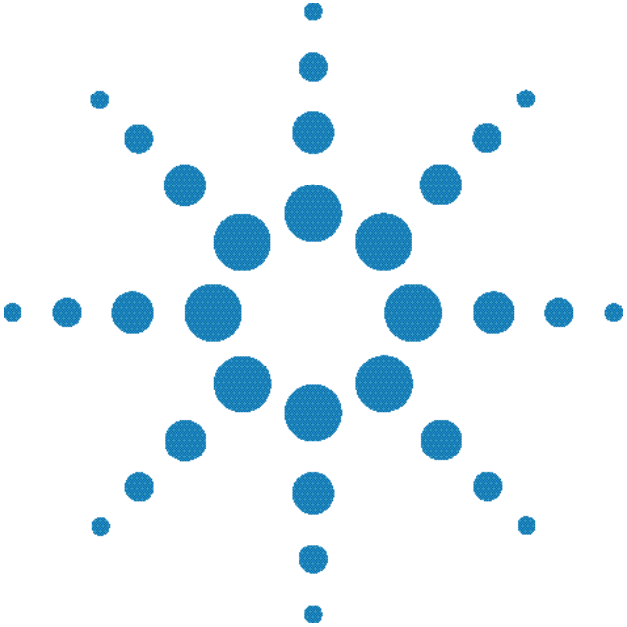
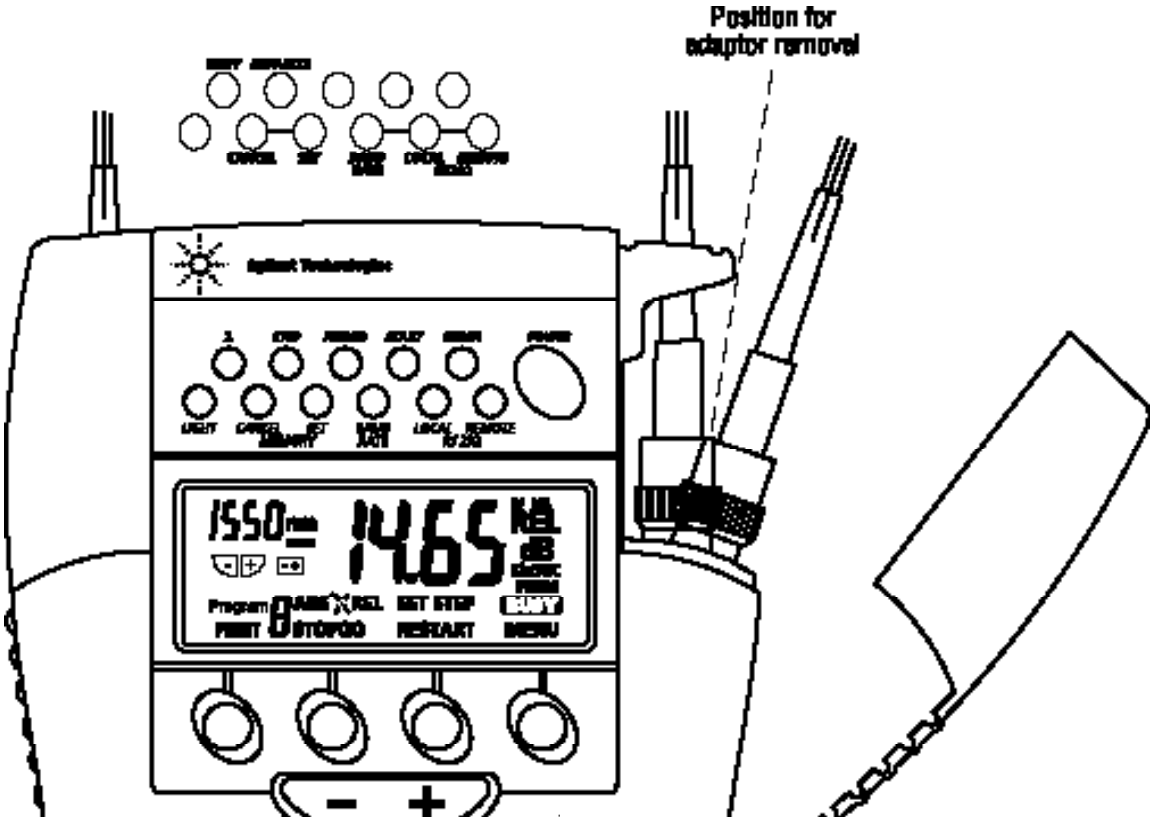


N3977A OPTICAL ATTENUATOR

Operating and
Maintenance Guide

Agilent Technologies


Position for
adaptor removal
1550
14.65
Program
RESET
STOP/GO
RESTART
MENU

- To remove **interchangeable connector**, move interface to mid position, and pull off adaptor.
- To **defeat auto power-off**, hold POWER for 3 seconds at turn on until ON or perm are displayed.
- To access **hidden keypad**, pull up display cover.
- To **exit** any mode, push MENU.

MANUAL OPERATION

- Select POWER:
- Push λ for **manual mode**, then +/- to select the required wavelength, then SET:
- To **set attenuation**, toggle +/- as required,
- To enter **step mode**, push STEP, then toggle +/-. Then to set the step size, push SET STEP, +/- for required value, then SET.
- To display **relative attenuation**, push ABS/REL. To zero the display, push ABS/REL again, or to set a value, enter the value with +/-, then push SET.

PROGRAM OPERATION

- Select POWER:
- Push PROGRAM for program mode.
- To **run a program**: Toggle +/- then SET to select the required program. Push GO to start the program, then STOP, GO, RESTART if required.
- To **set up a program**: Toggle +/- then SET to select the required location. Then on the hidden keypad: λ then +/, STEP then +/-, PERIOD then +/-, START then +/-, FINISH then +/-, then SET to enter the program.

N3977A

OPTICAL ATTENUATOR

Congratulations on your purchase of this instrument, which has been engineered to provide the best possible reliability, convenience and performance. To get the best use from your equipment and ensure its safe operation, please spend a few minutes to read this manual.

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BEFORE READING FURTHER, OPEN THE CONTROL PANEL PICTURE AT THE BACK OF THE MANUAL

Any adjustment, maintenance, or repair of this product must be performed by qualified personnel. Contact your customer engineer through your local Agilent Technologies Service Center. You can find a list of local service representatives on the Web at: http://www.agilent.com/find/assist

If you do not have access to the Internet, one of these centers can direct you to your nearest representative:

United States	1 800 452 4844
Canada	1 877 894 4414 (905) 206 4120 (Fax)
Europe	(31 20) 547 2323 (31 20) 547 2390 (Fax)
Japan	(81) 426 56 7832 (81) 426 56 7840 (Fax)
Latin America	(305) 269 7500 (305) 269 7599 (Fax)
Australia	1 800 629 485 (613) 9272 0749 (Fax)
New Zealand	0800 738 378 64 4 495 8950 (Fax)
Asia-Pacific	(852) 3197 7777 (852) 2506 9284 (Fax)

■ INTRODUCTION AND APPLICATIONS

The N3977A Optical Attenuator creates accurate variable optical losses in fibre optic systems. Compact and simple to operate, it is the ideal equipment for field or laboratory use, with features for use by installers, technicians and engineers.

The design of the instrument includes compliant shock absorbing corners for drop protection, and an extremely tough polycarbonate housing. The latest materials and methods have been used to produce an elegant yet rugged instrument.

The innovative optical connector port gives improved ease of access, connector lifetime and performance, and is drop protected by a snap on cover. A unique interchangeable connector system covers most connector requirements, and is easily disassembled for cleaning.

The long battery life of 200 - 600 hours (depending on motor activity) from 2 C cells eliminates the need for re-chargeable batteries and external power supplies.

It is calibrated at 1310 & 1550nm, over 2.50 - 60.00 dB.

A convenient menu driven interface guides the user through operational sequences, and a hidden keypad accesses advanced functions.

Three different display modes include: actual attenuation, relative attenuation (eg set to 0 dB at a particular level) and arbitrary attenuation (eg set display to read any value).

Different operation modes include: continuously variable, step, multiple user setable program modes.

The attenuator comes with a fully Traceable Calibration Certificate.

This combination of factors provides the highest level of measurement confidence. These instruments can therefore be used as secondary standards with a recommended 1 year re-calibration cycle.

Exceptional accuracy and linearity is achieved during manufacture by calibrating every incremental 0.05 dB setting of the attenuator at each wavelength.

Attenuation is achieved by movement of a neutral density filter positioned in the optical path. Attenuation remains unchanged when the instrument is turned off. Low back reflection and PMD is achieved through optimal design of the optical path.

Typical Applications

- Measurement situations where traceability and full documentation is required
- Optical Margin Testing on digital or analogue transmission systems
- Temporary attenuator pad during commissioning of systems
- Linearity testing of optical equipment and components
- Quality assurance and acceptance testing

■ SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies Inc. assumes no liability for the customer's failure to comply with these requirements.

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

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice or the like, 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.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

CAUTION

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

REQUIREMENT COMPLIANCE

CE N 10149

Initial Inspection

Inspect the shipping container for damage. If there is damage to the container or Cushioning, keep them until you have checked the contents of the shipment for completeness and verified the instrument both mechanically and electrically.

The Performance Tests give procedures for checking the operation of the instrument. If the contents are incomplete, mechanical damage or defect is apparent, or if an instrument does not pass the operator's checks, notify the nearest Agilent Technologies Sales/Service Office (see page 3).

WARNING

To avoid any hazard, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, etc.).

WARNING

You MUST return instruments with malfunctions to an Agilent Technologies Service Center for repair and calibration.

Line Power Requirements

The Agilent N3977A Attenuator operates at line power when applied to the optional external power supply N3979A 9VDC.

Operating Environment

The Agilent N3977A Attenuator can be operated at temperatures between - 10°C and + 55°C and at relative humidity of <95%.

Storage and Shipment

The Agilent N3977A Attenuator can be stored or shipped at temperatures between - 25°C and + 70°C and at relative humidity of <95%. Protect the module from temperature extremes that may cause condensation within it.

■ BATTERY AND EXTERNAL POWER

The instrument is powered by two 1.5V dry batteries (Alkaline C) for an operating period of typically 200 - 600 hours, or two 1.2V rechargeable batteries for an operating period of approximately 100 – 300 hours.

Do not use lithium batteries or other batteries with a nominal voltage greater than 1.8 V.

The instrument will be damaged.

When the batteries are low, the low-battery indicator is shown on the display. At this stage, there is approximately enough energy for another 30 minutes of use.

For saving of energy the instrument automatically turns off after 10 minutes without operation.

For changing the battery open the cover of the battery compartment at the base of the instrument, remove the batteries, insert new batteries (check polarity) and close the cover again.

Rechargeable batteries must be charged by an external charger.

For operation of the instrument by external power use Agilent AC adaptor N3979A (9V DC 1.33 A, ⊕–(•–⊖).

Use of the external power supply disconnects the batteries.

Ensure that the mains supply has the correct voltage rating and safety compliance as relevant. Do not use non-compliant or doubtful mains equipment.

The optical port is mounted on a swivel, which allows the connector to be angled outwards for accessibility, and then pushed back and covered with the snap cover to provide dirt and drop protection.

The connectors can affect the achieved return loss performance of the instrument. With PC or flat polish connectors, the return loss performance is likely to be determined by the connectors.

Optical connectors are precision components, and require care in use:

- Do not use damaged connectors.
- Always clean the mating connector tip and ferrule before mating, using approved materials.
- Do not touch connector tips with your fingers, since body oils and dirt can impair connector performance.
- Keep all ports and connectors covered, and away from dust when not in use.
- The soft case provided enables the instrument to be stored without removing the patchcords. This practice saves time and will lead to extended connector life and more repeatable measurement performance.
- APC polish connectors should not be mated with PC or flat polish connectors.
- Either port can be used as an optical input or output.

Interchangeable connector

To remove the connector adaptor, swivel the connector port to it's mid-way point (see dotted line on diagram at back of manual), and then pull off the adaptor. To replace the adaptor use the same procedure, and ensure that the locating lug is correctly aligned.

- For more effective results, clean the instrument connector after removing the connector adaptor.
- Replacement of the fixed part of the connector must be performed at an authorised service center.

In this manual, refer to the sections on Cleaning Information and Procedures for further information.

■ GETTING STARTED AND TURNING ON

This and following sections show you how to use the features of your instrument.

Inspect any mains voltage accessories for correct voltage rating, plug style and safety compliance as relevant. Contact your local representative if in any doubt as to the safety compliance of supplied equipment.

Check that the correct accessories and optical connectors have been supplied. If you have any queries, please call your local representative as soon as possible to have the situation resolved.

To prepare the attenuator for use:

Put in the batteries, or plug in external power into the socket at the top of the instrument. (see page 8: Battery and External Power)

Push the green Power button. The display will come on. A low battery condition will be indicated on the display. Pushing the green Power button again will turn the instrument off.

To stop the instrument turning off 10 minutes after the last key press, hold the green Power button down for 3 seconds during turn-on. ' Perm ' on the display indicates that the unit will stay on permanently.

The current attenuation setting remains unchanged when the attenuator is switched on and off.

The instrument stores various user settings when it is turned off, for use next time. This customises the unit for your use.

To backlight the display temporarily, select ' light '. To illuminate continuously, keep the button depressed for 3 seconds. The backlight will drain the batteries faster.

To access the optical connectors, grasp a top corner of the instrument, and pull off the cover. Note that the connector can be swivelled slightly to improve access. You may need to fit the interchangeable adaptors onto the instrument prior to use.

Note that the hidden keypad is accessed by pulling up the hinged display cover.

To add the car ry strap: slip the end of the strap through the slit on the curved section at the back of the instrument, and secure the buckle.

To learn how to use the instrument, go to the next section ' Simple Operation '.

Should the instrument fail to turn on, it is possible that the microprocessor needs re-booting. To do this, remove the batteries and external power for at least 40 seconds, then re-insert them to re-boot the software.

■ SIMPLE OPERATION

To fully demonstrate the attenuator's operation, you will require two patchcords, a precision light source and a power meter with an InGaAs detector. Use of a low stability source or meter with a Ge detector, will result in reduced measurement performance.

This instrument is easily used by untrained operators, who will quickly find that the interactive menu is very simple to use. The default mode can be used to perform simple testing. The following sequence will demonstrate how to use the attenuator.

Turn on the light source and power meter, and connect them together with a patchlead. After the stabilisation period, take a reference reading, so that the meter reads 0.00 dB, and then connect the attenuator between the source and meter.

Turn on the attenuator by pushing the green Power button, then:

Follow the button sequence indicated by the flashing display, starting with the wavelength selection λ.

You can always go back to a previous menu selection by selecting MENU.

The current calibration wavelength is displayed on the top left of the display. For correct display of attenuation, the calibration wavelength is set to the appropriate window (eg 1310, 1550 nm) using the + - button, then SET.

If the wavelength is set incorrectly, the instrument will appear to function properly, however the displayed attenuation will be inaccurate.

Once the wavelength has been set, the attenuation level can be set as required with the + - button. The instrument sets the requested attenuation level with an internal motor drive. You hear some motor noise when setting the attenuation. While the motor is in operation, a 'busy' indicator will show on the LCD.

The attenuation can be set outside the calibrated range of 2.5 - 60 dB, in which case HI or LO will be displayed and the attenuator will set to the highest or lowest value possible (this will vary between instruments). Some functions are locked out when HI or LO are displayed.

Note that to achieve the most simple level of operation, the operator sequence is simply:

Power / wavelength / + - / set / adjust.

If the wavelength of the source, meter and attenuator are correctly set, the meter and attenuator should display similar readings, with discrepancies caused mainly by connector uncertainty. Note that any source drift will also cause extra variation. The attenuator reading displays the complete instrument loss, including the average optical connector loss.

■ STEP MODE

The user can set a step size of 0.05 - 10 dB in increments of 0.05 dB.

■ This is very convenient when performing linearity tests, or simply to speed up operation if the default step size of 0.1 dB is not found convenient.

For example, when testing optical power meter linearity, the step size might be set to 10 dB.

(Prior to using this mode, select: Power / Wavelength / + - / Set)

To use the step mode, simply push the STEP button. The +/- button will now increment according to the previously used step size.

To alter the step size, push the SET STEP button, use the +/- button to display the required step size, and push SET. The unit will now operate in step mode using the new step value.

To exit this mode, push MENU.

■ ABSOLUTE/RELATIVE DISPLAY MODES

Sometimes it is convenient to display relative attenuation, for instance:

- Attenuation relative to a reference value. The display is zeroed at a particular point, and subsequent readings are relative to this.
- The display is set to an arbitrary value. For example to display the absolute optical power coming out of the attenuator when a particular light source is attached. Or you might set the display to read total link loss including the attenuator loss.

(Prior to using this mode, select: Power / Wavelength / + - / Set / Abs/Rel. The attenuation display will change to the current relative attenuation value).

In relative mode, REL shows on the top right side of the display. Note that negative attenuation values can also be displayed in this mode. Then:

Either: Zero the display, by pushing the REL button.

Or: Set the display to an arbitrary value. Adjust the display with the + - button, then push SET.

To exit this mode, push the ABS/REL button again (or MENU), and the REL indicator will disappear.

■ PROGRAM MODE

- Program mode is a powerful productivity enhancing facility. It enables unskilled operators to use pre-set routines, and skilled users to operate more efficiently. 15 different user programs (1 to F) can be set up and stored in non-volatile memory.
- The program mode is particularly useful when performing optical margin testing, since a slow uniform increase of attenuation can be automatically achieved over a desired range. Thus the user is free to watch other instruments and system controls during the test.

The buttons used to set up the program modes are hidden, and are accessed by lifting the hinged LCD cover. This enables an experienced user to set up programs, and then put a seal on the cover to prevent inexperienced staff from altering the programs.

To use a previously set program (programs 1, 5, 6, 7 were factory set):

1. Turn the instrument on, and select PROGRAM.

2. Select the desired program with the + / - button, and push SET.

3. You can then select GO, STOP, RESTART as appropriate.

Pushing STOP and then GO simply halts the program, and then continues. Pushing RESTART will take you back to the start of the program.

To exit this mode, push (stop, then) MENU.

- Every attempt has been made to make your instrument as rugged as possible. However due to the precision mechanical nature of optical attenuator mechanisms, these instruments are more easily damaged by physical abuse than other instruments. Accordingly, do not subject this instrument to extreme conditions.
- To clean the unit, use alcohol or other non solvent cleaning agents. Acetone or other more active solvents may damage the case.
- During storage and transport, keep the instrument in it's carry case to protect against crushing, vibration, dust and moisture.
- The instrument is resistant to normal dust and moisture, however it is not waterproof. If moisture does get into the instrument, dry it out carefully before using it again.
- To maintain instrument accuracy, follow the directions in this manual on Optical Connectors.
- Do not exceed the maximum input optical power level.
- Where possible, avoid strong direct sunlight from heating the instrument.
- During prolonged storage, remove batteries to eliminate the possibility of acid leakage. Use only high quality sealed alkaline batteries, to avoid acid leakage.

■ ACCURACY CONSIDERATIONS

The following factors may affect your measurements:

- Optical connectors need to be kept scrupulously clean and in good condition. See page 9.
- There are limits on the repeatability of the attenuator setting. This is typically ±0.02 dB.
- There may be inaccuracies due to the operational wavelength being slightly different to the calibration wavelength. This error is normally small, since the instrument has a flat spectral response. The expected inaccuracy can be approximated as:

$$Attenuation \approx A_{displayed} - 0.00027\ \Delta\lambda\ .(5 + A_{displayed})^{typ.}$$

where $A_{displayed}$ is the displayed attenuation in dB and $\Delta\lambda$= wavelength difference from calibration wavelengths in nm

For example, with the attenuator set at 1310 and 60 dB, and with 1550 nm light, the actual attenuation will be approximately 55.79 dB.

- Different polarisation of light can create minor changes. To eliminate this, keep your overall measurement system physically stable. Keep patchleads neat, coiled and stable.
- Temperature effects are too small to characterise reliably, and are unlikely to be an issue.
- Ge power meters are inherently non linear by about ±0.04 dB. This will noticeably degrade the accuracy of work done with such a meter.
- Sources may drift: when you have finished a test, go back to the start position to check if your meter reading is still within acceptable limits.
- Cladding mode light transmission can affect some fibre types (most fibers strip off cladding modes).

You may find that your power meter linearity disagrees with the attenuator at low power levels. Many power meters have poor linearity at low power levels. If in any doubt, introduce a step attenuator into the system (say 20 dB, a bad connection will suffice!), and repeat similar power meter readings using a different region of the attenuator.

For example, if during testing, the power meter disagrees with the attenuator where the meter reads below say -40 dBm and the attenuator was between -35 and -50 dB to achieve these readings, try introducing an additional 20 dB loss somewhere else. Now repeat the measurement with the power meter still reading below -40 dBm, but to achieve this the attenuator is reading between -15 and -30 dB. If the same non-linearity is evident, then it is the power meter that is non linear.

■ MAINTENANCE

CAUTION! This equipment contains delicate and expensive fiber optic, electronic and mechanical components. Do not open unless:

- The warranty has expired (opening the unit will invalidate any warranty claim).
- You are authorised to do so.
- You have familiarity with handling optical fibers.
- You have a static protected workstation.

This unit contains static sensitive devices. Anti-static handling procedures should be observed at all times when handling internal circuits. Be certain never to touch a soldering iron onto the optical fibers, since damage to the plastic coating will cause subsequent fiber breakage.

Please note there are no internal potentiometers, fuses, switches or calibration features. The pcb has all surface mount devices.

The optical attenuator module is sealed and not accessible. A problem with the optical module will require return to Agilent Technologies for repair.

Note on servo system and motion controller: The linear servomotor is geared through a sealed high reduction gearbox. Position feedback is taken from the attenuator vane. The entire servo system has been designed to be very robust and with plenty of spare torque to overcome sticky oil and other start up problems. Remaining problems that the user might be able to service are: mechanical parts coming loose, or dirt in the external transfer gears causing erratic motor movement.

Opening the instrument:

Remove the batteries and leave the battery cover open.

Pull open the optical connector covers. Place the instrument face down on a soft mat, and undo the 6 screws in the rear housing. The instrument can now be gently pulled apart from the bottom.

The instrument will come into two halves joined by a ribbon cable. The optical and mechanical sections are located in the bottom half, with the pcb and controls in the top half.

The hinged display cover can be easily removed at this point.

Cleaning of the optical connectors can be achieved at this point.

The ribbon cable can be safely disengaged from it's socket to completely separate the instrument halves.

Further dis-assembly from this stage should be easily apparent to a technician.

The punch-down terminals used for discrete wire terminations can be disassembled by pulling up the plastic cap, and then pulling out the wire. It is re-assembled by pushing down the wire with the plastic cap.

General electrical parameters are as follows: Vss to Vcc = 3.3 V, Battery power down current about 0.3 mA, active current about 11 mA, motor current is very difficult to measure, but is typically about 150 mA.

The only critical adjustment that can be affected by disassembly is adjustment of the motor gear separation, which is a separate adjustment on the base of the internal metal chassis. The gear train should run freely, without binding.

Do not attempt to dismantle the optical module: this contains extremely precisely aligned optical components.

Re-assembly:

This is the reverse of the previous procedure. During re-assembly take care not to trap or snag the optical fibers.

The ribbon cable is most easily re-assembled with the help of long nosed pliers.

When mating the two halves, be sure that the two optical connector pivots are properly positioned.

■ INSTRUMENT RETURNS

Before returning equipment to Agilent for repair or calibration, please check with your local Agilent Technologies Service Center (see page 3) to obtain a tracking number and shipping details.

Please state clearly the problem requiring attention.

Please include your contact phone and fax number, and return shipping details.

If the goods are under warranty, it would be helpful to include the original order / contract details.

If the goods are not under warranty, work will only proceed when a repair order has been issued. Please either include a repair order with the equipment, or request that a quotation be provided.

Linearity The maximum difference between a measured attenuation step and the corresponding displayed attenuation step, in dB/dB.

Polarisation Sensitivity The dependence of the loss on the input polarization state, expressed as ±half the difference (in dB) between the highest and the lowest loss.

Insertion loss The attenuation at a given attenuation setting, defined as the additional loss caused by inserting the attenuator into a through connection.

Calibration wavelengths	1310 nm and 1550 nm
Wavelength dependence (1200-1600 nm):	$Attenuation \approx A_{displayed}$ -0.00027 $\Delta\lambda$.(5 + $A_{displayed})^{typ.}$ where $A_{displayed}$ is the displayed attenuation in dB and $\Delta\lambda$= wavelength difference from calibration wavelengths in nm
Wavelength Range	1200 to 1600 nm
Attenuation Range	2.50 to 60.00 dB
Repeatability	± 0.03 dB (at fixed polarization state)
Insertion loss at Low position	< 2.5 dB
Linearity	± 0.003 dB/dB ± 0.05 dB (at fixed polarization state, for the specified attenuation range, no optical discontinuity during adjustment)
Warm-up period	None
Thermal stability	±0.02 dB typical over temperature, at fixed polarization state, exclusive of connector drift
Maximum input power	< 200 mW, +23 dBm
Return Loss	< -40dB (typical) with physical-contact connectors of perfect quality

Power:

200 - 600 hours typ depending on motor use (backlight off) from 2 alkaline C cells.

External power: nominal 9 V DC, 200 mA via plug with 2.5 mm +ve pin.

Selectable auto-off 10 minutes after last key press. Low battery indicator.

Safety:

This instrument contains no hazardous optical or electrical items. The following information is for your reference: When using this equipment, optical safety precautions should be observed commensurate with the maximum available source power, since most of this power can also be coupled out of the instrument.

This instrument is manufactured under an ISO9001 approved Quality System, and is CE compliant.

Agilent maintains an ongoing program of product and process improvement, and reserves the right to improve or amend specifications without notice.

Ordering information:

Singlemode Automated Optical Attenuator N3977A

Standard Accessories:

Alkaline Batteries,Traceable Calibration Certificate
Operation Manual
Carry Strap
Soft Carry Pouch
ST, SC, FC Connectors

The N3977A Optical Attenuator is supplied with a straight contact output connector interface. To connect to the instrument, you must attach your connector interface (see list connector interfaces below) to the interface adaptor, then connect your cable.

Agilent service Part No.	Description
N3970-63240	ST
N3970-63246	SC
N3970-63251	FC

Optional Accessories:

Agilent Part No.	Description
N3979A	Power Supply 9V DC

Australian and International Patents.

The procedures in this section test the performance of the instrument. The complete specifications to which the Agilent N3977A Optical Attenuator is tested are given on pages 24-26. All tests can be performed without access to the interior of the instrument. The test equipment given corresponds to tests carried out with Diamond HMS-10 connectors and FC/PC connectors on the DUT (device under test).

Equipment Required

Equipment required for the performance test is listed in the table on page 28. Any equipment that satisfies the critical specifications of the equipment given in the table may be substituted for the recommended models.

Table 1 Required Equipment

Instrument/Accessory	Recommended Model	Required Characteristics	Alternative Models
Lightwave Multimeter	8163A		8164A, 8166A
Optical Power Sensor	81632A		81635A
Laser Source 1310/1550 nm	81654A	1305±25 nm 1550±30 nm Short Term Stability < ±0.005 dB	81657A or 81650A and 81651A or 81655A and 81656A
Connector Interfaces	81000AI 81000SI		
FC/PC Feedthrough Adapter	1005-0256		
Singlemode Fiber	81101PC 81113PC		81101FC
FC Connector Adaptor for N3977A	N3970-63251 (2ea)		

Note: Instead of 8163A and 81632A and 81654A also the older but discontinued equipment 8153A and 81532A and 81554SM can be used.

Test Record

Results of the performance test may be tabulated on the Test Record provided at the end of the test procedure. It is recommended that you fill out the Test Record and refer to it while doing the test. Since the test limits and setup information are printed on the Test Record for easy reference, the record can also be used as an abbreviated test procedure (if you are already familiar with the test procedures). The Test Record can also be used as a permanent record and may be reproduced without written permission from Agilent Technologies.

Test Failure

If the Agilent N3977A fails any performance test, return the instrument to the nearest Agilent Technologies Sales/Service Office for repair (see page 3).

Instrument Specification

Specifications are the performance characteristics of the instrument that is certified. These specifications, listed on page 24, are the performance standards or limits against which the Agilent N3977A can be tested.

Any changes in the specifications due to manufacturing changes, design, or tracebility to the National Institute of Standards and Technology (NIST), will be covered in a manual change supplement, or revised manual. Such specifications supersede any that were previously published.

Performance Test

The performance tests given in this section includes the Insertion Loss Test, the Linearity Test and the Attenuation Repeatability Test. Perform each step in the order given, using the corresponding test equipment.

Note: Make sure that all optical connections are dry and clean. DO NOT USE INDEX MATCHING OIL. For cleaning, use the cleaning instructions given in "Cleaning Procedures" on page 43.

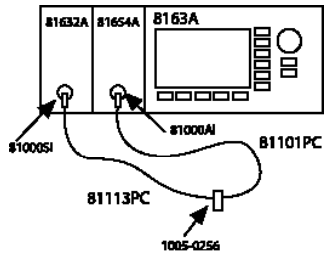
Make sure that all patchcords are fixed to the table so that they won't move during measurements.

Make sure that the ambient conditions are in the following ranges:

Temperature	23°C ±3K
Relative humidity	45 to 75 %

Insertion Loss Test

1. Make sure that you satisfy the environmental conditions.
2. Make sure all your connectors are clean.
3. Connect the equipment as shown in figure below.



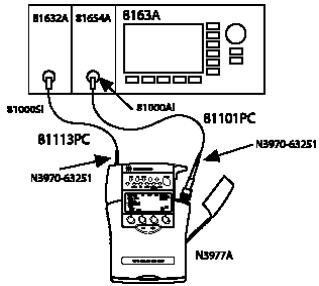
Test setup for the Insertion Loss Test Reference Measurement

a. Make sure that all Patchcords are fixed to the table and won't move during measurements.

b. The test is either performed at 1310 nm or at 1550 nm.

4. Switch on the instruments.
   a. Switch on the lightwave multimeter
   b.Configure the laser source.
   - Set the laser source attenuation to 0 dB
   - Set the wavelength to 1310 nm or to 1550 nm
   - Note the actual (displayed) wavelength of the laser source in the test report

   c. Configure the optical power sensor.
   - Set the unit to dB
   - Set the wavelength to 1310 nm/1550 nm
   - Set the averaging time, T, to 500 ms
   - Set AUTO ranging on
   - With the laser source disabled, zero the power meter
5. Enable the laser source and set Display to Reference on the power meter
6. Connect the equipment as shown opposite - replace the feedthrough adapter by the DUT.



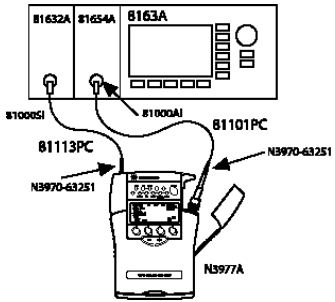
Test setup for the Insertion Loss Test Reference Measurement

7. Perform the measurement
   a. Switch on the N3977A (DUT) for permanent operation, by holding the POWER key down for 3 seconds during turn-on until PERM is shown in the display.
   - Set the wavelength to 1310 nm / 1550 nm
   - Set the unit to dB
   - Set the attenuation to “Lo”

   b. Enable the laser source and note the power meter reading (in dB) in the test record

Linearity Test

1. Make sure that you satisfy the environmental conditions.
2. Make sure all your connectors are clean.
3. Connect the equipment as shown in figure below.



Test setup for the Linearity Test

a. Make sure that all Patchcords are fixed to the table and won't move during measurements.

b. The test is either performed at 1310 nm or at 1550 nm.

4. Switch on the instruments.

   a. Switch on the lightwave multimeter

   b.Configure the laser source.

   - Set the laser source attenuation to 0 dB
   - Set the wavelength to 1310 nm
   - Note the actual (displayed) wavelength of the laser source in the test report

   c. Configure the optical power sensor.

   - Set the unit to dB
   - Set the wavelength to 1310 nm
   - Set the averaging time, T, to 500 ms
   - Set AUTO ranging on
   - With the laser source disabled, zero the power meter

   d. Switch on the N3977A (DUT) for permanent operation, by holding the POWER key down for 3 seconds during turn-on until PERM is shown in the display.

   - Set the wavelength to 1310 nm
   - Set the unit to dB

- Set the wavelength to 1310 nm
- Set the unit to dB
- Set the step size to the minimum valua 0.05 dB
- Set the attenuation to 3.00 dB
- Set the step size to 1.00 dB

5. Perform the measurement.
   a. Enable the laser source and set Display to Reference on the power meter
   b. Increase the DUT attenuation in steps as shown below and note the value (dB) shown on the power sensor channel in the test report.

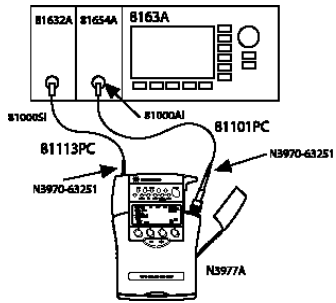
3 dB Reference

4dB	5 dB	6 dB	10 dB
14 dB	34 dB	54 dB	60 dB

6. Repeat from list item 4 to list item 5 at 1550 nm

Attenuation Repeatability Test

1. Make sure that you satisfy the environmental conditions.
2. Make sure all your connectors are clean.
3. Connect the equipment as shown in figure below.



Test setup for the Attenuation repeatability Test

a. Make sure that all Patchcords are fixed to the table and won't move during measurements.

b. The test is either performed at 1310 nm or at 1550 nm.

4. Switch on the instruments.

   a. Switch on the lightwave multimeter

   b.Configure the laser source.

   - Set the laser source attenuation to 0 dB
   - Set the wavelength to 1310 nm / 1550 nm
   - Note the actual (displayed) wavelength of the laser source in the test report

   c. Configure the optical power sensor.

   - Set the unit to dB
   - Set the wavelength to 1310 nm / 1550 nm
   - Set the averaging time, T, to 500 ms
   - Set AUTO ranging on
   - With the laser source disabled, zero the power meter

   d. Switch on the N3977A (DUT) for permanent operation, by holding the POWER key down for 3 seconds during turn-on until PERM is shown in the display.

   - Set the wavelength to 1310 nm / 1550 nm

- Set the unit to dB
- Set the step size to the minimum value 0.05 dB
- Set the attenuation to an integer value (like 5.00 dB)
- Set the step size to 1.00 dB

5. Start the measurement
   a. Enable the laser source
   b. Set the DUT attenuation to 3.00 dB
   c. Press 'Dsp->Ref' on the power sensor channel
   d. Set the attenuation to any other value (e.g. 10.00 dB) and wait until it has settled at this value (The BUSY sign in the display must be off).
   e. Change the attenuation back to the previous value.
   f. Note the deviation (dB) shown on the power sensor channel in the test report.
6. Repeat this measurement (list item 5.b. to list item 5.f.) for the following attenuation settings:

6 dB	14 dB	26 dB
38 dB	52 dB	60 dB

■ PERFORMANCE TEST

Model N3977A Optical Attenuator

Serial No. _____

Options _____

Firmware Rev. _____

Date _____

Ambient Temperature _____ ^{0}C

Relative Humidity _____ %

Line Frequency _____ Hz

Test Facility _____

Performed by _____

Customer _____

Report No _____

Special Notes _____

Description	Model No.	Trace No	Cal. Due Date
1. Lightwave Multimeter	8163A		
2. Optical Power Sensor	81632A		
3. Laser Source 1310/1550 nm	81654A		
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Accessories	#Product
Singlemode Fibers	1 81101PC
	1 81113PC
Connector Interfaces	1 81000AI
	1 81000SI
	1 1005-0256
	2 N3970-63251

■ PERFORMANCE TEST

Model N3977A Optical Attenuartor Report No. _____ Date _____

Insertion Loss Test

Test Wavelength = _____ nm

			N3977A, DUT Measurement Results	Maximum Spec.
			_____ dB	2.5 dBm
	Measurement Uncertainty		_____ dB	

Model N3977A Optical Attenuartor Report No. _____ Date _____

Linearity Test

Test Wavelength = _____nm

Attenuator Setting	Minimum Spec.	N3977A, DUT Measurement Results	Maximum Spec.
3dB		REF	
4dB	-1.053 dBm	_____ dB	-0.947 dBm
5dB	-2.056 dBm	_____ dB	-1.944 dBm
6dB	-3.059 dBm	_____ dB	-2.941 dBm
10dB	-7.071 dBm	_____ dB	-6.929 dBm
14dB	-11.083 dBm	_____ dB	-11.917 dBm
34dB	-31.143 dBm	_____ dB	-30.857 dBm
54dB	-51.203 dBm	_____ dB	-50.797 dBm
60dB	-57.221 dBm	_____ dB	-56.779 dBm
Measurement Uncertainty		_____ dB	

Test Wavelength = _____nm

Attenuator Setting	Minimum Spec.	N3977A, DUT Measurement Results	Maximum Spec.
3dB		REF	
4dB	-1.053 dBm	_____ dB	-0.947 dBm
5dB	-2.056 dBm	_____ dB	-1.944 dBm
6dB	-3.059 dBm	_____ dB	-2.941 dBm
10dB	-7.071 dBm	_____ dB	-6.929 dBm
14dB	-11.083 dBm	_____ dB	-11.917 dBm
34dB	-31.143 dBm	_____ dB	-30.857 dBm
54dB	-51.203 dBm	_____ dB	-50.797 dBm
60dB	-57.221 dBm	_____ dB	-56.779 dBm
Measurement Uncertainty		_____ dB	

Model N3977A Optical Attenuartor Report No. _____ Date _____

Repeatability Test

Test Wavelength = _____ nm

Attenuator Setting		Minimum Spec.	N3977A, DUT Measurement Results	Maximum Spec.
3dB	Dsp->Ref	-0.03 dBm	_____ dB	+0.03 dBm
6dB	Dsp->Ref	-0.03 dBm	_____ dB	+0.03 dBm
14dB	Dsp->Ref	-0.03 dBm	_____ dB	+0.03 dBm
26dB	Dsp->Ref	-0.03 dBm	_____ dB	+0.03 dBm
38dB	Dsp->Ref	-0.03 dBm	_____ dB	+0.03 dBm
52dB	Dsp->Ref	-0.03 dBm	_____ dB	+0.03 dBm
60dB	Dsp->Ref	-0.03 dBm	_____ dB	+0.03 dBm
Measurement Uncertainty			_____ dB	

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

Please try, whenever possible, to use physically contacting connectors, and dry connections.

Clean the connectors, interfaces, and bushings carefully after use.

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

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

For more information about Cleaning Instruments, please consult the Pocket Guide "Cleaning Procedures for Lightwave Test and Measurement Equipment" (Agilent P/N 5963-3538F). If you do not have a copy of this pocket guide, Agilent will provide you with one free of charge.

Safety Precautions

Please follow the following safety rules.

- Do not remove instrument covers when operating.
- Ensure that the instrument is switched off throughout the cleaning procedures.
- Use of controls or adjustments or performance of procedures other than those specified may result in hazardous radiation exposure.
- Make sure that you disable all sources when you are cleaning any optical interfaces.
- Under no circumstances look into the end of an optical device attached to optical outputs when the device is operational. The laser radiation is not visible to the human eye, but it can seriously damage your eyesight.
- To prevent electrical shock, disconnect the instrument from the mains before cleaning. Use a dry cloth, or one slightly.

dampened with water, to clean the external case parts. Do not attempt to clean internally.

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

* Refer servicing only to qualified and authorised personnel.

Why is it important to clean optical devices ?

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

Furthermore, the power density may burn dust into the fiber and cause additional damage (for example, 0 dBm optical power in a single mode fiber causes a power density of approximately 16 million W/m2). If this happens, measurements become inaccurate and non-repeatable. Cleaning is, therefore, an essential yet difficult task. Unfortunately, when comparing most published cleaning recommendations, you will discover that they contain several inconsistencies. In this section, we want to suggest ways to help you clean your various optical devices, and thus significantly improve the accuracy and repeatability of your lightwave measurements.

You should only clean instruments with a fixed connector interface when it is absolutely necessary. This is because it is difficult to remove any used alcohol or filaments from the input of the optical block.

It is important, therefore, to keep dust caps on the equipment at all times, except when your optical device is in use.

If you do discover filaments or particles, the only way to clean a fixed connector interface and the input of the optical block is to use compressed air.

If there are fluids or fat in the connector, please refer the instrument to the skilled personnel of Agilent's service team.

CAUTION! Only use clean, dry compressed air. Make sure that the air is free of dust, water, and oil. If the air that you use is not clean and dry, this can lead to filmy deposits or scratches on the surface of your connector interface. This will degrade the performance of your transmission system.

Never try to open the instrument and clean the optical block by yourself, because it is easy to scratch optical components, and cause them to become misaligned.

■ DISCLAIMER & WARRANTY

Information in this manual is given in good faith for the benefit of the user. It cannot be used as the basis for claims against Agilent Technologies or its representatives, if accidental damage or inconvenience results from use or attempted repair of the equipment.

Agilent Technologies products are guaranteed against defective components and workmanship for a period of 3 years from the date of delivery, unless specifically stated in the original purchase contract or agreement. This warranty excludes optical connectors or incorrect use. Opening the instrument will invalidate the warranty. Liability is limited solely to repair of the equipment.