Keysight N774x Series

N7744A 4-Channel Optical Multiport Power Meter (LXI)
N7745A 8-Channel Optical Multiport Power Meter (LXI)
N7747A 2-Channel High Sensitivity Optical Power Meter
N7748A 4-Channel High Sensitivity Optical Power Meter

KEYSIGHT
TECHNOLOGIES

User's Guide

Notices

Manual Part Number

N7744-90B01

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Keysight Technologies,

Deutschland GmbH

Herrenberger Str. 130

71034 Böblingen, Germany

For Assistance and Support

http://www.keysight.com/find/assist

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Warranty

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Safety Notices

CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Contents

1
Getting Started

Overview

This chapter helps you start using your N77-Series instrument.

Keysight N7744A and N7745A Optical Power Meter

The Keysight N7744A and Keysight N7745A are LXI compliant optical power meters with 4 or 8 power-sensor ports respectively. They address productivity challenges by increasing throughput and operational efficiency using industry-leading device connectivity, high-speed acquisition of measurement data and fast data transfer for post-processing.

The Keysight N7744A and Keysight N7745A are designed to characterize optical multiport components, such as multiplexers, PON splitters, wavelength selective switches (WSS) and ROADMs, in all product phases from R&D to manufacturing.

The one rack unit (1U half-rack high) instrument can be operated alone or with other units, by PC connected over LAN, USB, or GPIB.

The unprecedented N7740A fiber connectivity concept consists of a quadruple adapter (quad-adapter) with a quick-locking mechanism. Up to four fiber connectors from the device under test (DUT) can be connected in a comfortable working position to one quad-adapter. The push-on locking mechanism makes it easy and secure to attach the quad-adapter to and remove the quad-adapter from the instrument in seconds. With multiple quad-adapters, the measurement task can be fully separated from the DUT connection task. This means a further increase in test throughput. Where this is not an issue, traditional single connector connectivity is supported as well.

These power meters are highly compatible with setups and programs developed using the Keysight 816x modular power meters. They are also easy to synchronize with Keysight tunable laser sources, to make spectral measurements. The functionality for time-dependent measurement has been extended with sampling at up to 1 MHz and data logging of up to 1 million samples for each port.

Keysight N7747A and N7748A Optical Power Meter

The two-port N7747A and 4-port N7748A optical power meters bring the highest performance in terms of sensitivity, noise and relative accuracy to the compact N77 instrument platform. These instruments combine the optical performance of the 81634B sensor modules with the large memory, fast data transfer and small footprint of the N77 series platform. Eight high-sensitivity optical power meters now fit in a single rack unit. Optical connections are made with the interchangeable 81000xI connector interface system.

Initial Inspection

Inspect the shipping container for damage. If there is damage to the container or cushioning, keep them until you have checked the contents of the shipment for completeness and verified the instrument both mechanically and electrically. The Function Tests give a procedure for checking the operation of the instrument. If the contents are incomplete, mechanical damage or defect is apparent, or if an instrument does not pass the operator's checks, notify the nearest Keysight Technologies Sales/Service Office.

> **NOTE**
>
> To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, and so on).

Safety Considerations

Safety Considerations - Overview

The following generalsafety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Keysight Technologies Inc. assumes no liability for the customer's failure to comply with these requirements. This product has been designed and tested in accordance with IEC Publication 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory, and has been supplied in a safe condition. The instruction documentation contains information and warnings that must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

Safety Symbols

<table>
<tr>
<td>**CAUTION**</td>
<td>The *caution* sign denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in damage to or destruction of the product. Do not proceed beyond a caution sign until the indicated conditions are fully understood and met.</td>
</tr>
<tr>
<td>**WARNING**</td>
<td>**The *warning* sign denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a warning sign until the indicated conditions are fully understood and met.**</td>
</tr>
</table>

General

This is a Safety Class 1 instrument (provided with a protective earth terminal) and has been manufactured and tested according to international safety standards.

Before operation, you should review the instrument and manual for safety markings and instructions. You must follow these to ensure safe operation and to maintain the instrument in safe condition.

Some circuits are powered whenever the instrument is connected to the AC power source. To disconnect from the line power, disconnect the power cord either at the rear power inlet or at the AC line power source (receptacle). One of these must always be accessible. If the instrument is in a cabinet, it must be disconnected from the line power by the system's line power switch.

WARNING   **To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, and so on).**

Operating Environment

WARNING   **The instrument is not designed for outdoor use. To prevent potential fire or shock hazard, do not expose the instrument to rain or other excessive moisture.**

Line Power Requirements

CAUTION   The instrument complies with installation category II and can operate from the single-phase AC power source that supplies between 100 V and 240 V at a frequency in the range 50/60 Hz. The maximum voltage fluctuation is 10% of the nominal supply voltage. The maximum power consumption is 60 VA with all options installed.

Input/Output Signals

<table>
<tr><td>

CAUTION

</td><td>

There is one input BNC connector: Trigger In. This is a TTL input.

A maximum of 5 V can be applied as an external voltage to this input connector.

There is one output BNC connector: Trigger Out. This is a TTL output. Do not apply an external voltage to this connector.

The N7747A and N7748A have front-panel BNC connectors for each optical port. This is an analog voltage output (0 to 2V). Do not apply an external voltage to this connector.

</td></tr>
</table>

Line Power Connectors

In accordance with international safety standards, the instrument has a three-wire power cable. When connected to an appropriate AC power receptacle, this cable earths the instrument cabinet. The type of power cable shipped with each instrument depends on the country of destination. Please refer to "Accessories" section in the User's Guide for the part numbers of available power cables.

<table>
<tr><td>

WARNING

</td><td>

To avoid the possibility of injury or death, you must observe the following precautions before switching on the instrument.

- **Insert the power cable plug only into a socket outlet provided with a protective earth contact. Do not negate this protective action by the using an extension cord without a protective conductor.**

- **Do not interrupt the protective earth connection intentionally.**

- **Do not remove protective covers. Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made only by qualified service personnel.**

- **Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.**

- **Defective, damaged, or malfunctioning laser sources must be returned to an Keysight Technologies Service Center.**

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

</td></tr>
</table>

Instrument Markings

⚠	The instruction manual symbol. The product is marked with this warning symbol when it is necessary for the user to refer to the instructions in the manual.
CE	The CE mark is the conformity marking of the European Community
CSA	The CSA mark is a registered trademark of the Canadian Standards Association.
C or RCM	The C-Tick or RCM mark is the certification mark of the Australian Communications Authority.
♲	The recycling symbol indicates the general ease with which the instrument can be recycled.
🗑	Do not dispose in domestic household waste. To return unwanted products, contact your local Keysight office, or see http://about.keysight.com/en/companyinfo/environment/takeback.shtml for more information.
KC	The KC mark is the Korean certification mark.

AC Line Power Supply Requirements

AC Line Power Supply Requirements - Overview

This secton provides information on:

- Line Power Requirements
- Line Power Cable

•   Changing the Fuse

Line Power Requirements

The instrument complies with installation category II and can operate from the single-phase AC power source that supplies between 100 V and 240 V at a frequency in the range 50/60 Hz. The maximum voltage fluctuation is 10% of the nominal supply voltage. The maximum power consumption is 60 VA with all options installed.

Line Power Cable

In accordance with international safety standards, the instrument has a three-wire power cable. When connected to an appropriate AC power receptacle, this cable earths the instrument cabinet. For the part number of the power cable for your country and instrument, see .

<table>
<tr><td>C A U T I O N</td><td>Please note that the switch on the front panel of the instrument does not stop the flow of power to the instrument.</td></tr>
</table>

If you need to turn off the power, unplug the instrument at the mains or remove the power cable connector from the appliance coupler at the rear of the instrument. For this reason, the power cable connection should be easily accessible - allowing you to turn off the power quickly. If the instrument is in a cabinet, it must be disconnected from the line power by the system's line power switch.

The power switch allows you to switch between stand-by mode and power-on mode.
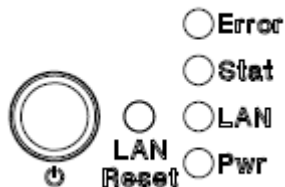
Figure 1   Power Switch

When the instrument is in stand-by mode, the Pwr LED is orange. When the instrument is powered-on, the Pwr LED is green.

<table>
<tr><td>**WARNING**</td><td>**To avoid the possibility of injury or death, you must observe the following precautions before switching on the instrument.**</td></tr>
</table>

- **Insert the power cable plug only into a socket outlet provided with a protective earth contact. Do not negate this protective action by using an extension cord without a protective conductor.**

- **Do not interrupt the protective earth connection intentionally.**

The AC power requirements are summarized on the rear panel of the instrument.
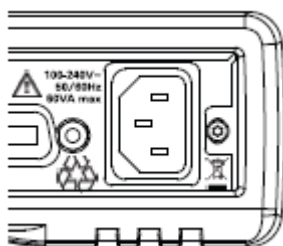
Figure 2   AC Power Requirement Markings

Changing the Fuse

<table>
<tr><td>**CAUTION**</td><td>There is no user replaceable fuse for the instrument. Changing the fuse should be carried out only by Keysight Technologies service personnel. If you need to get the fuse replaced refer to your nearest Keysight Technologies Sales/Service Office.</td></tr>
</table>

Operating and Storage Environment

Operating and Storage Environment - Overview

The following summarizes the operating environment ranges. In order for the instrument to meet specifications, the operating environment must be within these limits.

WARNING   **The instrument is not designed for outdoor use. To prevent potential fire or shock hazard, do not expose the instrument to rain or other excessive moisture.**

Temperature

The instrument should be protected from temperature extremes and changes in temperature that may cause condensation within it.

The operating temperature is from 5°C to +40°C (+10°C to +35°C for laser sources).

The storage temperature is from -40°C to +70°C.

Humidity

The operating humidity is 15 to 95%, non-condensing.

Altitude

The maximum operating altitude is 2000 m.

Pollution Protection

The instruments are designed for pollution degree 2.

Instrument Cooling

The instrument has a cooling fan mounted internally.

Mount or position your instrument upright and horizontally, as shown in Figure 4 so that air can circulate through it freely.

Operating Position

When operating the instrument choose a location that provides at least 75 mm (3 inches) of clearance at the rear, and at least 25 mm (1 inch) of clearance at each side. Failure to provide adequate air clearance may result in excessive internal temperature, reducing instrument reliability. The instrument should not be operated when resting on its rear or side panels.
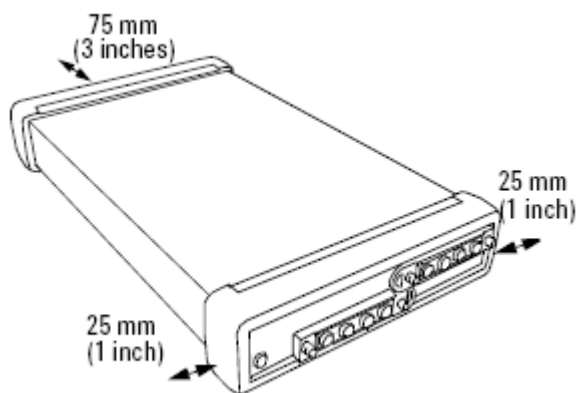
Figure 3   Correct Operating Position

(shown here for the Keysight N7744/5A, valid also for the N7747/48A, N7751/2A, Keysight N7761/2/4A, N7766/68A, N773xA and the N7711/4A)

Input and Output Connectors

Input and Output Connectors - Overview

This section provides information on:

- Front Panels - Multiport Power Meters
- Rear Panel

Front Panels - Multiport Power Meters
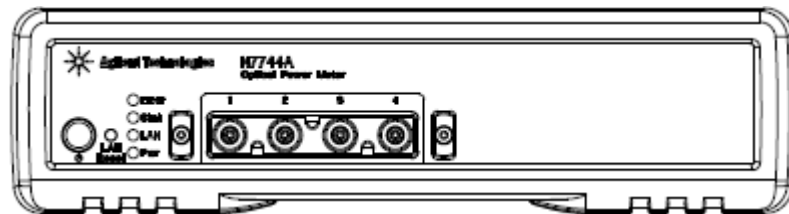
Figure 4   Front panel of the Keysight N7744A 4-Channel Optical Multiport Power Meter
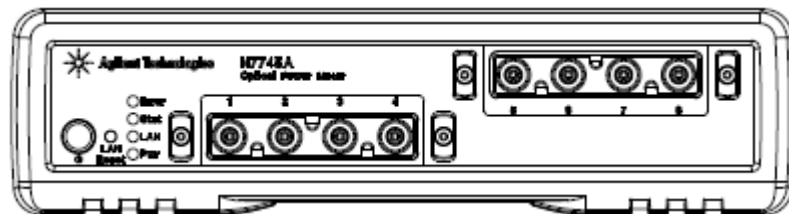
Figure 5   Front panel of the Keysight N7745A 8-Channel Optical Multiport Power Meter
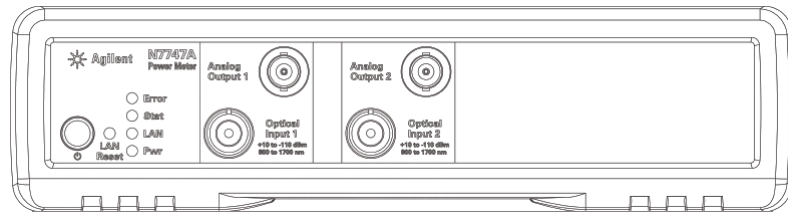
Figure 6   Front panel of the Keysight N7747A 2-Channel Optical Power Meter
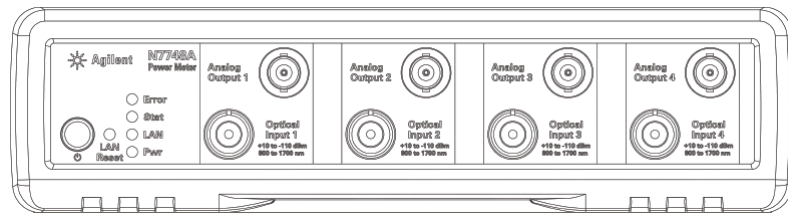
Figure 7   Front panel of the Keysight N7748A 4-Channel Optical Power Meter

Rear Panel
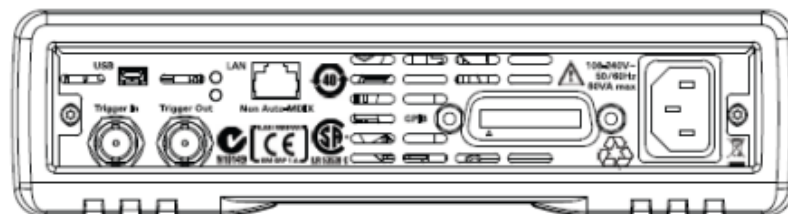
Figure 8   Rear panel of the Keysight N77xx Series instruments

Making Optical Connections

Making Optical Connections

The N774xA power meters do not make contact to the fiber connector faces and can be used with either angled or straight connectors. The N7744A and N7745A use the quad-adapters described below. The N7747A and N7748A use the interchangeable 81000xI connector interfaces, selected for the desire connector type. Common choices are the 81000FI for FC connectors, 81000KI for SC connectors, and 81002LI for LC connectors. The 81000BI can be used for bare fiber connections.

CAUTION	When using bare fiber connections to power meters, the length of fiber extending from the fiber holder must be carefully adjusted to avoid scratching the power meter optics.

NOTE	Connector ferrules with conical or raised-end faces also add positioning uncertainty and are not recommended for use with the N7747A or N7748A.

For further details on connector interfaces and accessories, refer to the "Accessories" section in the User's Guide.

Making Quad-adapter Connections on the Keysight N7744/45A Multiport Power Meter
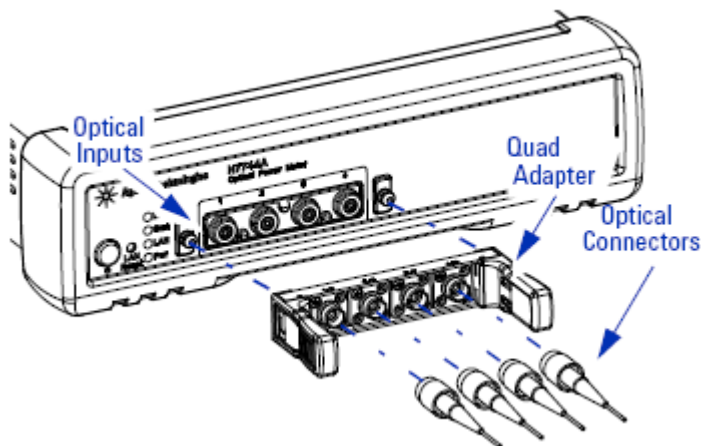
Figure 9   Connecting Optical Fibers

N O T E	Before you attach a quad-adapter or fiber, you should make sure they are clean. This is important for accurate measurements.

The fibers do not contact the optical inputs (all contact with the optical inputs should be avoided). Usually the only cleaning necessary for the optical inputs is the gentle removal of dust with pressurized, dry air.

For further information, refer to "Maintenance and Troubleshooting" section, described in this manual.

To use a quad-adapter to connect optical fibers to the power meter inputs:

1 Select the quad-adapter that suits the optical connector that your optical fiber is terminated with.

2 Attach the optical connectors to the quad-adapter. You can attach up to 4 fibers to the quad-adapter at the same time.

3 Make sure the number labels on the quad-adapter are at the top.

4 Connect the quad-adapter to the optical inputs by pressing it on until it clicks securely into place, without pressing the release levers.

Removing Quad-adapter Interfaces from the Keysight N7744/5A Multiport Power Meter

NOTE	There are release levers on both sides of the quad-adapter for removing it from the optical inputs.
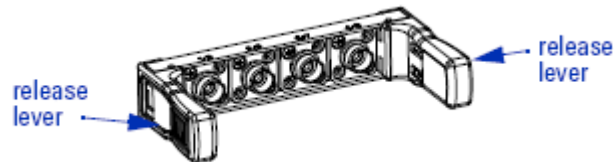
Figure 10 Removing Quad-adapter Interfaces

1 Press the release levers on both sides of the quad-adapter to release it from the front panel of the power meter.

2 You can now remove the optical connectors from the quad-adapter.

NOTE	Always place the dust cap on unused connector interfaces. You can use the quad-adapter dust caps to protect the four power meter inputs and the rear of the quad-adapter, for example, when fibers are attached.

Electrical Connectors

There are two BNC connectors on the rear panel of your instrument. These are the Trigger Out and the Trigger In connectors.

The N7747A and N7748A have a front panel BNC connector for each channel. These are for analog output signals and provide a voltage proportional to the input signal power in mW. The voltage is in the range 0-2 V and 1 V corresponds to the value of the currently selected power range. For example, when using the -10 dBm range, a 100 µW optical power will give 1 V analog output.

C A U T I O N   The Trigger In is a TTL input. A maximum of 5 V can be applied as an external voltage to this input connector.

The Trigger Output is a TTL output. Do not apply an external voltage to this connector.

No external voltage should be applied to the analog output connectors of the N7747A and N7748A.

LAN Interface

LAN Interface

This section explains the concept of LAN in details.

Selecting a LAN Network

For the purposes of this guide, a private (isolated) LAN network is defined as a network configuration in which instrument access is a direct connection between the computer and the instrument, or to multiple instruments connected via a *dedicated* router or switch. A site (company-wide) LAN is defined as a network in which instrument access is available to many users at on-site and remote locations. The instrument's application and/or your company's IT (Information Technology) department may have guidelines that help decide the type of network (private or site) used. If a network configuration has not been determined, refer to the following considerations concerning each type.

Private LAN Considerations

Among the basic parameters of a private LAN network to consider are security, performance, reliability, and IP address availability.

Security

A private network generally involves a direct connection between the computer and the instrument, or to multiple instruments using switches or routers. Access to the instrument is limited to users on the private network, as opposed to users on a site network that could locate and access the instrument from any location.

Private networks can reduce the possibility of tests being disrupted by unplanned or unauthorized access. Code generation for test systems on a private network is often simplified, as provisions against unauthorized users may not be required.

Performance

Test systems where large amounts of data are transferred usually have faster throughput on a private network. On a site network, heavy and unpredictable LAN traffic affects each instrument (node) on the network. The impact on a test system is that repeatability is difficult to achieve as latencies are difficult to account for.

Reliability

Private networks are fundamentally more reliable than site networks as they host fewer users and are less complex than site networks.

Private networks are isolated from conditions that could bring down (crash) a site network.

IP Address Availability

Every instrument (node) on a LAN (private or site) has an IP (Internet Protocol) address. Due to the expanding use of the internet, the number of site network IP addresses available is limited. By using a router with Dynamic Host Configuration Protocol (DHCP) capability on a private network, the router can assign an IP address to each instrument thus creating a sub-network (subnet) that does not consume site IP addresses.

Site LAN Considerations

For applications requiring access by many users or by users at distributed sites, a site LAN network is required. In addition to supporting multiple users, site LANs often offer the advantage of being maintained by IT departments. When using a site LAN, consult your IT department regarding LAN configuration and security issues.

Connecting the LAN Cable

LAN cables are connected between the LAN terminal on the instrument and the computer, or between the instrument and a router or switch if included in your network.

Private Network Connections

The figure below shows typical LAN cable connections for a private network.
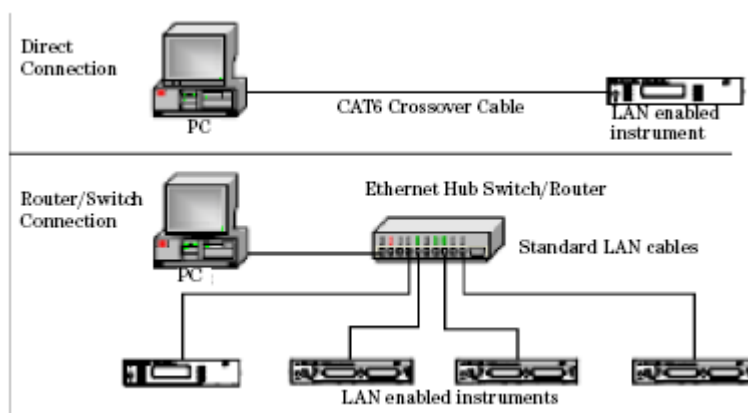
Figure 11   Typical Private (isolated) LAN Network Connections

If the instrument is connected directly to the PC, use a LAN crossover cable, as provided with the instrument. If your computer supports Auto-MDIX or contains a LAN card with gigabit data transfer rates, the (blue) crossover cable is not required. A standard LAN cable can be used instead.

For private LAN networks that include a switch or router, use standard LAN cables for all network connections. Do not use a crossover cable.

Site Network Connections

The following figure shows a typical LAN cable connection for a site network.
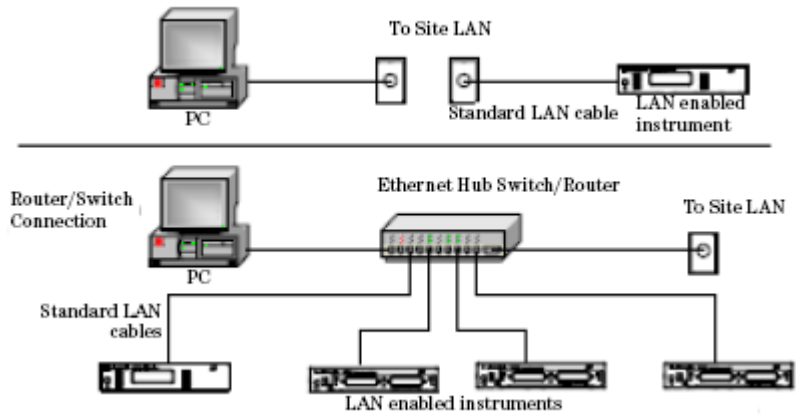
Figure 12   Typical Site LAN Network Connections.

On site networks, the instrument and the computer are connected directly to site LAN ports, or are connected to the site LAN through a switch. In each site network configuration, standard LAN cables are used.

The LAN LED

As the LAN connection is made, the DHCP server assigns an address and the LXI device identification proceeds you will see the following indicators:

Figure 13   The LAN LED

There may be a delay between making the LAN link (yellow status) and getting the IP address (green status). This delay may be longer if there

is no DHCP server, for example when the instrument is connected directly to a PC.

The LAN Reset button

This recessed button has two functions.

- Pressing the button briefly invokes a preset of the instrument and restores default measurement settings. This is equivalent to the programming command

  `:SYSTem:PRESet`

- Pressing and holding the button for 3 seconds will reset the LAN parameters to the factory default. This includes changing the password for modifying the configuration via LAN back to the default "Keysight". This is equivalent to the following sequence of programming commands:

  `:SYSTem:COMMunicate:ETHernet:RESet`

GPIB Interface

GPIB Interface

You can connect your GPIB interface into a star network, a linear network, or a combination star and linear network. The limitations imposed on this network are as follows:

- The total cable length cannot exceed 20 meters.

- The maximum cable length between devices is 4 meters, with an average separation of 2m between devices over the whole bus.

- No more than 15 devices may be interconnected on one bus.

Cables and Adapters

For further details on cables and adapters, refer to "Cables" section in the User's Guide.

Connector

The following figure shows the connector and pin assignments.

Connector Part Number: 1251-0293
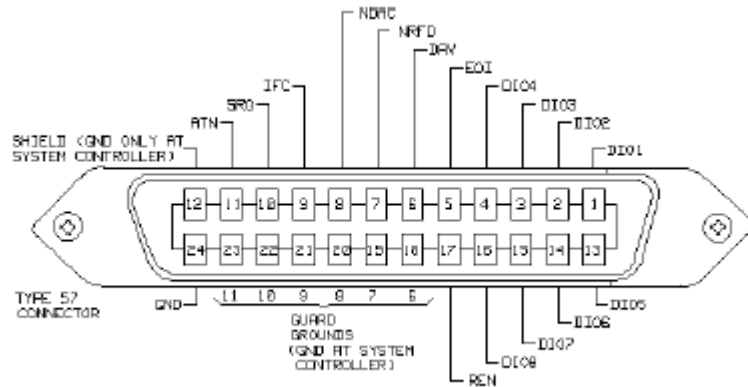
Figure 14   GPIB Connector

| **CAUTION** | Keysight Technologies products delivered now are equipped with connectors having ISO metric-threaded lock screws and stud mounts (ISO M3.5×0.6) that are black in color. Earlier connectors may have lock screws and stud mounts with English-threaded lock screws and stud mounts (6-32 UNC) that have a shiny nickel finish. |

| **CAUTION** | It is recommended that you do not stack more than three connectors, one on top of the other. |

Hand-tighten the connector lock screws. Do not use a screwdriver.

GPIB Logic Levels

The instrument's GPIB lines use standard TTL logic, as follows:

True = Low = digital ground or 0 Vdc to 0.4 Vdc

False = High = open or 2.5 Vdc to 5 Vdc

All GPIB lines have LOW assertion states. High states are held at 3.0 Vdc by pull-ups within the instrument. When a line functions as an input, it requires approximately 3.2 mA to pull it low through a closure to digital

ground. When a line functions as an output, it will sink up to 48 mA in the low state and approximately 0.6 mA in the high state.

NOTE   The GPIB line screens are not isolated from ground.

USB Interface

NOTE   Before connecting the instrument over USB, install the Keysight I/O Libraries Suite, which is included on a CD with the instrument.

The instrument is a USB device, with a mini-USB connector.

Powering Up the Instrument

Powering Up the Instrument

When you switch on the instrument, the LEDs on the front panel show the various stages of booting.

Figure 15   Powering Up the Instrument

Front Panel Indicators

During operation, you may notice the following LED indicators:

Hardware defect

| Red | Error |

LAN, USB or GPIB
communication

| Green blink | Stat |

Zeroing

| Yellow | Stat |
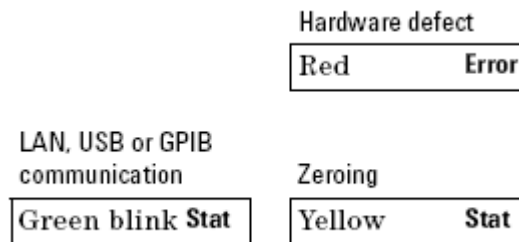
Figure 16   Front Panel Indicators

Connecting to the Instrument

Connecting to the Instrument - Overview

When you are first connecting the instrument, we recommend you use the Keysight Connection Expert included with the Keysight I/O libraries (available on the CD supplied with the instrument, or from www.keysight.com).

Connecting over USB

NOTE   The screenshots show the Keysight N7745A Multiport Power Meter. The same procedure applies when connecting an Keysight N7744/7/8A Multiport Power Meter, an Keysight N7751/2A Optical Attenuator and Power Meter, or an Keysight N7761/2/4/6/8A Optical Attenuator or an Keysight N7711/4A Tunable Laser System Source or an N773x Optical Switch.

1   If it is not already running, start the Keysight Connection Expert software.
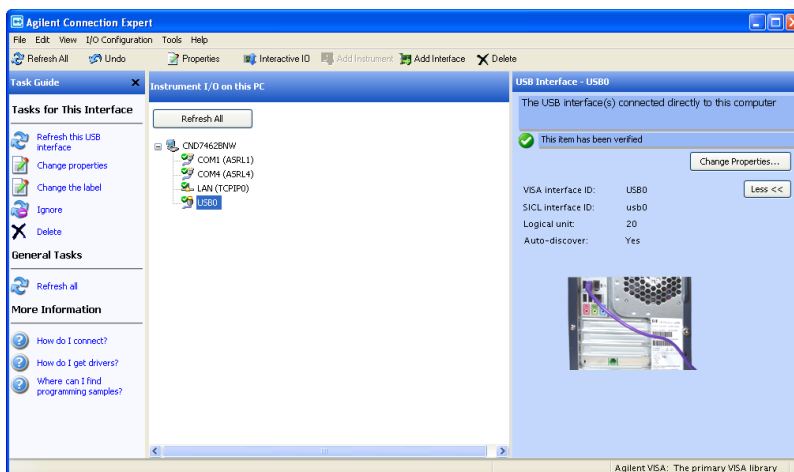
Figure 17   Keysight Connection Expert software

2 Attach the instrument to the USB. The first time you attach the instrument, follow the instructions on the screen to select the driver for this instrument.

When the instrument is connected, it is shown in the list.
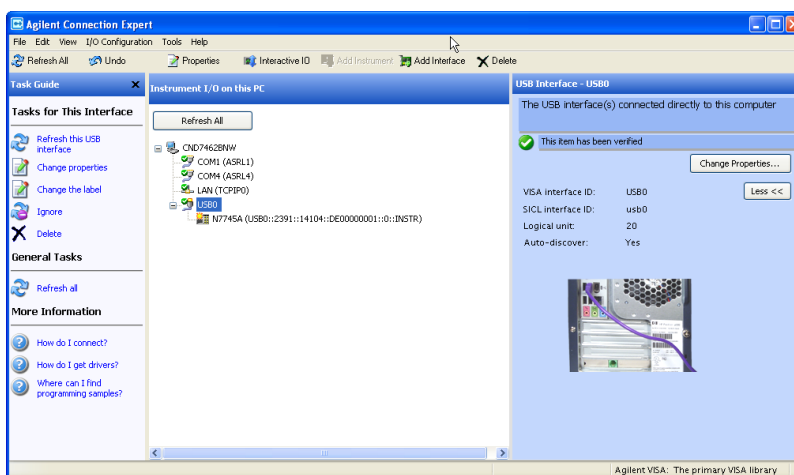
Figure 18   Select the instrument in the list

3 Select the instrument in the list to see the associated tasks (in the Task Guide on the left) and information (on the right).

Finding the IP Address of an instrument

1 Connect to the instrument over USB, as described above.

2 Select the instrument in the list.
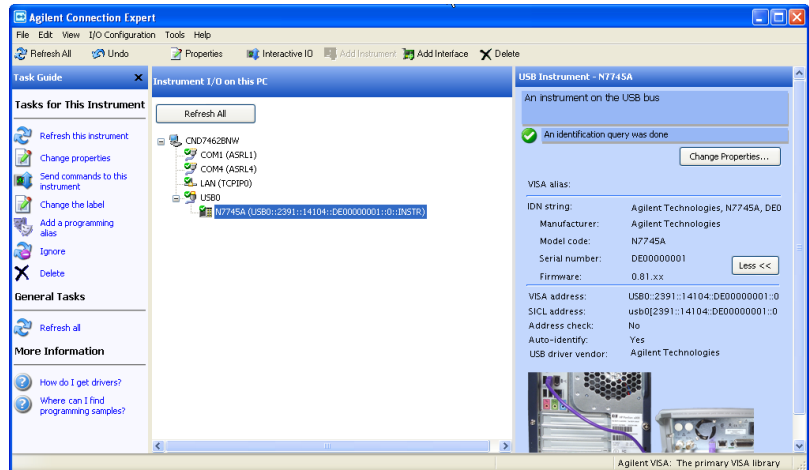
Figure 19   Select the instrument

3 Click on "Send commands to this instrument".

The default command is the *IDN? query.
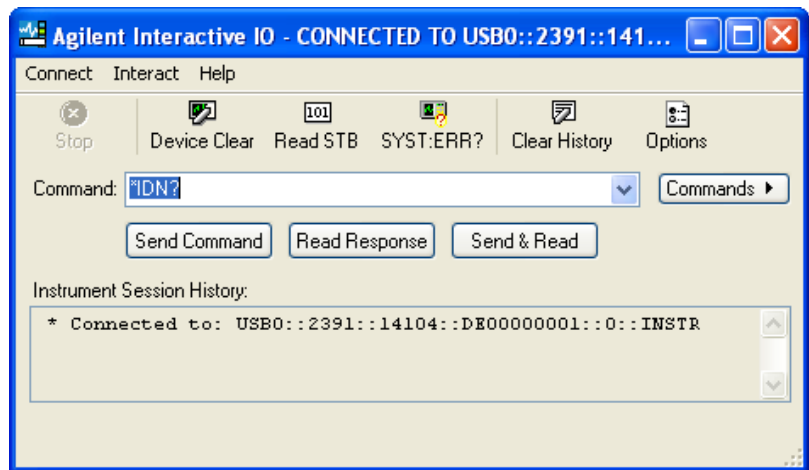
Figure 20   *IDN? query

4 Enter the command

:SYSTem:COMMunicate:ETHernet:IPADdress:CURRent?

then click on [Send & Read].

The instrument returns its current IP address.
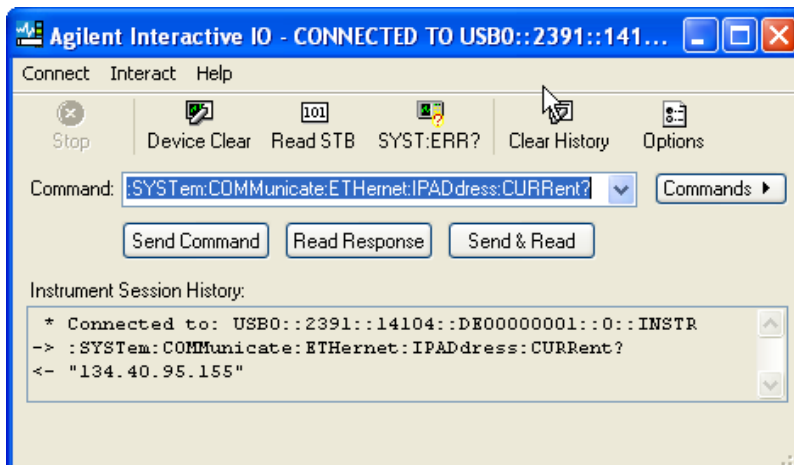
Figure 21   :SYSTem:COMMunicate:ETHernet:IPADdress:CURRent?

Connecting over LAN

1 Make sure the instrument is connected to the LAN, and that the LAN LED on the front panel is green. See, "LAN Interface" on page 23 for more information to connecting over LAN.

2 If it is not already running, start the Keysight Connection Expert software.

3 Select "LAN (TCPIP0)" in the list.
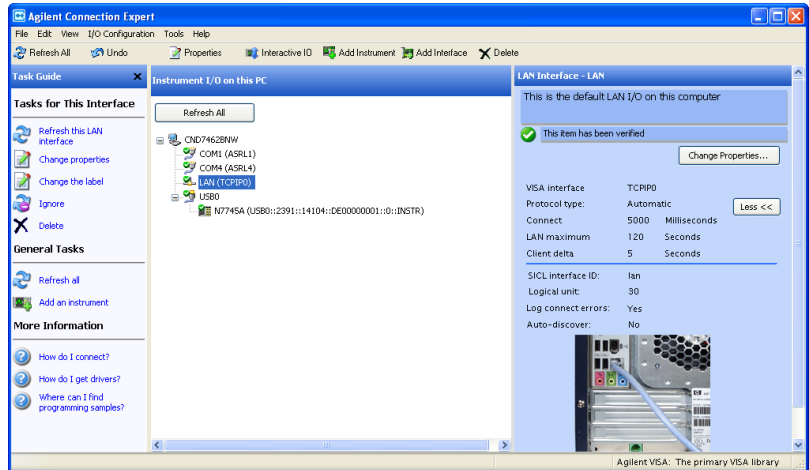
Figure 22

4 Click on "Add an instrument" in the Task Guide.

5 Wait for the scan to finish.

6 Select the instrument in the list.
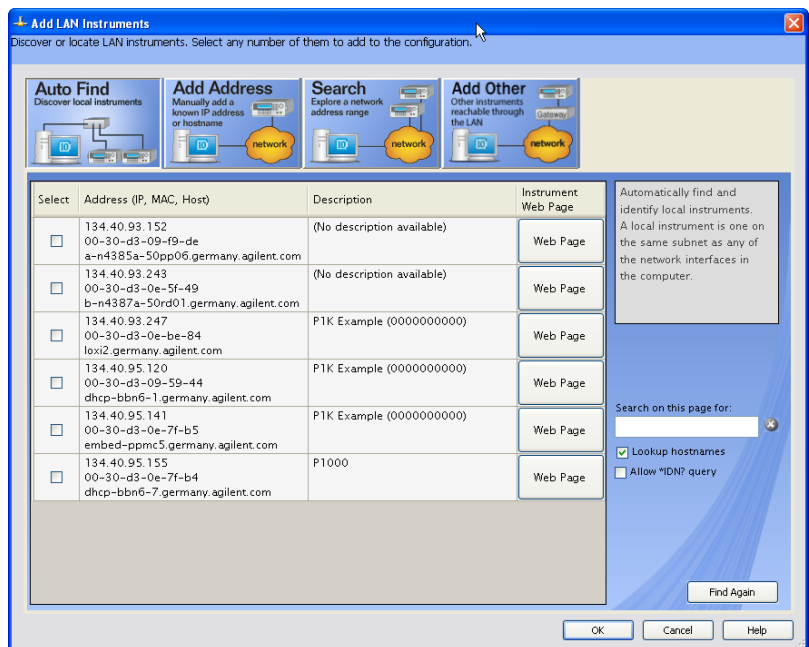
Figure 23

7 To show the description of the instrument, check the box for *IDN? query and click on "Find Again".
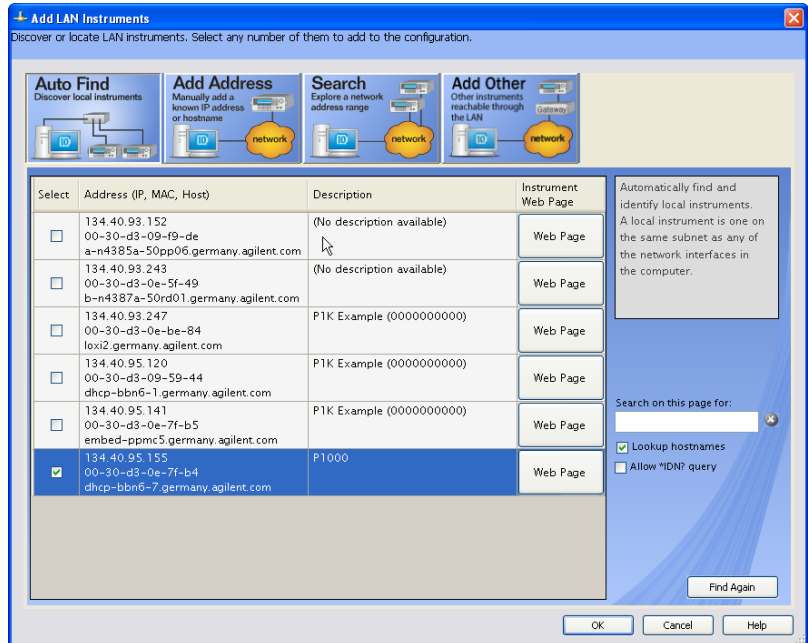
Figure 24

8 Select the instrument in the list to see the associated tasks (in the Task Guide on the left) and information (on the right).

• For the N774x Multiport power meters, click on the "Instrument Web Interface" button to control the instrument directly.
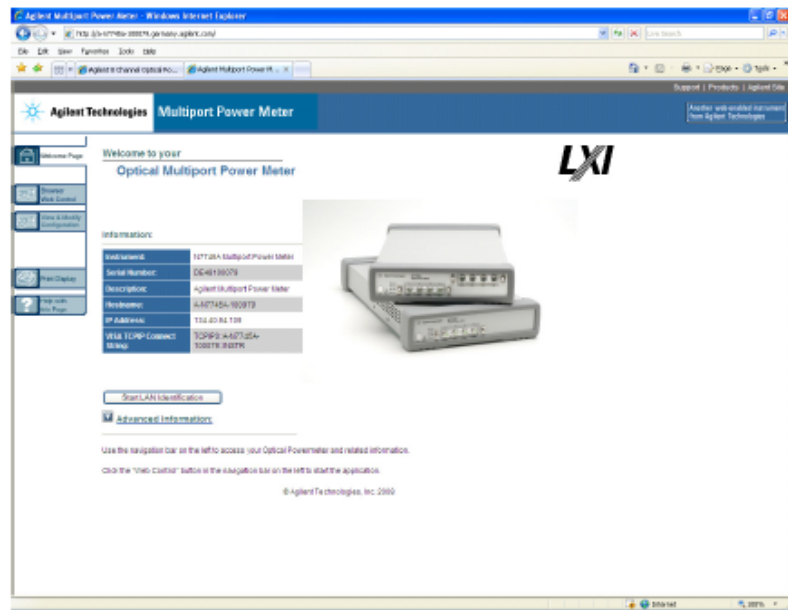
Figure 25

If it is not already installed, you will need to install a Java run-time engine to use this page.

Basic configuration and functionality are available from this web page.

- You can control any of the instruments from the Keysight N77xx Viewer.

  – Connecting and using the N77xx Viewer is described in "Connecting to the Instrument - Overview" on page 30.

More advanced functionality is available through programming with SCPI commands (described in the Programming Guide available on the CD supplied with the instrument or from www.keysight.com), or using the 816x VXI Plug&Play driver, version 4.4.2 or higher. You can also use the IVI-COM driver for the N7744A and N7745A Multiport power meters.

Claims and Repackaging

Claims and Repackaging - Overview

If physical damage is evident or if the instrument does not meet specification when received, notify the carrier and the nearest Keysight Technologies Sales/Service Office. The Keysight Technologies Sales/Service Office will arrange for repair or replacement of the unit without waiting for settlement of the claim against the carrier.

Return Shipments to Keysight Technologies

If the instrument is to be shipped to an Keysight Technologies Sales/Service Office, attach a tag showing owner, return address, model number and full serial number and the type of service required.

The original shipping carton and packing material may be reusable, but the Keysight Technologies Sales/Service Office will provide information and recommendations on materials to be used if the original packing is no longer available or reusable. General instructions for repackaging are as follows:

- Wrap instrument in heavy paper or plastic.

- Use strong shipping container. A double wall carton made of 350-pound test material is adequate.

- Use enough shock absorbing material (3 to 4 inch layer) around all sides of the instrument to provide a firm cushion and prevent movement inside container. Protect control panel with cardboard.

- Seal shipping container securely.

- Mark shipping container FRAGILE to encourage careful handling.

- In any correspondence, refer to instrument by model number and serial number.

Deleting user data

If you need to delete all your logged data and user configurations, that is to reset the instrument completely:

1 Press and hold the Reset/standby button until the instrument starts to reboot.

2 When the instrument reboots, press the Reset/standby button once more briefly, to confirm you want to delete all the stored data.

N77xx Viewer Common User Interface Functions

Connecting to an Instrument

When you first launch the N77xx Viewer, it is not connected to any of your instruments.

1 Click on the "Connect" icon at the top right of the window.

2 Select the instrument to which you want to connect from the list.
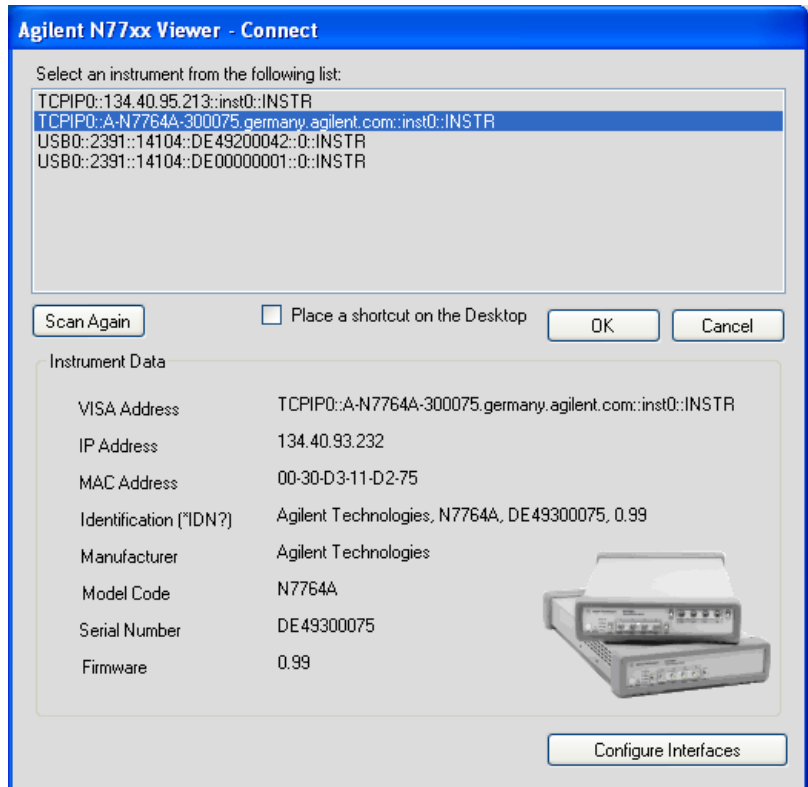
Figure 26 Connecting to an Instrument

3 The list shows instruments that have been given a VISA address.

If your instrument is not in the list,

1 Use the Keysight Connection Expert to check your instrument has a VISA address

2 Click on the "Scan Again" button.

Once communication has been established to the instrument, its details are shown.

4 If you need to change the connection configuration for an instrument on the LAN, click on the "Configure Interfaces" button.

You can only configure the LAN parameters before the instrument is connected.
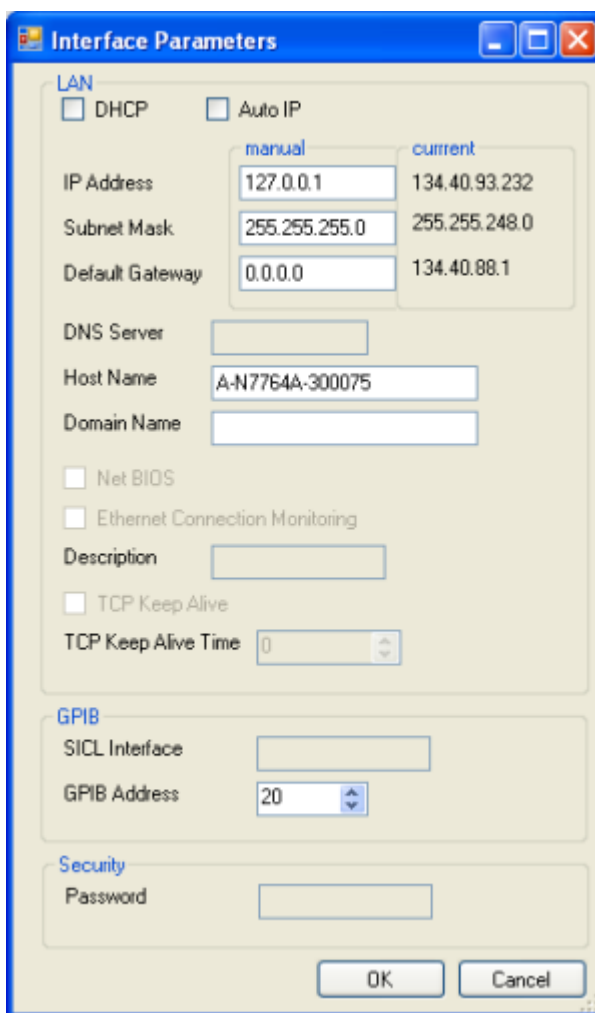
Figure 27   Interface Parameters

– Make sure both DHCP and Auto IP are not selected.

– You can now edit the IP parameters.

5 For instruments you use regularly, you can add a link on your desktop by putting a check mark in the box to "Place a shortcut on the Desktop".

6 Click on the "OK" button to finish the connection.

Viewing Measurements and Settings

The settings and readings of the instrument can be accessed directly from the main Viewer panel. Instruments with multiple channels have a tab for each channel. In addition, separate windows can be opened for simply viewing the settings and readings, as follows:

Viewing the measurement on a single channel

1 Click on the "New" button to open a window with the current measurement and parameter settings.
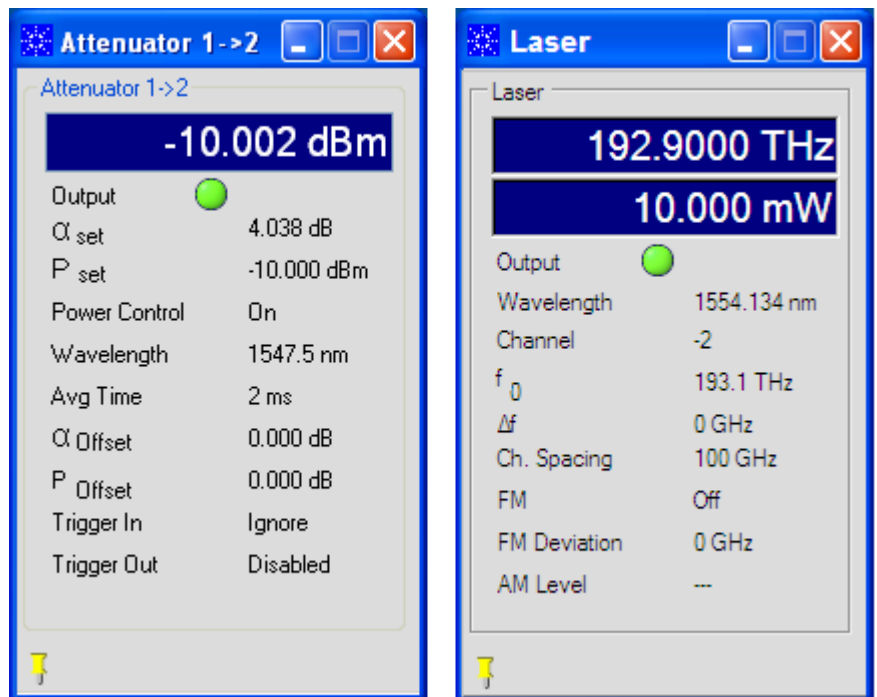
Figure 28 Viewing the measurement on a single channel attenuator/power meter (left) or tunable laser (right)

Viewing all channels

1 Click on "Overview" to open a window with the measurements on all channels.
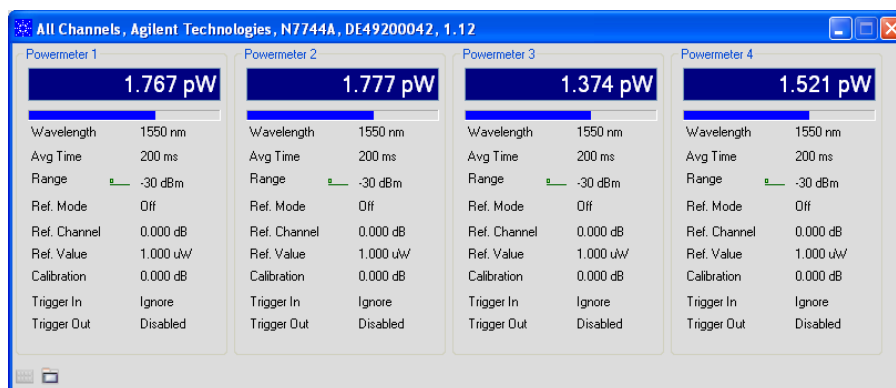
Figure 29   Viewing all channels

Saving and Recalling Configurations

Saving a configuration

You can save the current measurement configuration to either of two settings stored on the instrument.

1 In the File menu, select Save.

2 Enter or select the setting to which you want to save it.
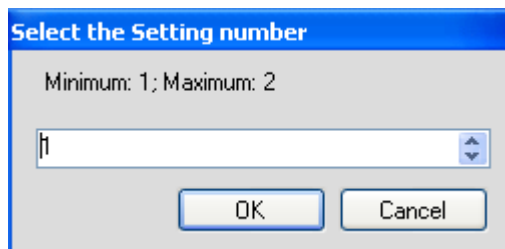
Figure 30   Saving a configuration

3 Click on the "OK" button.

Recalling a configuration

1 In the File menu, select Load.

2 Enter or select the setting you want to retrieve.

3 Click on the "OK" button.

Controlling the Instrument Refresh

1 In the File menu, select Update.

In the dialog, you can :
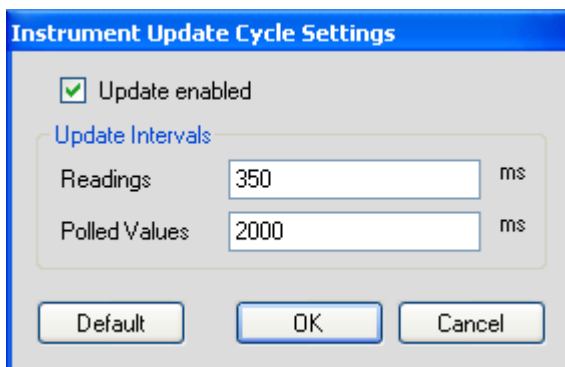
Figure 31   Controlling the Instrument Refresh

• Stop and start the display of all changes. Make sure to put a check in the box for "Update enabled", to enable the N77xx Viewer to display the status and results from the instrument. If there is no check in the box for "Update enabled", the display is not updated with the replies to queries sent to the instrument.

• Set the update interval for "Readings" to control how often the result is read from the instrument and the display updated.

• Set the update interval for "Polled Values" to control how often the measurement parameters are read from the instrument and the display updated. This is useful if, for example, more than one person can control the instrument.

2 When you have set all the values, click on the "OK" button.

2
Power Measurement

Power Measurement

This chapter describes how to measure optical power using the Keysight N7744A/N7745A/N7747A/N7748A Optical Multiport Power Meter.

- "Controlling the Optical Multiport Power Meter" on page 43
- "The Power Value" on page 47

Controlling the Optical Multiport Power Meter

There are different possibilities to control the instrument:

- LAN Connection: [Instrument Web Interface]

- LAN / USB / GPIB Connection: [N77xx Viewer]

- LAN / USB / GPIB: Programming with SCPI commands (described in the Programming Guide available on the CD supplied with the instrument or from www.keysight.com), or using the 816x VXI Plug&Play driver. For the Keysight N7744A/N7745A Optical Multiport Power Meter, you can also use the associated IVI-COM drivers.

To connect to the instrument see " Input and Output Connectors - Overview" on page 18.

To display the Web Interface of the Multiport Power Meter please either

- Press the "Instrument Web Interface" Button within the Connection Expert, or

- Enter the instrument's IP Address or DNS Address in the Address Line of your browser.

The browser starts with the screen shown in the figure, below.
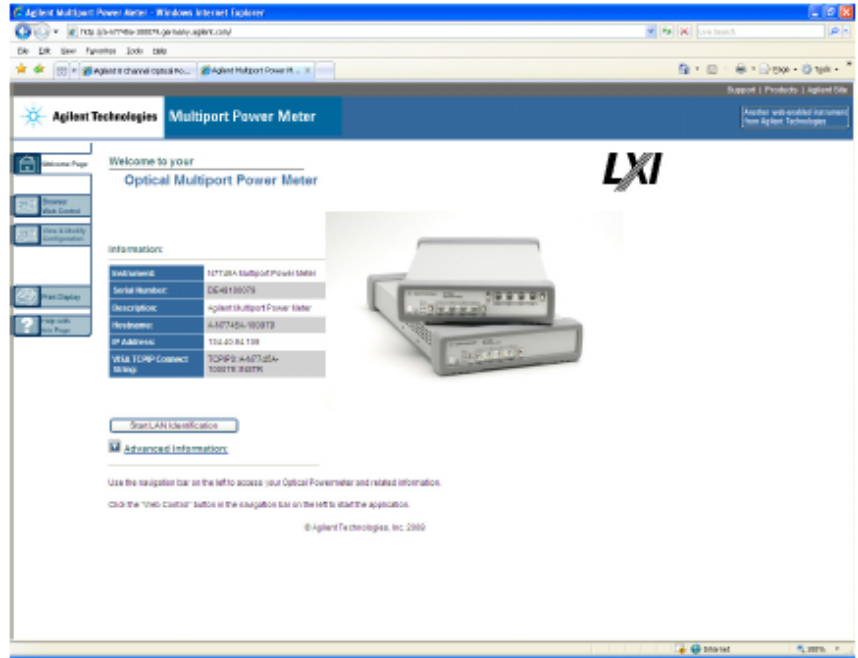
Figure 32   The Welcome Page

Select the "Browser Web Control" tab on the left.
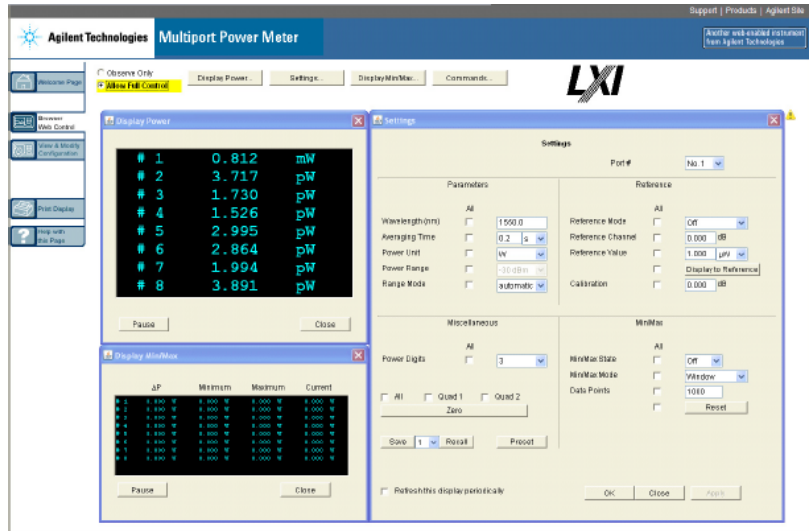
Figure 33   The Browser Web Control

How to Change the Settings of the Optical Multiport Power Meter

To change the settings of the Optical Multiport Power Meter from the Browser Web control window, you must select the "Allow Full Control" button. Now you are able to change the settings (see the figure, below) of the Optical Multiport Power Meter. The changes are made when you press the "Apply" button. If you selected the "All" checkbox, the setting is applied to all ports.

To quickly and reproducibly set the measurement parameters, use the Measurement Settings buffers. These let you save and recall sets of settings with single programming commands. For further details, refer to "Handling Measurement Settings - The :CONFigure:MEASurement:SETTing subtree" in the Programming Guide.
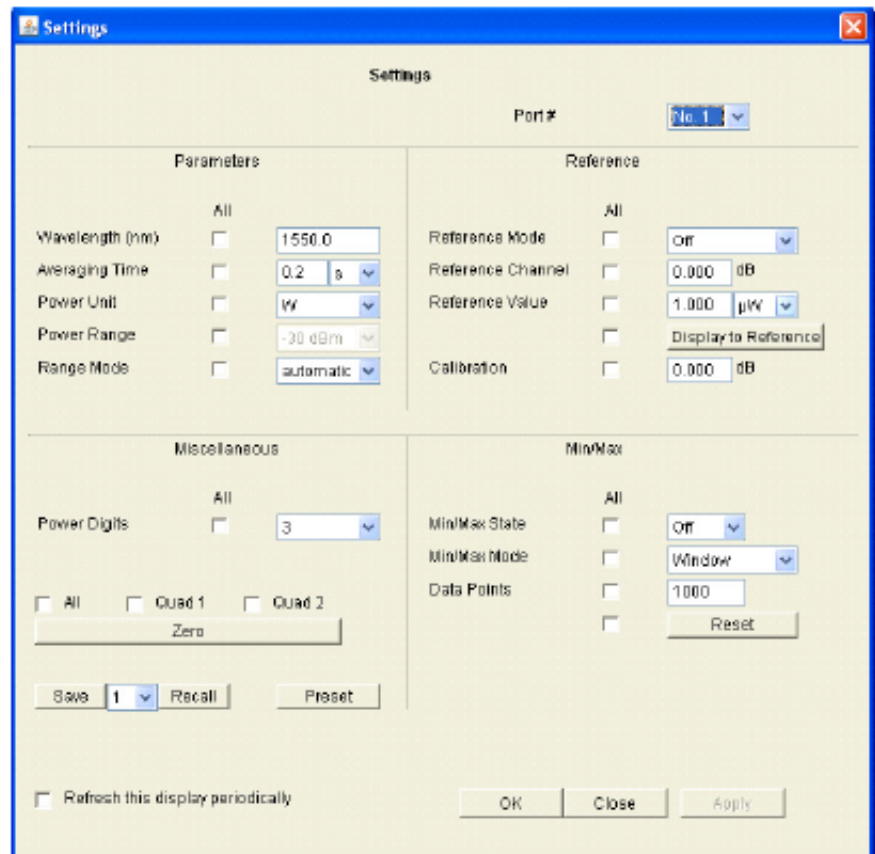
Figure 34   Settings of the Optical Multiport Power Meter

The most convenient way to control one or more Multiport Power Meters is using the N77xx Viewer, which is a control and display graphical user interface.
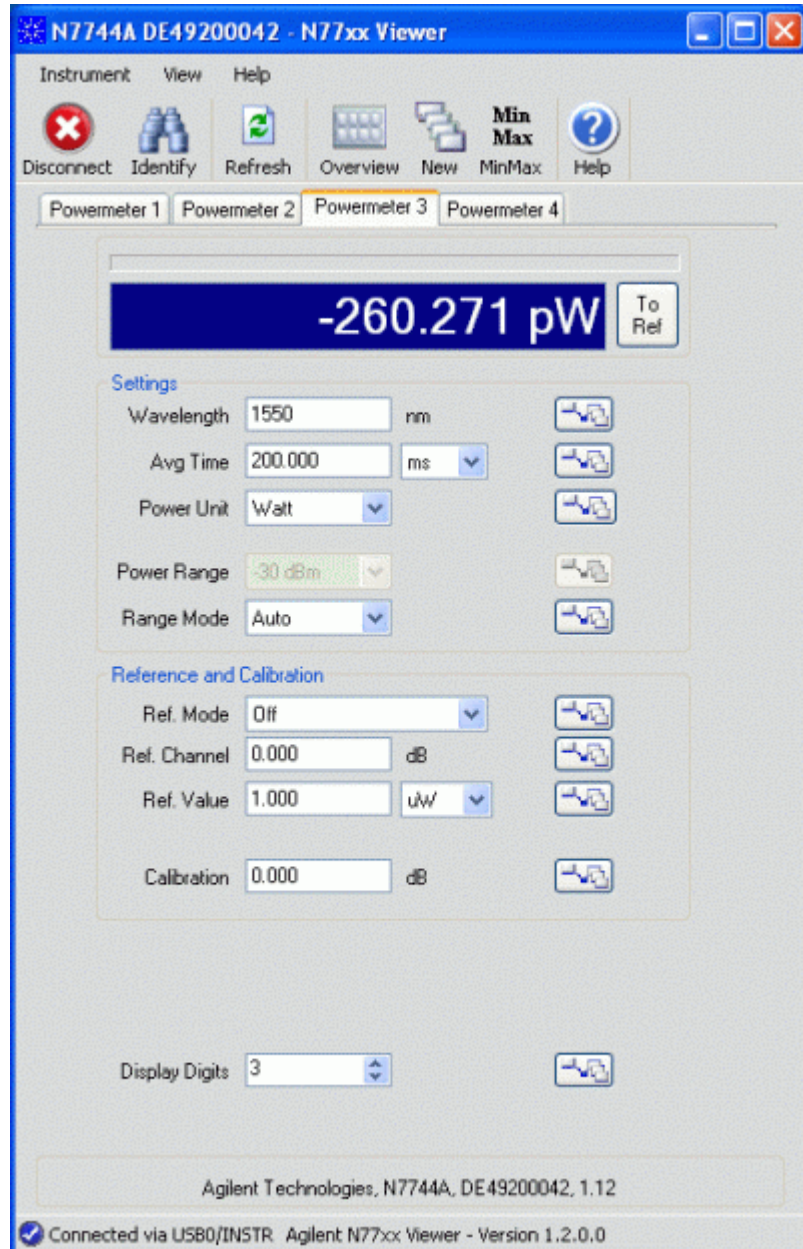
Figure 35 The N77xx Viewer

The Viewer is available to download from the product webpage which you can access at

Then select "Technical Support" followed by "Drivers & Software".

Figure 36   Technical Support

On this webpage you will also find additional software tools like:

- Firmware update utility
- Firmware update file
- VXI Plug&Play Drivers
- IVI Drivers

How to Measure Power

The Power Value

For each port, the optical power is measured and returned or displayed. The power reading represents the average optical power over the selected averaging time. The power meter can continuously self-trigger new measurements or be configured to wait for external software or hardware triggers.

How to Set the Number of Digits

When the power is displayed with the Web Interface or the Viewer program, you can set the maximum number of digits that are used in power measurement. This is the maximum number of digits after the decimal point.

How to Set the Power Unit

The Power Unit setting allows you to select either W, dBm or dB as the units in which power is displayed or returned. For returning large amounts of logged data, the fastest data transfer is achieved using W units.

What are the Power Units?

Watts (W) are the SI unit for power measurement.

You can also measure power in dB or dBm. Values returned in these units are derived from measurement in Watts.

By selecting dBm, the following calculation is made:

$$P_{dBm} = 10\log\frac{P_{input}(W)}{1 \times 10^{-3}(W)}$$

Where,

P_{dBm} is the power value returned in dBm, and

P_{input} is the input signal level in Watts.

Power, in units of dBm, is measured relative to 1 mW. It is an absolute power measurement.

Power, in units of dB, is measured relative to a particular reference power value. For information on selecting this reference value, see How to Input a Reference Level.

The following calculation is made:

$$P_{dB} = 10\log\frac{P_{input}(W)}{P_{ref}(W)}$$

Where,

P_{dB} is the power value returned in dB,

P_{input} is the input signal level in Watts, and

P_{ref} is the chosen reference power value in Watts.

How to Set the Calibration Offset

This is a calibration offset that you can enter to compensate for external optical circuitry, for example, an attenuator, switch, or a 3 dB coupler. The calibration offset, [Cal], is automatically subtracted from the input signal, as expressed in dB.

$$P_{measured}(dBm) = P_{input}(dBm) - CAL(dB)$$

where,

$P_{measured}$ is the adjusted value of the signal read in dBm,

P_{input} is the input signal level in dBm, and

CAL is the calibration offset in decibels (dB).

How to Set the Reference Level

How to Input a Reference Level

dB results are shown relative to a reference level. Setting, or changing, the reference only affects results that are returned in dB.

You can set the reference level in units of dBm or Watts. Depending on which is selected the following equations are used to calculate the power level in dB:

P_{dB} = $P_{measured}$(dBm) - REF(dBm)

or

$$P_{dB} = 10\log\frac{P_{measured}(W)}{REF(W)}$$

where,

P_{dB} is the returned relative power,

$P_{measured}$ is the absolute power level (see), and

REF is the reference level.

How to Set the Reference Value to the Current Power Value

In addition to entering a new reference value, you can change the reference value to the current power value from the N77xx Viewer or by programming.

This takes the input power level and stores it as the reference. Setting the reference only affects results returned in dB.

The power value in dBm or Watts is stored as the reference, that is:

REF = P$_{measured}$

where,

REF is the reference, and

P$_{measured}$ is the absolute power level (see "How to Set the Calibration Offset" on page 49).

How to Reference Another Power Measurement Port

You can use the reference mode to reference to another port's current power level. If you choose this mode, the reference of the port continuously updates to the current power value measured by the other port.

The following equations describe how the power in dB is calculated if you reference another port:

P$_{dB}$ = P$_{measuredA}$(dBm) - P$_{measuredB}$(dBm) - REF(dB)

or

$$P_{dB} = 10 \log \frac{P_{measuredA}(W)}{P_{measuredB}(W)} - REF(dB)$$

where:

P$_{dB}$ is the relative power,

P$_{measuredA}$ is the absolute power level (see "How to Set the Calibration Offset" on page 49) measured by the current port, and

P$_{measuredB}$ is the absolute power level (see "How to Set the Calibration Offset" on page 49) measured by the port you choose to reference, and *REF* is the reference level in decibels (dB).

How to Set the Wavelength

This is the wavelength value of the signal to be measured. The responsivity of the Power Meter varies with wavelength.

For accurate absolute power measurement, you need to input the wavelength of the optical input.

For relative power measurements, this setting is not critical.

How to Remove Electrical Offsets (Zero)

Optical Power Meters measure optical power by converting optical power to electrical current, and then measuring electrical current. An electrical offset is electrical current that is always present, even if there is no optical power input. If electrical offsets are not removed, they affect the accuracy of power measurement, especially at low optical power levels.

Performing a zero sets the zero power level to the average electrical offset level for the current environmental conditions.

N O T E   The environmental conditions and the temperature of the instrument NOTE affect electrical offset.

For the best results you must:

- Allow the instrument time to acclimatize (around 24 hours).

- Allow the instrument time to warm up (around 20 minutes).

- Make sure that the optical input is not receiving any light or use the zeroing adapter. If you are using multi-mode fiberoptic cable, you must disconnect the cable and cover the input to the Power Meter to perform a zero.

It is good practice to perform a zero before making any sensitive measurements.

Logging data over a wide dynamic range is a typical case that requires a valid zero setting.

1 In the File menu, select Zeroing.
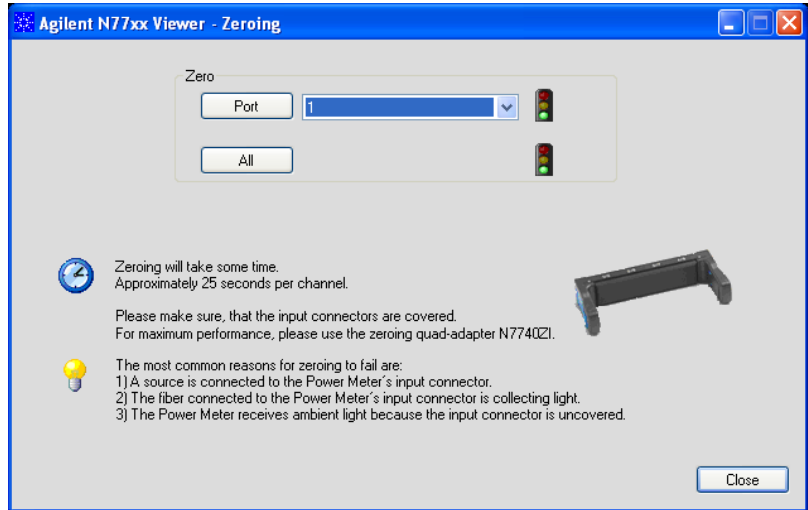
Figure 37

2   Select the channel you want to zero from the drop down list and click on the "Port" button.

OR

Click on the "All" button.

While the zero is running, the traffic light flashes amber.

If you receive a zero error, the zeroing operation has failed because the Power Meter received light. The most common reason for zeroing to fail is if:

- a source is connected to the Power Meter's input connector,

- the fiber connected to the Power Meter's input connector is collecting light, or

- the Power Meter receives ambient light because the input connector is uncovered.

  When zeroing is finished, the traffic light is green. You can now proceed with your measurements.

When environmental conditions are stable, the zero setting will remain valid over long times and the same settings will be active after rebooting the instrument.

How to Choose the Range Mode

You can choose either of two ranging modes:

- *<Auto>*, the auto-ranging mode, ensures that the result has a returned value between 9% and 100% of full scale. The default state is for automatic ranging to be enabled.

- *<Manual>*, which allows you to set a user-defined range.

How to Set the Range

The range setting determines the power levels that can be measured. The setting should be high enough for the applied power, but lower settings will provide a lower noise level for weak signals.

If you choose auto-ranging mode, this parameter can not be set. The Range parameter returns the automatically-determined range.

If the measured power is more than 3dB greater than the range setting, the power cannot be measured and an overflow is indicated by the returned power value. This means that the measured power is greater than the Upper Power Limit. You must increase the [*Range*] value.

More more details, see the following table.

Upper Power Limit

The following table shows the upper power limit at the available power ranges. The lowest measurable power in each range is determined by the noise level, which depends on the range setting and the averaging time.

Table 3   Upper Power Limits for Various Power Ranges

[RANGE]	Upper Power Limit	
10 dBm	10.000 mW	10.000 dBm
0 dBm	1.9999 mW	3.000 dBm
-10 dBm	199.99 µW	-7.000 dBm
-20 dBm	19.999 µW	-17.000 dBm
-30 dBm	1.9999 µW	-27.000 dBm

Table 3	Upper Power Limits for Various Power Ranges	
[RANGE]	**Upper Power Limit**	
-40 dBm	199.99 nW	-37.000 dBm
-50 dBm	199.99 nW	-47.000 dBm
-60 dBm	199.99 nW	-57.000 dBm
-70 dBm	199.99 pW	-67.000 dBm

How to Set the Averaging Time

This is the length of time over which a signal is averaged to produce a measured value. Longer averaging times increase the accuracy and improve the noise rejection.

The averaging time of the N7744A and N7745A can be set over a wide range from 1 μs to 10s. Up to 2 ms, the setting can be varied with a typical resolution of 2 μs, and for higher averaging times the setting resolution is about 0.1%. This flexible setting time supports optimal synchronization with the time scale of the signals. The high sampling rate with short averaging times is supported by the high cutoff frequency, as shown in the specifications. These bandwidths are reduced in steps, when longer averaging times are used to improve the noise performance while maintaining signal fidelity.

For the N7747A and N7748A, the averaging time can be set from 25 μs to 10 s. Up to 2 ms, the setting can be varied with a typical resolution of 2 μs, and for higher averaging times the setting resolution is about 0.1%. The bandwidth is fixed with the chosen power range, as listed in the specifications and independent of the selected averaging time. Individual values for live readings and for the MinMax mode, are generated with a minimum resolution of 1 ms. This limit does not apply to the Logging and Stability functions.

How to Set Automatic Gain for Averaging Modulated Signals

A fast Auto Gain switching is used to achieve the high dynamic range in the N7744A and N7745A. In some applications, like determining the average power of signals modulated with periods shorter than the averaging time, this switching produces irregular readings. In such

cases, the Auto Gain should be turned off, as described in the programming guide. This setting takes effect after setting the averaging time on the port directly or via function parameters.

How to Choose the MinMax Mode

MinMax mode measures the incoming power and returns the minimum value measured, and the maximum value measured. The difference between these values, delta P, is returned in place of P, the power value. This mode is intended principally for polarization dependent measurements, but can be used for other types of measurement.
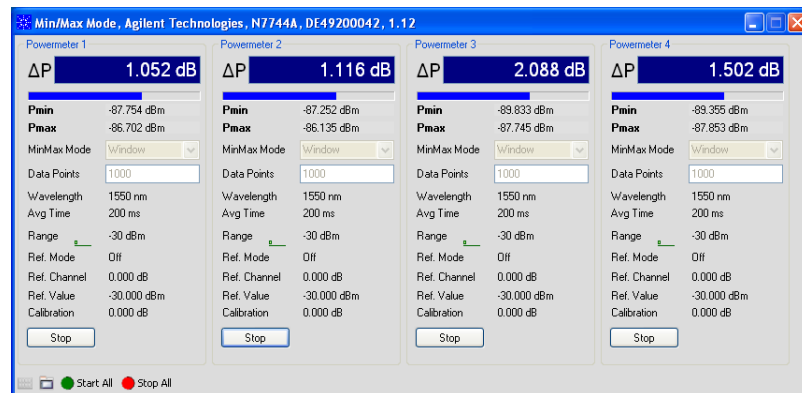
Figure 38   How to Choose the MinMax Mode

The Min/Max mode can be activated from both the Web Control Interface and the N77xx Viewer, as well as with direct programming described in the Programming Guide.You can choose two modes of operation from the MinMax mode menu:

- *<Continuous>* mode, which compares each new measured value with the maximum and minimum values so far, and replaces them as necessary.

  This mode is useful for measuring the Polarization Dependent Loss (PDL) of a component. Run the application while sweeping the polarization of the source applied to the component.

- *<Refresh>* mode, which records the minimum and maximum values until N samples have been compared. After N samples the minimum and maximum values are reset and a new MinMax measurement begins.

  You can use Refresh mode, for example, when you are searching for or setting the position of minimum PDL.
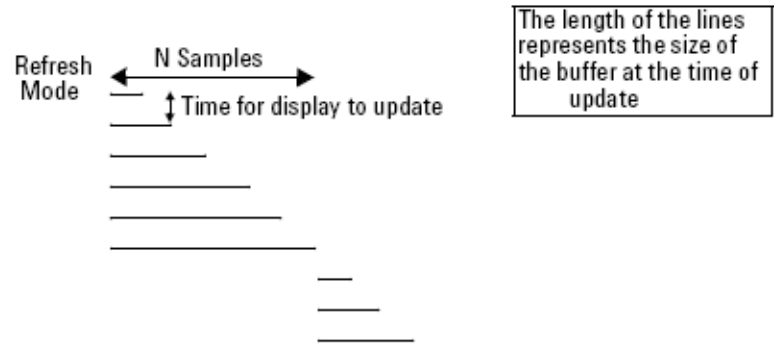
Figure 39   Refresh Mode

NOTE	Window mode is not currently implemented in the N774xA and N775xA. For compatibility with existing software it can be selected but functions the same as Refresh mode.

NOTE	The minimum sampling period in Min/Max mode, dependent on the rate of commands and number of active ports, is about 2 ms.

How to Use External Triggers

The Optical Multiport Power Meter lets you trigger the instrument to perform tasks and to output trigger signals to external measurement instruments using the rear panel BNC connectors.

1   In the File menu, select Trigger.
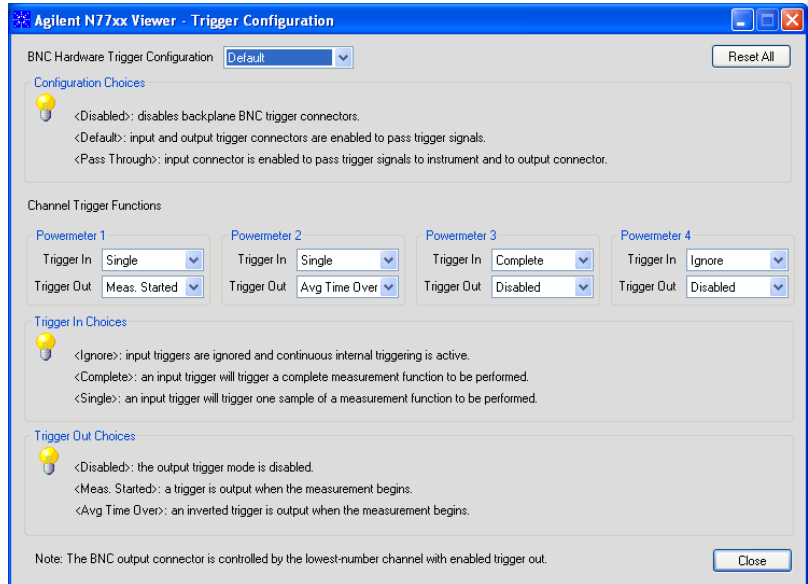
Figure 40 Trigger Configuration

2 Set the trigger configuration

By default, the trigger level at the external trigger connector is active high. This means when a trigger rises above the high TTL level (rising edge), a trigger is accepted.

You can select three modes of triggering from the trigger configuration menu:

- <Disabled>, if you do want to disable triggering.

- <Default> to enable the trigger connectors.

- <Pass Through> if you want an input trigger to automatically generate an output trigger. This lets you trigger another instrument almost simultaneously.

3 Set the input trigger functions

The power meter ports can be configured individually to respond to an input trigger by:

- <Ignore> The trigger is ignored.

- <Single Measurement> The trigger causes a single power measurement to be made.

- <Complete Measurement> The trigger will cause an active measurement function like logging to begin and continue until completed.

4 Set the output trigger functions

The power meter ports can be configured individually to generate output triggers for the following events:

- <Disabled> No triggers are generated.

- <Meas. started> An output trigger is generated when a power measurement begins.

- <Avg Time Over> An inverted trigger is generated for each measurement sample.

For further information on triggering, please refer to the Keysight N77xx-Series Programming Guide, in the chapter "Triggering - The TRIGger Subsystem".

3
Power Meter Applications

Power Meter Applications

This chapter explains how to set up and perform the following applications using the N7744/5/7/8A Optical Multiport Power Meter.

- The Logging application logs power measurements. The Logging application performs measurements consecutively without the possibility of any pause between measurements.

- The Stability application logs power measurements. The Stability application differs from the Logging application because:

  - the period time, the time it takes from the start of one measurement period until another measurement period starts, may be greater than or equal to the averaging time.

These applications can be accessed with programming commands as described in the Programming Guide.

The Logging Application

The Logging Application logs a series of power measurements for a number of power meter ports.
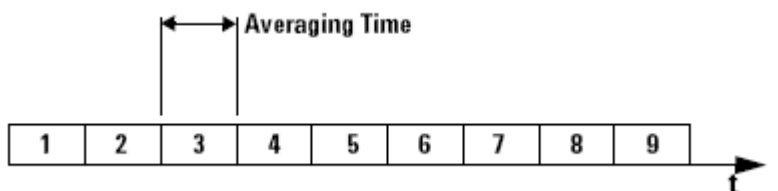
Figure 41   Example Logging Application

The most important parameters for the logging application are:

- *[Samples]*, this is the number of samples that will be performed during the logging application, and

- *[AvgTime]*, the averaging time is the length of time over which a signal is averaged. Longer averaging times increase the accuracy and improve the noise rejection. Longer averaging times also improve sensitivity.

The total time for a logging application is the number of samples multiplied by the averaging time. The power range is constant during a logging application and autoranging is disabled.

The Logging application differs from the "The Stability Application" (see, "The Stability Application" on page 61) because all power measurements are performed consecutively without the possibility of any pause between measurements, as shown in the figure, above.

While performing the logging application all used ports of the instrument will have the same averaging time and number of samples. Setup parameters for each of the ports should be set before the logging is started on any port. Only N7747A and N7748A allow different settings for logging parameters on each channel.

The logging function is often used together with single-measurement input triggering for synchronized measurement with another instrument, especially for spectral measurements with a tunable laser.

Continuous Logging Using Data Buffers

Enhanced logging functionality is available using two data buffers for each port.

The MPPM ensures there is no time lag between logging and data availability by using a data buffer with a capacity of 1M samples for each channel. You can read the most recent results out of one buffer out while the next logging measurement is filling the other buffer.

You can use this to speed up applications with repeated logging operations. It is especially valuable for monitoring signals over extended periods to detect transient events.

To use the data buffers, set the logging function to perform a fixed or indefinite number of "LOOP"s, as described in the Programming Guide.

- When LOOP = 1, default logging behavior is selected, that is measurements are made and the results are written to the first buffer.

- If LOOP = 0, logging continues, writing the results into alternate buffers, until you stop it.

- When LOOP = n>1, then upon completion of a logging measurement, another is started and the results are written in rotation to the two buffers (first to buffer A, then buffer B, then buffer A, and so on).

  This is repeated until n logging measurements have been performed. For example, if n=2, both buffers are filled, and you can upload a total of 2M samples for the channel.

  You can also use input triggers to begin individual loops or to begin multiple loops with an initial trigger.

  The "Index" value is updated to indicate that data from each LOOP is available for readout.

The Stability Application

The Stability Application logs a series of power measurements for a number of power meter ports.
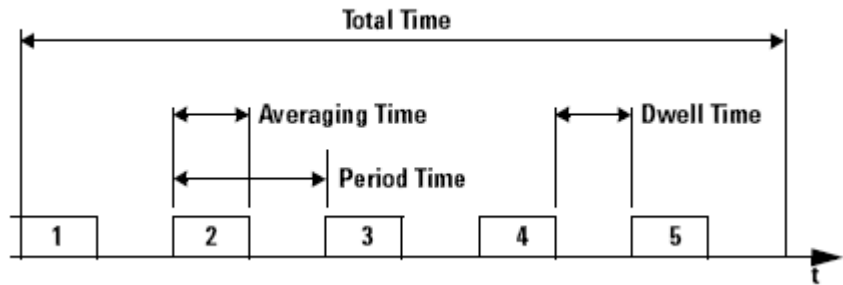
Figure 42   Example Stability Application

The Stability application differs from the "The Logging Application" because you set the averaging time, the total time, and the period time after which each new measurement is started. Period time must be greater than or equal to the averaging time you set.

This leaves the following two possibilities:

- The averaging time is less than the period time, there is a dwell time between the commencement of each power measurement, as shown in the figure, above.

- The averaging time is equal to the period time, all power measuremant are performed without any dwell time.

NOTE The total time concludes after the last dwell time period, not after the last averaging time period.

The Stability application enables you to make periodic power measurements over a long time (277 hours (11 days and 13 hours)).

4
Specifications and Regulations Compliance

Definition of Terms

(Applicable) fiber type

Connection type for which the specifications and characteristics apply (if not differently stated).

Averaging time

Specifies the period during which the power meter or monitor power meter takes readings from the photodetector. The displayed power result is the (arithmetical) average of these readings.

Constant operating conditions

This generally includes constant values of temperature, humidity, wavelength, input power level, polarization state and mode distribution, if the quantity is not explicitly subject to variation.

Data logging capability

Maximum number of power readings per port that can be captured during a logging operation.

Drift (dark)

Specifies the maximum deviation from zero of the measured power with no optical input (dark) over time, excluding , power expressed in Watts.

Measurement: From the dark measurement result P_i, a polynomial fit F_i is calculated. The fit incorporates the least square-sum difference and

uses 3rd-order for the N7744A and N7745A and 1st-order for the N7747A and N7748A. The Drift D is calculated by

$D = max_i\{F_i\}$ *or* $mini\{F_i\}$, whichever is worse.
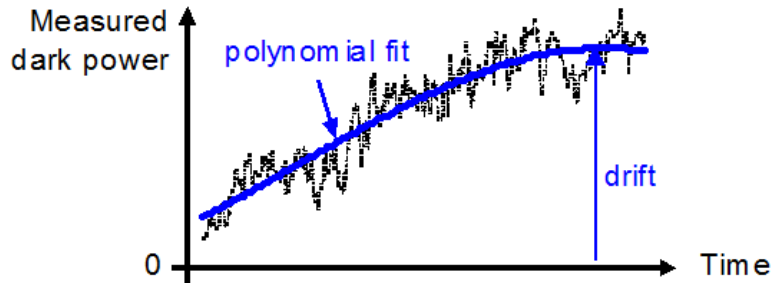
Figure 43 Drift (dark)

Conditions: All ports dark. Observation time as specified. Other conditions as specified.

Dynamic range (logging mode)

For a fixed power meter range, dynamic range D specifies the difference between the maximum displayable value P_{max} in dBm in the corresponding power meter range and the minimum measurable power P_{min} in dBm.

Conditions: As specified.

Measurement: P_{max} is 3 dB above the nominal power meter range value (that is, in the +0 dBm power meter range P_{max} is +3 dBm), except for the +10 dBm range with P_{max} = +10 dBm. P_{min},dBm is calculated as the root-sum-square (RSS) of the specified "Noise 2 sigma (dark)" (see, and "Drift (dark)" (see, . RSS is calculated in linear units (Watts).

Frequency Response

Specifies the frequency f_{resp} up to which the power meter's transfer function is above a defined cutoff level.

The transfer function is the measured optical amplitude on a modulated sinusoidal optical input divided by the actual amplitude over modulation frequency, expressed in dB.

Conditions: Cutoff level as specified. Other conditions as specified.

Linearity

Specifies the relative difference between the measured (displayed) power ratio D_x/D_0 and the actual (true) power ratio P_x/P_0, caused by changing the power level from the reference level P_0 to an arbitrary level P_x.

Powers expressed in Watts.

Excluding "Noise pp (dark)" (see, and "Drift (dark)" (see,).

$$L_\% = \left(\frac{D_x/D_0}{P_x/P_0} - 1 \right) \text{ when expressed in \%.}$$

$$L_{\mathrm{dB}} = 10 \log\left(\frac{D_x/D_0}{P_x/P_0} \right) \text{ when expressed in dB.}$$

Conditions: Reference power level P_0 = 0.01 mW (-20 dBm). Other conditions as specified.

Maximum safe (input) power

The maximum input power that can be applied to any port of the power meter or attenuator without permanent change to its characteristics.

Attention: Applying more than the specified power might damage the power meter or attenuator!

NOTE For input powers > 20 dBm, clean connectors in good condition are vital to avoid thermally induced fiber damage.

Minimum averaging time

The minimum selectable averaging time.

Noise pp (dark)

Specifies the peak-to-peak (pp) change of displayed power over time with zero input power (dark), excluding "Drift (dark)" (see,) for the N7744A and the N7745A only. Powers expressed in Watts.

Conditions: All ports dark. Averaging time as specified. Other conditions as specified.

Measurement: As for "Drift (dark)". From the measured Pi and the fitted curve F_i the noise curve $N_i = P_i - F_i$ is calculated.

The noise N is

$N = max_i\{N_i\} - min_i\{N_i\}$

Noise 2 sigma (dark)

Specifies twice the standard deviation of the measured dark power (with zero input power), excluding "Drift (dark)". Power are expressed in Watts.

Conditions: All ports dark. Averaging time as specified. Other conditions as specified.

Measurement: As for "Drift (dark)" (see,). From the measurement result Pi and the fitted curve Fi the noise N is calculated by

$N = 2*StDev_i\{P_i - F_i\}, where StDev_i\{\}$ denotes the standard deviation over indices i.

Operating humidity

Humidity range where the instrument is designed to be operated.

The instrument must not be operated outside this range. If previously stored beyond this range, wait for acclimation before turning on the instrument.

Operating temperature

Temperature range for which the specifications apply if not differently stated.

The instrument must not be operated outside this range. If previously stored beyond this range, wait for acclimation before turning on the instrument.

Operating temperature and humidity

The ambient temperature range and humidity range of the tunable laser source for which the specifications apply.

N O T E	If the tunable laser source module is rack- mounted the temperature and humidity within the rack apply.

Polarization dependent responsivity (PDR)

Specifies the dependence of the measured power on the input state of polarization (SOP) as ± half the difference between the highest and the lowest measured power over all SOPs, expressed in dB.

Powers expressed in dBm.

Conditions: As specified.

Port separation (static)

Specifies the difference between the power P applied to one port and the measured power D on any other port with no applied power (dark). Excluding "Noise pp (dark)" (see, "Noise pp (dark)" on page 65) and "Drift (dark)" (see, "Drift (dark)" on page 63).

Powers expressed in dBm, port separation S expressed in dB,

$S = P - D$
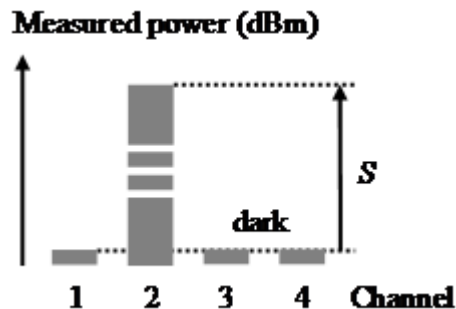
Figure 44   Port separation (static)

Conditions: Applied power level as specified.

Port separation, dynamic

Specifies the difference between step power input P_{step} (with positive or negative slope) applied to one port and the maximum measured power change D_{chng} (positive or negative) on any other port without applied power (dark). Excluding "Noise pp (dark)" (see, "Noise pp (dark)" on page 65) and "Drift (dark)" (see, "Drift (dark)" on page 63).

Powers expressed in dBm, dynamic port separation SD expressed in dB.

$SD = P_{step} - D_{chng}$

Conditions: Power step height as specified (1 mW).

Power range

Specifies the range from the smallest input power that causes a significant change of the measured (displayed) power to the highest power for which the specifications apply if not differently stated.

Range settling time (one range step)

When changing from one power meter range to the next (one range higher or lower), the settling time specifies the time required for the power meter to settle into the new range. Measurements starting after that period are within specifications.

The time starts when the instrument receives the range change command (manual range) or when the instrument detects the requirement for power meter range change (autorange).

Conditions: As specified.

Relative port to port uncertainty

Specifies ± half the maximum difference between the measured powers of different ports when applying the same stimulus. Measured powers expressed in dBm, the relative port to port uncertainty U expressed in ±dB.
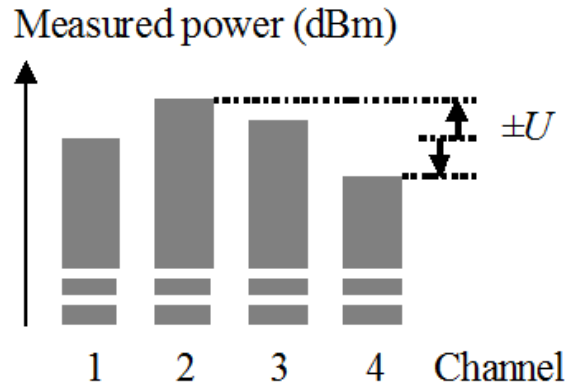
Figure 45   Relative port to port uncertainty

Conditions: As specified.

Return loss

The ratio between the incident power and the power reflected back from the instrument into the input fiber, expressed in dB.

Conditions: As specified. (For attenuators: applicable to both ports with fiber cables with high quality connectors in perfect optical condition on both attenuator ports and the respective second port terminated (zero reflectance).)

Measurement: With return loss meter and non-coherent source of applicable wavelength.

Specification wavelength range

The wavelength range for which all specifications and characteristics apply, if not differently stated.

Spectral ripple (power meter; due to interference)

A coherent input signal causes optical interference[1] between reflective interfaces within the power meter's optical assembly, including the end face of a connected fiber. Optical interference causes a wavelength-dependent periodic change of the power meter's responsivity. Spectral ripple is defined as ± half the difference between the highest and the lowest power resulting from the periodic change.

Conditions: Constant input power, constant state of polarization (SOP). Connector as specified. Other conditions as specified.

Measurement: Using a laser source without spectral ripple or with known (monitored) spectral ripple and linewidth < 100 MHz and stepping the wavelength over the specified range. The periodic part in the measurement result is separated by subtracting the polynomial 2nd order fit (low frequency part).

Storage conditions

Allowed temperature and humidity range for the non-operating instrument. Wait for acclimation to within the "Operating temperature" before turning on the instrument.

Total uncertainty

The maximum relative difference U between measured (displayed) power M and actual (true) power P for a specified set of operating conditions, expressed in percent. Powers expressed in Watts. Excluding "Noise pp (dark)" (see, "Noise pp (dark)" on page 65) and "Drift (dark)" (see, "Drift (dark)" on page 63).

$U = 100\% * (M/P - 1)$

Conditions: Operating conditions as specified. Other conditions as specified.

Uncertainty at reference conditions

The maximum relative difference U between measured (displayed) power M and actual (true) power P for the specified set of reference conditions, including all uncertainties in the calibration chain from the national calibration laboratory to the test meter, expressed in percent. Powers expressed in Watts.

$U = 100\% * (M/P - 1)$

Conditions: Reference conditions as specified.

Wavelength range

The range of wavelengths for which the power meter is calibrated, or that can be set at the attenuator and for which the specifications apply (if not differently stated).

Warm-up time

Time after power-up of the acclimated instrument after which the specifications and characteristics apply.

Literature

Fiber Optic Test and Measurement, Hewlett Packard Professional Books, edited by Prentice Hall, ISBN 0-13-534330-5

Technical Specifications - Keysight N7744A and N7745A

	Agilent N7744A, N7745A		
Sensor element	InGaAs		
Wavelength range	1250 nm to 1650 nm		
Specification wavelength range	1250 nm to 1625 nm (if not stated differently)		
Power range	-80 dBm to +10 dBm		
Maximum safe power	+16 dBm		
Data logging capability	2 buffers per port, each with capacitiy for 1 Mio. measurement points		
Averaging time	1 µs to 10 s		
Applicable fiber type	Standard SM and MM $\leq$ 62.5 µm core size, NA $\leq$ 0.24		
Uncertainty at reference conditions [f1] [f3]	±2.5%		
Total uncertainty [f2] [f5] [f6]	±4.5%		
Relative port to port uncertainty [f1] [f3] [f4] [f10]	typ. ±0.05 dB		
Linearity [f5] [f6] at (23 ± 5)°C	±0.02 dB ± 3 pW		
over operating temperature	±0.04 dB ± 5 pW		
Polarization dependent responsivity [f3] [f7]	< ±0.015 dB (1520 nm to 1580 nm) typ. < ±0.01 dB (1250 nm to 1580 nm)		
Spectral ripple (due to interference) [f9]	< ±0.01 dB (1520 nm to 1625 nm) typ. < ±0.01 dB (1250 nm to 1520 nm)		
Drift (dark) [f4]	±9 pW		
Noise peak-to-peak (dark) [f3]	< 7 pW (1 s averaging time, 300 s observation time)		

Noise 2σ [f3] (100,000 samples)	Averaging time: 1 µs	25 µs	1 ms
PM range -30 dBm	typ. < 0.1 nW	< 0.025 nW	< 0.005 nW
-20 dBm	typ. < 1.5 nW	< 0.15 nW	< 0.02 nW
-10 dBm	typ. < 6 nW	< 0.5 nW	< 0.08 nW
0 dBm	typ. < 60 nW	< 4 nW	< 0.8 nW
+10 dBm	typ. < 600 nW	< 40 nW	< 8 nW

Dynamic range (logging mode) [f3] [f4]	Averaging time: 1 µs	25 µs	1 ms
PM range -30 dBm	typ. > 43 dB	> 49 dB	> 57 dB
-20 dBm	typ. > 43 dB	> 54 dB	> 62 dB
-10 dBm	typ. > 46 dB	> 57 dB	> 64 dB
0 dBm	typ. > 46 dB	> 57 dB	> 63 dB
+10 dBm	typ. > 43 dB	> 54 dB	> 60 dB

Port separation [f5]	> 85 dB (CW) (one neighbor port with 0 dBm)		
Port separation, dynamic [f5]	> 70 dB typ. (one neighbor port with 0 dBm power in 0 dBm power meter range)		
Frequency response	3 dB cutoff frequency at 1 µs averaging time, typ.		
-30 dBm range	10 kHz		
-20 dBm range	130 kHz		
-10 to +10 dBm range	250 kHz		

	Agilent N7744A, N7745A
Return loss [f8]	> 50 dB (1520nm to 1580nm) typ. > 57 dB (1280 nm to 1580 nm)
Line Power	AC 100 - 240 V ± 10%, 50/60Hz, 60VA max.
Operating temperature	+5 °C to +40 °C
Operating humidity	15% to 95%, non-condensing
Storage conditions	-40 °C to +70 °C
Warm-up time	20 min.
Recommended recalibration period	24 months
Dimensions	372 mm × 212 mm × 43 mm (excluding front and back rubber cushions)
Weight	3 kg (6 lb)
LXI Compliance	LXI Class C, ver. 1.2

[f1] Reference conditions:

• Single mode fiber SMF 9 µm

• Power level: -20 dBm to 0 dBm

• On day of calibration (add ±0.3% for aging over one year; add ±0.6% for aging over two years)

• Spectral width of source < 10 nm full width half maximum (FWHM)

• Wavelength setting of power sensor corresponds to source wavelength ± 0.4 nm

[f2] Operating conditions:

• Single mode fiber SMF. For multimode fiber, typical.

• Within one year of calibration; add ±0.3% for second year

• Spectral width <10 nm FWHM

• Wavelength setting of power sensor corresponds to source wavelength ± 0.4 nm

[f3] Ambient temperature (23 ± 5) °C

[f4] Temperature constant within ±1 K after zeroing

[f5] Excluding noise and offset drift

[f6] Power range -60 dBm to +10 dBm

[f7] Straight connector, SMF

[f8] Connector 8° angled, ceramic ferrule, SMF

[f9] For constant state of polarization, source linewidth <100 MHz, angled connector 8°, wavelength range 1520 nm to 1625 nm. Typical for 1250 nm to 1520 nm. Add ±0.01 dB typ. within specification wavelength range for straight connector with ceramic ferrule.

[f10] Same 4-detector block, same wavelength

Technical Specifications - Keysight N7747A and N7748A

		N7747A and N7748A
Sensor element		InGaAs
Wavelength range		800 nm to 1700 nm
Power range		−110 dBm to +10 dBm
Maximum safe input power		+16 dBm
Applicable fiber type		Standard SM and MM, ≤ 100 μm core size, NA ≤ 0.3
Uncertainty at reference conditions [1]		± 2.5% (1000 nm to 1630 nm)
Total uncertainty [2, 3]		± 4.5% (1000 nm to 1630 nm)
Polarization dependent responsivity [4]		< ± 0.005 dB
Spectral ripple [5]	Due to interference	< ± 0.005 dB
Linearity [3, 6]		< ± 0.015 dB (at 23 °C ± 5 °C)
		< ± 0.030 dB (in operating temperature range)
		< ± 0.005 dB (fixed power range ≥ −20 dBm, within 10 dB below range setting)
Noise [7]	Peak to peak, dark, including drift	< 0.1 pW (1200 nm to 1630 nm)
Drift [7]		< ± 0.05 pW
Return loss [8]		> 55 dB
Supplementary characteristics		
Frequency response	3 dB cutoff, also for analog output	5.0 kHz (+10 dBm to −20 dBm range)
		4.0 kHz (−30 dBm to −40 dBm range)
		0.3 kHz (−40 dBm to −70 dBm range)
Averaging time		25 μs to 10 s, typ. setting resolution 0.1% down to 2 μs
Data logging capability		2 buffers/port, each with 1 Mio. measurement point capacity

1. *Reference conditions:*
   ◦ *Power level 10 μW (−20 dBm), continuous wave (CW)*
   ◦ *Fiber 50 μm graded-index, NA = 0.2*
   ◦ *Ambient temperature 23 °C ± 5 °C*
   ◦ *On day of calibration (add ± 0.3% for aging over one year, add ± 0.6% over two years)*
   ◦ *Spectral width of source < 10 nm (FWHM)*
   ◦ *Wavelength setting at power sensor must correspond to source wavelength ± 0.4 nm*

2. *Operating conditions:*
   ◦ *Fiber ≤ 50 μm, NA ≤ 0.2*
   ◦ *Connectors with 2.5 mm ferrule with flat face (fiber tip offset not more than 0.3 mm from 2.5 mm cross-section) with straight or angled polish*
   ◦ *Within one year after calibration, add 0.3% for second year*
   ◦ *Operating temperature range as specified, humidity: Non-condensing*

3. *Excluding noise and drift*

4. *All states of polarization at constant wavelength (1550 nm ± 30 nm) and constant power, straight connector, T = 23 °C ± 5 °C. For angled connector (8°) add ± 0.01 dB typ.*

5. *Test conditions: wavelength 1550 nm ± 30 nm, fixed state of polarization, constant power, temperature 23 °C ± 5°C, linewidth of source ≥ 100 MHz, angled connector 8°*

6. *CW, −90 dBm to +10 dBm, 1000 nm to 1630 nm*

7. *Averaging time 1 s, T = 23 °C ± 5 °C, ΔT ±1 °C, observation time 300 s*

8. *Wavelength 1310 nm ± 30 nm and 1550 nm ± 30 nm, standard single mode fiber, angled connector 8°, T=23 °C ± 5 °C*

General Characteristics

Analog output	0 to 2 V in to open, 600 Ω typ. output impedance, max input voltage ± 10 V
Dimensions (D x W x H)	460 mm x 212 mm x 43 mm
	1 RU height, half-rack width (excluding front and back rubber cushions)
Weight	N7747A: 3.5 kg ; N7748A: 4.0 kg
Recommended recalibration period	2 years
Operating temperature	5 °C to +40 °C
Operating humidity	Noncondensing
Altitude	2000 m
Pollution protection	Designed for pollution Degree 2
Warm-up time	20 minutes
Interfaces	The instruments can be controlled via LAN, USB or GPIB interfaces
Power consumption	Line power: AC 100 to 240 V ± 10%, 50/60 Hz, 60 VA max.

Definitions

Generally, all specifications are valid at the stated operating and measurement conditions and settings, with uninterrupted line voltage.

Specifications (guaranteed)

Describes warranted product performance that is valid under the specified conditions.

Specifications include guard bands to account for the expected statistical performance distribution, measurement uncertainties changes in performance due to environmental changes and aging of components.

Typical values (characteristics)

Characteristics describe the product performance that is usually met but not guaranteed. Typical values are based on data from a representative set of instruments.

General characteristics

Give additional information for using the instrument. These are general descriptive terms that do not imply a level of performance.

Declaration of Conformity - Keysight N7744A and N7745A

The latest version of the Declaration of Conformity can be found here
http://www.keysight.com/go/conformity

KEYSIGHT TECHNOLOGIES	**DECLARATION OF CONFORMITY** According to EN ISO/IEC 17050-1:2004	**CE**
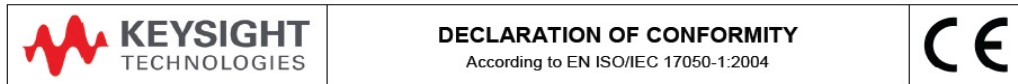
Manufacturer's Name: Keysight Technologies Deutschland GmbH
Manufacturer's Address: Herrenberger Strasse 130
D-71034 Boeblingen
Germany

Declares under sole responsibility that the product as originally delivered

Product Name: **Optical Power Meter**
Model Number:
N7744A 4 Channels
N7745A 8 Channels
N7747A 2 Channels, High Performance
N7748A 4 Channels, High Performance
Product Options: *This declaration covers all options of the above system.*

complies with the essential requirements of the following applicable European Directives, and carries the CE marking accordingly:

- *The Low Voltage Directive 2006/95/EC*
- *The EMC Directive 2004/108/EC*

and conforms with the following product standards:

	Standard	**Limit**
EMC	IEC 61326-1:2012 / EN 61326-1:2013	
	Reference Standards	
	CISPR 11:2009+A1:2010 / EN 55011:2009+A1:2010	Group 1 Class A
	IEC 61000-4-2:2008 / EN 61000-4-2:2009	4 kV CD, 8 kV AD
	IEC 61000-4-3:2006+A1:2007+A2:2010 /	3 V/m / 80 MHz-2 GHz, 1V/m / 2-2.7 GHz
	EN 61000-4-3:2006+A1:2008+A2 :2010	
	IEC 61000-4-4:2004+A1:2010 / EN 61000-4-4:2004+A1 :2010	0.5 kV signal lines, 1 kV power lines
	IEC 61000-4-5: 2005 / EN 61000-4-5:2006	0.5 kV line-line, 1 kV line-ground
	IEC 61000-4-6:2008 / EN 61000-4-6:2009	3 V, 0.15-80 MHz
	IEC 61000-4-11:2004 / EN 61000-4-11:2004	0% for 1 / 0.5 (0°, 180°) cycle
		0% for 250 / 300 cycles
		70% for 25 / 30 cycles
	Canada: ICES/NMB-001:2006	
	Australia/New Zealand: AS/NZS CISPR 11:2011	
Safety	IEC 61010-1:2010 / EN 61010-1:2010	
	Canada: CAN/CSA-C22.2 No. 61010-1-04	
	USA: ANSI/UL 61010-1:2004	

Supplementary Information:

The product was tested in a typical configuration with Keysight Technologies test systems.
This DoC applies to above-listed products placed on the EU market after:

2014-August-01
Date

Hans-Martin Fischer
Product Quality & Compliance

For further information, please contact your local Keysight Technologies sales office, agent or distributor.
Or Keysight Technologies Deutschland GmbH, Herrenberger Strasse 130, 71304 Boeblingen, Germany

Year of first marking: 2008   Revision: A

Declaration of Conformity - Keysight N7747A and N7748A

The latest version of the Declaration of Conformity can be found here
http://www.keysight.com/go/conformity

KEYSIGHT TECHNOLOGIES | **DECLARATION OF CONFORMITY** According to EN ISO/IEC 17050-1:2004 | C E

Manufacturer's Name:
Manufacturer's Address:

Keysight Technologies Deutschland GmbH
Herrenberger Strasse 130
D-71034 Boeblingen
Germany

Declares under sole responsibility that the product as originally delivered

Product Name:
Model Number:

Optical Power Meter

N7744A	4 Channels	
N7745A	8 Channels	
N7747A	2 Channels, High Performance	
N7748A	4 Channels, High Performance	

Product Options: *This declaration covers all options of the above system.*

complies with the essential requirements of the following applicable European Directives, and carries the CE marking accordingly:

- *The Low Voltage Directive 2006/95/EC*
- *The EMC Directive 2004/108/EC*

and conforms with the following product standards:

	Standard	*Limit*
EMC	IEC 61326-1:2012 / EN 61326-1:2013	
	Reference Standards	
	CISPR 11:2009+A1:2010 / EN 55011:2009+A1:2010	Group 1 Class A
	IEC 61000-4-2:2008 / EN 61000-4-2:2009	4 kV CD, 8 kV AD
	IEC 61000-4-3:2006+A1:2007+A2:2010 /	3 V/m / 80 MHz-2 GHz, 1V/m / 2-2.7 GHz
	EN 61000-4-3:2006+A1:2008+A2 :2010	
	IEC 61000-4-4:2004+A1:2010 / EN 61000-4-4:2004+A1 :2010	0.5 kV signal lines, 1 kV power lines
	IEC 61000-4-5: 2005 / EN 61000-4-5:2006	0.5 kV line-line, 1 kV line-ground
	IEC 61000-4-6:2008 / EN 61000-4-6:2009	3 V, 0.15-80 MHz
	IEC 61000-4-11:2004 / EN 61000-4-11:2004	0% for 1 / 0.5 (0°, 180°) cycle
		0% for 250 / 300 cycles
		70% for 25 / 30 cycles
	Canada: ICES/NMB-001:2006	
	Australia/New Zealand: AS/NZS CISPR 11:2011	
Safety	IEC 61010-1:2010 / EN 61010-1:2010	
	Canada: CAN/CSA-C22.2 No. 61010-1-04	
	USA: ANSI/UL 61010-1:2004	

Supplementary Information:

The product was tested in a typical configuration with Keysight Technologies test systems.
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2014-August-01
Date

Hans-Martin Fischer

Product Quality & Compliance

For further information, please contact your local Keysight Technologies sales office, agent or distributor.
Or Keysight Technologies Deutschland GmbH, Herrenberger Strasse 130, 71304 Boeblingen, Germany

Year of first marking: 2008   Revision: A

Regulations Information

EMC Canada

These ISM devices comply with Canadian ICES-001. Ces appareils ISM sont conformes à la norme NMB-001 du Canada.

Acoustic Noise Information Germany

ISO 7779 L_{pA} < 70 dB(A), normal operation, operator position.

Certification

Certification

Keysight Technologies Inc. certifies that this product met its published specifications at the time of shipment from the factory. Keysight Technologies further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, NIST to the extent allowed by the Institutes's calibration facility, and to the calibration facilities of other International Standards Organization members.

Remove All Doubt

Remove All Doubt

Our repair and calibration services will get your equipment back to you, performing like new, when promised. You will get full value out of your Keysight equipment throughout its lifetime. Your equipment will be serviced by Keysight-trained technicians using the latest factory calibration procedures, automated repair diagnostics and genuine parts. You will always have the utmost confidence in your measurements. Keysight offers a wide range of additional expert test and measurement services for your equipment, including initial start-up assistance, onsite education and training, as well as design, system integration, and project management. For more information on repair and calibration services, go to

www.keysight.com/find/removealldoubt

Keysight E-mail Updates

Get the latest information on the products and applications you select.

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Keysight Direct

Quickly choose and use your test equipment solutions with confidence.

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Keysight Open

Keysight Open simplifies the process of connecting and programming test systems to help engineers design, validate and manufacture electronic products. Keysight offers open connectivity for a broad range of systemready instruments, open industry software, PC-standard I/O and global support, which are combined to more easily integrate test system development.

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LXI

LXI is the LAN-based successor to GPIB, providing faster, more efficient connectivity. Keysight is a founding member of the LXI consortium.

www.lxistandard.org

www.keysight.com

For more information on Keysight Technologies products, applications and services, please contact your local Keysight office. The complete list is available at:

www.keysight.com/find/contactus

5
Accessories

Accessories - Overview

The instruments are available in various configurations for the best possible match to the most common applications.

This chapter provides information on the available options and accessories.

Instrument and Options - Keysight N7744A and N7745A

Table 4

N7744A, N7745A ordering options	
N7744A	Optical Multiport Power Meter (4 channel)
N7748A	Optical Multiport Power Meter (8 channel)
includes: USB and cross-over LAN cable	
Accessories	
N7740FI	FC Connector Adapter for Optical Multiport Power Meter
N7740KI	SC Connector Adapter for Optical Multiport Power Meter

Table 4

N7744A, N7745A ordering options	
N7740LI	LC Connector Adapter for Optical Multiport Power Meter
N7740MI	MU Connector Adapter for Optical Multiport Power Meter
N7740ZI	Blank Zeroing Connector Adapter for Optical Multiport Power Meter
N7740BI	Bare Fibre Connector Adapter for Optical Multiport Power Meter
81004BM	Bare Fibre Holder Set for 0-400 µm Fibres (4 each with gauge)
81009BM	Bare Fibre Holder Set for 400-900 µm Fibres (4 each with gauge)
N7744A-100	Rack Mount Kit for one or two Multiport Power Meter Units

NOTE N7744A-100 does not mount two units of different depth.

Service and Repair	
R-50C-011-3	Keysight calibration up-front support plan 3 year coverage
R-50C-011-5	Keysight calibration up-front support plan 5 year coverage

Instrument and Options – Keysight N7747A and N7748A

Table 6

N7747A, N7748A ordering options	
N7747A	Optical High Performance Power Meter (2 channel)
N7748A	Optical High Performance Power Meter (4 channel)
includes: USB and cross-over LAN cable	
Accessories	
81000FI	FC Connector Interface
81000KI	SC Connector Interface
81000PI	E-2000 Connector Interface (sensor only)
81000SI	DIN 47256/4108 Connector Interface
81000VI	ST Connector Interface
81002LI	LC Connector Interface
81002MI	MU Connector Interface
81000BI	Bare Fiber Interface Kit
N7744A-100	Rack Mount Kit for one or two Optical High Performance Power Meter Units

N O T E	The sensors are optimized for use with 2.5 mm ferrule connectors, for which the positioning is most repeatable. For use with LC or MU connectors with 1.25 mm ferrules, only the 81002LI for LC or 81002MI for MU should be used. The 81000LI and 81000MI should not be used. But positioning uncertainty with the 81002LI or 81002MI can still degrade the absolute power uncertainty by up to +/- 1 dB, considering worst-case offsets within the tolerances of the connectors and adapters. For LC and MU connectors, use of the 8162x optical power heads or the N7744A and N7745A power meters with corresponding adapters is recommended for highest accuracy.

Ferrules with conical or raised-end faces also add positioning uncertainty and are not recommended for use with the N7747A or N7748A.

Service and Repair

R-50C-011-3	Keysight calibration up-front support plan 3 year coverage
R-50C-011-5	Keysight calibration up-front support plan 5 year coverage

Cables

- GPIB Cable, 10833A, 1 m (3.3 feet)
- GPIB Cable, 10833B, 2 m (6.6 feet)
- GPIB Cable, 10833C, 4 m (13.2 feet)
- GPIB Cable, 10833D, 0.5 m (1.6 feet)
- GPIB Adapter, 10834A, 2.3 cm extender. Use this adapter if there is no space to connect your GPIB cable directly to a GPIB interface.
- USB Cable, 8121-1243, 2 m (6.6 feet)
- Cross-over LAN cable, 5061-0701, 2.1 m (7 feet)

6
Maintenance and Troubleshooting

Maintenance and Troubleshooting - Overview

This section provides detailed information on:

- Cleaning Instructions

- Firmware Upgrades

- Error Messages

- Data Sanitation

Cleaning Instructions

Cleaning Instructions

The following Cleaning Instructions contain some general safety precautions, which must be observed during all phases of cleaning. Consult your specific optical device manuals or guides for full information on safety matters.

Please try, whenever possible, to use physically contacting connectors, and dry connections. Clean the connectors, interfaces, and bushings carefully after use.

If you are unsure of the correct cleaning procedure for your optical device, we recommend that you first try cleaning a dummy or test device.

Keysight Technologies assume no liability for the customer's failure to comply with these requirements.

Cleaning Instructions for this Instrument

The Cleaning Instructions apply to a number of different types of Optical Equipment. Most relevant for this instrument is the section "How to clean connector adapters" on page 95 for cleaning the quad-adapters, and "How to clean optical glass plates" on page 96 for cleaning the front of the instrument.

Safety Precautions

Please follow the following safety rules:

* Do not remove instrument covers when operating.

* Ensure that the instrument is switched off throughout the cleaning procedures.

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

* Make sure that you disable all sources when you are cleaning any optical interfaces.

* Under no circumstances look into the end of an optical device attached to optical outputs when the device is operational. The laser radiation is not visible to the human eye, but it can seriously damage your eyesight.

* To prevent electrical shock, disconnect the instrument from the mains before cleaning. Use a dry cloth, or one slightly dampened with water, to clean the external case parts. Do not attempt to clean internally.

* Do not install parts or perform any unauthorized modification to optical devices.

* Refer servicing only to qualified and authorized personnel.

Why is it important to clean optical devices?

In transmission links optical fiber cores are about 9 µm (0.00035") in diameter. Dust and other particles, however, can range from tenths to hundredths of microns in diameter. Their comparative size means that they can cover a part of the end of a fiber core, and as a result will reduce the performance of your system.

Furthermore, the power density may burn dust into the fiber and cause additional damage (for example, 0 dBm optical power in a single mode fiber causes a power density of approximately 16 million W/m2). If this happens, measurements become inaccurate and non-repeatable.

Cleaning is, therefore, an essential yet difficult task. Unfortunately, when comparing most published cleaning recommendations, you will discover that they contain several inconsistencies. In this section, we want to suggest ways to help you clean your various optical devices, and thus significantly improve the accuracy and repeatability of your lightwave measurements.

What do I need for proper cleaning?

Some Standard Cleaning Equipment is necessary for cleaning your instrument. For certain cleaning procedures, you may also require certain Additional Cleaning Equipment.

Standard Cleaning Equipment

Before you can start your cleaning procedure you need the following standard equipment:

- Dust and shutter caps
- Isopropyl alcohol
- Cotton swabs
- Soft tissues
- Pipe cleaner
- Compressed air

Dust and shutter caps

All of Keysight Technologies' lightwave instruments are delivered with either laser shutter caps or dust caps on the lightwave adapter. Any cables come with covers to protect the cable ends from damage or contamination.

We suggest these protected coverings should be kept on the equipment at all times, except when your optical device is in use. Be careful when replacing dust caps after use. Do not press the bottom of the cap onto the fiber too hard, as any dust in the cap can scratch or pollute your fiber surface.

If you need further dust caps, please contact your nearest Keysight Technologies sales office.

Isopropyl alcohol

This solvent is usually available from any local pharmaceutical supplier or chemist's shop.

If you use isopropyl alcohol to clean your optical device, do not immediately dry the surface with compressed air (except when you are cleaning very sensitive optical devices). This is because the dust and the dirt is solved and will leave behind filmy deposits after the alcohol is evaporated. You should therefore first remove the alcohol and the dust with a soft tissue, and then use compressed air to blow away any remaining filaments.

If possible avoid using denatured alcohol containing additives. Instead, apply alcohol used for medical purposes. Never try to drink this alcohol, as it may seriously damage to your health.

Do not use any other solvents, as some may damage plastic materials and claddings. Acetone, for example, will dissolve the epoxy used with fiber optic connectors. To avoid damage, only use isopropyl alcohol.

Cotton swabs

We recommend that you use swabs such as Q-tips or other cotton swabs normally available from local distributors of medical and hygiene products (for example, a supermarket or a chemist's shop). You may be able to obtain various sizes of swab. If this is the case, select the smallest size for your smallest devices.

Ensure that you use natural cotton swabs. Foam swabs will often leave behind filmy deposits after cleaning.

Use care when cleaning, and avoid pressing too hard onto your optical device with the swab. Too much pressure may scratch the surface, and could cause your device to become misaligned. It is advisable to rub gently over the surface using only a small circular movement.

Swabs should be used straight out of the packet, and never used twice. This is because dust and dirt in the atmosphere, or from a first cleaning, may collect on your swab and scratch the surface of your optical device.

Soft tissues

These are available from most stores and distributors of medical and hygiene products such as supermarkets or chemists' shops.

We recommend that you do not use normal cotton tissues, but multi-layered soft tissues made from non-recycled cellulose. Cellulose tissues are very absorbent and softer. Consequently, they will not scratch the surface of your device over time.

Use care when cleaning, and avoid pressing on your optical device with the tissue. Pressing too hard may lead to scratches on the surface or misalignment of your device. Just rub gently over the surface using a small circular movement.

Use only clean, fresh soft tissues and never apply them twice. Any dust and dirt from the air which collects on your tissue, or which has gathered after initial cleaning, may scratch and pollute your optical device.

Pipe cleaner

Pipe cleaners can be purchased from tobacconists, and come in various shapes and sizes. The most suitable one to select for cleaning purposes has soft bristles, which will not produces scratches.

There are many different kinds of pipe cleaner available from tobacco shops.

The best way to use a pipe cleaner is to push it in and out of the device opening (for example, when cleaning an interface). While you are cleaning, you should slowly rotate the pipe cleaner.

Only use pipe cleaners on connector interfaces or on feed through adapters. Do not use them on optical head adapters, as the center of a pipe cleaner is hard metal and can damage the bottom of the adapter.

Your pipe cleaner should be new when you use it. If it has collected any dust or dirt, this can scratch or contaminate your device.

The tip and center of the pipe cleaner are made of metal. Avoid accidentally pressing these metal parts against the inside of the device, as this can cause scratches.

Compressed air

Compressed air can be purchased from any laboratory supplier.

It is essential that your compressed air is free of dust, water and oil. Only use clean, dry air. If not, this can lead to filmy deposits or scratches on the surface of your connector. This will reduce the performance of your transmission system.

When spraying compressed air, hold the can upright. If the can is held at a slant, propellant could escape and dirty your optical device. First spray into the air, as the initial stream of compressed air could contain

some condensation or propellant. Such condensation leaves behind a filmy deposit.

Please be friendly to your environment and use a CFC-free aerosol.

Additional Cleaning Equipment

Some Cleaning Procedures need the following equipment, which is not required to clean each instrument:

- Microscope with a magnification range about 50X up to 300X
- Ultrasonic bath
- Warm water and liquid soap
- Premoistened cleaning wipes
- Polymer film
- Infrared Sensor Card

Microscope with a magnification range about 50X up to 300X

A microscope can be found in most photography stores, or can be obtained through or specialist mail order companies. Special fiber-scopes are available from suppliers of splicing equipment.

Ideally, the light source on your microscope should be very flexible. This will allow you to examine your device closely and from different angles.

A microscope helps you to estimate the type and degree of dirt on your device. You can use a microscope to choose an appropriate cleaning method, and then to examine the results. You can also use your microscope to judge whether your optical device (such as a connector) is severely scratched and is, therefore, causing inaccurate measurements.

Ultrasonic bath

Ultrasonic baths are also available from photography or laboratory suppliers or specialist mail order companies.

An ultrasonic bath will gently remove fat and other stubborn dirt from your optical devices. This helps increase the life span of the optical devices.

Only use isopropyl alcohol in your ultrasonic bath, as other solvents may damage.

Warm water and liquid soap

Only use water if you are sure that there is no other way of cleaning your optical device without corrosion or damage. Do not use hot water, as this may cause mechanical stress, which can damage your optical device.

Ensure that your liquid soap has no abrasive properties or perfume in it. You should also avoid normal washing-up liquid, as it can cover your device in an iridescent film after it has been air-dried.

Some lenses and mirrors also have a special coating, which may be sensitive to mechanical stress, or to fat and liquids. For this reason we recommend you do not touch them.

If you are not sure how sensitive your device is to cleaning, please contact the manufacturer or your sales distributor.

Premoistened cleaning wipes

Use pre-moistened cleaning wipes as described in each individual cleaning procedure. Cleaning wipes may be used in every instance where a moistened soft tissue or cotton swab is applied.

Polymer film

Polymer film is available from laboratory suppliers or specialist mail order companies.

Using polymer film is a gentle method of cleaning extremely sensitive devices, such as reference reflectors and mirrors.

Infrared Sensor Card

Infrared sensor cards are available from laboratory suppliers or specialist mail order companies.

With this card you are able to control the shape of laser light emitted. The invisible laser beam is projected onto the sensor card, then becomes visible to the normal eye as a round spot.

Take care never to look into the end of a fiber or any other optical component, when they are in use. This is because the laser can seriously damage your eyes.

Preserving Connectors

Listed below are some hints on how best to keep your connectors in the best possible condition.

Making Connections

Before you make any connection you must ensure that all cables and connectors are clean. If they are dirty, use the appropriate cleaning procedure.

When inserting the ferrule of a patchcord into a connector or an adapter, make sure that the fiber end does not touch the outside of the mating connector or adapter. Otherwise you will rub the fiber end against an unsuitable surface, producing scratches and dirt deposits on the surface of your fiber.

Dust Caps and Shutter Caps

Be careful when replacing dust caps after use. Do not press the bottom of the cap onto the fiber as any dust in the cap can scratch or dirty your fiber surface.

When you have finished cleaning, put the dust cap back on, or close the shutter cap if the equipment is not going to be used immediately.

Keep the caps on the equipment always when it is not in use.

All of Keysight Technologies' lightwave instruments and accessories are shipped with either laser shutter caps or dust caps. If you need additional or replacement dust caps, contact your nearest Keysight Technologies Sales/Service Office.

Immersion Oil and Other Index Matching Compounds

Where it is possible, do not use immersion oil or other index matching compounds with your device. They are liable to impair and dirty the surface of the device. In addition, the characteristics of your device can be changed and your measurement results affected.

Cleaning Instrument Housings

Use a dry and very soft cotton tissue to clean the instrument housing and the keypad. Do not open the instruments as there is a danger of electric shock, or electrostatic discharge. Opening the instrument can

cause damage to sensitive components, and in addition your warranty will be voided.

Never open the instruments as they can be damaged. Opening the instruments puts you in danger of receiving an electrical shock from your device, and renders your warranty void.

Which Cleaning Procedure should I use?

Light dirt

If you just want to clean away light dirt, observe the following procedure for all devices:

1 Use compressed air to blow away large particles.

2 Clean the device with a dry cotton swab.

3 Use compressed air to blow away any remaining filament left by the swab.

Heavy dirt

If the above procedure is not enough to clean your instrument, follow one of the procedures below. Please consult "Cleaning Instructions for this Instrument" on page 86 for the procedure relevant for this instrument.

If you are unsure of how sensitive your device is to cleaning, please contact the manufacturer or your sales distributor

How to clean connectors

Cleaning connectors is difficult as the core diameter of a single-mode fiber is only about 9 µm. This generally means you cannot see streaks or scratches on the surface. To be certain of the condition of the surface of your connector and to check it after cleaning, you need a microscope.

In the case of scratches, or of dust that has been burnt onto the surface of the connector, you may have no option but to polish the connector. This depends on the degree of dirtiness, or the depth of the scratches. This is a difficult procedure and should only be performed by skilled personal, and as a last resort as it wears out your connector.

WARNING   **Never look into the end of an optical cable that is connected to an active source.**

To assess the projection of the emitted light beam you can use an infrared sensor card. Hold the card approximately 5 cm from the output of the connector. The invisible emitted light is project onto the card and becomes visible as a small circular spot.

Preferred Procedure

Use the following procedure on most occasions.

1 Clean the connector by rubbing a new, dry cotton-swab over the surface using a small circular movement.

2 Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the connector:

1 Moisten a new cotton-swab with isopropyl alcohol.

2 Clean the connector by rubbing the cotton-swab over the surface using a small circular movement.

3 Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.

4 Blow away any remaining lint with compressed air.

An Alternative Procedure

A better, more gentle, but more expensive cleaning procedure is to use an ultrasonic bath with isopropyl alcohol.

1 Hold the tip of the connector in the bath for at least three minutes.

2 Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.

3 Blow away any remaining lint with compressed air.

How to clean connector adapters

Preferred Procedure

Use the following procedure on most occasions.

1   Clean the adapter by rubbing a new, dry cotton-swab over the surface using a small circular movement.

2   Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the adapter:

1   Moisten a new cotton-swab with isopropyl alcohol.

2   Clean the adapter by rubbing the cotton-swab over the surface using a small circular movement.

3   Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.

4   Blow away any remaining lint with compressed air.

How to clean bare fiber adapters

Bare fiber adapters are difficult to clean.

Protect from dust unless they are in use.

CAUTION   Never use any kind of solvent when cleaning a bare fiber adapter as solvents can damage the foam inside some adapters.

They can deposit dissolved dirt in the groove, which can then dirty the surface of an inserted fiber.

Preferred Procedure

Use the following procedure on most occasions.

1   Blow away any dust or dirt with compressed air.

How to clean optical glass plates

The multiport power meter has an optical glass plate to protect the sensor. This has a special coating that is sensitive to solvents, grease, liquid and mechanical abrasion. Take extra care when cleaning this plate.

Preferred Procedure

Use the following procedure on most occasions.

1   Clean the plate by rubbing a new, dry cotton-swab over the surface using a small circular movement.

2   Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the plate:

1   Moisten a new cotton-swab with isopropyl alcohol.

2   Clean the plate by rubbing the cotton-swab over the surface using a small circular movement.

3   Using a new, dry cotton-swab remove the alcohol, any dissolved sediment and dust.

4   Blow away any remaining lint with compressed air.

Additional Cleaning Information

The following cleaning procedures may be used with other optical equipment:

•   How to clean bare fiber ends

How to clean bare fiber ends

Bare fiber ends are often used for splices or, together with other optical components, to create a parallel beam. The end of a fiber can often be scratched. You make a new cleave. To do this:

1   Strip off the cladding.

2   Take a new soft-tissue and moisten it with isopropyl alcohol.

3   Carefully clean the bare fiber with this tissue.

4 Make your cleave and immediately insert the fiber into your bare fiber adapter in order to protect the surface from dirt.

Other Cleaning Hints

Selecting the correct cleaning method is an important element in maintaining your equipment and saving you time and money. This Appendix highlights the main cleaning methods, but cannot address every individual circumstance.

This section contain some additional hints which we hope will help you further. For further information, please contact your local Keysight Technologies representative.

Making the connection

Before you make any connection you must ensure that all lightwave cables and connectors are clean. If not, then use appropriate the cleaning methods.

When you insert the ferrule of a patchcord into a connector or an adapter, ensure that the fiber end does not touch the outside of the mating connector or adapter. Otherwise, the fiber end will rub up against something which could scratch it and leave deposits.

Lens cleaning papers

Note that some special lens cleaning papers are not suitable for cleaning optical devices like connectors, interfaces, lenses, mirrors and so on. To be absolutely certain that a cleaning paper is applicable, please ask the salesperson or the manufacturer.

Firmware Upgrades

Updated versions of the firmware for your instrument may be released from time to time. These will then be available from the Keysight web page (www.keysight.com/find/octfirmware) and will include the update application and instructions.

Error Messages

SYST:ERR?

The `syst:err?` command returns the next error from the error queue (refer to the Programming Guide for details).

Each error has an error code and a short description of the error, separated by comma. Please note that the error codes are returned as signed integer numbers in a range from -32768 to +32767 (INT16). Negative error numbers are defined by the SCPI standard, positive error numbers are device dependent.

Hardware Error

If the Red "Error" LED on the front panel is illuminated it may indicate a hardware error. The defective channel(s) is then deactivated and is no longer in specification. The unit should be sent for repair. The command `Stat[n]:ques:cond?` can be used to identify the defective channel, as detailed in the Programming Guide.

Example: `Stat2:ques:cond? -> 1`

Indicates a hardware error on channel 2 of the N7747A or N7748A.

Data Sanitation

Memory Inventory

The instruments have the following memory size:

EEPROM 2 Mb for N7744A and N7747A. 3 Mb for N7745A and N7748A. This memory does not contain any customer data.

Flash ROM 16 MB. This memory can contain calibration data, and so on, as well as user parameter settings, zeroing data and logged information (the log contains limited operational information).

DRAM 128 MB volatile working memory. This contains data for current and recent calibrating and measuring.

Clearing User Data

Clearing the DRAM

All data in the DRAM is cleared by powering the instrument off.

Clearing the Flash ROM

The user data can be cleared from the Flash ROM by:

1 Reset the instrument to factory default.

   a Send the command:

     SYSTem:PRESet

     OR

   b Press the LAN Reset button on the front panel briefly (<1 s).

2 Clear the instrument log.

   a Send the special command

     DIAG:SYST:FLAS:LOGF:ERAS

   The contents of the log can be checked with the query READ:LOGF?.

3 Clear the Ethernet settings

   a Connect to the instrument by some means other than the LAN, using VISA Assistant (for example over USB). Send the command:

     SYSTem:COMMunicate:ETHernet:RESet

     OR

   b With the instrument connected over the LAN (the LAN LED is green), press and hold the LAN Reset button for more than 3s.

In either case, the instrument reboots.

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