	49
5	Data	Stays high	X	58	88

*Assumes primary address = 22.

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Section 3
Operation

3.1 Introduction

The Model 835-IEEE Interface is designed to interface the Model 835 to the IEEE-488 bus. The current, and therefore power, ranges, zero check, logarithm, (dBm/dB), attenuator, ratio/referene, wavelength, and null features are controlled by programming commands over the IEEE-488 bus. In addition, interface characteristics such as End or Identify (EOI), Status Request Conditions (SRQ), Output Format, and Data Terminator can be programmed. Data sent by the interface includes power, power range, wavelength, detector and attenuator serial numbers, status byte, and status word.This section deals with important hardware and software aspects of bus operation, and describes important programming functions in detail. Included are: general bus commands, device-dependent commands, status word and status byte, and other important operating information.

3.2 Hardware Considerations

Before the Model 835 can be used with the IEEE-488 bus, the instrument must be connected to the bus using a suitable connector. Also, the instrument must be set up for addressable operation and the primary address must be properly selected as described in this section.

Note

Allow the Model 835 (with installed 835-IEEE interface) to warm up (power on) for one hour before using in order to stablize analog circuitry.

3.2.1 Typical Controlled Systems

The IEEE-488 bus is a parallel interface in a data transfer and control system. As a result, adding more devices is simply a matter of using more cables to make the desired connections. Because of this flexibility, system complexity can range from a very simple to an extremely complex system.

Figure 3-1 shows two typical system configurations. Figure 3-1(a) shows the simplest possible controlled system. The controller is used to send commands to the instrument, which sends data back to the controller.

The system becomes more complex in Figure 3-1(b), where additional instrumentation is added. Depending on programming, all data may be routed through the controller, or it may be transmitted directly from one instrument to another.

For very complex applications, a larger computer can be used. Tape drives or disks can then be used to store data.

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Figure 3-1. Typical Controlled Systems

3.2.2 Bus Connections

The Model 835 is connected to the bus through an IEEE-488 connector, shown in Figure 3-2. This connector is designed to be stacked to allow a number of parallel connections on one instrument.

Note

To avoid possible mechanical damage, it is recommended that no more than three connectors be stacked on any one connector on an instrument. Otherwise, resulting strain may cause internal damage.

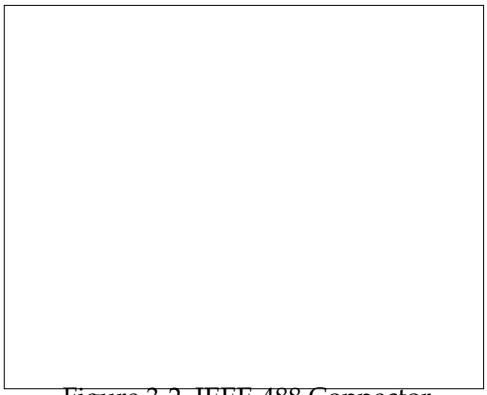


Figure 3-2. IEEE-488 Connector

A typical connecting arrangement for the bus is shown in Figure 3-3. Each cable normally has the standard IEEE connector on each end. Once the connections are made, the screws are to be tightened securely. (The connector is located on the rear panel of the Model 835.)

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Note

The IEEE-488 bus is limited to a maximum of 15 devices, including the controller. Also, the maximum cable length is 20 meters. Failure to comply with these limits will probably result in erratic bus operation.

Custom cables may be constructed using the information in Table 3-1 and Figure 3-4. Table 3-1 lists the contact assigments for the various bus lines, and Figure 3-4 shows contact designations. Contact 18 through 24 are return lines

for the indicated signal lines, and the cable shield is connected to contact 12. Each ground line is connected to digital common in the Model 835.

Figure 3-4. Contact Assignments

Caution

Voltage between IEEE common and ground must not exceed 30V, or damage to the instrument may occur.

A typical signal line bus driver is shown in Figure 3-5. With the configuration shown, the driver has bidirectional capability. When the I/O control line is high, the driver functions as an output bus driver for the line. When the control line is low, the driver is set up for line input operation.

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Table 3-1. IEEE Contact Designations

Contact Number	IEEE-488 Designation	Type
1	D101	Data
2	D102	Data
3	D103	Data
4	D104	Data
5	EOl (24)*	Management
6	DAV	Handshake
7	NRFD	Handshake
8	NDAC	Handshake
9	IFC	Management
10	SRQ	Management
11	ATN	Management
12	SHIELD	Ground
13	D105	Data
14	D106	Data
15	D107	Data
16	D108	Data
17	REN (24)*	Management
18	Gnd, (6)*	Ground
19	Gnd, (7)*	Ground
20	Gnd, (8)*	Ground
21	Gnd, (9)*	Ground
22	Gnd, (10)*	Ground
23	Gnd, (11)*	Ground
24	Gnd, LOGIC	Ground

*Numbers in parentheses refer to signal ground return of reference contact number EO1 and REN signal lines return on contact 24.

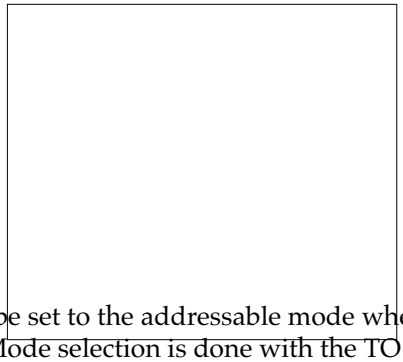
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Note

Not all signal lines use the bidirectional capability. Some lines, such as ATN, will always function as output lines from the controller and as input lines for all other devices on the bus.

Figure 3-5. Typical IEEE-488 Bus Driver (One of 16)

3.2.3 Addressable Mode Selection

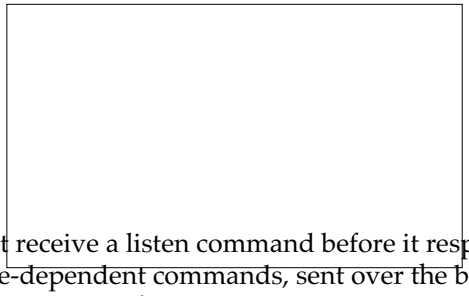


The Model 835 must be set to the addressable mode when used with an external controller. Mode selection is done with the TO/ADDRESSABLE mode selection switch located on the rear panel of the Model 835. This switch is grouped with the five switches that set the primary address; these switches are located on the rear panel of the Model 835. Figure 3-6 shows the switch (6) set at the ADDRESSABLE position.

The TO/ADDRESSABLE switch mode is read only at power-up. If the mode is changed, the Model 835 must first be turned off, then powered-up again (cycle instrument power), before it will respond to the new switch position.

Figure 3-6. TO/ADDRESSABLE and Primary Address Switches (Factory Set Address 22 Shown)

3.2.4 Primary Address Selection



The Model 835 must receive a listen command before it responds to the addressed, or device-dependent commands, sent over the bus. Similarly, a talk command must be sent to the Model 835 before it will transmit its data string, status word, or status byte. These talk and listen commands are sent with the primary address of the instrument. The primary address of the Model 835 interface is set to 22 at the factory, but it may be set to any value between 0 and 30 by placing the primary address switches (1-5, Figure 3-6) to the required positions. The primary address, used for the Model 835 in the controller's programming language must be identical to the primary address set on the Model 835.

Note

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The primary address switches set address is read only at power-up. If the address is changed, the Model 835 must be first turned off, and then powered-up again (cycle power) before the new address can be used.

Correct switch positions for the factory set address of 22 is shown in Figure 3-6. (If a different address is required, the primary address may be changed as indicated in Table 3-2.

Note

If other instrumentation is also connected to the bus, be sure that each device has a different primary address. Not complying with this precaution may result in erratic bus operation.

The primary address switches are binary weighted; A1 is the least significant bit, and A5 is the most significant bit. (For example, the binary value for a primary address of eight is 01000. Use the tip of a pen or pencil to operate the switches.)

Note

No instrument on the bus (including the Model 835) should be operated with a primary address of 31, although it is possible to set the switches to those positions (11111). This address is reserved for the UNL and UNT commands. (If primary address 31 is used, instruments will respond by removing themselves from the talk or listen modes.)

3.3 Software Assembly

The most sophisticated computer in the world is useless without the necessary software. This basic requirement is also true of the IEEE-488 bus, which requires the use of handler routines described in this section.

3.3.1 Controller Interface Routines

Before a controller can be used with the IEEE-488 interface, the user must make certain that appropriate handler software is present in the controller. (For example, with the HP-85 computer, the HP-85 interface card must be used with an additional I/O ROM - which contains the necessary handler software.)

Other small computers that can be used as controllers have limited IEEE command capability. PET/CBM computers, for example, are incapable of sending the universal and addressed multiline commands from BASIC, although most of these commands may be sent through machine-language routines. Capabilities of other small computers depend on the particular interface used. (Often, little software "tricks" are required to achieve the desired results.)

It is very important to make sure the proper software is being used with the interface. Often, the user may incorrectly suspect that a hardware problem is causing an intermittent fault, when in fact, software is the problem.

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Table 3-2. Primary Address Switch Positions

Primary Address	5	4	3	2	1
0	0	0	0	0	0
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
5	0	0	1	0	1
6	0	0	1	1	0
7	0	0	1	1	1
8	0	1	0	0	0
9	0	1	0	0	1
10	0	1	0	1	0
11	0	1	0	1	1
12	0	1	1	0	0
13	0	1	1	0	1
14	0	1	1	1	0
15	0	1	1	1	1
16	1	0	0	0	0
17	1	0	0	0	1
18	1	0	0	1	0
19	1	0	0	1	1
20	1	0	1	0	0
21	1	0	1	0	1
22	1	0	1	1	0
23	1	0	1	1	1
24	1	1	0	0	0
25	1	1	0	0	1
26	1	1	0	1	0
27	1	1	0	1	1
28	1	1	1	0	0
29	1	1	1	0	1
30	1	1	1	1	0

3.3.2 HP-85 BASIC Statements

Many of the programming instructions use examples written in Hewlett-Packard Model 85 BASIC. The HP-85 was chosen for these examples because it has a large number of BASIC statements that control IEEE-488 operation. This section covers those HP-85 BASIC statements that are essential to Model 835 operation.

A complete list of HP-85 IEEE-488 BASIC statements is in Table 3-3. All the statements in the table have a one or three digit interface select code, which is set to 7 at the factory. The last two digits, of those statements that require three digits, specify the primary address. Generally, only those commands that actually require an address to be sent over the bus need to specify the primary address.

The statements in the table with three digits assume that the primary address

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of the device (in this case the Model 835) is set at 22. Other primary addresses require that the last two digits be set to the corresponding value. (For example, to send a GTL command to device 21, the following BASIC statement is used: LOCAL 721.)

Some of the statements in the table have two forms; the exact configuration used depends on the desired command. (For example, CLEAR 7 causes a DCL to be sent, while CLEAR 722 causes an SDC to be transmitted to device 22.)

The third column of Table 3-3 lists the mnemonics for the command sequences. While most of these have been covered before, the following information should be noted. As described earlier, the ATN line is set low by the controller if the data bus contains a multiline command. This is indicated in the table by ANDing the ATN mnemonics with the first command on the bus. (For example, ATN*GET sends ATN and GET simultaneously.)

Two commands not previously covered are MLA (My Listen Address) and MTA (My Talk Address). These are ordinary PCG (Primary Command Group) addresses sent by the HP-85 for bus operation in some situations. The Model 835 normally ignores these commands, but other devices may require that MLA and MTA be present in the command sequence - under certain circumstances.

Note

The HP-85 address is set to 21 at the factory. Since each device on the bus must have a unique primary address, do not set the Model 835 to this address to avoid conflict with the HP-85.

3.3.3 Interface Function Codes

Table 3-3. HP-85 IEEE-488 BASIC Statements

Statement	Action	Bus Command Sequence
ABORTIO 7	Send IFC	IFC
CLEAR 7	Send DCL	ATN*DCL
CLEAR 722	Send SDC to device 22.	ATN*UNL;MTA;LAG;SDC
ENTER 722;A$	Device 22 addressed to talk. Data placed in A$.	ATN*UNL;MLA;TAG;$\overline{\text{ATN}}$;data
LOCAL 722	Send GTL to device 22.	ATN*UNL;MTA;LAG;GTL
LOCAL LOCKOUT 7	Send LLO	ATN*LLO
OUTPUT 722;A$	Device 22 addressed to listen. Transmit A$.	ATN*MTA;UNL;LAG;$\overline{\text{ATN}}$;data
REMOTE 7	Set REN true.	REN
REMOTE 722	Send REN true. Address device 22 to listen	REN;ATN*UNL;MTA;LAG
RESET 7	Send IFC, cancel REN.	IFC;REN;$\overline{\text{REN}}$
SPOLL(722)	Address device 22 to talk. Conduct serial poll.	ATN*UNL;MLA;TAG;SPE; $\overline{\text{ATN}}$; status byte; ATN*SPD;UNT
TRIGGER 7	Send GET	ATN*GET
TRIGGER 722	Address device 22 to listen. Send GET.	ATN*UNL;MTA;LAG;GET

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The interface function codes are specified in the IEEE-488 (1978 Standards). These codes define an instrument's ability to support various interface functions, and are not to be confused with programming commands found elsewhere in this manual.

The codes for the Model 835 are listed in Table 3-4. These codes are also on the rear panel of the instrument for convenience, above the IEEE connector.

Table 3-4. Model 835 Interface Function Codes

Code	Interface Function
SH1	Source Handshake Capability
AH1	Acceptor Handshake Capability
T5	Talker (Basic Talker, Serial Poll, Talk Only Mode, Unaddressed To Talk On LAG)
L4	Listener (Basic Listener, Unaddressed To Listen on TAG)
SR1	Service Request Capability
RL1	Local Lockout/Remote Capability
PP0	No Parallel Poll Capability
DC1	Device Clear Capability
DT1	Device Trigger Capability
C0	No Controller Capability
E1	Open Collector Bus Drivers
TE0	No Extended Talker Capabilities
LE0	No Extended Listener Capabilities

The numeric value following each one or two letter code defines Model 835 capabilities/functions as follows:

1. SH1 (Source Handshake Function) - The ability to initiate the transfer of message/data on the data bus.
2. AH1 (Acceptor Handshake Function) - The ability to ensure proper reception of message/data on the data bus.
3. T5 (Talker Function) - The ability to send device-dependent data over the bus (to other devices). (Talker capabilities exist only after the instrument has been addressed to talk.)
4. L4 (Listener Function) - The ability to receive device-dependent data over the bus from other devices. (Listener function capabilities exist only after it is addressed to listen.)
5. SR1 (Service Request Function) - The ability to request service from the controller.
6. RL1 (Remote-Local Function) - The ability to be in remote or local modes of operation. Local Lockout capability.
7. PP0 (Parallel Poll Function) - The Model 835 has no parallel polling capabilities.
8. DC1 (Device Clear Function) - The ability for Model 835 to be cleared (initalized).
9. DT1 (Device Trigger Function) - The ability to have its readings triggered.

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10. C0 (Controller Function) - The Model 835 has no controller capabilities.
11. TE0 (Extended Talker Capabilities) - The Model 835 has no extended talker capabilities.
12. LE0 (Extended Listener Capabilities) - The Model 835 has no extended listener capabilities.

3.3.4 Model 835 Interface Commands

Interface commands controlling Model 835 operation are listed in Table 3-5. (Not included in the table are device-dependent commands, which are covered in detail in paragraph 3.5.)

Table 3-5. IEEE Command Groups

HANDSHAKE COMMAND GROUP

DAC = DATA ACCEPTED
RFD = READY FOR DATA
DAV = DATA VALID

UNIVERSAL COMMAND GROUP

ATN = ATTENTION
DCL = DEVICE CLEAR
IFC = INTERFACE CLEAR
LLO = LOCAL LOCKOUT
REN = REMOTE ENABLE
SPD = SERIAL POLL DISABLE
SPE = SERIAL POLL ENABLE

ADDRESS COMMAND GROUP

LISTEN: LAG = LISTEN ADDRESS GROUP
MLA = MY LISTEN ADDRESS
UNL = UNLISTEN
TALK: TAG = TALK ADDRESS GROUP
MTA = MY TALK ADDRESS
UNT = UNTALK
OTA = OTHER TALK ADDRESS

ADRESSED COMMAND GROUP

ACG = ADDRESSED COMMAND GROUP
GET = GROUP EXECUTE TRIGGER
GTL = GO TO LOCAL
SDC = SELECTIVE DEVICE CLEAR

STATUS COMMAND GROUP

RQS = REQUEST SERVICE
SRQ = SERIAL POLL REQUEST
STB = STATUS BYTE
EOI = END

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3.4 General Bus Command Programming

General bus commands are those commands with the same general meaning regardless of instrument configuration. These commands are grouped into two categories:

1. Addressed Commands: These commands require that the primary address of the instrument be identical to the primary address in the controller's programming language.
2. Unaddressed Commands: No primary address is required for these commands. All devices with capabilities and set up to implement these commands will do so simultaneously when the command is sent.

General bus commands are summarized in Table 3-6, which also lists the HP-85 BASIC statement that sends each command. (Each addressed command statement assumes a primary address of 22.)

Note

The Model 835 must be set for a primary address of 22 to work with addressed command examples.

3.4.1 REN (Remote Enable)

The remote enable command is sent to the Model 835 by the controller to set it up for remote operation. Generally, this should be done before attempting to program the instrument over the bus. The Model 835 indicates that it is in the remote mode by displaying the RMT annunciator.

To set up the Model 835 in the remote mode, the following steps must be performed at the controller:

1. Set the REN line low.
2. Address and command the Model 835 to listen.

Note

Setting REN true without addressing does not cause the RMT annunciator to turn on; however, once REN is true, the RMT annunciator turns on the next time an addressed command is received.

Programming Example - This sequence is automatically sent by the HP-85,

Table 3-6. General Bus Commands

Command	Addressing Required ?	HP-85 BASIC Statement
REN	Yes	REMOTE 722
IFC	No	ABORTIO 7
GTL	Yes	LOCAL 722
DCL	No	CLEAR 7
LLO	No	LOCAL LOCKOUT 7
SDC	Yes	CLEAR 722
GET*	Yes	TRIGGER 722
GET*	No	TRIGGER 7

*GET - sent with or without addressing.

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when the following is typed into the keyboard:

REMOTE 722 (END LINE)

After the END LINE key is pressed, the Model 835 RMT annunciator comes on. (If not, check to see that the instrument is set for the proper primary address. Also, check to see that all bus connections are secure.)

3.4.2 IFC (Interface Clear)

The IFC command is sent by the controller to set the Model 835 to the talk and listen idle states.

To send the IFC command, the controller need only set the IFC line true.

Programming Example - Before demonstrating the IFC command, turn on the RMT annunciator if it is not already on, by entering the following statements into the HP-85 computer:

REMOTE 722 (End Line)

The RMT annunciator is now on. The IFC command may now be sent by entering the following statement into the HP-85:

ABORTIO 7 (End Line)

After the END LINE key is pressed, the Model 835 is in the talk idle state.

3.4.3 GTL (Go To Local)

The GTL command takes the instrument out of the remote mode. To send the GTL command, the following sequence must be performed at the controller:

1. Set ATN true.
2. Address the Model 835 to listen.
3. Place the GTL command on the bus.

Programming Example - If the instrument is not in the remote mode, enter the following statement into the HP-85:

REMOTE 722 (End Line)

Check to see that the RMT annunciator is on. The GTL command sequence is automatically sent by the HP-85 with the following statement:

LOCAL 722 (End Line)

The RMT annunciator then turns off.

Note

Setting REN false with the LOCAL 7 statement also takes the instrument out of the remote mode.

3.4.4 DCL (Device Clear)

The DCL command may be used to clear the Model 835, setting it to a known state. All devices on the bus equipped to respond to a DCL do so simultaneously. (When the Model 835 receives a DCL command, it returns to the default conditions in Table 3-7.

To send the DCL command, the following steps must be performed on the

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Table 3-7. Default Conditions

(Status Upon Power Up or After SDC or DCL)

Mode	Value	Status
Attenuator	—	Reflects saved status in NVRAM.
Wavelength	—	Reflects saved value in NVRAM.
Log (dBm/dB)	D0	Off
Ratio/Ref	F0	Off
Calibration	—	Off
Zero Check	C0	Off
Range	R0	Autorange
Relative	Z0	Off
EOI	K0	Send EOI.
Trigger	T0	Continuous on Talk.
SRQ	M00	Disabled
Data Format	G0	Send prefix.
Terminator	Y(CR LF)	CR LF

controller :

1. Set ATN true.
2. Set the DCL command on the bus.

Programming Example - Using front panel controls, select the 2µW range. Also enable the REL and LOG modes. Now enter the following statement into the HP-85:

CLEAR 7 (End Line)

After the END LINE key is pressed, the instrument returns to power-up status.

3.4.5 SDC (Selective Device Clear)

The SDC command performs the same function as the DCL command, except that only the addressed device responds. This command is useful for clearing only selected instruments instead of all instruments simultaneously. The Model 835 returns to the default conditions listed in Table 3-7 when responding to an SDC command.

To transmit the SDC command, the following steps must be performed on the controller :

1. Set ATN true.
2. Address the Model 835 to listen.
3. Set the SDC command on the data bus.

Programming Example - Using front panel controls, select the 2µW range and enable the REL mode. Enter the following statement into the HP-85:

CLEAR 712 (End Line)

Note that the instrument does not respond because the SDC command was

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sent with a primary address of 12. Then enter the following statement into the HP-85 keyboard:

CLEAR 722 (End Line)

The instrument returns to the default conditions listed in Table 3-7.

3.4.6 GET (Group Execute Trigger)

The GET command is sent to the Model 835 to trigger the instrument. The GET command is only one of several methods that can be used to trigger readings. (More detailed information on all trigger modes, including GET is in paragraph 3.5.8.

To send the GET command over the bus, the following sequence must be performed on the controller:

1. Set ATN true.
2. Address the Model 835 to listen.
3. Place the GET command on the data.

GET can also be sent, without addressing, by omitting step 2.

Programming Example - Type in the following statement in the HP-85 keyboard:

REMOTE 722 (End Line)

Set the instrument in the one-shot on GET trigger mode with the following statement:

OUTPUT 722; "T3X" (End Line)

After the END LINE key is pressed, the instrument waits for a trigger.

The instrument may be triggered to take a single reading, with the following statement:

TRIGGER 722 (End Line)

After END LINE is pressed one reading is processed.

Note

Model 835 also responds to GET without addressing. This command is sent with the following HP-85 statement:

TRIGGER 7

The preceding examples use device-dependent commands to select instrument trigger modes. These commands are covered in detail in paragraph 3.5.

3.4.7 LLO (Local Lockout)

The Local Lockout Command is used to remove the instrument from local operating mode. After the unit executes LLO, all its front panel controls except POWER and those buttons which control the bar graph display will be inoperative. REN must be true for the instrument to respond to LLO. REN must be set false to cancel LLO.

To send the LLO command, the controller must perform the following steps:

1. Set ATN true.
2. Place the LLO command on the data bus

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Programming Example — The LLO command is sent by using the HP-85 statements:

REMOTE 7 (End Line)
LOCAL LOCKOUT 7 (End Line)

After the second statement is entered, the instrument's front panel controls, with the exception of POWER, ZOOM <|, |>, and OFFSET will be locked out.

To re-enable local operation, use the following statements:

LOCAL 7 (End Line)
REMOTE 722 (End Line)

3.4.8 SPE, SPD (Serial Polling)

The serial polling sequence requests and obtains the Model 835 status byte. Usually, the serial polling sequence is used to determine which of several devices has requested service over the SRQ line. (However, the serial polling sequence may be used at any time to obtain the status byte format, refer to paragraph 3.5.10.)

The serial polling sequence is conducted as follows:

1. The controller sets the ATN line true.
2. The SPE (Serial Poll Enable) command is sent on the bus by the controller.
3. The Model 835 is addressed to talk.
4. The controller sets ATN false.
5. The instrument then sets its status byte on the bus which is read by the controller.
6. The controller then sets the ATN line low and sends SPD (Serial Poll Disable) on the bus to end the serial polling sequence.

Steps 3 through 5 may be repeated for other instruments on the bus, by using the correct talk address for each instrument. (ATN must be true when the talk address is transmitted, and false when the status byte is read.)

Programming Example — The HP-85 SPOLL statement automatically performs the serial polling sequence. To demonstrate serial polling, momentarily power down the Model 835 and enter the following statements into the HP-85 keyboard.

REMOTE 722 (End Line)
S = SPOLL (722) (End Line)
DISP S (End Line)

After END LINE is pressed the second time, the computer performs the serial polling sequence. After the END LINE is pressed the last time, the status byte value is displayed on the CRT. (Paragraph 3.5.10 covers the status byte format in detail.)

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3.5 Device-Dependent Command Programming

IEEE device-dependent commands are sent to the Model 835 to control various operating modes such as attenuator, Log (dBm/dB), ratio/reference, relative, range, wavelength and data format. Each command is made up of an ASCII alpha character followed by one or more numbers designating specific parameters. For example, Log (dBm/dB) is programmed by sending an ASCII "D" followed by a zero or one (for turning it off or on). (The IEEE bus treats device-dependent commands as data since ATN is high when the commands are transmitted.)

A number of commands may be grouped together in one string. A command string is terminated by an ASCII "X" character, which tells the instrument to execute the command string.

If an illegal command or command parameter is present within a command string, the instrument will:

1. Ignore the entire command string.
2. Set appropriate error bits in the status byte.
3. Generate an SRQ if programmed to do so.

These programming aspects are covered in paragraph 3.5.10.

HP-85 examples are included throughout this section to clarify programming.

Note

Before performing a programming example, it is recommended that the instrument be set to its default values by sending an SDC over the bus. (For information on using the SDC command, refer to paragraph 3.4.5.)

If the HP-85 "hangs up" at any point, operation may be restored by holding the SHIFT key down and then pressing RESET on the keyboard.

In order to send a device-dependent command, the following sequence must be performed on the controller:

1. Set ATN true.
2. Address the Model 835 to listen.
3. Set ATN false.
4. Send the command string over the data bus, one byte at a time.

Programming Example — Device-dependent commands are sent by the HP-85 using the following statement:

OUTPUT 722;A$ (End Line)

A$ in this case contains the ASCII characters that form the command string.

Note

REN must be true when attempting to program the Model 835. If REN is false, the RMT annunciator is off.

Commands that affect the Model 835 are listed in Table 3-8. (All commands listed in Table 3-8 are covered in detail in following paragraphs.)

Note

Programming Examples that follow assume that the Model 835 primary address is 22 (factory setting).

3.5.1 Execute (X)

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Table 3-8. Device-Dependent Command Summary

Mode	Command	Description	
Attenuator	A0	Attenuator Off	
	A1	Attentuator On	
Zero Check	C0	Zero check Off	
	C1	Zero check On	
LOG (dBm/dB)	D0	LOG (dBm/dB) Off	
	D1	LOG (dBm/dB) On	
Ratio/Reference	F0	Ratio/Reference Off	
	F1	Ratio/Reference On	
Range		Sending Current	Reading Power
	R0	Auto	Auto
	R1	2 nA	2 nW
	R2	20 nA	20 nW
	R3	200 nA	200 nW
	R4	2 µA	2 µW
	R5	20 µA	20 µW
	R6	200 µA	200 µW
	R7	2 mA	2 mW
	R8	—	20 mW
	R9	—	200 mW
	R10	—	2 W
	R11	—	20 W
Null (Rel)	Z0	Null off	
	Z1	Null on	
Trigger	T0	Continuous on talk.	
	T1	One-shot on talk.	
	T2	Continuous on GET.	
	T3	One-shot on GET.	
	T4	Continuous on X.	
	T5	One-shot on X.	
EOI	K0	EOI enabled. (Transmit on last byte out.)	
	K1	EOI disabled.	
Status Word	U0	Output status word.	
Wavelength	U1	Output wavelength string	
SRQ Mode	Mnn	SRQ on error and/or data conditions.	
Data Format	G0	Readings with prefix.	
	G1	Readings without prefix.	
Digital Calibration	V± n.nnnn E±nn	n represents calibration value.	
Store	L0	Store current calibration constants and exit calibration.	
Terminator	Y(ASCII)	ASCII character.	
	Y(LF)	CR LF	
	Y(CR)	LF CR	
	Y(DEL)	None	
Execute	X	Execute other device-dependent commands.	

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The execute command is implemented by sending an ASCII "X" on the bus. It tells the Model 835 to execute other device-dependent commands. Generally, the "X" character is the last byte in the command string. The execute character also controls instrument operation in the T4 and T5 trigger modes (paragraph 3.5.8).

Note

Command strings sent without an execute character are not executed at that time; they are stored in command buffer. The next time an execute character is received, the stored commands are executed, if all previous string commands were valid.

Programming Example — Enter the following statement sequence in the HP-85 keyboard:

REMOTE 722 (End Line)
OUTPUT 722; "X" (End Line)

After the END LINE key is pressed the second time, the instrument receives the command. (No changes occur for this example because no other commands were given.)

3.5.2 Zero Check (C)

Zero check is controlled by sending one of the following commands on the bus:

C0 = Zero Check Off
C1 = Zero Check On

Once zero check is enabled (C1 sent), the display can be zeroed using the REL feature, or the front panel zero pot.

At power-up, or after the instrument receives a DCL or SDC command, the C0 mode is enabled.

Programming Example - Enter the following statements into the HP-85 Keyboard:

REMOTE 722 (End Line)
OUTPUT 722; "C1X" (End Line)

After the END LINE key is pressed the second time, zero check is enabled and indicated by the ZERO CHECK annuncia

3.5.3 Log - dBm/dB (D)

The Log function is controlled by sending one of the following commands over the bus:

D0 = Log (dBm/dB) OFF
D1 = Log (dBm/dB) ON

At power-up, or after the instrument receives a DCL or SDC command, the D0 mode is enabled.

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Programming Example - Enter the following statements into the HP-85 keyboard:

REMOTE 722 (End Line)
OUTPUT 722; "D1X"(End Line)

After the END LINE key is pressed the second time, the LOG (dBm/dB) function is enabled and indicated by the LOG annunica

3.5.4 Attenuator (A)

The attenuator function is controlled by sending one of the following commands over the bus :

A0 = Attenuator Off
A1 = Attenuator On

At power-up, or after the instrument receives a DCL or SDC command, the A0 mode is enabled.

Programming Example - Cycle power on the Model 835 and manually select the attenuator mode. Enter the following statements into the HP-85:

REMOTE 722 (End Line)
OUTPUT 722; "A1X" (End Line)

After the END LINE key is pressed the second time, attenuator function is enabled and indicated by the attenuator annuncia

3.5.5 Ratio/Reference (F)

The Ratio/Reference function is controlled by sending one of the following commands over the bus:

F0 = Ratio/Reference Mode Off
F1 = Ratio/Reference Mode On

At power-up, or after the instrument receives a DCL or SDC command, the F0 mode is enabled.

Programming Example - Cycle power on the Model 835 and manually select the ratio/reference mode. Enter the following statements into the HP-85:

REMOTE 722 (End Line)
OUTPUT 722; "FIX" (End Line)

After the END LINE key is pressed the second time, the ratio/reference function is enabled and indicated by the power an

3.5.6 Range (R)

Selection of the current ranges or autoranging are programmable using the bus. The full scale power range for any particular current range depends on the detector response, and is therefore wavelength dependent. The range commands are in Table 3-8.

After power-up, or after receiving a DCL or SDC, the range of the Model 835 changes its range to autoranging.

Programming Example - Cycle power on the Model 835 and manually select

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the 2mW range. Enter the following statements into the HP-85:

REMOTE 722(End Line)
OUTPUT 722; "R5X" (End Line)

After END LINE is pressed the second time, the instrument switches to the R5 current range (20 µA).

Note

The range set over the IEEE bus is the current range, not the power range. The power range for a given current range is determined by the detector response. For most detectors without attenuators, the current range is the same as the power range. However, when using attenuators, they may be three (3) or more orders of magnitude different. The difference is wavelength dependent.

To determine the power and current range correspondence, set range R7 (2mA), and read the status word (paragraph 3.5.15). Read bits 8 and 9 to determine the power range. The difference between the current range set and the power range read is the same for all ranges at a particular wavelength. For example, is the range R7 is set by executing and R7X command, and the range indicated in bits 8 and 9 of the status word contain 09, the 2 mA current trange corresponds to a 200 mW power range. Similarly, the 200 µA current range (R6) corresponds to the 20 mW power range (08). Note that the difference may be wavelength dependent.

3.5.7 Null (REL) (Z)

The Null (REL) modes is used for baseline suppression, as described in paragraph 2.7.7 of the Model 835 Operating Manual (Newport Part # 13767-01). When a correct Null On (Z1) command is executed, the input current is stored. The stored current is subtracted from subsequent readings, and the difference between the input and stored current is used to compute the optical power.

When Null Off (Z0) is executed, the stored current is cleared.

The Null mode is controlled by sending one of the following commands over the bus:

Z0 = Null Off
Z1 = Null On

After power-up, or after DCL or SDC, Z0 is selected.

Programming Example - With the front panel Null button, turn Null off, and enter the following statements into the HP-85 keyboard:

REMOTE 722 (End Line)
OUTPUT 722;"Z1X" (End Line)

After the END LINE key is pressed the second time, the REL annunciator turns on.

3.5.8 Triggering (T)

Triggering starts a reading conversion with the instrument. The Model 835 may be triggered in two basic ways: in a continuous mode, a single trigger command starts a continuous series of readings. In a one-shot trigger mode, a separate trigger is required to start each conversion.

The Model 835 has six trigger commands as follows:

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T0 Continuous On Talk
T1 One-Shot On Talk
T2 Continuous On GET
T3 One-Shot On GET
T4 Continuous On X
T5 One-Shot On X

After power-up, or after a DCL or SDC command, the T0 mode is enabled.

In the T0 and T1 modes, triggering occurs by addressing the Model 835 to talk, In the T2 and T3 modes, a GET command provides the trigger. In the T4 and T5 modes, the execute (X) character triggers the instrument.

Programming Example - Select the one-shot on talk mode with the following HP-85 statement sequence:

REMOTE 722 (End Line)
OUTPUT 722;"T1X" (End Line)

After the END LINE key is pressed the second time, the instrument is in the one-shot on talk trigger mode. The instrument is waiting for a trigger.

Trigger the instrument, with a talk command, by entering the following statement into the HP-85:

ENTER 722;A$ (End Line)

After pressing END LINE one reading is processed. To continue taking readings in this mode, one talk command must be sent for each conversion.

3.5.9 EOI (K)

The EOI line on the bus is usually set low by a device during the last byte of its data transfer sequence. This properly identifies the last byte, allowing variable length data words to be transmitted. The Model 835 normally sends EOI during the last byte of its data string or status word. The EOI response of the instrument is sent with one of the following commands:

KO sends EOI during last byte.
K1 sends no EOI.
At power-up, the KO mode is enabled.

Programming Example-Model 835 EOI response is suppressed with the following HP-85 statement sequence:

REMOTE 722 (END LINE)
OUTPUT 722;"K1X" (END LINE)

Note

The HP-85 does not normally rely on EOI to mark the last byte of data transfer. Some controllers, however, may require that EOI be present at the end of transmitting.

3.5.10 SRQ Mode (M) and Status Byte Format

The SRQ command controls which of a number of conditions within the Model 835 that cause the instrument to request service from the controller by generating an SRQ command. Once an SRQ is generated, the Model 835 status byte can be checked to determine if it was the Model 835 that requested service. (Other bits in the status byte may also be set depending on certain

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data or error conditions.)

The Model 835 can be programmed to generate an SRQ, if one or more of the following conditions exist:

1. A reading has been completed.
2. An overflow condition occurs.
3. A busy condition occurs.
4. An Illegal Device-Dependent Command Option (IDDCO) is received.
5. An Illegal Device-Dependent command (IDDC) is received.
6. The instrument is not in remote when a command is sent.

After power-up, or after a DCL or SDC command, SRQ is disabled.

SRQ MASK-To facilitate SRQ programming, the Model 835 uses an internal mask to generate an SRQ. When a particular mask bit is set, the Model 835 sends an SRQ when those conditions occur. Bits within the mask are controlled by sending the ASCII letter "M", followed by a decimal number to set the appropriate bits. The commands to set the various mask bits are listed in Table 3-9.

Table 3-9. SRQ Mask Commands

Command	Status Bits Set	Conditions to Generate SRQ
M0	None	Clears SRQ Data Mask
M1	B0	Reading Overflow
M8	B3	Reading Done
M9	B3, B0	Reading Done or Reading Overflow
M16	B4	Busy
M17	B4, B0	Busy or Reading Overflow
M24	B4, B3	Busy or Reading Done
M25	B4, B3, B0	Busy, Reading Done or Reading Overflow
M32	None	Clears SRQ Error Mask
M33	B5, B0	IDDCO
M34	B5, B1	IDDC
M35	B5, B1, B0	IDDC or IDDCO
M36	B5, B2	Not in Remote
M37	B5, B2, B0	Not in Remote or IDDCO
M38	B5, B2, B1	Not in Remote or IDDC
M39	B5, B2, B1, B0	Not in Remote, IDDC or IDDCO

Programming Example - Cycle power on the Model 835, program it for SRQ on IDDCO, and output the status word.

```
Program                    Comments
10 REMOTE 722              Set up for remote operation.
20 OUTPUT 722; "M33X"      Program for SRQ on IDDCO.
30 OUTPUT 722; "U0X"       Send status command. Section 3.5.15
40 ENTER 722; A$           Enter commands into computer.
50 DISP A$                 Display on CRT
60 END
```


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After entering the program, press the HP-85 run key. The U0 status word is displayed. The Me bytes (Figure 3-9) contain "01", indicating Model 835 is now programmed to SRQ on an IDDCO.

Status Byte Format-The status byte contains information relating to data and error conditions within the instrument. When a particular bit is set, certain conditions are present. The meanings of the various bits are listed in Table 3-10. Figure 3-7 shows the general format of the status byte, which is obtained by using the SPE and SPD polling sequence described in paragraph 3.4.8.

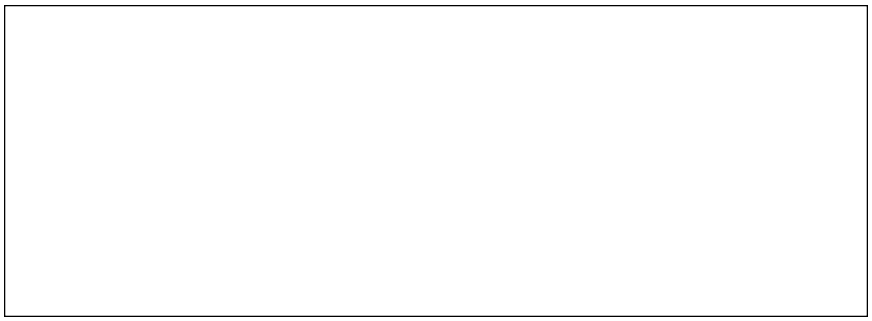


Figure 3-7. Status Byte Format

If the status byte is read when no SRQ was generated by the Model 835 (bit 6 is clear), the current status of the instrument is read. (For example, if a reading is done, bit 3 is set.)

When an SRQ is generated by the Model 835, bit 6 of the status byte is set. If the SRQ was caused by an error condition, bit 5 is also set along with one of the error condition bits (B0, B1 or B2). (Only the error that causes the initial SRQ will be defined by the status byte.)

If the SRQ was caused by a data condition, bit 5 is clear and the appropriate data condition bits (B0, B3 and B4) are set. If the busy condition caused the SRQ, then only the busy bit is set.

After an SRQ, the status byte remains unchanged until it is read.

The various bits in the status byte are described below:

1. Reading Overflow-Set when an overrange input is applied to the instrument.
2. Reading Done-Set when the instrument has completed the present conversion, and is ready to take another reading.
3. Busy-The instrument is still executing a prior command and is not yet ready to accept a new command.
4. IDDCO-An illegal command option such as R8 has been sent. This bit is cleared when the status byte is read.
5. IDDC-An illegal command sets this bit. For example, N1 is illegal since no such letter exists in the command set. The IDDC bit is cleared on a reading of the status byte.
6. Not in remote-Model 835 is in local mode of operation.

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Table 3-10. Status Byte and Mask Interpretation

Bit	Bit 5 = 0 (Data Conditions)	Bit 5 = 1 (Error Conditions)
0 (LSB)	Overflow	IDDCO
1	N/A	IDDC
2	N/A	No remote
3	Reading done	N/A
4	Busy	N/A
5	Data	Error
6	SRQ	SRQ
7	N/A	N/A

N/A = Bit ignored
Mnnn (nnn = 0 to 255, base 10)

Notes:

1. Once the Model 835 generates an SRQ, its status byte must be read to clear the SRQ line. (Otherwise, the instrument continuously sends SRQ.)
2. The Model 835 may be programmed to generate an SRQ for more than one condition simultaneously.

Programming Example - Enter the following program into the HP-85:

```
Program                          Comments
 10 REMOTE 722                   Set up for remote operation.
 20 OUTPUT 722; "M33X"           Program for SRQ on IDDCO.
 30 OUTPUT 722; "A20X"           Attempt to program illegal command option.
 40 S= SPOLL (722)               Perform serial poll.
 50 DISP "B7B6B5B4B3B2B1B0"
 60 FOR I= 7 TO 0 STEP-1         Loop eight times
 70 DISP BIT (S,I);
 80 NEXT 1
 90 DISP
100 END
```

Press the HP-85 RUN key. The computer conducts a serial poll and displays the status byte bits in order on the CRT. The SRQ (B6), error (B5), and IDDCO (B0) bits are set because line 30 of the program attempted to program the instrument with an illegal command option (R8).

3.5.11 Data Format

Model 835 data is transmitted over the bus as a string of ASCII characters, in the format shown in Figure 3-8. The first character indicates the function. The mantissa of the reading is made up of 7 characters, including sign and decimal point, while the exponent requires three characters. To obtain the data string from the instrument, the controller must perform the following sequence:

1. Set ATN low.
2. Address the instrument to talk.
3. Set ATN high.
4. Input the data string one byte at a time.

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NOTE

The data string can be sent without the prefix. For more information, refer to paragraph 3.5.12.

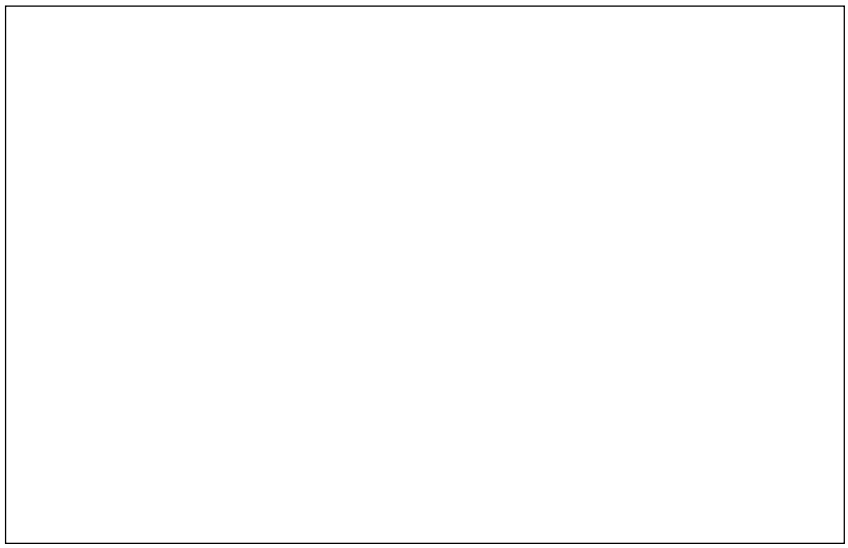


Figure 3-8. Data Format

output a data string.

Program	Comments
10 REMOTE 722	Set for remote operation.
20 ENTER 722;A$	Enter for command into computer.
30 DISP A$	Display on CRT
40 END	

Press the run key of the HP-85 and the data string is displayed.

3.5.12 Prefix (G)

At use of the G command, the prefix for the status word or data string can be either transmitted or deleted. The commands are as follows:

G0 = Include Prefix or Postfix.
G1 = Suppress Prefix or Postfix.

After power-up, or after a DCL or SDC command, the G0 mode is enabled.

Programming Example - Program the Model 835 to output a data string without the prefix or postfix.

Program	Comments
10 REMOTE 722	Set for remote operation.
20 OUTPUT 722; "G1X"	Send prefix command.
30 ENTER 722; A$	Enter command into computer.
40 DISP A$	Display on CRT.
50 END	

Press the HP-85 run key. The data string is displayed without the prefix.

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3.5.13 Programmable Terminator (Y)

The Model 835 uses special terminator characters to mark the end of its data string or status word. To allow a wide variety of controllers to be used, the terminator can be changed by sending the appropriate command over the bus. The default value is the commonly used carriage return, line feed (CR LF) sequence. The terminator sequence will assume this default value at power-up, or after the instrument receives a DCL or SDC.

The terminator may be programmed by sending the ASCII character Y, followed by the desired character. Any ASCII character except one of the following may be used:

1. Any capital letter.
2. Any number.
3. Blank
4. + - / , . or e

Special command characters program the instrument for special terminator sequences as follows:

1. Y(LF) = CR LF (Two terminators - Power Default)
2. Y(CR) = LF CR (Two terminators)
3. Y(DEL)= No terminator

Note

Most controllers use the CR or LF character to terminate their input sequence. (Using a nonstandard terminator may cause the controller to hang up unless special programming is used.)

Programming Example-The terminator can be eliminated by sending an ASCII DEL with the following HP-85 statements:

```
REMOTE 722 (END LINE)
OUTPUT 722;"Y";CHR$(127);"X"(END LINE)
```

When END LINE is pressed the second time, the terminator is suppressed; no terminator will be sent by the instrument when data is requested. The absence of the normal terminator may be verified by entering the following statement into the HP-85 keyboard.

```
ENTER 722;A$ (END LINE)
```

At this point, the HP-85 ceases to operate, because it is waiting for the standard CR LF terminator sequence to terminate the ENTER statement. The computer may be reset by holding down the SHIFT key and pressing RESET on the keyboard. To return the instrument to the normal terminator sequence, enter the following statement into the HP-85:

```
OUTPUT 722;"Y";CHR$(10);"X" (END LINE)
```

3.5.14 Setting The Wavelength (W)

The calibration wavelength of the Model 835 can be set by sending the following over the bus:

W+nnnn

Where nnnn is the wavelength in nm to be set. The wavelength sent is rounded to the nearest 10nm increment. (For example, an input of W+1234 is rounded to 1230.)

Programming Example - Cycle power on the Model 835 and manually set

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600 nm wavelength. If the detector is not calibrated for 600 nm, select any wavelength for which the detector is calibrated. Enter the following statements into the HP-85:

REMOTE 722 (END LINE)
OUTPUT 722; "W+950X" (END LINE)

After END LINE is pressed the second time, the wavelength annunciator indicates 950 nm and the appropriate calibration for 950 nm will be used.

Note

If the detector is not calibrated for 950 nm, the detector (or attenuator) serial number will be displayed, and the wavelength annunciator turns off. Use this to obtain the detector/attenuator serial numbers.

3.5.15 Status Word (U0)

The status word commands allow access to information concerning present operating modes of the instrument. When the status word command is given, the Model 835 transmits status information - instead of its normal data string the next time it is addressed to talk. Model 835 status word command is:

U0 = Send instrument status on operating modes such as range, LOG, etc.

The general format for the U0 command is shown in Figure 3-9. The letters in the U0 format correspond to other device-dependent commands, such as RANGE (R), LOG (D), etc.

Notes:

1. Status word information is returned only once each time the command is sent. Once status is read, the instrument sends its normal data string the next time it is addressed to talk.
2. The returned terminator character (Y) is derived by ANDing the byte with 00001111, and ORing the result with 00110000. For example, the last byte in the normal (CR LF) terminator sequence is a LF or ASCII 10 (00001010). ANDing with 00001111 yields 00001010. ORing with 00110000 results in 00111010, which is printed out as an ASCII colon (:).
3. The status word should not be confused with the status byte. The status word contains a number of bytes pertaining to the various operating modes of the instrument. The status byte is a single byte that is read with the SPE, SPD, command sequence and contains informaiton on SRQ status and error and data conditions.
4. The returned SRQ mode (M) value is determined, by adding up the values of the bit positions in the status byte that could cause an SRQ, according to the previously programmed value of th SRQ mode. For complete information on the SRQ mask and status byte, refer to paragraph 3.5.10.

Programming Example - Enter the program below into the HP-85. Be sure to include line numbers.

Program	Comments
10 REMOTE 722	Set up instrument for remote operation.
20 OUTPUT 722; "U0X"	Send U0 status command.
30 ENTER 722; A$	Enter status word into computer.
40 DISP A$	Display on CRT.
50 END	

After entering the program, press the HP-85 RUN key. The U0 status word is

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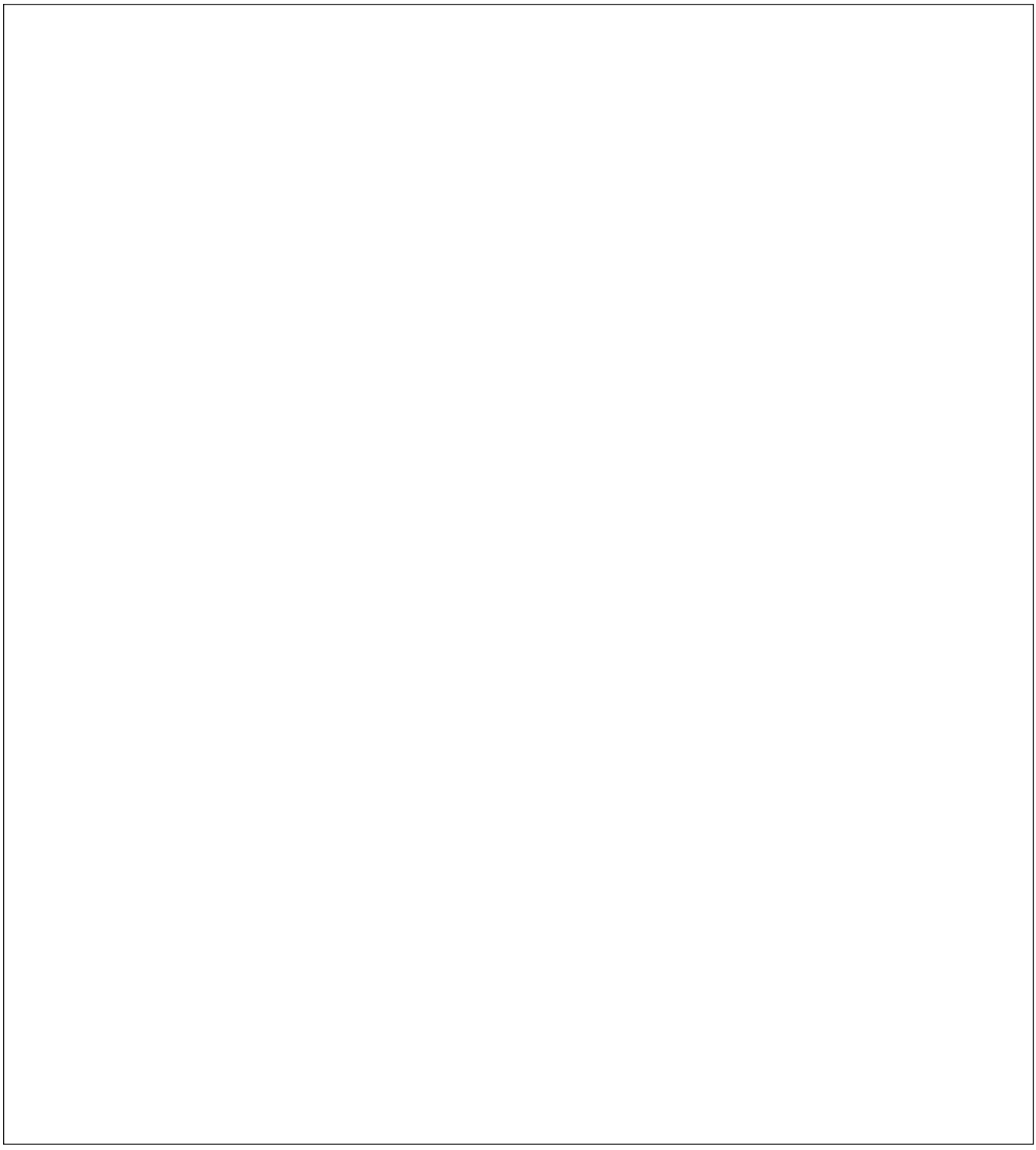


Figure 3-9. General Format U0 Command

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then displayed on the CRT.

3.5.16 Wavelength (U1)

The wavelength reading function is controlled by sending the following command over the bus.

U1 = Read Wavelength

Wavelength information is in an alternate output string on talk. The wavelength (WAVE1000) string is in the form of WAVEnnnn where: nnnn represents the wavelength.

The returned wavelength setting is in 10nm increments over the calibration range of the detector/attenuator.

The U1 wavelength transmission is automatically disabled when the normal STATUS WORD (U0) is commanded (paragraph 3.5.15).

Programming Example - To display the wavelength, enter the program below into the HP-85. Be sure to include line numbers.

Program	Comments
10 REMOTE 722	Set up instrument for remote operation.
20 OUTPUT 722; "U1X"	Send U1 wavelength command.
30 ENTER 722; A$	Enter wavelength word into computer.
40 DISP A$	Display on CRT.
50 END	

After entering the program press the HP-85 RUN key. The U1 status word is then displayed on the CRT.

3.5.17 Serial Numbers Detector and Attenuator

Serial numbers of the detector or attenuator are returned after a "U1" command if the wavelength set is outside of the calibration range. For setting the wavelength outside calibration limits, refer to paragraph 3.5.14.

If the Attenuator mode is On when U1 is executed, the attenuator serial number will be returned. Attenuator serial number is in the form:

SAT#nnnnn (nnnnn = 00001 to 09999)

If the Attenuator mode is Off when U1 is executed, the detector serial number is returned in the form:

SPR#nnnnn (nnnnn = 00001 to 09999)

Programming Example - To read the detector serial number, attenuator off

Programming	Comments
10 REMOTE 722	Set up instrument for remote operation
20 OUTPUT 722 ; "A0XW+9000X"	Attenuator off. Set wavelength out of bounds
30 ENTER 722 ; A$	Take reading
40 DISP A$	Wavelength is out of bounds, so S/N is displayed
50 END	

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3.6 Talker Only Operation

The talker only mode may be used to send data to a listen only device such as a printer. When the Model 835 is in the talker only mode, it ignores commands given over the bus. The talker only mode is enabled by placing the TO/ADDRESSABLE switch in the TO position (Figure 3-6).

NOTE

The status of the TO/ADDRESSABLE switch is read-only at power-up. If the switch position is changed, the instrument must be momentarily powered down before it recognizes the new switch condition. Sending commands to the instrument when it is in the talker only mode may cause the controller to hang up.

When the Model 835 is used in the talker only mode, it may be interfaced with one or more listeners. Each of these devices and associated cabling should conform to IEEE-488(1978 Standards).

The Model 835 transmits its normal data string in bit-parallel byte-serial fashion over the bus as requested by the listeners. (The data format is the same one used for addressable operation and is described in detail in paragraph 3.5.11.) If the address switches are set to an odd number the prefix is sent with the reading. An even address number sends only the data.

Every reading taken by the Model 835 will be send over the interface, or about 5 to 6 readings per second. The listener must accept data at a high enough rate or some characters of the transmitted data may not be received.

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Section 4
Theory of Operation

4.1 Introduction

This section contains the basic circuit description of the Model 835. The IEEE-488 interface option enables the Model 835 to be used in a measurement system with programm control through the IEEE-488 bus. Explanation of the complicated software is beyond the scope of this section.

4.2 Circuit Description

The entire IEEE-488 interface circuitry is located on a single PCB. The heart of the IEEE option is the General Purpose Interface Bus Adapter (U104) and the microprocessor (U101). The GPIBA is capable of performing all IEEE Talker-Listener protocols. The bidirectional data lines DO through D7 permit the transfer of data between the microprocessor and the GPIBA. The transceiver U105 and U107 are used to drive the output. Data is buffered by U105 and U107 and is transmitted to the bus via connector J1007.

The primary address switches (SW101) select the primary address, and permit selection of 31 primary Talker/Listener address pairs. To address the Model 835 the controller must send the primary address of the Model 835. The factory set primary address of the Model 835 is 22 (10110). The microprocessor reads the primary address from S101 and then knows which Talker/Listener address to assign the GPIBA (U104) and thus the Model 835.

Note

The primary address is updated only at power up.

This function is accessed with the address switch enable (AS) signal. The AS signal is derived from the microprocessor (U101) and enables the three state latch U103. Enabling U103 places the address on the data bus (DO-D4 and D7).

The opto-isolators (U109 and U111) isolate the Model 835 from earth ground, which is available from the controller (or one of the instruments on the IEEE bus).

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Section 5
Maintenance

5.1 Introduction

This secton contains information necessary to maintain the Model 835 Interface. Installation procedures, troubleshooting information and instructions concerning care in handling static sensitive devices is included. All service information is intended for qualified electronic maintenance personnel only.

5.2 Installation

The Model 835 Interface is field installable. To install the Model 835 Interface into a Model 835, perform the following procedures and see Fig. 6-1.

WARNING

Installation of the Model 835 Interface should only be performed by qualified electronic maintenance personnel. To prevent a shock hazard, unplug the line cord, and all test leads, from the instrument before removing the top cover.

1. Remove and retain the top cover, rear panel and power cord. (The top cover is secured by four screws accessible from the bottom of the instrument.)
2. Install the rear standoff by positioning it over the hole in the PC board, as shown in Figure 6-1; and pressing firmly until it snaps securely into the board.
3. Install the cable clamp so that there is no slack in the display cable under the IEEE board. The display cable must not touch the IEEE board.
4. Position the Model 835 Interface loosely on the rear standoff.

WARNING

Do not push down on plug P1008, (on the left side as viwed from the front) of the PC board. The male connector pins will pass through jack P1008 and may cause personal injury.

5. Guide the long pins of P1008 into J1008, then carefully and firmly push down on that end of the board to mate the connectors.
6. Carefully push down on the other side of the IEEE board, until it snaps onto the rear standoff. Make sure the board is seated securely and properly on the front stand off.
7. Install modified back panel with cutout for IEEE connector, and connect power cord connector onto PC board.
8. Install the modified top cover.

WARNING

If the Model 835 Interface is subsequently removed, use the original rear panel supplied with the Model 835 (if available). If the modified rear panel is used, cover the holes normally occupied by the IEEE connector and switch. Failure to cover these holes could result in a shock hazard that can cause severe injury or death.

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5.5 Special Handling of Static Sensitive Devices

CMOS devices function at high impedance levels. Normal static charge can destroy these devices. All the static sensitive devices for the Model 835 Interface are listed in Table 5-1. Following steps 1 through 7 provide instructions on how to avoid damaging these devices.

1. Handle and transport the devices in protective containers, antistatic tubes or conductive foam.
2. Use a properly grounded work bench, and a grounding wriststrap.
3. Handle device by the body only.
4. While inserting devices, PC boards must be grounded to bench.
5. Use antistatic solder suckers.
6. Use grounded tip soldering irons.
7. After devices are soldered or inserted into sockets they are protected, and normal handling can resume.

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Section 6
Service

6.1 duction

This section contains information about servicing the Model 835-IEEE Interface, and component location drawings. The Model 835-IEEE Interface is designed to be serviced by replacing the PC board, rear panel and power cord. This method eliminates the need for the user to return the entire unit to the factory for repair. In some instances, however, field repair may be more appropriate. Contact Newport Corporation or your newport representative for assistance.

6.2 Factory Service

To obtain information concerning factory service, contact the factory or your Newport representative. Please have the following information available:

1. Instrument Model Number
2. Instrument Serial Number
3. Detector Serial Number and, if available, calibration date.
4. Attenuator Serial Number and, if available, calibration date.
5. Description of problem.

When returning the instrument to Newport, please complete the service form which follows this section and return it with the instrument, circuit board or parts.

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Figure 6-1. Model 835-IEEE Interface Installation

Figure 6-2. Model 835-IEEE Component Location Drawing

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SERVICE FORM

Model No. _____ Serial No. _____ P.O. No. _____ Date _____

Name _____

Company _____

Address _____

City _____ State _____ Zip _____

Country _____

List all control settings and describe problem. _____

_____

_____

_____ (Attach additional sheets as necessary.)

Show a block diagram of your measurement system including all instruments connected (whether power is turned on or not). Also describe signal source.

Where is the measurement being performed? (factory, controlled laboratory, out-of-doors, etc.)_____

_____

What power line voltage is used? _____ Variation? _____

Frequency? _____ Ambient Temperature? _____

Variation? _ °F. Rel. Humidity? _____ Other? _____

Any additional information. (If special modifications have been made by the user, please describe below.)

_____

_____

*Be sure to include your name and phone number on this service form.

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