

# Keysight N77xx Series

N7751A 1-Channel Optical Attenuator and Power Meter  
N7752A 2-Channel Optical Attenuator and Power Meter  
N7761A 1-Channel Optical Attenuator  
N7762A 2-Channel Optical Attenuator  
N7764A 4-Channel Optical Attenuator  
N7766A 2-Channel Multimode Optical Attenuator  
N7768A 4-Channel Multimode Optical Attenuator

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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.

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# 1

## Getting Started

### Overview

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

- “Keysight N775xA Optical Attenuator and Power Meter and N776xA Optical Attenuator” on page 10
- “Initial Inspection” on page 12
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## **Keysight N775xA Optical Attenuator and Power Meter and N776xA Optical Attenuator**

The Keysight N775xA and N776xA are compact multichannel attenuators and power meters. They are a new class of remote-controlled fiber optic instruments. All attenuators feature power control functionality to set the output power level of the attenuator.

The Keysight N7751A and Keysight N7752A are optical attenuators for single mode fiber with one and two single-mode fiber attenuator channels respectively and two extra optical power meter channels, for convenient power measurements and setup calibration. The Keysight N7761A, Keysight N7762A and Keysight N7764A are single-mode fiber optical attenuators for single mode fiber, with one, two and four attenuator channels respectively.

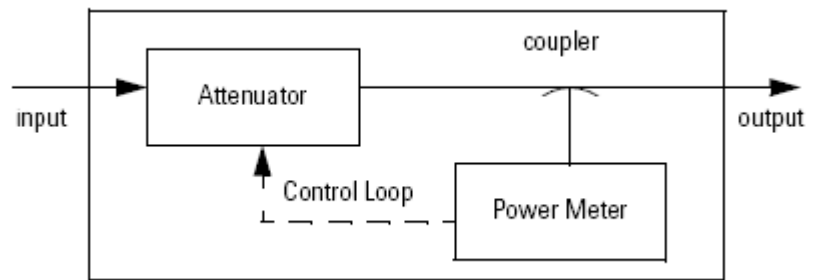
All N775xA and N776xA attenuators address productivity challenges by increasing throughput and operational efficiency.

The Keysight N7766A and the Keysight N7768A are optical attenuators for multimode fibers with two or four attenuator channels respectively. Both multimode attenuators are available with 50 micro-meter, 62.5 micro-meter, or 80 micro-meter-core multimode fibre.

The N7766A and N7768A are 2 and 4 channel multimode fiber attenuators that are optimized for quick power setting and preservation of the input modal power distribution.

The attenuators are designed to attenuate and control the power of light in optical fibers. They allow you to accurately and repeatably set the attenuation factor or power level manually using the Viewer software, or using the programming interface.

The attenuators include power control functionality that allow you to set the output power level of the attenuator. When power control mode is enabled, the module automatically corrects for power changes at the input so that the output power level you set is maintained.



**Figure 1** Optical Attenuators with Power Control

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

These attenuators and power meters are fully compatible with setups and programs developed using the Keysight 8157x modular attenuators and basic 8163x optical power meter commands, not including logging functionality.

### Modal Fidelity for Multimode Fiber Systems

Signals in multimode fibers are distributed over a range of mode groups that can have different loss and delay in a link. For dependable multimode transceiver testing, the instrument used to set the power level should not change this modal distribution. The bulk-optic filter and collimated beam path of Keysight multimode attenuators are designed to assure homogeneous attenuation of all input modes.

## 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 general safety 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

### CAUTION

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.

---

### WARNING

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.

---



The apparatus will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect the apparatus against damage.

---

## 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 to 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

### CAUTION

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.

---

## 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 - Overview” on page 79](#) for the part numbers of available power cables.



**WARNING**

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.

## 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.



The CE mark is the conformity marking of the European Community



The CSA mark is the certification mark of the Canadian Standards Association.



The C-Tick or RCM mark is the certification mark of the Australian Communications Authority.



The KC mark is the Korean certification mark.



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.

## AC Line Power Supply Requirements

### AC Line Power Supply Requirements - Overview

This section 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 to 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

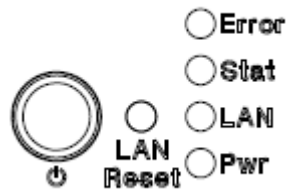
In accordance with international safety standards, the instrument has a three-wire power cable. When connected to an appropriate AC power receptacle, this cable earths the instrument cabinet. For the part number of the power cable for your country and instrument see the “[Accessories - Overview](#)” on page 79.

**CAUTION**

Please note that the switch on the front panel of the instrument does not stop the flow of power to the instrument.

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 2** Power Switch

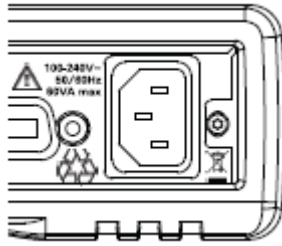
When the instrument is in stand-by mode, the Pwr LED is orange. When the instrument is powered-on, the Pwr LED is green.

**WARNING**

**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 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 3** AC Power Requirement Markings

## Changing the Fuse

### CAUTION

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.

---

## 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.

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.

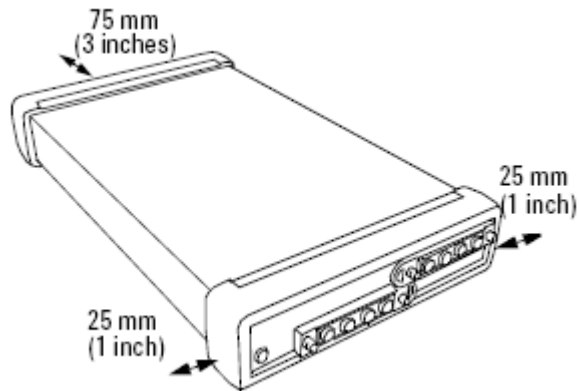
## **Instrument Cooling**

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 4** Correct Operating Position

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

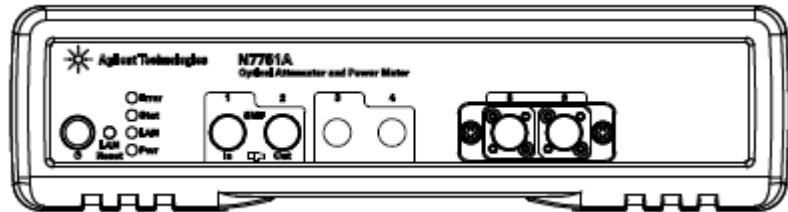
## Input and Output Connectors

### Input and Output Connectors - Overview

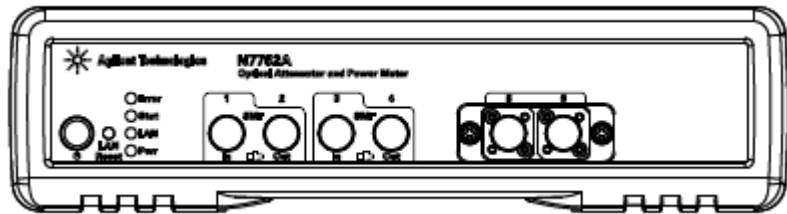
This section provides information on:

- Front Panels - Multiport Power Meters
- Front Panels - Optical Attenuators
- Front Panels - Tunable Laser Source
- Rear Panel

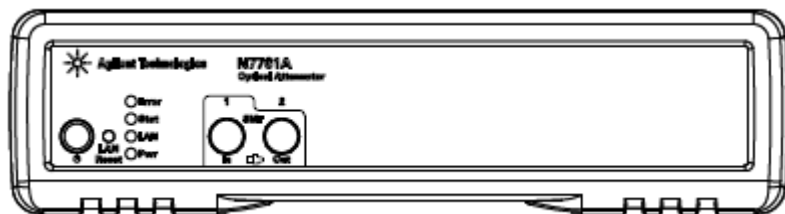
## Front Panels - Optical Attenuators



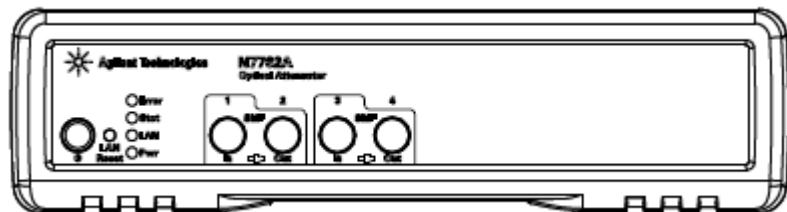
**Figure 5** Front panel of the Keysight N7751A 1-Channel Optical Attenuator and 2-Channel Power Meter



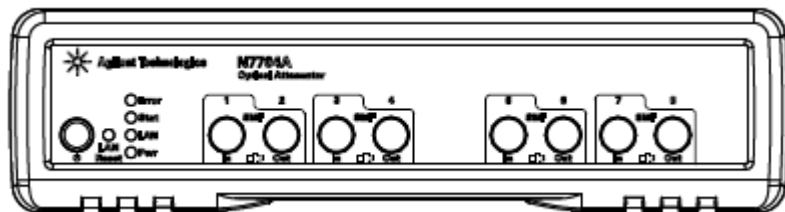
**Figure 6** Front panel of the Keysight N7752A 2-Channel Optical Attenuator and 2-Channel Power Meter



**Figure 7** Front panel of the Keysight N7761A 1-Channel Optical Attenuator



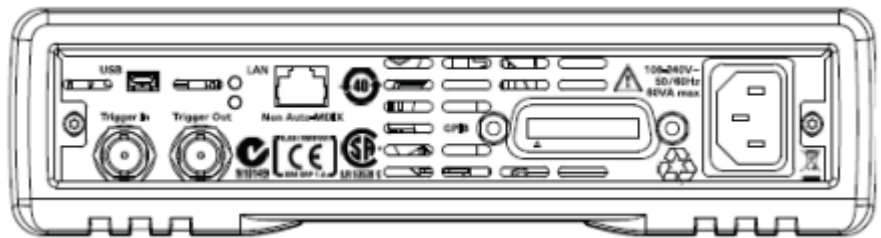
**Figure 8** Front panel of the Keysight N7762A and N7766A 2-Channel Optical Attenuator



**Figure 9** Front panel of the Keysight N7764A and N7768A 4-Channel Optical Attenuator



## Rear Panel



**Figure 10** Rear panel of the Keysight N7744/5A Optical Multiport Power Meter, Keysight N7751/2A Optical Attenuator and Power Meter, and Keysight N7761/2/4/6/8A Optical Attenuator and Keysight N7711/4A Tunable Laser System Source

## Making Optical Connections

### Making Optical Connections

The optical attenuators are designed for use with FC connectors. Attenuators ordered with option 021 have straight connector interfaces. Attenuators ordered with option 022 have angled connector interfaces. The N7751/2A power meters also use FC connectors but are non-contact. They can be used with both angled and straight connectors. The N7766A and N7768A multimode attenuators have straight connector interfaces. The fiber option determines the dimensions of the internal fiber core, such as 50 or 62.5 $\mu\text{m}$ . Best performance is achieved by matching this to the fibers used in the setup.

**CAUTION**

If the connectors on your attenuator or lasers are angled, you can only use cables with angled connectors with the instrument.

If the connectors on your attenuator are straight, you can only use cables with straight connectors with the instrument.



**Figure 11** Angled and Straight Connector Symbols

The above figure shows the symbols that tell you whether the optical connectors of your instrument are angled or straight. The angled contact connector symbol is colored green.

You should connect straight contact fiber end connectors with neutral sleeves to straight contact connectors, or connect angled contact fiber end connectors with green sleeves to angled contact connectors.

See [“Accessories - Overview” on page 79](#) for further details on connector interfaces and accessories.

## Electrical Connectors

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

**CAUTION**

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 the only output BNC connector. This is a TTL output. Do not apply an external voltage to this connector.

---

## 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

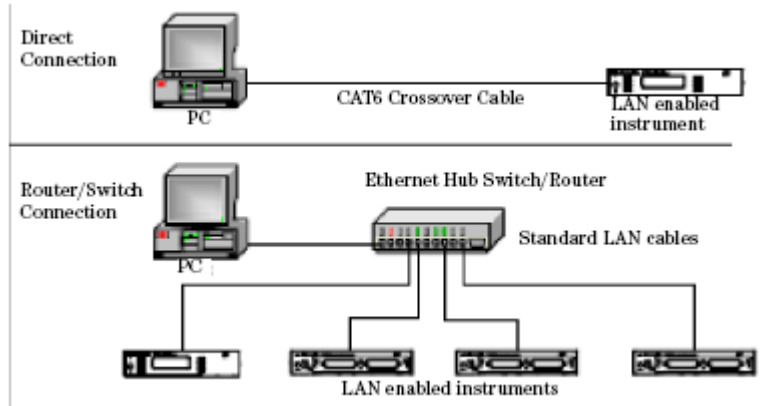
For applications requiring access by many users or by users at distributed sites, a site LAN network is required. In addition to supporting multiple users, site LANs often offer the advantage of being maintained by IT departments. When using a site LAN, consult your IT department regarding LAN configuration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



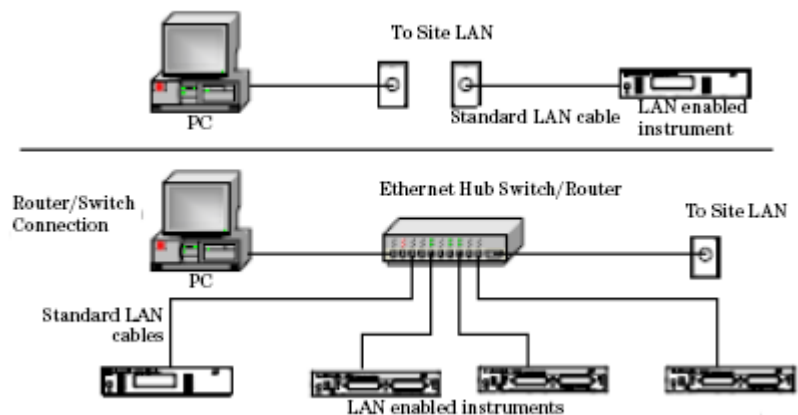
**Figure 15** Typical Private (isolated) LAN Network Connections

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 16** 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:

No LAN link	LAN link No IP Address	LAN link	LXI Device identification
Red LAN	Yellow LAN	Green LAN	Green LAN blink

**Figure 17** 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

See “Cables” on page 81 for details on cables and adapters.

## Connector

The following figure shows the connector and pin assignments.

Connector Part Number: 1251-0293

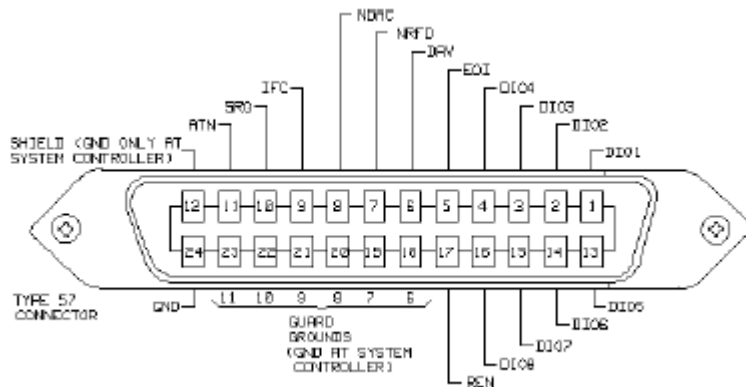


Figure 18 GPIB Connector

**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.

Standby	Power On	FPGAs loaded	Analog Board 1 loaded	Analog Board 2 loaded
<b>Error</b>	<b>Yellow Error</b>	<b>Green Error</b>	<b>Green Error</b>	<b>Green Error</b>
<b>Stat</b>	<b>Yellow Stat</b>	<b>Yellow Stat</b>	<b>Green Stat</b>	<b>Green Stat</b>
<b>LAN</b>	<b>Yellow LAN</b>	<b>Yellow LAN</b>	<b>Yellow LAN</b>	<b>Green LAN</b>
<b>Yellow Pwr</b>	<b>Green Pwr</b>	<b>Green Pwr</b>	<b>Green Pwr</b>	<b>Green Pwr</b>

**Figure 19** Powering Up the Instrument

### Front Panel Indicators

During operation, you may notice the following LED indicators:

	Hardware defect
	<b>Red Error</b>
LAN, USB or GPIB communication	Zeroing
<b>Green blink Stat</b>	<b>Yellow Stat</b>

**Figure 20** Front Panel Indicators

## Connecting to the Instrument

### Connecting to the Instrument - Overview

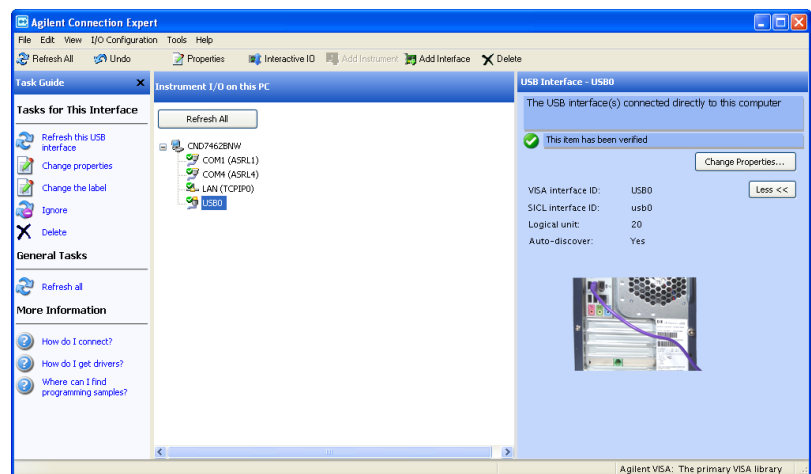
When you are first connecting the instrument, we recommend you use the Keysight Connection Expert included with the Keysight I/O libraries (available on the CD supplied with the instrument, or from [www.keysight.com](http://www.keysight.com)).

### Connecting over USB

#### NOTE

The screenshots show the Keysight N7745A Multiport Power Meter. The same procedure applies when connecting an Keysight N7744A 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.

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



**Figure 21** 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.

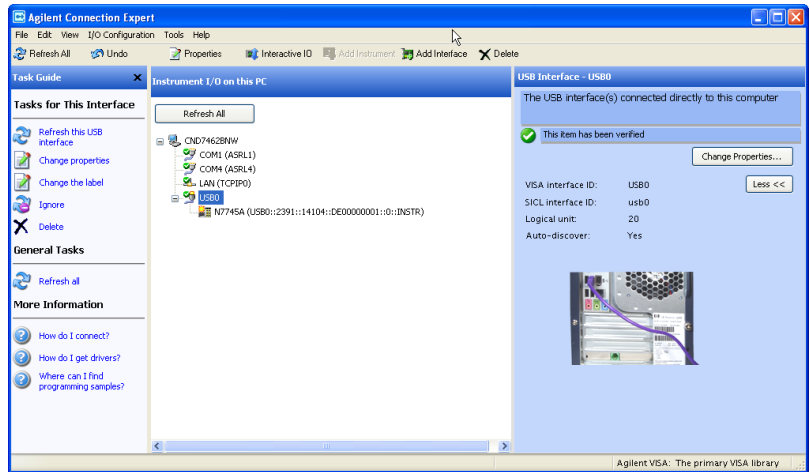


Figure 22 Select the instrument in the list

- 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.

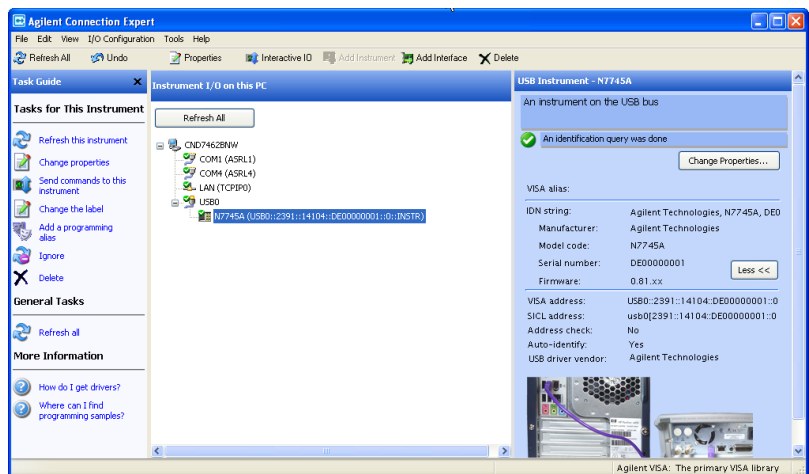
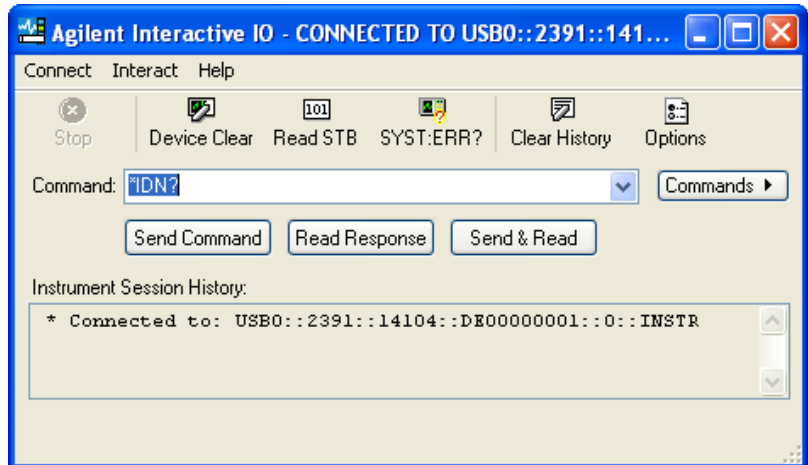


Figure 23 Select the instrument

- 3 Click on “Send commands to this instrument”.

The default command is the \*IDN? query.



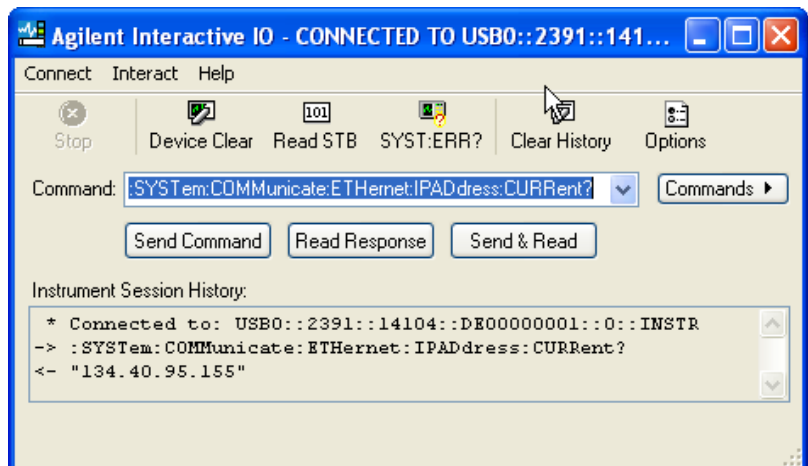
**Figure 24** \*IDN? query 4

Enter the command

```
:SYSTem:COMMunicate:ETHernet:IPAdDress:CURRent?
```

then click on [Send & Read].

The instrument returns its current IP address.



**Figure 25** :SYSTem:COMMunicate:ETHernet:IPAdDress:CURRent?

## Connecting over LAN

### NOTE

The screenshots show the Keysight N7745A Multiport Power Meter. The same procedure applies when connecting to other N77xx instruments like attenuators and laser sources.

- 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 29 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.

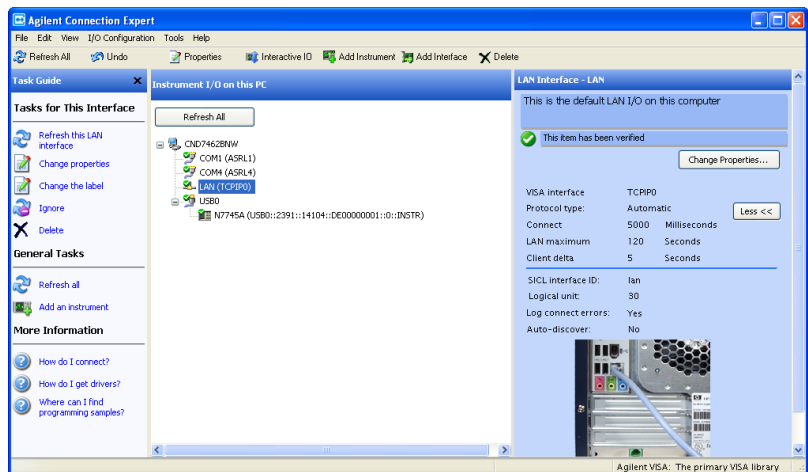


Figure 26

- 4 Click on “Add an instrument” in the Task Guide.
- 5 Wait for the scan to finish.
- 6 Select the instrument in the list.



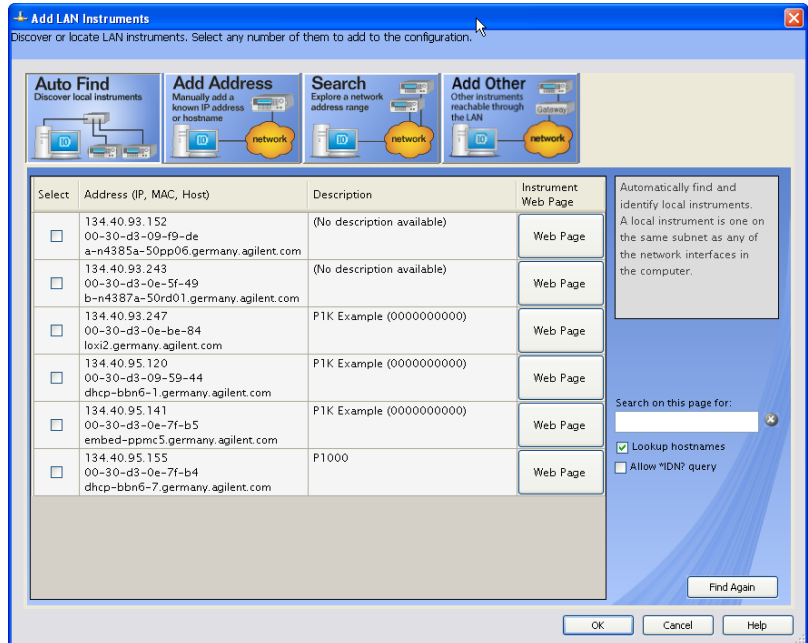


Figure 27

- 7 To show the description of the N775xA or N776xA, check the box for \*IDN? query and click on "Find Again".

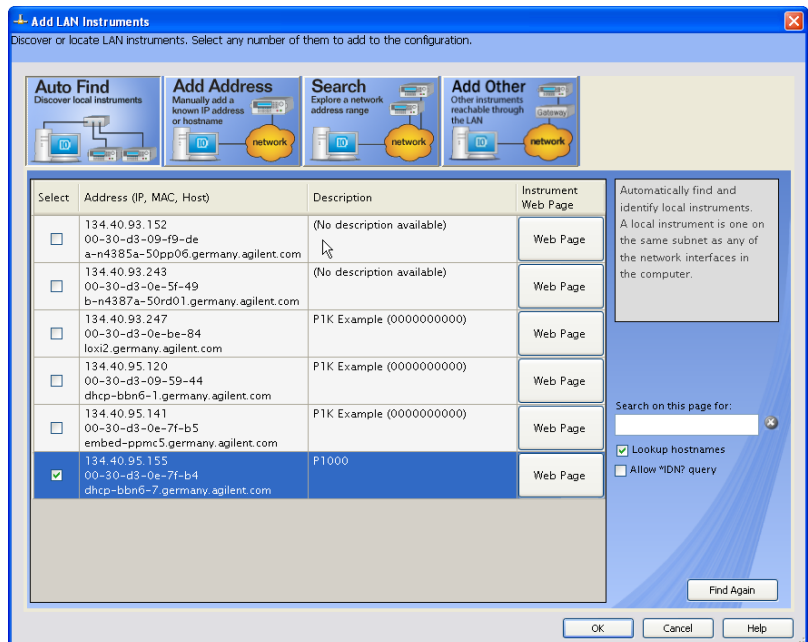
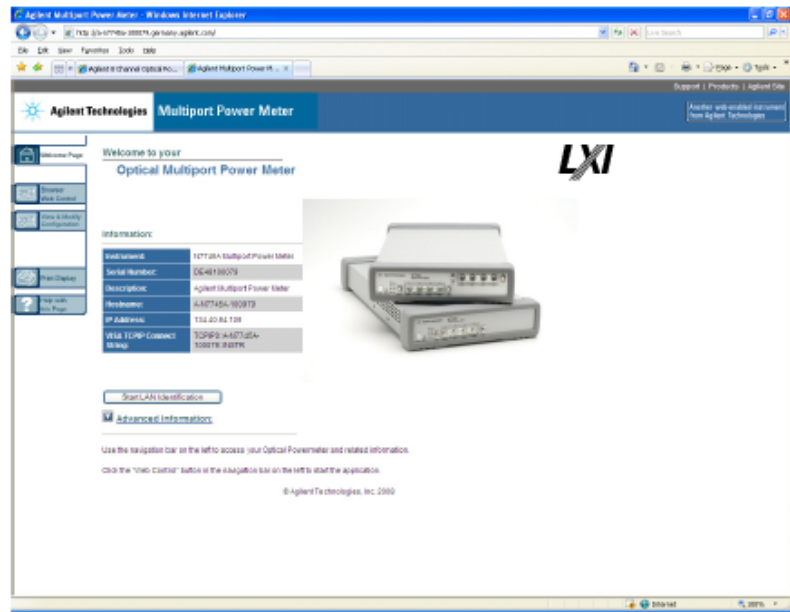


Figure 28

- 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 29**

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.

- For the attenuators, and as an alternative for the power meters, you can control the instrument from the Keysight N77xx Viewer.
  - Connecting using the N77xx Viewer is described in .
  - Making power measurements with the N77xx Viewer is described in .
  - Controlling attenuation with the N77xx Viewer is described in **“Controlling the Optical Attenuator” on page 49.**

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](http://www.keysight.com)), or using the 816x VXI Plug&Play driver, version 4.3 or higher. For the N774x Multiport power meters you can also use the IVI-COM driver.

## Claims and Repackaging

### Claims and Repackaging

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:

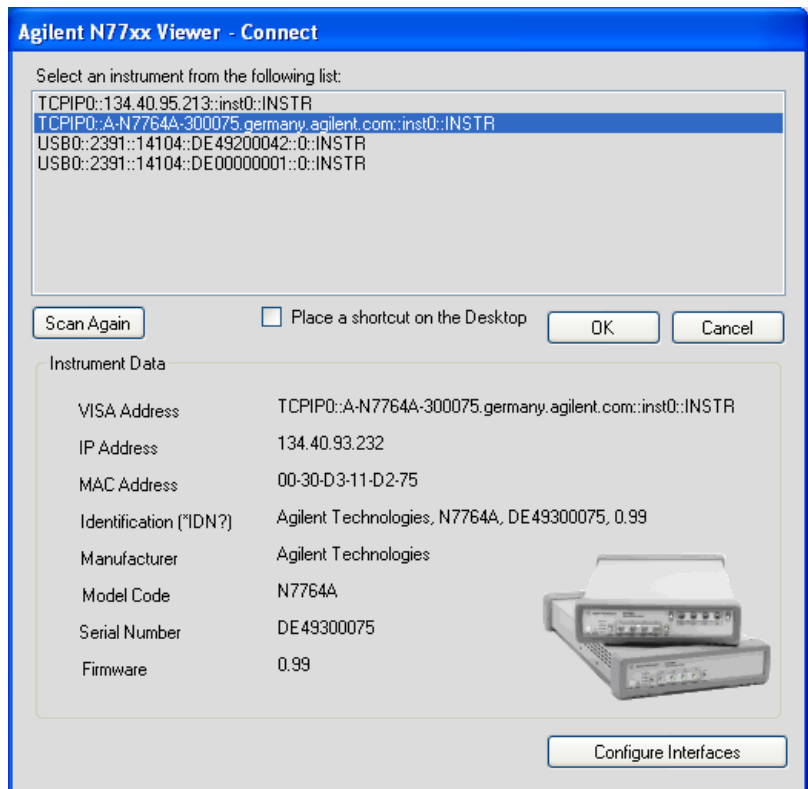
- 1 Press and hold the Reset/standby button until the instrument starts to reboot.
- 2 When the instrument reboots, press the Reset/standby button once more briefly, to confirm you want to delete all the stored data.

## 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 30** Connecting to an Instrument

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

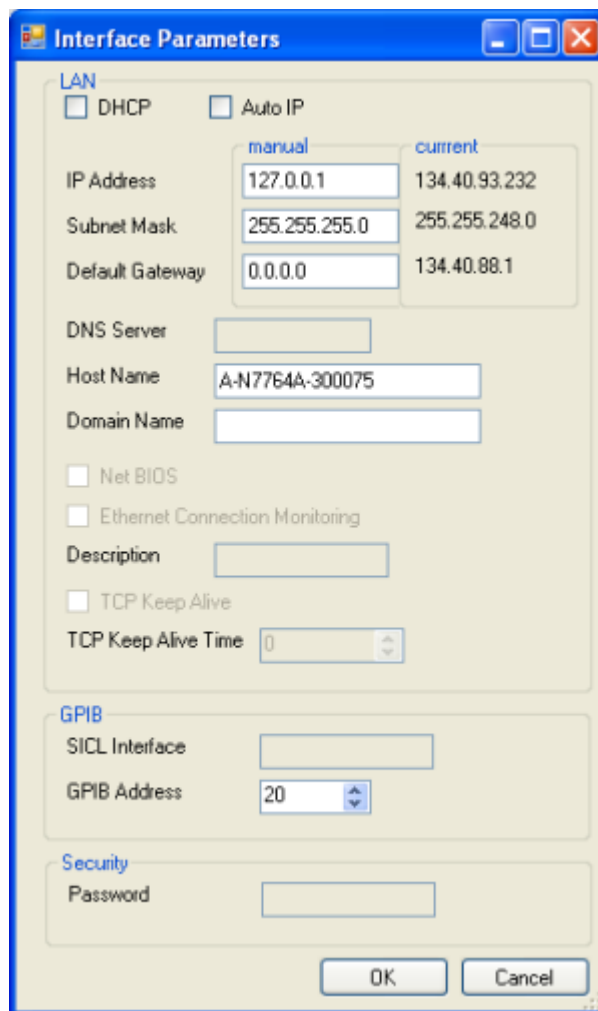
If your instrument is not in the list,

- 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 31** Interface Parameters

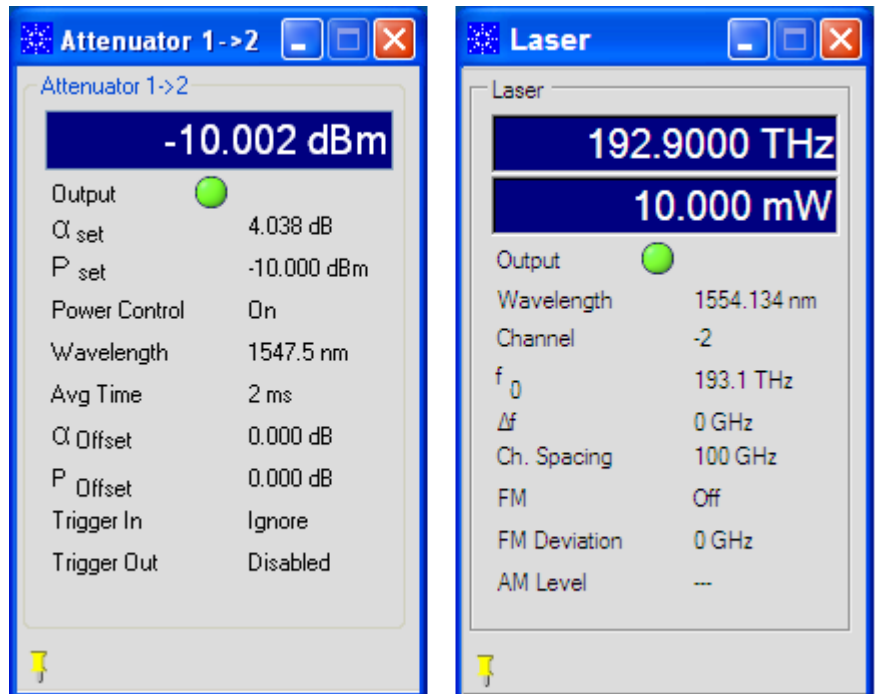
- Make sure both DHCP and Auto IP are not selected.
  - You can now edit the IP parameters.
- 5 For instruments you use regularly, you can add a link on your desktop by putting a check mark in the box to “Place a shortcut on the Desktop”.
  - 6 Click on the “OK” button to finish the connection.

## Viewing Measurements

There are two ways you can view results for a power meter or attenuator.

### 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 32** Viewing the measurement on a single channel attenuator/power meter (left) or tunable laser (right)

## Viewing all measurements

- 1 Click on Overview to open a window with the measurements on all channels.

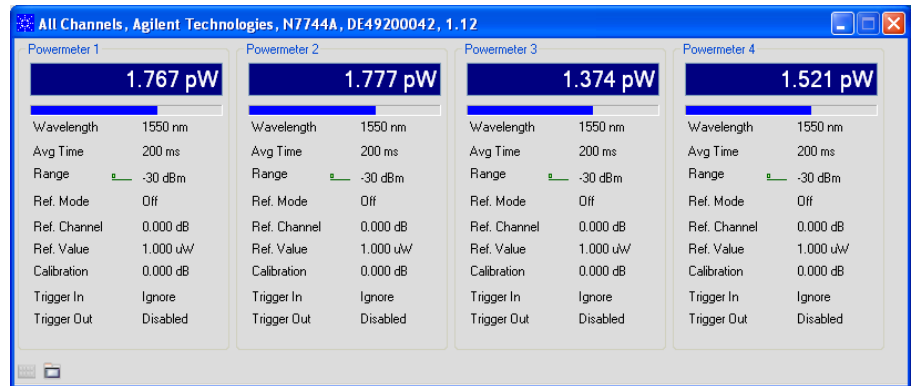


Figure 33 Viewing all measurements

## 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.

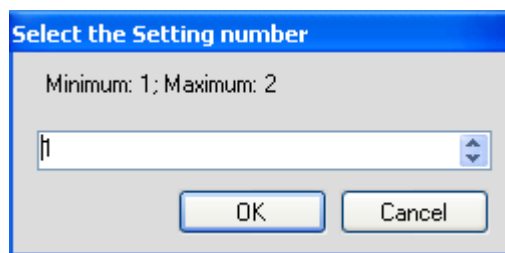


Figure 34 Saving a configuration

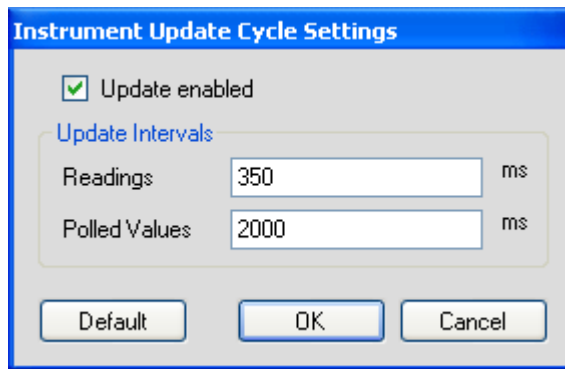
- 3 Click on the "OK" button.

### 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 35** 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 Attenuation

### Attenuation

This chapter describes how to use the Keysight N7751A and N7752A Optical Attenuator and Power Meter, the Keysight N7761A, N7762A, and N7764A Single Mode Fiber Optical Attenuator and the Keysight N7766A and N7768A multimode fiber Optical Attenuators to attenuate and control optical power.

If you want to control the power meter channels, please refer the following sections:

- “Controlling the Optical Attenuator” on page 49
- “Setting the Attenuation” on page 52
- “Applying an Offset Table” on page 56

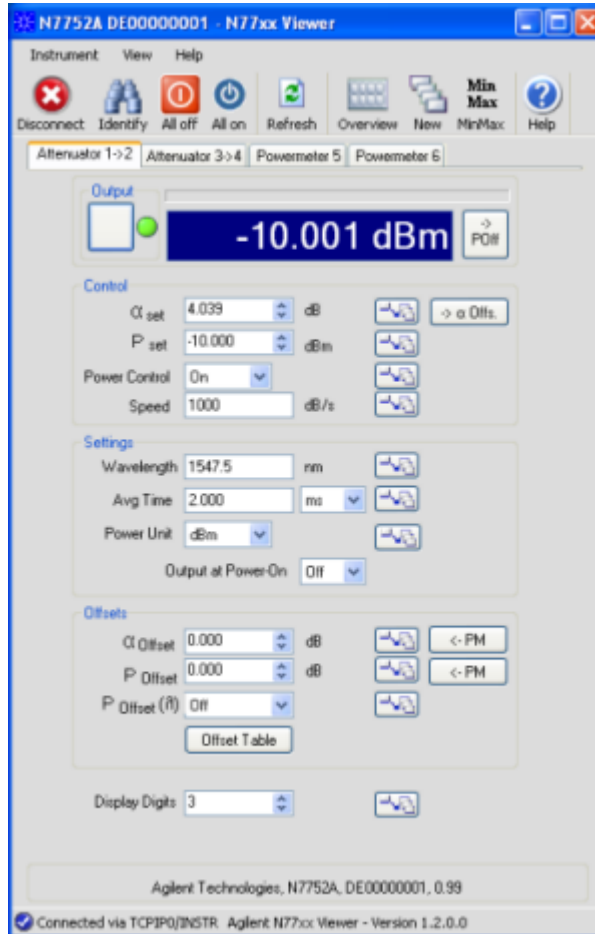
### Controlling the Optical Attenuator

There are different possibilities to control the instrument:

- 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](http://www.keysight.com)), or associated drivers, including the 816x VXI Plug&Play driver.

To connect to the instrument see “Input and Output Connectors - Overview” on page 22.

The most convenient way to control one or more Attenuators is using the Keysight N77xx Viewer, which is a control and display graphical user interface.

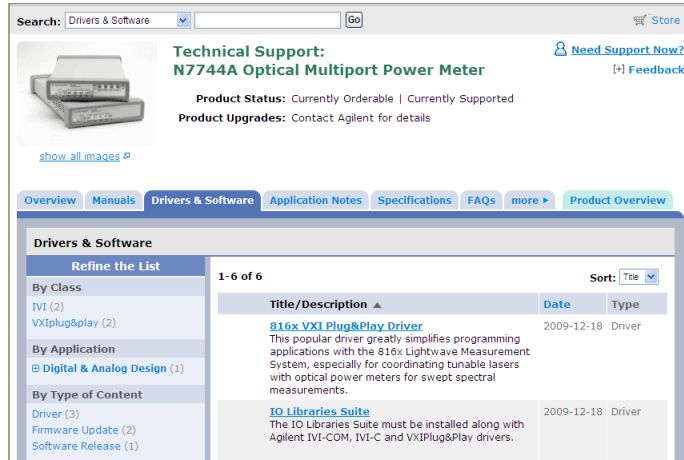


**Figure 36** The Viewer

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

<http://www.keysight.com/find/voa>

Then select the tab “Technical Support” followed by “Drivers & Software”.



**Figure 37** Technical Support N7744A

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

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

## Setting Attenuation

### Setting the Number of Digits displayed

When the power is displayed with 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.

### Selecting the Power Units

The Power Unit setting allows you to select either Watts (W) or dBm as the units in which the output power is displayed or controlled. Attenuation or offset values are in dB, and are the power relative to the input power.

## Setting the Attenuation

Before applying an attenuation factor, set the Attenuator module to the appropriate wavelength.

The instrument uses a filter technology with a low wavelength dependence. Nevertheless, for the best possible accuracy:

- If the source is of a particular wavelength, set the Attenuator module to that wavelength.
- If the source is a multi-wavelength DWDM signal, set the Attenuator module to the weighted wavelength of the spectrum.

You can set the attenuation for each channel. The power reading represents the average optical power over the selected averaging time. For optimal output power control the power meter continuously self-triggers new measurements.

### Applying an Attenuation Offset

Attenuating an input signal to a device under test (DUT) introduces additional connectors and other components into your optical test setup. Use the attenuation offset to compensate for the insertion loss of these components.

- 1 Measure the insertion loss of the attenuator and the connecting cables using a reference power meter.

If you are using an N775xA attenuator and power meter, you can use the internal power meter.

- Using all the components and connectors, without a DUT connected, connect the output of the attenuator to the input of the power meter.
- Calculate the difference between the power at the attenuator output, and the power measured by the power meter.

- 2 Enter the result into an `Offset` parameter.

The attenuator then compensates for this value.

### Setting the Filter Transition Speed

By default, the attenuation transition speed to a new setting is as fast as possible. If your test setup requires a slower attenuation transition speed, set a `<Speed>` between 0.1 and 1000 dB/s.

The N7766A and N7768A multimode attenuators accept controlled speeds between 0.1 and 80 dB/s and a full speed of about 1000 dB/s. Settings above 80 dB/s will result in full-speed operation.

## How to Remove Electrical Offsets (Zero)

The optical power meters in the attenuator 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 attenuation and power control, 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.

### NOTE

The environmental conditions and the temperature of the instrument 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 and output is not receiving any light. If you are using multi-mode fiber-optic cable, you must disconnect the cable and cover the input and the output of the attenuator to perform a zero.

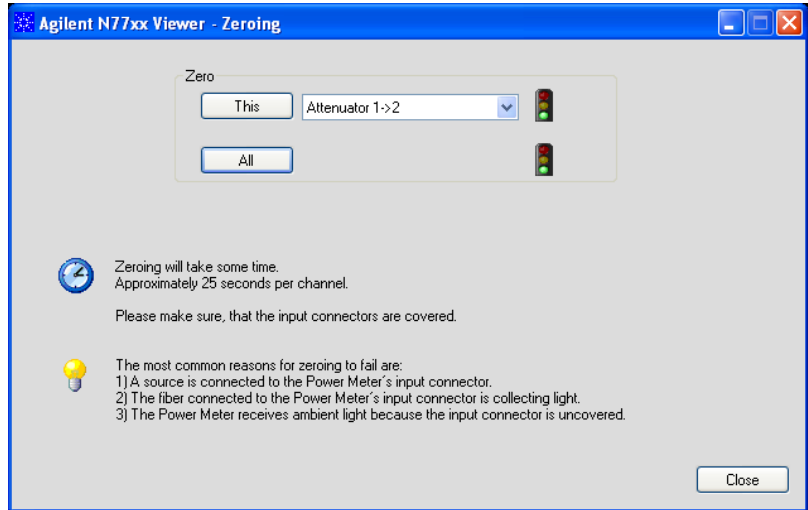
It is good practice to perform a zero before making any sensitive measurements.

### NOTE

While zeroing an attenuator's power monitor or an integrated power meter, all attenuators in the unit are stopped and all shutters are closed to ensure the best possible zeroing performance.

---

- 1 In the File menu, select Zeroing.



**Figure 38** How to Remove Electrical Offsets (Zero)

- 2 Select the channel you want to zero from the drop down list and click on the “This” button.

OR

Click on the “All” button.

While the zero function 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 attenuator’s input or output connector,
- the fiber connected to the attenuator’s input or output connector is collecting light, or
- the attenuator receives ambient light because the input or output 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.

## Enabling and Disabling the Output

You can turn on and off the attenuator output both for protection purposes or to simulate channel drops.

Select or deselect the <Output>.

- When the “Output” box is checked, the output is on.
- When the “Output” box is not checked, the attenuation is set to the optical path blocking attenuation (>40 dB).
  - To turn on all the attenuator outputs, click on [All on].
  - To turn off all the attenuator outputs, click on [All off].

## How to Set a Power Level

Power Control automatically corrects for power changes at the attenuator input to maintain your desired output power. This feature is designed to compensate, for example, for unknown or drifting input power.

When Power Control is On:

- 1 After entering a new Pset, the attenuator is driven with the selected attenuation transition speed until the output power has reached Pset.
- 2 After settling, the power control uses the attenuation transition speed of 1000dB/s to achieve best input power correction.
- 3 Input power is measured using your set Averaging Time.
- 4 The attenuator can only maintain your desired  $P_{\text{set}}$  for attenuations down to 0 dB, and within the specified attenuation and power setting range.
  - a Set the Wavelength to the wavelength of the source.
  - b Edit  $P_{\text{set}}$  to set the power output of the attenuator directly.

## Applying a Power Offset

Attenuation in your optical test setup can be compensated so the displayed output power value accurately reflects the power applied to the DUT.

**NOTE**

Before taking a power measurement, make sure the source is warmed up so that its power output is stable.

---

- 1 Measure the insertion loss of the components between the attenuator output and the DUT, using a reference power meter.
- 2 Enter the result into the P Offset parameter.

## 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.

## 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 stability and improve the noise rejection.

The averaging time of the power meter and power monitor in the attenuator can be set over a wide range from 2ms to 1s.

Please note, even if you set a longer averaging time, internally the power control always works with an average time of 2ms to achieve best input power correction.

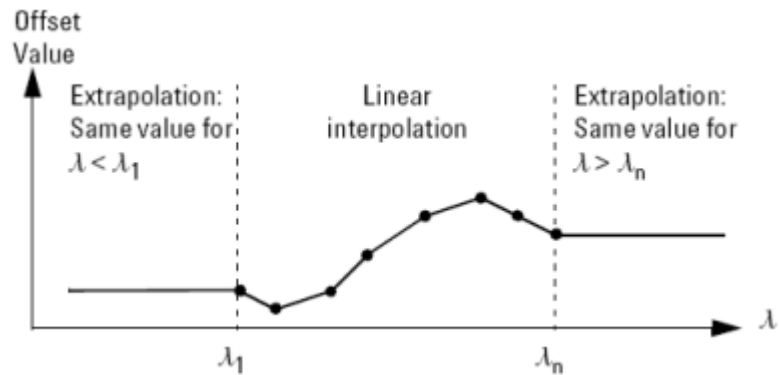
## Compensating for Wavelength Dependencies in your test setup

### Applying an Offset Table

For the  $P_{\text{Offset}}(1)$  parameter select <On> to enable or <Off> to disable the Wavelength Offset Table.

When  $P_{\text{Offset}}(1)$  is enabled, the offset applied depends on the operating wavelength you set for the attenuator.





**Figure 39** Extrapolation and Interpolation of Offset Values

- If the operating wavelength matches a wavelength stored in the Offset Table, the exact offset value is used.
- If the operating wavelength is between two wavelengths stored in the Offset Table, the offset applied is calculated by linear interpolation.
- If the operating wavelength is greater than, or less than, the range of wavelengths stored in the Offset Table, the offset value for the closest wavelength is extrapolated.

### Creating or Editing the Offset Table

You can create or edit the Offset Table if the  $P_{\text{Offset}}(\lambda)$  function is not on.

- 1 Make sure the the  $P_{\text{Offset}}(\lambda)$  function is NOT on.
- 2 Click the “Offset Table” button.
- 3 If you want to edit an existing offset table, click the “Load” button to load it from your PC, or click on the “Get from N77xx” button, to load the table being used by the attenuator.
  - To add a new pair, enter the wavelength:offset pair in the empty row at the bottom of the table.
  - The Offset Table is automatically ordered by wavelength; there is no need to enter wavelength:offset pairs in any particular order.
  - To edit the offset for an existing entry, click in the field and enter the new offset.
  - To remove an existing entry, click in the wavelength field and delete the wavelength.
- 4 To save a copy of the offset table to your PC, click the “Save” button.

## 2 Attenuation

To apply the offset table, click on “Set to N77xx” button, to save it to the attenuator for use.

- 5 Click on the “OK” button.

# 3 Specifications and Regulations Compliance

## Definition of Terms

### (Applicable) fiber type

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

### Attenuation

Difference (in dB) between “Total loss” (with any attenuation setting, see “Total loss” on page 70) and “Insertion loss” (i.e. with attenuation set to zero, see “Insertion loss” on page 62) of the attenuator.

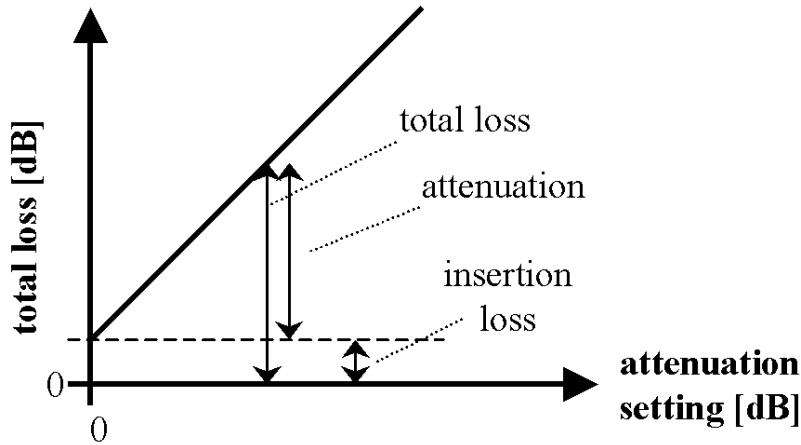


Figure 40 Attenuation

### Attenuation setting mode

Operating mode where the user sets the desired attenuation. The power control function is deactivated in this mode (see also “Power setting mode” on page 66).

### Attenuation accuracy (uncertainty)

The maximum possible difference (in dB) between the displayed “Attenuation” (see, “Attenuation” on page 59) and actual “Attenuation” (see, “Attenuation” on page 59).

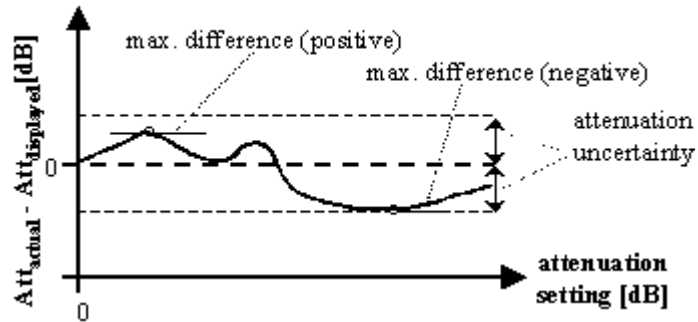


Figure 41 Attenuation accuracy (uncertainty)

**Conditions:** Attenuator set to the wavelength of the source. Input polarization, temperature range, maximum power and input mode (multimode attenuators only) as specified. Other conditions as specified.

**Measurement:** With Fabry-Pérot laser source of applicable wavelength, polarization scrambler (if applicable), and optical power meter.

**NOTE**

When using a polarized source, the attenuation uncertainty increases by  $\pm$  half the specified polarization dependent loss of the attenuator (if specified).

### 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.

### Drift (dark)

Specifies the maximum deviation from zero of the measured power with no optical input (dark) over time, excluding “Noise pp (dark)” on page 63, power expressed in Watts.

**Measurement:** From the dark measurement result  $P_i$ , the 3rd order polynomial fit  $F_i$  is calculated. The fit incorporates the least square-sum difference. The Drift  $D$  is calculated by

$$D = \max_i\{F_i\} \text{ or } \min_i\{F_i\}, \text{ whichever is worse.}$$

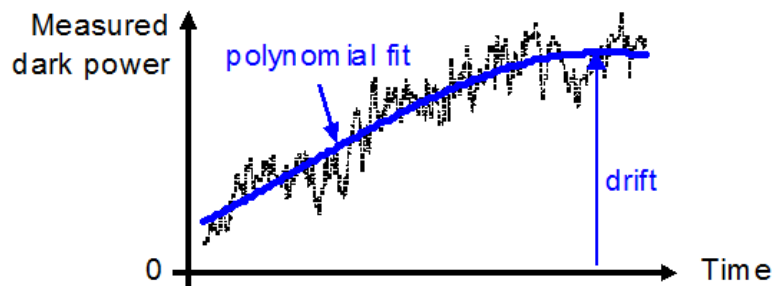


Figure 42 Drift (dark)

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

### Insertion loss

Specifies the “Total loss” at a displayed attenuation of 0 dB

**Conditions:** Temperature range, wavelength range, source polarization input polarization, input mode (multimode attenuators only) as specified.

**Measurement:** With Fabry-Pérot Laser Source, polarization controller (if applicable) and power meter, using high quality connectors in perfect optical condition.

#### NOTE

“Insertion loss excluding connectors” means connector loss is not part of the loss value.

“Insertion loss including connectors” includes the additional insertion loss from the connectors.

---

### 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, “[Noise pp \(dark\)](#)” on page 63 ) and “Drift (dark)” (see, “[Drift \(dark\)](#)” on page 61).

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

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

Conditions: Reference power level  $P_0 = 0.01 \text{ mW}$  (-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!

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

#### NOTE

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### Noise pp (dark)

Specifies the peak-to-peak (pp) change of displayed power over time with zero input power (dark), excluding "Drift (dark)" (see, "[Drift \(dark\)](#)" on page 61). Powers expressed in Watts.

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

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

The noise  $N$  is

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

**NOTE**

Note: The noise pp specification (rather than noise 2 sigma) is given for legacy reasons.

---

### 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, “**Drift (dark)**” on page 61). From the measurement result  $P_i$  and the fitted curve  $F_i$  the noise  $N$  is calculated by

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

### 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.



### **Optical path blocking**

Maximum possible attenuation.

### **Polarization dependent loss (PDL)**

The dependence of the “Total loss” (see, “**Total loss**” on page 70) on the input polarization state, expressed as the full difference (in dB) between the highest and the lowest total loss.

**Conditions:** Temperature range, input mode as specified.

**Measurement:** Using high quality connectors in perfect optical condition.

---

**NOTE**

PDL is a peak-to-peak value.

---

### **Polarization dependent responsivity (PDR)**

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

Powers expressed in dBm.

**Conditions:** As specified.

### 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.

**Measurement:** The lower limit corresponds to half the "Noise pp (dark)" (see, "Noise pp (dark)" on page 63).

### Power setting mode

Operating mode where the user sets the desired output power. The power control function of the attenuator automatically adjusts the attenuation to get the set output power (see also, "Attenuation setting mode" on page 60).

### Range in attenuation setting mode

Attenuation range that can be set at the attenuator in the Attenuation Setting Mode and for which the specifications apply (if not differently stated).

### Range in power setting mode

Range of optical output power that can be set at the attenuator in the Power Setting Mode and for which the specifications apply (if not differently stated).

#### NOTE

The actual minimum value is determined by the optical input power minus the maximum attenuation.

---

### Relative uncertainty of monitor power meter

When changing the output power of the attenuator, the relative power meter uncertainty is the maximum error of the displayed output power ratio to the actual output power ratio. This uncertainty is caused by the internal power meter's nonlinearity and noise and by errors in the sensing hardware, expressed as  $\pm$  half the span of all possible errors with an offset due to the noise level of the power meter. Symbol *RU*.

**Conditions:** Reference power level 1mW, wavelength and polarization state constant; power limitations as in the Specifications; zeroing prior to measurement.

**Measurement:** The nonlinearity is calculated using the displayed power ratio  $D_2 / D_1$  and the corresponding actual power ratio  $P_2 / P_1$ :

$$N_{dB}(1, 2) = 10 \log \left( \frac{D_1 / D_2}{P_2 / P_1} \right)$$

The relative power meter uncertainty is then calculated using:

$$RU_{dB} = \pm \frac{\max |N_{dB}(1, 2)|}{2}$$

RU is then expressed in dB and the offset is expressed in pW.

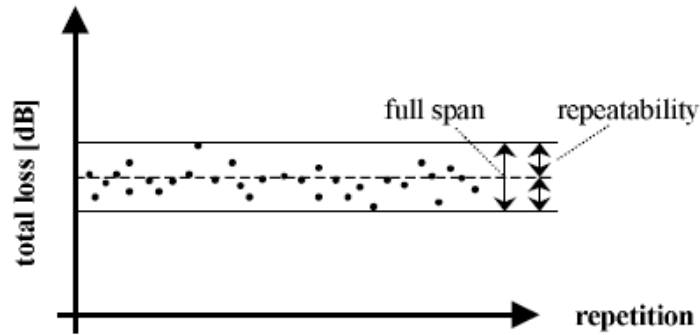
#### NOTE

Absolute power accuracy attainable with the help of an external optical power meter.

---

**Repeatability (of attenuation/total loss, or power level)** Specifies the uncertainty in reproducing the “Total loss” on page 70 (or “Attenuation” on page 59, or power level) after randomly changing

and resetting the attenuation or power level. The repeatability is defined as  $\pm$  half the difference between the highest and the lowest measured attenuation or power level over the repeated changing and resetting of the attenuation or power level.



**Figure 43** Repeatability

**Conditions:** Constant operating conditions. Operating in power setting mode requires zeroing prior to measurement.

### Resolution

The smallest possible increment or decrement in Attenuation Setting Mode or Power Setting Mode.

### 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.

**NOTE**

The measurement result includes internal reflections in the instrument, such as reflections from both attenuator ports.

### **Settling Time**

Maximum time needed to change the attenuation or power level by a specified step, from the beginning until the end of the change.

### **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<sup>1</sup> 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  $\pm$  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 loss

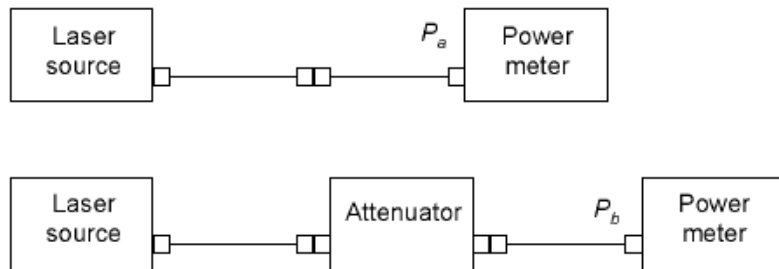
The change of power level after inserting the attenuator between two connectorized patchcords, at an arbitrary attenuation setting, expressed in dB. Its value TL can be calculated from:

$$TL(dB) = 10 \log \frac{P_a}{P_b} = P_a(dBm) - P_b(dBm)$$

where:

$P_a$  = power measured at the end of the two patchcords.

$P_b$  = power measured after the insertion of the attenuator.



**Figure 44** Total loss

**Conditions:** Patchcord cables with high quality connectors in perfect optical condition on both attenuator ports.

**NOTE**

The total loss depends on the attenuation setting.

**NOTE**

Total loss includes the loss of one additional connector pair.

### **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 63) and "Drift (dark)" (see, "Drift (dark)" on page 61).

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

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

### **Transition speed**

Specifies the settable attenuation change rate of the attenuator.

### **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, 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**

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

## Technical Specifications - Optical Variable Attenuator and Power Meter

### Optical Attenuator

#### Single-Mode Fiber Optical Attenuators

N7751A, N7752A, N7761A, N7762A, N7764A		
Connectivity	FC/APC angled (Option -022) or FC/PC straight (Option -021) contact connector interface	
Fiber type	9/125 $\mu\text{m}$ SMF 28	
Wavelength range	1260 nm to 1640 nm	
Attenuation range	0 dB to 40 dB (45 dB typ.)	
	Attenuation setting mode	Power setting mode
Range	0 dB to 40 dB	-50 dBm to +20 dBm
Resolution	0.01 dB	0.01 dB
Repeatability <sup>1</sup>	typ. +/- 0.05 dB for attenuation 0 dB to 30 dB typ. +/- 0.10 dB for attenuation 30 dB to 40 dB	$\pm 0.025$ dB
Accuracy (uncertainty) <sup>1-3</sup>	typ. $\pm 0.10$ dB for attenuation 0 dB to 10 dB typ. $\pm 0.15$ dB for attenuation 10 dB to 20 dB typ. $\pm 0.40$ dB for attenuation 20 dB to 40 dB	
Relative accuracy (uncertainty) <sup>1,2,4</sup>		$\pm 0.05$ dB $\pm 300$ pW
Polarization dependent loss <sup>5</sup>	typ. $\leq 0.15$ dB <sub>pp</sub> for attenuation 0 dB to 10 dB typ. $\leq 0.25$ dB <sub>pp</sub> for attenuation 10 dB to 20 dB typ. $\leq 0.5$ dB <sub>pp</sub> for attenuation 20 dB to 40 dB	$\leq 0.15$ dB <sub>pp</sub> <sup>6</sup>
Settling time	typ. 20 ms <sup>7</sup>	typ. 100 ms <sup>6</sup>
Insertion loss <sup>8</sup>	typ. $\leq 1.2$ dB (excluding connectors) $\leq 2.2$ dB (including connectors) <sup>9</sup>	
Attenuation transition speed	selectable from 0.1 to 1000 dB/s	
Relative uncertainty of monitor power meter <sup>2,10</sup>	$\pm 0.05$ dB $\pm 300$ pW	
Averaging time of monitor power meter	2 ms to 1 s	
Return loss	typ. 45 dB	
Maximum safe input power	+23 dBm if applied to input port; < +18 dBm if applied to output port	
Optical path blocking	typ. 45 dB	

1. At constant operating conditions.
2. For unpolarized light. Temperature constant and between  $(23 \pm 5)$  °C.
3. For  $(1310 \pm 15)$  nm,  $(1490 \pm 10)$  nm and  $(1550 \pm 15)$  nm.
4. Output power > -40 dBm, input power < +10 dBm.  
For input power > +10 dBm add typ.  $\pm 0.02$  dB.
5. For  $(1550 \pm 15)$  nm. Add typ. 0.05 dB for  $(1310 \pm 15)$  nm and  $(1490 \pm 10)$  nm.
6. Output power > -30 dBm, input power < +10 dBm.
7. For 20 dB step.
8. For  $(1550 \pm 15)$  nm. Add typ. 0.20 dB for  $(1310 \pm 15)$  nm and  $(1490 \pm 10)$  nm.
9. Measured with Agilent reference connectors.
10. For  $(1550 \pm 15)$  nm.



## Multimode Fiber Optical Attenuators

N7766A and N7768A		
Connectivity	FC/PC straight contact connector interface	
Fiber type	50/125 $\mu\text{m}$ (Option 050) or 62.5/125 $\mu\text{m}$ (Option 062) 80 $\mu\text{m}$ -core (Option 080) MMF	
Wavelength range	800 nm to 1370 nm	
Attenuation range	0 dB to 35 dB	
	Attenuation setting mode	Power setting mode
Range	0 dB to 35 dB	-35 dBm to +20 dBm
Resolution	0.03 dB	0.03 dB
Repeatability <sup>1,2,5</sup>	$\pm 0.025$ dB	$\pm 0.025$ dB
Accuracy (uncertainty) <sup>1-5</sup>	$\pm 0.25$ dB; typ. $\pm 0.15$ dB	
Relative accuracy (uncertainty) <sup>1-6</sup>		$\pm 0.1$ dB
Settling time (for 20 dB step)	typ. 200 ms	typ. 200 ms
Insertion loss <sup>1-5</sup>	$\leq 2.0$ dB; typ. $\leq 1.3$ dB	
Attenuation transition speed	Selectable from 0.1 to 80 and 1000 dB/s	
Relative uncertainty of monitor power meter <sup>1-6</sup>	$\pm 0.1$ dB	
Averaging time of monitor power meter	2 ms to 1 s	
Return loss <sup>2,5,7</sup>	typ. 25 dB	
Maximum safe input power <sup>3,8</sup>	+23 dBm	
Optical path blocking	typ. 60 dB	

1. At constant operating conditions.
2. Effective spectral bandwidth of input signal > 30 nm.
3. For mode launch conditions from IEEE 802.3: encircled flux < 30% in 4.5  $\mu\text{m}$  radius and > 86% inside 19  $\mu\text{m}$  for 50/125  $\mu\text{m}$  fiber; < 25% inside 4.5  $\mu\text{m}$  and > 75% inside 15  $\mu\text{m}$  for 62.5/125  $\mu\text{m}$  fiber; encircled flux < 30% in 7  $\mu\text{m}$  radius and > 86% inside 30  $\mu\text{m}$  for 80  $\mu\text{m}$ -core fiber (scaled from 50/125  $\mu\text{m}$  conditions).
4. For unpolarized light. Temperature constant and within  $(23 \pm 5)$  °C.
5. For  $(850 \pm 15)$  nm and  $(1300 \pm 15)$  nm; for  $(1060 \pm 15)$  nm, add typ.  $\pm 0.1$  dB to accuracy (uncertainty), relative accuracy (uncertainty) and relative uncertainty of monitor power meter and add typ. 0.5 dB to insertion loss.
6. For 2 ms averaging time. Output power > -30 dBm, input power < +10 dBm, attenuation setting  $\leq 30$  dB.
7. The return loss is primarily limited by the return loss of the front-panel connections.
8. Agilent assumes no responsibility for damage caused by scratched or poorly cleaned connectors.

## Optical Power Meter

N7751A and N7752A	
Sensor element	InGaAs
Wavelength range	1260 nm to 1640 nm
Specification wavelength range	(1310 ± 15) nm, (1490 ± 10) nm, (1550 ± 15) nm
Power range	-80 dBm to +10 dBm
Maximum safe power	+16 dBm
Averaging time	2 ms to 1 s
Applicable fiber type	Standard SM and MM ≤ 62.5 μm core size, NA ≤ 0.24
Uncertainty at reference conditions <sup>1,3</sup>	± 2.5%
Total uncertainty <sup>1,5,8</sup>	± 4.5%
Linearity <sup>7</sup> at (23 ± 5)°C over operating temperature	± 0.02 dB ± 0.04 dB
Polarization dependent responsivity (PDR) <sup>3,8</sup>	typ. < ± 0.01 dB (1260 nm to 1580 nm)
Spectral ripple (due to interference) <sup>10</sup>	typ. < ± 0.01 dB
Drift (dark) <sup>4</sup>	± 9 pW
Noise pp (dark) <sup>3</sup> , (1s averaging time, 300s observation time)	< 7 pW <sub>pp</sub>
Return loss <sup>9</sup>	typ. > 57 dB

1. 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 FWHM.

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

2. Operating conditions:

Single mode fiber SMF. For multimode fiber, typical.

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

Spectral width of source < 10 nm FWHM.

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

3. Ambient temperature (23 ± 5) °C.

4. Temperature constant within ± 1 K after zeroing.

5. Excluding noise and offset drift.

6. Power range -60 dBm to +10 dBm.

7. Power range -40 dBm to +10 dBm. For power < -40 dBm add 0.05 dB.

8. Straight connector, SMF.

9. Angled connector 8°, ceramic ferrule, SMF.

10. For constant state of polarization, source linewidth < 100 MHz, angled connector 8°, wavelength range 1260 nm to 1625 nm. Add ± 0.01 dB typ. within specification wavelength range for straight connector with ceramic ferrule.

## General Characteristics

### Dimensions (D x W x H):

1U half-rack  
372 mm x 212 mm x 43 mm

for N7766A and N7768A  
460 mm x 212 mm x 43 mm

*(excluding front and back rubber  
cushions)*

### Weight:

Approx. 3 kg

### Recommended recalibration period

24 month

### Operating temperature

+5 °C to +40 °C

### Operating humidity

15% to 95%, non-condensing

### Altitude

The maximum operating altitude is  
2000 m.

### Pollution protection

The Agilent N775xA/6xA is 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 - 240 V  $\pm$  10%,  
50/60 Hz, 60 VA max.

## Declarations of Conformity - Optical Multiport Attenuator and Power Meter

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



**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 Multiport Attenuator and Power Meter  
**Model Number:**

<b>N7751A</b>	1-Channel Optical Attenuator and Power Meter
<b>N7752A</b>	2-Channel Optical Attenuator and Power Meter
<b>N7761A</b>	1-Channel Optical Attenuator
<b>N7762A</b>	2-Channel Optical Attenuator
<b>N7764A</b>	4-Channel Optical Attenuator
<b>N7766A</b>	2-Channel Multimode Optical Attenuator
<b>N7768A</b>	4-Channel Multimode Optical Attenuator

**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:

<b>EMC</b>	<b>Standard</b>	<b>Limit</b>
	IEC 61326-1:2012 / EN 61326-1:2013	
	<i>Reference Standards</i>	
	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 / EN 61000-4-3:2006+A1:2007+A2:2010	3 V/m / 80 MHz-2 GHz, 1V/m / 2-2.7 GHz
	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	
<b>Safety</b>	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

## 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.

## 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](http://www.keysight.com/find/removealldoubt)

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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](http://www.lxistandard.org)

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[www.keysight.com/find/contactus](http://www.keysight.com/find/contactus)

# 4

## 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 - Agilent N7751A, N7752A, N7761A, N7762A, N7764A, N7766A, N7768A

All systems have 3 year warranty

Model number	
N7751A	Optical attenuator (1 channel) with optical power meter (2 channels)
N7752A	Optical attenuator (2 channels) with optical power meter (2 channels)
N7761A	Optical attenuator (1 channel)
N7762A	Optical attenuator (2 channels)
N7764A	Optical attenuator (4 channels)
N7766A	Optical attenuator (2 channels multimode)
N7768A	Optical attenuator (4 channels multimode)
Connector interface options (for N7751A, N7752A, N7761A, N7762A, N7764A)	
-021	Straight-contact FC/PC, 9/125 $\mu\text{m}$ SMF
-022	Angled-contact FC/APC, 9/125 $\mu\text{m}$ SMF
Multimode fiber options (for N7766A, N7768A)	
-050	50/125 $\mu\text{m}$ MMF, straight-contact FC/PC connector
-062	60/125 $\mu\text{m}$ MMF, straight-contact FC/PC connector
-080	80 $\mu\text{m}$ -Core MMF, straight-contact FC/PC connector
Accessories	
N7744-100	Rack Mount Kit for 1 or 2 Units of Same Depth
Warranty	
All systems have 3 year warranty	



## 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)



# 5

## 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 93 for cleaning the quad-adapters, and “How to clean optical glass plates” on page 94 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  $\mu\text{m}$  (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/m<sup>2</sup>). 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 produce 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 84](#) 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  $\mu\text{m}$ . 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](http://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.

## Data Sanitation

### Memory Inventory

The instruments have the following memory size:

**EEPROM** 2 Mb for N7761A and N7762A. 3 Mb for N7764A, N7751A, N7752A and N7766A. 4 Mb for N7768A. 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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