IQ-1600 High-Speed Power Meter Series

IQ-1610 Single-Channel Power Meter
IQ-1620 Dual-Channel Power Meter
IQ-1640 Four-Channel Power Meter

Instruction Manual

Second Edition

P/N: MAN-143-I .2ACE

If the equipment described herein bears the CE *symbol, the said equipment complies with the European Community Directive and Standards found in the Declaration of Conformity.*

If the equipment described herein bears an **FCC** *statement, the said equipment complies with the relevant Federal Communications Commission standards.*

November 1999

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Certification Information

F.C.C. Information to User

This unit has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 (Subpart B) of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This unit generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this unit does cause harmful interference to radio or television reception, which can be determined by turning the unit off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the unit and receiver.
- Connect the unit into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Warning

Changes or modifications not expressly approved by EXFO Electro-Optical Engineering, Inc. could void the user's authority to operate the unit.

INDEPENDENT LABORATORY TESTING

This unit has undergone extensive CE certification testing both internally, at EXFO, and externally, at an independent, qualified laboratory. All pre-qualification tests were performed at EXFO while all final tests were performed at UltraTech Engineering Labs, Inc., a renowned test laboratory from Mississauga, Canada. This guarantees the unerring objectivity and authoritative compliance of all test results.

CE INFORMATION TO USER

This unit has been tested and found to comply with the limits for a Class B digital device. Please see the Declaration of Conformity.

1 Introduction

Presenting the IQ-1600 High-Speed Power Meter Series

The IQ-1600 High-Speed Power Meter, part of the IQ-200 Optical Test System, provides all the performance you need to increase your testing efficiency. With its high sampling rate and fast stabilization, the IQ-1600 is ideal for system monitoring and high-density WDM component characterization and assembly.

The IQ-1600 module comes in configurations of one, two, and four channels. Its high performance automatic gain control (AGC) algorithms result in short stabilization times for the photodetector. In automatic gain range mode, power fluctuations of up to 95 dB will stabilize within 15 ms, and a continuous sampling rate of up to 256 samples per second can be produced.

The other mode of operation lets you bypass the AGC algorithms and select the gain range for individual channels. The dynamic range will be limited to that of the selected range, but in return, shorter stabilization times will be achieved. In this, the IQ-1600 stabilizes in less than 1 ms and has sampling rates as high as 4096 samples per second.

To take full advantage of high sampling rates, it must be possible to synchronize the acquisition. The IQ-1600 provides two types of synchronization triggers. A power level trigger can start an acquisition when the power incident to the detector reaches a particular threshold. Also, a TTL voltage (electrical) trigger can be used to start an acquisition, using the external trigger connection. For both types of trigger, synchronization of all optical channels (dual- and four-channel models) is simultaneous.

The IQ-1600 is the perfect power meter for component manufacturers who need to characterize DWDM filters and multiplexers. As part of the IQ-12004 DWDM Passive Component Test System, the IQ-1600 is combined with the IQ-2600 Tunable Laser Source and an IQ Wavelength Meter to a create high performance and efficient component test system.

All test results can be easily accessed from the unique graphical acquisition mode, an innovative way to display optical power measurements. Switching and transient responses or continuous readings can be viewed as easily as if you were using a digital oscilloscope with an opto-electronic converter. The data file format and management functions help you import and analyze your measurements, as well as create reports with other software applications.

The IQ-1600 High-Speed Power Meter is Windows- and PC-based. It can be combined with many other fiber-optic instruments and is easily integrated into networks through common interfaces.

IQ-200 Optical Test System Product Line

The IQ-200 Optical Test System is constructed on a modular architecture which permits easy and efficient test system integration, making it perfectly suitable for production and laboratory applications. Thanks to the Windows compatible IQ Software, the IQ-200 Optical Test System combines power, performance, and flexibility with a user-friendly interface. The system is composed of a control unit, the IQ-203, IQ-206 Expansion Units, and instrument modules. The IQ-203 can house three modules, while the IQ-206 can house up to six. Up to four IQ-206 Expansion Units can be connected to the control unit, enabling a possibility of 27 instruments. The IQ-203 can be replaced by a computer equipped with a special adapter card (IQ-206 PC Expansion Card).

For more information on the IQ-200 Optical Test System and the IQ Software, please refer to the *IQ-200 Optical Test System* Instruction Manual.

2 Preliminary Information

General Description

The IQ-1600 High-Speed Power Meter is equipped with one, two, or four indium gallium arsenide (InGaAs) detectors depending on the option selected at ordering time. Each power channel (detector) is independently controlled and can achieve a sampling rate of up to 4096 Hz.

Power transitions of up to 95 dB will stabilize within 15 ms. Faster stabilization time will be achieved with reduced dynamic range. Stabilization within 1 ms is possible when the gain of the detector amplification stage is manually locked on a specific scale (“Manual Range”).

Power measurement acquisitions can be electrically synchronized with the external trigger input, or optically synchronized by programming a power level threshold.

Data acquisitions can be saved on file directly from the user interface. Real-time graphical display of acquired data is also possible.

The IQ-1600 is suitable for the following applications and many more:

- Insertion loss of passive components in the production environment
- Manual or automated splice loss measurement
- Characterization of Wavelength Division Multiplexing (WDM) MUX/DEMUX, used in conjunction with a tunable laser source, or within the IQ-12004 DWDM Passive Component Test System
- Optical switch characterization (switching time, insertion loss)
- Component and system monitoring
- Absolute power measurements
- Source stability characterization, etc.

The different IQ-1600 options are summarized in the table below:

Model	Number of Channels	Analog Output	External Trigger
IQ-1610	1	✓	✓
IQ-1620	2 (+ 1 virtual)	✓	✓
IQ-1640	4 (+ 2 virtual)	—	✓

Table 2-1. *IQ-1600 Features*

Please refer to Section 12, *Technical Specifications*, for further details.

The IQ-1600 supports both local and remote control. Local control is carried out via the Windows compatible software. The software provides a user-friendly interface offering flexible power meter operation.

Remote control is accomplished through one of the following ways:

- GPIB interface
- RS-232 external interface
- Windows OLE (Object Linking and Embedding) automation with OCX interface
- LabVIEW (graphical programming) application
- Windows DDE (Dynamic Data Exchange) communication channel

Please refer to the *IQ-200 GPIB and Application* Development Guide for detailed information about remote control of the IQ components.

The product nameplate is located on a side panel near the rear of every module.

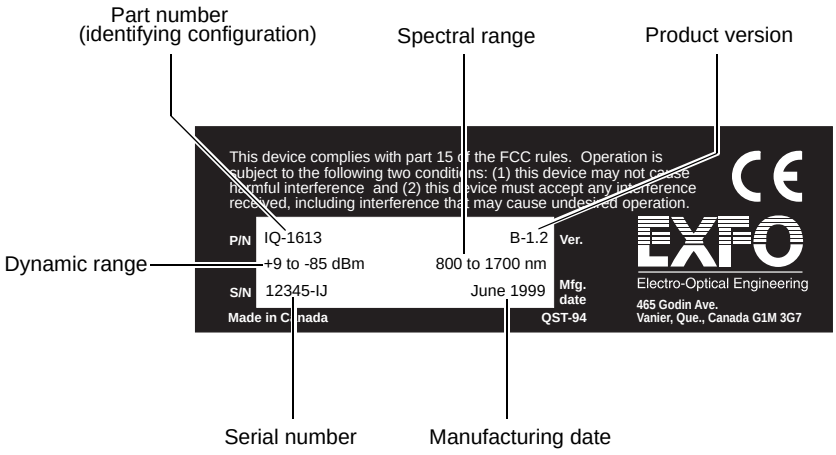

Figure 2-1. *Module Nameplate*

Note: *The information found on the nameplate will differ according to the module configuration.*

Front Panel Description

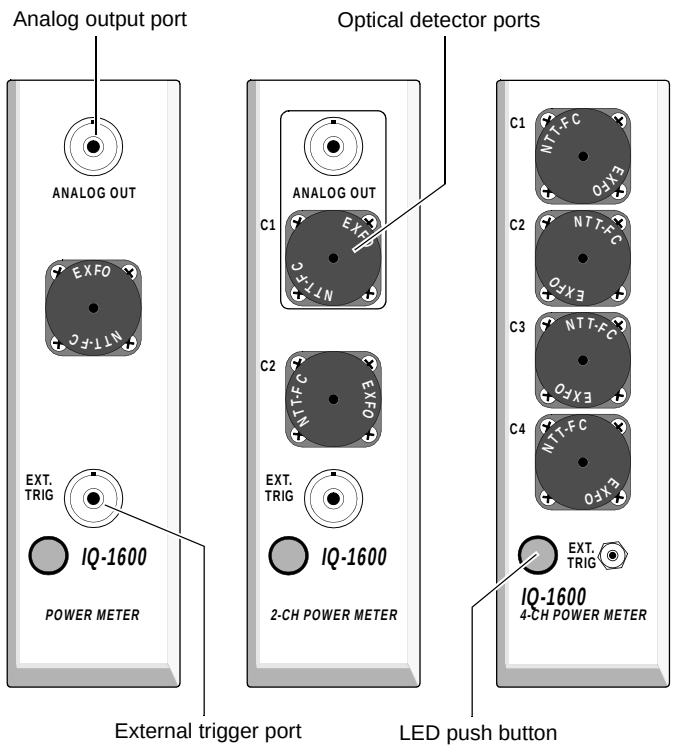

Figure 2-2. *Front Panel of the Power Meter Modules*

Note: *Actual port(s) and adapter(s) may differ from those depicted in the illustrations.*

Detector Ports

The optical detectors (one, two, or four per module) are located on the front panel of the modules. The protective caps, provided with the module, should be installed on the detectors whenever the module is not being used.

LED Push Button

The LED push button has the following three functions:

- The LED push button will illuminate when the system is powered on.
- Pressing the LED push button activates the main window.
- Pressing the LED push button when the main window is open activates the monitor window.

Note: *The monitor window is a compact window displaying basic data and is fully explained in* Monitor Window *on page 12.*

External Trigger Port

The external trigger port can be connected to a TTL voltage source for synchronization of data acquisitions. The external trigger is available on all IQ-1600 models. A BNC connector is used on single- and dual-channel models. An SMB connector is used on the four-channel model. Please see *External Trigger* on page 74 for more information on uses and operation of the external trigger.

Analog Output Port

The analog output port is available on single- and dual-channel IQ-1600 models only and uses a BNC connector. It provides an electrical signal proportional to the power incident to the detector (channel #1 only). Please see *Analog Output (IQ-1610, IQ-1620)* on page 76 for more information on uses and operation of the analog output.

Module Insertion

CAUTION

Never insert or remove any module while the IQ-203/IQ-206 is powered on. This will result in damage to the module and to the IQ-203/IQ-206.

To insert the module,

1. Turn off the IQ-203/IQ-206.
2. Insert the module into any available slot. The IQ-203/IQ-206 will automatically recognize the module no matter what slot it is inserted into.

IMPORTANT

Be sure to insert the module all the way to the back of the IQ-203/IQ-206 to ensure the backplane connectors are properly mated. The module is correctly inserted when the module front panel is flush with the IQ-203/IQ-206 front panel.

Optical Connections

The fiber-optic test jumper ends should always be cleaned before being connected to the modules to ensure optimum performance and avoid erroneous readings. *Cleaning the Fiber Ends* on page 146 describes the fiber end cleaning procedure.

To connect the fiber-optic test jumper to the power meter module,

1. Remove the connector cap.
2. Screw a fiber-optic adapter onto the detector housing (if not already installed).
3. Ensure that the test jumper's connector is clean and dry.

4. Align the test jumper connector and detector port so that the fiber end does not touch the outside of the port or rub against other surfaces.
5. Connect the fiber to the fiber-optic adapter. Do not overtighten.

Module Removal

CAUTION

Never insert or remove any module when the IQ-203 Mainframe or the IQ-206 Expansion Unit is powered on. This will result in immediate irreparable damage to the module and IQ-203/IQ-206.

To remove module from IQ-203/IQ-206,

1. Make sure the IQ-203/IQ-206 is powered off.
2. If your module has a locking mechanism (which can be found under the front panel of the module), press it up as shown in Figure 2-3. Otherwise, simply place your fingers under the front panel of the module.
3. Firmly pull the module outward.

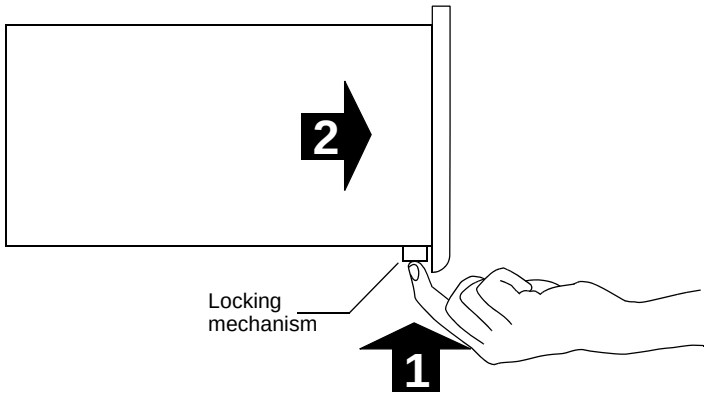

Figure 2-3. *Removing an IQ Module*

4. Put one of the supplied protective covers over the empty slot to prevent dust from entering the module.

Loading the Application

The many features of the IQ-1600 Power Meter Series are controlled using the Windows compatible IQ Software. Please refer to the *IQ-200 Optical Test System* Instruction Manual for information regarding the IQ-200 Optical Test System, IQ-203 Mainframe, and IQ Software conventions.

Please note that the IQ-203/IQ-206 should be equipped with a minimum of 32 MB of RAM and a 200 MHz Pentium processor to fully benefit from the IQ-1600 system speed.

Note: *If the IQ-203/206 is equipped with a 486 processor, the highest* Continuous *sampling rate allowable is 8 per second (see* Performing Continuous Acquisition *on page 43).*

As explained in the *IQ-200 Optical Test System* Instruction Manual, an icon appears in the IQ Software main window for each module in the IQ-200 Optical Test System.

There are two ways to load the application software:

- Press the LED push button on the front panel of the desired module.
- Double-click on the desired icon in the IQ-200 Optical Test System main window.

Once the application is loaded, the corresponding main window opens. The main window contains all the necessary commands to control the power meter.

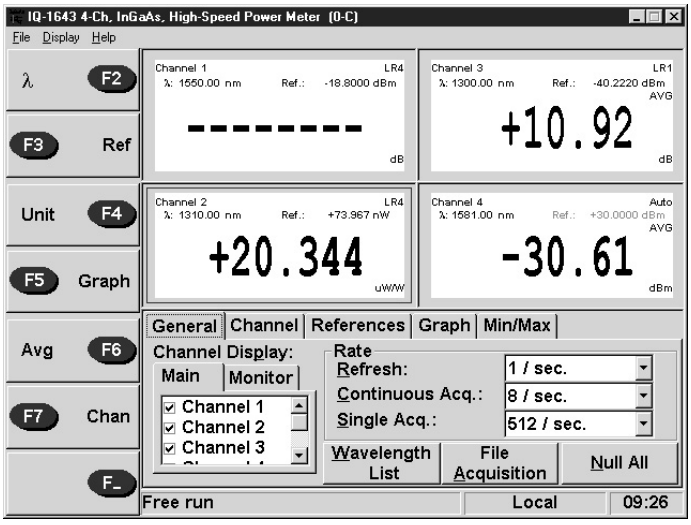

Figure 2-4. *Typical Main Window*

Note: *Depending on the configuration of your module, the actual main window may differ from the one depicted in the illustration.*

Detailed information on the main window and its components is given in Figure 4-1 on page 17.

IMPORTANT

When the application is activated after a cold start, allow the power meter to warm up for about 20 minutes until the electronics stabilizes and can meet announced optical specifications.

Before proceeding with optical power measurements, the electronic offset nulling should be performed to guarantee results accuracy. The offset nulling procedure is given in *Nulling Electrical Offsets* on page 23.

Monitor Window

The monitor window displays basic operating information (for up to four channels at a time in the case of an IQ-1640). Using the monitor window with other module monitor windows allows the creation of an integrated data display screen (refer to the *IQ-200 Optical Test System* Instruction Manual). The size and position of the monitor window can be customized.

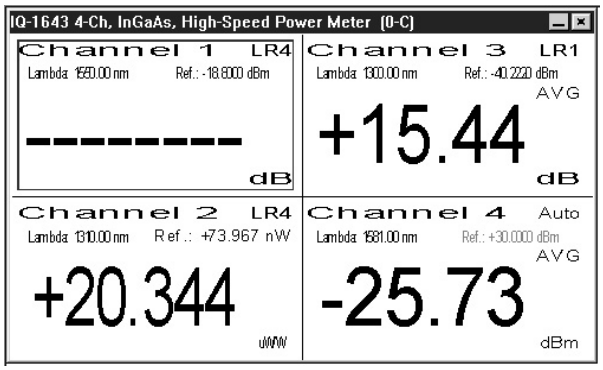

Figure 2-5. *Monitor Window*

Opening the Monitor Window

There are three ways to open the monitor window:

- In the main window, choose *Monitor* from the *Display* menu.
- In the main window, click on ▁ (in the top right corner).
- Push the LED button (on the front panel of the module).

Closing the Monitor Window

There are two ways to close the monitor window and return to the main window:

- Double-click anywhere in the monitor window.
- Press the LED push button (on the front panel of the module).

Note: *The function buttons can be accessed while in monitor window view by positioning the cursor inside the monitor window and clicking the right mouse button. The function button keypad will appear to the left of the monitor window.*

Exiting the Application Software

Closing any application software that is not in use is a good way to free system memory. The application software can be closed either from the main window or the monitor window.

From the Main Window

There are three ways to exit the application software from the main window.

- Choose *Exit* from the *File* menu.
- Click on ☒ (in the top right corner of the main window).
- Click on the module icon (in the top left corner of the main window) and select *Close*.

From the Monitor Window

To exit the application software from the monitor window, click on ☒ (in the top right corner), then select *Yes*.

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3 General Safety Information

Safety Conventions

The following conventions should be understood before operating the unit:

WARNING

Refers to a potential *personal* hazard. It requires a procedure which, if not correctly followed, may result in bodily harm or injury. Do not proceed beyond a **WARNING** unless the required conditions are understood and met.

CAUTION

Refers to a potential *product* hazard. It requires a procedure which, if not correctly followed, may result in component damage. Do not proceed beyond a **CAUTION** unless the required conditions are understood and met.

IMPORTANT

Refers to any information regarding the operation of the product which should not be overlooked.

Safety Instructions

Operation

WARNING

Do not install or terminate fibers while a laser source is active. Never look directly into a live fiber and ensure that your eyes are protected at all times.

CAUTION

Use of controls, adjustments, and procedures for operation and maintenance other than those specified herein may result in hazardous radiation exposure.

CAUTION

Use of optical instruments with this product will increase eye hazard.

Module Insertion

CAUTION

Never insert or remove any module while the IQ-203/IQ-206 is powered on. This will result in damage to the module and to the IQ-203/IQ-206.

IMPORTANT

Be sure to insert the module all the way to the back of the IQ-203/IQ-206 to ensure the backplane connectors are properly mated. The module is correctly inserted when the module front panel is flush with the IQ-203/IQ-206 front panel.

Module Removal

CAUTION

Never insert or remove any module when the IQ-203 Mainframe or the IQ-206 Expansion Unit is powered on. This will result in immediate irreparable damage to the module and the IQ-203/IQ-206.

Maintenance

IMPORTANT

When the module is not being used, the protective cap(s) should be fitted over the detector port(s).

4 Basic Operation

Configuration and operation of the IQ-1600 is carried out in Normal mode. It provides all the controls to change operating parameters and view power readings. The IQ-1600 may also be operated in Graphical Display mode (see *Graphical Display Mode* on page 61).

Normal Mode Main Window Description

The Normal mode main window can be divided into five sections:

- title bar and menu bar
- function buttons
- parameter definition tabs
- data display
- status bar

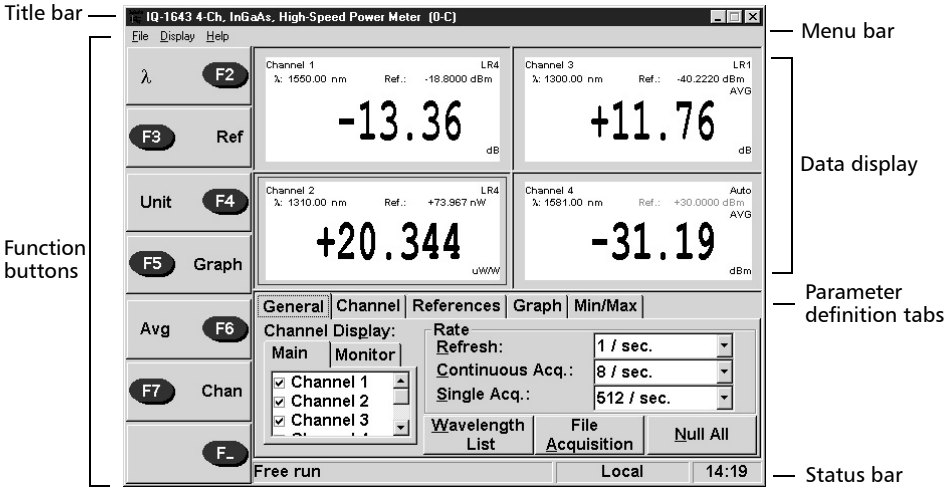

Figure 4-1. *Normal Mode Main Window*

Note: *Depending on the configuration of your module, the main window may differ from the illustration.*

Title Bar and Menu Bar

The title bar and menu bar are at the top of the main window (see Figure 4-1). The title bar indicates the type of power meter you are using. The menu bar contains drop-down menus that are explained in the following table:

Menu	Option	Function
File	Open config.	Opens to a previously saved configuration.
	Save config.	Saves the current configuration.
	Exit	Closes the application.
Display	Monitor	Opens the monitor window, which displays basic power meter data (see *Monitor Window* on page 12 for detailed information).
Help	Online Manual	Opens the Help file, which contains the text of this instruction manual in PDF format.
	Hardware	Opens a window which provides the following hardware information: module model number, software version number, module ID, module serial number, checksum status, and embedded software version number.
	About	Opens a window which provides the following information: module model number, software version number, telephone numbers, e-mail, and web site addresses for technical assistance, available IQ-203 system memory (RAM), and remaining hard disk drive storage space.

Table 4-1. *Main Window Drop-Down Menus*

Function Buttons

The function buttons, along the left side of the main window (see Figure 4-1), are used to directly control the power meter.

Button	Description
λ F2	Switches to the next wavelength as defined by the contents of the λ list box (see *Setting Wavelength* on page 29), for the currently selected channel when using a multi-channel power meter.
F3 Ref	Performs a reference power measurement for the currently selected channel, depending on the parameters set in the *References* section (see *Measuring Relative Power* on page 33).
Unit F4	Changes the unit for the currently selected channel. Units used are dB, dBm, W (pW, nW, µW, mW..., according to the power of the signal), and W/W. See *Selecting Measurement Unit* on page 39.
F5 Graph	Opens the *Graphical Display Mode* window, allowing real-time or deferred power readings of up to eight channels to be displayed at a time in a graphical or tabular format (see *Graphical Display Mode* on page 61).
Avg F6	Toggles between averaged and unaveraged displayed values (see *Using Averaged Measurement* on page 38) for the currently selected channel.
F7 Chan	Switches to the next channel (IQ-1620 and IQ-1640).
F-	Transfers control between software function buttons and IQ-203 front panel hardware keys (refer to the *IQ-200 Optical Test System* Instruction Manual).

Table 4-2. *Normal Mode Function Buttons*

Note: *The function buttons are also available in monitor window mode. Place the cursor in the monitor window and press the right mouse button.*

Note: *When function buttons are disabled, they appear gray.*

In addition, the following shortcuts are directly accessible from your optional hardware keyboard:

- *F1:* same effect as the *Online Manual* option in the *Help* menu.
- *F2* to *F7:* same effect as the corresponding function buttons.
- *F12:* same effect as the *F_* function button.
- *Alt-F4:* same effect as the *Exit* option in the *File* menu.

Parameter Definition Tabs

Choosing any of the parameter definition tabs (see Figure 4-1) opens a window for the definition and customization of various operating parameters.

Tab	Description
General	Opens the *General* section, allowing the module's general application parameters to be set.
Channel	Opens the *Channel* section, allowing channel-specific parameters to be customized.
References	Opens the *References* section, allowing the type of reference that will be used when choosing *F3* to be set (see *Entering the Current Power as the Reference Value* on page 33 and *Entering a Specific Reference Value* on page 35).
Graph	Opens the *Graph* section, allowing the basic parameters of the graphical application to be set (see *Setting Graph Mode* on page 57).
Min/Max	Opens the *Min/Max* section, allowing the extremes of a varying power signal to be recorded (see *Using Min/Max Function* on page 45).

Table 4-3. *Parameter Definition Tabs*

Data Display

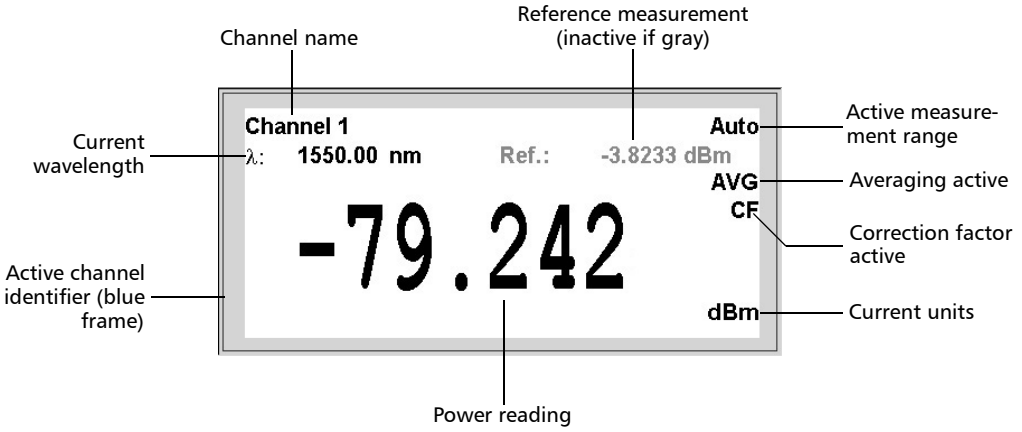

Figure 4-2. *Data Display Window*

- *Channel name:* Displays the user-defined channel name. See *Entering a Channel Name* on page 28.
- *Current wavelength:* Displays the currently active wavelength. See *Setting Wavelength* on page 29.
- *Power reading:* Displays the current power reading in dBm, dB, W units (pW, nW, µW, mW...), or W/W. When a dashed line (– – – – – – –) is displayed, the power level detected is below the lower limit of the selected measurement range. When a crossed line is displayed (+ + + + + + +), the power level detected is above the upper limit of the selected measurement range. See *Selecting Measurement Unit* on page 39. When *! ! ! ! ! ! !* is displayed, the displayed data is in transition (range was changed during a *Continuous* acquisition with Autorange selected). When * * * * * * * is displayed, a *Single*[1] acquisition is running.

1. To distinguish between *Single* and *Continuous* acquisitions, see *Performing Continuous Acquisition* on page 43 and *File Acquisition* on page 47.

- *Auto* marker*:* Displays the currently selected power measurement range: *Auto* = Autorange, *LR* = Manual Low Range, and *HR* = Manual High Range. See *Setting Measurement Range* on page 41.
- *Ref* marker: Displays the reference measurement. See *Measuring Relative Power* on page 33.
- *AVG* marker: Indicates that the averaging function is active. See *Using Averaged Measurement* on page 38.
- *CF* marker: Indicates that a correction factor is being used. See *Measuring Corrected Power* on page 37.

Status Bar

The status bar displays the current module's status as follows:

- *Free run:* The power meter is in normal mode.
- *Waiting for trigger or start time:* Data acquisition will begin after a specified time or trigger condition.
- *Acquiring into file:* Data acquisition into file is in progress.
- *Processing...:* One or several commands have been sent to the power meter module and are being processed.
- *Single acquisition in Graph mode: Single* acquisition in Graph mode is in progress.
- *Single acquisition in progress: Single* acquisition is in progress without trigger.

On the status bar, you also find the *Local, Remote,* or *Lockout* indication, which specifies if the power meter is controlled locally or remotely. The following table explains the meaning of these indications. Finally, the status bar displays the time.

Indication	Meaning
Local	The unit is locally controlled.
Remote	The unit is remotely controlled but local commands can still be used.
Lockout	The unit is remotely controlled.

Table 4-4. *Module Control Status*

Nulling Electrical Offsets

The *Offset Nulling* function provides a zero power reference measurement, thus eliminating the effects of electronic dark current. For better results and accuracy, you must ensure that offsets are nulled before each testing session, each time the unit is powered on, or whenever environmental conditions change while the power meter is operating (temperature and humidity variations will affect the performance of optical detectors).

IMPORTANT

When the application is activated after a cold start, allow the power meter to warm up for about 20 minutes until the electronics stabilizes before nulling offsets.

Light must not reach the detector when performing the offset nulling.

To perform an offset nulling,

1. Install the protective cap over the detector port.
2. If necessary, select the desired channel (on a multi-channel high-speed power meter). To set the channel, see *Selecting the Channel (IQ-1620, IQ-1640)* on page 26.

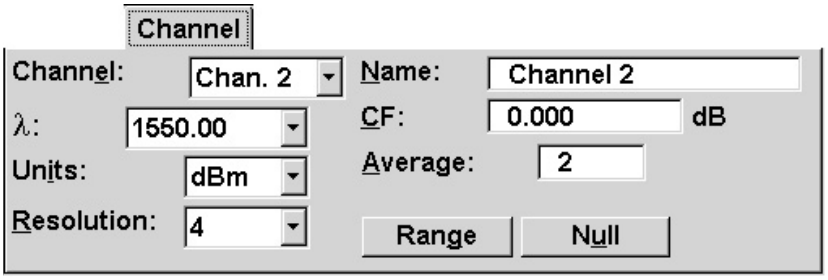

Figure 4-3. *Channel Section (IQ-1620 or IQ-1640)*

3. In the *Channel* section, click on *Null.* A message prompts you to ensure that the detector cap is properly installed.

4. Choose *OK* to perform the offset nulling, or *Cancel* to exit. A message window is displayed during the offset nulling process, which takes approximately 10 seconds.

Note: *Offset nulling constants are retained for all channels until a new nulling measurement is performed.*

To perform an offset nulling on all channels at the same time when using a multi-channel power meter,

1. Install the protective caps over the detector ports.

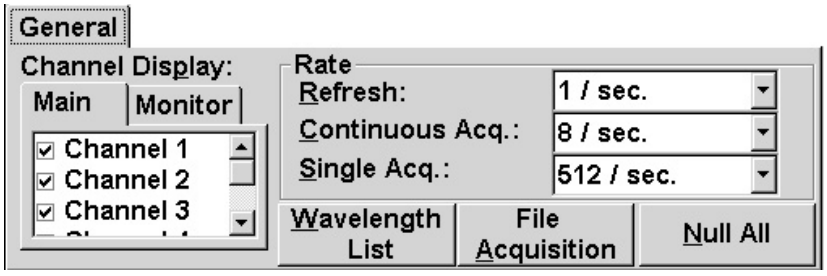

Figure 4-4. *General Section (IQ-1620 or IQ-1640)*

2. In the *General* section, click on *Null All.* A message prompts you to ensure that the detector caps are properly installed.

3. Choose *OK* to perform the offset nulling, or *Cancel* to exit. A message window is displayed during the offset nulling process, which takes approximately 10 seconds per channel.

Note: *Offset nulling constants are retained for all channels until a new nulling measurement is performed.*

Setting Channel

Setting Channel Display (IQ-1620, IQ-1640)

1. In the *General* section, click on *Main* or *Monitor* to select channel display in the matching window.

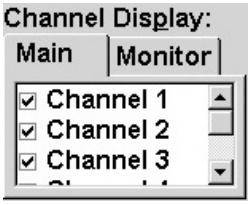

Figure 4-5. *Channel Display List Box*

2. Select or disable the desired channel(s). Up to two channels can be displayed using an IQ-1620 and up to four channels using an IQ-1640 power meter, including one or two virtual channels respectively. A check mark (√) appears in front of the selected channel(s), and the main or monitor window immediately reflects your selection.

Note: *Displayed channels can differ between the main window and the monitor window.*

Selecting the Channel (IQ-1620, IQ-1640)

The IQ-1620 and IQ-1640 have two and four independent optical channels respectively.

To select an optical channel,

In the *Channel* section, open the *Channel* list box and click on the desired channel.

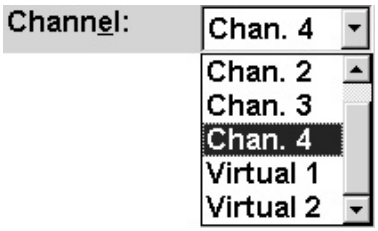

Figure 4-6. *Channel Selection List Box*

Or

Choose *F7 (Chan)* from the main window (see Figure 4-1 on page 17).

Or

Click on the appropriate data display zone (see Figure 4-1 on page 17).

Selecting a Virtual Channel (IQ-1620, IQ-1640)

In addition to the optical channels, the IQ software offers one virtual channel for the IQ-1620 and two virtual channels for the IQ-1640.

A virtual channel is a combination (sum, difference, product, or ratio) of the measured power from any two optical channels. This feature provides an extremely flexible comparative measurement display. A virtual channel is used and controlled in the same way as an optical channel. Virtual channels only apply to *Continuous* acquisitions.

The virtual channel is an excellent tool for comparing two optical channels. For example, if two devices (connected to channels #1 and #4) are supposed to have identical power levels, displaying a virtual channel (defined as channel #1 minus channel #4) provides quick monitoring of both devices and highlights any power fluctuations.

To define a virtual channel,

1. In the *Channel* section, open the *Channel* list box.
2. Click on the desired virtual channel (when using an IQ-1620, only virtual channel #1 can be selected).
3. In the first box of the *Operation* area, select the first optical channel.
4. In the second box, select the virtual channel operator (+, -, *, or /).
5. In the third box, select the second channel.

Figure 4-7. *Defining the Virtual Channel*

Since operations between channels cannot be made with any type of measurement unit, the second channel and the operator can be selected according to the unit of the first channel as described in the following table:

First Channel Unit	Second Channel Unit	Virtual Channel Unit and Allowed Operators
dBm	dBm	dB (operator -)
dBm	dB	dBm (operators + and -)
dB	dBm	dBm (operators + and -)
dB	dB	dB (operators + and -)

Table 4-5. *Channel Unit Combinations (Part 1 of 2)*

First Channel Unit	Second Channel Unit	Virtual Channel Unit and Allowed Operators
W	W	W/W (operator /)
W	W/W	W (operators * and /)
W/W	W	W (operators * and /)
W/W	W/W	W/W (operators * and /)

Table 4-5. *Channel Unit Combinations (Part 2 of 2)*

Note: *Since a virtual channel consists of a mathematical operation using two optical channels, the only parameter that can be set for a virtual channel is its name.*

Entering a Channel Name

A user-selected name can be given to each power meter channel, including a virtual channel. The channel name appears in the main window as well as in the monitor window. Naming each channel is particularly useful when more than one power measurement needs to be displayed, especially in monitor window mode with several optical power meters displayed simultaneously. The name should be as self-explanatory as possible (for example “Power-Fiber 1”).

To enter a channel name,

1. If necessary, select the channel for which you want to set the name.
2. In the *Channel* section, click on the *Name* edit box. If you double-click on it, the software keypad will appear.

Figure 4-8. *Channel Name Edit Box*

3. Using the software keypad or your optional hardware keyboard, enter any descriptive text of up to 55 characters, then choose *Enter*.

Tip: *Lower case characters need less screen space and therefore allow longer descriptive names.*

Setting Wavelength

When performing accurate optical power measurements, it is important that the IQ-1600 High-Speed Power Meter is set to the correct wavelength to compensate for the responsivity of the photodetector at the incident wavelength. Ideally, the power meter's wavelength should be set as close as possible to the wavelength of the optical source being used.

Selecting the Wavelength

The wavelength must be selected from the wavelength list. To set the wavelength list, see *Wavelength List* on page 30.

To select the wavelength,

1. If necessary, select the channel for which you want to set the wavelength.
2. In the *Channel* section, open the λ list box.

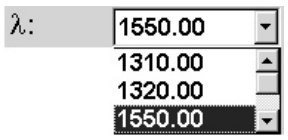

Figure 4-9. *Setting Wavelength*

3. Click on the desired value. The λ list box will close, the selected value will be displayed, and measurements will be taken at the set wavelength.

Note: *It is also possible to scroll through the wavelength list by choosing* (λ) F2 *from the main window.*

Wavelength List

The values contained in the λ list box, accessible from the *Channel* section (see above) or by choosing *(λ) F2* from the main window, determine which wavelengths are available during operation of the IQ-1600. Please refer to the Certificate of Compliance supplied with your power meter for information about the specified wavelengths allowable. Up to 40 wavelengths can be included in the list at the same time.

To add a wavelength to the λ list,

1. In the *General* section, click on *Wavelength List*.

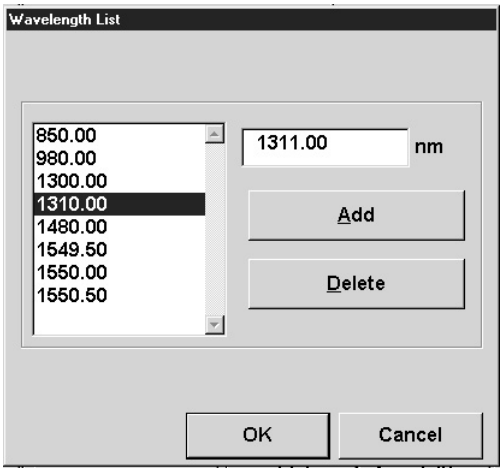

Figure 4-10. *Wavelength List Window*

2. Click on the *nm* edit box. If you double-click on it, the abridged software keypad will appear.

3. Using the abridged software keypad or your optional hardware keyboard, enter the wavelength value to be added. You can enter a value with a 0.01 nm resolution.

4. Choose *Add* to confirm the new wavelength.

Note: *A warning message is displayed if the new wavelength is not within the power meter's wavelength range, or if the new wavelength is already included in the list.*

5. Choose *OK* to confirm the storage, or *Cancel* to exit the *Wavelength List* window without storing the change.

Note: *Choosing* OK *does not affect the currently selected wavelength.*

To delete a wavelength from the λ list,

1. In the *General* section, click on *Wavelength List*.

2. Scroll through the wavelength list box and highlight the wavelength to be deleted.

3. Choose *Delete* to confirm the operation.

Note: *You can delete more than one wavelength by holding down the* Shift *or* Ctrl *key and selecting the appropriate wavelengths simultaneously. Next, press the* Delete *key to complete the multiple deletion.*

Note: *It is not possible to delete a wavelength that is currently being used.*

4. Choose *OK* to confirm the deletion, or *Cancel* to exit the *Wavelength List* window without deleting the wavelength.

Measuring Power

Power measurements can be displayed in three different ways:

- ➤ absolute power
- ➤ relative power
- ➤ corrected power (absolute or relative power plus/times a correction factor)

Measuring Absolute Power

When in absolute power, measured values are displayed in either dBm or W units (pW, nW, µW, mW...) and the displayed value represents the absolute optical power reaching the detector within specified uncertainty.

Figure 4-11. *Absolute Power Display*

To display absolute power,

1. If necessary, select the required channel.
2. Select the appropriate wavelength.
3. Choose *(Unit) F4* until the desired display unit is shown.

Note: *When displaying absolute power, the* Ref *value appears gray.*

An absolute power measurement in negative W units indicates that electrical offsets were improperly nulled. If this happens, repeat the offset nulling (see *Nulling Electrical Offsets* on page 23).

Measuring Relative Power

Power measurements can be displayed as a deviation from an absolute reference value. The relative power is particularly useful when performing insertion loss measurements.

Relative power is displayed in dB when the reference value is measured in dBm. In this case, the value will be either positive or negative, as the actual measured power is higher or lower than the reference power.

If the reference value is in W, the relative power will be displayed in W/W. In this case, the relative power is the deviation ratio from the reference and will always be a positive value.

In Figure 4-12, the measured power is 31.077 dB higher than the reference value of -34.263 dBm. The absolute power is -3.186 dBm.

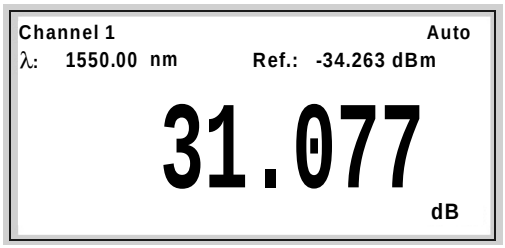

Figure 4-12. *Relative Power Display*

To display significant relative power values, it is important to have an appropriate reference value. Two choices of references are available. Both are applied by choosing *F3 (Ref)* from the main window.

Entering the Current Power as the Reference Value

This type of reference is a current power measurement that cannot be modified by the user.

To enter the current power measurement (module reference) as the reference,

1. Using appropriate adapters and test jumpers, connect the optical circuit being referenced to a detector port.

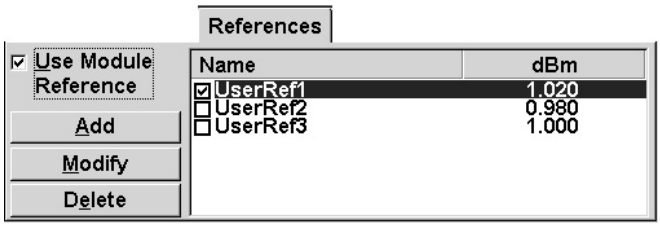

Figure 4-13. *References Section*

2. If necessary, select the appropriate channel.

3. In the *References* section, ensure that the reference will be taken from a current power measurement and not from the user-defined list. For this, the *Use Module Reference* check box must be enabled as shown in Figure 4-13.

4. Select the appropriate wavelength.

5. Choose *F3 (Ref)*.

The power meter will take a reference measurement and the *Ref.* value displayed will be updated to reflect the new reference. Once the reference measurement has been performed, the power meter automatically displays relative power in dB if the currently selected measurement unit is dB or dBm, or in W/W if the currently selected measurement unit is W or W/W. The reference value will be displayed until a new reference has been taken.

Note: *Choosing* F3 (Ref) *switches the current channel display to relative mode.*

You might want to switch from absolute power measurements to relative power measurements and use the previously stored reference value.

1. If necessary, select the appropriate channel.

2. Select the desired wavelength.

3. Choose *(Unit) F4* until the display switches to relative mode in dB, where the value displayed is equal to the absolute power minus the previously stored reference power, or in W/W, where the value displayed is the deviation ratio from the reference.

Note: *When displaying relative power, the* Ref *value appears in black. A reference value is retained for each channel.*

Tip: *The reference value can be reset at any time by choosing* F3 (Ref).

Entering a Specific Reference Value

This type of reference is a predefined user reference that is chosen from a list.

To select a user-defined reference,

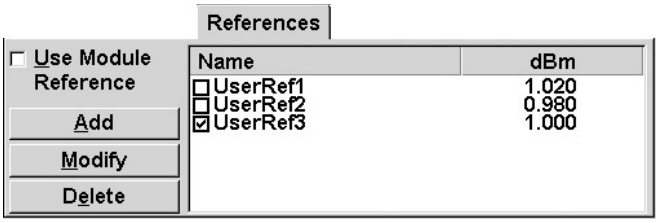

Figure 4-14. *References Section*

1. In the *References* section, disable the *Use Module Reference* check box. This will only be possible if at least one user reference is already included in the reference list.
2. Select the desired reference in the reference list by clicking on the matching check box. Only one reference can be selected at a time.

Note: *The reference will not be active until you choose* F3 (Ref) *from the main window.*

To add a user reference to the list,

1. In the *References* section, click on *Add*. An empty line appears on top of the reference list. If you double-click on it, the software keypad will appear.
2. Using the software keypad or your optional hardware keyboard, enter a text of up to 15 characters.
3. Enter a reference from -100.000 dBm to 100.000 dBm (if the currently selected measurement unit is dB or dBm) or from -13 W to +7 W (if the currently selected measurement unit is W or W/W). Up to 40 user references can be entered.

Note: *The user reference list applies to all channels (when using an IQ-1620 or IQ-1640), but the selected user reference applies only to the currently selected channel.*

To modify a user reference in the list,

1. In the *References* section, select the reference to be modified by clicking on it in the reference list.
2. Click on *Modify*.
3. Proceed with the required change (reference name or value). You can switch between the two fields using the cursor or the *Tab* key.

To delete a user reference from the list,

1. In the *References* section, select the reference to be deleted by clicking on it in the reference list.
2. Click on *Delete*.
3. Choose *OK* to confirm the deletion.

Note: *You can delete more than one user reference by holding down the* Shift *or* Ctrl *key and selecting the appropriate user references simultaneously. Next, click on* Delete *then choose* OK *to confirm the multiple deletion.*

Measuring Corrected Power

Applying a correction factor to the measured power is useful when compensating for known inaccuracies (power gains or losses) at specific wavelengths.

A correction factor (CF) can be applied to any measurement that is displayed in either dB, dBm, W, or W/W.

When a dB correction factor different from 0.000 is defined, the displayed power is equal to the actual power **plus** the value of the correction factor. When a W/W correction factor different from 1.000 is defined, the displayed power is equal to the actual power **times** the value of the correction factor. With an active correction factor, the *CF* marker appears in the data display for the matching channel.

Note: *Special care must be taken when setting a correction factor as it emulates a new calibration (the module calibration is not affected and will be restored by setting back the CF to a null value).*

When expressed in dB, the correction factor can be a positive or negative value. When the currently selected measurement unit is W, the correction factor is expressed in W/W, indicating a multiplication factor for the current wavelength and channel. The correction factor expressed in W/W will always be a positive value.

To use corrected power, i.e., to set a correction factor,

1. If necessary, select the channel for which you want to set the correction factor.
2. Select the wavelength to which the correction factor will be applied.
3. In the *Channel* section, click on the *CF* edit box. If you double-click on it, the abridged software keypad will appear.

Figure 4-15. *Correction Factor Edit Box*

4. Using the abridged software keypad or your optional hardware keyboard, enter a correction factor between -10.000 dB to 6.989 dB, or 0.100 W/W to 5.000 W/W, then choose *Enter*.

Note: *Although the wavelength list applies to all channels, the correction factor applies to the specific wavelength and channel at which it was set.*

Using Averaged Measurement

When averaging is enabled, the most recent measurement samples, for which you can set the number, are used to compute an unweighted average. This average is displayed as the measured value. The *AVG* marker will also be displayed to the right of the value for the matching channel, indicating that averaging is enabled.

To toggle between averaged and unaveraged power measurement,

1. If necessary, select the desired channel.
2. In the main window, choose *(Avg) F6*.

To choose the number for averaging,

1. In the *Channel* section, click on the *Average* edit box. If you double-click on it, the abridged software keypad will appear.

Figure 4-16. *Average Edit Box*

2. Using the abridged software keypad or your optional hardware keyboard, enter a value between 2 (default value) and 999, then choose *Enter*.

Selecting Measurement Unit

Power measurements can be displayed in dB, dBm, W, or W/W (the latter indicating the ratio between the power received and the reference for the current wavelength and channel). When W or W/W is selected, the software automatically selects W units (pW, nW, µW, mW...) depending on the measured power and sensitivity of the detector.

To select the measurement unit,

1. If necessary, select the channel for which you want to set the measurement unit.
2. In the *Channel* section, open the *Units* list box.

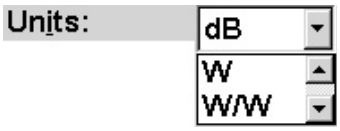

Figure 4-17. *Units List Box*

3. Click on the desired unit.

Note: *The measurement unit can also be selected from the main window by choosing* (Unit) F4.

Setting Display Resolution

Depending on the required resolution and operating power level, 0, 1, 2, 3, or 4 digits can be displayed after the decimal point. When *Auto* is selected, the display resolution is determined by the power level being measured.

Note: *The* Auto *marker in the data display does not refer to the automatic display resolution but to the measurement range (see* Setting Measurement Range *on page 41).*

To select the display resolution of a power measurement expressed in dB or dBm,

1. If necessary, select the channel in which you want to set the display resolution.
2. In the *Channel* section, open the *Resolution* list box.

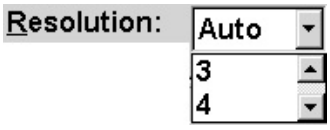

Figure 4-18. *Display Resolution List Box*

3. Click on the number of digits required after the decimal point.

Note: *When W or W/W is selected, the display resolution changes to* Auto *(the appropriate W unit will be used according to the power of the signal detected). It is then impossible to access the display resolution list box.*

Setting Refresh Rate

This function allows you to define the refresh rate of the power readings on the display. The refresh rate applies to all channels when using a multi-channel power meter.

To set the refresh rate,

1. In the *General* section, open the *Refresh Rate* list box.

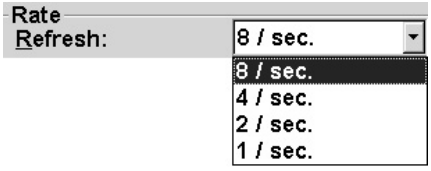

Figure 4-19. *Refresh Rate List Box*

2. Select a value between 16 / sec., 8 / sec., 4 / sec., 2 / sec., and 1 / sec.

Note: *Changing the refresh rate will affect the* Continuous *acquisition rate so that the two rates remain as consistent as possible. See Table 4-7 for the relationship between the two.*

Setting Measurement Range

The measurement range and gain scale applied to the power measurement detector can be manually selected to prevent the automatic scale adjustment performed by the instrument. A manual adjustment of the dynamic gain scale will lock the measurement range to a specific level.

The measuring range should be locked when the analog output [see *Analog Output (IQ-1610, IQ-1620)* on page 76] is used to avoid variations in voltage output due to gain scales. It is also necessary to use a manual range to achieve high-rate acquisitions (see *File Acquisition* on page 47) and graphical acquisitions (see *Graphical Display Mode* on page 61).

Two types of manual ranges are available. The *Low* range provides a lower dynamic range (typically 35 dB) per scale with better signal-to-noise ratio and resolution. The *High* range provides a higher dynamic range (typically 42 dB) per scale with an inferior signal-to-noise ratio. Each channel is adjusted independently in the case of a multi-channel power meter.

To set the measurement range,

1. If necessary, select the channel for which you want to set the range.
2. In the *Channel* section, click on *Range*. The currently selected channel is displayed in the title bar of the *Range* window.

Tip: *Select* Manual *range for a* Continuous *acquisition when the input signal has unstable or modulated variations. This prevents* ! ! ! ! ! ! ! *from being displayed upon constantly changing gain scales.*

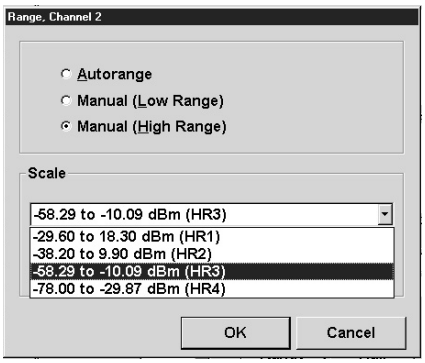

Figure 4-20. *Range Window*

3. Click the radio button matching the required type of range.

4. Scroll through the *Scale* list box and highlight the required scale. The table below displays the permitted scales when the currently selected measurement unit is dB or dBm. The power values displayed are typical at 1310 nm.

Low Range (LR)	High Range (HR)
-3.90 to 18.30 dBm (LR1)[a]	-29.60 to 18.30 dBm (HR1)[a]
-12.50 to 9.90 dBm (LR2)[a]	-38.20 to 9.90 dBm (HR2)[a]
-32.49 to -10.09 dBm (LR3)	-58.29 to -10.09 dBm (HR3)
-52.27 to -29.87 dBm (LR4)	-78.00 to -29.87 dBm (HR4)
-72.01 to -49.61 dBm (LR5)	—
-90.00 to -69.61 dBm (LR6)	—

Table 4-6. *Available Ranges (with dB or dBm Selected)*

a. InGaAs detector has a +9 dBm saturation limit.

Note: *A high acquisition rate is possible only if a manual range has been set for all channels.*

Note: *To distinguish between* Single *and* Continuous *acquisitions, see* Performing Continuous Acquisition *below and* File Acquisition *on page 47.*

5. Choose *OK* to confirm the range or *Cancel* to exit the *Range* window without modifying the change.

Performing Continuous Acquisition

In a *Continuous* acquisition, power measurements are constantly updated on the measurement display for an unlimited period of time, whether in the normal mode main window, or in the graphical display (see *Graphical Display Mode* on page 61). Continuous samples can also be retrieved with the GPIB, RS-232, Windows OLE, or DDE interface (refer to the *IQ-200 GPIB and Application* Development Guide).

The *Continuous* acquisition rate function allows you to define the number of power readings per second that will typically be used in a *Continuous* acquisition.

According to your specific requirements and the power level, select a *Continuous* acquisition rate that will optimize instrument flexibility and measurement stability as well as determine the quantity of data generated during data acquisition.

To set a *Continuous* acquisition rate,

1. In the *General* section, open the *Continuous Acq. Rate* list box.

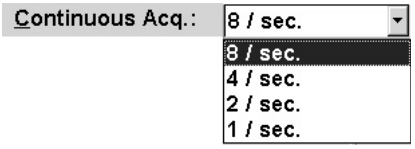

Figure 4-21. *Continuous Acquisition Rate List Box*

2. Select the desired value. You can choose among 11 sampling rates from 256 / sec. to 0.250 / sec. The acquisition rate applies to all channels when using a multi-channel power meter.

Note: *The 0.250 / sec.* Continuous *acquisition rate is not supported in Graphical Display mode.*

Note: *If the IQ-203/206 is equipped with a 486 processor, the highest* Continuous *acquisition rate permitted is 8 per second.*

Tip: *Use a lower* Continuous *acquisition rate with averaging active (see* Using Averaged Measurement *on page 38) for greater repeatability when measuring very low power.*

Note: *Changing the* Continuous *acquisition rate will affect the refresh rate (the refresh rate, however, will remain within its limits) so that the two rates remain as consistent as possible. See Table 4-7 for the relationship between the two.*

Refresh Rate	Continuous Acquisition Rate
16 / sec.	16 / sec. or more
8 / sec.	8 / sec. or more
4 / sec.	4 / sec. or more
2 / sec.	2 / sec. or more
1 / sec.	No restriction

Table 4-7. *Refresh Rate vs. Continuous Acquisition Rate*

Example: Adjusting the refresh rate to 16 / sec. when the *Continuous* acquisition rate is 4 / sec. will automatically change the *Continuous* acquisition rate to 16 / sec. If the refresh rate is now set to 8 / sec., the *Continuous* acquisition rate will remain 16 / sec. (see table). If the *Continuous* acquisition rate is now set to 256 / sec., the refresh rate will remain 8 / sec. However, if the *Continuous* acquisition rate is set to 2 / sec. (i.e., a lower value), the refresh rate will change to 2 / sec.

5 Advanced Functions

Using Min/Max Function

The *Min*/*Max* function allows you to record the extremes of a varying power signal when performing a *Continuous* acquisition. For example, it could be used to determine the stability of a light source over time, or to measure the polarization dependent loss (PDL) of a passive component when combined with a polarization state controller.

The function is started manually and can be stopped manually or automatically using the timer function. Minimum (*Min*) and maximum (*Max*) values can be recorded and displayed in any measurement units (dB, dBm, W, or W/W: see *Selecting Measurement Unit* on page 39). In logarithmic scales (dB and dBm), the difference between the maximum and minimum values is expressed as *Max - Min*. In linear scales (W and W/W), the difference is expressed as a ratio (*Max*/*Min*).

To use the *Min*/*Max* function,

1. Select a *Continuous* acquisition rate (see *Performing Continuous Acquisition* on page 43).

Figure 5-1. *Min/Max Section*

2. In the *Min*/*Max* section, open the *Channel* list box (when using a multi-channel power meter).
3. Select the channel for which you want to see the power variation data on screen.

Note: *Although you can select the channel at this stage, the* Min/Max *function will record data for all channels when using a multi-channel power meter.*

4. If you want to specify the duration of power measurements,

4a. Enable the *Use Timer* check box, then click on the edit box. If you double-click on it, the abridged software keypad will appear.

4b. Using the abridged software keypad or your optional hardware keyboard, enter the duration in the HHHH:MM:SS format. You can enter a value from 0000:00:01 to 9999:59:59.

5. Click on *Start* to launch power measurements. These can be stopped at any time by clicking *Stop*. If the timer is set, power measurements will stop automatically after the specified duration.

Note: *When using a multi-channel power meter, you can view the data for the other channels by selecting the desired channel in the* Channel *list box.*

Working with the Min/Max Function

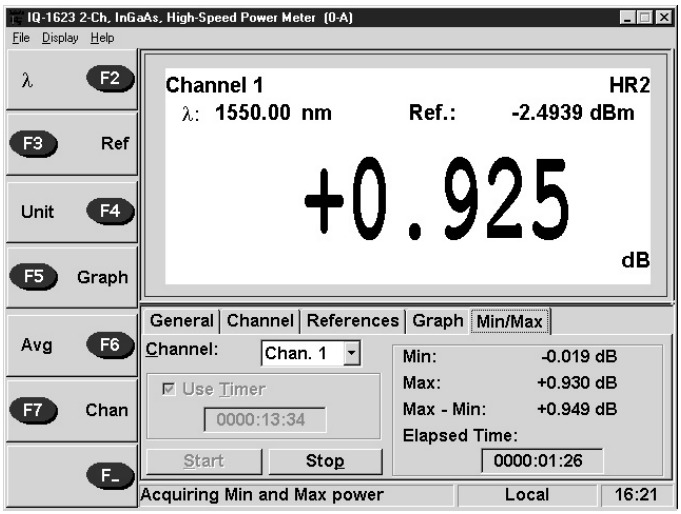

Figure 5-2. *Min/Max Function (Example)*

Figure 5-2 is an example where the *Min*/*Max* function is being used (with the timer function activated). While the *Min*, *Max*, and *Max - Min* values are displayed in real time in the right part of the *Min*/*Max* section, the time elapsed since power measurements were launched is also displayed.

Interpreting the Results of the Min/Max Function

The results of the *Min*/*Max* function are continuously updated in the matching fields. When a logarithmic scale is used, the *Max - Min* calculation is made to continuously provide the difference between the two extremes. In linear scale, the *Max*/*Min* ratio is computed to provide valuable information.

If the power reaches the saturation level, +++++++ will be recorded as the *Max* value. The *Max - Min* or *Max*/*Min* calculation will also be +++++++. If the detected power decreases below the lowest measurable power, the *Min* value will be ------- and both *Max - Min* or *Max*/*Min* will display -------. Finally, *!!!!!!!* will be displayed in a *Max*/*Min* calculation with a null *Min* value.

File Acquisition

The IQ-1600 application offers flexible data management where both timed and conditional data acquisitions are possible. File acquisition will perform power measurements for a fixed duration (**single** operation, as opposed to **continuous** operation) at a specific sampling rate and store the results on file.

With file acquisition, it is possible to use a very low (user-defined) acquisition rate, a *Continuous* acquisition rate (see *Performing Continuous Acquisition* on page 43), and, in particular, a very high acquisition rate from 512 per second to 4096 per second.

Three file acquisition modes are provided:

- timer
- trigger
- delay

In each case, measurements are taken at the selected sampling rate and saved to a user-specified data file. The size of the data files created during acquisition is proportional to the sampling rate and duration of the acquisition. Higher sampling rates and longer durations generate larger quantities of data.

Tip: *For long duration data acquisition, a low sampling rate will save significant data storage space.*

Timer Acquisition Method

Timer acquisition starts as soon as *Start* is chosen and continues for the time specified in the *Duration* edit box.

To use timer acquisition,

1. Select the appropriate wavelength (on all channels when using a multi-channel power meter).

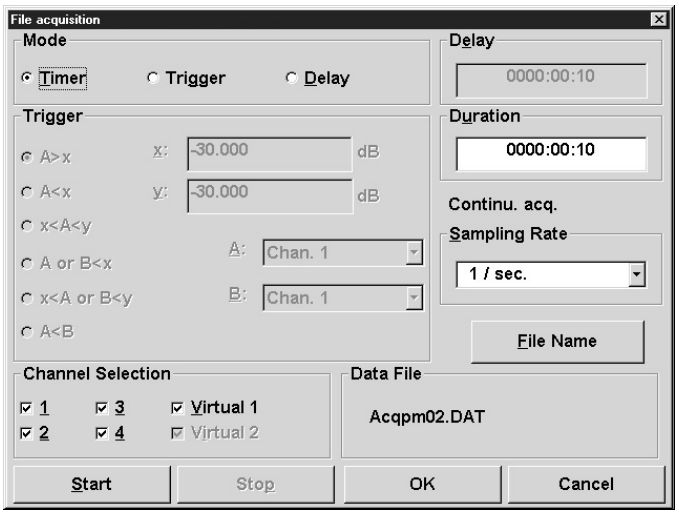

Figure 5-3. *File Acquisition Window*

2. In the *General* section, click on *File Acquisition* to open the *File Acquisition* window, illustrated in Figure 5-3.
3. Activate the *Timer* radio button.
4. In the *Channel Selection* box, select the channel(s) on which you want the power measurement data to be acquired.
5. Setting the acquisition rate:

   Open the *Sampling Rate* list box. You can choose from three types of acquisition rates that appear: either a *Continuous* acquisition rate, a *Single* acquisition rate[1] (512 Hz, 1024 Hz, 2048 Hz, or 4096 Hz), or a user-definable acquisition rate. The user-definable acquisition rate can be set from 1 / 10 sec. to 1 / 999 sec., from 1 / 1 min. to 1 / 999 min., or from 1 / 1 h to 1 / 999:59 h by directly entering the desired value in the edit box using the abridged software keypad or your optional hardware keyboard.
6. Setting the duration:

   Click on the *Duration* edit box. If you double-click on it, the abridged software keypad will appear. Using the abridged software keypad or your optional hardware keyboard, enter the duration in the HHHH:MM:SS format. You can enter a value from 0000:00:01 to 9999:59:59.
7. Choose *File Name*. The dialog box suggests a default name and path, which you can modify or confirm using the software keypad or your optional hardware keyboard.
8. Choose *Start*. The *Acquisition File* window will close and data recording will begin. During acquisition, the function buttons are disabled and *Acquiring into file* is displayed in the status bar of the main window.

1. Both the *Continuous* and the *Single* acquisition rates are set in the *General* section.

Choosing *OK* at this step will save the data acquisition parameters without starting the acquisition. Choosing *Cancel* will exit the *Acquisition File* window.

Data acquisition will continue for the specified duration.

Note: *If a* Single *acquisition rate is selected while one or more channels have been set to automatic power measurement range (see* Setting Measurement Range *on page 41), the file acquisition will not start and a warning message will prompt you to set a manual power measurement range for the channels concerned.*

Note: *Data acquisition can be terminated at any time by opening the* Acquisition File *window and choosing* Stop*. The accumulated data is available in the data file, with the message "Acquisition aborted" displayed at the end of the data acquisition file.*

Trigger Acquisition Method

Conditional data acquisition can be performed using trigger acquisition, where data recording begins when a specified condition is met, and continues for the time specified in the *Duration* edit box. Different trigger conditions are available. These conditions are explained in the following table, where **A** and/or **B** represent(s) the channel(s) on which the condition is to be met, and **x** and/or **y** represent(s) the desired power level threshold(s).

Trigger	Description
A > x	Acquisition will start when measured power is greater than the specified **x** value.
A < x	Acquisition will start when measured power is lower than the specified **x** value.

Table 5-1. *Data Acquisition Triggers (Part 1 of 2)*

Trigger	Description
x < A < y See note [a]	Acquisition will start when measured power falls beyond a specified value (**A > x**). Acquisition will start when measured power falls within a specified value (**A < y**).
A or B < x See notes [a] and [b]	Acquisition will start when measured power in either channel A ***or*** channel B is lower than the specified **x** value.
x < A or B < y See notes [a] and [b]	Acquisition will start when measured power in channel A falls beyond a specified value (**A > x**). Or: Acquisition will start when measured power in channel B falls within a specified value (**B < y**).
A < B See notes [a] and [b]	Acquisition will start when measured power of channel A is lower than measured power of channel B.
External trigger See note [c]	Acquisition will be triggered by an external signal, whether on positive or negative TTL voltage transitions. See *External Trigger* on page 74 for additional information on this feature.

Table 5-1. *Data Acquisition Triggers (Part 2 of 2)*

a. Only when using a *Continuous* or a user-defined acquisition rate.
b. Only when using a multi-channel power meter.
c. Only when using a *Single* acquisition rate.

Note: *The trigger defines the condition for starting data acquisition. Once begun, acquisition will continue for the specified duration regardless of the measured power.*

To use trigger acquisition,

1. Select the appropriate wavelength (on all channels when using a multi-channel power meter).
2. In the *General* section, click on *File Acquisition* to open the *File Acquisition* window.

3. Activate the *Trigger* radio button.

4. In the *Channel Selection* box, select the channel(s) on which you want the power measurement data to be acquired.

5. Select the desired acquisition rate as explained on page 49. Depending on your selection, different trigger conditions will be accessible.

5a. External trigger

Figure 5-4. *Selecting the External Trigger*

1. If you selected a *Single* acquisition rate, you can activate the *External Trig* radio button and select whether the acquisition will be externally triggered on positive or negative TTL voltage transitions by clicking on the desired icon: choose  to select positive (from 0 to 5 V) transitions, or  to select negative (from 5 to 0 V) transitions.

2. You can also set the number of points that will be acquired on file before the trigger position is met in 5% steps from 0% to 50%. The default setting is 20%.

3. For more information about the external trigger function, see *External Trigger* on page 74.

5b. Power level trigger condition

1. Click on the appropriate trigger condition radio button.

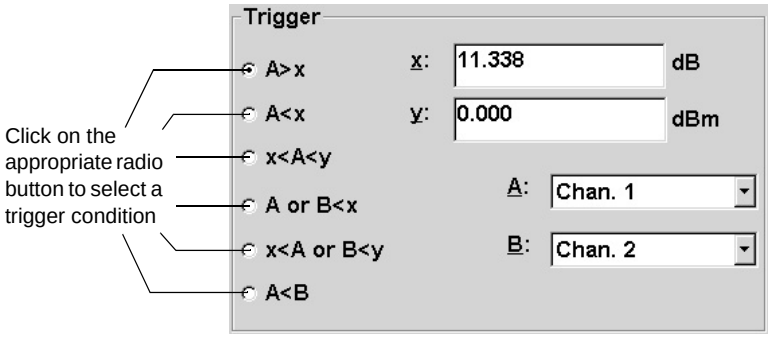

Figure 5-5. *Trigger Condition Box*

2. Select the channel (if applicable) to be taken as **A** and **B**. When using a *Continuous* acquisition rate, it is possible to select a virtual channel in the case of a multi-channel power meter.

Note: *The **x** and **y** values are displayed in the curently selected unit.*

3. Using the abridged software keypad or your optional hardware keyboard, enter the appropriate **x** and **y** values.

6. Select the desired duration as explained on page 49.

7. Choose *File Name*. The dialog box suggests a default name and path, which you can modify or confirm using the software keypad or your optional hardware keyboard.

8. Enable the acquisition by choosing *Start*. The *Acquisition File* window will close, and *Waiting for trigger or start time* will be displayed in the status bar.

Choosing *OK* at this step will save the data acquisition parameters without enabling the acquisition. Choosing *Cancel* will exit the *Acquisition File* window.

During acquisition, the function buttons are disabled and *Acquiring into file* is displayed in the status bar of the main window.

Once the acquisition starts, it will continue for the specified duration.

Note: *Data acquisition can be terminated at any time by opening the* Acquisition File *window and choosing* Stop*. The accumulated data is available in the data file, with the message "Acquisition aborted" displayed at the end of the data acquisition file.*

Delay Acquisition Method

Delay acquisition starts at a specified time after *Start* is chosen and continues for the time specified in the *Duration* edit box.

To use delay acquisition,

1. Select the appropriate wavelength (on all channels when using a multi-channel power meter).
2. In the *General* section, click on *File Acquisition* to open the *File Acquisition* window.
3. Activate the *Delay* radio button.
4. In the *Channel Selection* box, select the channel(s) on which you want the power measurement data to be acquired.
5. Select the desired acquisition rate as explained on page 49.

Note: *Delay acquisition is possible only if a* Continuous *or a user-defined acquisition rate has been set.*

6. Select the desired duration as explained on page 49.
7. Setting the delay:

   Click on the *Delay* edit box. If you double-click on it, the abridged software keypad will appear. Using the abridged software keypad or your optional hardware keyboard, enter the delay in the HHHH:MM:SS format. You can enter a value from 0000:00:01 to 9999:59:59.
8. Choose *File Name*. The dialog box suggests a default name and path, which you can modify or confirm using the software keypad or your optional hardware keyboard.

9. Enable the acquisition by choosing *Start*. The *Acquisition File* window will close, and *Waiting for trigger or start time* will be displayed in the status bar.

Choosing *OK* at this step will save the data acquisition parameters without enabling the acquisition. Choosing *Cancel* will exit the *Acquisition File* window.

During acquisition, the function buttons are disabled and *Acquiring into file* is displayed in the status bar of the main window.

Data acquisition will start after the specified delay and continue for the specified duration.

Note: *Data acquisition can be terminated at any time by opening the* Acquisition File *window and choosing* Stop. *The accumulated data is available in the data file, with the message "Acquisition aborted" displayed at the end of the data acquisition file.*

Consulting Data

Acquisition files (see *File Acquisition* on page 47) are saved in text format. Data may be viewed or printed using any text editor or word processor. The file has data fields separated by tabs, so it can be easily imported into most popular spreadsheet programs.

Note: *The IQ-203 operating system has two text editors: Windows Notepad and Windows WordPad. The figure below displays a data acquisition file in text format.*

```
EXFO_FILE:    ACQFILE,FPM   4 CHANNEL(S)
VERSION:      2.0

FILE:  C:\IQ\USERFILE\IQ1600\ACQPM00.DAT
FPM S/N:      0062084-2I
DATE:  Wed Oct 20  1999
TIME:  11:42:47

CHANNEL:            Channel 1         Channel 2     Channel 3          Channel 4
NAME:               Channel 1         Channel 2     Channel 3          Channel 4
LAMBDA:             1310.00 nm        1310.00 nm    1310.00 nm         1310.00 nm
CORRECTION FACTOR:  000.0000 dB       000.0000 dB   +001.0000E+00 W/W  +001.0000E+00 W/W
REFERENCE:          000.0000 dBm      000.0000 dBm  000.0000E-18 W     000.0000E-18 W
RATE:               256.000/sec.      256.000/sec.  256.000/sec.       256.000/sec.
DIGITS:             4                 Auto          Auto               Auto
AVG:                Off               Off           Off                Off
SCALE:              LR3               LR3           LR3                LR3
UNIT:               dBm               dBm           W                  W
Time (msec.)        Channel 1         Channel 2     Channel 3          Channel 4

0.000               -044.7532         -044.6975     +030.704E-09       +024.066E-09
3.906               -044.7348         -044.6427     +030.850E-09       +024.066E-09
7.813               -044.7348         -044.6427     +030.704E-09       +024.496E-09
11.719              -044.7532         -044.6975     +030.704E-09       +024.066E-09
15.625              -044.7348         -044.6427     +030.850E-09       +024.496E-09
19.531              -044.8090         -044.7160     +030.704E-09       +024.066E-09
23.438              -044.7348         -044.6975     +031.286E-09       +024.066E-09
27.344              -044.8090         -044.7160     +030.267E-09       +023.923E-09
31.250              -044.7348         -044.6975     +031.286E-09       +024.066E-09
35.156              -044.7532         -044.7717     +030.267E-09       +023.923E-09
39.063              -044.7348         -044.6975     +030.850E-09       +024.066E-09
. . . .
9988.281            -044.6079         -044.5527     +031.868E-09       +025.212E-09
9992.188            -044.6618         -044.6245     +031.868E-09       +025.069E-09
9996.094            -044.5900         -044.4997     +032.014E-09       +025.212E-09
10000.000           -044.6799         -044.5706     +031.286E-09       +025.069E-09

MINIMUM:            -044.8090         -044.7717     +030.267E-09       +023.923E-09
MAXIMUM:            -044.5369         -044.4997     +032.450E-09       +025.642E-09

                    (Max-Min)         (Max-Min)     (Max/Min)          (Max/Min)
RESULT:             +000.2721         +000.2720     +001.0721E+00      +001.0719E+00

Acquisition completed.
```

Figure 5-6. *Data Displayed by Text Editor*

Setting Graph Mode

The *Graph* section allows you to set the basic parameters for the graphical application, which is explained in *Graphical Display Mode* on page 61.

Two acquisition modes are available for graphical applications: *Continuous* mode, where measurements are displayed in real time on the graph as long as the *Stop* button is not pressed, and *Single* mode, where measurements are acquired at high speed for a specified duration and displayed on the graph after processing.

Selecting Continuous Acquisition Mode

1. In the *Graph* section, activate the *Continuous* radio button.

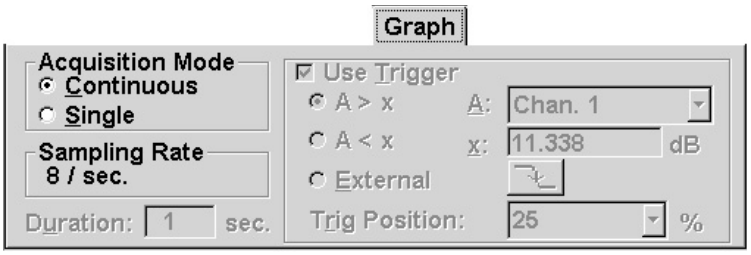

Figure 5-7. *Graph Section (Continuous Mode)*

2. The *Continuous* acquisition rate as set in the *General* section will be automatically selected. No other setting is possible in this section.

Once the acquisition is launched in the graphical application, it will continue until it is manually stopped.

For further details on how to use the graphical application, see *Typical Applications* on page 79 and *Graphical Display Mode* on page 61.

Selecting Single Acquisition Mode

1. In the *Graph* section, activate the *Single* radio button.

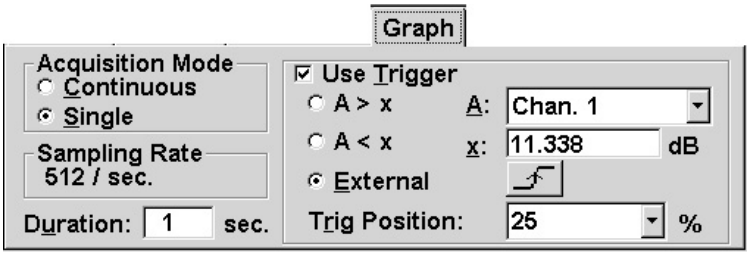

Figure 5-8. *Graph Section (Single Mode)*

Note: Single *acquisition mode is possible only if a manual range has been set for all channels. To set the range, see* Setting Measurement Range *on page 41.*

2. The *Single* acquisition rate as set in the *General* section will be automatically selected.

3. Setting the duration:

Click on the *Duration* edit box. If you double-click on it, the abridged software keypad will appear. Using the abridged software keypad or your optional hardware keyboard, enter the desired duration in seconds (minimum 1 second). The maximum duration permitted depends on the selected acquisition rate: a message will prompt you to enter a valid acquisition rate if the value entered exceeds the limit, depending on the selected acquisition rate.

4. Trigger

4a. Setting a power level trigger condition:

1. Enable the *Use Trigger* check box.

2. Click on the desired trigger condition radio button (A > x or A < x) and, using the abridged software keypad or your optional hardware keyboard, select the channel (if applicable) to be taken as **A** and enter the appropriate **x** value.

Or:

4b. Setting the external trigger:

1. Enable the *Use Trigger* check box.

2. Click on the *External* radio button.

3. Select whether the acquisition will be externally triggered on positive or negative TTL voltage transitions by clicking on the desired icon: choose  to select positive (from 0 to 5 V) transitions, or  to select negative (from 5 to 0 V) transitions.

4. Select the number of points that will be acquired before the trigger position is met in 5% steps from 0% to 50%. The default setting is 20%.

Once the acquisition is launched in the graphical application, it will continue for the time specified in the *Duration* edit box.

For further details on how to use the graphical application, see *Typical Applications* on page 79 and *Graphical Display Mode* on page 61.

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6 Graphical Display Mode

The graphical display mode simultaneously offers a sampling display of up to four channels in a tabular format and up to eight channels in a graphical format, in real time when using *Continuous* mode. The channels can be taken from any IQ power meter (IQ-1100, IQ-1200, IQ-1500), high-speed power meter (IQ-1600), PDL analyzer (IQ-3400), or Optical Spectrum Analyzer (IQ-5200) modules. Other features include zoom, adjustable markers with automatic delta calculation, minimum and maximum alarms, tabular data display, and printing capabilities.

Graphical Display Mode Window Description

The graphical display mode is accessed by choosing the *Graph* button from the *Normal mode* main window of any IQ module.

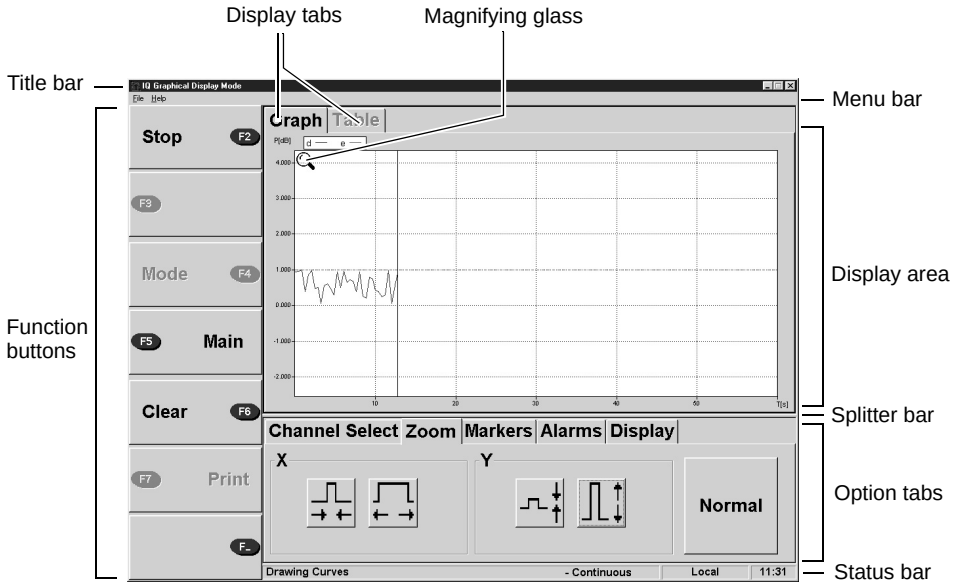

Figure 6-1. *Graphical Display Mode Window*

The *Graphical Display Mode* window can be divided into five sections:

- menu bar
- function buttons
- display tabs and display area
- status bar
- option tabs

Menu Bar

The title bar and the menu bar are at the top of the *Graphical Display Mode* window (see Figure 6-1). The menu bar contains drop-down menus that are explained in the following table:

Menu	Option	Function
File	Exit	Exits the graphical display mode and returns to the previously used IQ application. Saves the configuration at exit and later reopens with the same parameters.
Help	Online Manual	Opens the Help file, which contains the text of this instruction manual in PDF format.
	About	Opens a window which provides the following information: ➤ Software version ➤ Telephone numbers, e-mail, and web site addresses for technical assistance ➤ Available IQ-203 system memory (RAM) ➤ Remaining hard disk drive storage space

Table 6-1. *Graphical Display Mode Window Drop-Down Menus*

Function Buttons

The function buttons, along the left side of the *Graphical Display Mode* window (see Figure 6-1), are used for the direct control of features in the graphical display mode.

Button	Description
Start F2	Launches sampling according to the parameters set in the *Option* tabs. The *Start* button changes to *Stop* when sampling is in progress.
Stop F2	Stops or pauses sampling. Sampling can be resumed by choosing *Start*.
Mode F4	Sets the acquisition mode to be used (*Continuous* or *Single*).
F5 Main	Returns to the application from which the graphical application was launched.
Clear F6	Clears the data displayed in the display area.
F7 Print	Initiates printing of the display area (only if graphical display was selected).
F–	Transfers control to the IQ-203 front panel function keys (refer to the *IQ-200 Optical Test System* Instruction Manual).

Table 6-2. *Graphical Display Mode Function Buttons*

Note: *When function buttons are disabled, they appear gray.*

In addition, the following shortcuts are directly accessible from your optional hardware keyboard:

- *F1:* same effect as the *Online Manual* option in the *Help* menu.
- *F2* to *F7:* same effect as the matching function buttons.
- *F12:* same effect as the *F_* function button.
- *Alt-F4:* same effect as the *Exit* option in the *File* menu.
- *ESC:* same effect as the *Cancel* button when available.

Display Tabs and Display Area

The display tabs are located above the *Display area* (see Figure 6-1). Select *Graph* to display the power readings as a curve (one curve per channel). Select *Table* to display the power readings in a table (one column per channel). The units selected will be seconds and power readings will be displayed with a resolution of three digits after the decimal point.

Note: *It is not possible to toggle between* Table *format and* Graph *format during an acquisition. The desired format must be selected before starting the acquisition.*

Note: *In* Table *format, only the last 100 power readings will be displayed. Therefore,* Table *format is not appropriate when performing a high-rate (*Single*) acquisition.*

Clicking and dragging down the splitter bar (see Figure 6-1) will allow you to increase the size of the display area. To return to the display area's original size, simply click the splitter bar and drag it back into place.

The following two examples display typical power readings in graphical and tabular formats.

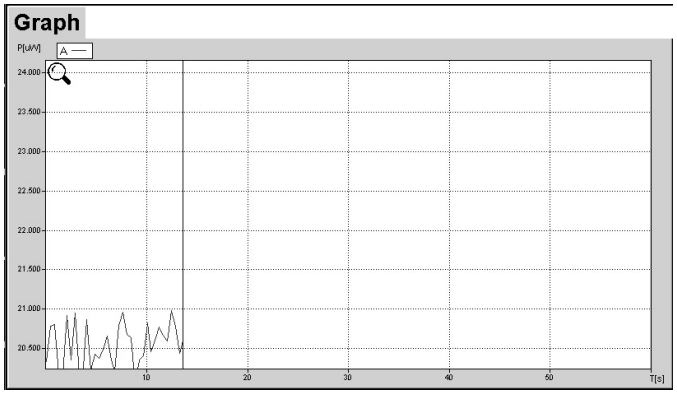

Figure 6-2. *Curve in Display Area (Graph)*

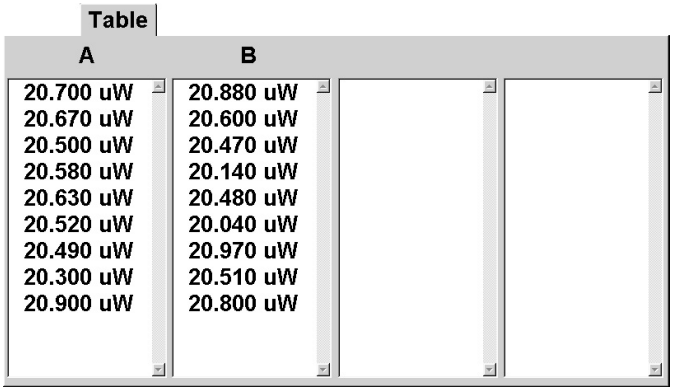

Figure 6-3. *Channel Results in Display Area (Table)*

Status Bar

The status bar displays the current status of the module.

- *Idle - Continuous:* The application is waiting for a command. The current acquisition mode is *Continuous*.
- *Idle - Single:* The application is waiting for a command. The current acquisition mode is *Single*.

- *Waiting... - Continuous:* The application is waiting for the first points of an acquisition in *Continuous* acquisition mode.
- *Waiting... - Single:* The application is waiting for the first points of an acquisition in *Single* acquisition mode.
- *Drawing Curves - Continuous:* An acquisition is in progress in *Continuous* acquisition mode and power readings are being displayed in *Graph* format.
- *Drawing Curves - Single:* An acquisition is in progress in *Single* acquisition mode and power readings are being displayed in *Graph* format.
- *Writing to Tables - Continuous:* An acquisition is in progress in *Continuous* acquisition mode and power readings are being displayed in *Table* format.
- *Writing to Tables - Single:* An acquisition is in progress in *Single* acquisition mode and power readings are being displayed in *Table* format.
- *Minimum Alarm Condition:* The minimum pre-defined alarm condition is being met.
- *Maximum Alarm Condition:* The maximum pre-defined alarm condition is being met.
- *Clearing:* All *Graph* or *Table* power readings are being erased.

Finally, the status bar displays the time.

Options

Channel Selection

Readings from as many as eight channels can be displayed in a graph, while readings from as many as four channels can be displayed in a table. Channels must be selected and have a character attributed to them for their readings to be displayed.

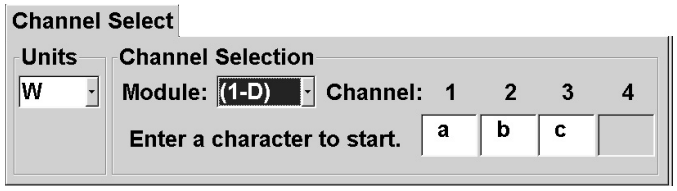

Figure 6-4. *Channel Selection Section*

1. Select the measurement unit (dBm, dB, or W) in which the readings will be displayed (on the **y** axis).

2. Scroll through the list of available IQ modules and select one.

The position of an IQ module is identified both with a number and a letter. The number indicates the unit in which the module is inserted (0 for the IQ-203 Mainframe and 1 to 4 for the IQ-206 Expansion Units connected to the Mainframe). The letter indicates the slot in which the module is inserted.

3. Depending on the number of channels available on the selected module, the *1, 2, 3,* or *4* boxes will be activated.

Note: *Only the IQ module channels set to the same measurement unit as that specified in the* Units *box will be listed.*

Note: *The acquisition mode selected (i.e.,* Continuous *or* Single*) must be the same as the one selected in the* Graph *section (see* Setting Graph Mode *on page 57). If not, choose* (Mode) F4 *to toggle between the two acquisition modes.*

4. To select a channel for display, enter the channel label, i.e., type a character (either a letter or number) in the matching box. This character will be used to identify the channel displayed. The same character can be used only once.

Note: *It is not possible to select channels from different IQ-1600 modules in* Single Acquisition *mode.*

5. Repeat steps 2, 3, and 4 for each required channel.

Tip: *You need to enter the information for the* Channel Select*,* Alarms*, and* Display *options before choosing* Start (F2).

Zoom Control

The *Zoom* window controls the view by increasing or diminishing the axis scales.

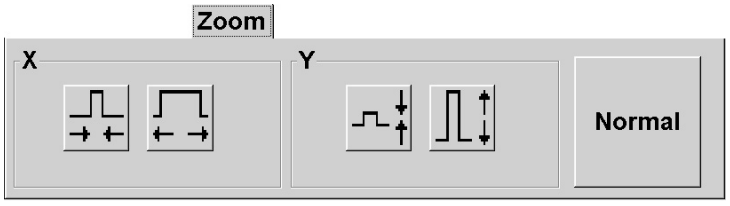

Figure 6-5. *Zoom Section*

The *Zoom* option will not be enabled until a few points have been acquired on the curve. With the magnifying glass positioned on the desired portion of the curve, select the appropriate button to diminish or increase the **x** axis, to shrink or spread the **y** axis, or to return to the original settings.

Figure 6-6. *Magnifying Glass*

Magnification on the **x** axis is possible within the limits imposed by the module sampling rate. For example, at the maximum magnification rate, the *Continuous* mode allows 0.004 sec. accuracy (sampling rate of 256 / sec.) and the *Single* mode allows 0.00025 sec. accuracy (sampling rate of 4096 / sec.).

Magnifying by a factor of up to 1000 can be achieved on the **y** axis.

The magnifying glass allows you to move the visible portion of the curve horizontally and vertically by dragging the magnifying glass with the left mouse button on the corresponding border of the display area.

Markers

The markers determine the exact coordinates of a particular point on a curve. You can also find the difference between the coordinates of two points on a curve. To use the marker feature, choose the *Markers* tab, at the bottom of the *Graphical Display Mode* window.

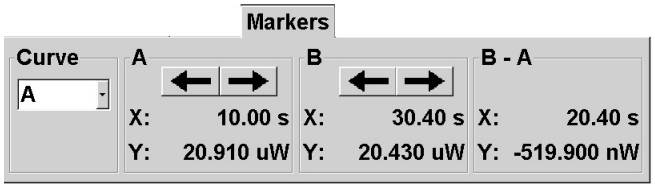

Figure 6-7. *Markers Section*

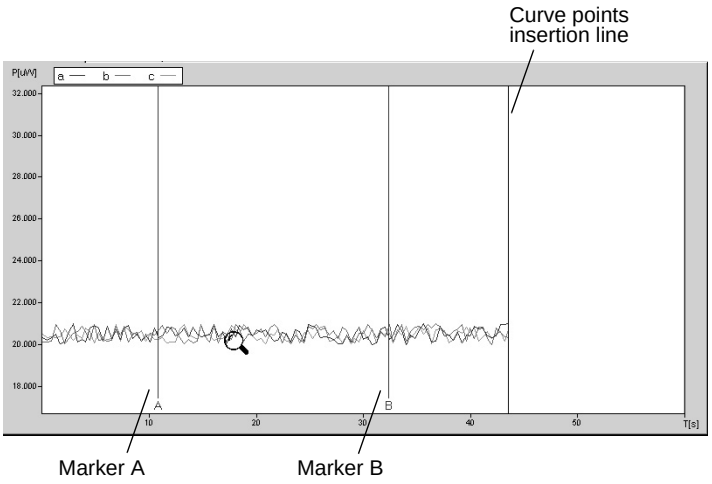

Figure 6-8. *Display Area*

➤ The **A** and **B** markers appear in the display area.

- The **A** box (see Figure 6-7) gives the coordinates of the point met by marker **A** on the selected curve.
- The **B** box (see Figure 6-7) gives the coordinates of the point met by marker **B** on the selected curve.
- The **B-A** box (see Figure 6-7) gives the difference between the coordinates of the points met by markers **A** and **B** on the selected curve.

To move a marker, choose the appropriate arrow in the *Markers* section, or click on the desired marker in the display area and drag it as required.

Only two markers are displayed at the same time on the curve selected in the *Curve* list box (accessible in the *Markers* section). The markers take the color of the selected curve.

Alarms

Alarms can be set to warn you when power levels of any channel go below or above pre-defined thresholds or outside specified limits. An audible and/or visual alarm is activated when the power level on any of the displayed channels goes above or below the pre-defined thresholds.

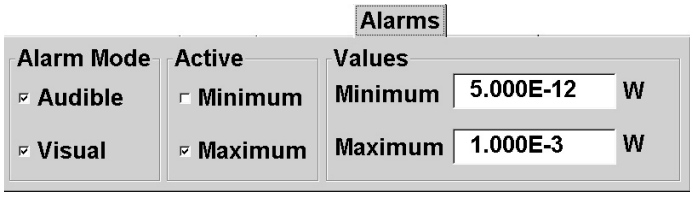

Figure 6-9. *Alarms Section*

First, select audible and/or visual alarm. Next, enter maximum and/or minimum alarm threshold values. Any value entered for the minimum and maximum values will be automatically transformed into scientific notation.

An audible alarm consists of small beeps generated by the computer. For a visual alarm, the *Min* and/or *Max* indication in the *Display Area* will be outlined in red horizontal dotted lines. The alarm status is displayed in the status bar, alternating between the system status and alarm status. Only the first occurrence, either the minimum or maximum alarm will be displayed in the status bar. To stop the alarm, press *Stop*.

Display

The *Display* section, which allows you to configure the data displayed, includes the following options:

- Display mode
- Scale
- Grid

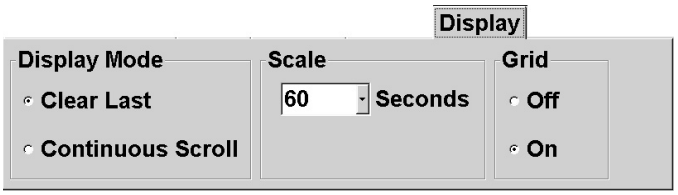

Figure 6-10. *Display Section*

Using the *Display Mode* option, two curve plottings can be selected (in *Continuous* mode only):

Clear Last	After having gone through a complete sweep of a time scale, curve plotting begins again at the zero point. The previous curve is overwritten as a new one is plotted.
Continuous Scroll	After having gone through a complete sweep of a time scale, curve plotting keeps going on the same curve. Only the portion of the curve plotted within the last time scale is kept in memory and displayed.

Notice that an insertion line moves along the **x** axis as curve plotting progresses.

The *Scale* setting determines the length of the **x** axis (time) when the zoom control is set to full view. It therefore determines how long the curve plotting process will take to carry out a complete sweep of the display (in full view). Nine choices are available in the *Scale* edit box: 5, 15, 30, 60, 120, 300, 600, 1800, and 3600 seconds.

The available scales depend on the maximum sampling rate allowed for the displayed curves.

Note: *The scale is automatically selected in* Single *acquisition mode. Therefore, it can only be selected when in* Continuous *acquisition mode.*

A grid can be displayed over the curve(s) in the graphical display area, so it is easier to refer to the **x** and **y** axes from a point on a curve. To turn the grid on or off, choose the appropriate radio button in the *Display* section.

7 External Trigger and Analog Output

This chapter describes how to use the external trigger (IQ-1610, IQ-1620, and IQ-1640) and analog output (IQ-1610 and IQ-1620) of the high-speed power meter.

Both the external trigger and analog output are accessible from the front panel of the IQ-1600 module.

Standard BNC connectors are used with the exception of the external trigger on the four-channel power meter, which uses an SMB connector due to the available space on the front panel of the module.

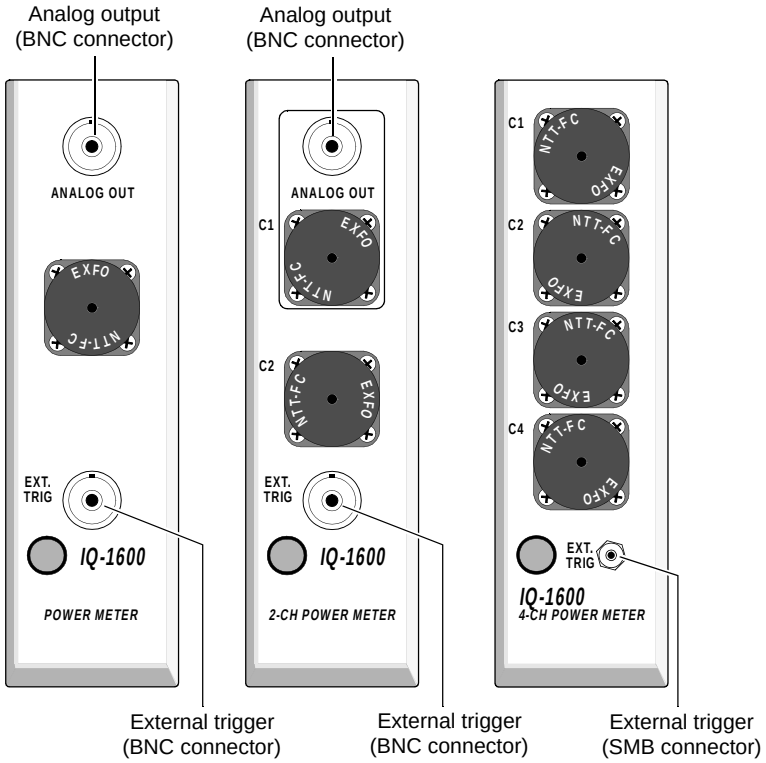

Figure 7-1. *Analog Output and External Trigger Ports*

External Trigger

The external trigger is used to synchronize or stimulate the acquisition of power measurements with an electrical signal (TTL level). *Single* acquisitions at up to 4096 Hz can be performed. The external trigger can only be used with a *Single* acquisition rate. The external trigger can be used to start a file acquisition or a graph acquisition.

With an externally triggered acquisition, whether for a file acquisition or for a graph acquisition, you can select the number of points that will be acquired before the trigger position is being met.

Note: *Since externally triggered acquisitions may be performed using a high acquisition rate only, a manual power range must be set for all channels.*

Connecting a TTL Source to the External Trigger

A synchronizing signal from a signal generator or from a control circuit may be connected to the external trigger input of the IQ-1600 module if it does not exceed TTL levels. The illustration below displays a typical connection setup for a signal generator.

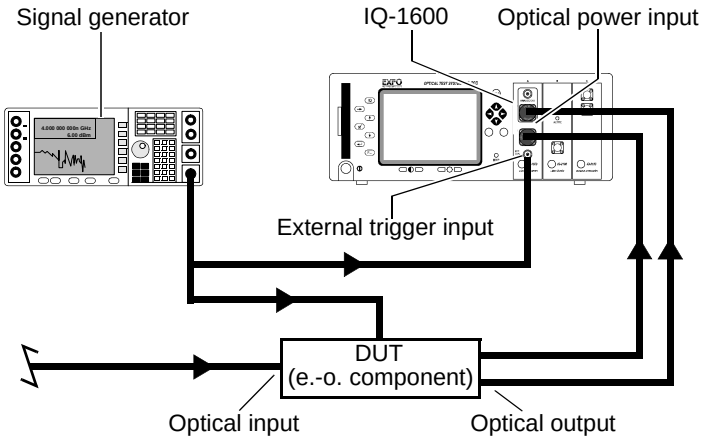

Figure 7-2. *Typical Signal Generator Connection*

External Trigger and File Acquisition

To prepare an externally triggered file acquisition, a *Single* acquisition rate must be selected (see *File Acquisition* on page 47).

Click on the *Trigger* radio button in the *File Acquisition* window, which is accessible from the *General* section, and ensure that *External Trig* is activated.

Choose whether the acquisition will be externally triggered on positive or negative TTL voltage transitions by selecting  or  respectively.

Set the trig position in 5% steps from 0% to 50%.

When you enable the externally triggered acquisition with *Start,* the acquisition will wait for the voltage transition to occur before storing the data on file.

External Trigger and Graphical Acquisition

The external trigger may be selected only if *Single* acquisition mode was selected.

After enabling the *Use Trigger* check box in the *Graph* section, choose whether the graphical acquisition will be externally triggered on positive or negative TTL voltage transitions by selecting  or  respectively.

Set the trig position in 5% steps from 0% to 50%.

Next, run the graphical application by choosing *F5 (Graph)* from the main window. Set the active channel(s), then enable the acquisition by choosing *(Start) F2*. The *"Waiting..."* message will appear on the status bar. The IQ-1600 is now waiting for the positive or negative voltage transition to occur at the external trigger input.

Upon voltage transition, the IQ-1600 records data at the specified sampling rate for a fixed duration, the *"Drawing Curves"* or *"Writing to Tables"* message appears, and the acquisition data is displayed on the graph window. Graph mode operation (zoom, markers, etc.) may then be performed at your convenience.

Graphical triggered acquisition can be repeated by choosing *(Start) F2*.

Analog Output (IQ-1610, IQ-1620)

The analog output provides an electrical signal proportional to the optical power input on the detector. It is available for channel #1 of both single- and dual-channel models.

The analog output signal is the redirection of the signal after the first amplification stage. Do not use the analog output in Autorange mode (see *Setting Measurement Range* on page 41) because the gain scales of the first amplification stage are constantly changed to optimize signal-to-noise ratio.

The following two figures illustrate typical use of the analog output.

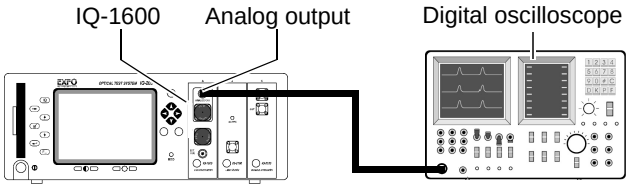

Figure 7-3. *Analog Output Connected to a Digital Oscilloscope*

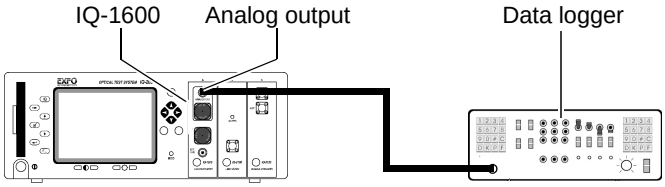

Figure 7-4. *Analog Output Connected to a Data Logger*

The user interface can be used to determine the operating power levels and to optimize the analog output range. Choose the optimum power range for your application. The table below provides the voltage vs. power information for each available manual range.

Manual Range	Power vs. Voltage[a]
LR1, HR1	2.15 V ±25%[b] at 18.30 dBm[c]
LR2, HR2	2.15 V ±25%[b] at 9.90 dBm
LR3, HR3	2.15 V ±25%[b] at -10.09 dBm
LR4, HR4	2.15 V ±25%[b] at -29.87 dBm
LR5	2.15 V ±25%[b] at -49.61 dBm
LR6	2.15 V ±25%[b] at -69.61 dBm

Table 7-1. *Voltage vs. Power*

a. At 1310 nm.
b. Large uncertainty is due to detector responsivity at 1310 nm.
c. Not guaranteed due to detector saturation.

When using the IQ-1600 with rising optical power, saturation of the scale converter will be reached when +++++++ is displayed. At that moment, the voltage in the analog output will be 2.15 V. Even with +++++++ displayed, the optical power can still be increased further, and the analog output will keep increasing proportionally. The voltage that can be read on the oscilloscope is then 3.95 V for HR1 to HR4 and LR1 to LR4, and 4.4 V for LR5 and LR6.

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8 Typical Applications

Introduction

To make accurate, significant, and repeatable power measurements, it is important to consider the following points:

- Connectors, fiber ends, ports, and detectors should be clean at all times.
- A null measurement should be performed prior to each user session or whenever there is a significant change in ambient temperature or environmental conditions. To perform a null measurement, see *Nulling Electrical Offsets* on page 23.
- The optical source should be stable.
- Appropriate test jumpers, connectors, and adapters must be used.
- Once a reference has been taken, ensure that the setup remains stable. To take a reference, see *Measuring Relative Power* on page 33.
- Since optical losses vary according to the launch and receive conditions and fiber type, controlling these conditions with mode filters and strippers is essential.

Performing Absolute Power Measurements

Absolute power measurements are necessary when performing system or component monitoring, quality control, system or component acceptance, and troubleshooting.

To carry out absolute power measurements,

1. Perform an offset nulling.
2. Using an appropriate test jumper and connector adapter, connect the DUT to the detector port.

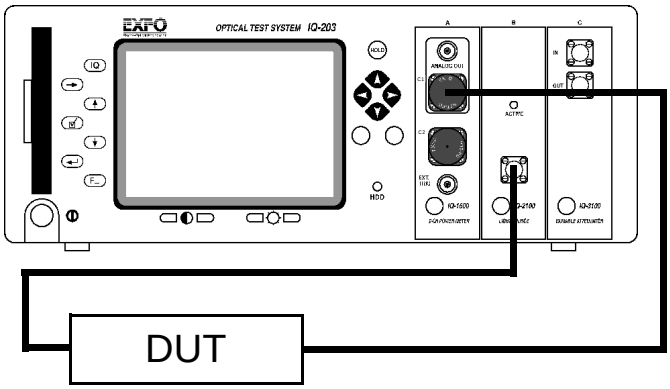

Figure 8-1. *Absolute Power Measurement Setup*

3. Adjust the power meter to the correct wavelength, 0.000 dB or 1.000 W/W correction factor, and set the display unit to dBm or W.

4. The absolute optical power can now be monitored and recorded.

Note: *With a multi-channel IQ-1600, absolute power can be simultaneously measured for each independent channel. Simply apply each step of the above procedure to all channels being used.*

Tip: *The high-speed power meter virtual channel (IQ-1620 or IQ-1640) is an excellent tool for comparing two optical channels. For example, if two devices (connected to channels #1 and #2) are supposed to have identical power levels, displaying a virtual channel (defined as channel #1 minus channel #2) provides easy monitoring of both devices and will quickly highlight any power fluctuations.*

Measuring Insertion Loss

To accurately measure the insertion loss of a fiber-optic component, use a light source (IQ-2100) and an IQ-1600 Power Meter.

1. Using two appropriate test jumpers and a bulkhead adapter, connect the source to the power meter as shown below. This setup will be used to record a reference value.

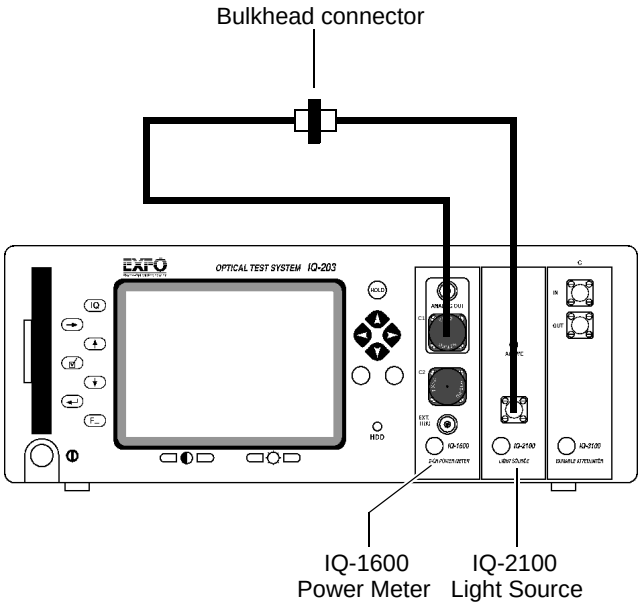

Figure 8-2. *Reference Measurement Setup*

2. Adjust the source and power meter to the appropriate wavelength.

3. Activate the source and select a suitable power output.

IMPORTANT

The absolute power output value is not particularly important when measuring insertion loss. It is very important, however, that the power level used for taking the reference measurement is identical to the power level used during the insertion loss measurement.

4. In the IQ-1600 Power Meter application (Normal mode), set the measurement units to dB or dBm and choose *F3 (Ref)* from the main window. The reference value has now been taken and the display should read *0.000 dB.*

5. Replace the bulkhead connector with the DUT as shown in Figure 8-3.

6. The insertion loss of the DUT is the relative measurement as displayed by the IQ-1600 software. For best results, ensure that the setup remains stable.

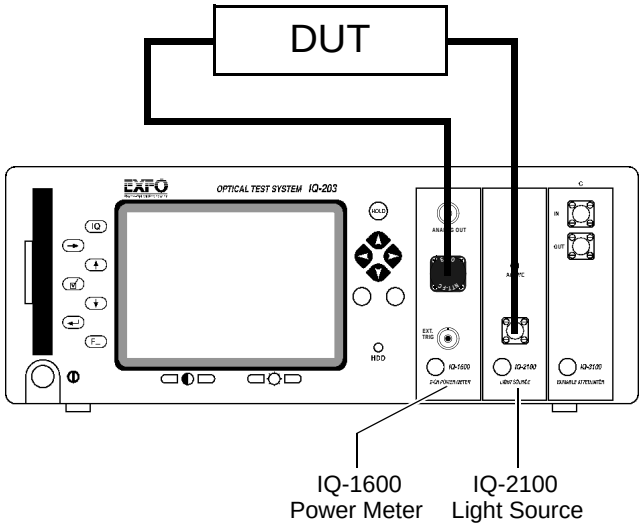

Figure 8-3. *Testing Insertion Loss*

7. With an IQ-1640 Four-Channel Power Meter, the previous procedure could be used to perform four simultaneous insertion loss measurements as shown in the following figure.

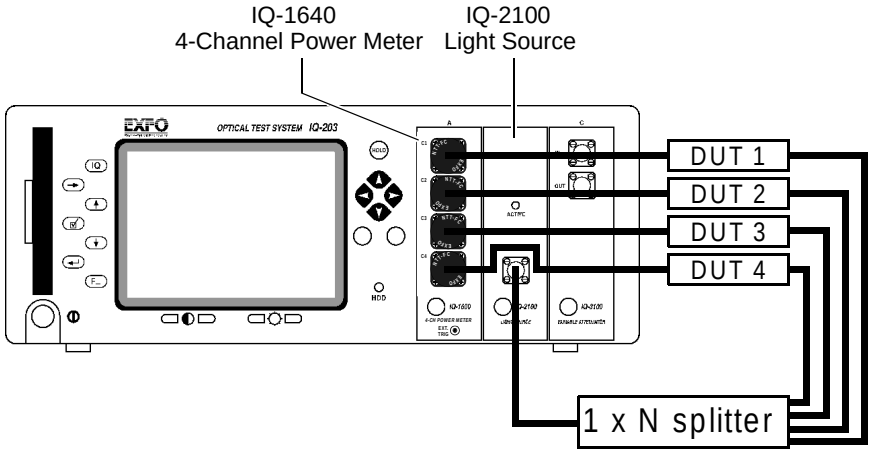

Figure 8-4. *Multi-Device Insertion Loss Testing*

Instrument Linearity Testing

As stated in *Measuring Insertion Loss* on page 81, absolute power levels are not particularly significant when measuring the insertion loss of a fiber-optic component. In calculating insertion loss, we are essentially measuring the difference between the power in and out of a DUT. To accurately measure delta power, instrument linearity is very important. The IQ-1600 high-speed power meter is specified as being very linear (±0.015 dB), down to -55 dBm. Not only is the IQ-1600 ideal for measuring insertion loss, it is also suitable as a reference instrument for determining the linearity of other fiber-optic components such as attenuators, other power meters, and optical detectors.

When verifying instrument linearity, a linear variable attenuator (e.g., IQ-3100) is also required. Before verifying the linearity of an optical detector, you must confirm the linearity of the attenuator being used.

Confirming the Linearity of the Attenuator Being Used

To confirm the linearity of the attenuator being used, you need a stable source (IQ-2100), a variable attenuator, an IQ-1600, two test jumpers, and appropriate connector adapters.

1. Connect the instruments as shown below.

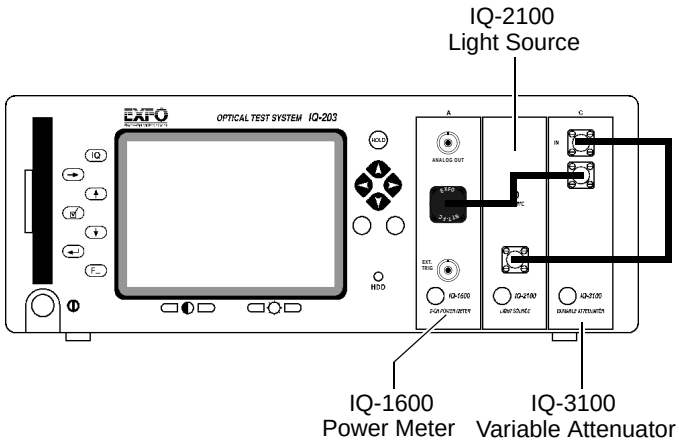

Figure 8-5. *Confirming Attenuator Linearity*

2. With all instruments set to the same wavelength and the attenuator set to minimum attenuation, take an IQ-1600 reference measurement and switch to relative display. Next, switch the attenuator to relative display mode.

3. At this time, both the attenuator and power meter will display *0.0 dB*. Increase the attenuation using constant step sizes, while recording the values from both displays (attenuator and power meter) at each step. Continue until the power meter indicates around -55 dB. The recorded values at each step should follow within allowable tolerances. If the values do not follow, there is a problem with the equipment setup or with one of the instruments. Before proceeding any further, the problem must be isolated.

Testing the Linearity of an Optical Detector

Once you are confident with both the test setup and instruments being used (see *Confirming the Linearity of the Attenuator Being Used* on page 84), you can now start testing for component linearity.

1. Disconnect the IQ-1600 from the circuit shown in Figure 8-5 and replace it with the detector being tested.
2. Reset the attenuator to minimum attenuation.
3. Increase the attenuation on the attenuator with constant step sizes, while recording the output read by the detector at each step.
4. When completed, the data can be analyzed to determine the detector's linearity.

Characterization of an Optical Switch

The high sampling rate, fast stabilization, trigger capability, and graphical mode of the IQ-1600 can be combined to easily characterize optical switches.

Figure 8-6 displays a simple test station for a 1 x 2 optical switch. A light source is connected to the common terminal of the optical switch. Each optical output of the switch is connected to an IQ-1623 Dual-Channel Power Meter detector. This test setup can be used to test both the repeatability and the settling time of the optical switch. For the latter test (in *Single* acquisition mode), the electrical signal that is used to command the switch is also connected to the external trigger input of the IQ-1623.

Testing Repeatability

The procedure to test the repeatability of an optical switch is relatively simple. First, a reference measurement must be taken on each channel. Next, repetitive transitions of the switch must be performed and the switch repeatability will be the total deviation from the reference points.

1. Connect the instruments as shown below.

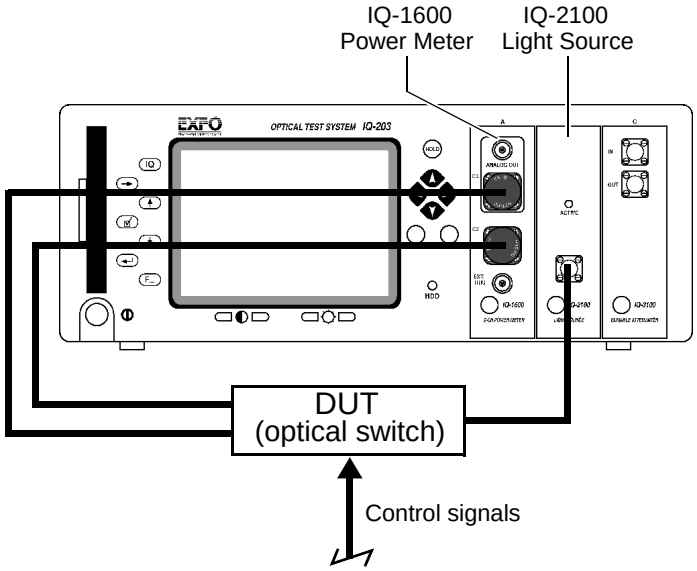

Figure 8-6. *Repeatability Test Setup for an Optical Switch*

2. Set the power meter channels to the same wavelength as the source.
3. Set the power meter channels to Autorange mode.
4. Set the switch to a first position and take a reference measurement on the power meter, selecting the active channel (the channel in which the switch has a minimum insertion loss).
5. Set the switch to the second position and take a reference measurement on the power meter, selecting the active channel.
6. Change the switch position from one channel to the other. For each channel, take note of the relative power measurement when the channel is active.
7. Repeat step 6 as many times as required.

8. For each channel, the total switch deviation will be the highest positive deviation minus the highest negative deviation relative to the original reference (taken at step 4). The repeatability of the switch insertion loss may be expressed as ± (total deviation in dB) / 2.

Testing the Settling Time

The triggering and fast stabilization of the IQ-1600 can be used to obtain fast power transitions. A good example of this is the settling time measurement for the optical switch . When an electrical control signal for the switch is available, a settling time including the electronics response time can be measured. This is easily done using the graph mode of the IQ-1600 application.

1. Connect the instruments as shown below.

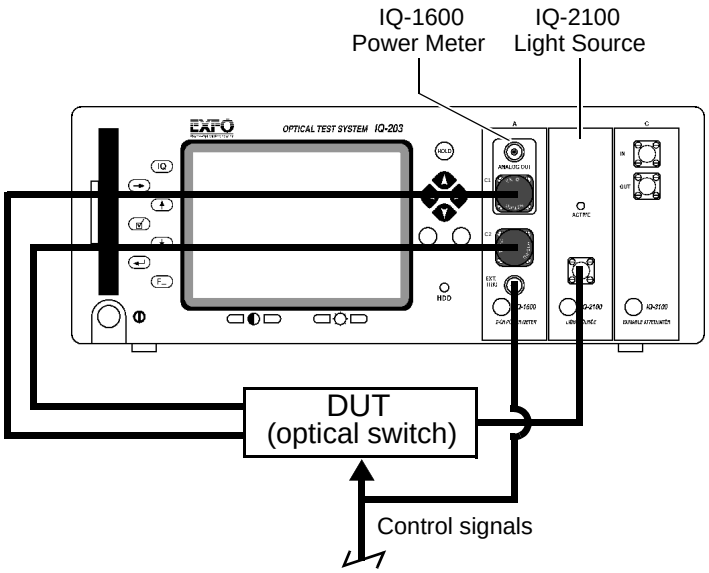

Figure 8-7. *Settling Time Measurement Setup for Optical Switch*

2. Set the power meter channel to the same wavelength as the source.
3. Set the power meter channels to the proper manual range, making sure that no saturation occurs on the active channel.
4. Select the highest single acquisition rate (4096 samples/sec.).
5. In the *Graph* section, select *Single Acquisition,* activate the *Use External Trigger* check box, and set the desired trigger position.
6. Access the graphical display mode by choosing *F5* from the Normal mode main window.
7. Set the optical switch to its initial position.
8. Choose *Start*. The *"Waiting..."* message will appear on the status bar of the graph window, as the instrument is waiting for a trigger.
9. Activate the electrical control signal, which acts as a trigger for the IQ-1600.
10. The status bar will display *"Drawing curves"* until the switch transition is totally acquired on screen (see Figure 8-8).

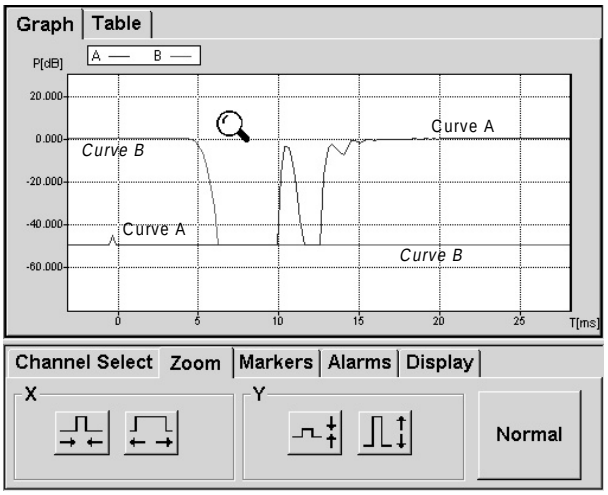

Figure 8-8. *Transition from Channel B to Channel A*

11. Using the zoom and markers, determine the switch time from the initial channel to the target channel (Figures 8-9 and 8-10). The position of the trigger corresponds to the “0” moment on the graph.

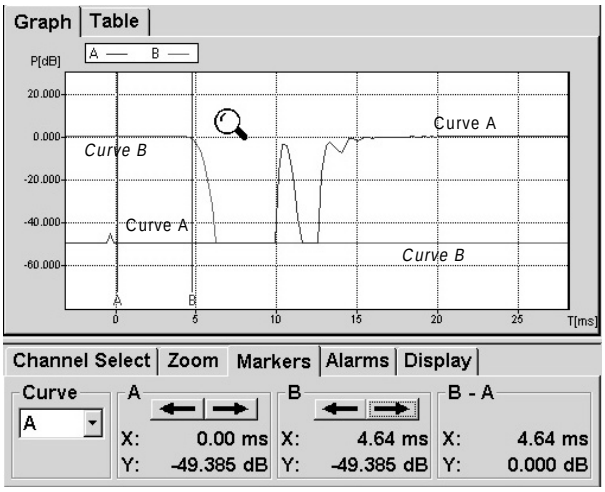

Figure 8-9. *Electronics Response Time*

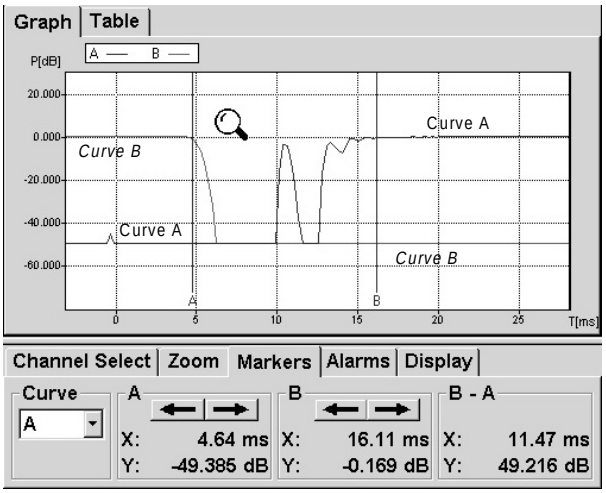

Figure 8-10. *Total Settling Time of the Optical Switch*

Figure 8-9 shows the electronics response time as 4.64 ms, while Figure 8-10 shows the settling time of the optical switch as 11.47 ms.

12. Repeat steps 7 to 11 for each transition to be characterized.

Note: *The* File Acquisition *function of the IQ-1600 can be used to make these measurements. The data can then be archived or retrieved using commercial spreadsheet software.*

9 Remote Control

Command Structure

The GPIB commands follow the guidelines determined by the Standard Commands for Programmable Instruments (SCPI) consortium. For example, the command syntax

FORM(0..26):READ[:DATA]<space><digit>

is used to change the measurement display resolution (number of digits after the decimal point) of a given module.

In this particular example,

- FORM identifies that the command is part of the SCPI FORMat subset of commands.
- (0..26) is a whole number between 0 and 26 that identifies the module.
- READ and DATA are keywords that define the function of the command.
- [ ] indicates that a keyword or parameter is optional.
- <space> is included to indicate that a space is required.
- <digit> is the command parameter.

Keywords must be separated by a colon. A typical command would be

FORM4:READ:DATA 1

This command instructs the module to display a power measurement with 1 digit after the decimal point.

Note: *It is recommended that you retrieve the response immediately after each query.*

General Commands

The IQ-1600 recognizes the main commands identified in IEEE 488.2.

Command	Function
*CLS	Clear status command
*ESE	Standard event status enable command
*ESE?	Standard event status enable query
*ESR?	Standard event status register query
*IDN?	Identification query
*LOK	Set Remote Lockout programming state
*OPC	Operation complete command
*OPC?	Operation complete query
*REM	Set Remote programming state
*RST	Reset command
*SRE	Service request enable command
*SRE?	Service request enable query
*STB?	Read status byte query
*TRG	Not supported
*TST?	Self-test query
*WAI	Not supported

Table 9-1. *General Commands Summary*

The commands are fully explained hereafter.

*CLS

Description This command sets the contents of the Standard Event Register (ESR), the Status Byte Register (STB), and the Error Queue (ERR) to zero. This command is commonly used to clear the status registers before enabling SRQ. Note that the output queue, Standard Event Status Enable Register (ESE), and Service Request Enable Register (SRE) are not affected.

Syntax *CLS

*ESE

Description This command is used to set bits in the Standard Event Status Enable Register (ESE) to a new value (initial value is 255). The contents of the ESE register are logically ANDed with the ESR register. A non zero result will set the Event Summary Bit (ESB) of the Status Byte Register (STB). This command is useful for selecting which events may generate an SRQ.

Syntax *ESE<space><value>

Parameter The <value> parameter must be between 0 and 255.

*ESE?

Description This query reads the contents of the Standard Event Status Enable Register (ESE).

Syntax *ESE?

Response A binary integer between 0 and 255.

*ESR?

Description This query reads the contents of the Standard Event Status Register (ESR).

Syntax *ESR?

Response A binary integer between 0 and 255.

*IDN?

Description This query reads the IQ system identification string.

Syntax *IDN?

Response “EXFO E.-O. Eng. IQ-200 OTS Vxx.xx”, where xx.xx is the current product version.

*LOK

Description This command is used to set the Remote Lockout programming state.

Syntax *LOK<space><data>

Parameters The <data> parameter can be “1” to set the Remote programming state to Remote Lockout or “0” to set the Remote programming state to Remote.

*OPC

Description This command will cause the SCPI Manager to generate the “Operation complete” message in the Standard Event Status Register (ESR) when all pending selected SCPI Manager’s operations have been completed.

Syntax *OPC

Example *OPC;*IDN?

*OPC?

Description This query puts an ASCII 1 in the output queue when the content of the input queue has been processed. This query is useful to prevent another command from being processed until the current command is complete.

Syntax *OPC?

Response “1”

*REM

Description This command is used to set the Remote programming state.

Syntax *REM<space><data>

Parameters The <data> parameter can be “1” to set the Remote programming state to Remote or “0” to set the Remote progamming state to Local.

*RST

Description This command empties the step response list. It is only seen when it is part of another multiple command. In the example below, by adding this command after *IDN?, you will not be able to access the answer. The *RST, in this instance, erases the identification string. In addition, this command performs the following operations:

1. Return to initial state before command was sent and not necessarily to previous settings.
2. Force the device to enter into an Operation Complete Command Idle State (OCIS).
3. Force the device to enter into an Operation Complete Query Active State (OQAS).
4. Initialize previous responses unless there has been a program message terminator preceded by an *RST.

Syntax *RST

Example *IDN?;*RST<NL>

*SRE

Description This command sets bits in the Service Request Enable Register (SRE; initial value is 255), and enables the corresponding bit in the Status Byte Register (STB). The command can be used to select which events can initiate a service request.

Syntax *SRE<space><value>

Parameter The <value> parameter must be between 0 and 255.

*SRE?

Description This query returns the contents of the Service Request Enable Register (SRE).

Syntax *SRE?

Response A binary integer between 0 and 255.

*STB?

Description This query returns the contents of the Status Byte Register (STB).

Syntax *STB?

Response A binary integer between 0 and 255.

*TST?

Description This query initiates an internal self-test and returns a binary value indicating the results of the test. If an error occurs, it is possible to return the error using the SYST:ERR? query.

Syntax *TST?

Response A binary value:
"0" -test is complete with no errors
"1" -test is complete with errors

Specific Commands

ABORt

Description This command stops any measurement in progress in Continuous mode, on all channels when using a multi-channel high-speed power meter.

Syntax ABOR(0..26)

Example ABOR3

FETCh[:SCALar]:POWer:DC?

Description This query returns the stored value (for the selected channel when using a multi-channel high-speed power meter).

Syntax FETC(0..26)[:SCAL]:POW:DC?

Response A power measurement in the "±999.9999E±99" exponential format in the currently selected unit. The number of digits after the decimal point depends on the selected resolution. To change the resolution of the displayed power value in dB or dBm, use the FORM:READ[:DATA] command. To know the current measurement unit, use the SENS:POW:UNIT? query.

Example FETC3:SCAL:POW:DC?

See also INIT:CONT, INIT:CONT?, INIT[:IMM], and READ[:SCAL]:POW:DC?

FORMat:READings[:DATA]

Description This command changes the resolution of the power value when dB or dBm is selected (for the selected channel when using a multi-channel high-speed power meter).

Syntax FORM(0..26):READ[:DATA]<space><digits>

Parameters The <digits> parameter can be:

"0" -zero digit after the decimal point
"1" -one digit after the decimal point
"2" -two digits after the decimal point
"3" -three digits after the decimal point
"4" -four digits after the decimal point
"5" -auto-resolution, determined by the measured power level

Example FORM3:READ:DATA 3

INITiate:AUTOstop

Description This command starts or stops an acquisition using the number of points set with the TRAC:POIN command, and the sampling rate set with the SENS:FREQ[:CONT] or the SENS:FREQ:NCON commands.

Syntax INIT(0..26):AUTO<space><boolean>[,<value>]

Parameters The <boolean> value refers to:
"0" -stop acquisition
"1" -start acquisition
The optional <value> parameter can be:
"CONT" or "0" -set Continuous acquisition rate
"NCON" or "1" -set Single acquisition rate.
The <value> parameter is considered only when starting an acquisition. If the <value> parameter is absent, the acquisition starts in Continuous mode by default.

Example INIT3:AUTO: 1,CONT

See also ABOR, INIT:AUTO:NCON, INIT:CONT, INIT:CONT?, INIT[:IMM], and TRAC:POIN

INITiate:AUTOstop?

Description This query returns a value indicating whether a programmed (or "Autostop") acquisition is in progress.

Syntax INIT(0..26):AUTO?

Response "0" -Autostop acquisition is off
"1" -Autostop acquisition is on

Example INIT3:AUTO?

See also ABOR, INIT:AUTO, INIT:CONT, INIT:CONT?, INIT[:IMM], and TRAC:POIN

INITiate:CONTinuous

Description This command starts or stops power measurements (for all channels when using a multi-channel high-speed power meter) in Continuous mode.

Syntax INIT(0..26):CONT<space><boolean>

Parameters The <boolean> value refers to:
"0" -stop measurements
"1" -start measurements

Example INIT3:CONT 1

See also FETC[:SCAL]:POW:DC?, INIT:CONT?, INIT[:IMM], and READ[:SCAL]:POW:DC?

INITiate:CONTinuous?

Description This query returns a value indicating whether power measurements are in progress (for all channels when using a multi-channel high-speed power meter) in Continuous mode.

Syntax INIT(0..26):CONT?

Response "0" -measurements stopped
"1" -measurements started

Example INIT3:CONT?

See also FETC[:SCAL]:POW:DC?, INIT[:IMM], and READ[:SCAL]:POW:DC?

INITiate:EXTRema

Description This command starts or stops Min/Max power measurements in Continuous acquisition mode (for all channels when using a multi-channel high-speed power meter).

Syntax INIT(0..26):EXTR<space><boolean>

Parameters The <boolean> value refers to:
"0" -stop Min/Max measurements
"1" -start Min/Max measurements

Example INIT3:EXTR 1

INITiate:EXTRema?

Description This query returns a value indicating whether Min/Max power measurements are in progress in Continuous acquisition mode (for all channels when using a multi-channel high-speed power meter).

Syntax INIT(0..26):EXTR?

Response "0" -Min/Max measurements are stopped
"1" -Min/Max measurements in progress

Example INIT3:EXTR?

INITiate[:IMMediate]

Description This command stores a power measurement value (for all channels when using a multi-channel high-speed power meter).

Syntax INIT(0..26)[:IMM]

Example INIT3:IMM

See also FETC[:SCAL]:POW:DC? and READ[:SCAL]:POW:DC?

INST:NSELect

Description This command selects a power meter channel (when using a multi-channel high-speed power meter). Until a new channel is selected, any subsequent commands will be directed to this channel. An error message appears if the command is sent to a single-channel power meter.

Syntax INST(0..26):NSEL<space><numeric_value>

Parameters The <numeric_value> parameter can be 1, 2, 3, or 4.

Example INST3:NSEL 4

INST:NSELect?

Description This query returns the currently selected power meter channel (when using a multi-channel high-speed power meter).

Syntax INST(0..26):NSEL?

Response A numeric value: 1, 2, 3, or 4.

Example INST3:NSEL?

MEASure[:SCALar]:POWer:MAXimum?

Description This query returns the maximum power measurement value recorded for the currently selected channel in Continuous acquisition mode.

Syntax MEAS(0..26)[:SCAL]:POW:MAX?

Response A power measurement in the "±999.9999E±99" exponential format in the currently selected unit. The number of digits after the decimal point depends on the selected resolution. To change the resolution of the displayed power value in dB or dBm, use the FORM:READ[:DATA] command. To know the current measurement unit, use the SENS:POW:UNIT? query.

Example MEAS3:SCAL:POW:MAX?

See also MEAS:SCAL:POW:MIN?

MEASure[:SCALar]:POWer:MINimum?

Description This query returns the minimum power measurement value recorded for the currently selected channel in Continuous acquisition mode.

Syntax MEAS(0..26)[:SCAL]:POW:MIN?

Response A power measurement in the "±999.9999E±99" exponential format in the currently selected unit. The number of digits after the decimal point depends on the selected resolution. To change the resolution of the displayed power value in dB or dBm, use the FORM:READ[:DATA] command. To know the current measurement unit, use the SENS:POW:UNIT? query.

Example MEAS3:SCAL:POW:MIN?

See also MEAS:SCAL:POW:MAX?

MMEMory:ACQuisition

Description This command starts or stops a file acquisition using the set Continuous or Single acquisition rate. Acquisition data will be recorded to the system hard disk in the \IQ\USERFILE\IQ1600 directory. The acquisition will start until an acquisition stop (MMEM:ACQ 0) command is sent, otherwise will last for the duration set using the MMEM:ACQ:DURA command.

Syntax MMEM(0..26):ACQ<space><boolean>[,<value>]

Parameters The <boolean> parameter can be:

"0" -stop file acquisition

"1" -start file acquisition

The optional <value> parameter can be:

"CONT" or "0" -set Continuous acquisition rate

"NCON" or "1" -set Single acquisition rate.

The <value> parameter is considered only when starting an acquisition. If the <value> parameter is absent, the acquisition starts in Continuous mode by default.

Example MMEM3:ACQ 1,CONT

See also MMEM:ACQ?, MMEM:ACQ:DURA, and MMEM:ACQ:DURA?

MMEMory:ACQuisition?

Description This query returns a value indicating whether a file acquisition is in progress.

Syntax MMEM(0..26):ACQ?

Response The response is in the format:
"0" -no file acquisition in progress
"1" -file acquisition in progress

Example MMEM3:ACQ?

See also MMEM:ACQ, MMEM:ACQ:DURA, and MMEM:ACQ:DURA?

MMEMory:ACQuisition:DURAtion

Description This command defines the duration of the file acquisition.

Syntax MMEM(0..26):ACQ:DURA<space><numeric_value><numeric_value><numeric_value>

Parameters The 1st <numeric_value> parameter represents the hours, from 0 to 9999.
The 2nd <numeric_value> parameter represents the minutes, from 0 to 59.
The 3rd <numeric_value> parameter represents the seconds, from 0 to 59.

Example MMEM3:ACQ:DURA 0,30,15

See also MMEM:ACQ, MMEM:ACQ?, and MMEM:ACQ:DURA?

Note If the set duration is greater than that permitted in Single acquisition mode, the duration of the next Single acquisition will be the maximum permitted for the current Single acquisition rate. Example: when using a 4096 Hz Single rate, if the set duration is 0000:10:00, the actual duration will be 0000:00:04.

MMEMory:ACQuisition:DURAtion?

Description This query returns a value indicating the duration of the file acquisition (and not the time remaining for the acquisition).

Syntax MMEM(0..26):ACQ:DURA?

Response A value indicating the duration of the file acquisition in the "HHHH:MM:SS" format.

Example MMEM3:ACQ:DURA?

See also MMEM:ACQ, MMEM:ACQ?, and MMEM:ACQ:DURA

READ[:SCALar]:POWer:DC?

Description This query performs an initiate and fetch (for the selected channel when using a multi-channel high-speed power meter). A measurement value is stored and returned.

Syntax READ(0..26)[:SCAL]:POW:DC?

Response A power measurement in the "±999.9999E±99" exponential format in the currently selected unit. The number of digits after the decimal point depends on the selected resolution.

Example READ3:SCAL:POW:DC?

See also FETC[:SCAL]:POW:DC?, INIT:AUTO, INIT:CONT, INIT:CONT?, and INIT[:IMM]

SENSitivity:AVERage:COUNt

Description This command sets the number of power measurements that will be used to compute data averaging (for the selected channel when using a multi-channel high-speed power meter).

Syntax SENS:AVER:COUN<space><digit>

Parameters The <digit> parameter is the number of power measurements to be used to compute data averaging in the “999” format.

Example SENS:AVER:COUN 12

See also SENS:AVER:COUN?, SENS:AVER:STAT, and SENS:AVER:STAT?

SENSitivity:AVERage:COUNt?

Description This query returns the number of power measurements used to compute data averaging (for the selected channel when using a multi-channel high-speed power meter).

Syntax SENS(0..26):AVER:COUN?

Response The number of power measurements used to compute data averaging in the “999” format.

Example SENS3:AVER:COUN?

See also SENS:AVER:COUN, SENS:AVER:STAT, and SENS:AVER:STAT?

SENSitivity:AVERage[:STATe]

Description This command activates or deactivates data averaging (for the selected channel when using a multi-channel high-speed power meter).

Syntax SENS(0..26):AVER[:STAT]<space><boolean>

Parameters The <boolean> parameter can be:
"0" -disable averaging
"1" -enable averaging

Example SENS3:AVER:STAT 1

SENSitivity:AVERage:STATe?

Description This query returns a value indicating whether data averaging is enabled or disabled (for the selected channel when using a multi-channel high-speed power meter).

Syntax SENS(0..26):AVER:STAT?

Response "0" -averaging is disabled
"1" -averaging is enabled

Example SENS3:AVER:STAT?

SENSitivity:CORRection:COLLect:ZERO

Description This command performs an offset nulling measurement (on the currently selected channel when using a multi-channel high-speed power meter). If light is detected, the “Light detected” error message is raised.

Syntax SENS(0..26):CORR:COLL:ZERO[ALL]

Parameters The optional <ALL> parameter will perform the null measurement on all channels when using a multi-channel high-speed power meter.

Example SENS3:CORR:COLL:ZERO

Note The “Null All” function is specific to the multi-channel power meter.

SENSitivity:CORRection:OFFSet[:MAGNitude]

Description This command sets a correction factor (for the selected channel when using a multi-channel high-speed power meter). The correction factor will be a positive or negative value when dB or dBm units are selected, or a positive value when W or W/W units are selected.

Syntax SENS(0..26):CORR:OFFS[:MAGN]<space><numeric_value><space><unit>

Parameters The <numeric_value> parameter is a correction factor with dB or W/W units.

-10.0 ≤ numeric_value ≤ 6.989 (dB)

0.1 ≤ numeric_value ≤ 5.0 (W/W)

The <unit> parameter can be DB or W/W

If an invalid <numeric_value> parameter is entered, the "Parameter out of range" message appears.

If an invalid <unit> parameter is entered, the "Data type error" message appears.

Example SENS3:CORR:OFFS:MAGN 22.105 DB

Note The correction factor when expressed in W/W indicates the ratio between the power received (in W) and the reference (in W) for the current wavelength and channel.

SENSitivity:FREQuency[:CONTinuous]

Description This command sets the continuous acquisition rate.

Syntax SENS(0..26):FREQ[:CONT]<space><numeric_value>[<space>HZ]

Parameters The <numeric_value> parameter is the continuous acquisition rate: 0.250 Hz, 0.500 Hz, 1 Hz, 2 Hz, 4 Hz, 8 Hz, 16 Hz, 32 Hz, 64 Hz, 128 Hz, and 256 Hz.

If an invalid parameter is entered, the “Invalid sampling rate” error message appears.

Example SENS3:FREQ:CONT 1

See also SENS:FREQ:CONT?, SENS:FREQ[:CONT]:CAT?, SENS:FREQ:NCON, SENS:FREQ:NCON?, and SENS:FREQ:NCON:CAT?

SENSitivity:FREQuency:CONTinuous?

Description This query returns the current continuous acquisition rate.

Syntax SENS(0..26):FREQ:CONT?

Response The current continuous acquisition rate in the “999.999” format.

Example SENS3:FREQ:CONT?

See also SENS:FREQ[:CONT], SENS:FREQ[:CONT]:CAT?, SENS:FREQ:NCON, SENS:FREQ:NCON?, and SENS:FREQ:NCON:CAT?

SENSitivity:FREQuency[:CONTinuous]:CATalog?

Description This query returns the list of available continuous acquisition rates.

Syntax SENS(0..26):FREQ[:CONT]:CAT?

Response The list of available continuous acquisition rates in the "999.999;999.999;..." format.

Example SENS3:FREQ:CONT:CAT?

See also SENS:FREQ[:CONT], SENS:FREQ:CONT?, SENS:FREQ:NCON, SENS:FREQ:NCON?, and SENS:FREQ:NCON:CAT?

SENSitivity:FREQuency:NCONtinuous

Description This command sets the single acquisition rate.

Syntax SENS(0..26):FREQ:NCON<space><numeric_value> [<space>HZ]

Parameters The <numeric_value> parameter is the single acquisition rate in the "9999" format: 512 Hz, 1024 Hz, 2048 Hz, and 4096 Hz. If an invalid parameter is entered, the "Illegal parameter value" error message appears.

Example SENS3:FREQ:NCON 512

See also SENS:FREQ[:CONT], SENS:FREQ:CONT?, SENS:FREQ[:CONT]:CAT?, SENS:FREQ:NCON?, and SENS:FREQ:NCON:CAT?

SENSitivity:FREQuency:NCONtinuous?

Description This query returns the single acquisition rate.

Syntax SENS(0..26):FREQ:NCON?

Response The current single acquisition rate in the “9999.9” format.

Example SENS3:FREQ:NCON?

See also SENS:FREQ[:CONT], SENS:FREQ:CONT?, SENS:FREQ[:CONT]:CAT?, SENS:FREQ:NCON, and SENS:FREQ:NCON:CAT?

SENSitivity:FREQuency:NCONtinuous:CATalog?

Description This query returns the list of available single acquisition rates.

Syntax SENS(0..26):FREQ:NCON:CAT?

Response The list of available single acquisition rates in the “9999.9;9999.9;...” format.

Example SENS3:FREQ:NCON:CAT?

See also SENS:FREQ[:CONT], SENS:FREQ:CONT?, SENS:FREQ[:CONT]:CAT?, SENS:FREQ:NCON, and SENS:FREQ:NCON?

SENSitivity:POWer:RANGe?

Description This query returns the currently selected power measurement range (for the selected channel when using a multi-channel high-speed power meter), expressed in dBm or W depending on the current unit.

Syntax SENS(0..26):POW:RANG?

Response The currently selected range (in dBm or W) in the "±99.99 to ±99.99" (dBm) or "+999.99E±999 to +999.99E±999" (W) format:

"AUTO" -automatic range (Autorange)

"HR1..4" -high range

"LR1..6" -low range

Example SENS3:POW:RANG?

See also SENS:POW:RANG:AUTO, SENS:POW:RANG:AUTO?, SENS:POW:RANG:HIGH, SENS:POW:RANG:LIST?, and SENS:POW:RANG:LOW

SENSitivity:POWer:RANGe:AUTOmatic

Description This command sets the power measurement range to automatic (Autorange), for the currently selected channel when using a multi-channel high-speed power meter.

Syntax SENS(0..26):POW:RANG:AUTO<space><boolean>

Parameters The <boolean> parameter can be:
"0" -disable Autorange
"1" -enable Autorange

Example SENS3:POW:RANG:AUTO 1

See also SENS:POW:RANG?, SENS:POW:RANG:AUTO?, SENS:POW:RANG:HIGH, SENS:POW:RANG:LIST?, and SENS:POW:RANG:LOW

Note The Autorange function can be performed in Continuous acquisition mode only. When Autorange is deactivated, LR1 is activated by default.

SENSitivity:POWer:RANGe:AUTOmatic?

Description This query returns a value indicating whether automatic power measurement range (Autorange) is enabled or disabled, for the currently selected channel when using a multi-channel high-speed power meter.

Syntax SENS(0..26):POW:RANG:AUTO?

Response "0" -Autorange is disabled
"1" -Autorange is enabled

Example SENS:POW:RANG:AUTO?

See also SENS:POW:RANG?, SENS:POW:RANG:AUTO, SENS:POW:RANG:HIGH, SENS:POW:RANG:LIST?, and SENS:POW:RANG:LOW

SENSitivity:POWer:RANGe:HIGH

Description This command sets the power measurement range to manual high (for the currently selected channel when using a multi-channel high-speed power meter).

Syntax SENS(0..26):POW:RANG:HIGH<space><numeric_value>

Parameters The <numeric_value> parameter can be 1, 2, 3, or 4 corresponding to manual HR1 to HR4.

Example SENS3:POW:RANG:HIGH 2

See also SENS:POW:RANG?, SENS:POW:RANG:AUTO, SENS:POW:RANG:AUTO?, SENS:POW:RANG:LIST?, and SENS:POW:RANG:LOW

SENSitivity:POWer:RANGe:LIST?

Description This query returns the list of all available measurement ranges, expressed in dBm or W depending on the current unit.

Syntax SENS:POW:RANG:LIST?

Response The list of available measuring ranges (in dBm or W) in the "±99.99 to ±99.99" (dBm) or "±999.9999E±99 to ±999.9999E±99" (W) format:

"AUTO" -automatic range (Autorange)

"HR1..4" -high range

"LR1..6" -low range

Example SENS3:POW:RANG:LIST?

See also SENS:POW:RANG?, SENS:POW:RANG:AUTO, SENS:POW:RANG:AUTO?, SENS:POW:RANG:HIGH, and SENS:POW:RANG:LOW

SENSitivity:POWer:RANGe:LOW

Description This command sets the power measurement range to manual low (for the currently selected channel when using a multi-channel high-speed power meter).

Syntax SENS(0..26):POW:RANG:LOW<space><numeric_value>

Parameters The <numeric_value> parameter can be 1, 2, 3, 4, 5, or 6 corresponding to manual LR1 to LR6.

Example SENS3:POW:RANG:LOW 4

See also SENS:POW:RANG?, SENS:POW:RANG:AUTO, SENS:POW:RANG:AUTO?, SENS:POW:RANG:HIGH, and SENS:POW:RANG:LIST?

SENSitivity:POWer:REFerence

Description This command sets a user-defined reference value (in dBm or W), for the selected channel when using a multi-channel high-speed power meter.

Syntax SENS(0..26):POW:REF<space><numeric_value><unit>

Parameters The <numeric_value> parameter is the user-defined reference value, in the "999.9999" (dBm) or "+9.9999E-999" (W) format.

The <unit> parameter represents the unit:

"DBM" -set dBm
"W" -set W
"MW" -set mW
"UW" -set µW
"NW" -set nW
"PW" -set pW

Example SENS3:POW:REF 10NW

SENSitivity:POWer:REFerence?

Description This query returns the reference power for the current wavelength (for the currently selected channel when using a multi-channel high-speed power meter).

Syntax SENS(0..26):POW:REF?

Response Current reference value in dBm or W (depending on the current unit), which can be any value within the power range of the power meter in the "±999.9999" (dBm) or "+9.9999E-999" (W) format.

Example SENS3:POW:REF?
49.428 dBm

SENSitivity:POWer:REFerence:DISPlay

Description This command performs a new reference measurement for the current wavelength and changes the display to read relative power (dB or W/W), for the selected channel when using a multi-channel high-speed power meter.

Syntax SENS(0..26):POW:REF:DISP

Example SENS3:POW:REF:DISP

SENSitivity:POWer:REFerence:STATe

Description This command selects whether absolute (dBm or W) or relative (dB or W/W) power measurements are performed (for the selected channel when using a multi-channel high-speed power meter).

Syntax SENS(0..26):POW:REF:STAT<space><boolean>

Parameters The <boolean> value represents either dB and W, or dBm and W/W:
"0" -select absolute (dBm or W)
"1" -select relative (dB or W/W)

Example SENS3:POW:REF:STAT 0

SENSitivity:POWer:REFerence:STATe?

Description This query returns a value indicating whether the high-speed power meter is displaying absolute (dBm or W) or relative (dB or W/W) power values (for the selected channel when using a multi-channel high-speed power meter).

Syntax SENS(0..26):POW:REF:STAT?

Response "0" -absolute mode (dBm or W)
"1" -relative mode (dB or W/W)

Example SENS3:POW:REF:STAT?

SENSitivity:POWer:UNIT

Description This command changes the absolute measurement display unit: dBm or W (for the selected channel when using a multi-channel high-speed power meter).

Syntax SENS(0..26):POW:UNIT<space><value>

Parameters The <value> parameter can be:
"DBM" or "0" -set power display to dBm
"W" or "1" -set power display to W (pW, nW, μW, mW...)

Example SENS3:POW:UNIT DBM

See also SENS:POW:UNIT? and UNIT:POW

SENSitivity:POWer:UNIT?

Description This query returns the current absolute power measurement display unit (for the selected channel when using a multi-channel high-speed power meter).

Syntax SENS(0..26):POW:UNIT?

Response "0" -current unit is dBm
"1" -current unit is W (pW, nW, µW, mW...)

Example SENS3:POW:UNIT?

See also SENS:POW:UNIT and UNIT:POW

SENSitivity:POWer:WAVelength

Description This command selects a new operating wavelength (for the selected channel when using a multi-channel high-speed power meter).

Syntax SENS(0..26):POW:WAV<space><numeric_value>
[<space>NM]

Parameters The <numeric_value> parameter is an operating wavelength using nm. Any wavelength within the spectral range of the power meter optical detector at 0.01 nm resolution may be selected. See the power meter instruction manual for the exact spectral range of each detector type. An invalid parameter will raise an “Illegal parameter value” error message.

Example SENS3:POW:WAV 1310.12

SENSitivity:POWer:WAVelength?

Description This query returns the currently selected wavelength (for the selected channel when using a multi-channel high-speed power meter).

Syntax SENS(0..26):POW:WAV?

Response The current wavelength in nanometers (nm) in the “9999.99 nm” format.

Example SENS3:POW:WAV?
1310.12 nm

TRACe:DATA?

Description This query returns the power measurements previously acquired with the INIT:AUTO command (for the currently selected channel when using a multi-channel high-speed power meter).

Syntax TRAC(0..26):DATA?<space><segment_nb>

Response Power measurements in the "±999.9999E±99; ±999.9999E±99;..." format.

The <segment_nb> parameter is the segment number. Each segment contains a maximum of 4096 values. The first segment bears number 0.

Example TRAC3:DATA? 4

See also TRAC:POIN

TRACe:MAXimum?

Description This query returns the maximum power measurement value previously acquired with the INIT:AUTO 1,NCON or MMEM:ACQ: 1,NCON command (in Single acquisition mode) and for the currently selected channel when using a multi-channel high-speed power meter.

Syntax TRAC(0..26):MAX?

Response A power measurement in the "±999.9999E±99" exponential format in the currently selected unit. The number of digits after the decimal point depends on the selected resolution. To change the resolution of the displayed power value in dB or dBm, use the FORM:READ[:DATA] command. To know the current measurement unit, use the SENS:POW:UNIT? query.

Example TRAC3:MAX?

See also TRACE:MIN?

TRACe:MINimum?

Description This query returns the minimum power measurement value previously acquired with the INIT:AUTO 1,NCON or MMEM:ACQ: 1,NCON command (in Single acquisition mode) and for the currently selected channel when using a multi-channel high-speed power meter.

Syntax TRAC(0..26):MIN?

Response A power measurement in the "±999.9999E±99" exponential format in the currently selected unit. The number of digits after the decimal point depends on the selected resolution. To change the resolution of the displayed power value in dB or dBm, use the FORM:READ[:DATA] command. To know the current measurement unit, use the SENS:POW:UNIT? query.

Example TRAC3:MIN?

See also TRAC:MAX?

TRACe:POINts

Description This command sets the number of points that will be used in the next programmed acquisition via the INIT:AUTO command. The maximum possible value is 16 383.

Syntax TRAC(0..26):POIN<space><numeric_value>[,ALL]

Parameters The <numeric_value> parameter is the number of points to be acquired using a programmed acquisition in the "99999" format.

The optional [ALL] parameter indicates if the number of points applies to the currently selected channel or to all channels (when using a multi-channel high-speed power meter).

Example TRAC3:POIN 1200 (1200 points for active channel)

TRAC3:POIN 1200,ALL (1200 points for all channels)

See also INIT:AUTO, TRAC:DATA? and TRAC:POIN?

TRACe:POINts?

Description This query returns the number of points acquired so far (for the currently selected channel when using a multi-channel high-speed power meter).

Syntax TRAC(0..26):POIN?

Response The number of points in the “99999” format.

Example TRAC3:POIN?

See also TRAC:DATA?

Note This query can be used before, during, and after the programmed acquisition (started using the INIT:AUTO command). Tip: this query is especially useful for determining the end of a programmed acquisition.

TRIGger:POSition

Description This command sets the position of the trigger. The percentage (in 5 % steps from 5 % to 50 %) applies to file acquisitions in Single mode (MMEM:ACQ 1,NCON) and to programmed acquisitions (INIT:AUTO 1,NCON). For a file acquisition, it is the percentage of the total duration (e.g., 50 % of 10 seconds means 5 sec. before the trigger and 5 sec. after the trigger). For a programmed acquisition, it is the percentage of points (e.g., 25 % of 1000 points means 250 points before the trigger and 750 points after the trigger).

Syntax TRIG(0..26):POS<space><value>

Parameters The <value> parameter can be:
"TRIG_POS0" or "0" -0 %
"TRIG_POS5" or "5" -5 %
"TRIG_POS10" or "10" -10 %
...
"TRIG_POS45" or "45" -45 %
"TRIG_POS50" or "50" -50 %

Example TRIG3:POS 20 or TRIG3:POS TRIG_POS20

See also TRIG:CAT?

TRIGger:POSition?

Description This query returns a value indicating the position of the trigger, i.e., the percentage of points that will be acquired in Single acquisition mode before the trigger is met.

Syntax TRIG(0..26):POS?

Response A value in the "99" format representing the percentage of points before the trigger.

Example TRIG3:POS?

TRIGger:POSition:CATalog?

Description This query returns a list of values indicating the available values of the trigger position, i.e., the percentage of points that will be acquired in Single acquisition mode before the trigger is met.

Syntax TRIG(0..26):POS:CAT?

Response A range of values in the “99;99;99...” format representing the available trigger positions.

Example TRIG3:POS:CAT?

See also TRIG:POS

TRIGger:SEQuence:LEVel

Description This command sets the power level of the trigger condition to be met to start an acquisition in dBm or W, depending on the currently selected unit. The trigger level must be set in absolute power measurement mode and must be within the range of the active channel.

Syntax TRIG(0..26):SEQ:LEV<numeric_value><unit>

Parameters The <numeric_value> is the trigger power level in the “-90.000” to “+90.000” (dBm) or in the “+001.0000” (pW) to “+999.9999” (kW) format.

The <unit> parameter represents the unit:

“DBM” -dBm

“W” -W units (pW, nW, μW, mW...)

Example TRIG3:SEQ:LEV 16.804 DBM

See also TRIG:SEQ:LEV?, TRIG:SEQ:SLOP, TRIG:SEQ:SLOP?, TRIG:SEQ:SOUR, TRIG:SEQ:SOUR?, TRIG:SEQ:STAT, and TRIG:SEQ:STAT?

TRIGger:SEQuence:LEVel?

Description This query returns the power level of the trigger condition to be met to start an acquisition, in dBm or W depending on the currently selected unit.

Syntax TRIG(0..26):SEQ:LEV?

Response The trigger power level in the "-90.000" to "+90.000" (dBm) or in the "+001.0000" (pW) to "+999.9999" (kW) format depending on the currently selected unit.

Example TRIG3:SEQ:LEV?

See also TRIG:SEQ:LEV, TRIG:SEQ:SLOP, TRIG:SEQ:SLOP?, TRIG:SEQ:SOUR, TRIG:SEQ:SOUR?, TRIG:SEQ:STAT, and TRIG:SEQ:STAT?

TRIGger:SEQuence:SLOPe

Description This command sets the edge status of the trigger condition, i.e., defines whether acquisitions will be triggered by positive or negative transitions.

Syntax TRIG(0..26):SEQ:SLOP<space><value>

Parameters The <value> parameter defines the trigger condition status:
"NEG" or "0" -falling edge trigger
"POS" or "1" -rising edge trigger

Example TRIG3:SEQ:SLOP POS

See also TRIG:SEQ:LEV, TRIG:SEQ:LEV?, TRIG:SEQ:SLOP, TRIG:SEQ:SLOP?, TRIG:SEQ:SOUR, TRIG:SEQ:SOUR?, TRIG:SEQ:STAT, and TRIG:SEQ:STAT?

TRIGger:SEQuence:SLOPe?

Description This query returns the rising or falling edge status of the trigger condition, i.e., whether positive or negative transitions will trigger the acquisition.

Syntax TRIG(0..26):SEQ:SLOP?

Response
POSITIVE -rising edge trigger
NEGATIVE -falling edge trigger

Example TRIG3:SEQ:SLOP?

See also TRIG:SEQ:LEV, TRIG:SEQ:LEV?, TRIG:SEQ:SLOP, TRIG:SEQ:SOUR, TRIG:SEQ:SOUR?, TRIG:SEQ:STAT, and TRIG:SEQ:STAT?

TRIGger:SEQuence:SOURce

Description This command sets the source of the trigger condition.

Syntax TRIG(0..26):SEQ:SOUR<space><value>

Parameters The <value> parameter can be:
"EXT" or "0" -external trigger
"INT1" or "1" -channel 1
"INT2" or "2" -channel 2 (IQ-1620 or IQ-1640)
"INT3" or "3" -channel 3 (IQ-1640)
"INT4" or "4"-channel 4 (IQ-1640)

Example TRIG3:SEQ:SOUR EXT

See also TRIG:SEQ:LEV, TRIG:SEQ:LEV?, TRIG:SEQ:SLOP, TRIG:SEQ:SLOP?, TRIG:SEQ:SOUR, TRIG:SEQ:SOUR?, TRIG:SEQ:STAT, and TRIG:SEQ:STAT?

TRIGger:SEQuence:SOURce?

Description This query returns the source of the trigger condition.

Syntax TRIG(0..26):SEQ:SOUR?

Response
"EXTERNAL" -external trigger
"INTERNAL1" -channel 1
"INTERNAL2" -channel 2 (IQ-1620 or IQ-1640)
"INTERNAL3" -channel 3 (IQ-1640)
"INTERNAL4" -channel 4 (IQ-1640)

Example TRIG3:SEQ:SOUR?

See also TRIG:SEQ:LEV, TRIG:SEQ:LEV?, TRIG:SEQ:SLOP, TRIG:SEQ:SLOP?, TRIG:SEQ:SOUR, TRIG:SEQ:STAT, and TRIG:SEQ:STAT?

TRIGger:SEQuence:STATe

Description This command sets the state of the trigger condition.

Syntax TRIG(0..26):SEQ:STAT<space><boolean>

Parameters The <boolean> parameter represents the status of the trigger condition:
"0" -deactivate trigger condition
"1" -activate trigger condition

Example TRIG3:SEQ:STAT 0

See also TRIG:SEQ:LEV, TRIG:SEQ:LEV?, TRIG:SEQ:SLOP, TRIG:SEQ:SLOP?, TRIG:SEQ:SOUR, TRIG:SEQ:SOUR?, and TRIG:SEQ:STAT?

TRIGger:SEQuence:STATe?

Description This query returns the status of the trigger condition.

Syntax TRIG(0..26):SEQ:STAT?

Response "0" -trigger inactive
"1" -trigger active

Example TRIG3:SEQ:STAT?

See also TRIG:SEQ:LEV, TRIG:SEQ:LEV?, TRIG:SEQ:SLOP, TRIG:SEQ:SLOP?, TRIG:SEQ:SOUR, TRIG:SEQ:SOUR?, and TRIG:SEQ:STAT

UNIT:POWer

Description This command changes the measurement unit (for the selected channel when using a multi-channel high-speed power meter).

Syntax UNIT(0..26):POW<space><value>

Parameters The <value> parameter can be:
"DB" or "0" -set measurement unit to dB
"DBM" or "1" -set measurement unit to dBm
"W" or "2" -set measurement unit to W (pW, nW, μW, mW...)
"W/W" or "3" -set measurement unit to W/W (pW/W, ...)

Example UNIT3:POW DBM

See also SENS:POW:UNIT and SENS:POW:UNIT?

Quick Reference Command Tree

Command					Parameter/ Response	Description
ABOR					—	Stop measurements
FETC	[SCAL]	POW	DC?		(±999.9999E±99)	Get stored value
FORM	READ	[DATA]		[a]	<0|1|2|3|4|5>	Set display resolution
INIT	AUTO			[a]	<0|1>[,<CONT|NCON|0|1>	Start/stop programmed acquisition
	AUTO?				(0|1)	Programmed acquisition in progress?
	CONT				<0|1>	Start/stop measurements
	CONT?				(0|1)	Measurements in progress?
	EXTR			[a]	<0|1>	Start/stop Min/Max measurements in Continuous mode
	EXTR?				(0|1)	Min/Max measurements in progress in Continuous mode?
	[IMM]				—	Store single measurement

Table 9-2. *IQ-1600 Quick Reference Command Tree (Part 1 of 5)*

Command					Parameter/ Response	Description
INST	NSEL			[a]	<channel#>	Set active channel
	NSEL?				(channel#)	Get active channel
MEAS	[SCAL]	POW	MAX?		(±999.9999E±99)	Get Max. in Continuous mode
			MIN?		(±999.9999E±99)	Get Min. in Continuous mode
MMEM	ACQ				<0|1>[,CONT|NCON|0|1]	Start/stop file acquisition
	ACQ?				(0|1)	File acquisition in progress?
	ACQ	DURA			<9999>,<99>,<99>	Set duration of file acquisition
		DURA?			(9999),(99),(99)	Get duration of file acquisition
READ	[SCAL]	POW	DC?		(±999.9999E±99)	Store and get value
SENS	AVER	COUN		[a]	<999>	Set number for data averaging
		COUN?			(999)	Get number for data averaging

Table 9-2. *IQ-1600 Quick Reference Command Tree (Part 2 of 5)*

Command					Parameter/ Response	Description
SENS	AVER	[STAT]		a	<0|1>	Activate/deactivate data averaging
		STAT?			(0|1)	Data averaging active?
	CORR	COLL	ZERO	a	[<ALL>]	Perform null measurement
		OFFS	[MAGN]	a	<-10.0 to +6.989 dB>] <0.1 to 5.0 W/W>]	Set correction factor
	FREQ	[CONT]		a	<value> [HZ]	Set continuous acquisition rate
		CONT?			(999.999)	Get continuous acquisition rate
		[CONT]	CAT?		(999.999;999.999;...)	List continuous acquisition rates
		NCON		a	<value> [HZ]	Set single acquisition rate
		NCON?			(9999.9)	Get single acquisition rate
		NCON	CAT?		(9999.9;9999.9;...)	List single acquisition rates
	POW	RANG?			(±xx.xx to ±xx.xx dBm) (+999.99E±999 to +999.99E±999 W)	Get range
		RANG	AUTO	a	<0|1>	Activate/deactivate Autorange

Table 9-2. *IQ-1600 Quick Reference Command Tree (Part 3 of 5)*

Command					Parameter/ Response	Description
SENS	POW	RANG	AUTO?		(0|1)	Autorange active?
			HIGH	a	<1|2|3|4>	Set manual high range
			LIST?		(±xx.xx to ±xx.xxdBm) (+999.99E±999 to +999.99E±999 W)	List ranges
			LOW	a	<1|2|3|4|5|6>	Set manual low range
		REF		a	<999.9999 dBm> <+9.9999E-999 W>	Set user reference
		REF?			(999.9999 dBm) (+9.9999E-999 W)	Get reference
		REF	DISP	a	—	Set new reference
			STAT	a	<0|1>	Set absolute or relative
			STAT?		(0|1)	Get absolute or relative
		UNIT		a	<DBM|W|0|1>	Set power unit
		UNIT?			(0|1)	Get power unit
		WAV		a	<value> [NM]	Set wavelength
		WAV?			(9999.99) NM	Get wavelength
TRAC	DATA?				(±999.9999E±99; ±999.9999E±99;...)	Get programmed acquisition measurements
	MAX?			a	(±999.9999E±99)	Get Max. in Single mode
	MIN?			a	(±999.9999E±99)	Get Min. in Single mode

Table 9-2. *IQ-1600 Quick Reference Command Tree (Part 4 of 5)*

Command				Parameter/ Response	Description
TRAC	POIN			<99999>[,ALL]	Set number of points
	POIN?			(99999)	Get number of points
TRIG	POS			<99|TRIG_POSx>	Set trigger position
	POS?			(99)	Get trigger position
	POS	CAT?		(99;99;99;...)	Get list of trigger positions
	SEQ	LEV	a	<+999.9999E+99> [DBM|W]	Set trigger level
		LEV?		(+999.9999E+99)	Get trigger level
		SLOP	a	<POS|NEG>	Set trigger edge
		SLOP?		(POSITIVE|NEGATIVE)	Get trigger edge
		SOUR	a	<EXT|INT1|2|3|4>	Set trigger source
		SOUR?		(EXTERNAL| INTERNAL1|2|3|4)	Get trigger source
		STAT		<0|1>	Activate/deactivate trigger
		STAT?		(0|1)	Trigger active?
UNIT	POW			<0|1|2|3|DB|DBM| W|W/W>	Set display unit

Table 9-2. *IQ-1600 Quick Reference Command Tree (Part 5 of 5)*

a. These commands are not executed if a data acquisition is in progress. The "Acquisition already running" message will be returned.

Error Messages

System and device specific errors are managed by the IQ-1600. The generic format for error messages is illustrated in Figure 9-1.

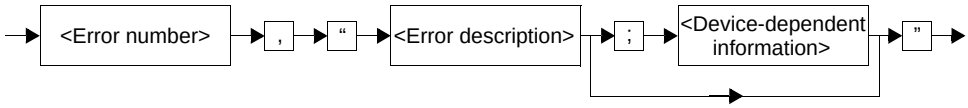

Figure 9-1. *Error Message Format*

As shown in the figure above, the message contains three parts: the error number, the error description, and device-dependent information. All error messages are stacked in a FIFO buffer. When there is at least one message in the buffer, bit 2 of the Status Byte Register is set to 1. Use the SYST:ERR? query to read the most recent message. The error message buffer is initialized when starting up the SCPI Manager, when executing the *CLS command, or when reading the last message stored in the buffer.

- Error messages ending with a negative number are SCPI-based errors.
- Error messages ending with a positive number are specific to the IQ-1600.

SCPI Management Errors (System Errors)

Error Number	Description	Probable Cause
-100	“Command error.”	The SCPI Manager does not recognize the command, probably due to invalid module address.
-101	“Undefined header.”	The SCPI Manager does not recognize the command, probably due to incorrect grammar.
-102	“Missing parameter.”	A required data parameter was not detected.
-103	“Parameter not allowed.”	Too many parameters were detected for the specified command.
-104	“Data type error.”	A data parameter is not the expected data type.
-200	“Execution error.”	An error occurred while executing the command.
-300	“Device dependent error.”	The device (module application) did not respond to the command within the given time-out value.
-400	“Query error.”	An attempt to read an empty buffer or buffer data has been lost.
-500	“System error.”	The system is out of memory.

Table 9-3. *SCPI Management Error Messages*

IQ-1600 Error Messages

Error Number	Description	Probable Cause
1602	“Invalid channel.”	The specified channel number is not valid.
1603	“Light on detector.”	A null command has been attempted with light reaching the detector.
1604	“Invalid parameter.”	The high-speed power meter has received a data parameter that it was not expecting.
1605	“Parameter out of range.”	The high-speed power meter has received a data parameter outside the valid range.
1606	“Acquisition already running.”	A command was sent while an acquisition was in progress.
1607	“Acquisition not running.”	A command that needs an acquisition to be accepted was sent with no acquisition in progress.
1612	“Invalid unit.”	The specified unit is not valid.
1613	“Invalid value.”	The specified value is not valid.
1614	“Invalid module.”	The selected IQ-1600 module is not available or is incompatible.
1615	“Invalid sampling rate.”	The selected sampling rate is not compatible with the current acquisition mode (continuous or single).
1616	“Module nulling timeout.”	A nulling process could not be performed.

Table 9-4. *IQ-1600 Error Messages (Part 1 of 2)*

Error Number	Description	Probable Cause
1617	“Automatic range cannot be used for single acquisition.”	A manual range must be selected for a single acquisition.
1618	“Command not processed: internal error.”	An internal error caused the command to fail.
1619	“Invalid scale.”	The specified type of scale (1, 2, 3, ...) is not valid.
1620	“Invalid range.”	The specified type of range (Auto, Manual High, or Manual Low) is not valid.
1621	“Unable to open file.”	Available disk space is low or unable to access acquisition file.
1622	“Settings conflict.”	There is a conflict between the different set acquisition parameters.

Table 9-4. *IQ-1600 Error Messages (Part 2 of 2)*

10 Troubleshooting

Solving Problems

The following table will help you track and correct some common problems. If the problem persists after performing the recommended action, please contact EXFO's Customer Service Group.

Problem	Probable Cause	Recommended Action
LED push button does not illuminate.	Power is not on.	Check AC power cord and turn ON the IQ-203 and IQ-206.
		Refer to the *IQ-200 Optical Test System* Instruction Manual to verify fuse.
	Module is not properly inserted.	Turn off the IQ-203 and IQ-206, then remove and reinsert the module.
	Computer locked up.	Reboot the IQ-203.
	LED is burnt.	Call EXFO.
Pushing LED push button does not open the module's main window.	Computer locked up.	Reboot the IQ-203.
IQ High-Speed Power Meter does not respond to new commands.	IQ Optical Test System still processing old commands. «Processing...» is displayed in the status bar.	New commands will be executed after completion of current processing.
– – – – – – – displayed as power value.	Power level is below the minimum detectable power.	Select an appropriate manual measurement range.

Table 10-1. *Locating Faults (Part 1 of 2)*

Problem	Probable Cause	Recommended Action
+++++++ displayed as power value.	Power level is above the maximum detectable power (saturation).	Select an appropriate manual measurement range if Autorange is selected.
		Turn the source off.
!!!!!!! displayed as power value.	Unstable or modulated input signal.	Select an appropriate manual measurement range.
Questionable readings displayed.	Dirty detector or optical connectors.	Clean the detector and all optical connections.
	Improper wavelength selected.	Switch to the correct wavelength on all instruments being used.
	Incorrect offset nulling.	Perform an offset nulling with protective cap installed.
	Unstable optical source.	Wait for source to stabilize.
	Wrong correction factor.	Reset the correction factor to 0.000 dB or 1.000 W/W.

Table 10-1. *Locating Faults (Part 2 of 2)*

Contacting the Customer Service Group

If you encounter any difficulty while operating this product, please call EXFO at one of the offices listed below. Our Customer Service Group is available in North America from 7:30 a.m. to 8:00 p.m. (Eastern Standard Time), Monday to Friday.

EXFO Electro-Optical Engineering (Corporate Headquarters)
465 Godin Avenue
Vanier QC G1M 3G7
Canada

1 800 663-3936 (USA and Canada)
Tel.: (418) 683-0211
Fax: (418) 683-2170
support@exfo.com
www.exfo.com

EXFO Europe
Centre d'Affaires Les Metz
100, rue Albert Calmette
78353 Jouy-en-Josas, France

Tel.: 33-1 34 63 00 20
Fax: 33-1 34 65 90 93

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11 Maintenance

Transportation and Storage

Maintain a temperature range within specifications when transporting or storing the unit. Transportation damage can occur from improper handling. The following steps are recommended to minimize the possibility of damage:

- Pack the unit in the original packing material when shipping.
- Store unit at room temperature in a clean and dry area.
- Avoid high humidity or large temperature fluctuations.
- Keep the unit out of direct sunlight.
- Avoid unnecessary shock and vibration.

WARNING

Do not install or terminate fibers while a laser source is active. Never look directly into a live fiber and ensure that your eyes are protected at all times.

CAUTION

Use of controls, adjustments, and procedures for operation and maintenance other than those specified herein may result in hazardous radiation exposure.

CAUTION

Use of optical instruments with this product will increase eye hazard.

General Maintenance

There are no user-serviceable components in the IQ High-Speed Power Meter modules, notwithstanding the procedure described in this section. The modules have been designed to require minimum maintenance and to provide reliable operation for many years to come.

IMPORTANT

When the module is not being used, the protective cap(s) should be fitted over the detector port(s).

Cleaning the Fiber Ends

The test jumper fiber ends must be kept clean at all times to ensure minimum loss and to reduce reflection.

1. Gently wipe the fiber ends with a lint-free swab dipped in isopropyl alcohol (98% pure or more).
2. Dry using clean compressed air.

Cleaning the Module's Front Panel

Gently wipe the module front panel with a soft cloth soaked with isopropyl alcohol. In no case should any corrosive agent be used to clean the front panel.

Cleaning the Detector Ports

The optical ports should also be cleaned regularly to ensure optimum performance.

1. Remove the protector cap.
2. Gently wipe the window of the detector with a lint-free swab dipped in isopropyl alcohol.
3. Dry using clean compressed air or with a dry lint-free swab.

Cleaning the Analog Output and External Trigger Ports

To ensure better performance and higher accuracy, gently wipe the inside of the analog output and external trigger ports with a lint-free swab dipped in isopropyl alcohol, then dry using clean compressed air or with a dry lint-free swab.

Recalibration

To ensure that the power meters remain within the published specifications and to maintain NIST traceability, EXFO recommends that an annual calibration be performed. Please contact EXFO for further information regarding calibration of the IQ-1600 High-Speed Power Meter.

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12 Technical Specifications

Optical Specifications[a]	
Model	**IQ-1613, IQ-1623, IQ-1643**
Detector type	InGaAs
Detector size (mm)	1
Wavelength range (nm)	800 to 1700
Power range[b] (dBm)	+9 to -85
Uncertainty[c] (0 to -55 dBm) (%)	±5
Linearity[d] (0 to -55 dBm) (dB)	±0.015
Power resolution (+9 to -40 dBm) (dB)	0.001
Wavelength resolution (nm)	0.01
Fiber type (µm)	5/125 to 62.5/125
Stabilization time (ms)	
Auto-ranging mode (+9 to -85 dBm)	<15
Fixed ranging mode (ranges 1 to 4)	<1

Table 12-1. *Optical Specifications*

a. All power specifications are measured at 1310 nm (unless otherwise specified) with a warm-up time of 20 minutes, followed by an offset nulling.
b. From 18° to 32°C (64° to 90°F).
c. Measured at 23° ±1°C (73° ±1°F) with FOA-222 between 1000 nm and 1650 nm. The uncertainty on absolute measurement may reach 0.22 dB. Add 1% to uncertainty below 1000 nm and 3% over 1650 nm.
d. Averaged measurement at constant temperature in 0° to 40°C (32° to 104°F) range.

Electrical Specifications		
Analog output	Bandwidth[a] (Hz)	Ranges 1 to 6: 700 k; 700 k; 30 k; 30 k; 150; 150
	Output voltage (V)	between 0 and 4, typically
	Output impedance (Ω)	640
External trigger	Input voltage (V)	0 to 5 (TTL)

Table 12-2. *Electrical Specifications*

a. Bandwidth corresponds to each electrical scale from the lowest to the highest gain.

Mechanical Specifications		
Temperature	Operating	0° to 50°C (32° to 122°F)
	Storage	-35° to 70°C (-35° to 158°F)
Relative humidity[a]	0 to 80% non-condensing	
Dimensions (H x W x D)	12 x 3.8 x 26.2 cm ($4\frac{3}{4}$ x $1\frac{1}{2}$ x 10 $\frac{1}{3}$ in.)	
Weight	0.7 kg (1.55 lb)	

Table 12-3. *Mechanical Specifications*

a. Measured in 0° to 40°C (32° to 104°F) range.

Specifications are subject to change without notice.

13 Warranty

General Information

EXFO Electro-Optical Engineering, Inc. (EXFO) warrants this equipment against defects in material and workmanship for a period of two years from the date of original shipment. EXFO also warrants that this equipment will meet applicable specifications under normal use.

During the warranty period, EXFO will, at its discretion, repair, replace, or issue credit for any defective product. This warranty also covers recalibration during two years if the equipment is repaired or if the original calibration is erroneous.

IMPORTANT

The warranty can become null and void if

- **the equipment has been tampered with, repaired, or worked upon by unauthorized individuals or non-EXFO personnel,**
- **the warranty sticker has been removed,**
- **case screws, other than those specified in this manual, have been removed,**
- **the case has been opened, other than as explained in this manual,**
- **the equipment serial number has been altered, erased, or removed,**
- **the equipment has been misused, neglected, or damaged by accident.**

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESSED, IMPLIED OR STATUTORY, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL EXFO BE LIABLE FOR SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

Liability

EXFO shall not be liable for damages resulting from the use of the purchased product, nor shall be responsible for any failure in the performance of other items to which the purchased product is connected or the operation of any system of which the purchased product may be a part.

Exclusions

EXFO reserves the right to make changes in the design or construction of any of its products at any time without incurring any obligation to make changes whatsoever on units purchased. Accessories, including but not limited to fuses, pilot lamps and batteries used with EXFO's products are not covered by this warranty.

Certification

EXFO certifies that this equipment met its published specifications at the time of shipment from the factory.

Service and Repairs

EXFO commits to providing product service and repair for five years after the date of purchase. To obtain service or repair for any equipment, follow the procedure below.

1. Call EXFO Customer Service Group. Support personnel will determine if the equipment requires service, repair, or calibration.
2. If the equipment must be returned to EXFO or an authorized service center, support personnel will issue a Return Merchandise Authorization (RMA) and an address for return.
3. If the unit has an internal storage device, do a backup of your data before sending the unit for repairs.

4. Pack the equipment in its original shipping material. Be sure to include a statement or report fully detailing the defect and the conditions under which it was observed.

IMPORTANT

Never send any unit or accessory back to EXFO without a Return Merchandise Authorization (RMA).

5. Return the equipment, prepaid, to the address given by the support personnel. Be sure to write the RMA on the shipping slip. EXFO will refuse and return any package which does not bear an RMA.

Note: *A test setup fee will apply to any returned unit which, after test, is found to meet the applicable specifications.*

After repair, the equipment will be returned with a repair report. If the equipment is not under warranty, the customer will be invoiced for the cost appearing on this report. Return-to-customer shipping costs will be paid by EXFO for equipment under warranty. Shipping insurance is at the customer's expense.

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Glossary

adapter	A device for coupling two connectors.
amplitude	The distance between high and low points of a waveform or signal.
ASCII	American Standard Code for Information Interchange. A system used to represent letters, numbers, symbols, and punctuation as bytes of binary signals.
attenuation	The diminution of average optical power. Attenuation results from absorption, scattering, and other radiation losses. Attenuation is generally expressed in dB without a negative sign.
attenuation coefficient	A factor expressing attenuation per unit length, expressed in dB/km.
attenuator	An optical device, either fixed or adjustable, that reduces the intensity of light propagating through it.
backscattering	That portion of scattered light that returns in a direction generally opposite to the direction of propagation.
baud rate	Measurement of data transmission speed, expressed in bits per second or bps.
Bellcore	Bell communications research, an organization that contains much of the former Bell labs. It specializes in telephone network technology, standards and interfaces.
BER	Bit error rate. On a transmission link, the number of digital “highs” that are interpreted as “lows”, and vice versa, divided by the total number of bits received. In modern networks, BERs much better than 10^{-9} are expected.
c	Velocity of light in a vacuum = 299 792 458 m/s
°C	Degree Celsius. To convert to Fahrenheit: $F = \frac{9}{5}C + 32$.
CFR	Code of Federal Regulations

connector	A junction that allows an optical fiber or cable to be repeatedly connected or disconnected to a device such as a source or detector.
coupler	A device whose purpose is to distribute optical power among two or more ports or to combine optical power from two or more fibers into a single port.
CW	Abbreviation for continuous wave. Refers to non-modulated, constant-intensity light.
dB	Decibel
dBm	Decibel referenced to a milliwatt.
DDE	Dynamic Data Exchange
decibel (dB)	The standard unit used to express gain or loss of optical power. A standard logarithmic unit for the ratio of two powers.
directivity	In a 3-port optical circulator, the ratio of power launched into port 1 that exits via port 2 vs. the fraction that exits via port 3.
DLL	Dynamic Link Library
DMA	Direct Memory Addressing
DUT	Device under test
EDFFA	Erbium doped fluoride fiber amplifier
EDFSA	Erbium doped silica fiber amplifier
EIA	Electronics Industries Association
electromagnetic interference	Any electrical or electromagnetic interference that causes degradation, failure in electronic equipment, or undesirable response. Optical fibers neither emit nor are affected by EMI.
EMI	Electromagnetic interference.
EOI	End of Image Marker
EOS	Effective Opening Size

ESB	Event Summary Bit
ESE	Standard Event Status Enable Register
ESR	Standard Event Status Register
f	Abbreviation for femto, which indicates 10^{-15} units.
f	Frequency, often also designated by ν.
FCC	Federal Communications Commission. A U.S. government body overseeing and regulating national electrical and radio communications. The FCC, formed in 1934, also deals with licences, tariffs, and limitations. The members of the commission are appointed by the U.S. president.
FIFO	First In First Out
frequency	The number of cycles per second, denoted by hertz (Hz).
G	Abbreviation for giga, which indicates 10^{9} units.
Ge	Germanium
GeX	High power germanium
GPIB	General Purpose Interface Bus
hr	Hour
Hz	Hertz. Denotes number of cycles per second.
IEC	International Electrotechnical Commission. A standardization body at the same level as ISO.
IEE	Institute of Electronic Engineering. It is a professional body covering all aspects of electronics and electrical engineering, including software, network, and computer engineering.
IEEE	Institute of Electrical and Electronics Engineering. It is a professional body very active, among other things, in many fiber-optic and opto-electronic related fields.
index matching material	A material, often a liquid or a cement, whose refractive index is nearly equal to the core index, used to reduce Fresnel reflections from a fiber's endface.

index of refraction	The ratio of the group velocity of light in a vacuum to the group velocity of light in a given medium.
InGaAs	Indium gallium arsenide
ISA	Industry Standard Architecture
ISO	International Organization for Standardization. Commonly believed to stand for International Standards Organization. In fact, ISO is not an abbreviation—it is intended to signify uniformity (derived from the Greek *iso* meaning “equal”). ISO is responsible for many standards including those for data communications and computing.
ITU	International Telecommunications Union. The ruling body for telecommunications and the source of many network standards.
jumper	Fiber-optic cable that has connectors terminated on both ends. Used to connect two pieces of equipment, modules, or components.
k	Abbreviation for kilo, which indicates 10^3 units.
LD	Laser diode
LED	Light emitting diode
loopback	Type of diagnostic test in which the transmitted signal is returned to the sending device after passing through a communications link or network.
M	Abbreviation for mega, which indicates 10^6 units.
m	Abbreviation for milli, which indicates 10^{-3} units.
min	Minute
n	Abbreviation for nano, which indicates 10^{-9} units.
n	Refractive index. For the silica glass used in optical fibers, $n \approx 1.465$.
NIST	National Institute of Standards and Technology. U.S. governmental body that provides the assistance in

	developing standards. It was formerly the National Bureau of Standards.
noise figure	A measure of the quality of an amplifier, defined as the ratio of output to input SNRs.
P	Abbreviation for peta, which indicates 10^{15} units.
p	Abbreviation for pico, which indicates 10^{-12} units
P	Power
PCS	Plastic-clad silica (fiber)
RMA	Return merchandise authorization
s	Second
SCPI	Standard Commands for Programmable Instruments
sensitivity	For an optical instrument, the smallest signal that can be detected in the absence of any other signal.
Si	Silicon
SNR	Signal-to-noise ratio. The ratio of the received optical power, divided by the noise floor for the optical system.
SRE	Service Request Enable Register
SRQ	Service Request
STB	Status Byte Register
t	Time
T	Abbreviation for tera, which indicates 10^{12} units.
V	volt
VA	volt-ampere
W	watt
wavelength	For monochromatic light, the distance between two successive peaks (or troughs) of the sinusoidally-varying electric-field amplitude. Note that, unlike frequency, the wavelength of light is inversely proportional to the refractive

	index of the medium through which it propagates. It is for this reason that accurate wavelength measurements are generally specified as being determined in “air” or in “vacuum”.
λ	lambda. Greek letter used to denote wavelength.
μ	Abbreviation for micro, which indicates 10^{-6} units.
ν	nu. Greek letter used to denote frequency. Traditionally, the physics community uses “ν” to denote frequency whereas the engineering community uses “*f*”.

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