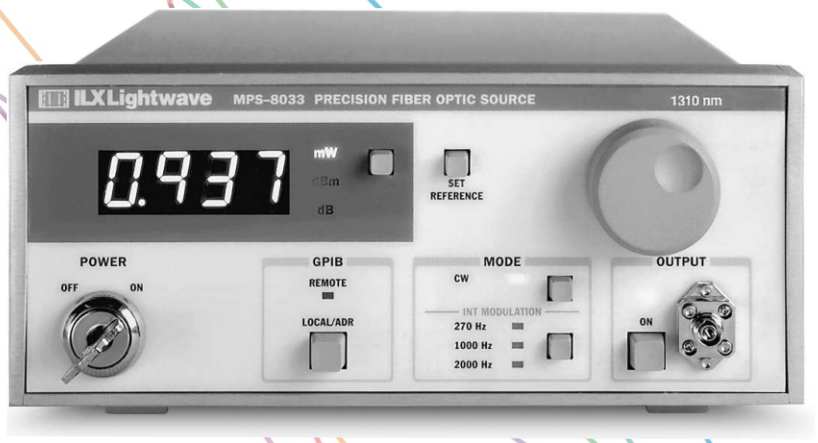
User's Guide

Precision Fiber Optic Sources
MPS-8033 Series



ILX Lightwave
Photonic Test & Measurement Instrumentation

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TABLE OF CONTENTS

Chapter 2 Local Operation

Chapter 3 Remote Operation

Chapter 4 Command Reference

Chapter 5 Maintenance

Chapter 6 Troubleshooting

Appendix A Error Messages

Appendix B Quick Start Guide

Appendix C GPIB System Controller Configuration

List of Figures

LIST OF TABLES

SAFETY AND WARRANTY INFORMATION

The Safety and Warranty Information section provides details about cautionary symbols used in the manual, safety markings used on the instrument, and information about the Warranty including Customer Service contact information.

Safety Information and the Manual

Throughout this manual, you will see the words *Caution* and *Warning* indicating potentially dangerous or hazardous situations which, if not avoided, could result in death, serious or minor injury, or damage to the product. Specifically:

CAUTION

Caution indicates a potentially hazardous situation which can result in minor or moderate injury or damage to the product or equipment.

WARNING

Warning indicates a potentially dangerous situation which can result in serious injury or death.

WARNING

Visible and/or invisible laser radiation. Avoid direct exposure to the beam.

These symbols are similar to the safety marking symbols described on page xii, and are used in conjunction with the safety symbols that appear on the instrument. See page xii for a complete description of these safety symbols.

General Safety Considerations

If any of the following conditions exist, or are even suspected, do not use the instrument until safe operation can be verified by trained service personnel:

- Visible damage
- Severe transport stress
- Prolonged storage under adverse conditions
- Failure to perform intended measurements or functions

If necessary, return the instrument to ILX Lightwave, or authorized local ILX Lightwave distributor, for service or repair to ensure that safety features are maintained (see the contact information on page xiv).

All instruments returned to ILX Lightwave are required to have a Return Authorization Number assigned by an official representative of ILX Lightwave Corporation. See Returning an Instrument on page xiii for more information.

SAFETY SYMBOLS

This section describes the safety symbols and classifications.

Technical specifications including electrical ratings and weight are included within the manual. See the Table of Contents to locate the specifications and other product information. The following classifications are standard across all ILX Lightwave products:

- Indoor use only
- Ordinary Protection: This product is NOT protected against the harmful ingress of moisture.
- Class I Equipment (grounded type)
- Mains supply voltage fluctuations are not to exceed ±10% of the nominal supply voltage.
- Pollution Degree II
- Installation (overvoltage) Category II for transient overvoltages
- Maximum Relative Humidity: <80% RH, non-condensing
- Operating temperature range of 0 °C to 40 °C
- Storage and transportation temperature of –40 °C to 70 °C
- Maximum altitude: 3000 m (9843 ft)
- This equipment is suitable for continuous operation.

Safety Marking Symbols

This section provides a description of the safety marking symbols that appear on the instrument. These symbols provide information about potentially dangerous situations which can result in death, injury, or damage to the instrument and other components.

 Caution, refer to manual	 Earth ground Terminal	 Alternating current	 Visible and/or invisible laser radiation
 Caution, risk of electric shock	 Protective Conductor Terminal	 Caution, hot surface	 Frame or chassis Terminal
 or (I) On: In position of a bistable push control. The slash (I) only denotes that mains are on.		 or (O) Off: Out position of a bistable push control. The circle (O) only denotes that mains are off.	

WARRANTY

ILX LIGHTWAVE CORPORATION warrants this instrument to be free from defects in material and workmanship for a period of one year from date of shipment. During the warranty period, ILX will repair or replace the unit, at our option, without charge.

Limitations

This warranty does not apply to fuses, lamps, defects caused by abuse, modifications, or to use of the product for which it was not intended**.**

This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability or fitness for any particular purpose. ILX Lightwave Corporation shall not be liable for any incidental, special, or consequential damages**.**

If a problem occurs, please contact ILX Lightwave Corporation with the instrument's serial number, and thoroughly describe the nature of the problem.

Returning an Instrument

If an instrument is to be shipped to ILX Lightwave for repair or service, be sure to:

1. Obtain a Return Authorization number (RA) from ILX Customer Service.
2. Attach a tag to the instrument identifying the owner and indicating the required service or repair. Include the instrument serial number from the rear panel of the instrument.
3. Attach the anti-static protective caps that were shipped with the instrument and place the instrument in a protective anti-static bag.
4. Place the instrument in the original packing container with at least 3 inches (7.5 cm) of compressible packaging material. **Shipping damage is not covered by this warranty.**
5. Secure the packing box with fiber reinforced strapping tape or metal bands.
6. Send the instrument, transportation pre-paid, to ILX Lightwave. Clearly write the return authorization number on the outside of the box and on the shipping paperwork. ILX Lightwave recommends you insure the shipment.

If the original shipping container is not available, place your instrument in a container with at least 3 inches (7.5 cm) of compressible packaging material on all sides.

Repairs are made and the instrument returned transportation pre-paid. Repairs are warranted for the remainder of the original warranty or for 90 days, whichever is greater.

Claims for Shipping Damage

When you receive the instrument, inspect it immediately for any damage or shortages on the packing list. If the instrument is damaged, file a claim with the carrier. The factory will supply you with a quotation for estimated costs of repair. You must negotiate and settle with the carrier for the amount of damage.

Comments, Suggestions, and Problems

To ensure that you get the most out of your ILX Lightwave product, we ask that you direct any product operation or service related questions or comments to ILX Lightwave Customer Support. You may contact us in whatever way is most convenient:

Phone . . . . . (800) 459-9459 or (406) 586-1244

Fax . . . . . (406) 586-9405

Email. . . . . support@ilxlightwave.com

Or mail to:

ILX Lightwave Corporation
P. O. Box 6310
Bozeman, Montana, U.S.A 59771
www.ilxlightwave.com

When you contact us, please have the following information:

Model Number: _____

Serial Number: _____

End-user Name: _____

Company: _____

Phone: _____

Fax: _____

Description or sketch of what is connected to the ILX Lightwave instrument: _____

Description of the problem: _____

If ILX Lightwave determines that a return to the factory is necessary, you are issued a Return Authorization (RA) number. Please mark this number on the outside of the shipping box.

You or your shipping service are responsible for any shipping damage when returning the instrument to ILX Lightwave; ILX recommends you insure the shipment. If the original shipping container is not available, place your instrument in a container with at least 3 inches (7.5 cm) of compressible packaging material on all sides.

We look forward to serving you even better in the future!

CHAPTER 1

INTRODUCTION AND SPECIFICATIONS

This manual contains operation and maintenance information for the MPS-8033 Precision Fiber Optic Source with laser options 01-06, Cx and Lx WDM telecommunications wavelength band options, the MPS-8033/55 and MPS-8033/65 Broadband ASE sources and Model 1231 GPIB Interface. If you want to get started immediately, read Appendix B, Quick Start, first. Appendix B, Quick Start Guide contains a section for quick familiarization of the 8033 front panel as well as detailed operation reference.

Product Overview

This section provides an overview of the MPS-8033 Precision Fiber Optic Sources and the MPS-8033 ASE Broadband Fiber Optic Sources.

MPS-8033 Precision Fiber Optic Sources

Model MPS-8033/01-06, MPS-8033/C1 or C2, and MPS-8033/L1 or L2 series fiber optic sources are micro-processor controlled laser diode sources that provide up to 20 mW of power at user specified wavelengths including DFB lasers in the WDM C-Band and L-Band wavelengths plus 850, 980, 1310, 1480, and 1550 nm Fabry Perot lasers. These sources are well suited for exacting laboratory and production automated test and measurement applications. These include active and passive component testing for high-precision IL and ORL measurements, environmental testing, and power meter and detector calibration. Instrument features include user adjustable light power output and internal modulation frequencies selected via front panel or remotely. High output stability for all options is achieved by using ILX Lightwave's proven laser diode current and temperature control technology. Each MPS-8033 comes with a standard GPIB interface and to close the loop with other lab measurement instruments, the instrument provides a TTL compatible trigger which is synchronized with the output of the internally modulated signal.

MPS-8033 Broadband 1550 nm ASE Fiber Optic Sources

The MPS-8033/55, and /65 Broadband 1550 nm ASE Sources are highly stabilized, wide spectral width, fiber-optic sources with output centered in the 1550 telecommunications band. When used in conjunction with an optical spectrum analyzer, the 8033/55 (/65) can be used for rapid, wide dynamic range spectral characterization of fiber-optic components such as filters, WDM couplers, and fiber Bragg gratings. These broadband sources are based on amplified spontaneous emission from an Erbium-doped fiber which is pumped with a 980 nm laser diode. The instrument's

broadband output is centered at 1550nm and spread over a 40 nm spectral width. High output stability is achieved by using ILX Lightwave's proven laser diode current and temperature control technology. Due to the nature of the light source, the output is intrinsically unpolarized. Select the MPS-8033/55 for 10 mW of broadband output power, or the MPS-8033/65 for 20 mW. See typical output spectrums (resolution @ 1nm) in Figure 1.1.

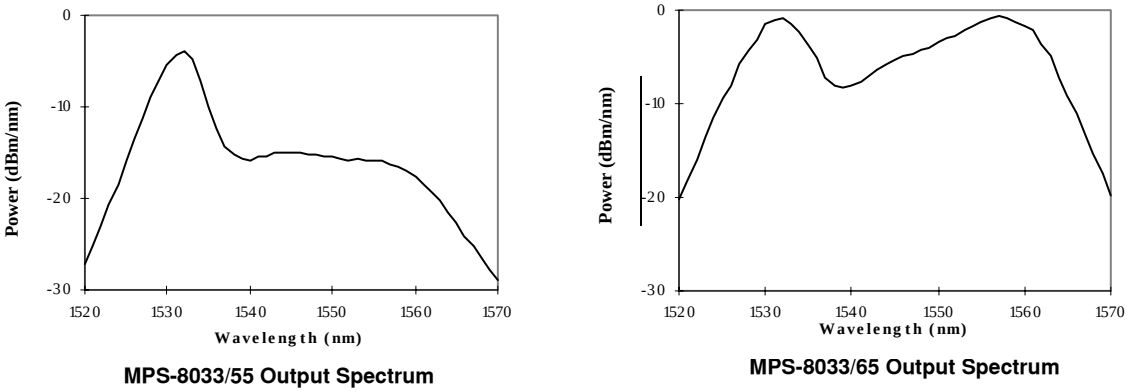


Figure 1.1 MPS-8033/55 and 65 Output Spectrums

Safety Considerations

This is a Class 1 Laser Product. Safety considerations are provided throughout this manual. These must be complied with to ensure safe operation of the MPS-8033. Please read the warnings and cautions provided before operating the 8033.

WARNING

Laser Radiation is not visible to the human eye, but can seriously damage eyesight. Never look into the end of an optical cable attached to the optical output when the source is operational. Refer Servicing to only to qualified, authorized personnel.

Available Options and Accessories

Options and accessories for the MPS-8033 sources include:

Table 1.1 Available Options

Options	**Description**
/01	1310 nm Fabry-Perot, 1 mW laser option
/02	1550 nm Fabry-Perot, 1 mW laser option
/03	1550 nm DFB w/optical isolator, 1 mW laser option
/04	980 nm Fabry-Perot , 1 mW laser option
/05	1480 nm Fabry-Perot, 1 mW laser option
/06	850 nm Fabry-Perot, multi-mode 1 mW laser option
/C1	C-Band 1527.98–1564.26 nm DFB laser option, 10 mW
/C2	C-Band 1527.98–1564.26 nm DFB laser option, 20 mW
/L1	L-Band 1564.26–1610.06 nm DFB laser option, 10 mW
/L2	L-Band 1564.26–1610.06 nm DFB laser option, 20 mW
/55	1550 nm ASE source option, 10 mW
/65	1550 nm ASE source option, 20 mW

Table 1.2 Accessories

Accessories	**Description**
RM124	**Single rack mount kit**
RM122	**Dual rack mount kit**

MPS-8033 Precision Source Specifications

OUTPUT	
Wavelength:	Dependent on Option (see Available Options and Accessories on page 3)
Wavelength Accuracy[1]: Options /Cx and /Lx Options /01 through /06	 ±0.1 nm ±20 nm
Output Power:	Dependent on Option (see Available Options and Accessories on page 3)
Power Stability (15 min)[2]:	±0.005 dB
Power Stability (24 hour)[3]:	±0.030 dB
Thermal Stability[4]:	0.2 dB
Optical Connector:	FC/APC
Fiber Type[5]:	SMF
MODULATION	
Type:	Internal, digital
Frequency:	270 Hz, 1 kHz, 2 kHz (front panel selectable) 160 Hz–15 kHz (GPIB selectable only)
Frequency Accuracy:	±0.01%
Duty Cycle:	50±2%
Edge Jitter:	0.01%

1. Standard for options /01 through /06, can specify tighter tolerance.
2. Temperature is constant (±0.1 °C) after one hour warm-up with output on.
3. Temperature is constant (±1.0 °C) after one hour warm-up with output on.
4. Over entire operating temperature range (0 °C to + 50 °C).
5. Option /06 (850 nm) is multi-mode.

MPS-8033 Broadband Source Specifications

OUTPUT	
Center Wavelength:	1550 nm
Wavelength Accuracy[1]:	±20 nm
Spectral Width[1]:	45 nm ±5 nm
Output Power: /55 option: /65 option:	 10 mW (10 dBm) 20 mW (13 dBm)
Output Polarization:	Unpolarized
Output Isolation:	>30 dB
Power Stability (15 min)[2]:	±0.010 dB
Power Stability (12 hour)[2]:	±0.030 dB
Optical Connector:	FC/APC
Fiber Type:	SMF

1. At -10 dBm
2. Temperature is constant (±2.0 °C) after two hour warm-up with output on.

General MPS-8033 Series Specifications

TRIGGER OUTPUT	
Type:	TTL
Jitter:	5 nS
Connector:	BNC
DISPLAY	
Linear Scale:	0.001 to 20.00 mW
Log Scale:	-20.0 to +13 dBm
GENERAL	
Line Voltage:	90 to 105 VAC 105 to 125 VAC 210 to 230 VAC 220 to 250 VAC
Operating Temperature:	0 °C to 50 °C
Humidity:	<90% relative humidity, non-condensing
Storage Temperature:	-40 °C to +70 °C
Warm Up:	1 hour
Weight:	<4.7 kg (10.3 lbs); DFB and FP sources <5 kg (10.5 lbs); ASE broadband sources
Size (HxWxD):	3.5 in x 8.4 in x 10.6 in 88 mm x 212 mm x 269 mm
Remote Interface:	GPIB (Standard)

CHAPTER 2

LOCAL OPERATION

This chapter describes how to install, adjust, and operate the MPS-8033 series fiber optic sources. It is divided into five sections covering installation, power-up, front panel and rear panel controls, and general operation.

A quick familiarization of the 8033's front panel features is presented on page 9. Appendix B, Appendix, Quick Start Guide on page 87, is intended for users who wish to begin operation immediately. It contains the minimum information required to safely operate the 8033.

Installation

This section provides installation procedures including safety considerations and power requirements.

Safety Considerations

The following warnings must be observed whenever the MPS-8033 is in operation. Failing to comply with these precautions could result in severe injury or death! These warnings also apply to the service and repair of the instrument. The MPS-8033 is a Class 1 Laser Product.

WARNING

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Do not enable the laser when there is no fiber attached to the optical output connector.

The optical output connector is at the bottom right on the MPS-8033 front panel. The laser is enabled by pressing the OUTPUT ON switch to the left of the optical output connector. The laser is on when the green LED indicator above the switch is solidly lit.

Never look into the end of a fiber optic cable attached to the optical output of the MPS-8033 when the device is operational.

The laser radiation is not visible to the human eye, but can seriously damage eyesight.

AC Power Considerations

The 8033 can be configured to operate at nominal line voltages of 100, 120, 220, or 240 VAC. Normally, this configuration is done at the factory and need not be changed before operating the instrument. Check to be sure that the voltage printed on the back panel of the instrument matches the power-line voltage in your area. Refer to Chapter 5, Maintenance, if it is necessary to reconfigure the input AC voltage range.

WARNING

To avoid electrical shock hazard, connect the instrument to a properly earth grounded, three prong receptacle only. Failure to observe this precaution can result in severe injury or death.

Tilt-Foot Adjustment

The MPS-8033 has front legs that extend to make it easier to view the display. Place the 8033 on a stable base and rotate the legs downward until they lock into position.

Rack Mounting

The MPS-8033 may be rack mounted by installing a rack mount flange on each side of the enclosure. The rack mount accessory kits contain detailed mounting instructions. Refer to Table 1.2 on page 3 for applicable rack mount accessory part numbers.

Power-Up Sequence

Connect the MPS-8033 to an AC power source. Turn the KEYLOCK switch clockwise to the **ON** position to supply power to the instrument and start the power up sequence.

The power-up sequence takes about six seconds. Initially, all LEDs illuminate and the seven-segment display denotes "8888". Then, all LEDs and the display are extinguished while the microprocessor executes a device self-test. If the self test fails, error message E720 is displayed. Refer to Appendix A for an explanation of error messages.

Table 2.1 8033 Default Settings

OUTPUT:	Off
MODE:	CW
DISPLAY:	Setpoint Power in mW
POWER (8033/0x):	1.000 mW
POWER (8033/C1/L1/55):	10.00 mW
POWER (8033/C2/L2/65):	20.00 mW
GPIB:	LOCAL (REMOTE if the *RST command was sent)
STEP:	.001 mW (GPIB only)

Introduction to the MPS-8033 Front Panel

The MPS-8033 front panel contains LED displays, switches, and a knob for control of the laser output. Each of the labeled areas on the front panel (i.e. GPIB, MODE, or OUTPUT) and the display and adjustment sections of the front panel, are described in a separate subsection in this chapter. The controls are designed to be intuitive and simple to operate.

Front Panel Familiarization

Refer to Figure 2.1 for the following discussions of the 8033 front panel sections. The key words are in bold type for easy identification.

General Functions

The **POWER KEYLOCK** switch is used to supply AC Power to the MPS-8033.

The **ADJUST KNOB** is used for entering values such as the output power, calibration values or setting the GPIB address.

To the left of the adjust knob are the display switches**.** The DISPLAY MODE switch changes the display units between: 1) linear (milliwatts), 2) log relative to one mW (dBm) and, 3) relative log (dB) scales. The **SET REFERENCE** switch establishes the power reference for the dB scale and it also changes the display units to dB.

At power-up, the 8033 will be configured to the same state that was present at the last power-down.

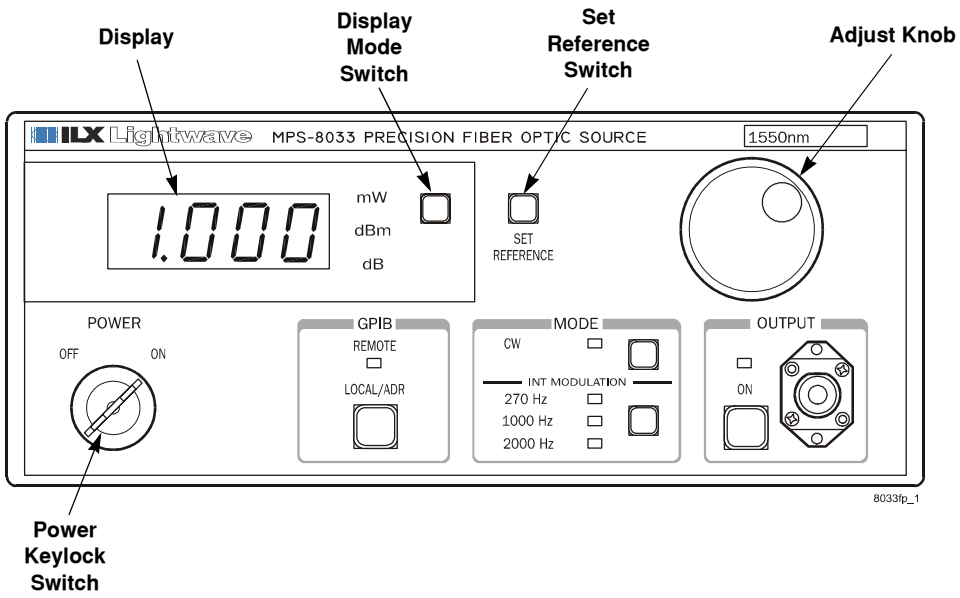


Figure 2.1 8033 Front Panel

MODE Section

When the **CW** switch is pressed the CW LED illuminates indicating the internal modulation function is disabled and a continuous wave output is enabled.

The first execution of the **INT MODULATION** switch will return the modulation to the last selected modulation frequency. Subsequent executions of the **INT MODULATION** switch will sequentially select between modulation frequencies.

The MODE switches select between either continuous wave or internally modulated optical outputs. The internally modulated output is a square wave pulse with a 50% duty cycle at one of three frequencies; 270, 1000, and 2000 Hertz.

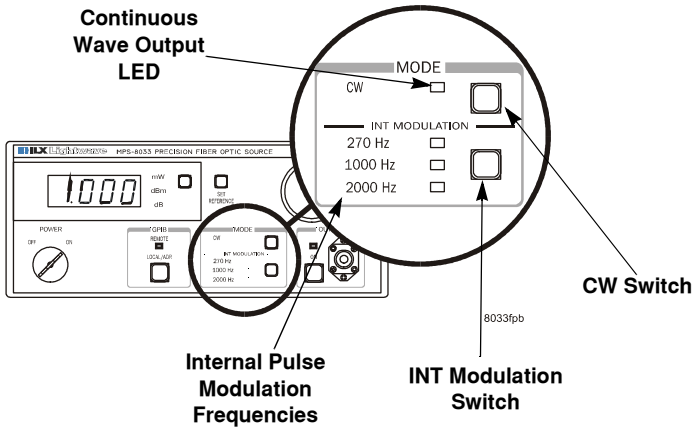


Figure 2.2 Mode Section

MODE SELECT

The **CW** switch is used to select Continuous Wave operation. When **CW** mode is selected, the corresponding LED becomes lit and all modulation is disabled.

To switch from CW to pulse modulation, the **INT MODULATION** switch must be pressed. The first execution of the **INT MODULATION** switch will return modulation to the last selected frequency. Subsequent executions of the **INT MODULATION** switch will sequentially cycle through the available modulation frequencies.

TTL Output

The rear panel TTL output is an electrical equivalent to the front panel modulated optical output.

OUTPUT Function

When the **ON** switch is pressed, the output on indicator flashes for two seconds before the laser is enabled. Following the delay, the output on indicator fully illuminates and the display switches to the actual measured output power.

Press the **ON** switch again to turn the output off. When the output is off, the display shows the desired optical output power. The following conditions automatically shut off the laser output:

- Keylock switch turned to off.
- AC Power Line Failure.
- Any internal hardware/software communication failure.

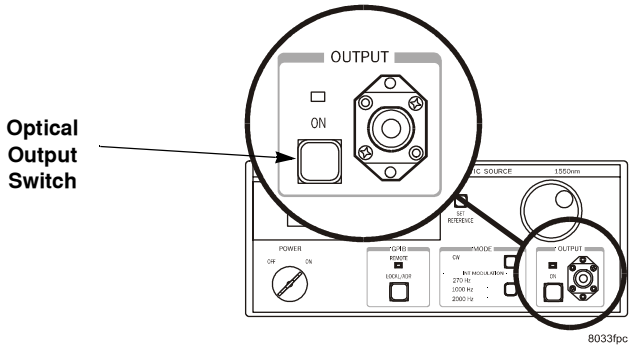


Figure 2.3 Output Section

GPIB Section

The **GPIB** section is located next to the power keylock switch at the bottom center of the 8033 front panel (see Figure 2.4 on page 12). The **GPIB** section contains the **LOCAL**/**ADR** switch and the **REMOTE** indicator. The functions of the indicator and switch are related to GPIB operations, as described below.

LOCAL control

The **LOCAL**/**ADR** switch is used for several functions. When the 8033 is in REMOTE all front panel controls are disabled except **LOCAL**/**ADR**. Press the **LOCAL**/**ADR** switch to return the device to LOCAL control, thus, re-enabling the front panel.

If the Local Lockout state has been activated by the host computer even the LOCAL/ADR switch is disabled. In this case, the host computer must deactivate the Local Lockout before front panel control can be restored.

When the unit is in LOCAL mode, pressing the **LOCAL**/**ADR** switch causes the GPIB address to be displayed, e.g. "-01-".

REMOTE control

Whenever the MPS-8033 is addressed by a system controller the REMOTE indicator illuminates and the front panel is disabled from manual control. Press **LOCAL**/**ADR** to return to local (manual) control.

GPIB Address

When the unit is in LOCAL mode, pressing the LOCAL/ADR switch causes the GPIB address to be displayed. The GPIB address may be changed by the following procedure. The usable GPIB address range is 0 to 30.

1. Press and release the **LOCAL/ADR** switch. If the current GPIB address is not on the display, press and release **LOCAL/ADR** again.
2. Press and hold the **SET REFERENCE** switch.
3. Use the **ADJUST** knob to select the desired GPIB address.
4. Release the **SET REFERENCE** switch to set the address into memory.

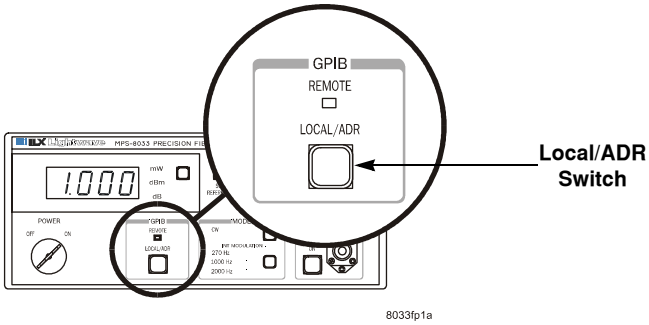


Figure 2.4 GPIB Section

ADJUST Section

The ADJUST section is located on the right side of the 8033 front panel. The **ADJUST** knob is used to change the light output power, enter instrument calibration data or set the GPIB address. Clockwise rotation of the knob increases the parameter value.

DISPLAY Section

The **DISPLAY** switch section is used to select the display mode. Optical power may be displayed in linear (milliwatts), log (dBm) and relative log (dB) scales. Pressing the **DISPLAY** switch causes the

display to cycle through the available display modes. The enunciator at the right of the display indicates which display mode has been selected.

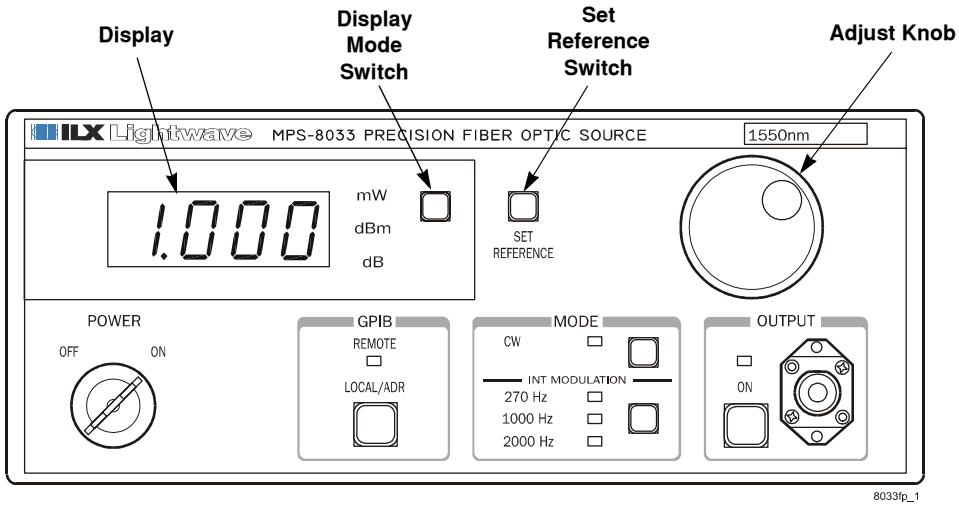


Figure 2.5 Display and Adjust Sections

Linear (mW) display

The display indicates the light output power in milliwatts.

Log (dBm) display

The display indicates the light output power in decibels relative to one milliwatt.

Relative Log (dB) display

The display indicates the light output power in decibels relative a user defined reference. Pressing the **SET REFERENCE** switch sets the reference point to the current output power value and changes the display to the dB mode.

To view the reference power, select the dB display mode and adjust the knob until the display denotes 0.00 dB. Then change the display mode to mW or dBm to view the reference.

Error Display

Execution and command errors are indicated on the seven segment display. Errors are shown as "Exxx" where xxx is a three digit number representing the unique error. Errors are displayed for three seconds or until the error causing condition is remedied, whichever is longer. Refer to Appendix A, Error Messages for a detailed list of error messages.

Back Panel Controls and Connections

Refer to Figure 2.4 for the following discussions of back panel controls and connectors.

TTL OUT Connector

The **TTL OUT** connector is located in the upper left hand corner of the rear panel. This output is the electrical equivalent of the front panel optical output and is primarily intended for use as a synchronization signal. Additionally, in CW mode, TTL OUT can be used to indicate output on.

GPIB Connector

The **GPIB connector** is located at the top center of the back panel. The 8033 GPIB connector meets IEEE-488.1 specifications. The interface specifications are listed in Table 3.1 on page 17.

AC Power Entry Module and Fuse

The AC Power Entry Module and fuse are located at the right side of the 8033's back panel. The 8033 must be connected to a properly rated AC source in order to operate. The fuse should only be replaced with the same value fuse, as indicated on the 8033's back panel.

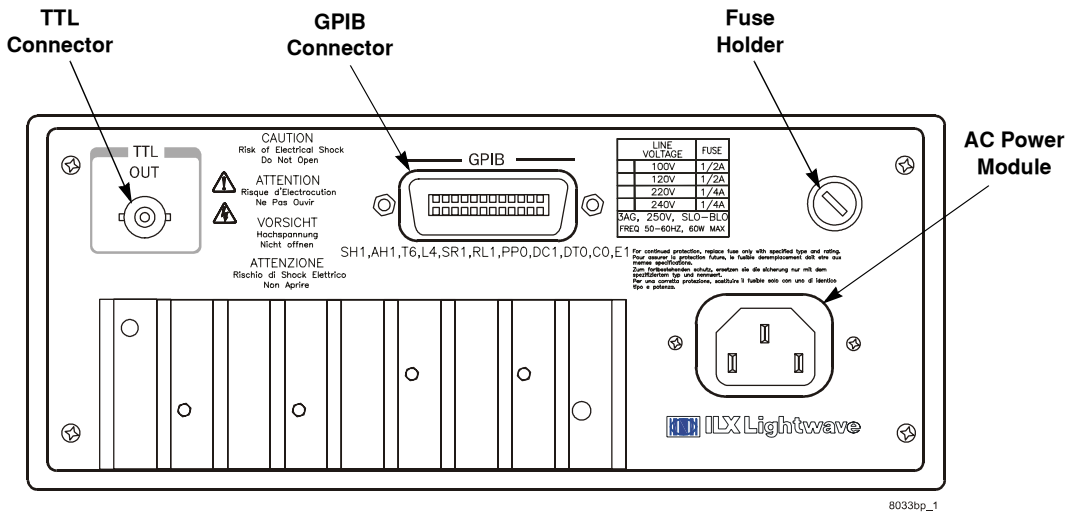


Figure 2.6 Back Panel

General Operating Procedures

The following sections present some guidelines for operation, as well as some common operating procedures. Remote operations are discussed in Chapter 3, Remote Operation and Chapter 4, Command Reference.

Warm Up and Environmental Considerations

Operate the MPS-8033 at an ambient temperature in the range of 0 to 50 °C. Storage temperatures should be in the range of -40 to +70 °C. To achieve rated stability, let the MPS-8033 warm up for at least 1 hour before use.

CW or Pulse Mode Operation

The MPS-8033 can be operated in either Continuous Wave (CW) or Internal Modulation (INT MODULATION) modes.

1. Plug the MPS-8033 into an AC power source supplying the correct voltage for your unit (refer to the back panel for the correct ratings).
2. Turn the front panel keylock switch to the on position to enable AC power. To achieve rated stability, let the MPS-8033 warm up for at least 1 hour before use.

   The optical output is off at power up, and the unit automatically configures its parameters to the state prior to the last power-down. The optical output power setting is indicated by the seven segment display with the corresponding enunciator in the display section of the front panel indicating which display mode (mW, dBm, or dB) is selected.
3. Connect the fiber optic patch cord to the front panel output connector.
4. Select the mode, **CW** or **INT MODULATION** by pressing the appropriate mode switch as needed.
5. Select the modulation frequency by pressing the **INT MODULATION** switch until the desired internal modulation frequency indicator is lit.
6. Set the optical power by turning the **ADJUST KNOB** until the display reads the desired value.
7. Turn the output on by pressing the **ON** switch. After a two second delay, the 8033 will automatically drive the laser to the desired power. While the laser is on, the output power or mode may be changed.
8. When testing is complete, turn the output off by pressing the **ON** switch. The output on indicator will extinguish.
9. When the 8033 is powered off, the state of the unit at power-down is saved in non-volatile memory.

Calibration Operation

The MPS-8033 can be calibrated with your own fiber optic patch cord. Refer to Calibration Overview on page 76.

Set Reference Operation

The reference level for the dB scale is set using the **SET REFERENCE** button. The following procedure indicates how to use this feature.

1. With the output on or off, adjust the power to the desired reference level. It is acceptable to set the reference in the mW or dBm scales.
2. Press the **SET REFERENCE** switch. Two things occur: The reference power level used by the dB scale is set to the level chosen in 1, and the display changes to the dB scale and displays 0.00.
3. When it is no longer desirable to display power in the relative mode, merely change the display scale to mW or dBm. The reference power will be held in memory until a new reference is chosen.
4. To view the reference power, select the dB display mode and adjust the knob until the display indicates 0.00 dB. Then change the display mode to mW or dBm to view the reference. Alternatively, the reference level may be calculated by subtracting the display value in dB from the display value in dBm.

TRIGGER OUT Operation

The **TTL OUT** trigger signal is available whenever the 8033 output is on. The TTL OUT trigger signal has the same frequency as the optical output signal, but at a TTL level. To use the OUT trigger, connect the device which is to be triggered to the 8033's back panel TTL OUT connector. Then operate the 8033 in any mode. In CW mode the TTL OUT signal may be used to indicate whether the output is on or off.

CHAPTER 3

REMOTE OPERATION

GPIB (General Purpose Interface Bus) is the common name for *ANSI/IEEE Standard 488.2 1987*, an industry standard for interconnecting test instruments in a system. Everything you can do from the front panel can also be done remotely, and in some cases, with more flexibility.

In remote operating mode, the 8033 offers all of the features accessible from the front panel. Additional features are available only via GPIB such as the STEP command which increments or decrements the optical power output by a user defined 'step' value. Five digits of resolution are available via GPIB whereas only four digits are shown on the front panel.

The MPS-8033 with the optional model 1231 complies with the IEEE 488.2/1987 standard to the extent shown in Table 3.1.

Table 3.1 IEEE-488 Interface Specification GPIB Capability

SH1	Source Handshake - complete compatibility
AH1	Acceptor Handshake - complete capability
T6	Talker Functions
L4	Listener Functions
SR1	Service Request - complete capability
RL1	Remote Local Function - complete capability
PP0	Remote Configuration Parallel Poll - no capability
DC1	Device Clear - complete capability
DT0	Device Trigger - no capability
C0	Controller Function - no capability
E1, E2	Three-state bus drivers with automatic switch to open collector during Parallel Poll

Basic GPIB Concepts

The information in this basic concepts discussion is normally not necessary to successfully operate the MPS-8033 through its GPIB interface, because your computer's GPIB controller usually handles them for you. However this is a useful perspective in understanding GPIB.

Data and Interface Messages

GPIB devices communicate with each other by sending data and interface messages. Data contains device-specific information such as programming instructions, measurement results, and instrument status. Each device has an address number, and ignores all data traffic not addressed to it. Depending on its content, data is often called a "device dependent message" or a "device dependent command". Interface messages manage the bus, with functions such as initializing the bus and addressing or unaddressing devices. In addition, some individual bus lines are designated for this purpose.

Talkers, Listeners, and Controllers

Every GPIB system consists of one or more "talkers" and "listeners", and often at least one "controller". Talkers supply data. Listeners accept data. A system can consist of simply a talker and listener, for example a meter connected to a datalogger or chart recorder. Controllers designate talkers and listeners. A controller is necessary when the active talkers or listeners must be changed. When the controller is a computer, it often also designates itself as a listener so it can collect data from designated talkers.

If there is more than one controller, only one can be the Controller In Charge (CIC). Control can be passed from one controller to another. In a multiple controller system, there can be one "System Controller"\" capable of asserting control (becoming CIC).

GPIB Cable Connections

Standard GPIB connectors can be connected together (stacked), allowing you to configure the system linearly, or in a star configuration.

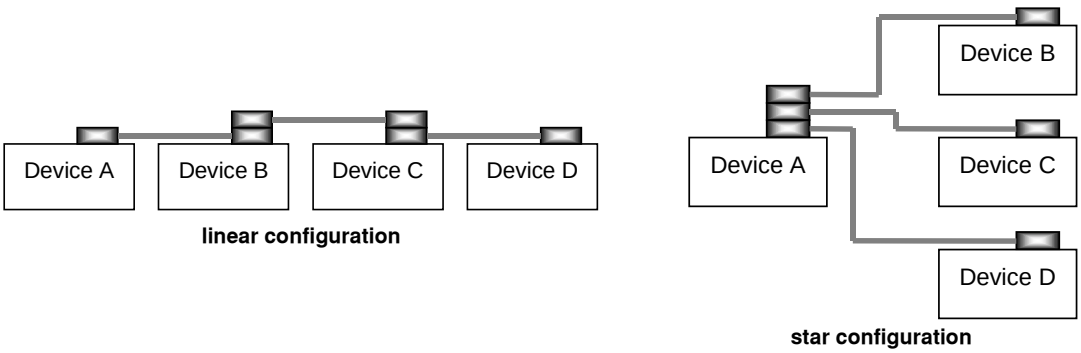


Figure 3.1 GPIB Cable Connections

The GPIB Connector

The standard GPIB connector consists of 16 signal lines in a 24-pin stackable connector. The extra pins are used for some twisted-pair wires. There are eight data input/output (IO) lines, three handshake lines, and five interface management lines.

Eight data input/output (DIO) lines carry both data (including device dependent commands) and interface messages. The ATN interface management line determines whether these lines contain data or interface messages.

Three handshake lines ensure that all data and messages are reliably transferred:

- NRFD (not ready for data) indicates whether a device can receive the next byte of data or message.
- NDAC (not data accepted) indicates whether a receiving device has accepted a byte of data or message.
- DAV (data valid) indicates that the signal levels on the data lines are stable and available for the receiving device(s) to accept.

Five interface management lines control the flow of information:

- ATN (attention) is set by the controller in charge to define the I/O lines for device-dependent data or interface messages.
- IFC (interface clear) is set by the system controller to initialize the bus and assert itself as controller in charge.
- REN (remote enable) is set by the controller to place addressed devices into remote or local (front panel) control mode.
- SRQ (service request) can be set by any device in the system to request service from the controller.
- EOI (end or identify) is used by talkers to identify the end of a message.

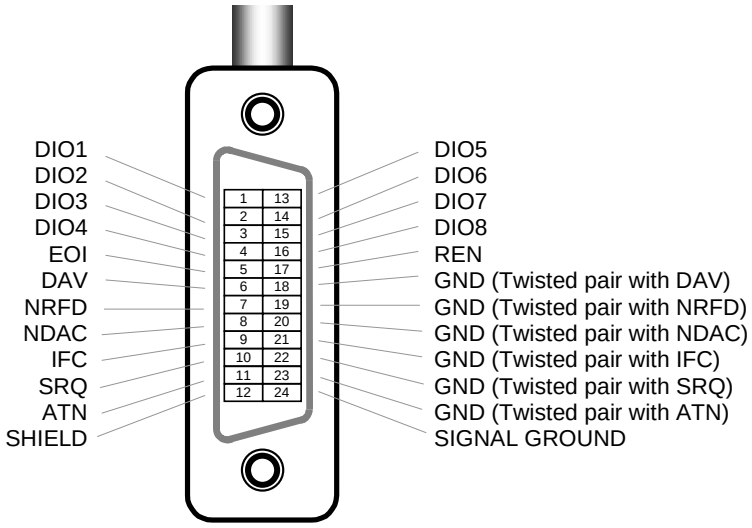


Figure 3.2 GPIB Connector Diagram

Other GPIB features include:

- A concise and straight-forward command set
- Full serial poll capability, with SRQ
- Full local/remote capability including LOCAL LOCKOUT

This chapter is a guide to the syntax and usage of the various IEEE/488.2 common commands. It also includes advanced programming tips for remote use with the 8033 device-dependent commands, hardware diagrams, and other information relating to remote operation.

This chapter is divided into three parts. The first part contains information for getting started using GPIB. It also contains the syntax for each 488.2 common command which is supported by the 8033. The second part contains information on status reporting and advanced programming techniques. The third part contains information on remote interface messages which are generally transparent to the user.

Configuring the GPIB Controller

To use the MPS-8033 remotely, an IEEE 488 interface adapter is required in your host computer. These adapters and support software are available from several manufacturers and can be installed in most computers. Appendix C describes how to configure many of these interface adapters for use with the 8033. This Chapter and Chapter 4 assume that you have a basic knowledge of the IEEE 488 interface bus and how to use it for instrument control. You should also be familiar with front panel operation of the MPS-8033. Manual (Local) operation of the 8033 is detailed in Chapter 2, Local Operation.

Changing Operation from Local to Remote

When the 8033 is in REMOTE all front panel controls are disabled except **LOCAL/ADR**. Press the **LOCAL/ADR** switch to return the device to LOCAL control, thus, re-enabling the front panel.

If the Local Lockout state has been activated by the host computer even the **LOCAL/ADR** switch is disabled. In this case, the host computer must deactivate the Local Lockout before front panel control can be restored.

When the unit is in LOCAL mode, pressing the **LOCAL/ADR** switch causes the GPIB address to be displayed for three seconds, e.g. "-01-".

Whenever the MPS-8033 is addressed by a system controller the REMOTE indicator illuminates and the front panel is disabled from manual control. Press **LOCAL/ADR** to return to local (manual) control.

Setting the GPIB Address

The talk and listen addresses on the 8033 are identical. When the unit is in LOCAL mode, pressing the **LOCAL/ADR** switch causes the GPIB address to be displayed. The usable GPIB address range is 0 to 30. Extended GPIB addressing is not implemented in the 8033. The GPIB address may be changed by the following procedure.

1. Press and release the **LOCAL/ADR** switch. If the current GPIB address is not on the display, press and release **LOCAL/ADR** again.
2. Press and hold the **SET REFERENCE** switch.

3 While holding the **SET REFERENCE** switch, use the **ADJUST** knob to select the desired GPIB address.

4 Release the **SET REFERENCE** switch to set the address into memory.

Command Syntax

This section describes command syntax and structure. You need this information to effectively write GPIB control programs. The syntax of GPIB commands follow the rules defined in the ANSI/IEEE 488.2-1987 standard. Later in this chapter you will be introduced to the error and status registers.

Letters

Any GPIB command or query must contain all of the letters which are shown in upper case in the command definition. Some of the device dependent commands include additional optional letters shown in lower case in the command reference (Chapter 4, Command Reference). Upper/lower case does not matter, it is used in this manual to identify optional letters. The optional letters must be in the correct sequence. Some examples of what works, and what does not:

Okay	Not Okay
`DIS`	`DS`
`Disp`	`dsp`
`Displ`	`dply`
`Displa`	`DSPLY`
`Display`	`disply`

White Space

"White space" is normally the space character (space bar). A single white space must separate a command from its parameters or data. For example:

Okay	Not Okay
`DELAY 500`	`DELAY500`

To enhance readability you can also use one or more white spaces before a comma, semicolon, or terminator. Since your computer normally puts the terminator at the end of each command string (line), this simply means that an extra space character at the end of your command line works OK.

A query has no space between the mnemonic and the question mark. For example:

Okay	Not Okay
`TIMER?`	`TIMER ?`

Note: Too many consecutive white spaces can overflow the 80-byte data I/O buffer.

Terminators

A program message terminator identifies the end of a command string. These are the valid terminator sequences:

- <NL>
- <^END>
- <NL><^END>

Many computers terminate with <CR><NL><^END> (Carriage Return - New Line - EOI). A carriage return (<CR>)is read as white space.

The 8033 terminates its responses with <CR><NL><^END>, unless you use the TERM command to change it.

If you encounter problems with GPIB communications, the terminator string can sometimes be the cause. Refer also to your GPIB interface (controller) manual.

Command Separators

You can put more than one command on the same line (same command string) if you separate them with a semicolon. The semicolon can be preceded by one or more spaces. Examples:

```
MODE:DBM; LASER:POW -3.0 DBM
:DIS ON; :las:mod:freq?
```

Parameters

Some commands require a parameter. The parameter must be separated from the command by at least one space.

The syntax symbol <nrf value> refers to the flexible numeric representation defined by the GPIB standard. It means that you can represent numbers in integer or floating point form, or in engineering/scientific notation. The IEEE-488.2 standard uses the names NR1, NR2, and NR3 respectively to denote "integer", "floating point", and "scientific notation". For example the number "twenty" may be represented by any of the following ASCII strings:

Integer	20	+20	NR1
Floating point	20.0	+20.0	NR2
Scientific notation	2.0E+1 2.0e+1	+2.0E+1 +2.0e+1	NR3

Substitute Parameter Names

For clarity in programming, the (Boolean) values of one and zero may also be represented by the appropriate substitute parameter names, as shown in Table 3.2.

Table 3.2 Substitute Parameter Names

SUBSTITUTE NAME	VALUE
ON	1
OFF	0
OLD	1
NEW	0
TRUE	1
FALSE	0

The ON parameter name could be used in place of the 1. The commands below are equal:

"DIS 1", "DIS ON", and "DIS TRUE"

Multiple Parameter Commands

No MPS-8033 GPIB commands expect multiple parameters.

Suffix Units

A suffix unit referes to the suffix program data that may follow an <nrf value>. If suffixes are not used, the default suffixes are assumed. The device interprets any alpha characters following decimal data as a suffix without regard to upper/lower case.

Table 3.3 MPS-8033 GPIB Suffixes

SUFFIX	DEFINITION
UW	Microwatts
MW*	Milliwatts
W	Watts
HZ*	Hertz
KZ, KHZ	Kilohertz
dBM	Decibels relative to 1 mW
dB	Decibels relative to the user defined reference

* Default unit

For more information on these definitions, refer to the IEEE-488.2 standard.

Some commands expect a parameter. For example, if the output power is to be entered, the command could be "LAS:POW .5". This would set the 8033's output power to .500 mW. If a single parameter is expected, it should follow the command with at least one space between the command and the parameter.

Command Tree Stucture

Many of the remote commands require a compound structure. This is done to distinguish between different commands of the same type. The first mnemonic opens a path to a set of commands relating to that path. The second mnemonic then defines the actual command.

This structure is illustrated in Figure 3.3. Table 4.1 on page 39 lists all of the device-dependent commands, with the full path shown for each command and a brief explanation of its usage.

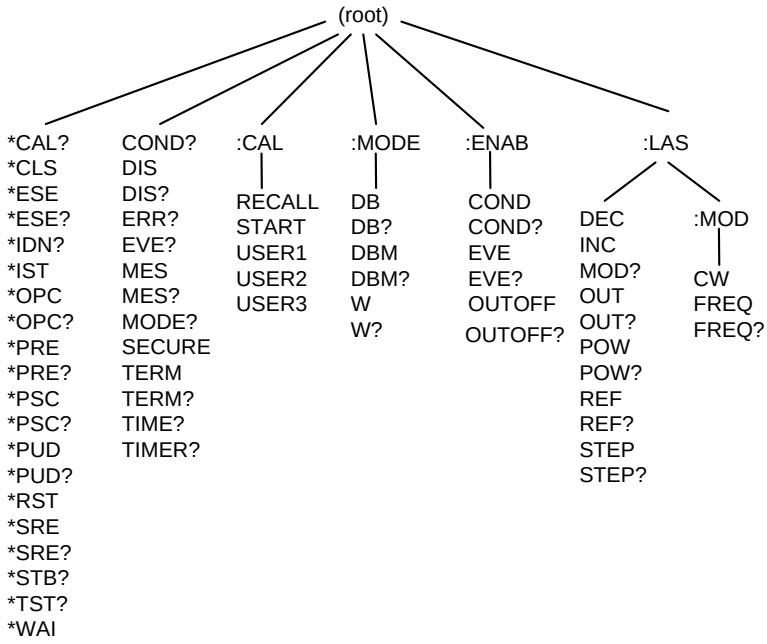


Figure 3.3 Command Path Structure

Syntax Summary

GPIB commands must contain all of the letters shown in upper case in the command definition. Optional letters shown in lower case for some device dependent commands in Chapter 4, Command Reference, are useful for clarity, but must be in the correct sequence.

A single white space must separate a command from its parameters or data. White space is normally the space character (space bar). Other control characters are also interpreted as white space. Do not use white space before the question mark in a query command.

If you encounter problems with GPIB communications, the terminator string can be the cause. Refer also to your GPIB interface (controller) manual. The instrument accepts <NL>, or <^END>, or <NL><^END> as a command line terminator. Many computers terminate with <CR> <NL> <^END> (Carriage Return - New Line - EOI). The instrument ignores <CR> (Carriage Return) as white space. The instrument terminates its responses with <CR><NL><^END>, unless you use the **TERM** command to change it.

You can put more than one command on the same line (same command string) if you separate them with a semicolon.

GPIB uses a flexible representation for numeric parameters: integer, floating point, or engineering/scientific notation. There are no default values for omitted parameters.

Some device-dependent GPIB commands are compound commands, in which the first mnemonic opens a path to a set of commands relating to that path. The second mnemonic then defines the actual command.

Following are examples of invalid syntax command strings that will produce errors:

Table 3.4 Invalid Syntax Command Strings

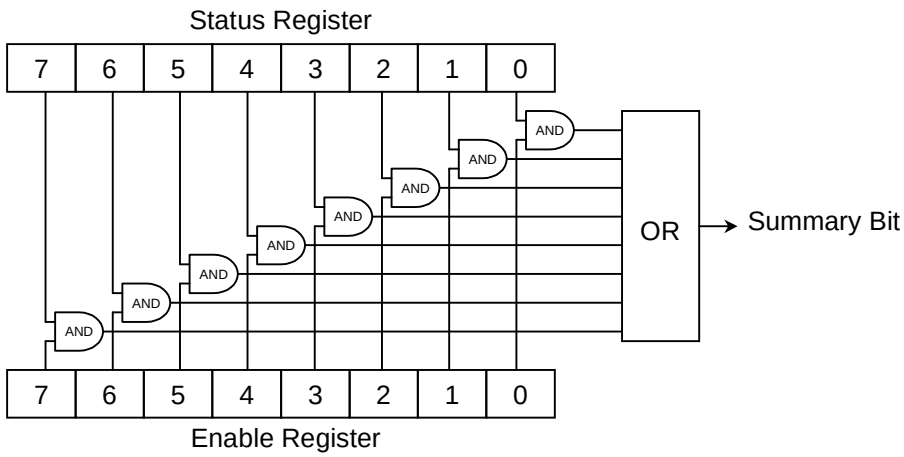
COMMAND	COMMENT
`MODE WATT`	Missing colon between program headers.
`MODE:DBM LAS:DEC`	Missing semicolon between commands.
`DIS ?`	Space not allowed before question mark.
`LAS:POW .777MW`	Space missing between the program data and the suffix unit.
`Disply`	Optional letters must follow the correct order. Therefore, "Dis", "Disp", "Displ", "Displa", or "Display" are equivalent.

Status Reporting

Internal registers are used to inform the control program of events and conditions. The status of the MPS-8033 is held within these four internal registers:

Condition:	The Condition Register monitors the state of the device. For example, if the output is on, bit #0 in the Condition Register is set.
Event:	The Event Register watches for changes in the device condition. For example, if the laser output is switched (on or off), bit #0 in the Event Register is set.
Standard Event:	The Standard Event Register is defined by the IEEE-488.2 standard and is responsible for monitor ing GPIB events such as Operation Complete and Command Errors.
Status Byte:	The Status Byte is also defined by the IEEE-488.2 standard. The status byte contains the summary of the other registers as well as reporting if the error and message available queues are active.

Each register has an **ENABLE** register associated with it. The enable register works like a mask or filter when updating that register's contents to the Status Byte. For example, the Condition Register is filtered (logically ANDed) with the Condition **ENABLE** Register. If the result is non-zero then Bit #1 in the Status Byte is set to one. The Enable registers are set via unique GPIB commands. For each register there is a corresponding enable register. Use the enable register as a mask so only the conditions you want to check are reported in the status byte register. This diagram illustrates the concept of enable registers:

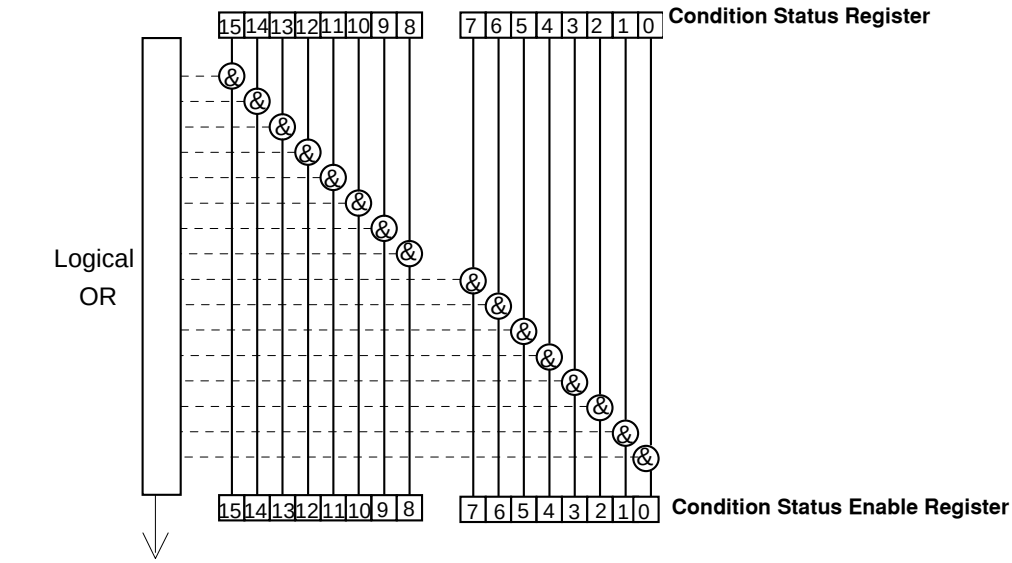


Register Structure and Contents

This section provides information about the structure and contents of the different internal registers.

Condition Status Register Pair

Condition Status is a 16-bit register/enable-register pair with this structure:



Bit Reference:

0- Output On	4- N/A	8- N/A	12- Calculation Error
1- Interlock Disabled	5- N/A	9- N/A	13- Hardware Error
2- N/A	6- N/A	10- N/A	14- Software Error
3- N/A	7- N/A	11- Cal Ready	15- Checksum Error

The Condition Status Enable Register allows you to control which events in the Condition Status Register can set bit 3 in the status byte register. Note that this register pair is identical to the Event Status register pair (above), except for bit 11.

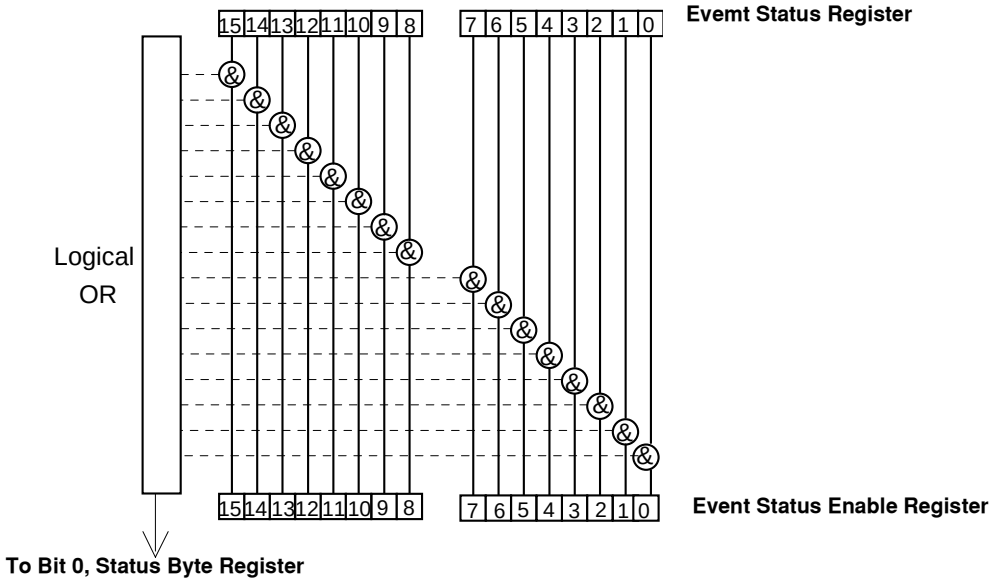
Conditions reflect the current state of the 8033, and so may change often. Querying the Condition Status Register does NOT change its contents.

Related commands: (See Chapter 4, Command Reference for details).

- ***COND?**—Query the contents of the Condition Status Register.
- ***ENABle:COND <nrf>**—Set an enable mask in the Condition Status Enable Register.
- ***ENABle:COND?**—Query the Condition Status Enable Register mask settings.

Event Status Register Contents

Event Status is a 16-bit register/enable-register pair with this structure:



Bit Reference:

0- Output Change	4- N/A	8- N/A	12- Calculation Error
1- Interlock Disabled	5- N/A	9- N/A	13- Hardware Error
2- Measurment Update	6- N/A	10- N/A	14- Software Error
3- N/A	7- N/A	11- N/A	15- Checksum Error

The Event Status Enable Register allows you to control which events in the Event Status Register can set bit 2 in the status byte register. Note that this register pair is identical to the Condition Status register pair (below), except for bit 11.

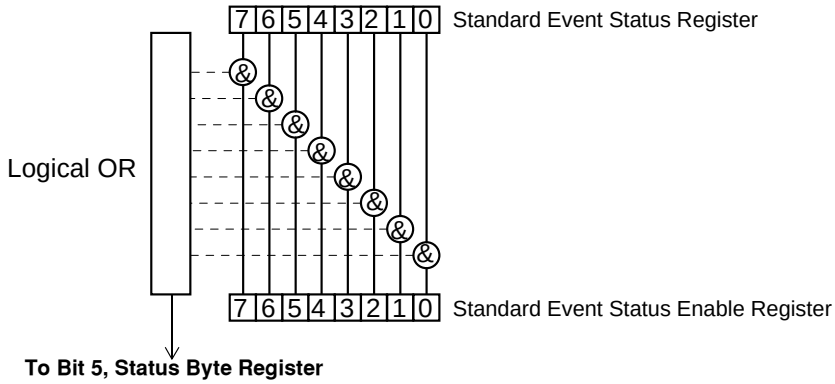
Event status indicates the FIRST occurrence, and does not change except when reset. The 8033 starts at power ON with the event status register set to all zeros. Querying the Event Status Register resets its contents to zeros.

Related commands: (See Chapter 4, Command Reference for details).

- ***EVEnt?**—Query the contents of the Event Status Register.
- ***ENABle:EVEnt <nrf>**—Set an enable mask in the Event Status Enable Register.
- ***ENABle:EVEnt?**—Query the Event Status Enable Register mask settings.

Standard Event Status Register

Standard Event Status is an 8-bit register/enable-register pair with this structure:



Bit Reference:

0- Operation Complete	4- Execution Error
1- N/A	5- Command Error
2- Query Error	6- User Request
3- Device Dependent Error	7- Power On

The Standard Event Status Enable Register allows you to control which events in the Standard Event Status Register can set bit 5 in the status byte register. The format of this register pair is defined by GPIB standards.

Standard event status indicates the FIRST occurrence, and does not change except when reset. The 8033 starts at power ON with the standard event status register set to all zeros. Querying the Standard Event Status Register resets its contents to zeros.

Bit 0 is key to an interrupt-driven control program, because it allows you to generate a service request (SRQ) when current operations are completed before making a measurement. To generate an operation complete SRQ, follow this sequence:

- ***ESE 1**—Enable bit 0 of the Standard Event Status Enable Register.
- ***SRE 32**—Enable bit 5 of the Service Request Enable Register.
- ***OPC**—Set bit 0 in the Event Status Register when all pending overlapped commands have been completed.

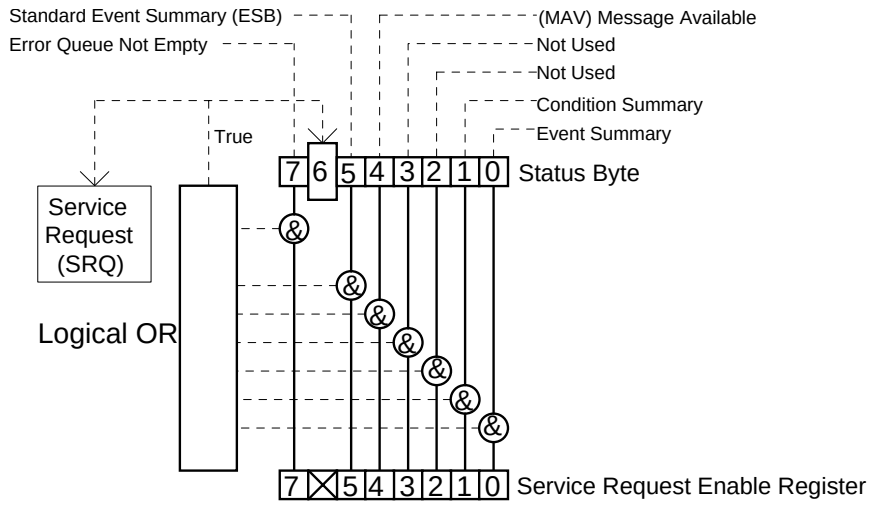
Related commands: (See Chapter 4, Command Reference for details).

- ***ESR?**—Query the contents of the Standard Event Status Register.
- ***ESE <nrf>**—Set an enable mask in the Standard Event Status Enable Register.
- ***ESE?**—Query the Standard Event Status Enable Register mask settings.

Status Byte and Service Request Enable Register

The Service Request Enable Register is logically ANDed to the Status Byte. If the result is non-zero, then bit #6 of the Status Byte is set to 1, and an SRQ interrupt is initiated.

Status Byte and Service Request Enable Register Pair are 8-bit registers with this structure:



Device Dependent Event and Condition Registers

The Event Registers are used to report events which occur during the operation of the 8033. Events differ from conditions in that events signal an occurrence once, and are not reset until the Event Register is queried or the 8033 is powered off. Conditions reflect the current state of the device, and therefore may change many times during operation. Querying a Condition Register does not change its contents.

Operation Complete Definition

Note that bit #0 of the Standard Event Status Register contains the Operation Complete flag. This bit may be used to signal an SRQ to the controlling software for more efficient, interrupt driven software. Enable the SRQ by setting bit #0 in the Standard Event Status Enable Register (*ESE) and bit #5 in the Service Request Enable Register (*SRE). This may be used to initiate service request routines which depend on the completion of all previous commands.

The following conditions define "Operation Complete" within the 8033:

- The controller, which is updating the hardware, is idle.
- No NVRAM (non-volatile random access memory) write cycles are in progress.
- No calibration routines are running.
- The output is off, or
- The output is on and the output-on delay period has finished.

ANSI/IEEE-488.2 Definitions

The following sections contain the relevant definitions for syntax diagrams and syntax elements for the GPIB commands, as defined by the IEEE-488.2 standard.

Power-on Conditions

At power-up, the 8033 initializes the device parameters with the same parameters as when the instrument was last shut-off. However, the output is always off at power-up. The unit default conditions may be recalled by using the *RST command.

Default Parameters

Except for suffixes there are no default values for omitted parameters. If a command is expecting a parameter and none is entered, an error is generated. If a suffix is omitted the default suffix is assumed.

However, if a reset is performed via a *RST command, the following parameters are set to the default state shown in Table 3.5.

Table 3.5 State of the 8033 after *RST

OUTPUT:	Off
MODE:	CW
DISPLAY:	Setpoint Power in mW
POWER: (8033/0x)	1.000 mW
POWER: (8033/C1/L1/55)	10.00 mW
POWER: (8033/C2/L2/65)	20.00 mW
GPIB:	REMOTE
STEP:	.001 mW (GPIB only)

Advanced Programming

Once you have become familiar with the command syntax and structure, you may take advantage of some programming shortcuts which are available. Due to the "tree-walking" capabilities of the 8033 software, you may elect to write command strings without constantly repeating the entire command path for each command.

The first command in the string must have it's entire path entered. Once a command level is reached, other commands which are at the same level (or higher level) may then be entered without repeating the entire path. To accomplish this, a semicolon (;) must be used to separate the commands in the string. The command following the semicolon need not specify its full path, if the same path which was previously used could be used for the new command.

For example, the following legal command string could be used to (1) set the 8033 output power and then (2) read the reference power:

```
LAS:POW 500 UW; REF?
```

In this case, the path "LAS:" is 'remembered' by the 8033 when the "REF?" query is sent. In the next example, the "COND?" query cannot be found in the "LAS:" path so the internal software looks for "COND?" at the next higher level (root level, in this case). The 8033 will proceed up the command tree looking for a command until it reaches the root level. An error is generated if the command cannot be found.

Care must be taken to avoid errors which are caused by trying to implement commands from the wrong path or level. For example, the following command string is intended to (1) set the device Condition Enable Register and (2) read the device Condition Register:

```
ENAB:COND 255; COND?
```

Instead, the 8033 will set the Condition Enable Register to 255 then readback the Condition Enable Register rather than the Condition Register. Placing a colon (:) before a command forces the parser to begin looking for the command at the root level. The following example would produce the desired effect:

```
ENAB:COND 255; :COND?
```

Consult Table 4.1 on page 39 when a command structure question arises.

The only exception to the rule described above is when common commands are used. Common Commands may be injected between other commands at the same level. The following command string is legal:

```
LAS:POW .1 MW; *CLS; REF .5 MW
```

In this example, the output power is set to 0 .1 mW, the status registers are cleared, and the reference power is set to 0.5 mW.

Error Messages

Error messages may appear on the 8033 display when error conditions occur which force the output off or reflect hardware errors in the 8033. These errors are also held internally for retrieval via GPIB.

The error queue can be read by issuing the **"ERR?"** command. This command returns a string containing up to ten error messages from the error message queue.

If **"ERR?"** is sent when the error queue is empty an ASCII zero (0) is returned. If the error queue is NOT empty then bit #7 in the Status Byte is set to one (1).

Refer to Appendix A, Error Messages on page 83 for an explanation of the error messages that are reported remotely by the 8033.

Command Timing

This section describes, for each device-dependent command, whether that command is performed in an overlapped or sequential manner. In other words, it states whether the next command may begin while this command is being executed, or if the next command must wait until this command is completed before its execution begins. See Operation Complete Definition on page 30 for conditions about setting the operation complete flag.

Sequential/Overlapped Commands

All device-dependent commands are executed in an overlapped manner: subsequent commands may begin before the current command is completed. Some common commands are sequential; the next command must wait until this command is completed. All device-dependent commands are executed in an overlapped manner, except the "DELAY" command which is sequential. The operation complete flag is set after the conditions outlined in the Operation Complete Definition have been satisfied.

The *WAI (common command) is an example of a sequential command which forces the next command to wait until the no-operation-pending flag is true. This is essentially the same as waiting for the OPC flag to become true, because the no-operations-pending flag is used to set the OPC flag (bit 0 of the Standard Event Status Register).

Commands which change the status of the instrument limits, or change its mode or current range, step value, or status enable registers, will not have their OPC flag set until all current writing to non-volatile memory has been completed. This ensures the OPC flag is never set prematurely.

Query Response Timing

Query responses are evaluated at the time the query request is parsed, and not at the time the response message is sent. In most cases this does not create a problem since the time between parsing a query and sending its response is small.

Input Buffer and Output Data

The Input buffer of the 8033 is 80 bytes. However, the <PROGRAM MESSAGE> may be longer.

The output (response) data of the 8033 is sent in blocks of up to 80 bytes in length. It is sent using high speed DMA within the 8033, but may be of indefinite length. Although some commands have a definite length response, such as the "MESsage?" query, the response length is indefinite because the 8033 will respond to multiple queries in a single response output. The user may enter as many queries as desired in a single input message, and the 8033 will respond to all of them in the same output message, if possible.

All query responses are evaluated at the time the query is parsed, and not at the time the response message is sent. In most cases this does not create a problem since the time between parsing a query and sending its response is small, unless the GPIB controller takes a long time to request the response.

Output Off Register

The Output Off Enable Register allows the user to determine which conditions and events cause the laser OUTPUT to be turned off. This register is configured in a manner which is similar to the status reporting register. However, it's output is not reported in the Status Byte Register. Rather, it goes to the hardware which controls the output switching. The events and conditions which may be set to cause the laser output to be turned off are shown in Figure 3.4.

The default (factory) setting for this register is 0. This setting is not affected by the *PSC (Power-On Status Clear) command.

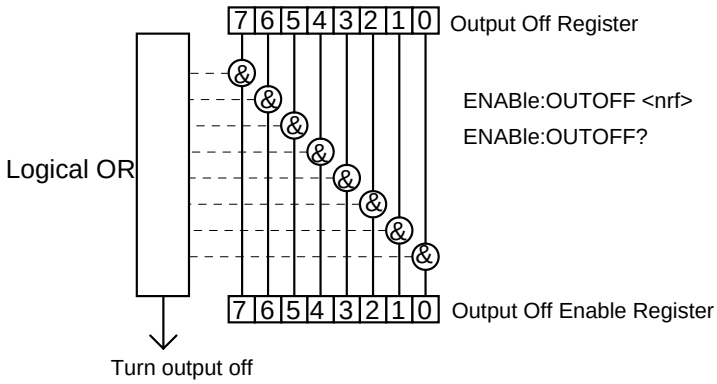


Figure 3.4 8033 Output Off Register

Bit Reference:

0- Interlock Broken
1 - Any Error
(bits 2 through 15 are not used)

Remote Interface Messages

The following sections are intended as a reference for using the 8033 with the GPIB option when an understanding of the lower level interface messages is required. These sections deal with the remote interface messages which are available with the 8033, and they contain a list of the Interface Function subsets. This information is generally not required by the user unless there is a question of compatibility of the 8033 with a specific controller. A list of interface messages which are not supported by the 8033 is shown in Table 3.7 on page 35. These messages are ignored by the 8033.

The interface messages listed in this chapter are handled by the Texas Instruments 9914 GPIB interface IC and the 80C188 microprocessor in the 8033, and are transparent to the higher level commands. However, they may be explicitly used in some GPIB programs. A list of the 8033's allowable interface messages is shown in Table 3.6.

Remote Messages

The following list contains GPIB remote messages which are compatible with the 8033 GPIB driver.

Table 3.6 8033 Allowable GPIB Interface Messages

ACG	GTL	OTA	PPR3	REN	SRQ
ATN	IDY	PCG	PPR4	RFD	STB
DAB	IFC	PPC	PPR5	RQS	TAG
DAC	LAG	PPE	PPR6	SCG	UCG
DAV	LLO	PPD	PPR7	SDC	UNL
DCL	MLA	PPR1	PPR8	SPD	UNT
END	MTA	PPR2	PPU	SPE	

Non-Supported Remote Interface Messages

Table 3.7 contains GPIB interface messages which are known to be incompatible with the 8033.

Table 3.7 Non-Supported Interface Messages for the 8033

EOS	MSA	NUL
GET	OSA	TCT

CHAPTER 4

COMMAND REFERENCE

This is a reference guide for GPIB commands that your MPS-8033 responds to, including both common and device dependent commands. It contains a reference section for all of the device-dependent commands, including those which may only be accessed via remote operation. Therefore, it is of primary interest to users who wish to utilize the GPIB option.

A short BASIC program example for remote operation of the 8033 is given in Programming Examples on page 72.

Notes about Syntax

The terminology required to successfully communicate with the MPS-8033 is detailed in Chapter 3, Remote Operation. Terms frequently used in this chapter are repeated below.

<white space> refers to ASCII characters (such as Space Bar) which are used as specific separators in the command syntax.

<nrf value> refers to the IEEE-488.2 standard for numeric format notation. It is a generic label which means either integer, floating point, scientific notation number representation may be used.

<suffix> refers to the IEEE-488.2 standard for suffixes. Legal suffixes used to command the MPS-8033 are described in Suffix Units on page 23.

The GPIB command set is designed to be intuitive yet create a simple GPIB software development environment. In most cases commands can be abbreviated. In the GPIB Command Reference Summary on page 39, the required letters for each command are shown in capital letters. Optional letters are shown in lower case and may be used to improve software readability.

Commands and Queries

There are two types of device communication: commands, which tell the device to do something and do not return anything; and queries, which return a stored value or instrument state but do not change the device state. Queries must be terminated with a question mark (?), while commands may require one or more parameters to follow.

Command:	`DIS OFF`	Turns off front panel display
Query:	`DIS?`	Returns 0 if display is off, 1 if display is on.

Substitute Parameter Names

For clarity in programming, the Boolean values of one and zero may also be represented by the appropriate substitute parameter names. For instance, the following commands render the same result.

```
DIS 1, DIS ON, DIS TRUE, DIS OLD
```

Compound Command Structure

Many of the 8033 remote commands require a compound structure. This is done to distinguish between different commands of the same type.

The compound command structure is similar to a directory path structure, as found in DOS. For example, commands which deal with the 8033's laser output have the path "LAS:", as in the following command to set the laser power,

```
LAS:POW .500 MW
```

The command structure is illustrated in Figure 4.1 on page 41. Table 4.1 on page 39 lists all of the 8033's commands, with the full path shown for each command and a brief explanation of its usage. The detailed descriptions for each command are provided in GPIB Command Reference Summary on page 39.

Common Commands

The GPIB Commands that are defined by the ANSI/IEEE-488.2-1987 standard are described in this chapter. These commands do not necessarily reflect front panel operations but are useful for generic device control. Some of the common commands are useful for advanced programming techniques, such as generating service requests.

GPIB Command Reference Summary

This section contains all of the device-dependent commands for the 8033, listed in alphabetical order. Sub-sections for each path are presented, listing all of the commands which are legal for that path. The command path 'tree' structure is illustrated best in Figure 4.1 on page 41.

Table 4.1 Command Reference

Name	Parameters Expected	Function
*CAL?		Used for the A/D calibration procedure.
CAL:RECALL	NONE	Used to recall the default calibration values.
CAL:START	NONE	Used to start the laser output power calibration cycle.
CAL:USER1	NONE	Used to set the first calibration point into memory.
CAL:USER2	NONE	Used to set the second calibration point into memory.
CAL:USER3	NONE	Used to set the third calibration point into memory.
*CLS		Resets the Standard Event Register, Status Byte and Error Queue to zero.
COND?	NONE	Returns the value of the Condition register.
*DLF		Used to force the 8033 to cease being a listener.
DIS	1	Turns the display on or off.
DIS?	NONE	Returns the display message or value.
ENAB:COND	1	Sets the enable register for Conditions.
ENAB:COND?	NONE	Returns the value of the Conditions enable register.
ENAB:EVE	1	Sets the enable register for Events.
ENAB:EVE?	NONE	Returns the value of the Event enable register.
ENAB:OUTOFF	1	Sets the enable register for Conditions/Events which turn the OUTPUT off.
ENAB:OUTOFF?	NONE	Returns the value of the Outoff enable register.
ERR?	NONE	Returns errors generated since the last query.
*ESE		Used to load the Standard Event Status Enable Register.
*ESE?		Determines which status bits can set the summary bit (bit 5) in the Status Byte.
*ESR?		Causes the 8033 to return the value of the **STANDARD EVENT REGISTER**.
EVE?	NONE	Returns the value of the Event register.
*IDN?		Causes the 8033 to return the **DEVICE IDENTIFICATION** string.
*IST?		Read the current state of the IEEE-488.1 'ist' local message in the 8033.
LAS:DEC	NONE	Used to decrement the output power by the STEP value.
LAS:INC	NONE	Used to increment the output power by the STEP value.
LAS:MOD:CW	NONE	Used to command the modulation to continuous wave.
LAS:MOD:FREQ	1	Used to command the modulation frequency.
LAS:MOD:FREQ?	NONE	Returns the modulation frequency (0 if CW).
LAS:MOD?	NONE	Returns the modulation frequency.
LAS:OUT	1	Used to turn the output ON or OFF.
LAS:OUT?	NONE	Returns the output ON/OFF status.

Table 4.1 Command Reference

Name	Parameters Expected	Function
LAS:POW	1	Used to set the optical output power.
LAS:POW?	NONE	Returns the output power in the selected display units.
LAS:REF	1	Used to set the reference power for dB mode.
LAS:REF?	NONE	Returns the reference power in the display units.
LAS:STEP	1	Used to set the DEC/INC step size.
LAS:STEP?	NONE	Returns the step size in the selected display.
MES	1	Used to enter a string of 16 ASCII bytes.
MES?	NONE	Returns a previously stored ASCII message.
MODE:DB	NONE	Commands the display units to dB.
MODE:DB?	NONE	Returns 1 if the display mode is dB.
MODE:DBM	NONE	Commands the display units to dBm.
MODE:DBM?	NONE	Returns 1 if the display mode is dBm.
MODE:W	NONE	Commands the display units to mW.
MODE:W?	NONE	Returns 1 if the display mode is mW.
MODE?	NONE	Returns the display units.
*OPC		Causes the 8033 to generate the **OPERATION COMPLETE** message in the Standard Event Status Register when all pending overlapped commands have been completed.
*OPC?		Places an ASCII character 1 into the 8033's Output Queue when all pending operations have been finished.
*PRE		Sets the parallel poll register enable bits.
*PRE?		Determine the contents of the **PARALLEL POLL ENABLE REGISTER**.
*PSC		Used to avoid any undesirable service requests when the 8033 is powered up.
*PSC?		Queries the 8033's power-on-status-clear flag.
*PUD		Stores data unique to the 8033.
*PUD?		Retrieves the contents of the *PUD storage area.
*RST		Performs a device reset.
SECURE	1	Used by service personnel to access to protected data.
*SRE		Sets the Service Request Enable Register bits to allow the 8033 to generate the user-selectable service requests.
*SRE?		Determine the current contents of the Service Request Enable Register.
*STB?		Reads the Status Byte.
TERM	1	Sets the program message terminator.
TERM?	NONE	Returns the program message terminator.
TIME?	NONE	Returns the elapsed time since last powered up.
TIMER?	NONE	Returns the elapsed time since the timer was last reset.
*TST?		Initiates an internal self-test and returns a response when complete.
*WAI		Prevents the 8033 from executing any further commands until the No-Operation-Pending flag is true.

Command Paths

The 8033 commands are structured in a tree format as shown in Figure 4.2. Each of the legal paths is listed below, followed by its list of path options, each of which is followed by the commands themselves.

First-time users should begin by using the full path notation. Once familiar with the paths, shortcuts are available. These shortcuts are described in Section 3.6.

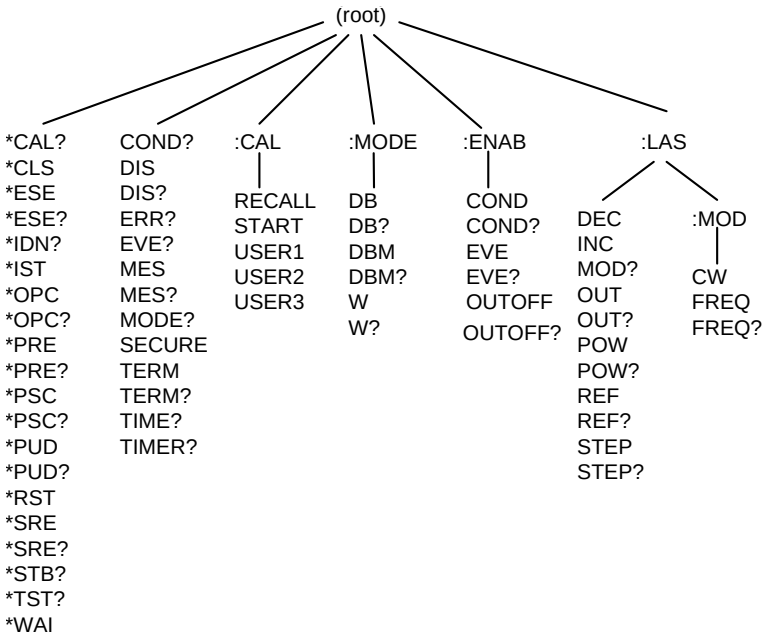


Figure 4.1 8033 Command Path Structure

GPIB Command Reference

The following pages contain a reference for all MPS-8033 GPIB commands. This reference contains useful information for both local and remote operation of the 8033. References to the front panel labels are capitalized; therefore, a reference to the **MODE** section refers to the Mode section on the 8033. In some references, parentheses are used to signify the labeled area for a particular switch or indicator on the front panel. For example, **(OUTPUT) ON** refers to the switch labeled "ON" in the "OUTPUT" section of the 8033 front panel.

In the headings of the command descriptions the required letters of a command are capitalized and the optional valid letters are in lower case. For example, the command heading **"LASer:POWer"** has the required letters, **"LAS:POW"**, but allows the use of **"LASER:POWER"** for clarity.

Command Types

Command types are indicated in the descriptions by these check boxes:

- **Common** commands and requests are defined by GPIB standards, and have consistent meanings for various instruments. "Common" commands start with "*". For example, `*IDN?` is a GPIB common query asking the instrument to identify itself. For more information on GPIB common commands, refer to an ANSI/IEEE 488 standard reference.
- **Device Dependent** commands and requests are unique to the instrument. For example, `MODE:DBM` selects measurements to be reported in logarithmic (dBm) units, same as pressing the dBm/W front panel switch.
- **Front Panel** commands duplicate actions that you can also perform by front panel operation.

---

*CAL?

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action	Adjusts the internal analog to digital (A/D) converter to reference points, then reports results.
Results	Zero = OK Non-zero = calibration error
Note	A/D referencing is performed each 10 minutes of inactive time.
Example	*CAL?

CAL:

COMMON
DEVICE DEPENDENT
FRONT PANEL

The CAL: command path is used to get to the MPS-8033's laser output calibration commands.

The following commands can be reached directly from the CAL: command path.

CAL:RECALL

CAL:START

CAL:USER1

CAL:USER2

CAL:USER3

Notes — The proper test equipment should be set up in order for these commands to work. Calibration is discussed in Chapter 6.

CAL:RECall

COMMON
DEVICE DEPENDENT
FRONT PANEL

The CAL:RECALL command will cause the 8033 to recall the default calibration values.

Parameters — None.

Notes — The 8033 can be calibrated by the user as described in Chapter 6. This command resets the unit to the default calibration values. A user calibration is recommended after this command is executed.

This command is available via the GPIB only.

Examples — "**CAL:RECALL**"

CAL:START

COMMON
DEVICE DEPENDENT
FRONT PANEL

The CAL:START command will cause the 8033 to begin the three point calibration procedure.

Parameters — None.

Notes — This command will initiate the laser output power calibration. The device will be forced to CW mode, milliwatt display and the laser will be turned ON to the first calibration value.

The proper test equipment should be set up in order for these commands to work. Calibration is discussed in Chapter 6.

ExamplesExamples"**CAL:START**"

CAL : USER1

COMMON
DEVICE DEPENDENT
FRONT PANEL

The CAL:USER1 command will cause the 8033 to set the first calibration point into memory.

Parameters None.

Notes In local control, this command is similar to pressing the **SET REFERENCE** switch while in the calibration mode.

This command will cause the 8033 to set the first calibration point into memory. This command must follow the CAL:START command and should not be used until the desired power level is achieved. The 8033 will then await the CAL:USER2 command.

The proper test equipment should be set up in order for these commands to work. Calibration is discussed in Chapter 6.

Examples "**CAL:USER1**"

CAL : USER2

COMMON
DEVICE DEPENDENT
FRONT PANEL

The CAL:USER2 command will cause the 8033 to set the second calibration point into memory.

Parameters None.

Notes In local control, this command is similar to pressing the **SET REFERENCE** switch while in the calibration mode.

The "CAL:USER2" command will cause the 8033 to set the second calibration point into memory. This command must follow the CAL:START and CAL:USER1 commands and should not be used until the desired power level is achieved.

The proper test equipment should be set up in order for these commands to work. Calibration is discussed in Chapter 6.

Examples "**CAL:USER2**"

CAL : USER3

COMMON
DEVICE DEPENDENT
FRONT PANEL

The CAL:USER3 command will cause the 8033 to set the third calibration point into memory.

SYNTAX DIAGRAM

Parameters None.

Notes In local control, this command is similar to pressing the **SET REFERENCE** switch while in the calibration mode.

The "CAL:USER3" command will cause the 8033 to set the third calibration point into memory. This command follows the CAL:USER2 command and should not be used until the desired power level is achieved. The 8033 will then complete the calibration procedure and return the device to the state before the calibration was initiated.

The proper test equipment is required. Calibration is discussed in Chapter 6.

Examples "**CAL:USER3**"

*CLS

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Clears status event registers: Event Status, Event Status Enable, and Error Queue.
Note Useful to clear registers before enabling service requests (SRQ).
Example ***CLS**

COND?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The COND? query returns the value of the 8033 status condition register.

Parameters None.

Response The response data is the binary sum of the following:

1	Output is ON	8192	Hardware Error
2	Interlock is disabled	16384	Software Error
4096	Calculation Error	32768	Software Checksum Error

Notes The condition status may be constantly changing. This register is not cleared when queried or when *CLS is issued.

The conditions which are reported to the status byte are filtered by the condition enable register (See ENAB:COND).

Examples "**COND?**" response: 1, means the laser output is ON.

DISplay

COMMON
DEVICE DEPENDENT
FRONT PANEL

The DISplay command enables or disables (turns off) the front panel display and LED indicators.

Parameters The <nrf value> of 0 or OFF to disable the display, 1 or ON to enable the display.

Notes When the display is enabled, the value displayed will depend upon the present mode of operation. When the display is disabled, the display contains a blank message and all of the front panel LEDs will be turned off. This command is useful when it is necessary to work in a dark environment.

Examples "**DIS ON**" action: display is turned on.
"**DIS 0**" action: display is turned off.

DISplay?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The DISplay? query returns the value shown on the display.

Parameters: None.

Response: The response data is an ASCII string, five bytes long.

Notes: This query returns the actual string from the output buffer to the display. If the display is disabled the query returns " ".

In local operation, the display is queried by visually reading the display value.

Examples:
"DIS?" response: -3.33, means the value on the display is -3.33.
"DIS?" response: E501, means the interlock broken error is displayed.
"DISPLAY?" response: " ", means the display is blank.

*DLF

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Used to force the 8033 to cease being a listener.

Example ***DLF**

ENABLe:

COMMON
DEVICE DEPENDENT
FRONT PANEL

The ENABle: command path is used to get to the MPS-8033's status enable commands. The following commands can be reached directly from the ENABle: command path.

```
ENABle:COND
ENABle:COND?
ENABle:EVEent
ENABle:EVEent?
ENABle:OUTOFF
ENABle:OUTOFF?
```

ENABle:COND

COMMON
DEVICE DEPENDENT
FRONT PANEL

The ENABle:COND command sets the condition status enable register for the 8033. This register is a filter which is logically ANDed to the condition register. If the result is non-zero, bit #1 in the Status Byte is set to one.

Parameters: An <nrf value> whose sum represents the enabled bits below:

1	Output is ON	8192	Hardware Error
2	Interlock is disabled	16384	Software Error
4096	Calculation Error	32768	Software Checksum Error

Notes: The condition enable register can be read by using the ENABle:COND? query.

The condition status can be monitored by the COND? query. If any of the enabled conditions are true, bit #1 of the status register will be set.

The enable registers retain their values at power-up unless the power-on status clear flag is set true (See *PSC in Chapter 3).

Examples: "**ENAB:COND 3**" action: allows the output on and interlock broken conditions to set bit #1 in the Status Byte.

ENABle:COND?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The ENABle:COND? query returns the value of the 8033 status condition enable register.

Parameters: None.

Response: The response data is the binary sum of the following:

1	Output is ON	8192	Hardware Error
2	Interlock is disabled	16384	Software Error
4096	Calculation Error	32768	Software Checksum Error

Notes: The condition enable register can be set by using the ENABle:COND command.

The condition status can be monitored by the COND? command.

Examples: "**ENAB:COND?**" response: 16385, means the output on and software error conditions are allowed to update bit #1 of the Status Byte.

ENABle:EVEnt

COMMON
DEVICE DEPENDENT
FRONT PANEL

The ENABle:EVEnt command sets the status event enable register for the 8033. This register is a filter which is logically ANDed to the event register. If the result is non-zero, bit #0 in the Status Byte is set to one.

Parameters — The <nrf value> represents the sum of the enabled bits below:

1	Output ON/OFF change	4096	Calculation Error
2	Interlock enabled/disabled	8192	Hardware Error
4	New measurement available	16384	Software Error
		32768	Software Checksum Error

Notes — The event enable register can be read by using the ENABle:EVEnt? query. The Event status can be monitored by the EVEnt? query.

The enable registers retain their values at power-up unless the power-on status clear flag is set true (See *PSC in Chapter 3).

Examples — "**ENAB:EVE 3**" action: allows the output ON/OFF change and interlock enabled/disabled change events to set bit #0 in the Status Byte.

ENABle:EVEnt?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The ENABle:EVEnt? query returns the value of the 8033 status event enable register.

Parameters — None.

Response — The response data is the binary sum of the following:

1	Output ON/OFF change	4096	Calculation Error
2	Interlock enabled/disabled	8192	Hardware Error
4	New measurement available	16384	Software Error
		32768	Software Checksum Error

Notes — The event enable register can be set using the ENABle:EVEnt command. The event status can be monitored by the EVEnt? command.

Examples — "**ENAB:EVE?**" response: 7, means the output on/off change, interlock enable/disable change and new measurements are allowed to update bit #0 of the Status Byte.

ENABle:OUTOFF

COMMON
DEVICE DEPENDENT
FRONT PANEL

The ENABle:OUTOFF command sets the outoff register for the 8033. This register is a filter which allows certain conditions to turn off the laser output.

Parameters An <nrf value> whose sum represents the enabled bits below:

1	Interlock broken
2	Misc. hardware errors

Notes The enabled Outoff bits can be read by using the ENABle:OUTOFF? query. The default value for this register is three.

Examples "**ENAB:OUTOFF 1**"action: allows the laser output to be turned off if the interlock is broken.

ENABle:OUTOFF?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The ENABle:OUTOFF? query returns the value of the 8033 outoff register.

Parameters None.

Response The response data is the binary sum of the following:

1	Interlock broken
2	Misc. hardware errors

Notes The enabled events or conditions which are used to turn the laser output off can be set by using the ENABle:OUTOFF command.

Examples "**ENAB:OUTOFF?**"response: 0, means there are no conditions that will automatically turn off the laser output.

ERRors?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The ERRors? query returns a list of command, execution, and device errors which have occurred since the last ERRors? query. These errors are indicated by a number which corresponds to the type of error which occurred. The error numbers are decoded in Appendix A.

Parameters None.

Response Each <response data> consists of an error code value.

Notes The response data will be a list of the current errors. The errors are represented by numbers and are separated by commas. A response of zero indicates that there are no errors to report. The response is sent as character data.

When the error queue is active (errors exist), bit #7 of the Status Byte is set to one.

Examples "**ERR?**" response: 0, means there are no errors to report.

"**ERRORS?**" response: 201, means that the <PROGRAM DATA> value is out of range.

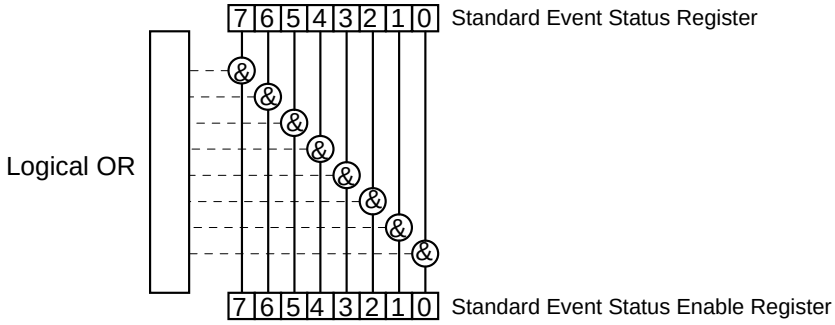
*ESE <nrf value>

Event Status Enable

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Enables bits in the standard event status enable register.

Response The value must be between 0 and 255.



Bit Reference

0- Operation Complete	4- Execution Error
1- N/A	5- Command Error
2- Query Error	6- User Request
3- Device Dependent Error	7- Power On

Notes Bit 5 of the status byte register is set if any enabled conditions are true.

Setting bit 0 allows you to generate service requests from overlapped commands as previous operations complete. This may be useful for ensuring that an operation is complete before starting a measurement.

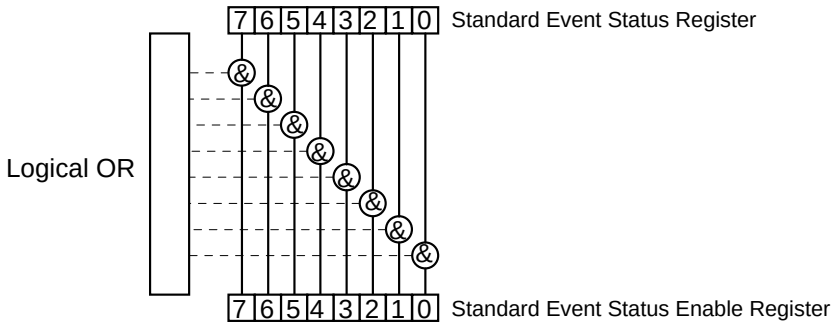
*ESE?

Event Status Enable?

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Requests the value in the standard event status enable register.

Response The value must be between 0 and 255.



Bit Reference

0- Operation Complete	4- Execution Error
1- N/A	5- Command Error
2- Query Error	6- User Request
3- Device Dependent Error	7- Power On

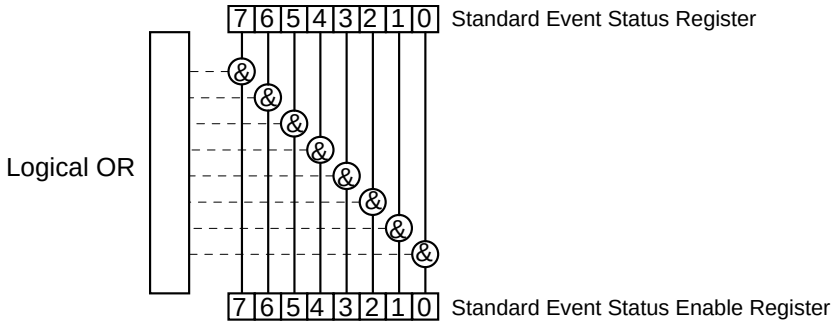
Notes Bit 5 of the status byte register is set if any enabled conditions are true.
Response is the sum of the enabled bits.

*ESR?

Standard Event Status Register?

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Requests the value in the standard event status register.
Response The value must be between 0 and 255.



Bit Reference

0- Operation Complete	4- Execution Error
1- N/A	5- Command Error
2- Query Error	6- User Request
3- Device Dependent Error	7- Power On

Notes Response is the sum of the enabled bits.
This command allows you to determine which type of error has occurred.

*IST

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Allows the user to read the current state of the IEEE-488.1 'ist' local message in the 8033.
Response 0 - IST message is false
1 - IST message is true

EVEnt?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The EVEnt? query returns the value of the status event register.

Parameters None.

Response The response data is the binary sum of the following:

1	Output ON/OFF change	4096	Calculation Error
2	Interlock enabled/disabled	8192	Hardware Error
4	New measurement available	16384	Software Error
		32768	Software Checksum Error

Notes The events which are summarized in bit #0 of the Status Byte can be set by using the ENABle:EVEnt command. The event status register is cleared when this command is sent or when the *CLS command is issued.

Examples "**EVE?**" response: 1, means the output status changed, (OFF to ON or ON to OFF).

LASer:

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer: command path is used to get to the MPS-8033's laser control commands. The following commands can be reached directly from the LASer: command path.

`LASer:DEC`	`LASer:INC`
`LASer:MODulation:CW`	`LASer:MODulation:FREQ`
`LASer:MODulation:FREQ?`	`LASer:MODulation?`
`LASer:OUTput`	`LASer:OUTput?`
`LASer:POWer`	`LASer:POWer?`
`LASer:REFerence`	`LASer:REFerence?`
`LASer:STEP`	`LASer:STEP?`

LASer:DEC

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:DEC command decrements the laser output power by the preset STEP value.

Parameters None.

Notes The step size may be edited via the LASer:STEP command. The default step size is .001 mW or .001 dB. The step size can be queried via the LASer:STEP? command.

The step size for the linear and log scales are kept separately. No conversion is done between display scales.

Examples "**LAS:DEC**" action: Decrements the output power by the amount of the step size for the present display mode.

LASer:INC

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:INC command increments the laser output power by the preset STEP value.

Parameters None.

Notes The step size may be edited via the LASer:STEP command. The default step size is .001 mW or .001 dB. The step size can be queried via the LASer:STEP? command.

The step size for the linear and log scales are kept separately. No conversion is done between display scales.

Examples **"LAS:INC"** action: Increments the output power by the amount of the step size for the present display mode.

LASer:MODulation:

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:MODulation: command path is used to get to the MPS-8033's laser modulation control commands.

The following commands can be reached directly from the LASer:MODulation command path.

```
LASer:MODulation:CW
LASer:MODulation:FREQ
LASer:MODulation:FREQ?
LASer:MODulation?
```

LASer:MODulation:CW

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:MODulation:CW command selects the continuous wave mode.

Parameters: None.

Notes: This command has the same effect as pressing the **CW** switch on the 8033 front panel.

In this mode, the pulse modulation is turned off.

Examples: "**LAS:MOD:CW**" action: Commands the unit to the continuous wave mode.

LASer:MODulation:FREQ

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:MODulation:FREQ command selects one of the internal modulation modes.

Parameters: The <nrf value> represents the internal modulation frequency. The optional <suffix unit> is the IEEE-488.2 approved frequency suffix.

Legal modulation frequencies:160 Hz to 15 KHz (GPIB only)

270 Hz (front panel)

1000 Hz (front panel)

2000 Hz (front panel

Legal suffixes: HZ Hertz
KZ, KHZ Kilohertz

Notes: This command has the same effect as pressing the **INT MODULATION** switch on the 8033 front panel.

If the <suffix> is not used, the default is HZ.

If frequencies other than 270, 1000 and 2000 Hz are selected, the front panel **MODE** indicators will all be off.

Examples: "**LAS:MOD:FREQ 2 KZ**"action: Commands the 8033 to the 2000 Hz internal modulation mode.

"**LAS:MOD:FREQ 1000**"action: Commands the 8033 to the 1000 Hz internal modulation mode.

LASer:MODulation:FREQ?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:MODulation:FREQ? query returns the value of the internal modulation frequency.

Parameters: None.

Response: The response data is internal modulation frequency in Hertz.

Notes: This command has the same effect as viewing the **INT MODULATION** indicators on the 8033 front panel.

If the 8033 is operating in the CW mode and the LAS:MOD:FREQ? query is issued the response is "0 HZ".

Examples: "**LAS:MOD:FREQ?**"response: 270 HZ, indicates the 8033 is operating in the 270 Hz pulse modulation mode.

LASer:MODulation?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:MOD? query returns the modulation mode.

Parameters: None.

Response: The response data is the modulation mode (CW 160 Hz to 15 kHz).

Notes: This command has the same effect as viewing the **MODE** LEDs on the 8033 front panel.

Examples: "**LAS:MOD?**" response: 1000 HZ, indicates the 8033 is operating in the 1000 Hz pulse modulation mode.

"**LAS:MOD?**" response: CW, indicates the 8033 is operating in the continuous wave mode.

LASer:OUTput

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:OUTput command turns the laser output on or off.

Parameters: The <nrf value> is 0 = OFF, and 1 = ON. Substitute values are shown in Table 3.4.

Notes: This command has the same effect as pressing the **(OUTPUT) ON** switch on the 8033 front panel.

Following the LAS:OUT ON command a **two second delay** period begins (indicated by the **(OUTPUT) ON** LED flashing). After the delay the laser will be turned on and the output on LED will become fully illuminated. Use the LAS:OUT? command to query the output status.

The LASer:OUTput OFF command is executed immediately.

Examples: "**LAS:OUT ON**" action: Starts the laser output on sequence. The output will be enabled two seconds after issue of the command.

"**LAS:OUTPUT 1**" action: Starts the laser output on sequence. The output will be enabled two seconds after issue of the command.

"**LAS:OUT OFF**" action: Turns the laser output off.

LASer:OUTput?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:OUTput? query returns the output on/off status.

Parameters None.

Response The response data is the status of the laser OUTPUT. If the output has been turned on but the two second turn on sequence is in effect the response will be zero (off).

0 = OFF
1 = ON

Notes This command has the same effect as viewing the **(OUTPUT) ON** indicator on the 8033 front panel.

Examples "**LAS:OUT?**" response: 1, indicates the 8033 output is ON (two second turn on sequence is also complete).

"**LAS:OUTPUT?**" response: 0, indicates the 8033 output is OFF (or the laser has been turned on but is still within the two second turn on delay).

LASer:POWer

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:POWer command sets the optical output power.

Parameters The <nrf value> represents the optical output power.

Legal power ranges:	**MPS-8033/0x**	**MPS-8033/55**	**MPS-8033/65**
Linear Scale:	.0010 to +1.1000 mW	.0010 to +12.00 mW	.0010 to +22.00 mW
Log Scale:	-20.00 to +0.410 dBm	-20.00 to +10.79 dBm	-20.00 to+13.42 dBm
Rel. Log Scale:	-20.00 to +20.00 dB	-20.00 to +20.00 dB	-20.00 to +20.00 dBm

Legal suffixes:

UW	microwatts
MW	milliwatts
W	watts
DBM	decibels relative to 1 mW
DB	decibels relative to the user defined reference

Notes This command has the same effect as using the **ADJUST KNOB** on the 8033 front panel to adjust the output power.

If the optional <suffix> is not used, MW is assumed.

The output power can be set with the output on or off.

Setting the power does not effect the present display mode. The following commands are equivalent and do not change the display scale.

"LAS:POW .500", "LAS:POW .500 MW", "LAS:POW 500 UW",

"LAS:POW .0005 W", "LAS:POW -3 DBM"

Examples "**LAS:POW .250**" action: Sets the optical power to .250 milliwatts.

"**LAS:POWER -3.00 DBM**"action: Sets the optical power to -3.00 dBm.

LASer:POWer?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:POWer? query returns the optical output power in the units of the present display mode.

Parameters None.

Response The response data is the optical power in the units of the present display mode.

Notes This command has the same effect as viewing the display on the 8033 front panel.

Examples "**LAS:POW?**" response: 0.5555, indicates the output power is 0.5555 mW.
"**LAS:POWER?**" response: -15.00, indicates the output power is -15 dBm.

LASer:REFerence

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:REFerence command sets the power reference which is used when the dB scale is displayed.

Parameters The <nrf value> represents the reference power.

Legal reference power ranges:	MPS-8033/0x	MPS-8033/55	MPS-8033/65
Linear Scale:	.0010 to +1.1000 mW	.0010 to +12.00 mW	.0010 to +22.00 mW
Log Scale:	-20.00 to +0.410 dBm	-20.00 to +10.79 dBm	-20.00 to+13.42 dBm

Legal suffixes are:

UW	microwatts
MW	milliwatts
W	watts
DBM	decibels relative to 1 mW

Notes This command has the same effect as using the **ADJUST KNOB** on the 8033 front panel to adjust the output power then pressing the **SET REFERENCE** switch. The display is not forced to the dB scale as it would be from a front panel (local) execution.

If the optional <suffix> is not used, MW is assumed.

The reference power can be set with the output on or off.

Examples "**LAS:REFERENCE 1.000**"action: Sets the reference power to 1 milliwatt.
"**LAS:REF -6.00 DBM**"action: Sets the reference power to -6.00 dBm.

LASer:REFerence?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:REFerence? query returns the reference power in the units of the present display mode.

Parameters: None.

Response: The response data is the reference power in the units of the present display mode.

Notes: This command has the same effect as manually switching to the dB scale, adjusting the display to 0.000 dB, switching to the mW or dBm scale and viewing the display.

Examples: "**LAS:REF?**" response: 0.5000, indicates the reference power is 0.5 mW.

"**LAS:REFERENCE?**" response: 0.0000, indicates the reference power is 0 dBm.

LASer:STEP

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:STEP command sets the power step size which is used with the increment and decrement commands.

Parameters: The <nrf value> represents the step size power.

Legal step size power ranges:

Linear Scale:	.0001 to +1.0000 milliwatts
Log Scale:	.0001 to 1.000 dBm

Legal suffixes are:

UW	microwatts
MW	milliwatts
W	watts
DB	decibels

Notes: The linear (mW) step and the log (dB) step are held in separate registers. When the increment or decrement command is issued the display units determine which step size register is used.

If the optional <suffix> is not used, MW is assumed.

The step size can be set with the output on or off.

Examples: "**LAS:STEP 0.500**"action: Sets the step size to 0.5 milliwatts.

"**LAS:STEP 0.01 DB**"action: Sets the step size to 0.01 dB.

LASer:STEP?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:STEP? query returns the step size in the units of the present display mode.

Parameters: None.

Response: The response data is the step size in the units of the present display mode.

Notes: The linear (mW) step and the log (dB) step are held in separate registers. When the increment or decrement command is issued the display units determine which step size register is used.

Examples: "**LAS:STEP?**" response: 0.0010, indicates the step size is 0.001 mW.

MESsage

COMMON
DEVICE DEPENDENT
FRONT PANEL

The MESsage command allows the use to enter an ASCII string of up to 16 non-zero characters. This command may be useful for storing messages which relate to a test or configuration.

Parameters: An ASCII string which is 1 to 16 bytes in length.

Notes: The message may contain any ASCII character, but will be terminated when a NULL terminator character is received. If the message has less than 16 bytes, the 8033 will fill the remaining message space with the space character. After 16 bytes have been entered, the 8033 will null-terminate the string.

Examples: "**MESSAGE "Thisisatest"**"action: The string, "Thisisatest" will be stored in non-volatile memory.

"**MES "Test3"**" action: The string, "Test3 " will be stored in non-volatile memory.

MESsage?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The MESsage? query returns the previously stored message. This message will always be 16 bytes long and enclosed in quotes.

Parameters: None.

Response: The response data is an ASCII string, 16 bytes long.

Notes: The response data will be a 16 byte long string. If there is no previously stored message, the response will be all spaces.

The message is entered via the MESsage command.

Examples: "**MES?**" response: "Test3 ", means the previously stored message was "Test3".

MODE:

COMMON
DEVICE DEPENDENT
FRONT PANEL

The MODE: command path is used to get to the MPS-8033's display control commands.

The following commands can be reached directly from the MODE: command path.

```
MODE:DB
MODE:DB?
MODE:DBM
MODE:DBM?
MODE:Watt
MODE:Watt?
```

MODE:DB

COMMON
DEVICE DEPENDENT
FRONT PANEL

The MODE:DB command activates the dB display mode. The dB scale is defined as decibels from a user defined reference power (See the LAS:REF command).

Parameters: None.

Notes: This command has the same effect as repeatedly pressing the **DISPLAY** switch on the 8033 front panel until the **dB** indicator is lit.

This command effects the display only. It has no effect on the output power.

When the output is off the 'setpoint' or desired power is displayed. When the output is turned on the actual measured power is displayed.

Examples: "**MODE:DB**" action: Sets the display mode to the decibels (dB) scale.

MODE:DB?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The MODE:DB? query returns the status of the DISPLAY mode switch with regard to the dB scale.

Parameters: None.

Response: The response of 1 means the dB scale is selected, and 0 means the dB scale is not selected.

Notes: In local operation, the status of the dB display mode is determined by visualizing the **dB** LED indicator.

When the output is off the 'setpoint' or desired power is displayed. When the output is turned on the actual measured power is displayed.

Examples: "**MODE:DB?**" response: 1, means the dB display mode is selected.

"**MODE:DB?**" response: 0, means the dB display mode is not selected.

MODE:DBM

COMMON
DEVICE DEPENDENT
FRONT PANEL

The MODE:DBM command activates the dBm display mode. The dBm scale is defined as decibels from a 1 mW reference.

Parameters: None.

Notes: This command has the same effect as repeatedly pressing the **DISPLAY** switch on the 8033 front panel until the **dBm** indicator is lit.

This command affects the display only. It has no effect on the output power.

When the output is off the 'setpoint' or desired power is displayed. When the output is turned on the actual measured power is displayed.

Examples: "**MODE:DBM**" action: Sets the display mode to the dBm scale.

MODE:DBM?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The MODE:DBM? query returns the status of the DISPLAY mode switch with regard to the dBm scale.

Parameters: None.

Response: The response of 1 means the dBm scale is selected, and 0 means the dBm scale is not selected.

Notes: In local operation, the status of the dBm display mode is determined by visualizing the **dBm** LED indicator.

When the output is off the 'setpoint' or desired power is displayed. When the output is turned on the actual measured power is displayed.

Examples: "**MODE:DBM?**" response: 1, means the dBm display mode is selected.

"**MODE:DBM?**" response: 0, means the dBm display mode is not selected.

MODE:Watt

COMMON
DEVICE DEPENDENT
FRONT PANEL

The MODE:Watt command activates the linear (mW) display mode.

Parameters: None.

Notes: This command has the same effect as repeatedly pressing the **DISPLAY** switch on the 8033 front panel until the **mW** indicator is lit.

This command effects the display only. It has no effect on the output power.

When the output is off the 'setpoint' or desired power is displayed. When the output is turned on the actual measured power is displayed.

Examples: "**MODE:W**" action: Sets the display mode to the linear scale.

MODE:Watt?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The MODE:Watt? query returns the status of the DISPLAY mode with regard to the mW scale.

Parameters: None.

Response: The response of 1 means the mW scale is selected, and 0 means the mW scale is not selected.

Notes: In local operation, the status of the mW display mode is determined by visualizing the **mW** LED indicator.

When the output is off the 'setpoint' or desired power is displayed. When the output is turned on the actual measured power is displayed.

Examples: "**MODE:WATT?**" response: 1, means the linear display mode is selected.

"**MODE:W?**" response: 0, means the linear display mode is not selected.

MODE?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The MODE? query responds with the units of display.

Parameters: None.

Response: The response is a string of up to three bytes that represent the display units.

MW	linear (mW) display is selected
DBM	log (dBm) relative to 1 mW is selected
DB	log (dB) relative to the user defined reference

Notes: In local operation, the status of the display mode is determined by visualizing the display LED indi-=cators.

When the output is off the 'setpoint' or desired power is displayed. When the output is turned on the actual measured power is displayed.

Examples: "**MODE?**" response: DBM, means the dBm display mode is selected.

*OPC

Operation Complete

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action: Sets the operation complete bit in the Event Status Register when all pending overlapped commands have been completed.

Response: None.

Example: `*OPC`

*OPC?

Operation Complete Query

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Places an ASCII character 1 into the intrument's Output Queue when all pending operations have been finished.

Response 1 - when all overlapped commands are complete.

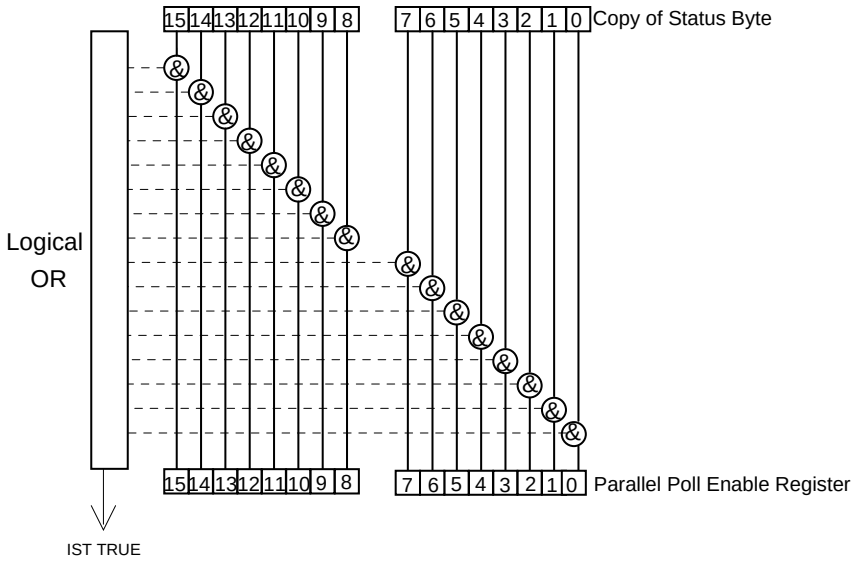
Example `*OPC?`

*PRE?

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Sets the parallel poll register enable bits for the format required by the 8033 in order that it may participate in parallel polling from the controller.

Response The value must be between 0 and 65535. The Parallel Poll Enable Register is logically ANDed with the Status Byte Register. If the result is non-zero the 'ist' (individual status) message is set true.



Bit Reference

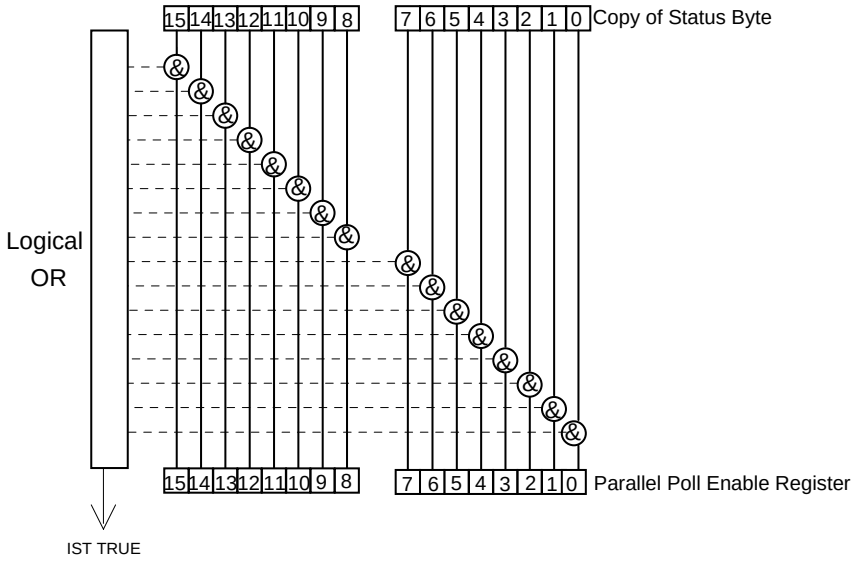
0- Event Summary	4- Message Available	8- N/A	12- N/A
1- Condition Summary	5- Event Status Summary	9- N/A	13- N/A
2- N/A	6- Master Status Summary	10- N/A	14- N/A
3- N/A	7- Error Message Available	11- N/A	15- N/A

*PRE?

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Determines the contents of the PARALLEL POLL ENABLE REGISTER.

Response The value must be between 0 and 65535. Binary Integer Sum of:



*PSC <nrf value>

Power-on Status Clear

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Sets automatic power-on clearing of the enable registers.

Values 0 = disable power-on clearing
1 = enable power-on clearing

Notes Any non-zero value is interpreted as 1.

Registers affected:

Condition Status Enable	Service Request Enable
Event Status Enable	Standard Event Status Enable

Factory default condition: disabled.

In the disabled state, the values of the enable registers are saved through power OFF/ON. The power-on status clear flag (see PSC?) is set false, disallowing service request interrupts after power-on.

In the enabled state, the enable registers are cleared during power ON. The power-on status clear flag (see PSC?) is set true, allowing service request interrupts after power-on.

Examples

***PSC 0**	Disable automatic power-on clearing of the enable registers.
***PSC 1**	Enable automatic power-on clearing of the enable registers.

*PSC?

Power-on Status Clear?

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Requests the state of the power-on status clear flag.

Response

0	The enable registers are saved through power OFF/ON.
1	The enable registers are cleared during power ON.

Registers affected:
Condition Status Enable: Service Request Enable
Event Status Enable: Standard Event Status Enable

See Chapter Three for more information on register structure.

Example ***PSC?** Request state of power-on status clear flag.

---

*PUD

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Stores data unique to the 8033, such as calibration date and serial number. This data is protected from change by the "SECURE <nrf>" command and is usually entered by the factory.

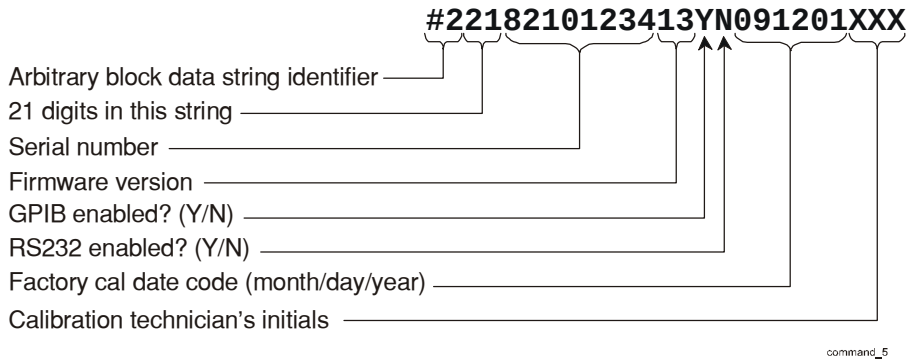
Notes The arbitrary block program data is exactly 25 bytes long.

*PUD?

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Requests the factory-stored identification string.

Response (sample)



*RST

Reset

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Performs a device reset and the following:

Sets OCIS state

Sets OQIS state

Notes **OCIS** = Operation-complete Command Idle State. This is the same state as after ***OPC**: no further operations to complete.

OQIS = Operation-complete Query Idle State. This is the same state as after ***OPC?**: no further operations to complete.

These idle states allow the 8033 to complete its reset process (no operations pending) before continuing with other operations.

Example *RST

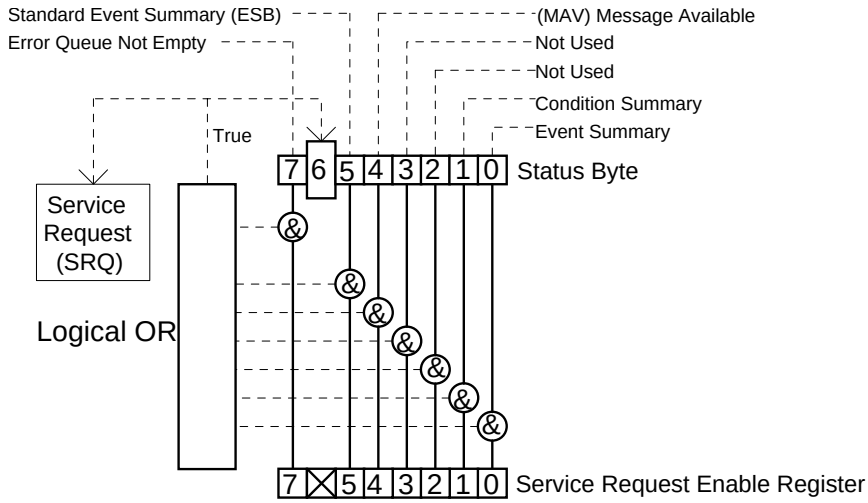
*SRE <nrf value>

Service Request Enable

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Enables bits in the service request enable register.

Values



Bit Reference

0- Event Summary	4- Message Available
1- Condition Summary	5- Event Status Summary
2- N/A	6- Request Service/Master Status Summary
3- N/A	7- Error Message Available

Notes Response is the sum of the enabled bits.

Example ***SRE 136**

*SRE?

Service Request Enable

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Requests the value in the service request enable register.

Notes Response is the sum of the enabled bits.

Response **Binter Interger Sum of enabled in *SRE Resister. Tehr value must be between 0 and 255.**

Example ***SRE?**

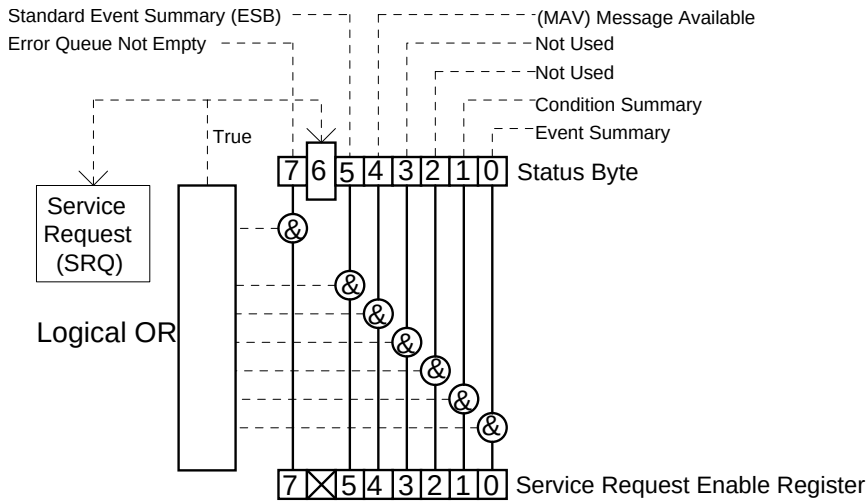
*STB?

Status Byte?

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Requests the value in the status byte register.

Values



Bit Reference

0- Event Summary	4- Message Available
1- Condition Summary	5- Event Status Summary
2- N/A	6- Request Service/Master Status Summary
3- N/A	7- Error Message Available

Notes Response is the sum of the enabled bits.

Example ***STB?**

TERM

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TERM command allows the programmer to select the message terminator type for GPIB messages. <CR> (carriage return), <CR><NL> (new line), <CR><^END> (EOI), <CR><NL><^END>, <NL><^END>, <NL>, and <^END> are allowed.

Parameters An <nrf value>, where the GPIB termination is one of the following:

0 -	<CR><NL><^END>	4 -	<NL><^END>
1 -	<CR><NL>	5 -	<NL>
2 -	<CR><^END>	6 -	<^END>
3 -	<CR>		

Notes <CR><NL><^END> (0) is the default type. This does not truly comply with the IEEE-488.2 specification. However, the <CR> character is ignored (treated as a white space), so this terminator may be used with other IEEE-488.2 compliant instruments.

Setting the terminator to anything other than number 4, <NL><^END> puts the 8033 out of compliance with the IEEE-488.2 specification. The other options are provided to allow compatibility with GPIB drivers which do not meet the IEEE-488.2 standard.

Use of terminator number 3 is especially risky with other devices which comply with the IEEE-488.2 specification. This is because the <CR> character is ignored, treated as a white space. Therefore, if number 3 terminator is used, other IEEE-488.2 devices may wait indefinitely for a message termination and "hang" the bus.

Examples "**TERM 5**" action: the <NL> (new line) terminator is selected. The 8033 will terminate messages with the <NL> character.

TERM?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TERM? query allows the programmer to determine which program message terminator is currently selected. <CR> (carriage return), <CR><NL> (new line), <CR><^END> (EOI), <CR><NL><^END>, <NL><^END>, <NL>, and <^END> are allowed.

Parameters None.

Response The response data is:

0 -	<CR><NL><^END>	4 -	<NL><^END>
1 -	<CR><NL>	5 -	<NL>
2 -	<CR><^END>	6 -	<^END>
3 -	<CR>		

Notes <CR><NL><^END> (0) is the default type.

Use of any terminator, other than number 4, removes the 8033 from strict compliance with the IEEE-488.2 standard.

Although the <CR> is recognized as a <white space> by the IEEE-488.2 specification, it is used as a possible terminator in order to be compatible with GPIB products which do not meet the IEEE-488.2 standard.

Examples "**TERM?**" response: 0, means the selected program message terminator is the <CR><NL><^END> characters, in that order.

TIME?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TIME? query allows the programmer to determine how much time has passed since the 8033 was last powered up.

Parameters: None.

Response: The response is character data in the form: hours:minutes:seconds.

Notes: The TIME clock is independent of the TIMER clock.

The clock "turns over" after about 1193 hours.

Examples: "**TIME?**" response: 0:01:02.36, means that 1 minute and 2.36 seconds have passed since the 8033 was powered up.

TIMER?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TIMER? query allows the programmer to determine how much time has passed since the last TIMER? query was issued.

Parameters: None.

Response: The response is character data in the form: hours:minutes:seconds.

Notes: Each time the TIMER? query is issued, the timer is reset to 0 and the elapsed time since the last TIMER? query is returned.

The timer counter is initialized at power-up. The first time the TIMER? is issued its response will be the same as the TIME? query.

The clock "turns over" after about 1193 hours.

Examples: "**TIME?**" response: 6:24:59.06, means that 6 hours, 24 minutes, 59.06 seconds have passed since the last TIMER? query was issued.

*TST?

Test?

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Performs internal self-test, then reports results.

Response 0 = test completed with no errors.
Non-zero = test not completed, or was completed with errors.

Example `TST?`

*WAI

Wait to Continue

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Prevents the 8033 from executing any further commands until OPC (operation complete) status is true.

Note This command can be used to make the 8033 wait until an operation is complete before continuing.

Example `*WAI` Wait until OPC status is true.

Error Messages

Error messages may appear on the display when error conditions occur in the 8033.

In remote operation, the current error list can be read by issuing the "ERR?" query. When this is done, a string will be returned containing the previously unread error messages (up to ten) which are currently in the error message queue. When the error queue is active, bit #7 of the Status Byte will be set to one.

Appendix A contains an explanation of the error messages which may be reported by the 8033 on the display or via remote operation.

Programming Examples

This section provides two simple examples of programming the 8033 over the GPIB.

Both examples are written in QuickBASIC for driving the National Instruments NI-488.2 GPIB card. The first is an example of a "driver" for GPIB communications with the 8033. The second is an example of how to enable the 8033 laser source and wait for the laser turn on sequence to complete. These examples are not complete, and therefore cannot be used by themselves. They do, however, illustrate the simplicity of programming the 8033. The initialization of some variables and files have been purposely omitted.

Programming Example: An MPS-8033 Driver

```
10    SUB
      Mps8033dvr(Device_id,Command$,Response$,Err$)
20    ' A subroutine to drive the ILX Lightwave MPS-8033
      Fiber Optic Source.  This driver
30    ' provides bus timeout protection and looks for device
      dependent errors.
40
50    ON ERROR GOTO handler                    ' Watch for software errors
60    CALL Ibtmo(Device_id, 10)                ' Provide 300 mSec timeout on GPIB
70
80    Cmd_len% = LEN(Command$)                 ' Get length of command string
90    IF (Cmd_len% > 0) THEN
100   CALL Ibwrt(Device_id,Command$)           ' Send the command
110   END IF
120
130   IF (INSTR(Command$,"?") THEN             ' Is the command a query?
140       CALL Ibrd(Device_id,Response$)        ' Get the response
150   END
160
170   CALL Ibwrt(Device_id,"*STB?")            ' Get the Status Byte
180   CALL Ibrd(Device_id,Status_byte%)
190   Err_bit% = Status_byte% AND 128          ' Is the error queue active bit set?
200   IF (Err_bit% > 0) THEN
210   CALL Ibwrt(Device_id,"ERR?")             ' Get the Error queue
220   CALL Ibrd(Device_id,Err$)                ' Report the Errors
230   PRINT "ERROR IN 8033 COMMUNICATIONS
      DEVICE DEPENDENT ERROR"
240   PRINT "ERRORS ARE:  " Err?
250   END IF
260
270   IF (Ibsta AND Timo) THEN PRINT "8033 GPIB  ' Did the bus timeout?
      TIMEOUT"
280   EXIT SUB
290
300:  Handler                                  ' Did the software bomb?
310   PRINT "MISC SOFTWARE GENERATED ERRORS
      IN 8033 DRIVER SUB"
320   END SUB
```

Programming Example: Laser output turn on subroutine

```
10    SUB Turnon8033(Device_id,On_ok%)
20    ' A subroutine to turn on the laser in the ILX Lightwave
      MPS-8033 Fiber Optic Source.
30
40    CALL Mps8033dvr(Device_id,"LAS:OUT                    ' Turn on laser
      ON",Response$,Err$)
50    On_ok% = 0                                            ' Initialize to laser off
60
70    WHILE (On_ok% = 0)                                    ' Loop until laser comes on
80       CALL                                               ' Is laser on yet?
      Mps8033dvr(Device_id,"LAS:OUT?",Response$,Err$)
90       On_ok% = VAL(Response$)                            ' Convert string to integer
100   WEND
110   END SUB
```

CHAPTER 5

MAINTENANCE

This chapter describes how to maintain the MPS-8033. Included are sections covering calibration, fuse replacement, line voltage selection, and disassembly.

WARNING

THE SERVICE PROCEDURES DESCRIBED IN THIS CHAPTER ARE FOR USE BY QUALIFIED PERSONNEL ONLY. POTENTIALLY LETHAL VOLTAGES EXIST WITHIN THE MPS-8033. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY OF THE PROCEDURES DESCRIBED IN THIS CHAPTER UNLESS YOU ARE QUALIFIED TO DO SO.

LASER DIODES ARE EXTREMELY SENSITIVE TO ELECTROSTATIC DISCHARGE. QUALIFIED SERVICE PERSONNEL ARE REQUIRED TO WEAR PROTECTIVE EYEGLASSES AND ANTI-STATIC WRIST BANDS WHILE WORKING ON THE MPS-8033 CIRCUIT BOARDS.

CAUTION! HIGH VOLTAGES ARE PRESENT ON AND AROUND THE PRINTED CIRCUIT BOARDS OF THE MPS-8033.

Calibration Overview

The instrument must be calibrated every 12 months or whenever performance verification indicates that calibration is necessary. All calibration can be done with the case closed. The instrument is calibrated by changing the internally stored digital calibration constants.

Recommended Equipment

Recommended test equipment for calibrating the instrument is listed in Table 5.1. Equipment other than that shown in the table may be used if the specifications meet or exceed those listed. Refer to Section 6.4 for calibration procedures using GPIB.

Table 5.1 Recommended Test Equipment for Calibration

Description	Mfg./Model	Specification
Optical Power Meter	ILX Lightwave OMM-6810B	Power Range .100 to 100 mW
Fiber Optic Patch Cord		SMF with FC/APC Connector, 3 meters

Environmental Conditions

Calibrate the instrument under nominal laboratory conditions. We recommend calibration at 23 °C ±1.0 °C. When necessary, however, the MPS-8033 may be calibrated at its intended use temperature if this is within the specified operating temperature range of 0 to 50 °C.

Warm Up

The MPS-8033 should be allowed to warm up with the laser output enabled for at least one hour before calibration.

Calibration Accuracy

The unit is calibrated at the factory using a 3-meter FC/APC single mode fiber (SMF) optic patch cord. The accuracy of the calibration is critically dependent on the patch cord used and the loss that occurs at the fiber optic connection with the instrument. These calibration procedures ensure the optical power at the end of the calibration patch cord through the front panel connection.

Local Operation Optical Power Calibration

The following procedure is for manual calibration of the MPS-8033 optical output power. Remote calibration is discussed in Remote Operation Optical Power Calibration on page 78. The instrument utilizes a 3-point calibration to characterize the power response of the source's laser diode.

Calibrating from the Front Panel

1. Connect the 8033 to an appropriate AC power source. Turn the power on and allow the 8033 to warm up for at least one hour. Enable the laser output by pressing the **(OUTPUT) ON** switch.
2. Connect the Optical Power Meter to an appropriate AC Power Source. Turn on the power and configure it for the following:

MODE:	Watts (linear)
RANGE:	Auto or mW
FILTER:	Slow
WAVELENGTH:	Equal to the wavelength of 8033 source (i.e. 1310 nm).

3. Comply with the warm-up considerations for the power meter. "Zero" the power meter per the Power Meter's instructions.
4. Connect the calibration fiber optic patch cord to the MPS-8033.
5. Connect the other end of the patch cord to the Optical Power Meter. Make sure the connections are clean and tight.
6. Start the calibration by simultaneously pressing **LOCAL**/**ADR** and **(MODE) CW**. The display clears for two seconds before the output is turned on and the power is set to the first calibration value.
7. Using the ADJUST KNOB, change the power until the 8033 display exactly matches the power displayed on the power meter.
8. Press **SET REFERENCE** to store the first calibration point into memory. The 8033 then switches to the next calibration value.
9. Use the ADJUST KNOB, change the power until the 8033 display exactly matches the power displayed on the power meter.
10. Press **SET REFERENCE** to store the second calibration point into memory. The 8033 switches to the final calibration value.
11. Using the ADJUST KNOB, change the power until the 8033 display exactly matches the power displayed on the power meter.
12. Press **SET REFERENCE** to store the third calibration point into memory. The 8033 internally computes the new calibration factors and returns the device to the same state as when the calibration was initiated.

The calibration is complete. The new calibration factors are stored in non-volatile RAM for safe keeping when the power to the device is turned off.

Remote Operation Optical Power Calibration

The following procedure is for calibration of the MPS-8033 optical power via GPIB. The 8033 utilizes a 3-point calibration to characterize the power response of the internal laser diode. It may help to be familiar with front panel calibration before attempting it remotely.

Calibrating through the GPIB

1. Connect the 8033 to an appropriate AC power source. Turn the power on and allow the 8033 to warm up for at least one hour.
2. Connect the Optical Power Meter to an appropriate AC Power Source. Turn on the power and comply with any warm up considerations. Zero the power meter per the power meter's instructions.
3. Connect the calibration fiber optic patch cord to the MPS-8033.
4. Connect the other end of the patch cord to the Optical Power Meter. Make sure the connections are clean and tight.
5. Remotely configure the MPS-8033 by using the following GPIB commands:

   ```
   *CLS

   LAS:STEP 0.0001 MW
   ```

6. Remotely configure the power meter for the following. This example assumes the ILX Lightwave OMM-6810B is being used.

   ```
   *CLS

   POWER: AUTO ON

   RATE SLOW

   WAVE  xxxx
   ```

   Where xxxx = wavelength of 8033 source in nanometers.

7. Start the calibration by sending the following command to the 8033.

   ```
   CAL:START
   ```

8. Create a software loop using the increment and decrement commands to adjust the output power from the 8033. Stay in the loop until the dislayed power of the 8033 is within 0.0001 mW of the measured power from the power meter. Use the following 8033 commands as necessary:

   ```
   LAS:INC

   LAS:DEC
   ```

   Use the following OMM-6810B Power Meter command to read the actual power:

   ```
   POW?
   ```

9. When the power measurements between the meter and the 8033 are within 0.0001 mW, send the following command to the 8033:

   ```
   CAL:USER1
   ```

10 Using the same methodology in step 8, create a loop to achieve the second power calibration value.

11 When the power measurements between the meter and the 8033 are within 0.0001 mW, send the following command to the 8033:

```
CAL:USER2
```

12 Using the same methodology in step 8, create a loop to achieve the final power calibration value.

13 When the power measurements between the meter and the 8033 are within 0.0001 mW, send the following command to the 8033:

```
CAL:USER3
```

14 The calibration is complete. The new calibration factors will be stored into non-volatile RAM for safe keeping when the power to the device is turned off.

Recalling the Factory Calibration

To reset the 8033 to the default calibration, send the following command via GPIB.

```
CAL:RECALL
```

When this command is issued the present calibration values are lost and the default calibration is reset. ILX Lightwave recommends a user calibration after you execute this command.

Cleaning the Internal Fiber Optic Connector

Occasionally the fiber optic output connector on the 8033 becomes dirty. This section describes two procedures for cleaning the end of the output fiber. The first method is the easiest way to clean the fiber end, while the second if extremely dirty connectors.

First method:

1 Dampen a small cotton swab with some reagent grade methanol.

2 Insert the swab into the FC bulkhead connector until it touches the end of the internal fiber.

3 Remove the swab. **Do not rotate the cotton swab when it is in contact with the fiber end**, as scratching of the fiber end may occur due to small pieces of dirt sitting there.

This cleaning procedure may be used as many times as necessary to remove contamination from the fiber end.

Second method: this procedure requires some disassembly of the 8033 and should be performed with caution.

CAUTION

Make sure that the instrument is off and unplugged before beginning this procedure.

1. Lay the instrument on its side, remove the two screws securing the bottom panel and remove the panel. The optical fiber is in a coil beneath the printed circuit board.
2. Remove the two screws securing the connector bezel to the front panel, and pull the connector assembly away from the front panel about one inch (2.5cm).
3. Remove the bulkhead connector from the FC connectorized fiber.
4. Dampen a small cotton swab with methanol. Gently and carefully wipe the side of the swab across the fiber.
5. Rotate the swab slightly in order to use a fresh surface on the next wipe and continue until clean.
6. Insert the fiber into the bulkhead connector.
7. Reattach the connector assembly to the front panel. Inspect the routing of the optical cable located at the bottom of the unit. The fiber must not be kinked in any way, or power stability will suffer. Dress the cable as necessary to make sure that all bends are gradual.
8. Replace the bottom cover and secure with the two screws.

Fuse Replacement

CAUTION

For continued protection, replace fuse with only same type and rating.

The fuse is accessible from the back panel of the 8033. Before replacing the fuse, turn power off and disconnect the line cord. Use only the fuses indicated below in Table 5.2.

Table 5.2 Fuse Replacement

Line Voltage	Fuse Replacement
100-120 VAC	0.5 Amp, 3AG, Slo Blo, 250 VAC
220-240 VAC	0.25 Amp, 3AG, Slo Blo, 250 VAC

Line Voltage Selection

Line voltage selection requires opening the case and exposure to potentially lethal voltages. These procedures are to be performed by qualified personnel only. Consult the factory for service information.

CHAPTER 6

TROUBLESHOOTING

This chapter is intended to be used as a guide when the MPS-8033 does not perform as expected. It is not a service manual, rather a guide to alleviating basic problems that can arise during operation.

Hardware Troubleshooting Guide

If you have difficulty operating the 8033, refer to the symptoms listed here. Some of the common causes and corrective actions for these symptoms are listed in this section.

Table 6.1 Hardware Troubleshooting

Symptoms	Causes and Corrective Actions
8033 will not power up	• Check the power cord to make sure that it is properly connected. Check the fuse for integrity and proper rating. • If the above suggestions fail, check the line voltage selection.
OUTPUT does not stay on	• Check the display for error messages when the **(OUTPUT) ON** switch is pressed "on". • "E501" indicates an open interlock (The interlock is an internal jumper on the 8033 Analog Board). • "E529" through "E975" indicates that there is an internal hardware/software communication problem which prevents the output from being enabled. • If GPIB is used, it is possible the Outoff register has been intentionally set to disable the output on certain conditions or events. Refer to the "ENAB:OUTOFF" command in Chapter 4. • It is possible an error condition occurred which turned the OUTPUT off, but the error was corrected before the user read the message. Error messages are displayed for three seconds or until the error causing condition is remedied.
Output Power does not agree with the front panel display	• The output connector may need cleaning. Clean the output fiber. See Cleaning the Internal Fiber Optic Connector on page 79. • The 8033 may require calibration.The accuracy of the calibration is critically dependent on the patch cord used and the loss that occurs at the fiber optic connection with the 8033. Calibration is described in Calibration Overview on page 76.

Table 6.1 Hardware Troubleshooting

Symptoms	Causes and Corrective Actions
Output is on but there is no light at the end of the patch cord	• Check the patch cord and the connection with the 8033 and other test equipment.

GPIB Troubleshooting Guide

If you have difficulty operating the 8033 via GPIB, refer to the symptoms listed here.

Symptoms	Causes and Corrective Actions
No response from 8033 upon a GPIB command (remote light does not come on)	• Check that a GPIB cable is connected between the 8033 and the system controller (your computer). This cable should be less than 3 meters long. • Check that the GPIB address is set properly and the controlling software is sending commands to the proper address. • Make sure no two devices have the same GPIB address. • Check that there are less than 15 devices on the bus and there is less than 20 meters of total cable. • Check that the GPIB controller card in the host computer is configured properly. • Try isolating the 8033 by removing all other instruments from the bus.
Slow or unexpected responseto GPIB commands	• Make sure no two devices have the same GPIB address. • Check that there are less than 15 devices on the bus and there is less than 20 meters of total cable. • Make sure the GPIB controller card in the host computer is configured properly. • Try isolating the 8033 by removing all other instruments from the bus.
Device does not respond to command (remote light is on)	• Read the error queue remotely (ERR?). The command syntax or command structure may be in error. • Read the status byte (*STB?) and condition register (COND?) for possible device problems. • Make sure the GPIB controller card in the host computer is configured properly.
Bus Hangs	• Place a software timeout around the command in question to prevent the hang. • Check the syntax of the command that is causing the hang-up. • Make sure the controlling software is not requesting information from the 8033 without first sending a query command. • Make sure the GPIB controller card in the host computer is configured properly. • Check GPIB cables and the GPIB address.

APPENDIX A

ERROR MESSAGES

When errors occur, messages may appear on the 8033 display. In remote operation, the current error list can be read by issuing the "ERR?" query. When this is done, a string will be returned containing all of the error messages which are currently in the error message queue.

Error Message Reference

Table A.2 contains all of the error messages which may be generated by the 8033. Not all of these messages may appear on the front panel display. Some refer to GPIB activities only.

The errors codes are numerically divided into areas of operation. Errors which pertain to the following areas are listed in the ranges shown in Table A.1.

Table A.1 Error Code Classifications

Error Code Range	Area of Operation
E-001 to E-099	Internal Program Errors
E-100 to E-199	Parser Errors
E-200 to E-299	Execution Control Errors
E-300 to E-399	GPIB Errors
E-400 to E-499	Not Used
E-500 to E-599	Laser Controller Errors
E-600 to E-699	Not Used
E-700 to E-999	Hardware Errors

Table A.2 Error Code Descriptions

Error Code	Explanation
E-001	Memory allocation failure.
E-101	<program mnemonic> is too long.
E-102	<PROGRAM MESSAGE UNIT> is too long.
E-103	<DEFINITE LENGTH ARBITRARY BLOCK PROGRAM DATA> length too long.
E-104	<NON-DECIMAL NUMERIC PROGRAM DATA> type not defined.
E-105	<DECIMAL PROGRAM DATA> exponent not valid.
E-106	<DECIMAL PROGRAM DATA> digit expected.
E-107	<DECIMAL PROGRAM DATA> digit not expected.
E-108	<DECIMAL PROGRAM DATA> more than one decimal point.
E-109	<DECIMAL PROGRAM DATA> more than one exponent indicator (E).
E-110	<SUFFIX PROGRAM DATA> must have digit following sign.
E-111	<SUFFIX PROGRAM DATA> must have alpha character following operator.
E-113	<ARBITRARY BLOCK PROGRAM DATA> length less than digit count.
E-114	<DEFINITE LENGTH BLOCK PROGRAM DATA> premature end of data.
E-115	<PLACEHOLDER PROGRAM DATA> identifier not valid.
E-116	Parser syntax error, character was not expected.
E-120	<program mnemonic> Lookup, word as part of a header path, has no commands.
E-121	<program mnemonic> Lookup, word as part of a header path, is not found.
E-122	<program mnemonic> Lookup, cannot find a null entry.
E-123	<program mnemonic> Lookup, word within context of current path, is not found.
E-124	<program mnemonic> Lookup, failed because query/command type match failed.
E-125	<program mnemonic> Lookup, word within context of common command path, is not found.
E-126	Too few or too many program data elements.
E-201	<PROGRAM DATA> value out of range.

Table A.2 Error Code Descriptions

Error Code	Explanation
E-202	<PROGRAM DATA> will not convert to valid type.
E-203	Security violation, command is not available without clearance.
E-204	<PROGRAM DATA> suffix type is not valid.
E-205	<PROGRAM DATA> is not a boolean value or word.
E-206	<PROGRAM DATA> will not convert to a signed 16 bit value.
E-207	<PROGRAM DATA> will not convert to an unsigned 16-bit value.
E-208	<PROGRAM DATA> will not convert to a signed 32 bit value.
E-209	<PROGRAM DATA> will not convert to an unsigned 32-bit value.
E-210	<PROGRAM DATA> will not convert to a floating point value.
E-211	<PROGRAM DATA> will not convert to a character value.
E-212	<PROGRAM DATA> will not convert to a byte array pointer.
E-213	<PROGRAM DATA> is incorrect block data length.
E-214	<PROGRAM DATA> length exceeds maximum.
E-301	A <RESPONSE MESSAGE> was ready, but controller failed to read it. (Query error).
E-501	Interlock disabled output.
E-511	Control error disabled output.
E-516	Incorrect Configuration for Calibration Sequence to start.
E-529	Hardware error disabled output.
E-532	Illegal Modulation Frequency chosen.
E-706	Auto-calibration cycle aborted.
E-720 to E-975	Invalid internal status reporting error.

APPENDIX B

QUICK START GUIDE

This chapter contains information that allows you to quickly install, configure, and operate the MPS-8033.

Installation

Check to make sure the voltage printed on the back panel of the instrument matches the power-line voltage in your area. Connect the MPS-8033 to the proper AC power receptacle and turn the front panel KEYLOCK switch to the "ON" position.

WARNING

The following warnings must be observed whenever the MPS-8033 is in operation. Failing to comply with these precautions could result in severe injury or death! These warnings also apply to the service and repair of the instrument. The MPS-8033 is a Class-1 Laser Product.

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Do not enable the laser when there is no fiber attached to the optical output connector.

The optical output connector is at the bottom right on the MPS-8033 front panel. The laser is enabled by pressing the OUTPUT ON switch to the left of the optical output connector. The laser is on when the green LED indicator above the switch is solidly lit.

Never look into the end of a fiber optic cable attached to the optical output of the MPS-8033 when the device is operational.

The laser radiation is not visible to the human eye, but can seriously damage eyesight.

To avoid electrical shock hazard, connect the instrument to properly earth- grounded, 3-prong receptacles only. Failure to observe this precaution can result in severe injury or death.

Operation

The following paragraphs briefly explain the operation of each function of the MPS-8033.

DISPLAY Use the DISPLAY switch to toggle the display units between linear scale (mW), log scale relative to 1 mW (dBm) and log scale relative to a user defined reference (dB).

ADJUST KNOB The ADJUST KNOB is used to set various parameters such as the output power and GPIB address. Clockwise rotation of the knob increases the parameter value.

MODE Use the CW switch to force the output to a continuous wave (CW) mode. The first execution of the INT MODULATION switch will change the modulation to the last used frequency. Subsequent executions of the INT MODULATION switch will toggle between the three available internal modulation frequencies.

SET REFERENCE Use the knob to set any desired reference power. Then press the SET REFERENCE switch to establish that power as the reference for the dB scale. When the SET REFERENCE switch is pressed the display automatically changes to the dB scale.

OUTPUT Connect a fiber optic patch cord to the FC connector on the front panel of the 8033. Press the (OUTPUT) ON switch to turn on the source. A two second safety delay is indicated by the flashing (OUTPUT) ON LED indicator. After the delay, the source enables and the indicator is solidly illuminated. To turn the source off press the (OUTPUT) ON switch again. The (OUTPUT) ON LED indicator will extinguish.

GPIB To view the GPIB address press the LOCAL/ADR switch when in the local mode. In remote, press LOCAL/ADR to return the device to local control. Instructions for setting the GPIB address are found in Setting the GPIB Address on page 20.

TTL OUT The TTL OUT connector on the rear panel is the electrical equivalent of the front panel optical output. It can be used as a synchronization signal.

ERRORS Errors are indicated on the display in the form Exxx where xxx is a three digit number representing the error. See Error Messages on page 83.

Power-on Conditions

At power-on, the 8033 initializes the instrument parameters to be the same as when the instrument was last powered-down. The laser output is always off at power-up.

More Information

Please read Chapter 2, Local Operation, to become familiar with all of the features of the 8033. GPIB operation is discussed in Chapter 3, Remote Operation and Chapter 4, Command Reference. Calibration is described in Chapter 5, Maintenance.

APPENDIX C

GPIB System Controller Configuration

This appendix provides a guide for setting up the GPIB System Controller for remote control of the MPS-8033. Routine GPIB operation is described in Chapter 3, Remote Operation and Chapter 4, Command Reference. A GPIB troubleshooting guide is found in Chapter 6, Troubleshooting.

Configuring the National Instruments NI-488.2 GPIB Controller

The National Instruments GPIB Controller card is configured using the 'ibconf' utility. Setup the MPS-8033 device file as follows:

Primary GPIB Address:	0 through 30
Secondary GPIB Address:	NONE
Timeout Setting:	1 sec
Serial Poll Timeout:	1 sec
Terminate Read on EOS:	No
Set EOI with EOS on Writes:	Yes
Type of Compare on EOS:	7-Bit
EOS Byte:	00h
Send EOI at end of Write:	Yes
Enable Repeat Addressing:	Yes

GPIB Termination Characters

The default termination characters for the 8033 are <CR><NL><^END>. This does not truly comply with the IEEE-488.2 specification. However, the <CR> character is ignored (treated as a white space), so this terminator may be used with other IEEE-488.2 compliant instruments.

Setting the terminator to anything other than number 4, <NL><^END> puts the 8033 out of compliance with the IEEE-488.2 specification. The other options are provided to allow compatibility with GPIB drivers which do not meet the IEEE-488.2 standard. Refer to the TERM command in Chapter 4, Command Reference and, if necessary, modify the termination sequence for the 8033 to match that of the system controller.

INDEX

S

T

W