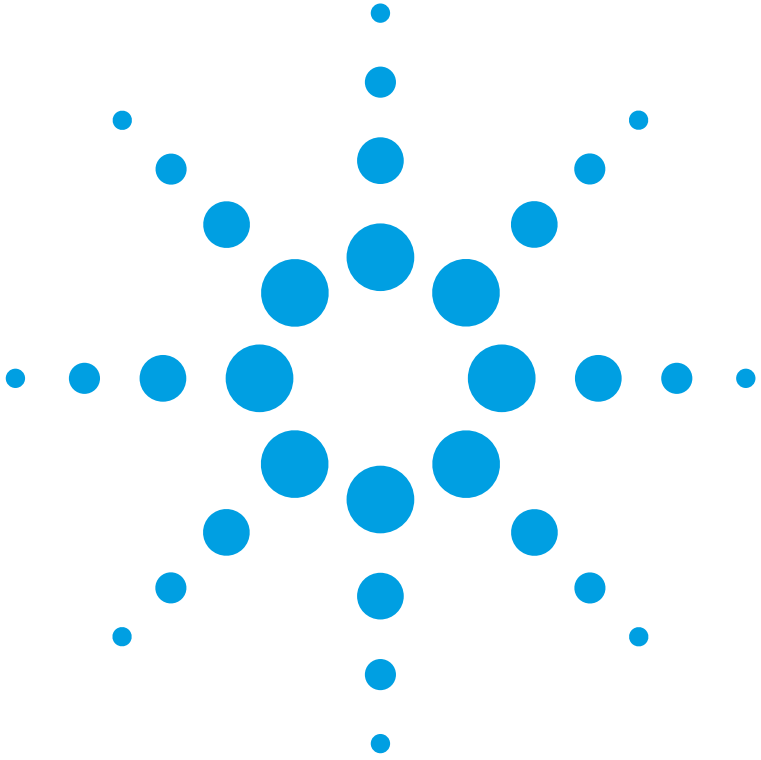
Agilent 86119A
Optical Sampler
User's Guide



Agilent Technologies

Notices

Manual Part Number

86119-90004

Edition

June 2004

Printed in USA

Agilent Technologies, Inc.
Digital Signal Analysis Operation
1400 Fountaingrove Parkway
Santa Rosa, CA 95403, USA

Warranty

The material contained in this document is provided “as is,” and is subject to being changed, without notice, in future editions. Further, to the maximum extent permitted by applicable law, Agilent disclaims all warranties, either express or implied, with regard to this manual and any information contained herein, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. Agilent shall not be liable for errors or for incidental or consequential damages in connection with the furnishing, use, or performance of this document or of any information contained herein. Should Agilent and the user have a separate written agreement with warranty terms covering the material in this document that conflict with these terms, the warranty terms in the separate agreement shall control.

Technology Licenses

The hardware and/or software described in this document are furnished under a license and may be used or copied only in accordance with the terms of such license.

Restricted Rights Legend

If software is for use in the performance of a U.S. Government prime contract or subcontract, Software is delivered and licensed as “Commercial computer software” as defined in DFAR 252.227-7014 (June 1995), or as a “commercial item” as defined in FAR 2.101(a) or as “Restricted computer software” as defined in FAR 52.227-19 (June 1987) or any equivalent agency regulation or contract clause. Use, duplication or disclosure of Software is subject to Agilent Technologies' standard commercial license terms, and non-DOD Departments and Agencies of the U.S. Government will receive no greater than Restricted Rights as defined in FAR 52.227-19(c)(1-2) (June 1987). U.S. Government users will receive no greater than Limited Rights as defined in FAR 52.227-14 (June 1987) or DFAR 252.227-7015 (b)(2) (November 1995), as applicable in any technical data.

Safety Notices

CAUTION

Caution 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

Warning 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.

Contents

Agilent 86119A — at a glance

The 86119A optical sampler provides time domain measurements of extremely fast optical communication signals. With over 700 GHz of optical measurement bandwidth, researchers can now see the true shape of their 40 to 320 Gb/s data.

The 86119A optical sampler is an accessory for Agilent 86100-series digital communication analyzers and is installed directly beneath the 86100A/B/C as shown in Figure 1.

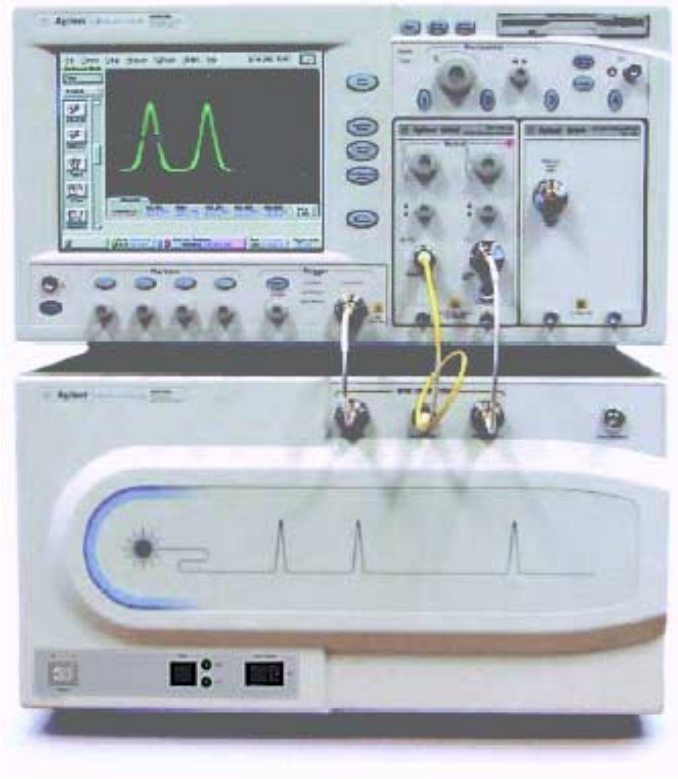


Figure 1. The 86119A with the 86100 DCA

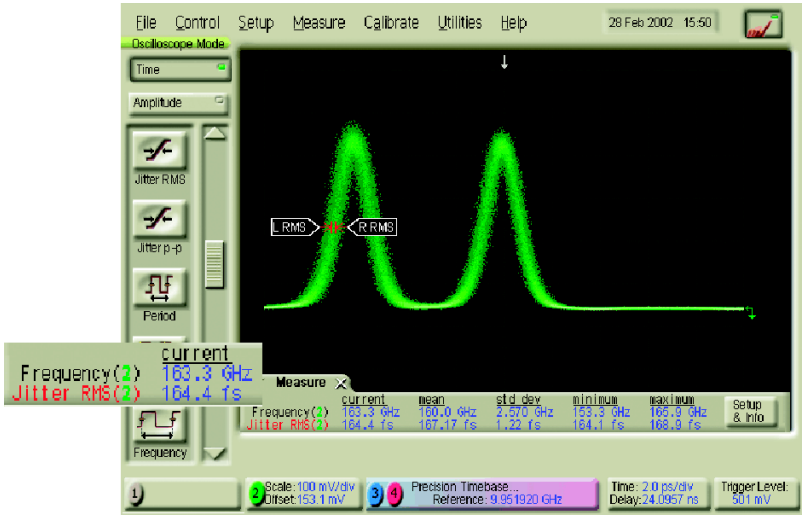


Figure 2. Measurement showing 160 Gb/s data

The 86119A requires the following specific hardware configuration of the 86100-series DCA:

- 86100A, 86100B, or 86100C DCA mainframe
- 86106B plug-in module (standard or option 410) installed in the left slot.
- 86107A precision timebase module (any option, as desired) installed in the right slot.

For information on using the instrument, refer to "Making Measurements with the 86119A" on page 24.

Front Panel Features

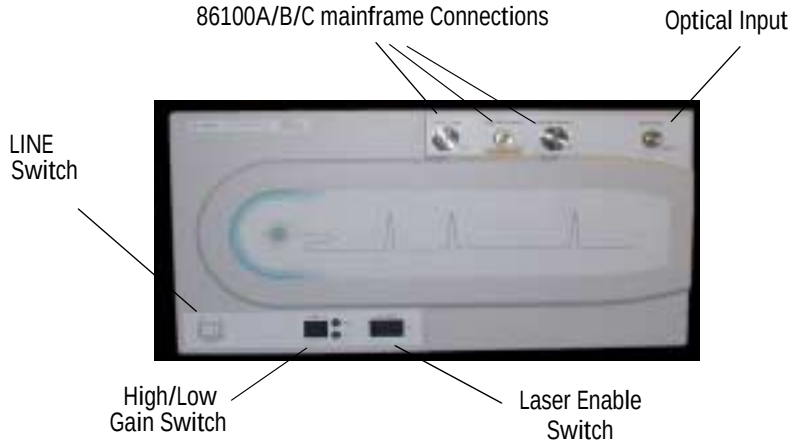


Figure 3. Front Panel Features

LINE switch

The front panel LINE switch disconnects the mains circuits from the mains supply after the EMC filters and before other parts of the instrument.

Optical Input

This is a 9 µm fiber-optic input connector with an angled fiber endface. An FC/PC APC (angled physical contact) adapter (wide-key) is placed on the connector at the factory. While other adapters available from Agilent will mechanically fit, only the FC/PC and Diamond/HMS-10 adapters are compatible with an angled connector. To maintain the quality of the input connector, it is recommend that you use a short, permanently connected fiber with user connections being made to the end of this fiber.

CAUTION

The optical input uses fiber having an angled endface. To avoid damaging the optical input, do not connect a fiber that has a flat optical endface. To connect a flat optical connector fiber, use an angle adapter.

CAUTION

Keep the optical signal's average power below 800 mW, to avoid damaging the instrument. Because damage due to high peak powers is more difficult to predict, it is recommended that the peak power levels be kept below 800 mW as well.

Laser Enable switch Turns on the internal sampling laser. Refer to "General Safety Considerations" on page 6 for laser classification information.

High/Low Gain switch The 86119A has two gain positions. For best sensitivity on low power signals, use high gain. For better linearity and higher power handling, select low gain.

86100A/B/C mainframe Connections Refer to "Step 2. Connect the 86119A to the 86100A/B/C" on page 11 for a description of making these connections.

86119A To 86100 Trigger: Use the trigger cable (Agilent Part 5061-6681) to connect to the 86100A/B/C Trigger Input connector.

86119A To 86106B Channel 1: Use the optical stabilization fiber (Agilent Part 1005-0173) to connect to the 86106B Channel 1 Input connector.

86119A To 86106B Channel 2: Use the signal cable (Agilent Part 5062-6684) to connect to the 86106B Channel 2 Input connector.

Laser classification

The 86119A is classified as an IEC LED Class 1 product. The total power of light energy radiated out of the "To 86106B Channel 1" connector is less than 50 uW at 1550 nm. Energy radiated at wavelengths from 600 nm to 1000 nm is less than 1 uW. Operator maintenance or precautions are not necessary to maintain safety. No controls, adjustments, or performance of procedures result in hazardous radiation exposure.

Rear Panel Features

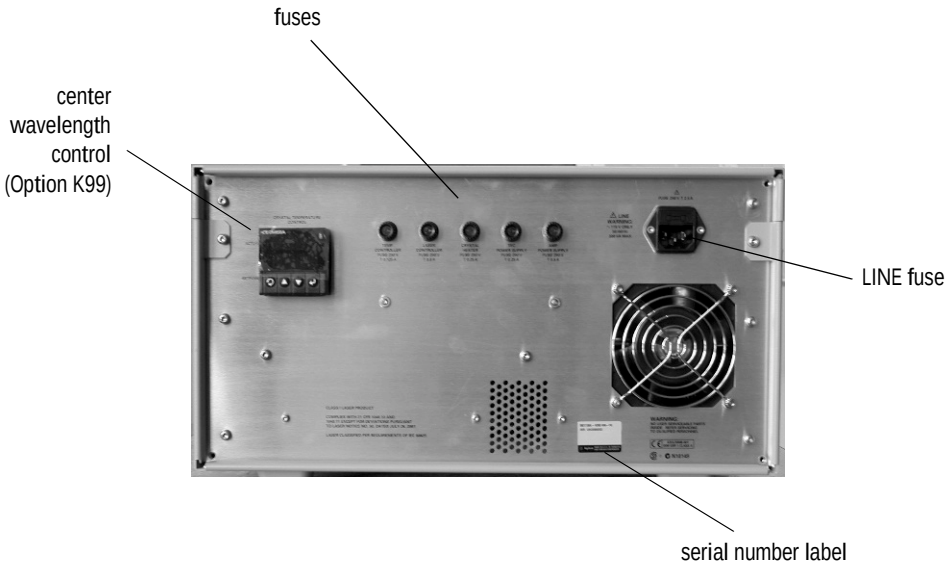


Figure 4. Rear Panel Features

LINE fuse

To replace or check the LINE fuse, refer to "To replace the LINE fuse" on page 33.

fuses

To replace or check on of the fuses located on the rear-panel fuse holders, refer to "To replace a rear-panel fuse" on page 34.

center wavelength control (Option K99)

Option K99 instruments can be used over a wider range of input signals by adjusting the center wavelength. This is accomplished by changing the temperature of the sampling crystal. Refer to "To set the center wavelength (Option K99)" on page 31.

serial number label

This label lists the unique identifiers assigned to your instrument. Be sure to include this information with any communication with Agilent about your product.

General Safety Considerations

This product has been designed and tested in accordance with the standards listed in the Manufacturer's Declaration of Conformity, and has been supplied in a safe condition. The product documentation contains information and warnings which must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

Before using this product, review the safety information for cautions and warnings.

Use this product according to the enclosure protection provided. This product does not protect against the ingress of water. This product protects against finger access to hazardous parts within the enclosure.

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

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

WARNING **To prevent electrical shock, disconnect the Agilent Technologies model 86119A 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 **For continued protection against fire hazard, replace line fuse only with same type and ratings. The use of other fuses or materials is prohibited.**

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 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.

ON and OFF ( ) symbols are used to mark the position 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 is a symbol of an Industrial Scientific and Medical Group 1 Class A product.

ICES/NMB-001

This is a marking to indicate product compliance with the Canadian Interference-Causing Equipment Standard.

Installing the 86119A

This section shows you how to set up your 86119A and connect the power and the accessories.

WARNING **This product is only designed to operate on 100/120V line voltage. The product may be damaged if connected directly to 220/240V line power. Operation on 220/240V requires the use of a step down transformer. For areas of the world where 220/240V operation is required an appropriate step down transformer is supplied (Agilent part number 9100-6131). To ensure safe operation, use only the supplied transformer to provide 100/120V.**

CAUTION VENTILATION REQUIREMENTS: The 86119A is not intended for mounting in cabinets or equipment racks. It is important that the temperature of the surrounding air be at 30°C or less. This cannot, in general, be accomplished in an enclosure.

CAUTION Electrostatic discharge (ESD) can damage or destroy electronic components. All work on electronic assemblies should be performed at a static-safe workstation.

This product is designed for use in Installation Category II and Pollution Degree 2 per IEC 1010-1 and 664 respectively.

Installation Category: Installation Categories (overvoltage categories) are determined by the transient overvoltage levels that may be expected. CAT I: Mains isolated. CAT II: Line voltage in appliance and to wall outlet. CAT III: Line voltage behind wall outlet to next level of distribution.

Step 1. Inspect the shipment

WARNING **The 86119A instrument weighs 24 kg (53 pounds). Two people are required to lift or move the product.**

Inspect the shipping container for damage.

Inspect the instrument.

Find the 86119A shipping list. Verify that you received all the accessories on this list.

The Table 1 lists some of the accessories that may be on the 86119A shipping list. The information on your actual shipping list is more accurate and should supersede the information in this table.

Table 1. Supplied Accessories

Accessory	Qty	Agilent Part Number
Trigger cable	2	5062-6681
Signal cable	2	5062-6684
Optical stabilization fiber	2	1005-0173
FC-APC Optical connector adapter [a]	2	1005-0089
Calibration factors disk	1	—
Step down (isolation) transformer for 220/240V operation.	1	9100-6131
Power cord to connect step down transformer for 220/240V operation to instrument.	1	8120-1752

a. These adapters come already attached to the 86119A's optical input and output connectors and may not be included on the 86119A shipping list.

Keep the shipping container and cushioning material until you have inspected the contents of the shipment for completeness and have checked the instrument mechanically and electrically.

If anything is missing or defective, contact your nearest Agilent Technologies Sales Office. Refer to "Agilent Technologies Service Offices" on page 52. If the shipment was damaged, contact the carrier, then contact the nearest Agilent Sales Office. Keep the shipping materials for the carrier's inspection. The Agilent Sales Office will arrange for repair or replacement at Agilent's option without waiting for claim settlement.

Step 2. Connect the 86119A to the 86100A/B/C

1. Position an 86100A/B/C DCA on top of the 86119A as shown in Figure 5. The DCA is not provided with the 86119A. Be sure to locate the 86119A in a position that allows easy access to the front-panel LINE switch, which is the 86119A's disconnecting device.
2. Install an 86106B plug-in module (standard or option 410) in the DCA's left slot.
3. Install an 86107A Precision Timebase module (any option, as desired) in the DCA's right slot.

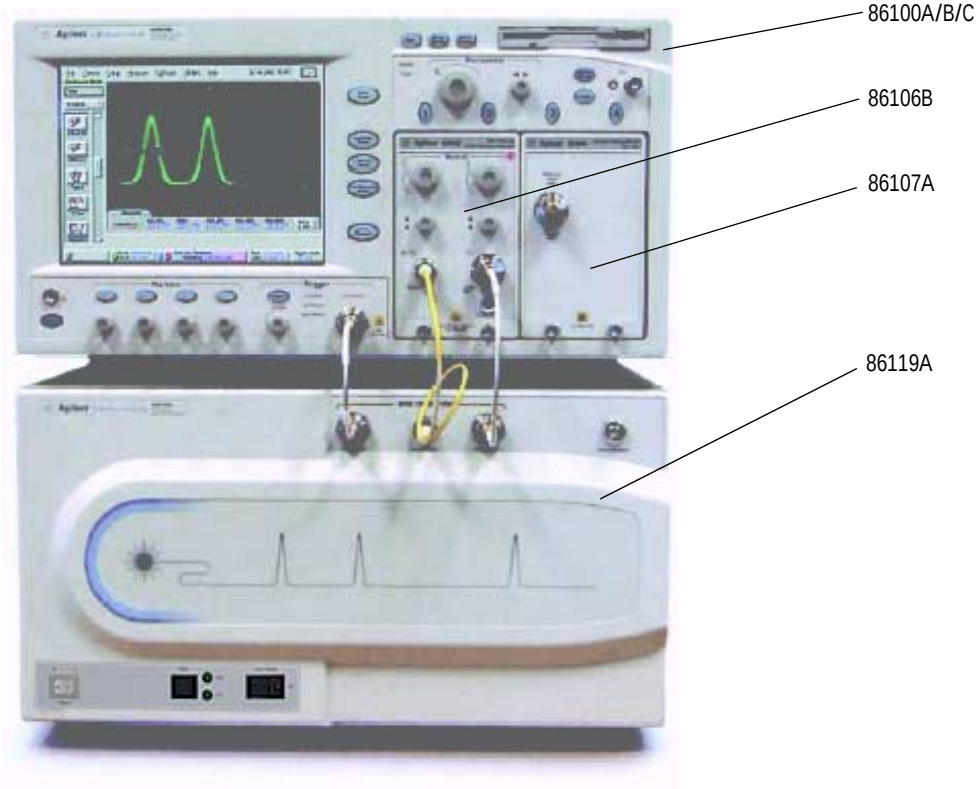


Figure 5. Connecting the 86119A

4. Connect the trigger cable (Agilent Part 5061-6681) between the 86100A/B/C

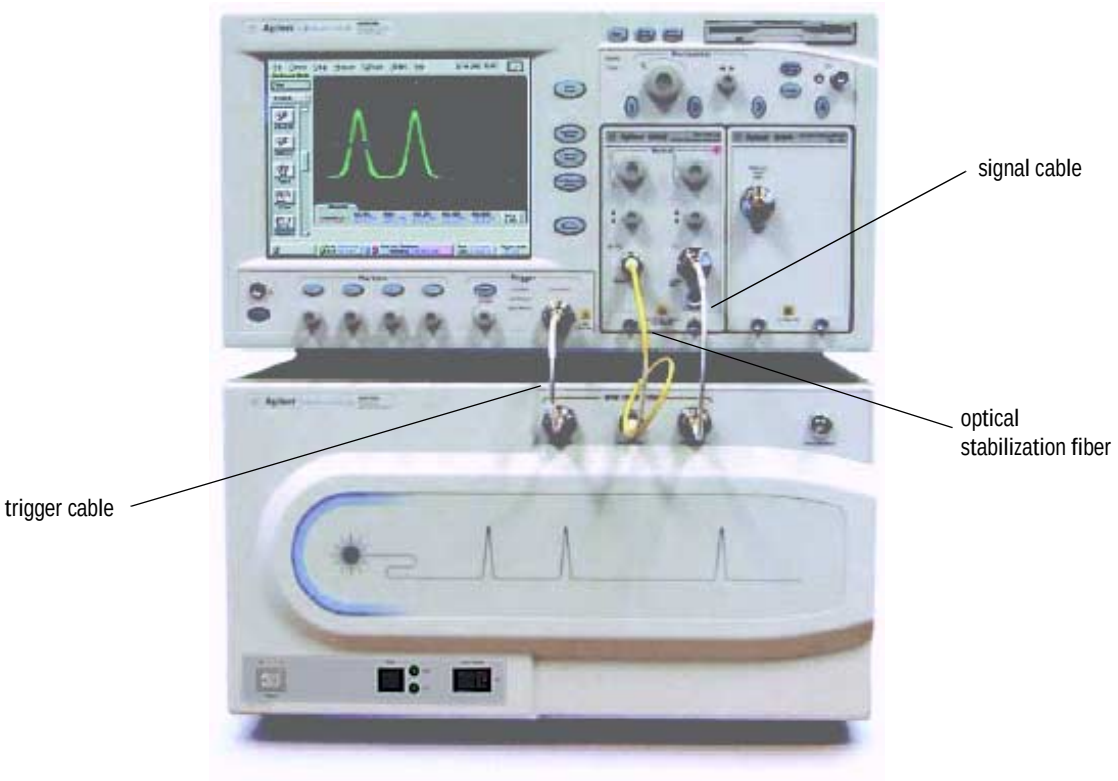
Trigger Input connector and the 86119A To 86100 Trigger connector.

CAUTION

Electrostatic discharge (ESD) can damage or destroy electronic components. Coaxial cables with both ends unconnected may store electrostatic charges. Before connecting any coaxial cable of this sort to a device or instrument, momentarily short the center and outer conductors of the cable. When making connections, ensure the proper use of a grounded, resistor-isolated wrist strap.

5 Connect the optical stabilization fiber (Agilent Part 1005-0173) between the 86106B Channel 1 Input connector and 86119A To 86106B Channel 1 connector.

6 Connect the signal cable (Agilent Part 5062-6684) between the 86106B Channel 2 Input connector and 86119A To 86106B Channel 2 connector.



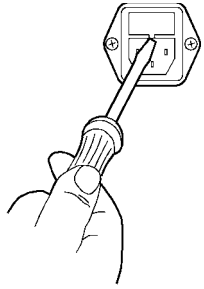
NOTE The exact cable lengths are necessary for the correct operation of the 86119A. Use only the specified Agilent parts. An extra set of cables is included with the 86119A.

Step 3. Check the fuses

1 Locate the line-input connector on the 86119A's rear panel.

2 Disconnect the line-power cable if it is connected.

3 Use a small flat-blade screwdriver to open the pull-out fuse drawer.



4 Verify that the value of the line-voltage fuse in the pull-out drawer is correct. The recommended fuse is type IEC 60127-2, 5X20 mm, 2.5A, 250V, Agilent part number 2110-1334 as listed in Table 2. Notice that an extra fuse is provided in a drawer located on the fuse holder. If the 86119A is being used with a step-down transformer as described in "Step 4. If the site's line power is 220/240V" on page 17, the fuse type and value described in this step does not change.

WARNING **For continued protection against fire hazard, replace line fuse only with same type and ratings, (type IEC 60127-2, 5X20 mm, 2.5A, 250V for 100/120V operation). The use of other fuses or materials is prohibited.**

5 Make sure that the correct rear-panel fuses are installed.

Table 2. Required Rear-Panel Fuses

Fuse Holder Label	Correct Fuse	Agilent Part Number
LINE Fuse	IEC 60127-2, 5x20 mm, 2.5 A, 250 V	2110-1334
Temp Controller	IEC 60127-2, 5x20 mm, 0.125 A, 250 V	2110-1339
Laser Controller	IEC 60127-2, 5x20 mm, 0.8 A, 250 V	2110-1338
Crystal Heater	IEC 60127-2, 5x20 mm, 0.25 A, 250 V	2110-1337
TEC Power Supply	IEC 60127-2, 5x20 mm, 0.25 A, 250 V	2110-1337
AMP Power Supply 2	IEC 60127-2, 5x20 mm, 0.5 A, 250 V	2110-1333

Step 4. If the site's line power is 100/120V

WARNING

This product is only designed to operate on 100/120V line voltage. The product may be damaged if connected directly to 220/240V line power. Operation on 220/240V requires the use of an agency approved isolation transformer (step down transformer), 230V to 240V, 2.5A, 600 VA (MAX), 50/60 Hz. Refer to "Step 4. If the site's line power is 220/240V" on page 17.

Install the instrument so that the ON / OFF switch is readily identifiable and is easily reached by the operator. The ON / OFF switch or detachable power cord is the instrument disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument. Alternatively, an externally installed switch or circuit breaker (which is readily identifiable and is easily reached by the operator) may be used as a disconnecting device.

1 Confirm that your site's power meets the requirements listed in Table 5. If you are installing the 86119A in an area of the world where 220/240V operation is required, refer to "Step 4. If the site's line power is 220/240V" on page 17.

Table 3. Line Power Requirements

Voltage	100–120 VAC
Power Consumption	< 360 VA
Frequency	47–66 Hz

2 Connect the line cord to the 86119A rear panel. The line cord provided is matched by Agilent to the country in which the order originates. Refer to Table 4 for a list of available line power cords.

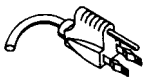
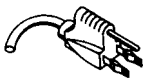
CAUTION

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

CAUTION

Before switching on this instrument, make sure the correct fuse is installed; the supply voltage is in the specified range.

Table 4. Available Line Cords

Plug Type	Cable Part No.	Plug Description	Length (in/cm)	Color	Country
125V 	8120-1378 8120-1521 8120-1992	Straight *NEMA5-15P 90° Straight (Medical) UL544	90/228 90/228 96/244	Jade Gray Jade Gray Black	United States, Canada, Mexico, Philippines, Taiwan
100V 	8120-4753 8120-4754	Straight MITI 90°	90/230 90/230	Dark Gray	Japan

* Part number shown for plug is the industry identifier for the plug only. Number shown for cable is the Agilent Technologies part number for the complete cable including the plug.

Step 4. If the site's line power is 220/240V

WARNING

This product is only designed to operate on 100/120V line voltage. The product may be damaged if connected directly to 220/240V line power. Operation on 220/240V requires the use of an agency approved isolation transformer (step-down transformer), 230V to 240V, 2.5A, 600 VA (MAX), 50/60 Hz. For areas of the world where 220/240V operation is required an appropriate step down transformer is supplied (Agilent part number 9100-6131). To ensure safe operation, use only the supplied transformer to provide 100/120V.

Install the instrument so that the ON / OFF switch is readily identifiable and is easily reached by the operator. The ON / OFF switch or detachable power cord is the instrument disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument. Alternatively, an externally installed switch or circuit breaker (which is readily identifiable and is easily reached by the operator) may be used as a disconnecting device.

1 If your site's line power is 100/120V, skip these steps and continue with "Step 5. Turn on the line power" on page 20.

2 Locate the step-down transformer, supplied with the 86119A, near to the 86100A/B/C mainframe. Do not connect any power cords at this time. See Figure 6. The step-down transformer provides the line power requirements listed in Table 5.

Table 5. 86119A Line Power Requirements

Voltage	100–120 VAC
Power Consumption	< 360 VA
Frequency	47–66 Hz

Figure 6. Step-Down Transformer

3 Locate the line cord receptacle on the step-down transformer's rear panel.

4 Look at the line voltage setting, shown in Figure 7, and confirm that it is set to a value that is appropriate for the site's line voltage: 220 or 240. To change the value, use a small flat-blade screwdriver to unlatch the fuse door. Then, pull out the fuse drawer and change the voltage setting tumbler so that it indicates the correct line voltage. Replace the fuse drawer, and close the fuse door.

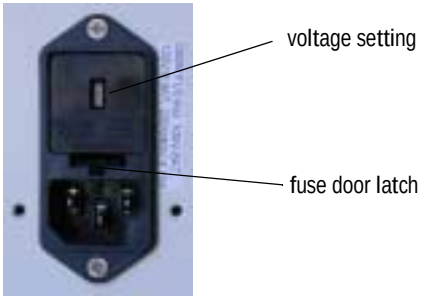


Figure 7. Voltage Setting on Step-down Transformer

5 Position the step-down transformer upside down, and locate the output voltage switch shown in Figure 8.

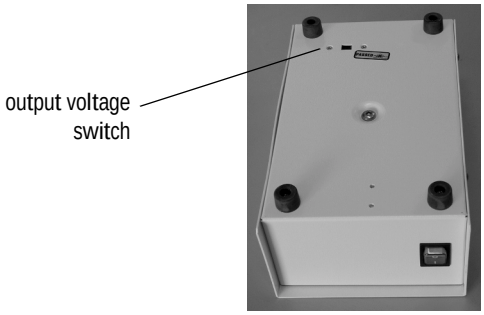


Figure 8. Output Voltage Switch

6 Confirm that the switch is positioned to the `115V` setting. If it indicates the `230V` setting, use a small flat-blade screwdriver to change the switch to the `115V` setting.

7 Connect one of the supplied line cords between the 86119A and the step-down transformer. Connect the remaining line cord between the step-down transformer and the line power.

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

CAUTION Before switching on this instrument, make sure the correct fuse is installed; the supply voltage is in the specified range. The transformer is installed between the voltage supply and the instrument.

Step 5. Turn on the line power

1. Press the power switch of the 86100A/B/C on.
2. Press the power switch at the lower left-hand corner of the 86119A front panel on.
3. For best operation, allow the units to warm up for at least one hour before making measurements.

CAUTION To avoid damaging the instrument, do not connect a fiber with a flat optical connector to the product's optical input connector. If the input connector is damaged, factor service is required. We recommend the use of a short, permanently connected fiber with user connections being made to the end of this fiber connector saver.

CAUTION To avoid damaging the instrument, if you want to connect a flat optical connector fiber, you must use an angle adapter.

Step 6. Check the 86100A/B/C Software Revision

For best performance, use the latest 86100A/B/C software.

To check the 86100A/B/C software revision

1. Touch or click the 86100A/B/C Help menu.
2. Click on About 86100...
3. Next to the heading, Software Revision, check the current version number. The 86119A requires 86100A/B/C version A.03.05 or later.

To upgrade the software

1. Free upgrades are available from the agilent.com website. Search for 86100 and follow the link to the 86100 mainframe home page and then the Software, Firmware, and Drivers section.
2. Locate the latest revision on the appropriate media (CD or floppy disks).
3. On the 86100A/B/C, click on the Utilities menu.
4. Click on Upgrade 86100 Software.

5 Follow the on-screen prompts.

Step 7. Load 86119A Calibration Factors

Each 86119A optical sampler has factory-measured calibration factors. These factors are stored on a disk shipped with the unit. In order to ensure correct optical amplitude calibration, load these factors into the 86100-series DCA before use. If the 86100-series DCA is replaced, the calibration factors should be reloaded into the new DCA.

1 Insert the provided calibration factor disk into the 86100-series DCA.

2 On the 86100A/B/C, click on the Setup menu.

3 Click on Optical Sampling....

4 Under the Optical Sampler Wavelength / Service Calibrated Wavelength section, click Load.

5 After the loading is complete, remove the disk. Retain the disk for future use.

Step 8. Calibrate the 86100 DCA modules

Before using the 86119A, the 86100-series DCA plug-in modules must be calibrated. After waiting the specified warm up time, perform the following steps for both the 86106B and 86107A modules. For more detailed instructions, refer to the 86100 online documentation

1. Click the Calibration menu.
2. Click All Calibrations.
3. Click Calibrate Left Module and follow the on-screen prompts. See Figure 9.
4. Repeat for right module.

Figure 9. Module Calibration Dialog Box

Step 9. Avoid costly repairs

CAUTION To avoid damaging the instrument, do not connect a fiber with a flat optical connector. If the input connector is damaged, factor service is required. We recommend the use of a short, permanently connected fiber with user connections being made to the end of this fiber connector saver.

CAUTION To avoid damaging the instrument, if you want to connect a flat optical connector fiber, you must use an angle adapter. The 86119A is shipped with an FC/PC APC connector adapter (wide-key). While other connector adapters available from Agilent will mechanically fit, only the FC/PC and Diamond/HMS-10 adapters are compatible with an angled connector.

CAUTION Keep the optical signal's average power below 800 mW, to avoid damaging the instrument. Because damage due to high peak powers is more difficult to predict, it is recommended that the peak power levels be kept below 800 mW as well.

To learn more about Agilent Technologies products, visit our website at http://www.agilent.com.

If you wish to find out more about your new instrument, use the keyword 86119A in your search.

Making Measurements with the 86119A

Before you perform the procedures in this section, study the following paragraphs. They contain some important requirements and guidelines concerning your optical input signal as well as the synchronous electrical clock reference. You must provide a synchronous electrical clock reference which is the instrument's timing reference.

Procedures

Optical input signal

Power Range

The 86119A provides a signal input dynamic range of more than three orders of magnitude. The lower limit is set by the input noise level. The exact value depends on the option ordered. Refer to Table 11 on page 47. The upper limit is set by the conversion gain of the unit. The minimum expected value can also be found in Table 11. For the best accuracy, perform an 86119A user calibration at the operating wavelength.

CAUTION

Keep the optical signal's average power below 800 mW, to avoid damaging the instrument. Because damage due to high peak powers is more difficult to predict, it is recommended that the peak power levels be kept below 800 mW as well.

Wavelength

The optical signal provided should be within the wavelength range of the 86119A which varies according to the 86119A option purchased. The nominal range is defined as where the sensitivity has dropped to 50% of the maximum; the total usable range is slightly larger.

- Option K99 has a ±6 nm wavelength window with a user settable center wavelength. The center frequency is tuned ±5 nm with the temperature controller located on the 86119A's rear panel. Refer to the "Setting Center Wavelength" section below for details.
- Option K98 has a ±14 nm wavelength window. The center wavelength is set at the factory (at the customer's request) within the range 1540 – 1560 nm. Refer to the test documentation supplied with the specific unit to determine the allowable range.

Polarization

The 86119A responds to only one input polarization state. This is essential to providing high sensitivity and low noise performance. You can use a polarizer at the input to avoid undesirable polarization effects. The signal should be linearly polarized at the 86119A input connector with the TE mode aligned to the connector key (horizontally) by one of two methods:

- If the device under test has linear polarized output, use polarization maintaining fiber between the device under test and the 86119A.
- Place a polarization controller immediately before the 86119A. Adjust the controller to maximize the signal on screen. Ensure that all fibers in the device under test are taped or otherwise secured to prevent movement.

Electrical clock reference

While the clock must be synchronous with the optical signal, it does not need to be sinusoidal. A square wave, for example, works fine. DC offsets should be minimized. Table 6 lists some requirements for the reference. Refer to the 86107A online documentation for more detailed requirements.

Table 6. Clock Reference Requirements

Amplitude (for best performance)	0.5Vpp - 1Vpp
Reference Clock DC offset	< 200 mV
Frequency Ranges (dependent on following 86107A options)	
Option 010	2.4 to 4 GHz and 9 to 12.6 GHz
Option 020	9 to12.6 GHz and 18 to 25 GHz
Option 040	9 to12.6 GHz, 18 to 25 GHz, and 39 to 45 GHz

To sample an optical signal

1. Install the 86119A as described in "Installing the 86119A" on page 8.
2. Connect an electrical clock reference to the 86107A precision timebase module's Reference Clock input. The 86107A option 040 module has two reference clock input connectors. For a 40 GHz clock, use the 2.4 mm RF input connector. For all other clock frequencies, use the 3.5 mm RF input connector.
3. Connect the optical signal to be characterized to the 86119A front-panel Optical Input connector. The input of the 86119A requires a single-mode fiber with an angled physical contact connector.

CAUTION To avoid damaging the instrument, do not connect a fiber with a flat optical connector. If the input connector is damaged, factor service is required. We recommend the use of a short, permanently connected fiber with user connections being made to the end of this fiber connector saver.

CAUTION To avoid damaging the instrument, if you want to connect a flat optical connector fiber, you must use an angle adapter. The 86119A is shipped with an FC/PC APC connector adapter (wide-key). While other connector adapters available from Agilent will mechanically fit, only the FC/PC and Diamond/HMS-10 adapters are compatible with an angled connector.

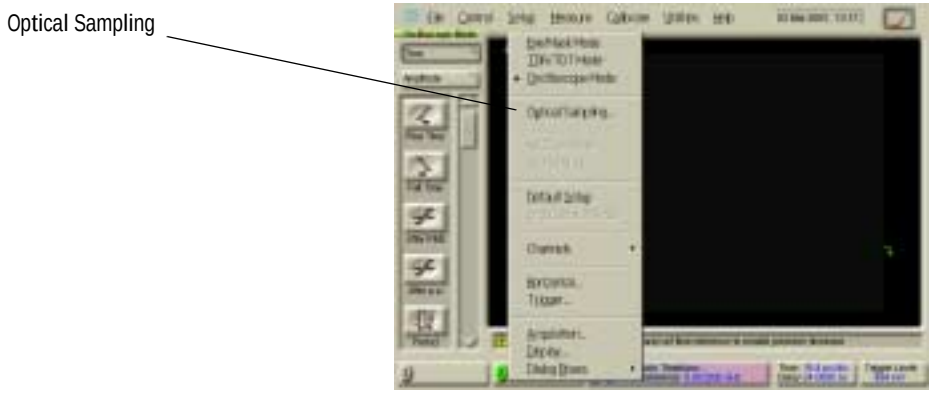
CAUTION Keep the optical signal's average power below 800 mW, to avoid damaging the instrument. Because damage due to high peak powers is more difficult to predict, it is recommended that the peak power levels be kept below 800 mW as well.

4. To prevent changes to input signal polarization, make sure that all fibers in the device under test are taped or otherwise secured to prevent movement.
5. Turn on the sampling laser by pressing the Laser Enable switch on the 86119A front panel.
6. Wait for the laser enable light to stop flashing before proceeding. This should take about five seconds. If the laser enable switch does not stop blinking, press the Laser Enable switch again. If the light still does not stop blinking, cycle the power of the 86119A and press the Laser Enable switch.

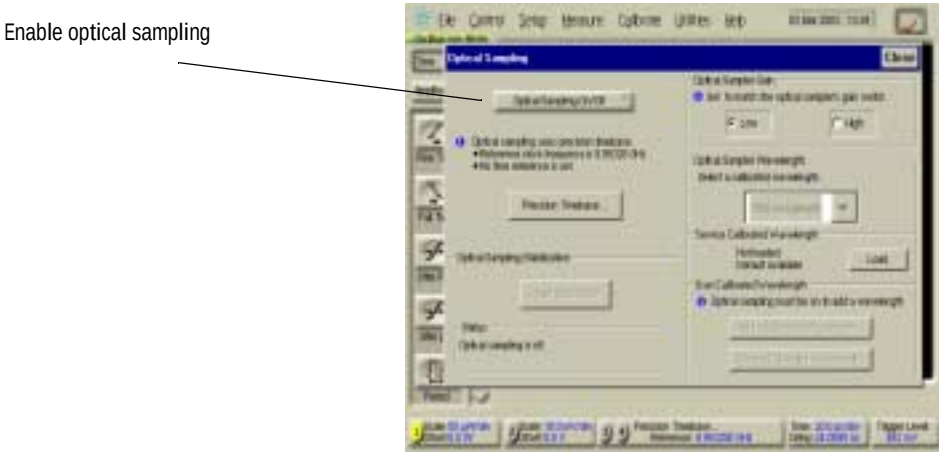
NOTE To prolong the service life of the 86119A sampling laser, disable the laser whenever the product is not actively in use. It is not necessary to keep the laser enabled to maintain the warm up temperature.

7 On the 86100A/B/C, click the Setup menu, and then click Optical Sampling.

NOTE Unless the appropriate 86106B and 86107A modules are installed in the 86100 mainframe, the Optical Sampling menu item will be inactive and gray.



8 Click on Optical Sampling On/Off to enable sampling.



Whenever optical sampling is turned on, the instrument automatically runs an optical sampling stabilization routine that allows exceptionally low jitter time-base performance. On occasion, the instrument may lose stabilization due to temperature change of the environment or excessive movement of the connections from the 86119A to the 86100A/B/C. It can also occur during the warm up period of the instrument. If stabilization is lost, the warning message *Optical sampling stabilization lost: Please check connections and reset stabilization* appears on the message area of the 86100A/B/C. Reset the stabilization:

a Click the Setup menu.

b Click Optical Sampling.

c Click the Reset Stabilization button.

9 Adjust the polarization state of the input signal by using one of two methods:

- Use polarization maintaining fiber between the device under test and the 86119A.
- Place a polarization controller immediately before the 86119A. Adjust the controller to maximize the signal on screen. Ensure that all fibers in the device under test are taped or otherwise secured to prevent movement.

To set the optical sampler gain

The 86119A has two gain positions. For best sensitivity on low power signals, use High Gain. For better linearity and higher power handling, choose Low Gain.

1 Press the Gain switch on the 86119 front panel until the desired LED is illuminated.

2 On the 86100A/B/C, click the Setup menu.

3 Click Optical Sampling.

4 Choose the appropriate check box in the Optical Sampler Gain section to match the 86119A front-panel setting. This allows for accurate scaling information.

To calibrate the 86119A optical path

Because the amplitude response of the 86119A is a strong function of wavelength, perform these steps to calibrate the 86119A at the precise wavelength of interest.

1. Two user supplied signals are required:
   - **a** An electrical clock at any frequency in the range of the 86107A.
   - **b** A CW optical source with known power at the desired wavelength.
2. Connect the electrical clock to the 86107A
3. Connect the CW optical source to the 86119A optical input

CAUTION To avoid damaging the instrument, do not connect a fiber with a flat optical connector. If the input connector is damaged, factory service is required. We recommend the use of a short, permanently connected fiber with user connections being made to the end of this fiber connector saver.

4. Enable optical sampling and ensure that the CW signal is visible completely on-screen
5. From the Optical Sampling dialog box, select Add a Calibrated Wavelength
6. Follow the on-screen prompts to complete the calibration

To set the center wavelength (Option K99)

The 86119A Option K99 has an adjustable center wavelength. By changing the temperature of the sampling crystal, it's wavelength acceptance can be changed. This allows the instrument to be used over a wider range of signals.

1 Locate the crystal temperature control setting located on the 86119A's rear panel.

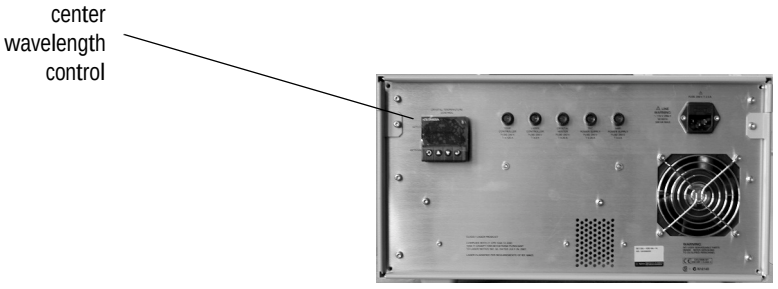


Figure 10. Location of Crystal Temperature Control

2 To change the setpoint, follow these steps:

a Press ↵ until the top display reads "SP1" (Setpoint 1).

b Press ↵ . The top display should show the current setpoint with the tenths digit flashing.

c Use ▲ and ▼ as necessary to adjust the setpoint.

d Press ↵ . The top display will momentarily show "Strd" to indicate the new setpoint has been stored and will then show "SP2". Setpoint 2 is not used and need not be set.

e Press ↵ two times to return to the standby mode with the display flashing "Stdby".

f Press ↵ . The top display will show the current crystal temperature and the bottom display shows the new setpoint.

3 The allowable range of temperatures is 35°C to 75°C. This will provide the specified range of wavelength tunability. Lower temperature corresponds to a numerically lower center wavelength. Refer to the supplied test data for

measurements on the specific instrument.

NOTE If the ambient air temperature exceeds the 30°C maximum, use of a 35°C crystal temperature is not possible.

4 If the crystal temperature exceeds 80°C, either through user setting or a fault condition, a latching alarm relay will disconnect the heater.

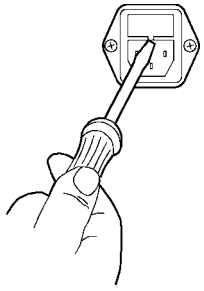
5 To reset the unit, turn off the line power and allow the crystal several minutes to cool.

6 Turn on the unit and ensure that the crystal temperature setpoint is in the allowable range.

CAUTION If the setpoint is correct, but the temperature exceeds 80°C repeatedly, turn off the unit immediately and return it for service. Excessive crystal temperature could cause expensive damage to your instrument.

To replace the LINE fuse

1. Locate the line-input connector on the instrument's rear panel.
2. Disconnect the line-power cable if it is connected.
3. Use a small flat-blade screwdriver to open the pull-out fuse drawer.



4. Locate the line-voltage fuse in the pull-out drawer. Replace it with the recommended fuse type IEC 60127-2, 5X20 mm, 2.5A, 250V, Agilent part number 2110-1334. Notice that an extra fuse is provided in a drawer located on the fuse holder.

WARNING **For continued protection against fire hazard, replace line fuse only with same type and ratings, (type IEC 60127-2, 5X20 mm, 2.5A, 250V for 100/120V operation). The use of other fuses or materials is prohibited.**

To replace a rear-panel fuse

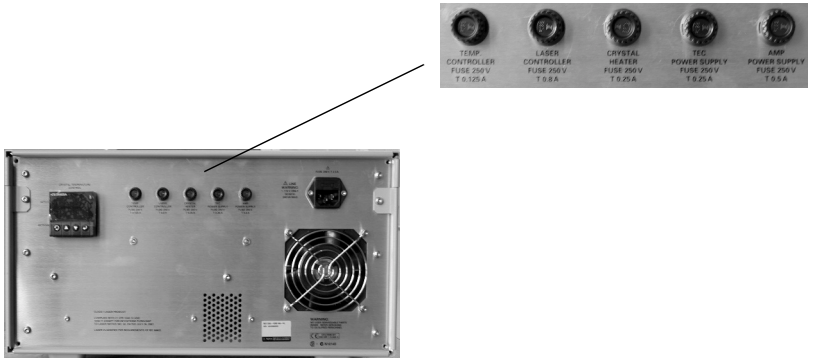


Figure 11. Rear-Panel Fuse Row

- The five rear-panel fuse holders are listed in Table 7. Replace any blown fuses with the correct fuse values listed in the table.

Table 7. Required Rear-Panel Fuses

Fuse Holder Label	Correct Fuse	Agilent Part Number
Temp Controller	IEC 60127-2, 5x20 mm, 0.125 A, 250 V	2110-1339
Laser Controller	IEC 60127-2, 5x20 mm, 0.8 A, 250 V	2110-1338
Crystal Heater	IEC 60127-2, 5x20 mm, 0.25 A, 250 V	2110-1337
TEC Power Supply	IEC 60127-2, 5x20 mm, 0.25 A, 250 V	2110-1337
AMP Power Supply	IEC 60127-2, 5x20 mm, 0.5 A, 250 V	2110-1333

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.

Caring for Electrical Connections

The following list includes the basic principles of microwave connector care:

Handling and storage

- Keep connectors clean
- Extend sleeve or connector nut
- Use plastic endcaps during storage
- Do *not* touch mating plane surfaces
- Do *not* set connectors contact-end down

Visual inspection

- Inspect all connectors carefully before every connection
- Look for metal particles, scratches, and dents
- Do *not* use damaged connectors

Cleaning

- Clean with compressed air first
- Clean the connector threads
- Do *not* use abrasives
- Do *not* get liquid onto the plastic support beads

Making connections

- Align connectors carefully
- Make preliminary connection lightly
- To tighten, turn connector nut *only*
- Do *not* apply bending force to connection
- Do *not* over tighten preliminary connection
- Do *not* twist or screw in connectors
- Do *not* tighten past the break point of the torque wrench

Inspecting Connectors

Before using connectors for a critical application, inspect the connector interfaces with a microscope (~20X). Look for dirt, contaminants, dented or scratched outer conductor mating surfaces, and damaged center conductors.

Inspecting SMA connectors

You must carefully inspect an SMA connector prior to mating with a precision 3.5mm connector (this includes a new SMA connector). This must be both a visual and mechanical inspection. Use a precision connector gauge designed to measure SMA connectors. Remember that gauging SMA connectors is the most important step you can take to prevent damaging your equipment.

A male SMA connector pin that is too long can smash or break the delicate fingers on the precision 3.5mm female connector.

Cleaning RF Connectors

The procedures in this section provide the proper steps for cleaning RF connectors. The initial cleaning, using alcohol as a solvent, gently removes any grit and oil. If a caked-on layer of material is still present, 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 8. Cleaning Accessories

Item	Agilent Part Number
Isopropyl alcohol	8500-5344
Cotton swabs	5080-5400
Compressed Air	8500-6659
Lint free cloth (one)	9310-4242
Connector care quick reference card	08510-90360

Table 9. Dust Caps Provided with Lightwave Instruments

Item	Agilent Part Number
Laser shutter cap	08145-64521
FC/PC dust cap	08154-44102
DIN dust cap	08154-44103
HMS 10 dust cap	08154-44101

To clean an RF connector

1. Use a swab dipped in clean isopropyl alcohol to clean off the outer conductor mating surfaces and the ends of the center conductors. Be careful not to let the alcohol get on the insulator bead, as this may damage the bead. Be careful not to exert too much force on the center conductors, especially slotless female center conductors, as they may be damaged. Use a swab that has a sharp enough corner to clean all areas of the connector interface. Don't forget to clean off the coupling nut threads.
2. Blow off the alcohol with clean compressed air. Compressed air can reduce the temperature of connectors dramatically, and this can have a significant effect upon the performance of calibration and verification components. If the connector components being cleaned are to be used in a critical measurement application, the temperature of these components should be allowed to stabilize before they are used.
3. Reinspect the connectors under the microscope. If the outer conductor mating face of a connector has raised material that would keep it from making complete contact with another connector, it should be replaced. If the fingers of a slotted female contact are spread open, rather than crimped closed, the connector should be replaced. If a connector has a slotless contact with damaged fingers, the connector should be repaired or replaced.

Theory of operation

Optical sampling is used to achieve extremely high bandwidth in the oscilloscope measurement. A pulsed 780 nm laser provides the sampling strobe. The pulse width of the sampling laser is approximately 200 fs wide. The sampling pulse is combined with the 1550 nm-band input signal in a low loss dichroic optical power combiner. The combined signal is then focused through nonlinear optical crystal (periodic poled lithium niobate, PPLN).

Optical mixing occurs when the sampling pulse and the 1550 nm input signal overlap in time, provided the polarization of the input signal and the sampling strobe are aligned. An external polarization controller on the input signal is typically required to achieve optimum nonlinear mixing and the best optical sampling system sensitivity.

The optical sum frequency signal at approximately 520 nm then represents a measurement of the input signal during the very narrow optical sampling pulse aperture. This 520 nm signal can then be detected with a very high sensitivity avalanche photo diode (APD). The gain of the APD is adjustable to achieve a high dynamic range in the measurement - from tens of uW to hundreds of mW. The sampling process is described in more detail in the reference.

The optical sampling process described above determines the vertical position of each sample on the oscilloscope screen. The timebase determines the horizontal or time position of each sample.

A random sampling timebase is used. The precise time of each sampling strobe pulse within one unit interval (period) of the electrical clock reference is determined by measuring each sampling strobe with an optical to electrical oscilloscope module. The electrical clock reference is separately measured with an 86107A precision timebase.

From these separate measurements the precise time of each sample is determined with low jitter and drift. This time value is used to place the horizontal position of each sample on the oscilloscope screen.

"1 THz Optical Sampling with a Bit Rate Agile Timebase", IEEE Photonics Tech. Lett., Vol. 14 pp. 1148-1150 (Aug. 2002).

User Messages

The following user messages are unique to the 86119A. For general 86100 user messages, refer to the 86100A/B/C online help.

`No optical sampling stabilization set:`

Displayed if optical sampling fails. More information is given by one of the following messages:

- `Left module calibration is required`,
- `Channel 1 signal is too large`,
- `Channel 1 signal is not present or too small`,
- `Please verify optical sampler is turned on and connected to the mainframe`,
- `Please check connection to front-panel trigger input`.

The detailed information provides insight into the root cause of the problem. Correct the error condition as appropriate.

`Optical sampling stabilization lost: Please check connections and reset stabilization`

Whenever optical sampling is turned on, the instrument automatically runs an optical sampling stabilization routine that allows exceptionally low jitter timebase performance. On occasion, the instrument may lose stabilization due to the following causes:

- Temperature change of the environment or during the warm up period of the instrument. Allow sufficient warm-up time and use only in a laboratory environment.
- Excessive movement of the cables and fibers from the 86119A to the 86100A/B/C. Use tape (or other means) to stabilize and prevent motion of fiber-optic cables.

To reset the stabilization

a Click the Setup menu.

b Click Optical Sampling.

c Click the Reset Stabilization button.

Optical sampling stabilization set

Displayed after optical sampling completes successfully.

Optical sampling user wavelength calibration data corrupted

Displayed when a user calibrated wavelength is selected and the calibration data has been corrupted. Delete that wavelength and redo the user calibration.

Precision timebase is required for optical sampling

Displayed when attempting to turn off precision timebase while optical sampling is on. It is not possible to use pattern triggering with the 86119A optical sampler.

Setting optical sampling stabilization...

Displayed while setting stabilization is in progress. Wait for the process to complete in a few seconds.

The selected measurement is not available with optical sampling

Displayed when attempting to turn on average optical power measurement while optical sampling is on. The 86119A does not perform average power measurements.

Remote Operation

There are a number of remote commands specific to the 86119A. They are only functional when the 86100 mainframe is configured for optical sampling with the correct modules. For more general information on remote programming, refer to the Infiniium DCA Agilent 86100A/B/C Programmer's Guide

:OSAMpling {{0|OFF}|{1|ON}}

This command is used to turn optical sampling on and off.

:OSAMpling?

This query returns whether optical sampling is on or off. If On then "1" is returned; if Off then "0" is returned.

:OSAMpling:GAIN {LOW|HIGH}

This command is used to set the DCA gain setting to match the gain setting on the 86119A optical sampler. It does not change the gain setting on the optical sampler. For proper operation these two independent controls should be set to the same value.

:OSAMpling:GAIN?

This query returns the DCA gain setting for optical sampling: "LOW" or "HIGH". It does not return the setting of the gain switch on the optical sampler. For proper operation these are two independent controls should be set to the same value.

:OSAMpling:STABilization?

This query returns the status of optical sampling stabilization. "1" is returned if optical sampling stabilization is set; "0" is returned if not set.

:OSAMpling:STABilization:RESet

This command resets optical sampling stabilization.

:OSAMpling:WAVelength:ADD

This command starts a user wavelength calibration. It is recommended that this command be followed by the query ":CALibrate:SDONe?". This query will return either a prompt for the next step in the calibration process or the final calibration status, i.e. "Done", "Failed" or "Cancelled".

:OSAMpling:WAVelength:DELete <wavelength>

This command is used to delete the calibration data for a user calibrated wavelength.

<wavelength> is the value of the wavelength in meters. For example, the following command deletes the user calibration data at 1553 nm:

":OSAMPling:WAVelength:DELete 1553e-9"

:OSAMpling:UCALibration:WAVelength <wavelength>

This command is used to specify the wavelength to be calibrated by the:OSAMPling:WAVelength:ADD command. During the calibration process the user is prompted to connect an optical calibration source to the optical sampler. The optical calibration source should have the wavelength specified by this command.

<wavelength> is the value of the wavelength in meters.

:OSAMpling:UCALibration:WAVelength?

This query returns the wavelength value that will be calibrated by the:OSAMpling:WAVelength:ADD command. The returned value is a wavelength value in meters.

:OSAMpling:UCALibration:POWer <power_level>

This command is used to specify the power level of the signal used to perform a user wavelength calibration. A user wavelength calibration is started by sending the command "OSAMPling:WAVelength:ADD".

<power_level> is the value in watts. This power level value is typically obtained by measuring the optical calibration source with an optical power meter.

:OSAMpling:UCALibration:POWer?

This query returns the power level that has been specified for the optical calibration source. The returned value is in watts.

:OSAMpling:WAVelength {SERVice | <wavelength>}

This command is used to specify the wavelength of the signal at the input to the optical sampler so that the proper calibration factors can be applied to measured data. The parameter "SERVice" selects the factory calibrated wavelength. The <wavelength> parameter is used to specify one of the user-calibrated wavelengths. It has units of meters.

:OSAMpling:WAVelength?

This query returns the currently selected wavelength. "SERV" is returned if the current wavelength is the service-calibrated wavelength. Otherwise, the returned value is the wavelength, in meters, of the currently selected user-calibrated wavelength.

:OSAMpling:WAVelength:LIST?

This query returns the number of user-calibrated wavelengths followed by a comma-separated list of the wavelengths in meters.

:OSAMpling:SCALibration:LOAD ["<path>"]

This command loads a service calibration data file into the Agilent 86100. The "<path>" parameter is optional; the default path is the floppy disk drive, A:\.

:PTEE <mask>

Bit 1 of the Precision Timebase Event Register is set to 1 to indicate optical sampling stabilization has been lost. The query ":PTER?" is used to read the Precision Timebase Event Register. The command "PTEE <mask>" is used to

set a mask in the Precision Timebase Event Enable Register. A "1" in Bit 1 enables the optical sampling stabilization lost bit to set Bit 11, the Precision Timebase Event bit, in the Operation Status Register. The query "PTEE?" returns the current mask value in the Precision Timebase Event Enable Register

:PTEE?

The query "PTEE?" returns the current mask value in the Precision Timebase Event Enable Register

:PTER?

The query ":PTER?" is used to read the Precision Timebase Event Register.

Specifications and Regulatory Information

The following specifications and regulatory information is included in this chapter:

Specifications

This section lists specifications and characteristics of the 86119A. The distinction between these terms is described as follows:

- Specifications describe warranted performance over the instrument's temperature range 15°C to +30°C. All specifications apply after the temperature of tthe 86119A has been stabilized after 60 minutes of continuous operation.
- *Characteristics* provide useful information by giving functional, but nonwarranted, performance parameters. *Characteristics are printed in italics.*

Table 10. Environmental Specifications

Operating Temperature.	15° C to +30° C CAUTION, Ventilation Requirements: The 86119A is not intended for mounting in cabinets or equipment racks. It is important that the temperature of the surrounding air be at 30°C or less. This cannot, in general, be accomplished in an enclosure.
Power	115VAC: 300 VA MAX.
Voltage	Nominal:115 VAC Range: 90-132 VAC
Frequency	Nominal 50-60 Hz Range 47-63 Hz
Storage Temperature	–10° C to +60°C
Use	Indoor
EMC	Conducted and radiated Emission is in compliance with CISPR 11 Class A and IEC 61326
Weight	24 kg (53 pounds)
Dimensions (excludes power cable) Height Width Length	 22.25 cn (8.75 inches) 42.5 cm (16.75 inches) 68.5 cm (27 inches)
Power Cable Length	2 meters

Table 11. Amplitude Performance Specifications

	Option K99	Option K98
Impulse Response (FWHM) (characteristic)	*590 fs*	*550 fs*
Bandwidth (characteristic) [1]	*700 GHz*	*750 GHz*
Center Wavelength Range (characteristic) [2]	*1555 nm (user settable ±5nm)*	*1540-1560 nm (set at factory)*
Wavelength Window (characteristic) [3]	*10 nm (–3 dB response)*	*28 nm (–3 dB response)*
Dark Noise Level (characteristic)	*<65 uW rms*	*<170 uW rms*
SNR at 10 mW Input (characteristic)	*27*	*17*
Scale Factor High Gain Low Gain	 100uW /div to 5 mW/div 2 mW/div to 100 mW/div	 200uW /div to 10 mW/div 5mW/div to 100 mW/div
CW Amplitude Accuracy (Low Gain Setting) (characteristic)	*±5%*	
Amplitude Offset	–600 mW to 200 mW (max)	
Max input (peak)	800 mW	
Input Connector	APC (angled physical contact)	
Input Optical Return Loss (characteristic)	*30 dB*	
Polarization Acceptance (characteristic)	*TE mode aligned with connector key (horizontal polarization)*	

Table 12. Timebase Performance Specifications [a]

Reference Clock Signal Type	Synchronous Clock, any waveform shape (S/N and subharmonic content requirements depend on 86107A option)
Reference Clock Signal Level	0.5Vpp - 1Vpp
Reference Clock DC offset	< 200mV
Reference Clock Frequency Ranges	
86107A - 10	2.4 to 4GHz 9 to 12.6GHz
86107A - 20	9 to12.6GHz 18 to 25GHz
86107A - 40	9 to12.6GHz 18 to 25GHz 39 to 45GHz
Jitter (RMS) (Depends on frequency range and clock amplitude)	
86107A - 10	<280fs
86107A - 20	<200fs
86107A - 40	<250fs
Timebase linearity error	<200fs

a. Specifications depend on 86107A option purchased

Regulatory Information

Laser Classification

- This product is classified as a Class 1 product per IEC 60825-1 (2001).
- This product complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice 50: July 26, 2001.

Compliance with Canadian EMC Requirements

- This ISM device complies with Canadian ICES-001.
- Cet appareil ISM est conforme a la norme NMB du Canada.

Compliance with German Noise Requirements

This is to declare that this instrument is in conformance with the German Regulation on Noise Declaration for Machines (Laermangabe nach der Maschinenlaermrerordnung -3.GSGV Deutschland).

Table 13. Notice for Germany: Noise Declaration

Acoustic Noise Emission	Geraeuschemission
LpA < 70 dB	LpA < 70 dB
Operator position	am Arbeitsplatz
Normal position	normaler Betrieb
per ISO 7779	nach DIN 45635 t.19

Returning the Instrument for Service

NOTE

Please notify the service office before returning your instrument for service. Any special arrangements for the instrument can be discussed at this time. This will help the Agilent service office repair and return your instrument as quickly as possible.

The instructions in this section show you how to properly package the instrument for return to an Agilent Technologies service office. For a list of offices, refer to "Agilent Technologies Service Offices" on page 52.

You must first always call the Agilent Technologies Instrument Support Center 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 the following number regardless of where you are located: 1(800) 403-0801.

If the instrument is still under warranty or is covered by an Agilent 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 maintenance plan, Agilent will notify you of the cost of the repair after examining the unit.

When an instrument is returned to an Agilent 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 original calibration data disks and the instrument being returned.

Please notify the service office before returning your instrument for service. Any special arrangements for the instrument can be discussed at this time. This will help the Agilent service office repair and return your instrument as quickly as possible.

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.

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 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 accom-

modate 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.

Agilent Technologies Service Offices

Call Center

For technical assistance, you can contact your local Agilent Technologies Call Center.

- In the Americas, call 1 (800) 452-4844
- In other regions, visit http://www.agilent.com and click **Contact Us**.

Service Center

Before returning an instrument for service, you must first call the Agilent Technologies Instrument Support Center.

- In all regions, call (800) 829-4444

Index