User's Guide

Fiber Optic Power Meter
FPM-8220

ILX Lightwave
Photonic Test and Measurement

ILX Lightwave Corporation · P. O. Box 6310 · Bozeman, MT, U.S.A. 59771 · U.S. & Canada: **1-800-459-9459** · International Inquiries: 406-556-2481 · Fax 406-586-9405

ilx.custhelp.com · www.ilxlightwave.com

700440 July 2011

Table of Contents

This page was intentially left blank.

Safety and Warranty Information

- ✓ Details about cautionary symbols
- ✓ Safety markings used on the instrument
- ✓ Information about the warranty
- ✓ 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 indicates a potentially hazardous situation which can result in minor or moderate injury or damage to the product or equipment.

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

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

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.

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 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


On: in position of bistable push control. The slash (|) only denotes that mains are on


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:

- Obtain a Return Authorization number (RA) from ILX Customer Service.
- 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.
- Attach the anti-static protective caps that were shipped with the instrument and place the instrument in a protective anti-static bag.
- 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.
- Secure the packing box with fiber reinforced strapping tape or metal bands.
- 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

On the web at: ilx.custhelp.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 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!

This page was intentionally left blank.

Chapter 1:
Introduction and Specifications

This chapter is an introduction to the FPM-8220 Fiber Optic Power Meter and the FMH-8705, FMH-8715 and FMH-87107 Fiber Optic Measurement Heads. This chapter also includes:

- ✓ Safety considerations and instructions
- ✓ Product Overview
- ✓ Options and accessories
- ✓ Specifications

Safety Considerations

If any of the following symptoms exist, or are even suspected, remove the FPM-8220 from service. Do not use the FPM-8220 until trained service personnel can verify safe operation.

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

If necessary, return the FPM-8220 to ILX Lightwave for service and repair to ensure that safety features are maintained.

Product Overview

The FPM-8220 is a precise and reliable tool for fiber optic power measurement. The FPM-8220 is compatible with the FMH-8705, FMH-8715, and FMH-87107 fiber optic measurement heads. The FMH-8705 accommodates wavelengths from 800 to 1650 nm and accurately measures power over a 86.5 dB dynamic range from +1.5 dBm to -85 dBm. Both the FMH-8715 and the FMH-87107 accommodate wavelengths from 800 to 1650 nm. The FMH-8715 accurately measures power over a 90 dB dynamic range, from +20 dBm to -70 dBm, while the FMH-87107 measures over a range of 90 dB, from +30 dBm to -60 dBm. NIST-traceable calibration assures consistent results. Other features include:

- Each reading is the average of up to 100 measurements to provide high accuracy even with unstable inputs
- Store and recall up to ten instrument settings

- Relative power can be displayed by a bar graph on the front panel for visual confirmation of the peaking of optical power in alignment applications
- 0 to 10 V analog output for fine resolution relative power monitoring
- A sophisticated USB and GPIB/IEEE 488.2 interface
- The fiber optic measurement head includes a two meter cable for convenient positioning near the device under test
- A heavy, robust design for production test workstations
- Customer upgradeable firmware via USB

Figure 1.1 – FPM-8220 Front Panel

Figure 1.2 – FPM-8220 Rear Panel

Options and Accessories

Options and accessories available for the FPM-8220 Fiber Optic Power Meter and the FMH-8700 series Fiber Optic Measurement Heads include the following:

Description	Model / Part Number
FC Adapter	CA -100
SC Adapter	CA -150
LC Adapter	CA - 200
Bare Ferrule Adapter	CA - 250
Bare Fiber Adapter Ring	CA - 120
Bare Fiber Holder (requires CA-120)	BF - 820
Rack Mount Kit, single instrument	RM - 144
Rack Mount Kit, dual instrument	RM - 145
Rack Mount Kit, FMH Measurement Heads	RM - 143

The CA-120 bare fiber adapter ring accepts ILX Lightwave BF-820 or Agilent 81000BA bare fiber holders. This compatibility also means you can use the BF-820 bare fiber holder with Agilent or HP power meters.

Specifications

	FMH-8715	FMH-87107	FMH-8705
Wavelength Range:	800 to 1650 nm	800 to 1650 nm	800 to 1650 nm
Power Range:	-70 to +20 dBm	-60 to +30 dBm	-85 to +1.5 dBm
Damage Threshold:[1]	+40 dBm <1 min.	+40 dBm <1 min.	+10 dBm
Accuracy[2,3,4]	±2.5% ±100 pW	±2.5% ±1 nW	±3.5% ±2 pW
Polarization Dependent Response:[5]	±0.006 dB	±0.006 dB	----------
Measurement Repeatability:[6]	<±0.01 dB	<±0.01 dB	----------
Noise:	≤ 100 pW p-p	≤ 1 nW p-p	< 2 pW p-p
Temperature Coefficient:[3]	<0.2% / °C	<0.2% / °C	<0.2% / °C
Linearity:[7]	±0.02 dB	±0.02 dB	±0.02 dB
	-35 to +20 dBm	-35 to +30 dBm	-60 to +1.5 dBm
Connector Port Effect Factor:[8]	1.02 typical	1.02 typical	NA
Connector Port Effect Error:[8]	±1.10%	±1.10%	NA
Beam Displacement Error:[9]	<±0.1% / mm	<±0.1% / mm	<±0.5% / mm
	(±0.025% typical)	(±0.025% typical)	(±0.125% typical)
Beam Divergence Error:[10]	±0.175%	±0.175%	±1.5%
Optical Measurement:	Integrating sphere with detector		Detector
Entrance Aperture:	5 mm	5 mm	3 mm
Numerical Aperture:	<0.4 NA	<0.4 NA	<0.4 NA
Sensor Type:	InGaAs	InGaAs	3.0 mm InGaAs
Connector Types:[11,12]	FC, SC, LC, bare fiber, bare ferrule		
Output Connector	DB-26 High Density, male		

GENERAL

Size:	86 x 86 x 100 mm (3.4" x 3.4" x 3.9")
Weight (8715/87107):	0.98 kg.; 2.15 lbs.
Weight (8705):	0.8 kg.; 1.75 lbs.
Operating Environment:	0°C to 40°C
Storage Environment:	-25°C to 65°C
Compliance:	RoHS, CE

GENERAL (FPM-8220)

Input Connector:	DB-26 high density, female
Power:	90 - 126 VAC, 50/60 Hz
	207 - 253 VAC, 50/60 Hz
GPIB Interface:	IEEE-488.2
USB Interface:	2.0
Compliance:	RoHS, CE
Warm Up:	1 hour to rated specifications
Dimensions:	330mm x 216mm x 90mm
	13" x 8.5" x 3.5"
Weight:	3.24 kg; 7.1 lbs.
Operating Environment:	5°C to 45°C
Storage Environment:	-25°C to 65°C

NOTES

1. Limit 40 dBm exposure to ≤ 1 minute to avoid thermal damage.
2. Reference Conditions: Input power level 10 µW continuous wave (CW), averaging time 1s, ambient temperature 21°C ±3°C, humidity 15 - 85% non-condensing, spectral width of source < 14 nm FWHM, user setting of wavelength must correspond to actual source center wavelength ±1 nm. Recommended calibration period 1 year.
3. Accuracy quoted for reference temperature of 21°C ±3°C. Assume ±5% accuracy at the limits of the operating temperature range 0°C < T < 40°C due to temperature coefficient.
4. Wavelength must not be equal to any water vapor absorption line.
5. Polarization Dependent Response (PDR) is a variation in meter response associated with changes in input polarization state. Measured at constant wavelength (1580 nm) and power (~0.5 dBm)
6. Fiber Input Repeatability measured by the variation in response from removing and replacing a connectorized single mode fiber into the detector head. Does not include bare fiber adapter.
7. Linearity is the variation from an actual measurement to an expected measurement over decades of optical input power. Valid across range limits when measured in auto-range mode.
8. Connector Port Effect is the maximum percent variation in optical integrating sphere transmission influenced by the reflectivity of different fiber optic connectors. This is calculated as follows.

$$CPE = \pm \frac{MAX(SFC, SSC, SLC, SBFA) - MIN(SFC, SSC, SLC, SBFA)}{2 * AVG(SFC, SSC, SLC, SBFA)}$$

Where SFC, SSC, SLC, SBFA are the signal levels measured when using the various fiber optic connectors.

9. Beam Displacement Error is the measurement uncertainty caused by an offset of the fiber connector offset from the center of the input aperture. Typical value includes machine tolerance stack up between center of the aperture and input fiber when fiber adapter is used. Does not include bare fiber adapter.
10. Beam Divergence Error is a calculated uncertainty based on the measured angle sensitivity of the measurement head. Value applies to input beams ≤0.40 A.
11. Adapters available for FC, SC, LC, and Bare Fibers.
12. Bare fibers can be supported with ILX Lightwave BF-820 or Agilent 81000BA bare fiber holders. ILX Lightwave BF-820 fiber holders are designed for fiber diameter 125 µm (250 µm and 900 µm buffer).

Chapter 2:
General Operation

This chapter describes how to set up and operate the FPM-8220 Fiber Optic Power Meter using the front panel controls.

- ✓ Installation
- ✓ Introduction to the FPM-8220 front panel
- ✓ FMH-8700 series fiber optic measurement head familiarization
- ✓ Analog Output
- ✓ General operating procedures

Installation

Grounding Requirements

The FPM-8220 Fiber Optic Power Meter comes with a three conductor AC power cable. The power cable must be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adaptor with the grounding wire connected to an electrical ground (safety ground). ILX Lightwave recommends connecting the instrument only to properly earth grounded receptacles. The power cord connector and power cable meet IEC safety standards.

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.

AC Line Power Requirements

The FPM-8220 is factory configured for operation at nominal line voltages of 100, 120, 220, or 240 VAC. Make sure the voltage requirements that are printed on the back panel of the instrument matches the power-line voltage in your area. Contact ILX Lightwave Customer Service if you need to reconfigure the input voltage range.

Power up Sequence

With the FPM-8220 connected to an AC power source, pressing **POWER (**  **)** supplies AC line power to the instrument and starts the following power-up sequence:

- All front panel indicators ON, all 7-segment displays indicate "8"
- All front panel indicators OFF
- Display shows serial number and firmware version of the meter

- If a measurement head is connected, the display shows the measurement head's serial number and calibration date. If the measurement head is not connected, the display shows "No Head Connected."

Each display lasts 2-3 seconds.

During the front panel indicator test, the FPM-8220 performs a self-test to ensure that internal hardware and software are communicating. If the FPM-8220 cannot successfully complete the test, an error message is displayed. See Appendix A for a complete list of error messages. After the self test, FPM-8220 configuration is set to the same state as when power was last turned off.

If you wish, you can use the recall function to quickly get to a different configuration. See Store and Recall for more information.

Firmware Upgradeability

The firmware on the FPM-8220 can be reinstalled or upgraded via USB 2.0 by visiting the ILX Lightwave website at www.ilxlightwave.com. Follow the directions on the FPM-8220 product web page to complete the firmware upgrade.

GPIB Communication

The IEEE 488.2 GPIB interface connector is located on the rear panel, directly above the power input (See Figure 1.2 on page 2). The 24-pin connector is tapered to ensure proper orientation of the GPIB cable. Use fingers to tighten the two screws on the cable connector.

A total of 15 devices can be connected together on the same GPIB interface bus. The cables have double-sided male/female connectors on each end so that several cables can be stacked. This allows more than one cable to be attached to any one device. However, the maximum length of the GPIB interface bus must not exceed 20 meters (65 feet), or 3 meters (10 feet) per device.

USB Communication

The USB connector is located on the back rear panel, next to the GPIB connector. This USB connector is the square "B"-style connector. A standard USB A/B cable is required to communicate with the instrument. To communicate to the instrument using USB, install the USB Driver found on the accompanying CD or on the website prior to connecting the unit to the PC. Please refer to Chapter 3 for more detailed instructions on operating the instrument through USB.

Connecting a Measurement Head

All optical measurement heads interface with the instrument via the 26 pin high density 'D' connector located on the lower left side of the rear panel.

Tilt Foot Adjustment

The FPM-8220 has front legs that extend to make it easier to view the displays. To use them, rotate the legs downward until they lock into position.

Rack Mounting

The FPM-8220 conforms to international standards for a 2U height ½ width rack mounting. Available rack mount accessory kits contain detailed mounting instructions.

Front Panel Operation

This section describes the fundamentals of front panel operation for the FPM-8220 Fiber Optic Power Meter. Both of the labeled areas on the front panel, SETUP and MODE, and the display are described below.

Figure 2.1 – Front Panel Display

Power On / Off

The **POWER** ( ) button applies power to the FPM-8220 and starts the power-up sequence described in Chapter 1.

Setup

Up Arrow	The **UP ARROW** ( ) is used to increase values for gain adjustment, wavelength, display filter, store and recall bins, GPIB address, and the user calibration factor. In auto gain range operation mode, the arrow key can be used to put the instrument into manual gain range mode.
Down Arrow	The **DOWN ARROW** ( ) is used to decrease values for gain adjustment, wavelength, display filter, store and recall bins, GPIB address, and the user calibration factor. In auto gain range operation mode, the arrow key can be used to put the instrument into manual gain range mode.
Enter	Pressing the **ENTER** pushbutton stores a new value of the parameter that is currently being adjusted.
Recall	Pressing **RECALL** allows the user to recall a stored instrument setup from recall bins numbered 0 to 10. Savable settings include gain range, wavelength, display mode, filter mode, and the user calibration offset value. To select a stored setup, first press the **RECALL** pushbutton then use the **UP ARROW** and the **DOWN ARROW** to select the appropriate recall bin and press **ENTER** to select the stored bin.
Bin 0	Factory default instrument configuration
Bin MsmtHead	Measurement Head information including model number, serial number,

Info	and last calibration date.
Store	Pressing **STORE** allows the user to save an instrument setup, including gain range, wavelength, display mode, filter mode, and user calibration offset value, in bins numbered 1-10. To save a setup, first press the **STORE** pushbutton, then use the **UP ARROW** and the **DOWN ARROW** to select the appropriate store bin and press **ENTER.**
Wavelength	By pressing **WAVELENGTH (λ)** and using the **UP ARROW** and the **DOWN ARROW,** the user can adjust the wavelength to that of the input light for accurate power measurements. The wavelength adjustment range is dependent upon the FMH-8700 series Fiber Optic Measurement Head connected to the FPM-8220.
Local	When the instrument is in remote operation mode, pressing the **RECALL** pushbutton will put the instrument back to local (front panel) control mode.
Remote	Upon receipt of a command through either the USB or GPIB interface bus, the instrument automatically enters remote mode; indicated by **RMT** in the upper right corner of the display. During remote communication, the front panel will be locked. Pressing the **RECALL** pushbutton will unlock the front panel.
GPIB Address	Pressing **RECALL** and the **UP ARROW** pushbuttons simultaneously will put the instrument in the GPIB address adjust mode. The currently stored GPIB address will appear in the parameter line of the display. Pressing the **UP ARROW** or the **DOWN ARROW** changes the address number.

Mode

dBm/W	Pressing **dBm/W** changes the measurement dimensions from dBm to watts. Pressing the button again changes the dimensions back.
REF	Pressing and immediately releasing the **REF** pushbutton puts the instrument into reference measurement mode where the displayed measurement is relative to the set reference value. When in reference mode, the display's enunciator changes to dB or W, depending on the mode, and a delta symbol is displayed, right justified, in the enunciator field. To set a new reference value, hold **REF** for five seconds.
View Ref	To view the set reference value, press the **dBm/W** and **REF** pushbuttons simultaneously. The value is displayed for 3 seconds in the parameter line.
Auto/Man	Pressing **AUTO/MAN** changes the instrument's measurement mode to either auto, where the gain range is changed through a firmware algorithm depending on the input, or manual, where the gain range is set by the user. If the instrument is in auto measurement mode, pressing either of the arrow pushbuttons changes the measurement mode to manual. In manual mode, the gain range is displayed on the parameter line. Pressing the **UP**

ARROW or the **DOWN ARROW** changes the gain range. The full scale measurement for each gain range is displayed, right justified, in the parameter field.

Filter — Pressing **FILTER** offers three display update rates: slow, medium, and fast.

Indicator	Averaging	Display Update Rate
SLOW	100 measurements	5 seconds
MEDIUM	10 measurements	500 ms
FAST	1 measurement	50 ms

CAL — Pressing **CAL** initiates the calibration measurement function, which multiplies every measurement by a calibration factor. The range of calibration is 0.500 to 2.500. The default value is 1.000. The LED above the **CAL** pushbutton will illuminate for any value other than 1.000. Use the **UP ARROW** and the **DOWN ARROW** to adjust the calibration factor.

Zero — Pressing **ZERO** initiates the meter zero function. Increasing dashes in the numerical part of the display, along with a "Zeroing" enunciator in the parameter line of the display, shows the function's status.

Display — Pressing **DISPLAY** cycles the bottom dot matrix display from the instrument's setting information to the brightness of the display to a bar graph.

Display

The bottom dot matrix display can show the instrument's setting information, the display's brightness, or a bar graph.

Setting Information – Displays from left to right wavelength, filter speed, and gain range/auto. The far right will display gain range if in manual mode or "Auto" if auto gain range.

Figure 2.2 – Setting Information in Manual Mode

Figure 2.3 – Setting Information in Auto Mode

Brightness – When the brightness is displayed, the **UP ARROW** and the **DOWN ARROW** adjusts the brightness of the display from 1 to 10.

Figure 2.4 – Brightness Display

Bar Graph - The bar graph display shows relative input level as a percentage of full scale for each gain range. In fast and medium filter speeds, the bar graph will update at 50ms. In slow filter speed, the bar graph will update every 200ms.

Figure 2.5 – Bar Graph Display

Error Codes

The FPM-8220 indicates front panel operation errors on the measurement display with an error code. A complete list of error codes is listed in Chapter 5.

The FPM-8220 Fiber Optic Measurement Heads

The FPM-8220 is compatible with three fiber optic measurement heads:

FMH-8705 InGaAs, Fiber Optic Measurement Head, Detector Only (+1.5 to -75 dBm)
FMH-8715 InGaAs, Fiber Optic Measurement Head, Integrating Sphere (+20 to -70 dBm)
FMH-87107 InGaAs, Fiber Optic Measurement Head, Integrating Sphere (+30 to -50 dBm)

The FMH-8705 is a detector only measurement head designed to provide a low optical power measurement range.

The FMH-8715 and FMH-87107 use integrating sphere technology to provide high accuracy optical power measurements. More than a simple integrating sphere, the innovative integrating cavity design in the FMH-8715 and FMH-87107 is the primary reason the FMH-8220 Fiber Optic Power Meter is able to deliver excellent repeatability in a production workstation environment. Key features of the measurements heads, and their benefits to you, include:

Feature	Benefit
Minimal response to changes in the state of polarization	Measure loss due to polarization without concern for meter errors
Minimal response to changes in fiber extension in the holder	Obtain the same results with different users
Minimal response to rotating the fiber holder with a non-angled cleave	No need to rotate the fiber holder for maximum reading with a non-angled cleave
Bare fiber end face cannot contact detector surface	Impossible to damage detector with fiber
Bare and connectorized fiber measurements from the same fiber end face position	Compare bare and connectorized fiber measurements with confidence
Production tested bare fiber holder easily guide the fiber to the correct place every time	No tedium to slow your testing or introduce errors
Detector head designed to accept ILX's BF-820 or Agilent 81000BA bare fiber holders	Use ILX's BF-820 holder with Agilent power heads or use Agilent's 81000BA holders in the FPM-8220; this interchangeability means that there is no need to alter procedures, or buy different holders
Precision quick-align, threadless adapters for most connector type and the bare fiber holder	Just push in or pull out; easily self-aligns and snaps into place; no threads

Protecting the FMH-8705 Fiber Optic Measurement Head

The fiber optic measurement head uses a 3mm detector that has been hermetically sealed in a TO-Can package. To avoid accidental damage the plastic shipping protector should be installed when a fiber optic adapter is not in use.

Protecting the FMH-8715 and FMH-87107 Fiber Optic Measurement Heads

The fiber optic measurement head cavity entrance is small (5mm) so it will not allow debris to enter the cavity; however, over time, dust and pollution in the air can degrade measurement accuracy. After using the head, protect the cavity by covering the aperture with the plastic shipping protector, place the head face down on the table or leave a connector or bare fiber holder in place.

Cavity contamination can also happen if you are doing environmental testing where humidity causes condensation. If you suspect the cavity has been contaminated, contact ILX Lightwave Customer Service. In most cases we can clean it and recalibrate it for you. Also, contact ILX Lightwave Customer Service if a replacement protective cap is needed. See Comments, Suggestions, and Problems on page viii for contact information.

Measurements through a Connector

With the adaptors available from ILX Lightwave, the FMH-8700 series Fiber Optic Measurement Heads can make measurements through most common fiber optic connectors.

To install an adapter:

1. Align the mating hole on the connector with the alignment pin on the head.

2. Press it into place, then rotate it slightly until the alignment pin has seated. Make sure the adapter is fully seated around its circumference.

Figure 2.6 – Seating the Alignment Pin

Small spring-loaded balls (ball plungers) in the side of the adaptor mate with a channel in the FMH-8700 series Fiber Optic Measurement Heads to hold the adaptor in position. Once the adaptor is in place, you can connect fibers repeatedly to the meter. There is no need to remove the adaptor unless you need to use a different connector type.

Note: Always clean the tip of the connector ferrule before a measurement, using the proper tools and a good technique. The core of a single-mode telecom-grade fiber is only about 9µm in diameter; the smallest contaminant can cause significant errors.

To remove an adaptor, grasp its outer ring and pull it out.

Measurements through Bare Fiber

The aim in developing the FMH-8715 and FMH-87107 was to solve the measurement issues that affect repeatability when the fiber endface is not polished in a connector ferrule. The result is a fiber optic power meter optimized for bare fiber measurements. The measurements are highly repeatable, the meter is easy to use, and the detectors are virtually unaffected by the polarization state of the fiber or by the rotation of the fiber holder.

Fiber optic measurement heads, such as the ILX Lightwave FMH-8705, normally have their detector mounted at an angle to prevent reflections back into the input fiber; however, this arrangement is less than ideal for measurements through bare fiber. Among the detractors from measurement repeatability is:

- The variation in distance from the fiber endface to the detector. If you are not careful, you can scratch the detector face.
- Slight variations in the angle of the glass cleave at the core exit point. In a standard telecom fiber, the core containing the light is only about 0.5% of the endface surface area and that is the only part that matters for exit angle.

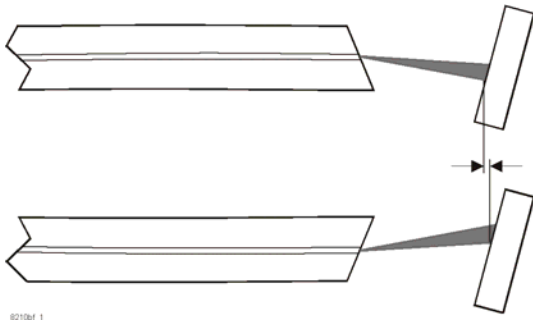


Figure 2.7 – Bare Fiber Measurement Diagram

The CA-120 Bare Fiber Adapter Ring

The CA-120 Bare Fiber Adapter Ring is a round ferrous ring that mounts in the FMH-8700 series Fiber Optic Measurement Heads and mates with magnets in either the ILX Lightwave BF-820 Bare Fiber Holder or the Agilent 81000BA Bare Fiber Holder. The adapter ring has no alignment hole so you can just press it into place in the detector head. Check that the adaptor ring is flush to the face of the detector head all around. Rotating the ring helps to ensure that it is seated properly.

Figure 2.8 - CA-120 Bare Fiber Adapter Ring

Measuring with the BF-820 Bare Fiber Holder

The ILX Lightwave BF-820 Bare Fiber Holder was designed, tested and optimized for production workstations. Its opening action and internal alignment guides make it easy and fast to correctly place the fiber every time.

1. Carefully strip, clean, and cleave the fiber. Strip the jacket, then strip at least 1.3 cm of buffer (1/2-inch) from the fiber. If the fiber endface touches anything after cleaving, clean it and cleave it again.

Note: The BF-820 is designed for 125 µm clad fiber.

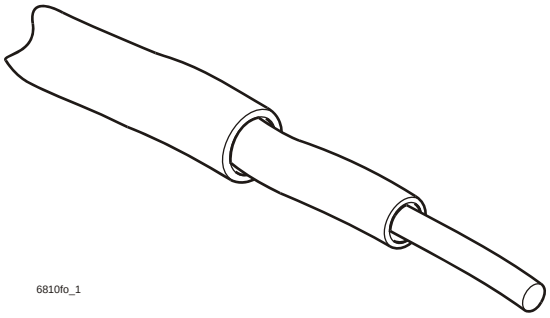


Figure 2.9 – Strip and Cleave the Fiber

2. Squeeze the BF-820 bare fiber holder by its feet to open the body and expose the alignment guides.

Figure 2.10 – BF-820 Bare Fiber Holder

3. Lay the fiber in the holder with the stripped and cleaved fiber protruding from the nose (detector-side) of the holder.

4. Gently pull the fiber until the buffer is aligned with the marks on the holder. Make sure the buffer does not extend beyond the marks, toward the nose-end of the holder.

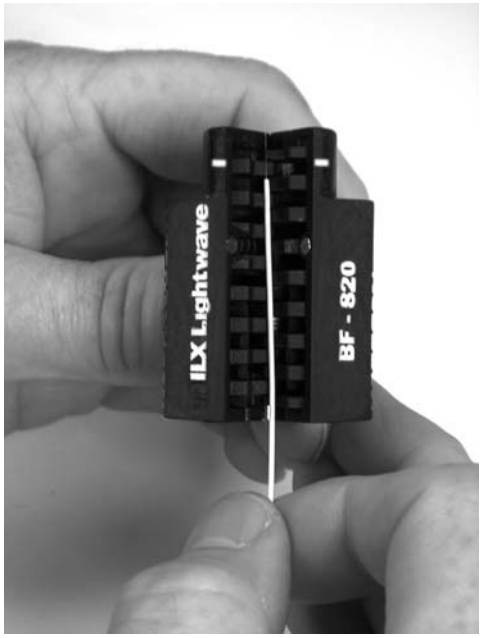


Figure 2.11 – Place Fiber in BF-820 Holder

5. The fiber must extend between1.0 mm and 5.0 mm from the holder to ensure accurate measurements from the FPM-8220.

6. Release the feet and close the holder. The holder is held shut by a spring and several magnets. Grasping the holder by the body, insert the fiber holder into the bare-fiber adaptor ring making sure that the fiber endface does not touch anything. If the fiber endface makes contact with anything, it must be cleaned and recleaved.

Note: Make sure to grasp the holder by the body when inserting or removing it from the detector. Grasping the holder by the feet can cause the fiber to come loose.

7. Connect or turn on your light source.

Figure 2.12 – Inserting the BF-820

Measuring with the Agilent 81000BA Bare Fiber Holder

Refer to Agilent documentation for detailed instructions on the use and care of the 81000BA. If you are familiar with the Agilent 81000BA bare fiber holder and have established procedures, the FPM-8220 does not require you to change those procedures.

The measurement procedure is the same as the BF-820 described above. Be sure to strip enough fiber to allow 3.0 mm protruding from the front of the Agilent holder after you have the fiber in place.

With either bare fiber holder, check that the fiber extension is straight from the front of the holder. If it is not straight, this indicates the holder is bending the fiber. Bending will affect measurement accuracy, and may cause the fiber end to break off.

Measuring with Cleaved Angles

For some applications, you may want to use a special cleaver capable of cleaving fiber at an angle. This can reduce source instability caused by reflections from the cleaved endface. The FMH-8700 series Fiber Optic Measurement Heads can reliably make this measurement. If your fiber is cleaved at an angle, rotate the fiber holder after inserting it into the head and check whether the rotation effects the measurement. For small cleave angles (<~2×) you will probably not see an effect. For larger cleave angles, rotate the holder for a maximum reading. Be sure there is enough relaxed fiber behind the holder that the rotation does not induce bending stresses.

Measuring Higher Power

The FMH-8705 will not be damaged by input power up to **+10 dBm (10 mW)**. The FMH-8715 and FMH-87107 will not be damaged by input power up to **+40 dBm (10 W)** detected for less than 1 minute. However, linearity generally moves outside specification limits above the specified input power limit (see Table 1.2 on page 4).

The best way to measure high power is to use a calibrated attenuator. You can then use CAL to set a compensating factor.

Understanding the Calibration Certificate

Your FPM-8220 and FMH-8700 are supplied with a certificate for NIST traceable calibration from ILX Lightwave's calibration laboratory. The following section explains the information on your calibration certificate.

Photodetector Responsivity

The FPM-8220 Fiber Optic Meter is a stable, low noise current meter that is compatible with three fiber optic measurement heads: the FMH-8705, the FMH-8715 and the FMH-87107. The FMH-8705 is a detector only, fiber optic measurement head design to measure very low power. The FMH-8715 and FMH-87107 are integrating sphere based fiber optic measurement heads with an integrated photodetector. The integrating sphere randomizes light input, so changes in input polarization and pattern orientation have little net effect on the detector.

Factory calibration data is stored in the internal EEPROM of the FMH-8700 series Fiber Optic Measurement Head. Factory calibration is a process of recording the detector current while

varying the wavelength. The result is a table of detector responses, recorded every 10 nanometers, in A per W. When you input light, the FMH-8700 series of Fiber Optic Measurement Head measures detector current, then uses your wavelength setting to look up the conversion factor on the calibration table. Interpolation algorithms are used for wavelengths between these calibration points. Figure 2.13 is a sample of detector response plotted as a function of wavelength. The chart is based on data from the FMH-8700 series of Fiber Optic Measurement Head calibrations that are performed at ILX Lightwave's NIST-traceable calibration laboratory.

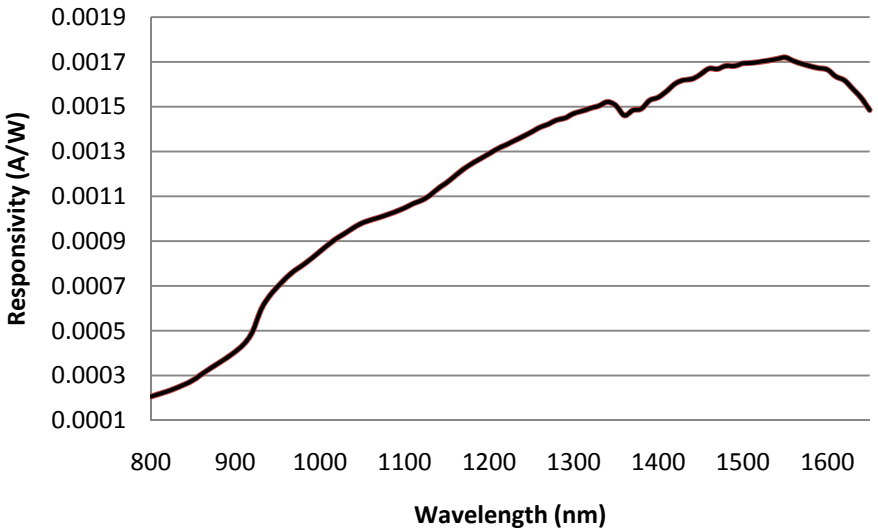


Figure 2.13 – Sample Detector Response

The detector response is shown as photodetector current (amperes) per unit of optical power (watts).

The following are true for all FHM-8700 series Fiber Optic Measurement Heads and are exemplified in the chart in Figure 2.12.

- The highest detector current (greatest sensitivity) is at the longer wavelengths, normally used for telecom work.
- Changes in detector response are significant enough that the meter must know the wavelength in order to accurately display optical power.
- The flatness (or steepness) of the curve at any point is a measure of how much effect an error in wavelength input will have on the measurement result.
- Detector response is less at shorter wavelengths.

Analog Output (BNC)

A BNC output connector is provided on the rear panel to give you direct access to the amplified photodetector signal. Keep the FPM-8220 in manual range mode when you use the analog output. This is a very low-noise, stable output that is normalized to 10V to represent percentage of full scale. For example, 7.1V = 71% of range. This information is represented by the bar graph on the front panel but with greater resolution. Since the resolution is mostly determined by the instrument that you connect it to, this output is useful for monitoring small changes. With a typical output impedance of 1000Ω, you can directly connect the meter to most data loggers or digital voltmeters. The analog

output is most commonly used for relative power measurements or as a controlling input for automatic fiber alignment systems.

For such tests, the absolute value, represented by the analog output voltage, is usually not of concern, only the change relative to a starting point. For monitoring relative power measurements, put the meter in auto mode to find the appropriate gain range; then set the meter to manual mode to avoid changing gain ranges during the test.

Gain Range Boundaries

Understanding how the gain ranges and detector response relate to analog output can be useful in interpreting analog voltage. The gain range is related to the current from the photodetector, not to the direct light power, because the semiconductor photodetector response varies with wavelength. The FPM-8220 meter has eight gain ranges. Each range increases gain by 10 times over the previous range. The analog output varies 0 V to 10 V representing minimum to maximum current output for that range. The maximum current for each range is:

Range	Maximum Current
0	10mA
1	1mA
2	100μA
3	10μA
4	1μA
5	100nA
6	10nA

Determining Range

The FPM-8220 will display the gain range by pressing **AUTO/MAN** or the **UP ARROW** or the **DOWN ARROW**.

Relating Optical Power to Analog Voltage

The most direct way to relate optical power to analog voltage is to read the power from the front panel or by remote interface while noting the voltage. If you set up a remote interface automated system with a data logger or voltmeter, you can directly correlate power and analog output voltage in your data.

You can also get this information from calibrated detector response data. You can get the detector response data in two ways:

1. The remote commands RESP? tells you the calibrated detector response in mA/mW for the specified wavelength. You can get the response for any wavelength by first using the WAVE command:

   For example: WAVE 1480; RESP?

   This sequence returns the calibrated detector response for 1480 nm.

2. The factory calibration certificate includes a table of detector response at every 10 nm.

The accuracy of power measurement via the analog output of the FPM-8220 is not a factory specification; however, the user will find it to be stable, reliable, and useful. The following relationship will allow the user to convert analog voltage output into power output.

$$Power = \frac{V_{meas}}{G_r * \rho(\lambda)}$$

Where V_{meas} is the voltage measured at the analog voltage output, G_r is the gain of the instrument when operating in range r, and ρ(λ) is the responsivity of the measurement head photodiode.

The steps for converting analog voltage to power are as follows:

1. Make sure optical power input is ON.
2. Connect a voltmeter to the analog output.
3. Find the range of the instrument and then look up the gain of that range in the table above.
4. Lookup the photodiode responsivity in the appropriate table on the measurement head's calibration certificate.
5. Divide the analog voltage by the product of the gain and the responsivity to get the power.

As an example, suppose that we are trying to measure the power of a 1550nm laser. We record the analog voltage output, V_{meas}, at 3.5V. Query the instrument to determine the gain range. In this example, the gain range is 3 so the gain is 10V/10µA. The gain value is calculated by dividing the full scale voltage range on the instrument in combination with the heads by the maximum current boundary of gain range 3, located on the table above. We then go to table 1 of the calibration certificate for the measurement head and find the responsivity of the head at 1550nm, which is 6.0739E-3 A/W. The power of the laser is:

$$Power = \frac{V_{meas}}{G_r * \rho(\lambda)} = \frac{3.5\text{V}}{(10\text{V}/\mu\text{A}) * (6.0739E-3\ A/W)} = 57.62nW = -42.39dBm$$

General Operation

The discussion below presents guidelines for operation as well as some common operating procedures. Remote operations are discussed in the next chapter.

Warm-up and Environmental Considerations

To achieve the rated accuracy, allow the FPM-8220 to warm up for at least one hour before use. Operate the meter within the environmental limits specified in Chapter 1. The best accuracy is achieved near the calibration temperatures.

Summary of Operating Procedures

The following list is a summary of operating procedures, discussed in depth earlier in this chapter.

1. Install the appropriate fiber adaptor in the detector head. Connect your input fiber or patch cord.
2. Recall your previously saved setup by pressing **RECALL** or by setting the parameters individually as described in the following steps:
    a. Press **WAVELENGTH** and adjust the wavelength by pressing the **UP ARROW** or the **DOWN ARROW**.
    b. Press **AUTO/MAN** to select either auto or manual gain range. In manual gain mode, press the **UP ARROW** or **the DOWN ARROW** to adjust the gain.
3. Set the calibration constant by pressing **CAL**. The factory default for this factor is 1.000.
4. Input power:
    a. In manual mode, the display "- - - - - OVR" indicates the input power is greater than 97.5% of the range. In auto mode, this indicates input power is greater than 1.4mW for model 8705, 100mW for model 8715, or 1W for model 87107.
    b. In Manual Range mode, the display "-99.999 dBm" or "0.000 nW" indicates the input power is less than 5.0% of range. In Auto Range mode, this indicates input power is less than 3.2×10^{-9}mW for model 8705, 1.0×10^{-7}mW for model 8715, or 1.0×10^{-6}mW for model 87107.
5. To save a new setup, press **STORE** followed by the **UP ARROW** or the **DOWN ARROW** and select bin number 1 through 10. Then press **ENTER**. Whether or not you save the instrument's settings before powering down, they will return, exactly as they were the last time the instrument was used, when the FPM-8220 is rebooted.

Chapter 3:
Remote Operation

This chapter is an overview of the remote operation of the FPM-8220 Fiber Optic Power Meter.

- ✓ Applying power
- ✓ Connecting to the instrument
- ✓ Front panel operation

GPIB (General Purpose Interface Bus) is the common name for ANSI/IEEE Standard 488, an industry standard for interconnecting test instruments in a system. The FPM-8220 also has USB (Universal Serial Bus) so that the instrument can be connected to a computer without a GPIB card. Every operation that you can perform from your FPM-8220 front panel can also be done remotely through the rear panel GPIB or USB interface. In addition, some features are available only through remote operation. For example, the DELAY command automatically sets a delay time before the execution of further commands.

Remote control can be useful for building an automated test system that includes other instruments. It is also useful for structuring and collecting data for longer tests, such as environmental and component burn-in tests.

Remote Operation Features

- A concise and straightforward command set
- Full talk/listen capability
- Full serial poll capability, with SRQ
- Full local/remote capability

This chapter explains GPIB and USB concepts, system setup, and command syntax. Chapter 4 is a reference guide of FPM-8220 responses to remote commands.

This chapter assumes:

- Your computer has an appropriate GPIB interface or the instrument is connected via USB 2.0.
- You have a basic knowledge of programming or have informational sources at your disposal.
- You are familiar with the front panel operating controls on the FPM-8220. (Chapter 2)

GPIB interface adaptors and support software for standard desktop PCs are available from several manufacturers. Contact ILX Lightwave Customer Service for more information.

Basic GPIB Concepts

The basic GPIB concepts are not necessary to successfully operate the FPM-8220, but are a useful perspective in understanding GPIB communication.

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 (see below). The end of this chapter includes information on interface messages supported by the FPM-8220.

Talkers, Listeners, and Controllers

Every GPIB system consists of one or more talkers, listeners and often at least one controller. Talkers supply data and listeners accept data. 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 computer to another. In a multiple controller system, there can be one System Controller capable of asserting control and becoming the CIC.

GPIB Cable Connections

Standard GPIB connectors can be connected together (stacked) allowing the system to be configured linearly, or in a star configuration, which is shown in Figure 3.1.

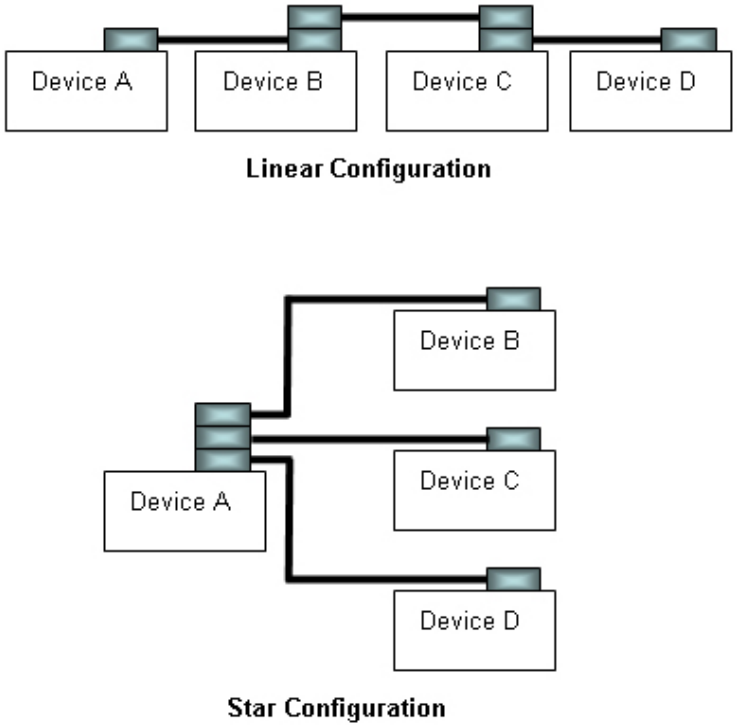


Figure 3.1 – GPIB Cable Connection

The GPIB Connector

The standard GPIB connector consists of 16 signal lines in a 24-pin stackable connector, as shown in Figure 3.2. The extra pins are used to make twisted pairs with several of the lines. There are eight data input/output lines, three handshake lines, and five interface management lines.

Eight data I/O (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.

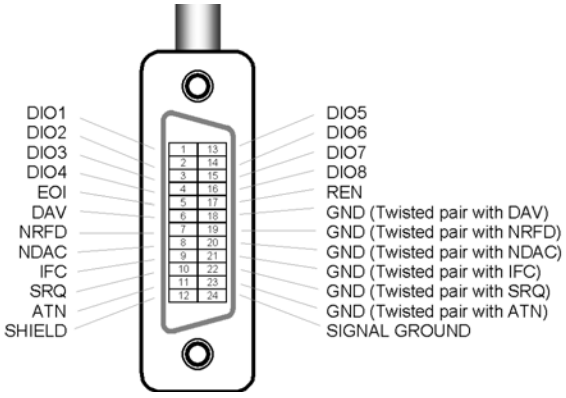


Figure 3.2 - GPIB

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 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.

Configuring the GPIB Controller

Refer to your computer's GPIB interface documentation for details on how to set it up. These settings are important:

Primary GPIB Address	1 through 30
Secondary GPIB Address	NONE
Timeout	1 second
Serial Port Timeout	1 second
Terminate Read on EOS	No
Set EOI with EOS on Writes	Yes
Type of Compare on EOS	7-bit
EOS Byte	00h

Please note that overlooking these settings is a common cause of problems.

Changing Operation from Local to Remote

Sending a command over the GPIB or USB bus automatically puts the instrument in remote mode, which is indicated by the **RMT** in the upper right corner of the display. When the instrument is in remote mode, all front panel controls are disabled except for the **RECALL** button. Pressing the **RECALL** button returns the instrument to local control mode unless the local lockout state has been activated by the host computer. Local lockout disables all front panel controls, including the **RECALL** button, until this condition is changed by the host computer.

Setting the GPIB Address

In local mode, press **RECALL** and **the UP ARROW** buttons simultaneously to display the GPIB address. While the GPIB address is displayed, you can change it to any of 30 addresses from "- 01 -" to "- 30 -" by pressing the **UP ARROW** or the **DOWN ARROW**.

Basic USB concepts

Universal Serial Bus (USB) is a specification to establish communication between devices and a host controller, which has effectively replaced a variety of earlier interfaces such as serial and parallel ports. There are three USB standards available, including USB 1.1, USB 2.0, and USB 3.0. Our device is designed to conform to the USB 2.0 standard and USBTMC 488 substandard. USB cables use 4 lines - Power, Ground and a twisted pair differential +/- data lines using NRZI encoding. The USB connectors are designed so that power and ground are applied before the signal lines are connected. When the host powers up it performs the enumeration process by polling each of the Slave devices in turn (using the reserved address 0), assigning each one a unique address and finding out from each device what its speed is and what type of data transfer it wishes to perform. The enumeration process also takes place whenever a device is plugged into an active network. The connectors design along with the process of enumeration and a lot of host software allows devices to be described as "Plug-and-Play".

When the USB device is enumerated and gets an address from the host, it presents the host with information about itself in the form of a series of descriptors. The device descriptor tells the host the vendor and the product ID. The configuration descriptors offer a power consumption value and a number of interface descriptors. Each of these interface descriptors define a number of endpoints, which are the sources and destinations for data transfers. The endpoint descriptors provide the following detail transfer type: bulk, interrupt, isochronous, direction, packet sizes, bandwidth requirement and repeat interval.

In USB communication, a typical transaction consists of a number of packets - a token indicating the type of data that the host is sending or requiring, the data and in some cases an acknowledgement. Each packet is preceded by a sync field and followed by an end of packet marker. These transactions are used to provide four basic data transfer mechanisms, including control, interrupt, bulk, and isochronous types.

USBTMC stands for USB Test and Measurement Class. USBTMC is a protocol built on top of USB that allows GPIB-like communication with USB devices. From the user's point of view, the USB device behaves just like a GPIB device. For example, you can use VISA Write to send the *IDN? Query and use VISA Read to get the response. The USBTMC protocol supports service request, triggers and other GPIB specific operations. USBTMC allows instrument manufacturers to upgrade the physical layer from GPIB to USB while maintaining software compatibility with existing software, such as instrument drivers and any application that uses VISA.

GPIB vs. USB Communication

When using the USB interface, the remote GPIB command set is fully operable. Command syntax does not vary between communication protocols. However, the commands which affect GPIB hardware operation will not be useful. For example, “*SRE” may be sent via USB but and service request (SRQ) via GPIB would not be visible since USB has no hardware to support it. This is because SRQ is a function of the GPIB interface hardware and is not available via USB.

All commands received by the USB interface are acknowledged by the instrument transmitting “Ready” when the command operation is complete. Queries are acknowledged by the specific query response message. Multiple commands/queries separated by semicolons and issued as one command string are only acknowledged with a “Ready” response if the entire command string contains no queries. (See the Command Separators section later in this chapter for additional details.)

Command Syntax

The discussions below describe command syntax and structure. You need this information to effectively write GPIB and USB control programs for the FPM-8220. The syntax of FPM-8220 commands follow the rules defined in the ANSI/IEEE-488 standard. ANSI/IEEE-488 uses standard terminology. To clarify understanding, we use simpler terms for this manual.

Letters

Any 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). Upper/lower case does not matter to the FPM-8220. It is just 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:

Table 3.1 – Acceptable and Not Acceptable Spelling

Acceptable	Not Acceptable
DISP	DS
DISPlay or DISPLAY	Displa or DISPL

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:

Table 3.2 – White Space

Acceptable	Not Acceptable
WAVE 1234	WAVE1234

To enhance readability, one or more white spaces may be used before a comma, semicolon, or terminator. Since the computer normally places the terminator at the end of each command string, this simply means that an extra space character at the end of the command line is acceptable.

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

Table 3.3 – Query Formatting

Acceptable	Not Acceptable
DISPLAY?	DISPLAY ?

Note: Too many consecutive white spaces can overflow the 1024-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 FPM-8220 terminates its responses with <NL><END>, unless the TERM command is used to change it.

If problems are encountered with remote communication, the terminator string can be the cause. Refer to the computer's GPIB or USB interface manual for information on configuring its terminator string.

Command Separators

More than one command may be placed in the same command string if each command is separated by a semicolon. The semicolon can be preceded by one or more spaces. For example:

```
DISPLAY ON;*IDN?;RANGE?
DISPLAY ON ; *IDN?;  RANGE?
```

Parameters

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

The syntax symbol <nrf value> refers to the flexible numeric representation defined by the GPIB standard. It means that numbers may be represented 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:

Table 3.4 – Parameters

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

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

There are no default values for omitted parameters. If a command is expecting a parameter and nothing is entered, an error is generated.

For further clarity in programming, the Boolean values of one (1) and zero (0) may be used or their names as indicated in Table 3.5.

Table 3.5 – Substitute Parameter Values

Substitute Name	Value
ON	1
OFF	0

Command Tree Structure

The FPM-8220 Fiber Optic Power Meter device-dependent commands are structured in a tree format as shown in Figure 3.3. Each of the legal paths is shown, followed by its list of path options, followed by the commands themselves. It is recommended that the first-time user begin learning the commands by using the full path notation. Once familiar with the commands, command path shortcuts may be used.

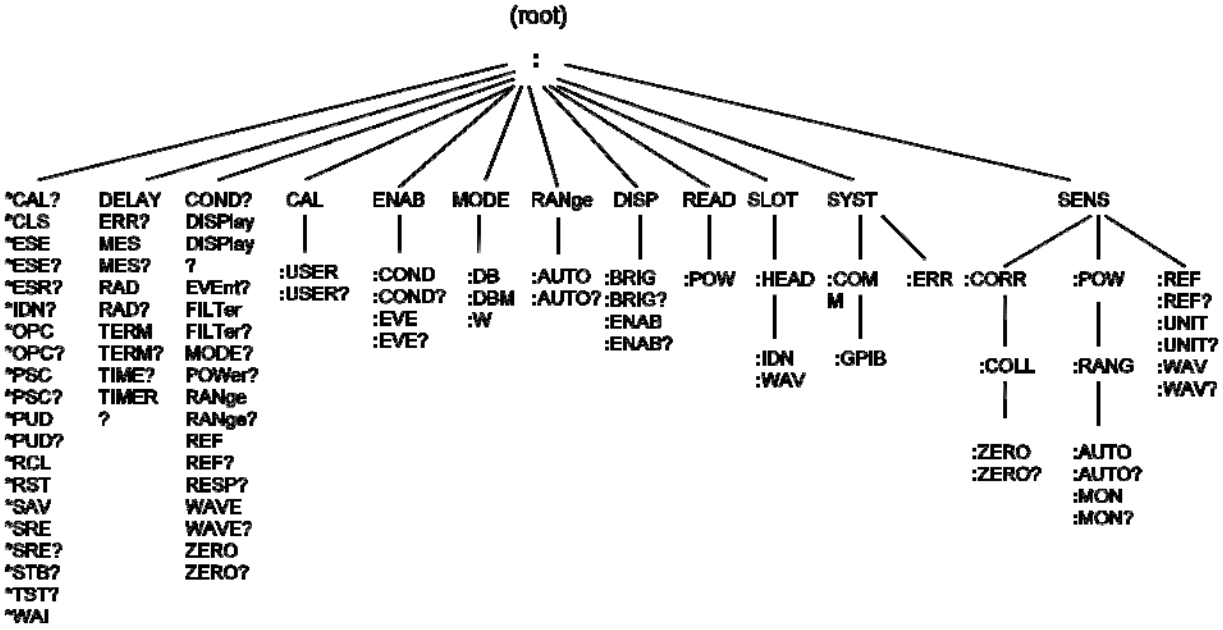


Figure 3.3 – Command Path Structure

Syntax Summary

Commands must contain all of the letters shown in uppercase in the command definition. Optional letters shown in lowercase for some device dependent commands in the command reference (Chapter 4) 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 problems are encountered with communications, the terminator string may be the cause. Refer to the GPIB or USB interface manual for additional information. 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 FPM-8220 terminates its responses with <NL><^END>.

More than one command may be on the same command line if the commands are separated with semicolons.

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

Some device-dependent 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.

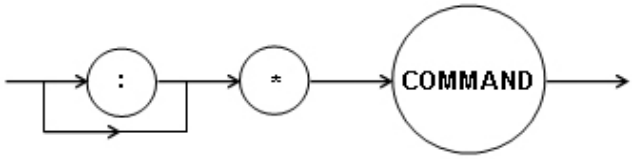
Table 3.6 shows some examples of invalid syntax command strings that will produce errors:

Table 3.6 – Invalid Syntax Command Strings

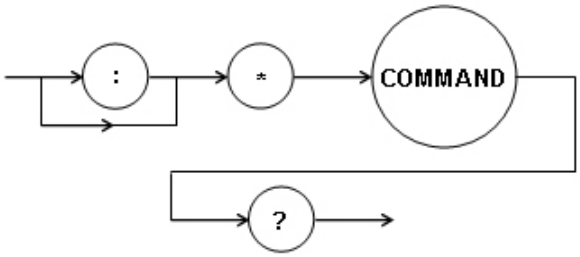
COMMAND	COMMENT
SYSTEM ERROR?	Missing colon;
RANGE:AUTO 1 *IDN?	Missing semicolon
ADDRESS:GPIB ?	Space not allowed before question mark.
WAVE1234;*IDN?	Space missing between WAVE command and the parameter value 1234.

IEEE 488.2 Common Commands

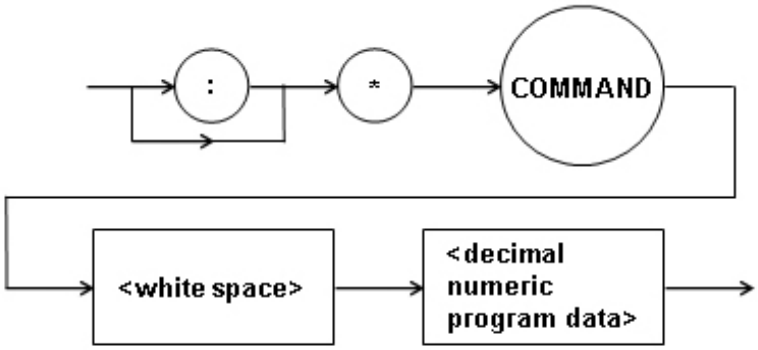
The IEEE 488.2 Common Commands and Queries are distinguished by the "*" which begins each mnemonic. The diagrams below show the syntax structure for common commands, common command queries, and common commands with numeric data required.



Common Command



Common Command Query



Common Command with Numeric Data

Figure 3.4 – Common Command Diagrams

Numeric data is required with *PSC (1 = on, 0 = off), *RCL (0 – 10, see front panel Recall function), *SAV (1 – 10, see front panel Store function), and *ESE (0 – 255, see Figure 3.5 – GPIB connector diagram).

All the IEEE 488.2 Common Commands supported by the FPM-8220 are listed in Table 3.7.

Table 3.7 – IEEE 488.2 Common Commands Supported by FPM-8220

*CAL?	*CLS	*ESE	*ESE?
*ESR?	*IDN	*OPC	*OPC?
*PSC	*PSC?	*RCL	*RST
*SAV	*SRE	*SRE?	*STB?
*TST?	*WAI		

See Chapter 4 – Command Reference for descriptions of all commands, including common commands, supported by the FPM-8220.

Status Reporting

This section contains information that is relevant for understanding instrument error and status reporting. It also contains information regarding the use of the instrument status for generating interrupts for interrupt driven programs or subroutines. Understanding the Operation Complete definition for the instrument is useful for program synchronization.

Event and Condition Registers

In addition to the required IEEE 488.2 status reporting structure, the FPM-8220 remote interface provides Event and Condition Registers for power meter operations. The Event Registers are used to report events which occur during the operation of the FPM-8220 Fiber Optic Power Meter. Events differ from conditions in that events signal an occurrence one time, and are not reset until the Event Register is queried or the FPM-8220 is powered off. Conditions reflect the current state of the instrument and therefore may change many times during operation. Querying a Condition Register does not change its contents.

Figure 3.5 shows the status reporting scheme of the FPM-8220 Fiber Optic Power Meter. Each of the registers which may be accessed by a command or query has the appropriate command or query written above or below the register representation. For example, the Condition Register may be queried via the “COND?” query.

The condition or event registers are logically ANDed with their respective enable registers. These bits are then logically ORed to form a summary message in the status byte for that particular register.

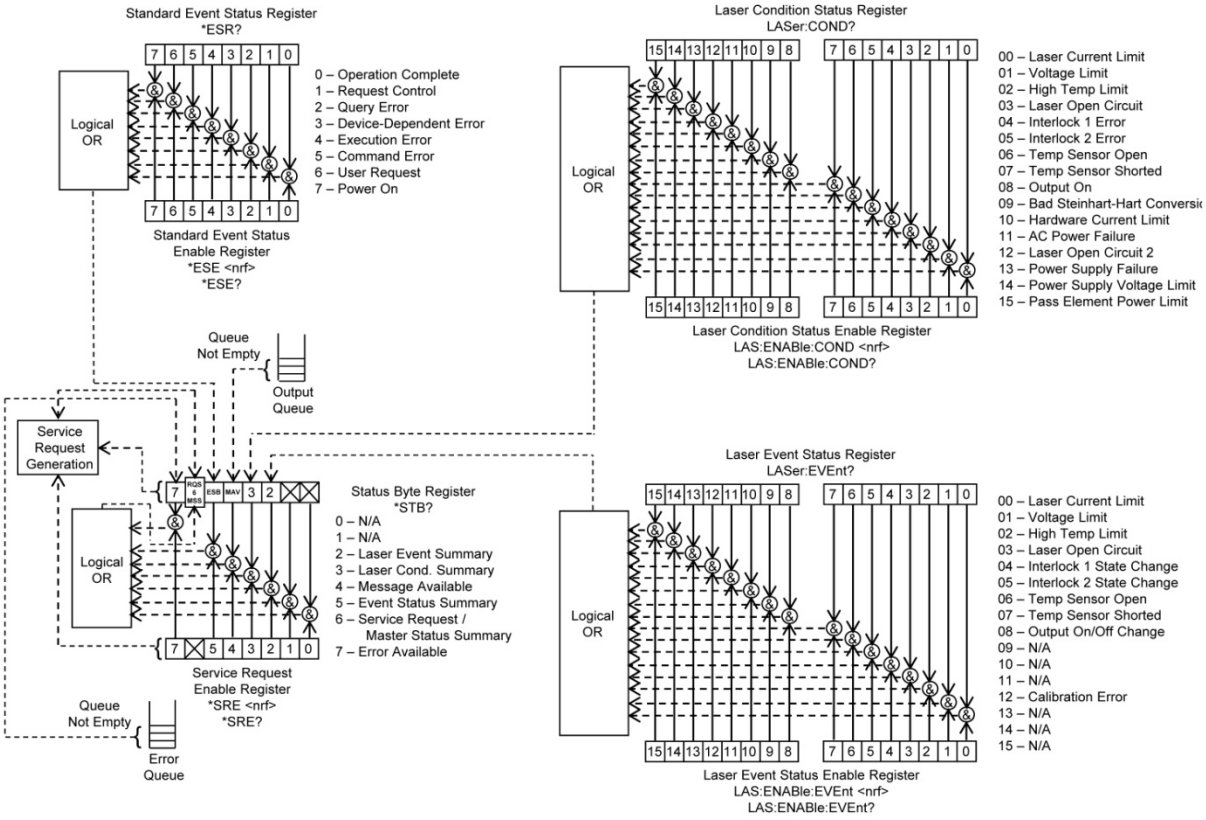


Figure 3.5 – Status Reporting Scheme

Note that Bit 0 of the Standard Event Status Register contains the status of the Operation Complete flag. Enabling this bit via the *ESE command allows the user to update Bit 5 of the Status Byte. Then, if the SRE mask has Bit 5 set, and the user issues an *OPC command, the SRQ signal will be generated upon completion of the currently processed commands. This may be used to initiate service request routines which depend on the completion of all previous commands. This allows the use of the operation complete features of the FPM-8220, without the need for program looping or polling which can tie up the GPIB bus. Operation Complete on the FPM-8220 is defined as:

- No operations to the power meter hardware are pending.
- No EEPROM (non-volatile) memory write cycles are in progress.

Note: If the GPIB or USB times out while waiting for a response, either set the GPIB time-out longer or use SRQ-generated interrupts. See the GPIB interface manual for time-out configuration or SRQ programming setup. The *OPC, *OPC?, and *WAI commands should not be used inside a calibration routine.

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 the first is being executed, or if it must wait until the first command is completed before its execution begins. See the Operation Complete Definition earlier in this chapter 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 has completed. Some common commands are sequential; the next command must wait until this command has 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.

*WAI is an example of a sequential command which forces the next command to wait until the no-operation 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, 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.

Chapter 4:
Command Reference

This chapter is a guide to all of the device-dependent commands for the FPM-8220 Fiber Optic Power Meter. This chapter is divided into two parts.

- ✓ Overview of the remote commands
- ✓ List of remote commands in alphabetical order within the categories of IEEE 488.2 common commands, device specific commands, and extra commands.

Remote Command Reference Summary

This section contains all of the commands for the FPM-8220 Fiber Optic Power Meter, listed in alphabetical order. Subsections for each path are presented, listing the commands which are legal for that path. See Figure 3.3 for the command path tree structure.

Table 4.1 – Remote Command Summary Reference List (IEEE 488.2 Common Commands and Agilent compatible commands)

Name	Parameters	Function
*CAL?	NONE	Calibrate internal analog to digital (A/D) converter
*CLS	NONE	Resets the Standard Event Register, Status Byte and Error Queue to zero.
*ESE	1	Sets the Standard Event Status Enable Register.
*ESE?	NONE	Returns the value of the Standard Event Status Enable Register.
*ESR?	NONE	Returns the value of the Standard Event Status Register.
*IDN?	NONE	Returns the Device Identification string.
*OPC	1	Generates the Operation Complete message in the Standard Event Status Register.
*OPC?	NONE	Places an ASCII character 1 into the Output Queue.
*PSC	1	Used to avoid any undesirable service requests.
*PSC?	NONE	Queries the Power-On-Status-Clear Flag.
*RCL	1	Used to recall a stored setup configuration.
*RST	NONE	Forces a device reset.
*SAV	1	Saves the current setup configuration.
*SRE	1	Sets the Service Request Enable Register bits to allow generation of user-selectable service requests.
*SRE?	NONE	Returns the current contents of the Service Request Enable Register.
*STB?	NONE	Returns the current contents of the Status Byte Register.
*TST?	NONE	Initiates an internal self-test and returns a response when complete.
*WAI	NONE	Prevents executing any further commands until the No-Operation-Pending flag is true.

Table 4.1 – Remote Command Summary Reference List (Device Specific Commands)

Name	Parameters	Function
CAL:USER	1	Set a user cal gain factor
CAL:USER?	NONE	Request the user cal gain factor
COND?	NONE	Request the status condition register
DISPlay	1	Turns the display on/off
DISPlay?	NONE	Returns display state
DELAY	1	Delays processing of further commands for the defined time (in milliseconds).
ENABle:COND	1	Set the condition status enable register
ENABle:COND?	NONE	Request the condition status enable register
ENABle:EVEnt	1	Set the event status enable register
ENABle:EVEnt?	NONE	Request the event status enable register
ERRors?	NONE	Request errors since last ERR? request
EVEnt?	NONE	Requests the event status register
FILTer	1	Select fast, medium, or slow mode
FILTer?	NONE	Request the measurement filter setting
MESsage	1	Store character string into message memory
MESsage?	NONE	Request character string from message memory
MODE?	NONE	Request the measurement mode
MODE:DB	NONE	Select decibels (dB) relative measurement mode
MODE:DBM	NONE	Select logarithmic (dBm) measurement mode
MODE:W	NONE	Select linear (watts) measurement mode
POWer?	NONE	Request the value of measured optical power
RADix	1	Set numeric responses type
RADix?	NONE	Request the radix of numeric responses
RANge	1	Set the photodetector current gain range
RANge?	NONE	Request the photodetector current gain range
RANge:AUTO	1	Set AUTO or MANUAL ranging mode
RANge:AUTO?	NONE	Request status: AUTO or MANUAL range
REF	1	Set a reference level in dBm
REF?	NONE	Request the reference level value
RESP?	NONE	Request the calibrated detector responsivity data
TERM	1	Define the message terminator
TERM?	NONE	Request the message terminator
TIME?	NONE	Request time since powered ON
TIMER?	NONE	Requests time since the last TIMER? query
WAVE	1	Set wavelength for calibrating detector response
WAVE?	NONE	Request wavelength for detector response
ZERO	1	Apply an internal offset
ZERO?	NONE	Request status of zero operation

Table 4.1 – Remote Command Summary Reference List (Extra Commands)

Name	Parameters	Function
DISPlay:BRIGhtness	1	Sets the display brightness
DISPlay:BRIGhtness?	NONE	Returns the display brightness
DISPlay[:ENABle]	1	Turns the display on/off
DISPlay[:ENABle]?	NONE	Returns display state
DISPlay:MODE	1	Sets the display mode
DISPlay:MODE?	NONE	Returns the display mode
READ:POWer?	NONE	Request the value of measured optical power
SENSe:CORRection:COLLect:ZERO	1	Apply an internal offset
SENSe:CORRection:COLLect:ZERO?	NONE	Request status of zero operation
SENSe:POWer:RANGe:AUTO	1	Set AUTO or MANUAL ranging mode
SENSe:POWer:RANGe:AUTO?	NONE	Request status: AUTO or MANUAL range
SENSe:POWer:RANGe:MONitor	1	Set the photodetector current gain range
SENSe:POWer:RANGe:MONitor?	NONE	Request the photodetector current gain range
SENSe:POWer:REFerence	1	Set a reference level in dBm
SENSe:POWer:REFerence?	NONE	Request the reference level value
SENSe:POWer:UNIT	1	Selects Logarithmic (dBm) unit or linear units (Watts) to be used in reporting measurements
SENSe:POWer:UNIT?	NONE	Requests FPM-8220's measurement mode.
SENSe:POWer:WAVelength	1	Set wavelength for calibrating detector response
SENSe:POWer:WAVelength?	NONE	Request wavelength for detector response
SLOT:[HEAD]:IDN?	NONE	Returns the head information
SYSTem:COMMunicate:GPIB?	NONE	Returns the GPIB address
SYSTem:ERRor?	NONE	Requests the current error in the error queue and then removes this error from the error queue

Command Reference

The following pages contain a reference for both common and device-dependent commands of the FPM-8220 Fiber Optic Power Meter. This reference contains useful information for both local and remote operation of the FPM-8220.

---

*CAL?

Common
Device Dependent
Front Panel

Action Adjusts the internal analog to digital (A/D) converter to reference points, then reports results.

Response Zero = OK
Non-zero = calibration error

Notes The A/D chip in the FPM-8220 performs automatic calibration. Thus, this query always return 0.

Example *CAL?

---

*CLS

Common
Device Dependent
Front Panel

Action Clears status event registers: Standard Event Status, Device Event Status, and Error Queue.

Notes Useful to clear registers before enabling service requests (SRQ).

Example *CLS

---

*ESE <nrf value>

Standard Event Status Enable

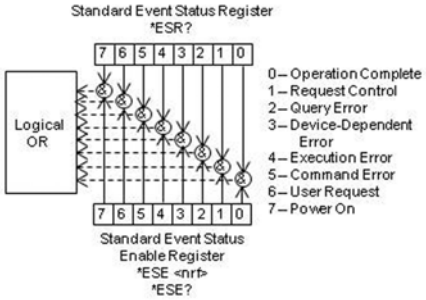
Common
Device Dependent
Front Panel

Action Enables bits in the Standard Event Status Enable Register.

Parameters The value must be between 0 and 255.

Notes Bit 5 of the Status Byte Register (STB) is set if any enabled conditions are true.

Setting Bit 0 allows for generation of service requests from overlapped commands as previous operations complete. This may be useful for ensuring that an operation is complete before starting a measurement.



Examples "*ESE 40" –action: Sets the Standard Event Status Enable Register to enable Bit 5 of the Status Byte Register if a device-dependent error or a command error occurs ($40 = 2^3 + 2^5$).

*ESE?

Standard Event Status Enable Query

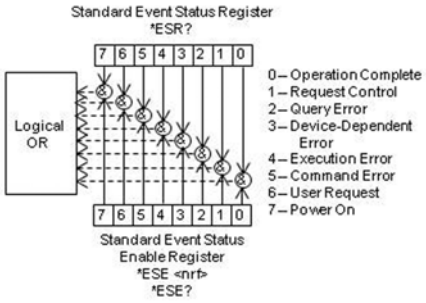
Common
Device Dependent
Front Panel

Action Requests the value of the Standard Event Status Enable Register.

Parameters None.

Notes Bit 5 of the Status Byte Register is set if any enabled conditions are true.

Response is the sum of the enabled bits and must be a value between 0 and 255.



Examples "*ESE?" –response: 68, meaning the User Request and Query Error bits have been enabled in the Standard Event Status Enable Register ($68 = 2^2 + 2^6$).

*ESR?

Standard Event Status Register Query

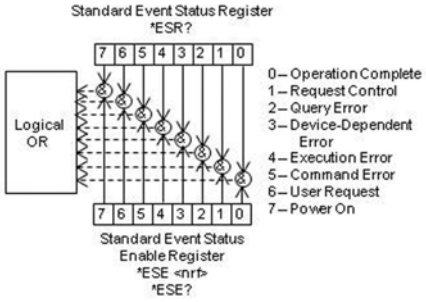
Common
Device Dependent
Front Panel

Action Requests the value of the Standard Event Status Register.

Parameters None.

Notes Response is the sum of the enabled bits and must be a value between 0 and 255.

Allows for the determination of which type of error has occurred.



Examples "*ESR?" –response: 32, meaning a command error has occurred.

*IDN?

Instrument Identification

Common
Device Dependent
Front Panel

Action Requests the instrument to identify itself.

Parameters None.

Notes Returns a comma delimited standard format ASCII identification string, from information stored in the instrument during manufacture. The information includes vendor name, product name, serial number, and firmware version.

Examples "*IDN?" –response: ILX Lightwave,8220,82200002,1.0

*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.

Parameters None.

Notes See the IEEE 488.2 specification for additional information.

Examples *OPC

*OPC?

Operation Complete Query

Common
Device Dependent
Front Panel

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

Parameters None.

Notes See the IEEE 488.2 specification for additional information.

Examples *OPC? –response: "1" when all overlapped commands are complete.

*PSC <nrf value>

Power-on Status Clear

Common
Device Dependent
Front Panel

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

Parameters One <nrf value> where 0 = disables power-on clearing and 1 = enables power-on clearing.

Notes Registers affected:

Device Condition Status Enable	Service Request Enable
Device 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 Query

Common
Device Dependent
Front Panel

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

Parameters None.

Notes Response: 0 – The enable registers are saved through power off/on.
1 – The enable registers are cleared during power on.

Registers affected:

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

See Chapter 3 for more information on register structure.

Examples

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

*RCL <nrf value>

Recall

Common
Device Dependent
Front Panel

Action Recalls a stored setup configuration from memory.

Parameters One <nrf value> with a value from 0 – 10.

Notes Configuration 0 is the factory-set default configuration.

If Configuration 0 is recalled via GPIB, the instrument will be in Remote mode. If it is recalled from the font panel, the instrument will be in Local mode.

The *SAV function is used to save configurations for convenient recall.

The current setup is automatically stored and recalled at the next power-on, unless *PSC is used to enable the power-on status clear flag.

Examples "*RCL 0" –response: instrument is reconfigured to factory-default settings.

*RST

Reset

Common
Device Dependent
Front Panel

Action Performs a device reset and sets the OCIS and OQIS states.

Parameters None.

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

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

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

Examples *RST

*SAV <nrf value>

Save

Common
Device Dependent
Front Panel

Action Saves the current instrument configuration to non-volatile memory.

Parameters One <nrf value> with a value from 1 – 10.

Notes Configuration 0 is reserved for the factory-set default configuration.

It is normally not necessary to save the current setup for next power-on. The current setup is automatically stored for recall at next power-on, unless the *PSC command is used to clear the power-on status.

Examples "*SAV 3" –response: the current instrument configuration is stored in memory location #3.

*SRE <nrf value>

Service Request Enable

Common
Device Dependent
Front Panel

Action Enables bits in the Service Request Enable Register.

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

Notes Refer to Figure 3.5 in Chapter 3 for a complete description of the Status Byte and Service Request Enable Register.

Examples "*SRE 136" –action: enables the service request enable register when a device condition summary or an error is available.

*SRE?

Service Request Enable Query

Common
Device Dependent
Front Panel

Action Returns the enabled bits in the Service Request Enable Register.

Parameters None.

Notes The response is the sum of the enabled bits and must be a value between 0 and 255.

Refer to Figure 3.5 in Chapter 3 for a complete description of the Status Byte and Service Request Enable Register.

Examples "*SRE?" –response: "136" specifies that the device condition summary and error available bits are enabled.

*STB?

Status Byte Query

Common
Device Dependent
Front Panel

Action Returns the value of the Status Byte Register.

Parameters None.

Notes The response is the sum of the enabled bits and must be a value between 0 and 255.

Refer to Figure 3.5 in Chapter 3 for a complete description of the Status Byte and Service Request Enable Register.

Examples "*STB?" –response: "200" specifies that the device condition summary, master status summary and error available bits are enabled.

*TST?

Self Test

Common
Device Dependent
Front Panel

Action Performs an internal self-test, then reports results.

Parameters None.

Notes Response 0 = test completed with no errors.
Response non-zero = test not completed or completed with errors.

Examples "*TST?" –response: "0" means test completed without errors.

*WAI

Wait to Continue

Common
Device Dependent
Front Panel

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

Parameters None.

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

Care should be taken to set the GPIB time-out appropriately for use with the *WAI command. After this command (or the Delay) command is sent, the instrument may receive up to 20 more commands before the wait period is over.

Examples "*WAI" –action: wait until OPC status is true.

CAL:USER <nrf value>

Common
Device Dependent
Front Panel

Action Sets a gain factor to be applied to all FPM-8220 measurements.

Parameters 0.500 to 2.500

Indicators Front panel USER CAL indicator is ON when the gain factor is any other value than 1.000.

Examples CAL:USER .5 - Results are half their normal value
CAL:USER 1.01 - Results are increased by 1%

CAL:USER?

Common
Device Dependent
Front Panel

Action Requests the FPM-8220 user-cal gain value.

Response A value between 0.500 and 2.500.

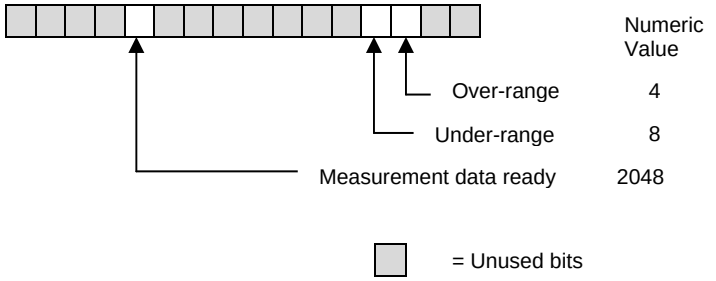
Examples CAL:USER? - Response 1.000 means there is no user-calibration gain factor.
CAL:user? - Response 1.010 means a user-calibration gain factor is increasing all results by 1%.

COND?

Common
Device Dependent
Front Panel

Action Requests the contents of the device condition status register.

Response A value between 0 and 65535



Notes The conditions reported to the status byte are set through the ENABle:COND command.

The condition status may be constantly changing, while the event status is only cleared when it is cleared or read. See *CLS and EVEnt? commands.

See Chapter 3 for more information about register structure.

Examples COND? - Response 4 means there is an over-range condition.

DELAY <nrf value>

Common
Device Dependent
Front Panel

Action Delays processing of further commands for the defined time (in milliseconds).

Parameters 0 to 65535

Notes Decimal values are rounded.

Small delay values may have no effect, because of time required for command processing. The actual minimum delay depends on the situation, for example whether a measurement is being done in background.

This delay command can be useful for creating delays based on the FPM-8220 clock rather than using the controller's clock.

Examples DELAY 2000 - Delay further processing 2 seconds.
DELAY 48.2 - Delay further processing 48 milliseconds.

DISPlay <nrf value>

Common
Device Dependent
Front Panel

Action Turns the front panel display on or off, including all indicators.

Parameters 0 = OFF
1 = ON

Notes Other non-zero values are interpreted as "1".
This command can be useful for working in a dark environment.

Examples DISPLAY 0 - Turn off the front panel display.
Disp:enab 1 - Enable the front panel display.

DISPlay?

Common
Device Dependent
Front Panel

Action Requests the front panel display status.

Response Returns the display status. 0 means OFF and 1 means ON.

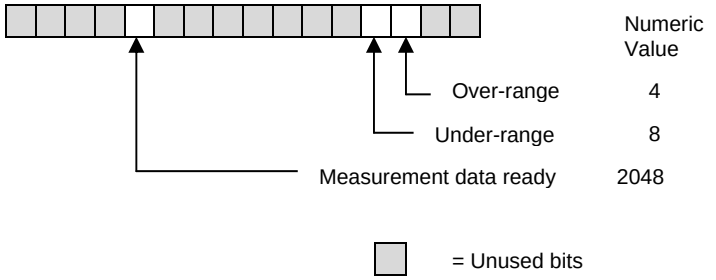
Examples DISPLAY? - Response "0" means the display is currently shut off
Disp? - Response "1" means the display is in normal state.

ENABle:COND <nrf value>

Common
Device Dependent
Front Panel

Action Enables bits in the device condition status enable register.

Paramters 0 to 65535



Notes Enabled/disabled conditions can be read by ENABle:COND?.

Changing condition status may be monitored by COND?.

Bit 3 of the status byte register is set if any device enabled conditions are true.

See Chapter 3 for more information about register structure.

Enable registers normally retain their values through power OFF/ON, unless the power-on status clear flag is set true. See *PSC.

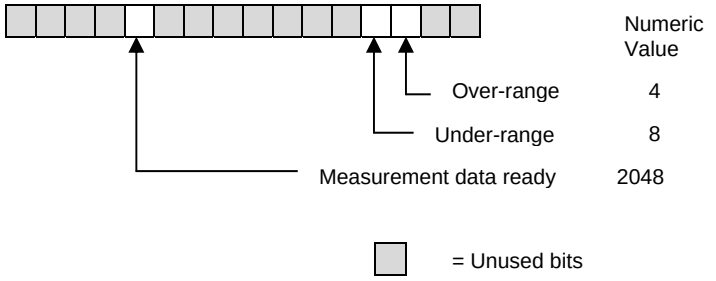
Examples ENAB:COND 12 - Enables the condition status register so that over-range and under-range error conditions are summarized in the status byte bit 3 (8 + 4 = 12).
Enable:cond #HC - Same as ENAB:COND 12, except using hexadecimal numbering. See RADix.

ENABle:COND?

Common
Device Dependent
Front Panel

Action Requests the value in the device condition status enable register.

Response 0 to 65535



Notes Enabled/disabled conditions can be set by ENABle:COND?. Changing condition status may be monitored by COND?. See Chapter 3 for more information about register structure.

Examples ENAB:COND? - Response 4 means that over range will be reported in status byte bit 3.
Enable:COND? - Response #H4 is the same as 4, except using hexadecimal numbering. See RADix.

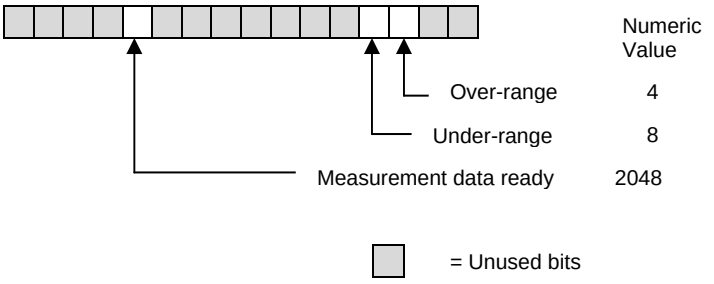
ENABle:EVEnt <nrf value>

Common
Device Dependent
Front Panel

Action Enables bits in the device event status enable register.

.

Parameters 0 to 65535



Notes Enabled/disabled events can be read by ENABle:EVEnt?.

Event status may be monitored by EVEnt?.

Bit 2 of the status byte register is set if any device enabled events are true, for generation of service requests.

See Chapter 3 for more information about register structure.

Enable registers normally retain their values through power OFF/ON, unless the power-on status clear flag is set true. See *PSC.

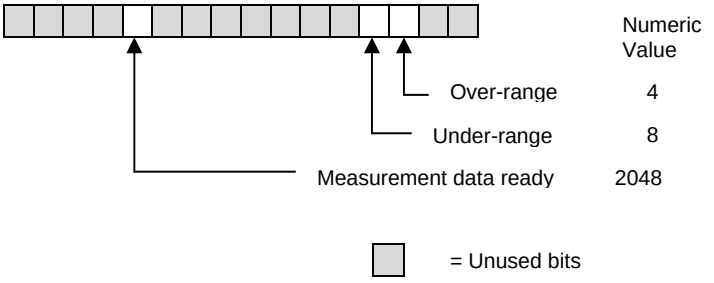
Examples ENAB:EVE 4 - Enables over-range event to be summarized in the status byte bit 2.
Enable:event #H4 - Same as ENAB:EVE 4, except using hexadecimal numbering. See RADix.

ENABle:EVEnt?

Common
Device Dependent
Front Panel

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

Response a value between 0 and 65535



Notes Enabled/disabled events can be set by ENABle:EVEnt. Changing event status may be monitored by EVEnt?. See Chapter 3 for more information about register structure.

Examples ENAB:EVE? - Response 2048 means that measurement ready will be reported in status byte bit 2.
Enable:event? - Response #H800 is the same as 2048, except using hexadecimal numbering. See RADix.

ERRors?

Common
Device Dependent
Front Panel

Action Requests a list of errors which have occurred since the last ERR? request.

Parameters None

Response ASCII character string: list of error numbers, separated by commas.

Notes 0 = no errors reported.
See Appendix A for a list of error numbers.

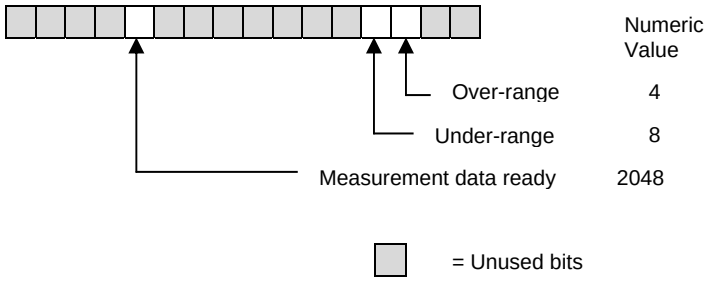
Examples ERR?- Response 0 means no errors to report.
Errors? - Response 530 means the measurement head is not connected.

EVEnt?

Common
Device Dependent
Front Panel

Action Requests the value in the device event status register.

Response A value between 0 and 65535



Notes Enabled/disabled events can be set by ENABle:EVEnt.
Status bits are set by events, and cleared when read or cleared by command. See *CLS and EVEnt? commands.

The measurement ready bit is set whenever the display value is updated. For example, in slow mode a new measurement is ready every 5 seconds. See FILTer below.
See Chapter 3 for more information about register structure.

Examples EVE? - Response 2052 means that over-range and measurement data ready events occurred since the last EVE? inquiry.
Event? - Response #H804 is the same as 2052, except using hexadecimal numbering. See RADix.

FILTer <nrf value>

Common
Device Dependent
Front Panel

Action Selects measurement averaging and display update rate.

Parameter One of the following strings: SLOW
MED
FAST

Notes Measurement samples are taken every 50 mSec.

Examples FILTER SLOW - Updates the display every 5 seconds with the average of 100 measurements.
Filter med - Updates the display every 0.5 seconds with the average of 10 measurements.
FILT Fast - Turns off measurement averaging. Updates the display every 50 milliseconds.

FILTer?

Common
Device Dependent
Front Panel

Action Requests the current setting for measurement averaging and display update.

Response One of the following ASCII character strings:

FAST
MED
SLOW

Notes The filter rate is set by the front panel, or by the FILTer command.

Examples FILTER? - Response SLOW means the display is updating every 5 seconds with the average of the previous 100 measurements.
Filt? - Response FASTmeans measurement averaging is off and the display is updating every 0.05 seconds.

MESsage <ASCII string>

Common
Device Dependent
Front Panel

Action Stores an ASCII string into FPM-8220 non-volatile memory.

Notes String is 1 to 16 non-zero ASCII characters. Strings longer than 16 characters are terminated to the first 16. Strings shorter than 16 characters are filled with spaces to 16.

Message string is retained through power OFF/ON.

Useful as a "scratchpad" for storing intermediate test status or configuration information.

Examples Message “Test 3" - Stores the string Test 3 in non-volatile memory.
Message Test 3 - Same as above. Quotes are optional.

MESSage?

Common
Device Dependent
Front Panel

Action Requests an ASCII string from FPM-8220 message memory.

Response 16-character string, followed by NULL terminator.

Notes As necessary, the string is filled with spaces to 16-character length. If no message string was stored, the response is a string of 16 spaces.

Examples Message? – Response “Test 3” means the previously stored message was Test 3.

MODE:DB

Common
Device Dependent
Front Panel

Action Selects Decibels (dB) relative to the reference value to be used in reporting measurements.

Notes MODE defines the units of value that will be used for responses to a POW? request.
This command has the same effect as selecting the display mode on the front panel.

Examples Mode:dB - Measurements will be reported in dB (decibels) relative to the reference value.

MODE:DBM

Common
Device Dependent
Front Panel

Action Selects Logarithmic (dBm) units to be used in reporting measurements.

Examples Mode:dBm - Measurements will be reported in dBm.

MODE:W

Common
Device Dependent
Front Panel

Action Selects Linear (watts) units to be used in reporting measurements.

Examples Mode:W - Measurements will be reported in Watts.

MODE?

Common
Device Dependent
Front Panel

Action Requests FPM-8220's measurement mode.

Response One of the following ASCII character strings:

dB
dBm
W

Notes This information is available on front panel indicators. See Chapter 2.
The response to MODE? is the units of value that will be used for responses to a POW? request.

Examples Mode? - Response W means that linear measurement mode (watts) is in effect.

POWer?

Common
Device Dependent
Front Panel

Action Requests the most recent value of measured optical power.

Response Numeric value.

Notes Units defined by MODE commands.

In dB or dBm mode, reports the same number as on the display.

In W mode, reports in scientific notation.

Monitor the Device Event Status Register for over-range or under-range conditions when using this query.

Examples Mode?;Power? - Response of DBM,-13.584 means the last measured power was-13.584 dBm.
MODE:W;POW? - Response 2.795E-006 means the last measured power was 2.795 µW.

RADix <nrf value>

Common
Device Dependent
Front Panel

Action
Sets the form (radix) of numeric responses.
Rad DEC Decimal numbers. (Default type when not specified).
Rad HEX Hexadecimal numbers
Rad BIN Binary numbers
Rad OCT Octal numbers

Notes
All status, condition, and event requests respond in the selected radix.
RADix defines responses, not data entry. To enter data in non-decimal form, use one of the following prefixes:

#H Hexadecimal
#O Octal
#B Binary

Examples
RAD DEC - Reset to the factory default decimal radix.
Radix HEX; *ESR? - Set hexadecimal radix. Response #H80 means power-on was detected.
rad oct - Set octal radix.

RADix?

Common
Device Dependent
Front Panel

Action
Requests the current form (radix) of numeric responses.

Responses

Dec	Decimal numbers. (Default type).
Hex	Hexadecimal numbers
Bin	Binary numbers
Oct	Octal numbers

Notes
Use the RADix command to change the radix setting.

Examples
Radix? - Response Hex means numeric responses will be in hexadecimal numbers.

RANge <nrf value>

Common
Device Dependent
Front Panel

Action
Sets the FPM-8220 photodetector current gain range.

Parameters
0 through 7

Notes
The InGaAs photodetector in the FPM-8220 converts optical power into electrical current. The FPM-8220 is a stable low noise current meter that uses calibration to report photodetector current as optical power. This current is proportional to optical power, but it also varies with wavelength. For *more information about gain ranges, see Gain Ranges on page 18.*

There are eight ranges in the FPM-8220 meter. Each range increases gain by 10x over the previous range. The maximum photodetector current for each range is as follows

Range	Maximum Current	Range	Maximum Current
0	10 mA	4	1 µA
1	1 mA	5	100 nA
2	100 µA	6	10 nA
3	10 µA		

Setting the gain range puts the FPM-8220 into MANUAL range mode.

Examples
Range 5 - Set the photodetector current gain to range 5: 100 nA full scale
RAN 6 - Set the photodetector current gain to range 6: 10 nA full scale

RANge?

Common
Device Dependent
Front Panel

Action Requests the FPM-8220 photodetector current gain range.

Response Integer number: 0 through 6

Notes See the discussion of RANge above for information about gain ranges.
Response is valid whether the FPM-8220 is in MANUAL or AUTO range mode.
Range information is not displayed on the FPM-8220 front panel.

Example Range - Response 5 means photodetector current gain is to range 5: 100 nA full scale

RANge:AUTO <nrf value>

Common
Device Dependent
Front Panel

Action Sets the FPM-8220 into AUTO or MANUAL ranging mode.

Values 0 = MANUAL ranging
1 = AUTO ranging

Notes Same function as pressing AUTO/MAN on the front panel.

Examples Range:AUTO 1 - Set the FPM-8220 into AUTO ranging mode.
RAN:AUTO 0 - Set the FPM-8220 into MANUAL ranging mode.

RANge:AUTO?

Common
Device Dependent
Front Panel

Action Requests the status of AUTO or MANUAL range mode.

Response 0 = MANUAL ranging, 1 = AUTO ranging

Notes This information is available on a front panel indicator.

Examples Range:AUTO? - Response **1** means the FPM-8220 is in AUTO ranging mode.

REF <nrf value>

Common
Device Dependent
Front Panel

Action Sets a reference level in dBm.

Parameters +30 to -120

Notes Measurements in dB are reported relative to this reference level. See **MODE:DB**. "+" is accepted but not necessary for positive values.

Front panel operation allows you to set the reference to the most recent measurement.. However the GPIB command allows you to set any arbitrary reference level.

Examples REF 0 - Set reference level to 0 dBm (1 mW).
Ref -18.24 - Set reference level to -18.24 dBm (15 µW).

Mode:dBm;Power? - Get most recent power measurement in dBm.
REF <power> - Using the result <power>, set the reference to the most recent power measurement.

REF?

Common
Device Dependent
Front Panel

Action Requests the reference level value.

Response GPIB-standard nrf value, in the units currently defined. See **MODE**.

Notes Same function as pressing **dBm/W** and **REF** together on the front panel.

Examples REF? - Response 0 means the reference level is 0 dBm.
Ref? - Response -20 means the reference level is -20 dBm (10 µW).
Ref? - Response 2.795E-006 means the reference level is 2.795 µW.

RESP?

Common
Device Dependent
Front Panel

Action Requests the calibrated detector responsivity for the currently selected wavelength.

Response GPIB standard <nrf value>, in units: mA / mW

Notes The information should correspond with that on your latest ILX Lightwave calibration certificate for this meter. If not, contact ILX Lightwave Customer Service to resolve the discrepancy.

This information can be useful for understanding the characteristics of your FPM-8220 meter. Notice for example that detector current is much less at shorter wavelengths.

For more information, see the discussion of the calibration certificate at the end of Chapter Two.

Examples RESP? - Response 1.193E-2 means the detector produces 0.01193 mA/mW at the currently set wavelength.

TERM <nrf value>

Common
Device Dependent
Front Panel

Action Defines the message terminator.

Paramters
0 = <**CR**><**NL**><^**END**>
1 = <**CR**><**NL**>
2 = <**CR**><^**END**>
3 = <**CR**>
4 = <**NL**><^**END**> FPM-8220 default and IEEE-488.2 Standard
5 = <**NL**>
6 = <^**END**>

Notes All settings other than TERM 4 are technically out of compliance with IEEE-488.2 specifications. However they are provided for flexible compatibility with various GPIB drivers.

TERM 3 will often cause "bus hang" problems, because IEEE-488.2 compliant instruments ignore the <CR> as white space, causing them to wait indefinitely for message termination.

Meanings of the acronyms are historical:
CR = Carriage Return (e.g.: a mechanical typewriter)
NL = New Line (e.g.: line-feed on a "line printer")
^END = EOI code (End Or Identify)

Examples Term 4 - Define the message terminator as the IEEE-488.2 standard: <NL><^END>

TERM?

Common
Device Dependent
Front Panel

Action Requests the currently defined message terminator.

Response 0 through 6, interpreted as follows:
0 = <**CR**><**NL**><^**END**>
1 = <**CR**><**NL**>
2 = <**CR**><^**END**>
3 = <**CR**>
4 = <**NL**><^**END**> IEEE-488.2 Standard and FPM-8220 default
5 = <**NL**>
6 = <^**END**>

Notes All settings other than TERM 4 are out of compliance with IEEE-488.2 specifications. They are provided for flexible compatibility with various GPIB drivers.
See TERM (above) for more information.

Examples Term? - Response 4 means the message terminator is the FPM-8220 default: <NL><^END>

TIME?

Common
Device Dependent
Front Panel

Action Requests the time since the last time the FPM-8220 was powered ON.

Response ASCII character data in the form hours:minutes:seconds

Notes Maximum time (clock "turns over") is1193 hours (~50 days).
The TIME clock is independent of the TIMER clock. See TIMER? below.

Examples Time? - Response 0:32:01.76 means 32 minutes and 1.76 seconds have elapsed since power-ON.

TIMER?

Common
Device Dependent
Front Panel

Actions Requests the time since the last TIMER? query. Resets the TIMER clock to zero.

Response ASCII character data in the form hours:minutes:seconds

Notes Maximum time (clock "turns over") is 1193 hours (~50 days).
The TIMER clock is independent of the TIME clock. See TIME? above.
The TIMER clock is set to zero at power-ON, so the first response will be the same as a TIME? query.

Examples Timer? - Response 0:00:12.07 means 12.07 seconds have elapsed since the last TIMER? query.

WAVE <nrf value>

Common
Device Dependent
Front Panel

Action Sets the wavelength (in nanometers) to be used in calibrating detector response.

Parameters 800 to 1650

Notes The FPM-8220's InGaAs detector produces current in proportion to light input. The amount of current varies also with wavelength. For this reason, it is important to give the FPM-8220 correct wavelength information.Calibration points are basically every 10 nm. When you give the FPM-8220 a wavelength between two calibration points, the resulting calibration factor is a linear interpolation between the two points.

Examples WAVE 1552 - Set wavelength response to 1552 nm. The calibration factor will be interpolated to include 20% of the change in calibration points from 1550 nm to 1560 nm.

WAVE?

Common
Device Dependent
Front Panel

Action Requests the wavelength to be used in calibrating detector response.

Response A GPIB-standard nrf value of the current wavelength setting.
See WAVE above.

Notes This information is available on the FPM-8220 front panel.

Examples WAVE? - Response 1552 means FPM-8220 wavelength response is set to 1552 nm. The calibration factor will be interpolated to include 20% of the change in calibration points from 1550 nm to 1560 nm.

ZERO

Common
Device Dependent
Front Panel

Action Applies an offset to internal FPM-8220 amplifiers to eliminate fixed errors from such effects as detector dark current and ambient light.

Notes This function is the same as the front panel ZERO button.

Before starting measurements it is good practice to first zero the meter. The concept is similar to shorting the leads of a voltmeter and making sure the meter reads zero.

To eliminate all offsets, no light must be on the detector. A connector adaptor can be used for this purpose, provided a patch cord is connected and the other end of the fiber is not exposed to ambient light.

You can usually use ZERO with your test setup connected to eliminate small external effects such as ambient room light from your measurement. However, the FPM-8220 limits the amount of offset because large external influences are too unstable to include in measurements. Error “Zeroing error” results when there is too much ambient light for the zero operation.

The FPM-8220 keeps the last zero setting, even when you turn power OFF. So if you zero the meter to your test setup, be sure to zero the meter again when you are finished. It may be more convenient to do this with the front panel ZERO button.

After ZERO, you should confirm completion with ZERO?. Then check the error queue (see ERRors?) before proceeding.

You can interrupt the zero process from the front panel even if it was initiated by GPIB by pressing the front panel ZERO button before it completes. If the zero process is interrupted or was not successful, gain offsets for the remaining unzeroed gain ranges remain unchanged.

Examples ZERO - Start the zero process.

ZERO?

Common
Device Dependent
Front Panel

Action Requests status of the FPM-8220 zero operation.

Response 0 = zero operation is not in progress.
1 = zero operation is in progress.

Examples ZERO? - Response 1 means the zero operation is in progress.
Zero? - Response 0 means the zero process is not in progress. If you just issued a ZERO command, this confirms the process is complete.

DISPlay:BRIGhtness <nrf value>

Common
Device Dependent
Front Panel

Action Set the display brightness.

Parameters 1 to 10

Examples DISPlay:BRIGhtness 10 – Set the display to the highest brightness

DISPlay:BRIGhtness?

Common
Device Dependent
Front Panel

Action Requests the display brightness.

Response 1 to 10.

Examples DISP:BRIG? - Response "5" means the display brightness is 5, which is medium brightness

DISPlay[:ENABle] <nrf value>

Common
Device Dependent
Front Panel

Action Turns the front panel display on or off, including all indicators.

Parameters 0 = OFF
1 = ON

Notes Other non-zero values are interpreted as "1".
This command can be useful for working in a dark environment.

Examples DISPLAY 0 - Turn off the front panel display.
Disp:enab 1 - Enable the front panel display.

DISPlay[:ENABle]?

Common
Device Dependent
Front Panel

Action Requests the front panel display status.

Response Returns the display status. 0 means OFF and 1 means ON.

Examples DISPLAY? - Response "0" means the display is currently shut off
Disp? - Response "1" means the display is in normal state.

DISPlay:MODE <nrf value>

Common

Device Dependent
Front Panel

Action Set the display mode.

Parameters One of the following string: NORMAL
BRIGHTNESS
BARGRAPH

Examples DISPlay:MODE BARGRAPH – Set to the bar graph display mode

DISPlay:MODE?

Common

Device Dependent

Front Panel

Action Requests the display mode.

Response One of the following string: NORMAL
BRIGHTNESS
BARGRAPH

Examples DISP:MODE? - Response "NORMAL" means the display is in normal display, which will show the wavelength, filter mode, and auto/manual range mode.

READ:POWer?

Common
Device Dependent
Front Panel

Action Requests the most recent value of measured optical power.

Response Numeric value.

Notes In dB or dBm mode, reports the same number as on the display.
In W mode, reports in scientific notation.

Monitor the Event Status Register for over-range or under-range conditions when using this query.

Examples Mode?; READ:POWer? - Response of DBM,-13.584 means the last measured power was-13.584 dBm.

SENSe:CORRection:COLLect:ZERO

Common
Device Dependent
Front Panel

Action Applies an offset to internal FPM-8220 amplifiers to eliminate fixed errors from such effects as detector dark current and ambient light.

Notes This function is the same as the front panel **ZERO** button.

Before starting measurements it is good practice to first zero the meter. The concept is similar to shorting the leads of a voltmeter and making sure the meter reads zero.

To eliminate all offsets, no light must be on the detector. A connector adaptor can be used for this purpose, provided a patch cord is connected and the other end of the fiber is not exposed to ambient light.

You can usually use ZERO with your test setup connected to eliminate small external effects such as ambient room light from your measurement. However, the FPM-8220 limits the amount of offset because large external influences are too unstable to include in measurements. Error "Zeroing error" results when there is too much ambient light for the zero operation.

The FPM-8220 keeps the last zero setting, even when you turn power OFF. So if you zero the meter to your test setup, be sure to zero the meter again when you are finished. It may be more convenient to do this with the front panel ZERO button.

After ZERO, you should confirm completion with ZERO?. Then check the error queue (see ERRors?) before proceeding.

You can interrupt the zero process from the front panel even if it was initiated by GPIB by pressing the front panel ZERO button before it completes.

If the zero process is interrupted or was not successful, gain offsets for the remaining unzeroed gain ranges remain unchanged.

Examples SENSe:CORRection:COLLect:ZERO - Start the zero process.

SENSe:CORRection:COLLect:ZERO?

Common
Device Dependent
Front Panel

Action Requests status of the FPM-8220 zero operation.

Response 0 = zero operation is not in progress.
1 = zero operation is in progress.

Notes Since the OPC flag is held false during the zero process, zero status can also be determined by checking OPC status. See ***OPC?**.

Examples SENSe:CORRection:COLLect:ZERO? - Response 1 means the zero operation is in progress.
SENSe:CORRection:COLLect:ZERO? - Response 0 means the zero process is not in progress. If you just issued a SENSe:CORRection:COLLect:ZERO command, this confirms the process is complete.

SENSe:POWer:RANGe:AUTO <nrf value>

Common
Device Dependent
Front Panel

Action Sets the FPM-8220 into AUTO or MANUAL ranging mode.

Values 0 = MANUAL ranging
1 = AUTO ranging

Notes Same function as pressing AUTO/MAN on the front panel.

Examples SENSe:POWer:RANGe:AUTO 1 - Set the FPM-8220 into AUTO ranging mode.
SENSe:POWer:RANGe:AUTO 0 - Set the FPM-8220 into MANUAL ranging mode.

SENSe:POWer:RANGe:AUTO?

Common
Device Dependent
Front Panel

Action Requests the status of AUTO or MANUAL range mode.

Response 0 = MANUAL ranging, 1 = AUTO ranging

Notes This information is available on a front panel indicator.

Examples SENSe:POWer:RANGe:AUTO? - Response 1 means the FPM-8220 is in AUTO ranging mode.

SENSe:POWer:RANGe:MONitor <nrf value>

Common
Device Dependent
Front Panel

Action Sets the FPM-8220 photodetector current gain range.

Parameters 0 through 7

Notes The InGaAs photodetector in the FPM-8220 converts optical power into electrical current. The FPM-8220 is a stable low noise current meter that uses calibration to report photodetector current as optical power. This current is proportional to optical power, but it also varies with wavelength. For *more information about gain ranges, see Gain Ranges on page 18.*

There are eight ranges in the FPM-8220 meter. Each range increases gain by 10x over the previous range. The maximum photodetector current for each range is as follows

Range	Maximum Current	Range	Maximum Current
0	10 mA	4	1 μA
1	1 mA	5	100 nA
2	100 μA	6	10 nA
3	10 μA		

Setting the gain range puts the FPM-8220 into MANUAL range mode.

Examples SENSe:POWer:RANGe:MONitor 5 - Set the photodetector current gain to range 5: 100 nA full scale

SENSe:POWer:RANGe:MONitor?

Common
Device Dependent
Front Panel

Action Requests the FPM-8220 photodetector current gain range.

Response Integer number: 0 through 6

Notes See the discussion of SENSe:POWer:RANGe:MONitor above for information about gain ranges.
Response is valid whether the FPM-8220 is in MANUAL or AUTO range mode.
Range information is not displayed on the FPM-8220 front panel.

Examples SENSe:POWer:RANGe:MONitor?- Response 5 means photodetector current gain is to range 5: 100 nA full scale

SENSe:POWer:REFerence <nrf value>

Common
Device Dependent
Front Panel

Action Sets a reference level in dBm.

Parameters +30 to -120

Notes Measurements in dB are reported relative to this reference level. See MODE:DB. "+" is accepted but not necessary for positive values.

Front panel operation allows you to set the reference to the most recent measurement. However the GPIB command allows you to set any arbitrary reference level.

Examples SENSe:POWer:REFerence 0 - Set reference level to 0 dBm (1 mW).
SENSe:POWer:REFerence -18.24 - Set reference level to -18.24 dBm (15 μW).

Mode:dBm;Power? - Get most recent power measurement in dBm.
SENSe:POWer:REFerence <power> - Using the result <power>, set the reference to the most recent power measurement.

SENSe:POWer:REFerence?

Common
Device Dependent
Front Panel

Action Requests the reference level value.

Response GPIB-standard nrf value, in the units currently defined. See MODE.

Notes Same function as pressing dBm/W and REF together on the front panel.

Examples SENSe:POWer:REFerence? - Response 0 means the reference level is 0 dBm.
SENSe:POWer:REFerence? - Response -20 means the reference level is -20 dBm (10 µW).
SENSe:POWer:REFerence? - Response 2.79565E-006 means the reference level is 2.79565 µW. Note the change in units.

SENSe:POWer:UNIT <nrf value>

Common
Device Dependent
Front Panel

Action Selects Logarithmic (dBm) unit or linear units (Watts) to be used in reporting measurements

Parameters 0 = logarithmic unit
1 = linear unit

Notes dBm is the log of the ratio of output power relative to one milliwatt.

Examples SENSe:POWer:UNIT 0 - Measurements will be reported in dBm.

SENSe:POWer:UNIT?

Common
Device Dependent
Front Panel

Action Requests FPM-8220's measurement mode.

Response 0 = logarithmic unit
1 = linear unit

Notes This information is available on front panel indicators. See Chapter 2.

Examples SENSe:POWer:UNIT? **-** Response **0** means that logarithmic measurement mode (dBm) is in effect.

SENSe:POWer:WAVelength <nrf value>

Common
Device Dependent
Front Panel

Action Sets the wavelength (in nanometers) to be used in calibrating detector response.

Parameters 800 to 1650

Notes The FPM-8220's InGaAs detector produces current in proportion to light input. The amount of current varies also with wavelength. For this reason, it is important to give the FPM-8220 correct wavelength information.

Calibration points are basically every 10 nm. When you give the FPM-8220 a wavelength between two calibration points, the resulting calibration factor is a linear interpolation between the two points.

Examples SENSe:POWer:WAVelength 1552 - Set wavelength response to 1552 nm. The calibration factor will be interpolated to include 20% of the change in calibration points from 1550 nm to 1560 nm.

SENSe:POWer:WAVelength?

Common
Device Dependent
Front Panel

Action Requests the wavelength to be used in calibrating detector response.

Response A GPIB-standard nrf value of the current wavelength setting.
See SENSe:POWer:WAVelength above.

Notes This information is available on the FPM-8220 front panel.

Examples SENSe:POWer:WAVelength? - Response 1552 means FPM-8220 wavelength response is set to 1552 nm. The calibration factor will be interpolated to include 20% of the change in calibration points from 1550 nm to 1560 nm.

SYSTem:COMMunicate:GPIB?

Common
Device Dependent
Front Panel

Action Returns the GPIB address.

Parameters 1 to 30

Examples SYSTem:COMMunicate:GPIB? – Response 12 means that the GPIB address is set to 12.

SYSTem:ERRor?

Common
Device Dependent
Front Panel

Action Requests the current error in the error queue and then removes this error from the error queue.

Parameters None

Response ASCII character string: Error number and error description separated by commas.

Notes See Appendix A for a list of error numbers.

Examples SYSTem:ERRor?- Response 0,”No error” means no errors to report.
SYSTem:ERRor? - Response 530, “Measurement head error” means the head is not connected.

Chapter 5: Troubleshooting

This chapter is to help you resolve problems quickly. If you need help, contact ILX Lightwave Customer Service. See page viii for contact information.

ILX Lightwave Corporation provides in-house and on-site calibration services for ILX instruments. Most ILX instruments, including the FPM-8220 require yearly calibration to ensure performance to published specifications. ILX factory calibrations employ NIST traceable measurement instrumentation, and our calibration engineers and technicians use automated test equipment to accurately and efficiently capture and record calibration data. An original certificate of calibration authenticity is provided with all instrument calibrations, and a detailed report showing any pre-calibration out-of-tolerance conditions is available upon request.

Calibration turn-times are normally five business days or less. On-site calibrations can be performed around your production schedule, night or day, seven days a week. Please contact ILX Customer Support (see Comments, Suggestions, and Problems on page viii for contact information) for additional calibration information.

For further assistance with technical solutions and troubleshooting, visit the www.ilxlightwave.com Support page (www.ilxlightwave.com/support/index.html), and the Library page (www.ilxlightwave.com/library/index.html) for Application Notes and Technical Notes.

Troubleshooting Guide

This section lists some common problems and corrective actions. The corrective actions may not solve the problem; in which case, you should contact ILX Lightwave.

For a comprehensive list of frequently asked questions, see the ILX Lightwave website or contact ILX Lightwave Customer Service (see Comments, Suggestions, and Problems on page viii for contact information).

Symptom	Corrective Action
The instrument does not power up	Check the power cord to make sure that it is properly connected and check the wall outlet by connecting to operational instrument.
The display reads “Zeroing Error”	Error message E-531 normally indicates that there is too much environmental light to properly zero the meter. The detector head must be connected to a fiber and the source’s output must be turned off.
Display shows ”------OVR”	There is too much optical power input for the range. Press the **DOWN ARROW** to change the gain range or select **AUTO/MAN**, the auto indicator appears in the display, to automatically select an appropriate gain range. You can then select **AUTO/MAN** again if you want to lock it into one range manually. If you see an “------OVR” indication in auto-range mode or in the highest range (lowest gain), the optical power input is beyond the FPM-8220’s upper limit. If you see an “------OVR” indication in manual-range mode, then the optical power input is greater than 97.5% of full scale for the current gain range.
Display shows “-99.999 dBm” or “0.000 nW”	Not enough optical power input for the range. Press the **DOWN ARROW** to change the gain range or select **AUTO/MAN,** the **auto** indicator is on in the display, to automatically select an appropriate gain range. You can then select **AUTO/MAN** again if you want to lock it into one range manually. If you see a “-99.999 dBm” or “0.000 nW” indication in auto-range mode, or in the lowest range (highest gain), the optical power input is below the FPM-8220's lower limit. If you see a “-99.999 dBm” or “0.000 nW” indication in manual-range mode, then the optical power input is less than 5.0% of full scale for the current gain range.
The instrument reads “Internal Communication Error”	E-532 is the internal communication error indicating, the FPM-8220 platform, is not functioning correctly. The instrument must be returned to ILX Lightwave if this error occurs.

No response from a remote command and the RMT indicator is off	Check that a GPIB or USB A/B cable, from the system controller, is connected to the FPM-8220. If you are using GPIB, the cable should be less than 3 meters (10 feet) long. Press **RECALL** and the **UP ARROW** at the same time to display the GPIB address for three seconds. If it is not correct, change it by pressing the **UP ARROW** or the **DOWN ARROW** until you see the correct address. Check that your controlling software is sending commands to the correct GPIB address or with the correct terminating character. Check that no two devices are set to the same GPIB address. Make sure that there are less than 15 devices on the bus. Check that total GPIB cable length is less than 20 meters (65 feet). Check the configuration of your GPIB controller card or COM port. Specifically note the information regarding the terminating character. Remove all other instruments from the GPIB bus to isolate the FPM-8220. If this corrects the problem, re-connect one instrument at a time until the problem returns. Then check the other instrument for address conflicts and proper GPIB function. 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.
Slow or unexpected response to remote commands	Check that no two devices are set to the same GPIB address. Make sure that there are less than 15 devices on the bus. Check the configuration of your GPIB controller card or COM port. Specifically note the information regarding the terminating character. Check that total GPIB cable length is less than 20 meters. Remove all other instruments from the bus to isolate the FPM-8220. If this corrects the problem, re-connect one instrument at a time until the problem returns. Then check the other instrument for address conflicts and proper GPIB function.

Is the FPM-8220 ANSI/IEEE 488.2 compatible?	The FPM-8220 is IEEE 488.2 compliant.
Problems using the Device Clear	The DCAS interrupt is not connected to the necessary microprocessor for clearing bus-hung conditions via Device Clear. The firmware does not terminate or complete all commands upon a Device Clear because of firmware/hardware timing issues and GPIB/USB architecture.
Instrument is reading “NO HEAD CONNECTED”	The instrument reads “NO HEAD CONNECTED” if it cannot locate a compatible head. Confirm that the connected head is an FMH-8700 and that the connector is secure. If the instrument still does not recognize the head, check that there are no bent pins in the connector. If there are, straighten the pin with needle nose pliers to ensure that it does not re-bend.

Optical Measurement Problems

Symptom	Corrective Action
Inconsistent readings	Make sure the connector adaptor is flush with the head. Verify the quality of cleave and the placement in the bare fiber holder. Rotate the connector adaptor until alignment pin snaps into place. Verify the fiber ferrule is clean.
Poor PDR measurement	Make sure you are using good, low PDL paddles.
Dirty head	Contact Customer Service; head needs to be sent in for cleaning.
ZERO function does not work	Error message E-531 normally indicates that there is too much environmental light to properly zero the meter. The detector head must be connected to a fiber and the source's output must be turned off.

Error Messages

Error messages may appear on the FPM-8220 display when error conditions occur in the instrument. In remote operation, use ERR? to read the current error list or SYST:ERR? to read the latest error. The ERR? command returns a string containing up to 10 of the error messages that are currently in the error message queue.

Error Code Tables

The error codes are classified and placed in tables corresponding to their classification. The classifications are Command Errors, Execution Errors, Device Errors, Query Errors and Instrument Specific Errors.

Table 5.1 - Command Errors

Error Code	Explanation
-104	Data type error
-108	Parameter not allowed
-113	Undefined header
-115	Unexpected number of parameters
-121	Invalid character in number
-123	Exponent too large
-151	Invalid string data
-160	Block data error
-161	Invalid block data

Table 5.2 - Execution Errors

Error Code	Explanation
-220	Parameter error
-222	Data out of range

Table 5.3 - Device Errors

Error Code	Explanation
-311	Memory error

Table 5.4 - Query Errors

Error Code	Explanation
-410	Query interrupted
-420	Query unterminated

Table 5.5 - Instrument Specific Errors

Error Code	Explanation
530	Measurement head error
531	Zeroing error
532	Internal communication error (the instrument needs to be returned to ILX)