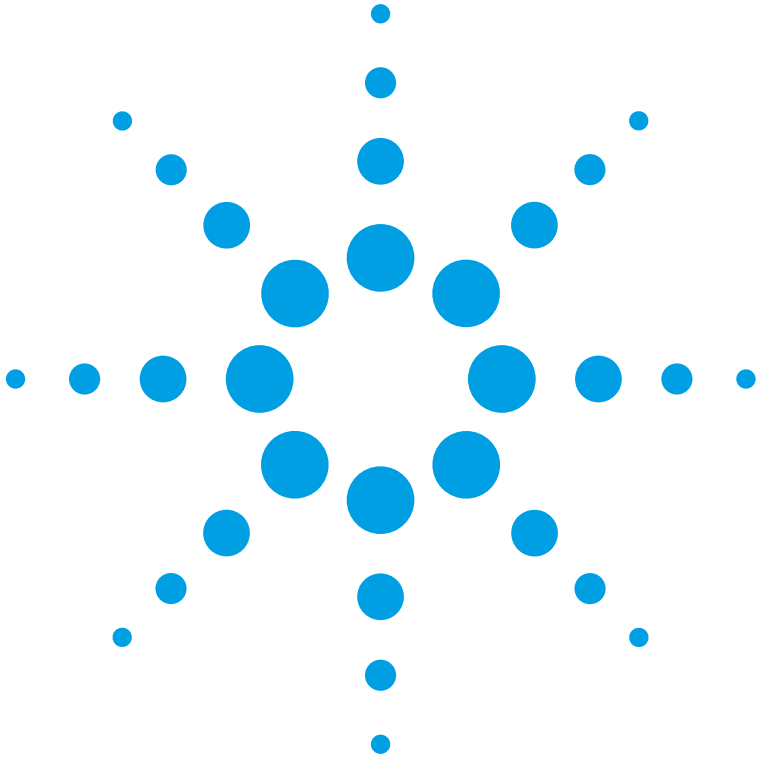
Agilent 11898A
Module Extender
User's Guide



Agilent Technologies

Agilent Part No. 11898-90002
Printed in USA
March 2000

Agilent Technologies
Lightwave Division
1400 Fountaingrove Parkway
Santa Rosa, CA 95403-1799,
USA
(707) 577-1400

Notice.
The information contained in this document is subject to change without notice. Companies, names, and data used in examples herein are fictitious unless otherwise noted. Agilent Technologies makes no warranty of any kind with regard to this material, including but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Agilent Technologies shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

Restricted Rights Legend.
Use, duplication, or disclosure by the U.S. Government is subject to restrictions as set forth in subparagraph (c) (1) (ii) of the Rights in Technical Data and Computer Software clause at DFARS 252.227-7013 for DOD agencies, and subparagraphs (c) (1) and (c) (2) of the Commercial Computer Software Restricted Rights clause at FAR 52.227-19 for other agencies.

Warranty.
This Agilent Technologies instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Agilent Technologies will, at its option, either repair or replace products which prove to be defective. For warranty service or repair, this product must be returned to a service facility designated by Agilent Technologies. Buyer shall prepay shipping charges to Agilent Technologies and Agilent Technologies shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to Agilent Technologies from another country.

Agilent Technologies warrants that its software and firmware designated by Agilent Technologies for use with an instrument will execute its programming instructions when properly installed on that instrument. Agilent Technologies does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error-free.

Limitation of Warranty.
The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

No other warranty is expressed or implied. Agilent Technologies specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

Exclusive Remedies.
The remedies provided herein are buyer's sole and exclusive remedies. Agilent Technologies shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

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 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 laser radiation symbol. This warning symbol is marked on products which have a laser output.


The AC symbol is used to indicate the required nature of the line module input power.


The ON symbols are used to mark the positions of the instrument power line switch.


The OFF symbols are used to mark the positions of the instrument power line switch.


The CE mark is a registered trademark of the European Community.


The CSA mark is a registered trademark of the Canadian Standards Association.


The C-Tick mark is a registered trademark of the Australian Spectrum Management Agency.

ISM1-A This text denotes the instrument is an Industrial Scientific and Medical Group 1 Class A product.

Typographical Conventions.
The following conventions are used in this book:

Key type for keys or text located on the keyboard or instrument.

Softkey type for key names that are displayed on the instrument's screen.

`Display type` for words or characters displayed on the computer's screen or instrument's display.

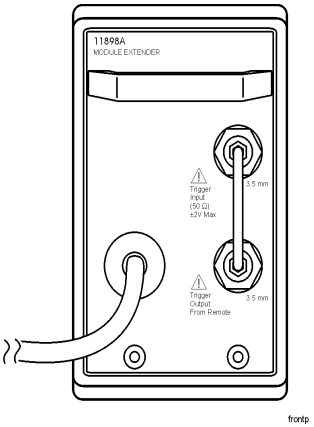
User type for words or characters that you type or enter.

Emphasis type for words or characters that emphasize some point or that are used as place holders for text that you type.

The Agilent 11898A—At a Glance

The Agilent 11898A module extender is an accessory for the Agilent 83480A Digital Communications Analyzer and the Agilent 54750A Digital Oscilloscope mainframes. The module extender makes it possible for plug-in modules to be operated remotely from the mainframe.

Using the module extender can improve measurement accuracy by enabling the module's connectors to be positioned near the device under test. This reduces the need for long cables, which are cumbersome and can introduce losses. This is particularly true when measuring extremely high-speed electrical signals. In these cases, locating the signal input in close proximity to the signal source increases accuracy and reduces the measurements artifacts caused by cables. If it is impractical to relocate the device under test to the front panel of the mainframe, the module extender provides an alternative method of minimizing cables.



The extender also makes it easy to test a device that must be isolated from vibration on an optical bench.

Measurement Accuracy

To ensure that you obtain the specified accuracy for the module you are using with the extender, you must perform a plug-in module vertical calibration after the module has been connected to the extender. The calibration must also be performed when you move a module extender or plug-in module from one slot to another, or from one mainframe to another. Refer to "Step 4. Perform Calibrations" on page 1-8 for information on performing a plug-in module vertical calibration.

CAUTION

The plug-in module input circuitry can be damaged when the *total* input power levels exceed +10 dBm (10 mW) on the optical channel or ±2 V + peak ac (+16 dBm) on the electrical channel. To prevent input damage, this specified level must not be exceeded.

General Safety Considerations

This product has been designed and tested in accordance with IEC Publication 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use, 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.

WARNING **If this instrument is not used as specified, the protection provided by the equipment could be impaired. This instrument must be used in a normal condition (in which all means for protection are intact) only.**

WARNING **To prevent electrical shock, disconnect the Agilent 11898A module extender from 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.**

WARNING **This is a Safety Class 1 product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the product is likely to make the product dangerous. Intentional interruption is prohibited.**

WARNING **No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock, do not remove covers.**

WARNING **For continued protection against fire hazard, replace line fuse only with same type and ratings, (type T 0.315A/250V for 100/120V operation and 0.16A/250V for 220/240V operation). The use of other fuses or materials is prohibited. Verify that the value of the line-voltage fuse is correct.**

- For 100/120V operation, use an IEC 127 5×20 mm, 0.315 A, 250 V, Agilent part number 2110-0449.
- For 220/240V operation, use an IEC 127 5×20 mm, 0.16 A, 250 V, Agilent Technologies part number 2110-0448.

CAUTION Before switching on this instrument, make sure that the line voltage selector switch is set to the line voltage of the power supply and the correct fuse is installed. Assure the supply voltage is in the specified range.

CAUTION This product is designed for use in Installation Category II and Pollution Degree 2 per IEC 1010 and 664 respectively.

CAUTION VENTILATION REQUIREMENTS: When installing the product in a cabinet, the convection into and out of the product must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the product by 4°C for every 100 watts dissipated in the cabinet. If the total power dissipated in the cabinet is greater than 800 watts, then forced convection must be used.

CAUTION Always use the three-prong ac power cord supplied with this instrument. Failure to ensure adequate earth grounding by not using this cord may cause instrument damage.

CAUTION *Do not* connect ac power until you have verified the line voltage is correct. Damage to the equipment could result.

CAUTION This instrument has autoranging line voltage input. Be sure the supply voltage is within the specified range.

CAUTION Electrostatic discharge (ESD) on or near input connectors can damage circuits inside the instrument. Repair of damage due to misuse is *not* covered under warranty. Before connecting any cable to the electrical input, momentarily short the center and outer conductors of the cable together. Personnel should be properly grounded, and should touch the frame of the instrument before touching any connector.

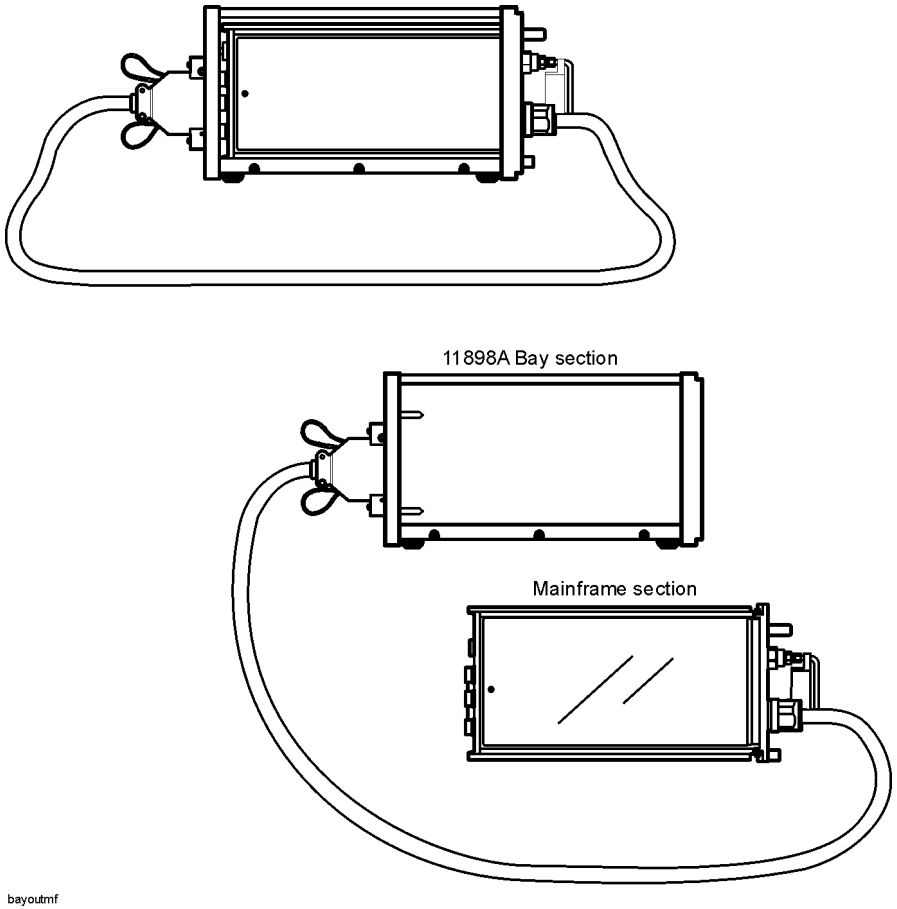
Contents

1

Using the Agilent 11898A Module Extender

Getting Started

This chapter shows how to install your Agilent 11898A module extender, and gives information for returning the module for service. Refer to Chapter 2, “Specifications and Regulatory Information” for information on operating conditions, such as temperature.



Agilent 11898A bay section inserted in mainframe section.

The Agilent 11898A module extender consists of two sections: the portion of the extender which is inserted in the mainframe, and the bay section which is the receptacle for the plug-in module. These sections are connected by a cable. The front panel of the module is part of the mainframe section. Throughout this document, “module extender” will be used to refer to the Agilent 11898A module extender, while “plug-in” will be used only to refer to modules used with the extender. The “mainframe section” of the extender is the section of the extender that is installed in the mainframe, and the “bay section” is the portion of the module extender where a plug-in is installed.

CAUTION This product is designed for use in INSTALLATION CATEGORY II and POLLUTION DEGREE 2, per IEC 1010 and 664 respectively.

CAUTION Input circuits can be damaged by electrostatic discharge (ESD). Therefore, avoid applying static discharges to the front-panel input connectors. Before connecting any coaxial cable to the connectors, momentarily short the center and outer conductors of the cable together. Avoid touching the front-panel input connectors without first touching the frame of the instrument. Be sure that the instrument is properly earth-grounded to prevent buildup of static charge. Refer to “Electrostatic Discharge Information” on page 3-5.

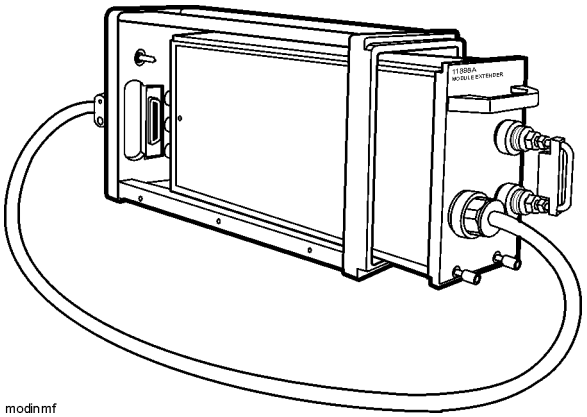
Step 1. Inspect the Shipment

Verify that all system components ordered have arrived by comparing the shipping forms to the original purchase order. Inspect all shipping containers.

If your shipment is damaged or incomplete, save the packing materials and notify both the shipping carrier and the nearest Agilent Technologies service office. Agilent Technologies will arrange for repair or replacement of damaged or incomplete shipments without waiting for a settlement from the transportation company. Notify the Agilent Technologies customer engineer of any problems.

Step 2. Prepare the Module Extender

- For shipping purposes, one end of the module extender is inserted into the other. Loosen the two knurled screws at the bottom of the front panel and separate the two pieces using the handle provided on the front panel.



modinmf

CAUTION When installing or removing the Agilent 11898A module extender, always use the handle provided on the front panel. Do *not* pull on the flexible cable or the semi-rigid RF cable on the front panel when handling the module. Pulling these cables will damage the cables or their connectors.

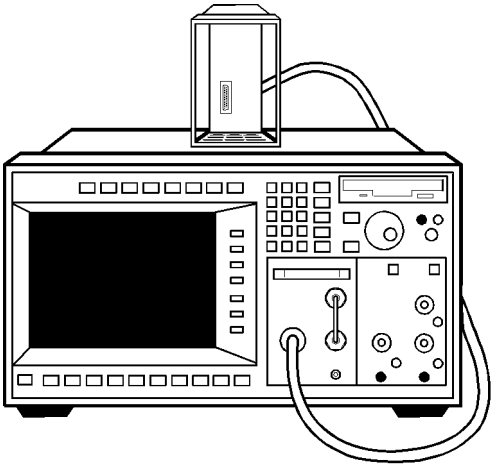
CAUTION Do not use non-Agilent Technologies extender cables to operate the plug-in module outside of the mainframe. The plug-in module can be damaged by improper grounding when using extender cables.

Step 3. Install the Module Extender

You do *not* need to turn off the mainframe to install or remove the module extender, or to install or remove a plug-in from the module extender.

1 Install the mainframe section of the module extender in an Agilent 83480A or Agilent 54750A mainframe and tighten the knurled screws on the module extender front panel.

The module extender can be installed in slots 1 and 2 or 3 and 4 on the Agilent 83480A or Agilent 54750A mainframe. The plug-in module will *not* function if the module extender is installed in slots 2 and 3.



inuse.cdr

2 Install a plug-in module in the bay section of the module extender and tighten the two knurled screws on the plug-in front panel.

These steps may be done in either order: by installing the module extender in the mainframe first, or by installing the plug-in in the bay of the module extender first.

Note

To make sure the measurement system operates properly, there must be a good ground connection from the module extender to the mainframe, and from the plug-in to the module extender. The RF connectors on the rear of the modules are spring-loaded, so finger-tighten the knurled screws on the front panels of the plug-in module and the module extender to make sure all connectors are fully seated.

3 Perform calibrations necessary to ensure performance of the plug-in.

WARNING **Do *not* block the sides or bottom of the module extender during operation. The Agilent 11898A uses convection cooling. Restricting the airflow could damage the instrument.**

CAUTION Use caution when installing and using the module extender to avoid damaging the extender cable.

Selecting the trigger input location

The Agilent 11898A module extender offers two triggering options: triggering at the mainframe, or triggering at the remote module.

- To input the trigger at the mainframe, disconnect both ends of the rigid RF cable from the front panel of the module extender. Attach the trigger signal to the Trigger Input connector on the front panel.
- To return to triggering at the remote module, reattach the rigid RF cable.

Step 4. Perform Calibrations

To ensure you obtain the specified accuracy, you must perform a plug-in module vertical calibration after connecting a plug-in module to the module extender. The calibration must also be performed when you move a plug-in module or the module extender from one slot to another, from one mainframe to another, or when the temperature changes by ≥±5°C.

CAUTION

The input circuits of the plug-in modules can be damaged by electrostatic discharge (ESD). Therefore, avoid applying static discharges to the front-panel input connectors. Before connecting any coaxial cable to the connectors, momentarily short the center and outer conductors of the cable together. Avoid touching the front-panel input connectors without first touching the frame of the instrument. Be sure that the instrument is properly earth-grounded to prevent buildup of static charge. For more information on ESD, refer to "Electrostatic Discharge Information" on page 3-5.

Performing a plug-in module vertical calibration

1. Press Utility, *Calibrate*, *Calibrate plug-in*.
2. Select the plug-in module to be calibrated by pressing *1 and 2* or *3 and 4*. (Select the slots where the module extender is installed.)
3. Start the calibration procedure by pressing *Start cal*.
4. Follow the on-screen instructions.

Calibrating voltage probes

Because the mainframe's CAL signal is a voltage source, you can let the instrument compensate for the actual characteristics of your probe by letting the instrument calibrate to the tip of the probe.

1 To calibrate a voltage probe to the probe tip, connect the probe to the CAL signal, then set the instrument as follows:

Electrical Channel
Electrical Scale...., *Atten units*, *ratio*
Units, *Volt*, *Done*, ENTER
Calibrate...., *Calibrate Probe*

The instrument automatically calibrates to the tip of the probe, sets the probe attenuation and compensates for any probe offset.

Active probes

For active probes that the instrument can identify through the probe power connector, like the Agilent 54701A, the instrument automatically adjusts the vertical scale factors for that channel, even if a probe calibration is not performed.

Passive probes

For passive probes or nonidentified probes, the instrument adjusts the vertical scale factors only if a probe calibration is performed.

Calibrating other devices

Because the mainframe's CAL signal is a voltage source, it *cannot* be used to calibrate to the probe tip when the units are set to Ampere, Watt, or Unknown. Instead, set the external gain and external offset to compensate for the actual characteristics of the probe or device. If you do not know the actual characteristics, you can refer to the typical specifications that came with the probe or device.

1 To compensate for the actual characteristics of the probe or device, set the instrument as follows:

Electrical Channel
Electrical Scale...., *Atten units*, *ratio*
Attenuation, *1:1*
Units, *Ampere* (Watt or unknown)
Ext gain(actual gain characteristics of the probe or device)
Ext offset(offset introduced by the probe or device)

Returning the Instrument for Service

The instructions in this section show you how to properly return the instrument for repair or calibration. Always call the Agilent Technologies Instrument Support Center first to initiate service *before* returning your instrument to a service office. This ensures that the repair (or calibration) can be properly tracked and that your instrument will be returned to you as quickly as possible. Call this number regardless of where you are located. Refer to "Agilent Technologies Service Offices" on page 3-17 for a list of service offices.

Agilent Technologies Instrument Support Center . . . . . (800) 403-0801

If the instrument is still under warranty or is covered by an Agilent Technologies maintenance contract, it will be repaired under the terms of the warranty or contract (the warranty is at the front of this manual). If the instrument is no longer under warranty or is not covered by an Agilent Technologies maintenance plan, Agilent Technologies will notify you of the cost of the repair after examining the unit.

When an instrument is returned to a Agilent Technologies service office for servicing, it must be adequately packaged and have a complete description of the failure symptoms attached. When describing the failure, please be as specific as possible about the nature of the problem. Include copies of additional failure information (such as the instrument failure settings, data related to instrument failure, and error messages) along with the instrument being returned.

Preparing the instrument for shipping

1 Write a complete description of the failure and attach it to the instrument. Include any specific performance details related to the problem. The following

information should be returned with the instrument.

- Type of service required.
- Date instrument was returned for repair.
- Description of the problem:
  - Whether problem is constant or intermittent.
  - Whether instrument is temperature-sensitive.
  - Whether instrument is vibration-sensitive.
  - Instrument settings required to reproduce the problem.
  - Performance data.
- Company name and return address.
- Name and phone number of technical contact person.
- Model number of returned instrument.
- Full serial number of returned instrument.
- List of any accessories returned with instrument.

2 Cover all front or rear-panel connectors that were originally covered when you first received the instrument.

CAUTION Cover electrical connectors to protect sensitive components from electrostatic damage. Cover optical connectors to protect them from damage due to physical contact or dust.

CAUTION Instrument damage can result from using packaging materials other than the original materials. Never use styrene pellets as packaging material. They do not adequately cushion the instrument or prevent it from shifting in the carton. They may also cause instrument damage by generating static electricity.

3 Pack the instrument in the original shipping containers. Original materials are available through any Agilent Technologies office. Or, use the following guidelines:

- Wrap the instrument in antistatic plastic to reduce the possibility of damage caused by electrostatic discharge.
- For instruments weighing less than 54 kg (120 lb), use a double-walled, corrugated cardboard carton of 159 kg (350 lb) test strength.
- The carton must be large enough to allow approximately 7 cm (3 inches) on all sides of the instrument for packing material, and strong enough to accommodate the weight of the instrument.
- Surround the equipment with approximately 7 cm (3 inches) of packing material, to protect the instrument and prevent it from moving in the carton. If packing foam is not available, the best alternative is S.D-240 Air Cap™ from

Sealed Air Corporation (Commerce, California 90001). Air Cap looks like a plastic sheet filled with air bubbles. Use the pink (antistatic) Air Cap™ to reduce static electricity. Wrapping the instrument several times in this material will protect the instrument and prevent it from moving in the carton.

4 Seal the carton with strong nylon adhesive tape.

5 Mark the carton “FRAGILE, HANDLE WITH CARE”.

6 Retain copies of all shipping papers.

2

Specifications and Regulatory Information

Specifications and Regulatory Information

The Agilent 11898A module extender does not have separate electrical, optical, temperature, or humidity specifications. For information on performance specifications and characteristics for plug-in modules used with the extender, refer to the documentation provided with the plug-in module. However, due to the additional cable length of the module extender, some plug-in performance parameters may be affected. This chapter provides information on the affected performance parameters.

Specifications *Specifications* described warranted performance.

Characteristics *Characteristics* provide useful, nonwarranted, information about the functions and performance of the instrument. *Characteristics are printed in italics.*

Specifications

Warm-up time

For standard mainframe operation, plug-in specifications are valid after a one-hour warm-up period. For operation with the module extender, specifications are valid after a *two-hour warm up period* (with the extender installed in the mainframe and the plug-in installed in the extender bay).

Trigger to signal delay

The displayed timebase values will not be correct when operating a plug-in with the module extender. The characteristic delays below must be added to the displayed value to obtain the correct approximate delay from the trigger signal.

Table 2-1. Trigger to Signal Delay

Method of Operation	Additional Delay	Minimum Required Trigger Delay
Standard mainframe operation	none	22 ns
Remote operation with module extender (trigger input at mainframe)	*approximately 8 ns*	*approximately 30 ns*
Remote operation with module extender (trigger input at remote module)	*approximately 18 ns*	*approximately 40 ns*

Trigger sensitivity

The extra length of trigger cable in the module extender results in additional loss at high frequencies. This loss must be considered when calculating trigger sensitivity.

A trigger input is provided at the mainframe end of the Agilent 11898A module extender module extender. Triggering at the mainframe is recommended for applications requiring the highest sensitivity, and for the enhanced trigger option (Option 100) of the mainframe at frequencies greater than 2.5 GHz.

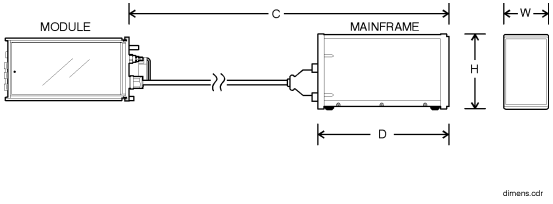
Table 2-2. Additional Trigger Path Loss

Method of Operation	Additional Trigger Path Loss	Trigger Sensitivity at 2.5 GHz
Remote operation with module extender (trigger input at mainframe)	none	200 mV pk-pk
Remote operation with module extender (trigger input at remote module)	*approximately 4 dB at 2.5 GHz*	*approximately 320 mV pk-pk*

General specifications

Table 2-3. General Specifications

Use	Indoor
Weight	approximately 1.8 kg (4 lb.)
Dimensions	
Height (H)	15.2 cm (6.0 in)
Width (W)	9.1 cm (3.6 in)
Depth (D)	27.8 cm (10.9 in)
Extension (C)	1.52m (60 in)



Declaration of Conformity

DECLARATION OF CONFORMITY

acccording to ISO/IEC Guide 22 and EN 45014

Manufacturer's Name: Hewlett-Packard Co.

Manufacturer's Address: 1400 Fountaingrove Parkway
Santa Rosa, CA 95403-1799
USA

declares that the product:

Product Name: Module Extender

Model Number: HP 11898A

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

conforms to the following Product specificiations:

Safety IEC 1010-1:1990+A1 /EN 61010-1:1993
CAN/CSA-C22.2 No. 1010.1-92

EMC: CISPR 11:1990/EN 55011:1991 Group 1, Class A
IEC 801-2:1984/EN 50082-1:1992 4 kV CD, 8 kV AD
IEC 801-3:1984/EN 50082-1:1992 3V/m, 27-500 MHz
IEC 801-4:1984/EN 50082-1:1992 0.5 kV sig. lines, 1 kV power lines
IEC 1000-3-2:1995 / EN 61000-3-2:1995
IEC 1000-3-3:1994 / EN 61000-3-3:1995

Supplementary Information:
The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE-marking accordingly.

Santa Rosa, CA, USA 27 Feb. 1997

John Hiatt/Quality Engineering Manager

European Contact: Your local Hewlett-Pckard Sales and Service Office or Hewlett-Packard GmbH, Department HQ-TRE, Herrenberger Strasse 130, D-71034 Böblingen, Germany (Fax +49-7031-14-3143)

3

Reference

In Case of Difficulty

This section provides a list of suggestions for you to follow if the plug-in module fails to operate.

Review the procedure being performed when the problem occurred. Before calling Agilent Technologies or returning the unit for service, a few minutes spent performing some simple checks may save waiting for your instrument to be repaired.

This section also includes information regarding electrostatic discharge (ESD), procedures for cleaning both optical and electrical connections, and a list of Agilent Technologies service offices.

If the mainframe does not operate

Make the following checks:

- ❒ Is the line fuse good?
- ❒ Does the line socket have power?
- ❒ Is the unit plugged in to the proper ac power source?
- ❒ Is the mainframe turned on?
- ❒ Is the rear-panel line switch set to on?
- ❒ Will the mainframe power up *without* the plug-in module installed?

If the mainframe still does not power up, refer to the optional *Agilent 83480A, 54750A Service Guide* or return the mainframe to a qualified service department.

If the plug-in does not operate

Make the following checks:

- ❒ Is the plug-in module firmly seated in the extender bay?
- ❒ Is the module extender firmly seated in the mainframe?
- ❒ Are the knurled screws at the bottom of the plug-in module finger-tight?
- ❒ Are the knurled screws on the module extender finger-tight?
- ❒ Are the module extender fuses good? (See "To inspect and replace fuses" on page 3-3.)
- ❒ Is a trigger signal connected to a trigger input? Try selecting *Free Run* from the Trigger menu.
- ❒ If other equipment, cables, and connectors are being used with the plug-in module, are they connected properly and operating correctly?
- ❒ Review the procedure for the test being performed when the problem appeared. Are all the settings correct? Can the problem be reproduced?
- ❒ Are the connectors clean? See "Cleaning Connections for Accurate Measurements" on page 3-7 for more information.

If all of the above steps check out okay, and the plug-in module still does not operate properly, refer to the Troubleshooting section of the documentation provided with the plug-in module.

To inspect and replace fuses

The Agilent 11898A module extender has two fuses inside the mainframe section of the module extender. The fuses protect the high current power supply lines in the unlikely event of a short circuit in the module or cable.

To inspect or replace these fuses:

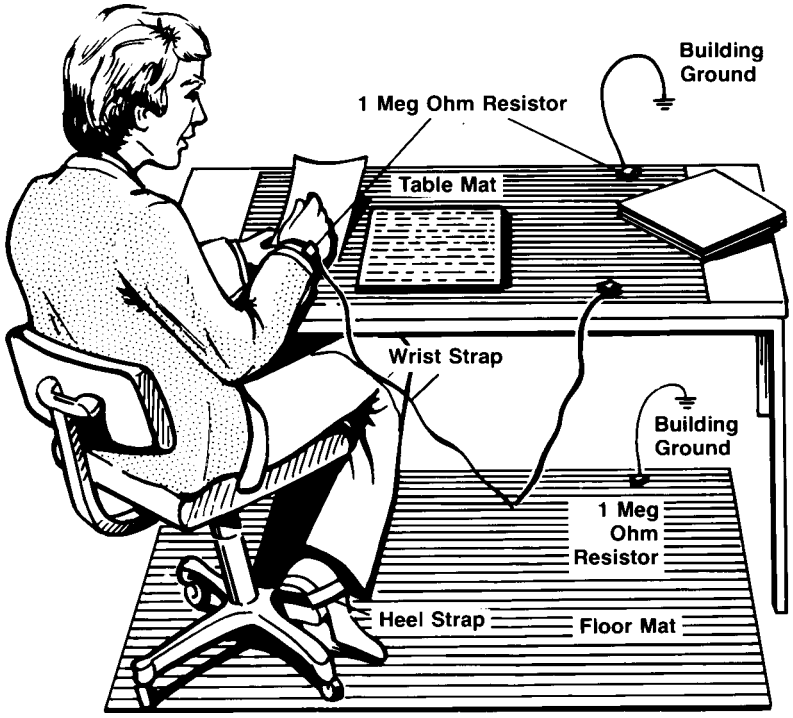
1. Remove the plug-in from the module extender bay.
2. Remove the module extender from the mainframe.
3. Gently pry the left-side cover from the module extender. A small screwdriver should be inserted at the rear corners of the side cover.
4. Use a fuse-puller to remove both fuses for inspection and/or replacement.

WARNING **Replace fuses only with fuses of the same type and rating. Both fuses are 250V, 1 amp, slo-blo.**

Electrostatic Discharge Information

Electrostatic discharge (ESD) can damage or destroy electronic components. All work on electronic assemblies should be performed at a static-safe work station. The following figure shows an example of a static-safe work station using two types of ESD protection:

- Conductive table-mat and wrist-strap combination.
- Conductive floor-mat and heel-strap combination.



Both types, when used together, provide a significant level of ESD protection. Of the two, only the table-mat and wrist-strap combination provides adequate ESD protection when used alone.

To ensure user safety, the static-safe accessories must provide at least 1 MΩ of isolation from ground. Refer to Table 3-1 for information on ordering static-safe accessories.

WARNING **These techniques for a static-safe work station should not be used when working on circuitry with a voltage potential greater than 500 volts.**

Table 3-1. Static-Safe Accessories

Agilent Part Number	Description
9300-0797	3M static control mat 0.6 m × 1.2 m (2 ft× 4 ft) and 4.6 cm (15 ft) ground wire. (The wrist-strap and wrist-strap cord are not included. They must be ordered separately.)
9300-0980	Wrist-strap cord 1.5 m (5 ft).
9300-1383	Wrist-strap, color black, stainless steel, without cord, has four adjustable links and a 7 mm post-type connection.
9300-1169	ESD heel-strap (reusable 6 to 12 months).

Cleaning Connections for Accurate Measurements

Today, advances in measurement capabilities make connectors and connection techniques more important than ever. Damage to the connectors on calibration and verification devices, test ports, cables, and other devices can degrade measurement accuracy and damage instruments. Replacing a damaged connector can cost thousands of dollars, not to mention lost time! This expense can be avoided by observing the simple precautions presented in this book. This book also contains a brief list of tips for caring for electrical connectors.

Choosing the Right Connector

A critical but often overlooked factor in making a good lightwave measurement is the selection of the fiber-optic connector. The differences in connector types are mainly in the mechanical assembly that holds the ferrule in position against another identical ferrule. Connectors also vary in the polish, curve, and concentricity of the core within the cladding. Mating one style of cable to another requires an adapter. Agilent Technologies offers adapters for most instruments to allow testing with many different cables. Figure 3-1 on page 3-8 shows the basic components of a typical connectors.

The system tolerance for reflection and insertion loss must be known when selecting a connector from the wide variety of currently available connectors. Some items to consider when selecting a connector are:

- How much insertion loss can be allowed?
- Will the connector need to make multiple connections? Some connectors are better than others, and some are very poor for making repeated connections.
- What is the reflection tolerance? Can the system take reflection degradation?
- Is an instrument-grade connector with a precision core alignment required?
- Is repeatability tolerance for reflection and loss important? Do your specifica-

tions take repeatability uncertainty into account?

- Will a connector degrade the return loss too much, or will a fusion splice be required? For example, many DFB lasers cannot operate with reflections from connectors. Often as much as 90 dB isolation is needed.

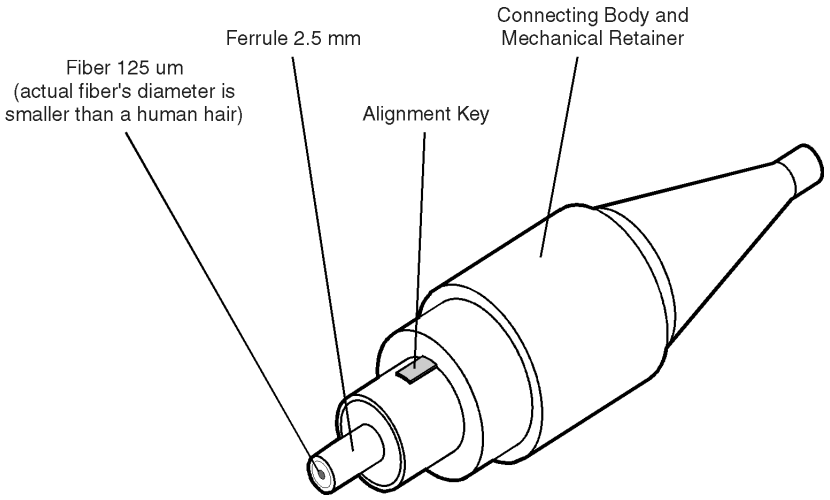


Figure 3-1. Basic components of a connector.

Over the last few years, the FC/PC style connector has emerged as the most popular connector for fiber-optic applications. While not the highest performing connector, it represents a good compromise between performance, reliability, and cost. If properly maintained and cleaned, this connector can withstand many repeated connections.

However, many instrument specifications require tighter tolerances than most connectors, including the FC/PC style, can deliver. These instruments cannot tolerate connectors with the large non-concentricities of the fiber common with ceramic style ferrules. When tighter alignment is required, Agilent Technologies instruments typically use a connector such as the Diamond HMS-10, which has concentric tolerances within a few tenths of a micron. Agilent Technologies then uses a special universal adapter, which allows other cable types to mate with this precision connector. See Figure 3-2.

Figure 3-2. Universal adapters to Diamond HMS-10.

The HMS-10 encases the fiber within a soft nickel silver (Cu/Ni/Zn) center which is surrounded by a tough tungsten carbide casing, as shown in Figure 3-3.

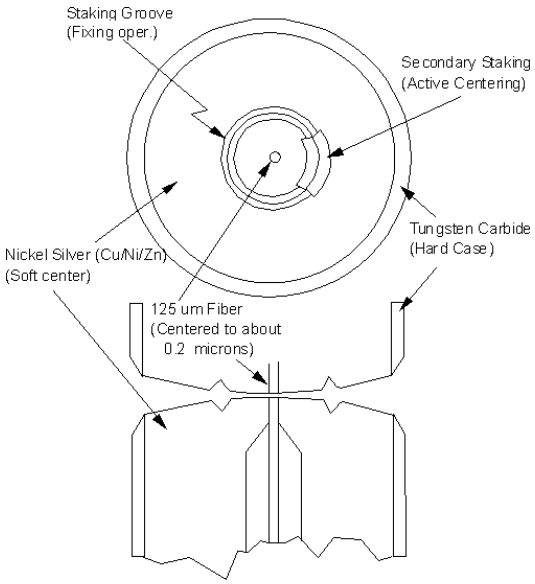


Figure 3-3. Cross-section of the Diamond HMS-10 connector.

The nickel silver allows an active centering process that permits the glass fiber to be moved to the desired position. This process first stakes the soft nickel silver to fix the fiber in a near-center location, then uses a post-active staking to shift the fiber into the desired position within 0.2 µm. This process, plus the keyed axis, allows very precise core-to-core alignments. This connector is found on most Agilent Technologies lightwave instruments.

The soft core, while allowing precise centering, is also the chief liability of the connector. The soft material is easily damaged. Care must be taken to minimize excessive scratching and wear. While minor wear is not a problem if the glass face is not affected, scratches or grit can cause the glass fiber to move out of alignment. Also, if unkeyed connectors are used, the nickel silver can be pushed onto the glass surface. Scratches, fiber movement, or glass contamination will cause loss of signal and increased reflections, resulting in poor return loss.

Inspecting Connectors

Because fiber-optic connectors are susceptible to damage that is not immediately obvious to the naked eye, poor measurements result without the user being aware. Microscopic examination and return loss measurements are the best way to ensure good measurements. Good cleaning practices can help ensure that optimum connector performance is maintained. With glass-to-glass interfaces, any degradation of a ferrule or the end of the fiber, any stray particles, or finger oil can have a significant effect on connector performance. Where many repeat connections are required, use of a connector saver or patch cable is recommended.

Figure 3-4 shows the end of a clean fiber-optic cable. The dark circle in the center of the micrograph is the fiber's 125 µm core and cladding which carries the light. The surrounding area is the soft nickel-silver ferrule. Figure 3-5 shows a dirty fiber end from neglect or perhaps improper cleaning. Material is smeared and ground into the end of the fiber causing light scattering and poor reflection. Not only is the precision polish lost, but this action can grind off the glass face and destroy the connector.

Figure 3-6 shows physical damage to the glass fiber end caused by either repeated connections made without removing loose particles or using improper cleaning tools. When severe, the damage of one connector end can be transferred to another good connector endface that comes in contact with the damaged one. Periodic checks of fiber ends, and replacing connecting cables after many connections is a wise practice.

The cure for these problems is disciplined connector care as described in the following list and in "Cleaning Connectors" on page 3-14.

Use the following guidelines to achieve the best possible performance when making measurements on a fiber-optic system:

- Never use metal or sharp objects to clean a connector and never scrape the connector.
- Avoid matching gel and oils.

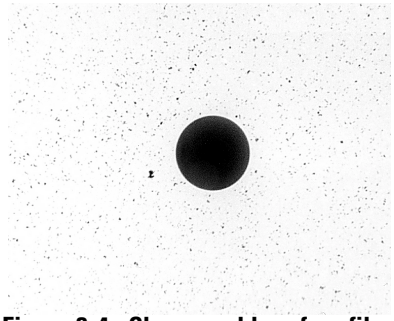


Figure 3-4. Clean, problem-free fiber end and ferrule.

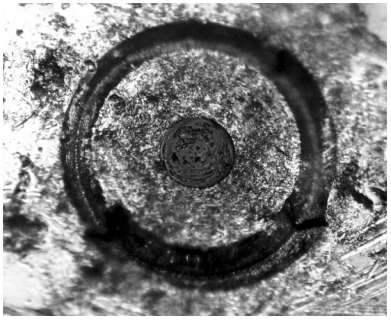


Figure 3-5. Dirty fiber end and ferrule from poor cleaning.

Figure 3-6. Damage from improper cleaning.

While these often work well on first insertion, they are great dirt magnets. The oil or gel grabs and holds grit that is then ground into the end of the fiber. Also, some early gels were designed for use with the FC, non-contacting connectors, using small glass spheres. When used with contacting connectors, these glass balls can scratch and pit the fiber. If an index matching gel or oil must be used, apply it to a freshly cleaned connector, make the measurement, and then immediately clean it off. Never use a gel for longer-term connections and never use it to improve a damaged connector. The gel can mask the extent of damage and continued use of a damaged fiber can transfer damage to the instrument.

- When inserting a fiber-optic cable into a connector, gently insert it in as straight a line as possible. Tipping and inserting at an angle can scrape material off the inside of the connector or even break the inside sleeve of connectors made with ceramic material.
- When inserting a fiber-optic connector into a connector, make sure that the fiber end does not touch the outside of the mating connector or adapter.
- Avoid over tightening connections.

  Unlike common electrical connections, tighter is *not* better. The purpose of the connector is to bring two fiber ends together. Once they touch, tightening only causes a greater force to be applied to the delicate fibers. With connectors that have a convex fiber end, the end can be pushed off-axis resulting in misalignment and excessive return loss. Many measurements are actually improved by backing off the connector pressure. Also, if a piece of grit does happen to get by the cleaning procedure, the tighter connection is more likely to damage the glass. Tighten the connectors just until the two fibers touch.

- Keep connectors covered when not in use.
- Use fusion splices on the more permanent critical nodes. Choose the best connector possible. Replace connecting cables regularly. Frequently measure the return loss of the connector to check for degradation, and clean every connector, every time.

  All connectors should be treated like the high-quality lens of a good camera. The weak link in instrument and system reliability is often the inappropriate use and care of the connector. Because current connectors are so easy to use, there tends to be reduced vigilance in connector care and cleaning. It takes only one missed cleaning for a piece of grit to permanently damage the glass and ruin the connector.

Measuring insertion loss and return loss

Consistent measurements with your lightwave equipment are a good indication that you have good connections. Since return loss and insertion loss are key factors in determining optical connector performance they can be used to determine connector degradation. A smooth, polished fiber end should produce a good return-loss measurement. The quality of the polish establishes the difference between the “PC” (physical contact) and the “Super PC” connectors. Most connectors today are physical contact which make glass-to-glass connections, therefore it is critical that the area around the glass core be clean and free of scratches. Although the major area of a connector, excluding the glass, may show scratches and wear, if the glass has maintained its polished smoothness, the connector can still provide a good low level return loss connection.

If you test your cables and accessories for insertion loss and return loss upon receipt, and retain the measured data for comparison, you will be able to tell in the future if any degradation has occurred. Typical values are less than 0.5 dB of loss, and sometimes as little as 0.1 dB of loss with high performance connectors. Return loss is a measure of reflection: the less reflection the better (the larger the return loss, the smaller the reflection). The best physically contacting connectors have return losses better than 50 dB, although 30 to 40 dB is more common.

Visual inspection of fiber ends

Visual inspection of fiber ends can be helpful. Contamination or imperfections on the cable end face can be detected as well as cracks or chips in the fiber itself. Use a microscope (100X to 200X magnification) to inspect the entire end face for contamination, raised metal, or dents in the metal as well as any other imperfections. Inspect the fiber for cracks and chips. Visible imperfections not touching the fiber core may not affect performance (unless the imperfections keep the fibers from contacting).

WARNING

Always remove both ends of fiber-optic cables from any instrument, system, or device before visually inspecting the fiber ends. Disable all optical sources before disconnecting fiber-optic cables. Failure to do so may result in permanent injury to your eyes.

Cleaning Connectors

The procedures in this section provide the proper steps for cleaning fiber-optic cables and Agilent Technologies universal adapters. The initial cleaning, using the alcohol as a solvent, gently removes any grit and oil. If a caked-on layer of material is still present, (this can happen if the beryllium-copper sides of the ferrule retainer get scraped and deposited on the end of the fiber during insertion of the cable), a second cleaning should be performed. It is not uncommon for a cable or connector to require more than one cleaning.

CAUTION

Agilent Technologies strongly recommends that index matching compounds *not* be applied to their instruments and accessories. Some compounds, such as gels, may be difficult to remove and can contain damaging particulates. If you think the use of such compounds is necessary, refer to the compound manufacturer for information on application and cleaning procedures.

Table 3-2. Cleaning Accessories

Item	Agilent Part Number
Any commercially available denatured alcohol	—
Cotton swabs	8520-0023
Small foam swabs	9300-1223
Compressed dust remover (non-residue)	8500-5262

Table 3-3. Dust Caps Provided with Lightwave Instruments

Item	Agilent Part Number
Laser shutter cap	08145-64521
FC/PC dust cap	08154-44102
Biconic dust cap	08154-44105
DIN dust cap	5040-9364
HMS10/dust cap	5040-9361
ST dust cap	5040-9366

To clean a non-lensed connector

CAUTION Do not use any type of foam swab to clean optical fiber ends. Foam swabs can leave filmy deposits on fiber ends that can degrade performance.

1. Apply pure isopropyl alcohol to a clean lint-free cotton swab or lens paper.

   Cotton swabs can be used as long as no cotton fibers remain on the fiber end after cleaning.

2. Clean the ferrules and other parts of the connector while avoiding the end of the fiber.
3. Apply isopropyl alcohol to a new clean lint-free cotton swab or lens paper.
4. Clean the fiber end with the swab or lens paper.

   Do *not* scrub during this initial cleaning because grit can be caught in the swab and become a gouging element.

5. Immediately dry the fiber end with a clean, dry, lint-free cotton swab or lens paper.
6. Blow across the connector end face from a distance of 6 to 8 inches using filtered, dry, compressed air. Aim the compressed air at a shallow angle to the fiber end face.

   Nitrogen gas or compressed dust remover can also be used.

CAUTION Do not shake, tip, or invert compressed air canisters, because this releases particles in the can into the air. Refer to instructions provided on the compressed air canister.

7 As soon as the connector is dry, connect or cover it for later use.

If the performance, after the initial cleaning, seems poor try cleaning the connector again. Often a second cleaning will restore proper performance. The second cleaning should be more arduous with a scrubbing action.

To clean an adapter

The fiber-optic input and output connectors on many Agilent Technologies instruments employ a universal adapter such as those shown in the following picture. These adapters allow you to connect the instrument to different types of fiber-optic cables.

Figure 3-7. Universal adapters.

1 Apply isopropyl alcohol to a clean foam swab.

Cotton swabs can be used as long as no cotton fibers remain after cleaning. The foam swabs listed in this section's introduction are small enough to fit into adapters.

Although foam swabs can leave filmy deposits, these deposits are very thin, and the risk of other contamination buildup on the inside of adapters greatly outweighs the risk of contamination by foam swabs.

2 Clean the adapter with the foam swab.

3 Dry the inside of the adapter with a clean, dry, foam swab.

4 Blow through the adapter using filtered, dry, compressed air.

Nitrogen gas or compressed dust remover can also be used. Do not shake, tip, or invert compressed air canisters, because this releases particles in the can into the air. Refer to instructions provided on the compressed air canister.

Agilent Technologies Service Offices

Before returning an instrument for service, call the Agilent Technologies Instrument Support Center at (800) 403-0801, visit the Test and Measurement Web Sites by Country page at http://www.tm.agilent.com/tmo/country/English/index.html, or call one of the numbers listed below.

Agilent Technologies Service Numbers

Austria	01/25125-7171
Belgium	32-2-778.37.71
Brazil	(11) 7297-8600
China	86 10 6261 3819
Denmark	45 99 12 88
Finland	358-10-855-2360
France	01.69.82.66.66
Germany	0180/524-6330
India	080-34 35788
Italy	+39 02 9212 2701
Ireland	01 615 8222
Japan	(81)-426-56-7832
Korea	82/2-3770-0419
Mexico	(5) 258-4826
Netherlands	020-547 6463
Norway	22 73 57 59
Russia	+7-095-797-3930
Spain	(34/91) 631 1213
Sweden	08-5064 8700
Switzerland	(01) 735 7200
United Kingdom	01 344 366666
United States and Canada	(800) 403-0801

Index