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PS3 SERIES
PDL MULTIMETER

User's Manual

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JDS Uniphase

SD000031 Rev. J April 2000

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Safety Information, Instructions, and Symbols

Safety Information

Classification

The unit consists of an exposed metal chassis that is connected directly to earth via a power cord and, therefore, is classified as a Class 1 instrument. Class 1 refers to equipment relying on ground protection as a means of shock protection.

The following symbol is used to indicate a protective conductor terminal in the unit.



Disconnecting from Line Power

Some of the circuits are powered whenever the unit is connected to the AC power source (line power). To ensure that the unit is not connected to the line power, disconnect the power cord from either the power inlet on the unit's rear panel or from the AC line-power source (receptacle). The power cord must always be accessible from one of these points. If the unit is installed in a cabinet, the operator must be able to disconnect the unit from the line power by the system's line-power switch.

Line Power Requirements

The unit can operate from any single-phase AC power source that supplies between 100 and 240 V at a frequency range of 50 to 60 Hz. The maximum power consumption is 80 VA.

Fuse Type

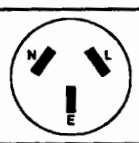
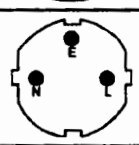
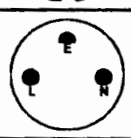
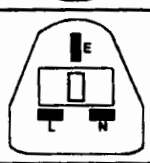
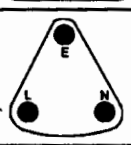
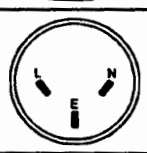
The fuse type used by the unit is (5x20) mm, T1A / 250 V (slow).

Line Power Cord

The unit uses a three-wire power cord. When connected to an appropriate AC power receptacle, this cable grounds the instrument chassis. JDS Uniphase supplies the type of power cord appropriate for the destination country (Table 1).

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Table 1: Power Plug Chart

Destination	Illustration	Part Number
Australia, China		A0102338
Austria, Belgium, Finland, France, The Netherlands, Germany, Spain, Portugal, Sweden, Chile		A0100741
Denmark		A0102681
Hong Kong, Ireland, United Kingdom, Malaysia		A0100740
India		A0102180
Israel		A0101407
Italy[1]		A0100742
North America, Central America, Columbia, Ecuador, Japan, Taiwan, Venezuela, Thailand		A0100483
Switzerland		A0101406

1 This plug is not polarized.
N Neutral
E Earth
L Line

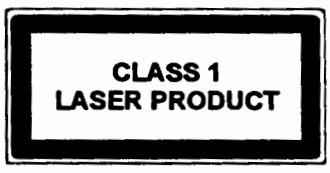
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Laser Specifications

The laser specifications are outlined in Table 2.

Table 2: Laser Specifications

Parameter	Specification
Wavelength	980*,1310, 1480, 1550, 1625, 1650 nm ±10 nm
Class	1
Output power	< -1 dBm
Numerical aperture	0.1
fiber core diameter	9 µm (*5µm)



Class 1 lasers are safe for continuous viewing. There can be more powerful lasers inside the unit, but no harmful radiation can escape the enclosure.

Safety Instructions

The following safety instructions must be observed whenever the unit is operated, serviced, or repaired. Failure to comply with any of these instructions or with any precaution or warning contained in the user's manual is in direct violation of the standards of design, manufacture, and intended use of the unit. JDS Uniphase assumes no liability for the customer's failure to comply with any of these safety requirements.

Before Initializing and Operating the Unit

☑ Inspect the unit for any signs of damage, and read the user's manual thoroughly.

☑ Install the unit as specified in the **Getting Started** section.

☑ Ensure that the unit and any devices or cords connected to it are properly grounded.

Operating the Unit



Warning

To avoid the risk of injury or death, always observe the following precautions before initializing the unit:

* For the model with Flexcor 1060 fiber (PS3x20).

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- If using a voltage-reducing autotransformer to power the unit, ensure that the common terminal connects to the earthed pole of the power source.
- Use only the type of power cord supplied with the unit.
- Connect the power cord only to a power outlet equipped with a protective earth contact. Never connect to an extension cord that is not equipped with this feature.
- Willfully interrupting the protective earth connection is prohibited.
- Never look into the end of an optical cable connected to an optical output device that is operating. Laser radiation is invisible, and direct exposure can severely injure the human eye. For more information, see the user's manual of the laser source in use.
- Turning off the power to the device does not always block the externally supplied radiation to the connector at the output of the unit.
- Do not use the unit outdoors.
- To prevent potential fire or shock hazard, do not expose the unit to any source of excessive moisture.
- Do not operate the unit when its covers or panels have been removed.
- Do not interrupt the protective earth grounding. Any such action can lead to a potential shock hazard that can result in serious personal injury.
- Do not operate the unit if an interruption to the protective grounding is suspected. In this case, ensure that the unit remains inoperative.
- Use only the type of fuse specified by the manufacturer as appropriate for this unit. Do not use repaired fuses, and avoid any situations that can short-circuit the fuse.
- Unless absolutely necessary, do not attempt to adjust or perform any maintenance or repair procedure when the unit is opened and connected to a power source.
- Repairs are to be carried out only by a qualified professional.
- Do not attempt any adjustment, maintenance, or repair procedure to the unit's internal mechanism if immediate first aid is not accessible.
- Disconnect the power cord from the unit before adding or removing any components.
- Operating the unit in the presence of flammable gases or fumes is extremely hazardous.
- Do not perform any operating or maintenance procedure that is not described in the user's manual.
- Some of the unit's capacitors can be charged even when the unit is not connected to the power source.

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Safety Symbols

The following symbols and messages can be marked on the unit (Table 3). Observe all safety instructions that are associated with a symbol.

Table 3: Safety Symbols

Symbol	Description
	Laser safety. See the user's manual for instructions on handling and operating the unit safely.
	See the user's manual for instructions on handling and operating the unit safely.
	Electrostatic discharge (ESD). See the user's manual for instructions on handling and operating the unit safely.
	Frame or chassis terminal for electrical grounding within the unit.
	Protective conductor terminal for electrical grounding to the earth.
WARNING	**The procedure can result in serious injury or loss of life if not carried out in proper compliance with all safety instructions. Ensure that all conditions necessary for safe handling and operation are met before proceeding.**
CAUTION	The procedure can result in serious damage to or destruction of the unit if not carried out in compliance with all instructions for proper use. Ensure that all conditions necessary for safe handling and operation are met before proceeding.

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Compliance

CE Compliance

The unit has been designed and tested to comply with directive 73/23/EEC and its subsequent amendments by the European Community (EC or CE). The directive relates to electrical equipment designed for use within certain voltage limits. It ensures that electrical equipment is constructed with good engineering practice in safety matters.

The unit has been designed and tested to comply with directive 89/336/EEC and its subsequent amendments. The directive relates to electromagnetic compatibility. It demands that electromagnetic disturbance does not exceed a prescribed level; that the equipment be immune to a prescribed level of ambient interference; that the equipment be protected against electrostatic discharges; and that the equipment be immune to all electrical shock wave disturbances. As of 1997, measures have been added to test for fire hazard, electric shock hazard, and also external exposure to other forms of energy.

The requirements specified by directive 89/336/EEC are as follows. CE compliance requires that the manufacturer or its authorized representative established within the Community affix the EC conformity mark to the apparatus or else to the packaging, instructions for use, or guarantee certificate. The EC conformity mark shall consist of the letters CE as specified and the figures of the year in which the mark was affixed. This mark should, where appropriate, be accompanied by the distinctive letters used by the notified body issuing the EC type-examination certificate. Where the apparatus is the subject of other Directives providing for the EC conformity mark, the affixing of the EC mark shall also indicate conformity with the relevant requirements of those other Directives.

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General Information and Specifications

General Information

This user's manual for the PS3 Series Polarization Dependent Loss Multimeter contains complete operating instructions. The inspection report and a description of any customer-requested information are found in the **Customized Features and Test Data** section.

The PS3 multimeter takes loss and polarization dependent loss (PDL) measurements on single-mode fiberoptic components, using either its internal Fabry-Perot laser diode source or an external source, such as a fixed or tunable wavelength source. In addition, the multimeter can make absolute power and return loss (RL) measurements.

PDL Theory

Similar to International Electrotechnical Commission (IEC) standard 61300-3-12 concerning polarization dependence of attenuation of a single-mode fiberoptic component, the unit uses the matrix calculation method.

The polarization of a component can be described by the Mueller matrix method. The first row of this 4x4 matrix provides all the information necessary to determine the insertion loss (IL) of a component for a given input polarization state. The values in the first row of the Mueller matrix can be calculated from the component's IL values for a number of input polarization states. The multimeter measures the IL of the component while generating four polarization states:

- Linear polarization at 0°
- Linear polarization at 90°
- Linear polarization at 45°
- Circular polarization

One method to determine the PDL of a component is to calculate the IL of all the possible polarization states to a given resolution and take the difference between the minimum (L_{min}) and maximum (L_{max}) ILs as the PDL. The multimeter calculates the PDL and average loss (L_{av}) analytically, using the values in the first row of the Mueller matrix.

Although the PDL and average loss are displayed in decibels (dB), the average loss is the average transmission converted to decibels. Thus, the average loss of an ideal polarizer is 3 dB = [-10 log (0.5)].

Generally, the minimum and maximum ILs can be calculated using the following formulas:

$$L_{min} = L_{av} + 10 \log [(1+10^{(-PDL/10)})/2] \text{ dB} \quad \text{and} \quad L_{max} = L_{min} + PDL \text{ dB}$$

However, for small PDLs the following formulas are used:

$$L_{min} = L_{av} - PDL/2 \text{ dB} \quad \text{and} \quad L_{max} = L_{av} + PDL/2 \text{ dB}$$

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When considering a system of several components, the Mueller matrices for the components can be combined by matrix multiplication to form a Mueller matrix for the entire system. However, if the polarization state is altered from the output of one component to the input of the next, for example by birefringence in optical fiber, extra Mueller matrices must be included in the calculation to account for these changes. These extra Mueller matrices alter the values in the first row of the Mueller matrix for the entire system and affect the PDL and average loss.

The PDL of a component has an associated phase angle. When several components are combined, the way in which the PDLs combine depends on their relative phase angles. The fibers between the components rotate the phase angles of the PDLs, and any movement of the fibers changes the amount of rotation. Therefore, the combined PDL is not more than the sum of the individual PDLs and is usually less.

The combined PDL is quite sensitive to the position of the fibers that connect the components. The combined PDL is not sensitive to the position of the input fiber to the first component or to the position of the output fiber from the last component. Therefore, if the PDL and its phase angle are stable for each component and the fiber between the components is stable, the combined PDL is stable.

The average loss does not have an associated phase angle, so the combined average loss is simply the sum of the average losses for each component.

To accurately measure the PDL of a device under test (DUT) or a system of components, the PDL of that part of the measurement apparatus connected to the output of the DUT is low compared to the DUT itself. And the measurement apparatus connected to the input of the DUT has either very low PDL compared to the DUT or a reasonably low but very stable PDL and phase angle that can be referenced out of the measurement.

Return Loss Measurements

Reflections in optical systems can come from a number of sources. Primary sources include the fiber (Rayleigh backscatter) and Fresnel reflections that occur at the planar junction of two materials having different refractive indices, for example, connector and fiber endfaces, splices, bulk optic interfaces, and detector surfaces.

Typically only Fresnel reflections are significant because transmitters are relatively insensitive to distributed reflections such as Rayleigh backscatter. Return Loss caused by Rayleigh backscatter varies with the length and type of fiber, and is only significant when measuring components with return loss below -40 dB. However, Rayleigh backscatter can be a large contributor to return loss in installed systems or when using long fiber.

The internal switch and coupler of the PS multimeter enable the multimeter to measure the internal light source signal (P_{in}), the signal offset with no light (P_{dark}), and the total signal level from internal and external return loss (P_{rl}).

The PS multimeter first calculates the total return loss from internal and external sources (RL_{tot}), using the following equation, where CAL is the factory-set calibration factor of the multimeter:

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$$RL_{tot} = -10 \log (P_{rl} - P_{dark})/(P_{in} - P_{dark}) - CAL \qquad [dB]$$

The return loss from external sources (RL) is then calculated using the following equation, where RL_0 is the stored value of the total return loss up to the device under test (DUT), and User CAL is the user-set calibration factor:

$$RL = -10 \log (10^{RL_{tot}/10} - 10^{RL_0/10}) + \text{User CAL} \qquad [dB]$$

The PS multimeter then displays the value of RL.

The RL measurement takes approximately one second to complete. Before this is done, the P_{in} and P_{dark} measurements are completed in approximately four seconds, during which time the return loss display is locked and the light from the output port is blocked. The values are then updated every minute.

Internal Optical Design

A schematic of the inside of the unit is shown in Figure 1.

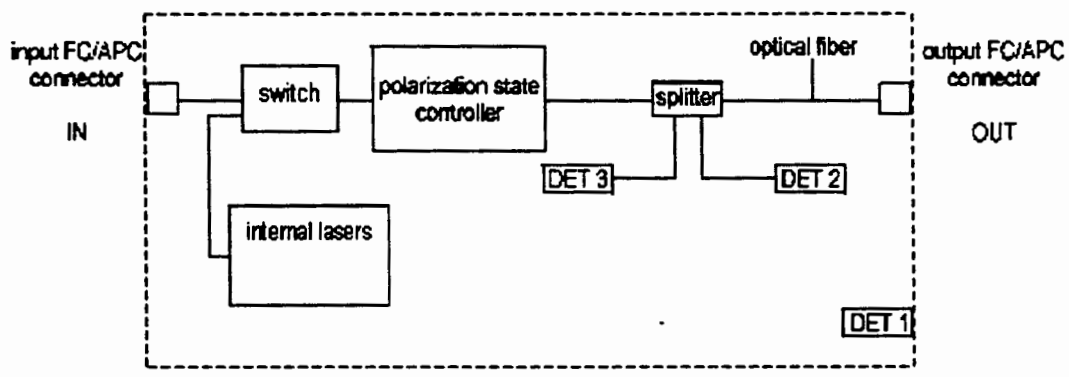


Figure 1: Internal Design

Inside the multimeter, a 1x3 optical switch determines whether the input light comes from one of the internal sources or from an external source connected to the IN port. The input light passes through a polarization state controller that generates the four polarization states for the loss measurements. In addition, the polarization state controller can also block the input light in order to measure the offset signal with no light from both detectors (the dark signal). The light leaving the polarization state controller is split by a coupler. So nominally 50% of the light goes straight to the OUT port and nominally 50% of the light goes to the internal reference detector (DET 2).

The absolute power measurements and the four loss measurements (one loss measurement for each polarization state) are made using the front-panel detector (DET 1). When making

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the loss measurements, the polarization state controller cycles through the four polarization states and the beam block state, and the multimeter measures the optical power from DET 1 and DET 2 simultaneously.

The multimeter compensates for any change in the optical power at the internal reference detector to ensure that accurate loss measurements are made regardless of drift in the source power or coupling of the input light through the polarization state controller.

When the multimeter is making absolute power measurements, the polarization state controller remains at the first polarization state, and the internal reference detector is not used.

Return loss measurements are made using the fourth port of the splitter, which couples nominally 50% of the reflected light into the internal backreflection detector (DET 3). The internal reference detector measures the output power level. DET 2 and DET 3 are measured simultaneously to ensure that accurate RL measurements are made regardless of drift in the source power or coupling of the input light through the polarization state controller.

The OUT port connector on the multimeter is an ultra-low reflection FC/APC connector. This type of connector does not limit the RL measurement range of the multimeter.

As RL measurements are made, the polarization state controller moves to a low loss state with about 3 dB less insertion loss than in absolute power (PWR) mode.

Polarization State Controller

The polarization state controller of the multimeter has a preferred input polarization state. The position of the input fiber between an external source and the multimeter needs to be adjusted in order to achieve a reasonable output power from the multimeter. A flip-in polarization rotating element in front of the polarization state controller alters the preferred input polarization state so that the maximum output power is provided.

Measurement Configuration

A typical measurement configuration is shown in Figure 2.

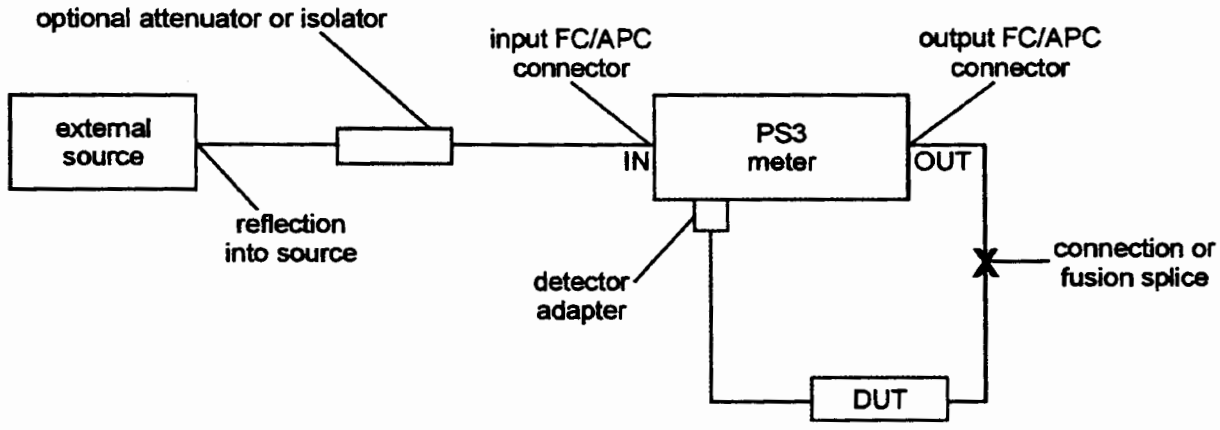


Figure 2: Measurement Configuration

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The multimeter accepts input powers of up to approximately 10 dBm. The throughput loss of the multimeter is typically about 10 dB if the position of the fiber from the source to the multimeter is optimized.

Using External Sources

There are two potential sources of error when using external sources for PDL measurements:

- Reflections from the output connector or cleaved end of the DUT fiber can feed back into the source, causing an error in the PDL measurement. This error occurs because the amount of reflection back into the source depends on the position of the polarization state controller.

- When highly coherent sources such as distributed feedback (DFB) or tunable lasers are used, light can reflect back and forth between interfaces (such as connectors) and interfere with the primary signal. This effect typically shows up as noise and drift in absolute power and loss measurements and as noise in PDL measurements. Even multilongitudinal mode lasers can show some interferometric effect.

The recommended solution to both problems is to use the spacers provided with the multimeter. When inserted into an FC/PC connection, preferably near the source, the spacer is typically sufficient to condition the external source. The spacer separates the connector ends and produces a reflection into the source that reduces its coherence length, and the spacer produces enough attenuation (approximately 7 dB) to isolate the external source from varying reflections.

The spacers can also be used in other spring-loaded 2.5 mm diameter ferrule connectors.

Both sources of error can still exist when making RL measurements; however, reflections back into the source are not typically a significant problem. Interference effects can be a large source of error at high return losses because interfering signals from different reflections can be similar in magnitude. Usually, it is not possible to reduce interference effects by reducing reflections because the reflections involved (for example, those caused by the internal splitter and the FC/APC output connector) are already as low as possible. In this case, the RL measurement range can be severely limited (to approximately 55 dB). Thus, the recommended solutions involve either reducing the coherence length of the external source or using a source such as the internal source of the multimeter.

Introducing a large reflection at the output of the laser, for example, by separating the connectors at the output of the source, sufficiently reduces the coherence length of a source, such as a DFB laser, so that accurate measurements can be made. However, this method does not work if the laser has a built-in isolator. The coherence length of a source with a built-in isolator can be reduced by modulation, for example, by using a sine wave with a frequency higher than 1 kHz.

If it is not possible to modulate the source or to introduce a large reflection back into the source, then an angled connector (APC-type) can be used at the front-panel detector. This procedure reduces the accuracy of PDL measurements because the angled connector in air has PDL (approximately 0.008 dB for an FC/APC connector).

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Output Optical Connections

The loss and PDL of the OUT optical connection of the multimeter are canceled out by the PDL reference measurement. However, if the loss and PDL of the OUT connection change with time, this directly affects the loss and PDL accuracy. Also, if the PDL of the connection is high, it affects the accuracy of the PDL measurement. When the highest measurement accuracy is required, allow the OUT optical connection to stabilize for at least 10 to 15 minutes after it is made. If measurements are made during this time, make the reference measurement often in order to maintain accuracy.

The FC/APC connector on the OUT port of the multimeter ensures that the return loss of the OUT optical connection is low enough for RL measurements. By terminating the output fiber, the user can verify that the background return loss is low. A factory-set offset for RL measurements accounts for the typical connection loss of the FC/APC connector at the OUT port of the multimeter.

Terminating for Return Loss Measurements

The multimeter measures the total RL of all components connected to it, including the internal splitter and the FC/APC OUT port connection. Termination techniques separate the RL of the DUT from other reflections by blocking all reflections from the termination point on.

The recommended technique for terminating Flexcor[1] 1060 fiber (fiber used in PS3X20 model) is to apply index matching gel directly to the fiber end.

Front-Panel Detector

The front-panel detector of the multimeter is designed for 0.1 NA fibers (standard single-mode fibers). When the front-panel detector is used with higher NA fibers or angled fiber ends, some of the light can be lost. This loss does not affect the average loss or PDL accuracy if the same connector or fiber end is left in the detector during the PDL reference measurement and DUT measurement.

When using different fibers or connectors in the average loss and PDL measurements, ensure that the measurement conditions are identical (for example, by using the same angle and orientation of connector if possible). Typically, the average loss measurement is more sensitive to the measurement conditions than the PDL measurement.

Accuracy of the PDL Measurement Method

The accuracy of a PDL measurement depends on the measurement method and how carefully the measurement is made.

Non-angled (PC-type) connections generally have a PDL from 0.002 to 0.020 dB. However, the PDL of a PC-type connector coupled into the front-panel detector of the multimeter typically cannot be measured because the area of the detector is larger than the diameter of

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[1] Flexcor is a trademark of Corning [R].

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the beam. And a poorly cleaned connector endface can have considerable PDL when coupled into the front-panel detector.

Connector cleanliness is essential when connecting to or coupling into the front-panel detector.

If highly accurate PDL measurements are required, do not couple APC-type connectors directly into the front-panel detector since the angled endface in air causes PDL. Similarly, cleaved fiber ends should have low angles. If the source is highly coherent and the coherence length cannot be reduced, then an angled fiber end is required. For lower coherence length sources, PC-type connectors perform better when coupled into the detector.

Fusion splices usually have very low PDL, but if the splice is packaged, ensure that it is not stressed.

Key Features

- Absolute power, PDL, and average loss measurements with up to 0.0001 dB resolution
- Return loss measurements to 60 dB
- High accuracy and wide dynamic range
- Accepts tunable or fixed wavelength sources over a wide wavelength range
- One- to two-second measurement interval
- Includes RS232C serial and IEEE 488.1 parallel interfaces

Applications

- Passive component qualifications
- Optical attenuator specifications
- Optical switch specifications
- Swept wavelength PDL measurements using a tunable source

Standard Accessories

- AC power cord
- Detector cap (mounted on the front-panel detector)
- FC detector adapter
- FC/APC-FC/PC jumper (for measurement purposes)
- Calibrated FC/APC-FC/PC jumper (available for RL calibration purposes in PS36x0 models only)
- Spacers for FC/PC connections
- Rack-mount kit with assembly instructions
- User's Manual

Optional Accessories

- Detector adapters
- Hybrid jumpers

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Specifications

The following table outines the optical specifications of the multimeter.

Table 4: Optical Specifications

Parameter	**PS30x0 * and PS36x0 Models**		
Built-in laser type	Fabry-Perot		
Laser wavelength *	1310, 1480, 1550, 1625, 1650 ± 10 nm		
Operating wavelength range [1]	1250 to 1350 nm and 1455 to 1665 nm (960 to 1060 nm for PS3X20 models		
Fiber type	9/125 µm SM (5/125 µm for PS3x20 model)		
Polarization dependence of attenuation of a single-mode fiberoptic component: matrix calculation method	IEC 61300-3-12		
PDL and Average Loss Measurements			
Optimization	1550 nm	1310 nm	980 nm
Absolute accuracy [2] PDL 1250 to 1350 nm	± (0.010 dB + 5% of PDL) dB maximum ± (0.004 dB + 2% of PDL) dB typical	± (0.005 dB + 5% of PDL) dB maximum ± (0.002 dB + 1% of PDL) dB typical	N/A
1455 to 1665 nm	± (0.005 dB + 5% of PDL) dB maximum ± (0.002 dB + 1% of PDL) dB typical	± (0.010 dB + 5% of PDL) dB maximum ± (0.004 dB + 2% of PDL) dB typical	N/A
960 to 1060 nm	N/A	N/A	± (0.005 dB + 5% of PDL) dB maximum ± (0.002 dB + 1% of PDL) dB typical
L_{av} (insertion loss)	± (0.05 dB + 2% of L_{av}) dB		
power	± 0.25 dB at -10 dBm		
Resolution	0.01, 0.001, or 0.0001 dB		
Repeatability [2] PDL	± (0.001 + 5% of PDL) dB		
L_{av} accuracy	± (0.001 + 2% of L_{av}) dB		
Dynamic range [3] PDL range [4]	0 to 5 dB		
L_{av} (insertion loss) (InGaAs 3 mm)	> 60 dB		
Return Loss Measurements (PS36x0 multimeters only)			
Resolution	1, 0.1, or 0.01 dB		
Absolute accuracy	± 1.0 dB		
Repeatability	± 0.7 dB		
RL range for 15 dBm output power [5]	> 60 dB		

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General	
Input voltage	100 to 240 V AC, 50 to 60 Hz
Power consumption	80 VA maximum
Rack mounting 19 inch (48.26 cm)	2 U high, half rack width
Dimensions (W x H x D)	21.2 x 8.9 x 35.5 cm
Weight	4 kg
Operating temperature	10 to 40 °C
Storage temperature	40 to 60 °C
Humidity	maximum 95% up to 40 °C decreasing 5% per °C from 40 to 60 ° C

* PS3000 has no internal laser and has 1550 nm optimized wavelength.

1. Specifications not guaranteed outside operating wavelength range.
2. Using a low coherence length source (distributed feedback and tunable lasers are modulated or have a large reflection at the output in order to reduce their coherence length) and following the recommended measurement procedure.
3. A measurement taken with output power less than - 25 dBm for the internal source and -3 0 dBm (dynamic range for -10 dBm at external input with the input fiber to the multimeter optimized for the most power). For an external source present at the multimeter's front panel detector can reduce resolution and/or accuracy.
4. Higher PDLs can be measured with reduced accuracy.
5. Output power is about 3 dB higher in RL mode than in power mode. Therefore, full RL range is obtained when the measured output power in power mode is - 18 dBm.

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Getting Started

The PS3 package consists of the multimeter, power cord, two jumpers, spacers, and a rack-mount kit.

Before Initializing and Operating the Unit

☑ Inspect the unit for any signs of damage.

☑ Read the user's manual thoroughly, and become familiar with all safety symbols and instructions to ensure that the unit is operated and maintained safely.

Initial Inspection



Warning

To avoid electrical shock, do not initialize or operate the unit if it bears any sign of damage to any portion of its exterior surface, such as the outer cover or panels.

Check that the unit and contents are complete:

1. Wear an anti-static wrist strap and work in an electrostatic discharge (ESD) controlled area.
2. Inspect the shipping container for any indication of excessive shock to the contents, and inspect the contents to ensure that the shipment is complete.
3. Inspect the unit for structural damage that can have occurred during shipping.
4. Ensure that the power switch is set to O (off), and connect the multimeter to a power source, using the AC power cord provided.
5. Set the power switch to I (on), and observe the power-up sequence. All key lamps and status LEDs light briefly. The PWR key lamp and the INT status LED remain lit as the calibration wavelength and the absolute power measured from the front-panel detector are displayed.
6. Allow the unit to warm up for 30 minutes before taking measurements.
7. Keep the packaging.

Immediately inform JDS Uniphase and, if necessary, the carrier if the contents of the shipment are incomplete, if the unit or any of its components are damaged or defective, or if the unit does not pass the initial inspection.

Operating Environment

In order for the unit to meet the warranted specifications, the operating environment must meet the following conditions for temperature, humidity, and ventilation.

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Temperature

The unit can be operated in the temperature range of 10 °C to 40 °C.

Humidity

The unit can be operated in environments with up to 95% humidity (10 to 40 °C). Do not expose it to any environmental conditions or changes to environmental conditions that can cause condensation to form inside the unit.

Ventilation

The unit contains a built-in cooling fan. Do not install it in any location where the ventilation is blocked. For optimum performance, the unit must be operated from a location that provides at least 75 mm (3 inches) of clearance at the rear. Blocking the air circulation around the unit can cause the unit to overheat, compromising its reliability.



Warning

- Do not use the unit outdoors.
- To prevent potential fire or shock hazard, do not expose the unit to any source of excessive moisture.

Storing and Shipping

To maintain optimum operating reliability, do not store the unit in locations where the temperature falls below -40 °C or rises above 60 °C. Avoid any environmental condition that can result in internal condensation. Ensure that these temperature and humidity requirements can also be met whenever the unit is shipped.

Claims and Repackaging

Immediately inform JDS Uniphase and, if necessary, the carrier, if

- The contents of the shipment are incomplete
- The unit or any of its components are damaged or defective
- The unit does not pass the initial inspection

In the event of carrier responsibility, JDS Uniphase will allow for the repair or replacement of the unit while a claim against the carrier is being processed.

Returning Shipments to JDS Uniphase

JDS Uniphase only accepts returns for which an approved Return Material Authorization (RMA) has been issued by JDS Uniphase sales personnel. This number must be obtained prior to shipping any material to JDS Uniphase. The owner's name and address, the model number and full serial number of the unit, the RMA number, and an itemized statement of claimed defects must be included with the return material.

Ship return material in the original shipping container and packing material. If these are not available, typical packaging guidelines are as follows:

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1. Wear an anti-static wrist strap and work in an ESD controlled area.
2. Cover the front panel, if applicable, with a strip of cardboard.
3. Wrap the unit in anti-static packaging. Use anti-static connector covers, as applicable.
4. Pack the unit in a reliable shipping container.
5. Use enough shock-absorbing material (10 to 15 cm or 4 to 6 in on all sides) to cushion the unit and prevent it from moving inside the container. Pink poly anti-static foam is the best material.
6. Seal the shipping container securely.
7. Clearly mark FRAGILE on its surface.
8. Always provide the model and serial number of the unit and, if necessary, the RMA number on any accompanying documentation.

Cleaning Connectors



Caution

- Connecting damaged or dirty fibers to the unit can damage the connectors on the unit.
- Never force an optical connector. Some connectors have a ceramic ferrule that can easily be broken.

Optical cable ends need to be cleaned before using them with the unit.

The following items are required for cleaning:

- Filtered compressed air or dusting gas (for example, Tech Spray Envi-Ro-Tech Duster 1671 gas, available at http://www.techspray.com/1671.htm)
- Lint-free pipe cleaners (for example, from 3M[2]) or lint-free swab
- Lint-free towels (for example, 10 x10 cm or 4 x 4 in HydroSorb III wipers, available at http://www.focenter.com/acctech/hydrosobr_wipers.htm)
- Optical grade isopropyl alcohol or optical grade 200° ethanol (do not use rubbing alcohol, which contains 30% water)

To clean the connectors:

1. Blow the sleeve with filtered compressed air (Figure 3).

[2] 3M is a trademark of 3M.

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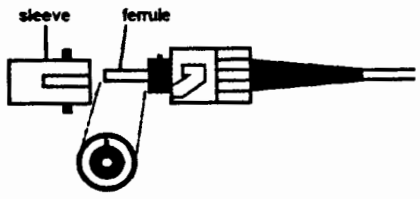


Figure 3: Connector Cleaning (connector type can vary)

2. Apply optical grade isopropyl alcohol or optical grade ethanol (do not use rubbing alcohol) to a small area of a lint-free towel and rub the end of the ferrule over the wet area.

3. Wipe the ferrule on a dry area of the lint-free towel.

4. Using the dusting gas or compressed air, blow the end of the ferrule.

5. Apply the alcohol or ethanol to a lint-free pipe cleaner or swab and wipe off the remaining parts of the connector.

6. With the other end of the pipe cleaner or swab, dry the areas cleaned.

7. Using the dusting gas or compressed air, blow the areas cleaned.

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Operating and Maintenance Instructions

Front Panel

The front panel shown (Figure 4) belongs to the PS3670 model. Not all PS3 Series multimeters are exactly as shown.

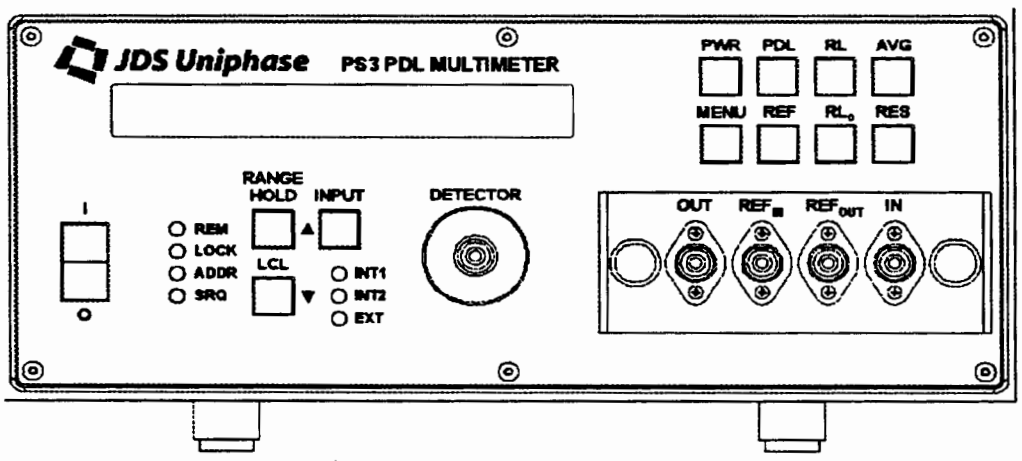


Figure 4: Front of Multimeter

Operating Keys

I/O	Power on/off switch.
PWR	Sets the multimeter to absolute power (PWR) measurement mode.
PDL	Sets the instrument to PDL measurement mode.
RL	Sets the instrument to return loss (RL) measurement mode. Holding down the RL key for two seconds activates the RL offset function.
AVG	Turns the averaging function on and off. The key lamp lights to indicate that the function is on.
MENU	Sets the instrument to MENU mode. The last menu item accessed is displayed. To cycle to the next menu item, press the MENU key again.
REF	Performs a reference measurement.
RL_0	Stores the background return loss (RL_0). The key lamp lights to indicate that the RL_0 value has been stored. If the key lamp is off, pressing the key stores the last return loss reading (including averaging if the function is on) as RL_0. If key lamp is on, pressing the key clears the stored RL_0 value.
RES	Changes the display resolution.
RANGE HOLD	Forces the multimeter to remain on the same range.
INPUT	Selects the input setting (INT1, INT2 or EXT).
LCL	Returns the multimeter to LOCAL mode from REMOTE mode.

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Status LEDs

All Models	
REM	Indicates that the multimeter is in REMOTE mode. All front-panel keys except LCL are locked out.
LOCK	Indicates that the multimeter is in LOCAL LOCKOUT mode. The function of the LCL key is disabled, and all front-panel keys are locked out.
ADDR	Indicates that the GPIB interface is in talk or listen state.
SRQ	Indicates that the multimeter interrupt logic has generated a service request interrupt on the GPIB interface.
PS3000 Models Only	
1	Indicates that an external source is being used with calibration setting #1.
2	Indicates that an external source is being used with calibration setting #2.
3	Indicates that an external source is being used with calibration setting #3.
PS30x0 and PS36x0 Models Only (where x can be 2, 3, 4, 5, 6, 8)	
INT1	Indicates that the internal laser diode source is being used.
EXT1	Indicates that the first external source is being used.
EXT2	Indicates that the second external source is being used.
PS30x0 and PS36x0 Models Only (where x can be 7, A, B, C)	
INT1	Indicates that the first internal laser diode source is being used.
INT2	Indicates that the second internal source is being used.
EXT	Indicates that the external source is being used. The second external source is activated by holding down the input key for 2-3 seconds.

Menu Settings

SRCE WAVE	Sets the calibration wavelength. A separate value is stored for each input setting.
# INPUTS	Sets the number of input settings that can be selected using the INPUT key.
AVG COUNT	Sets the number of measurements to be used in the running average when the averaging function is activated.
GPIB ADDR	Sets the GPIB interface address.

Connector Panel

Two FC/APC fiberoptic connectors are mounted on a removable panel.

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Rear Panel

The back of the unit is shown in Figure 5.

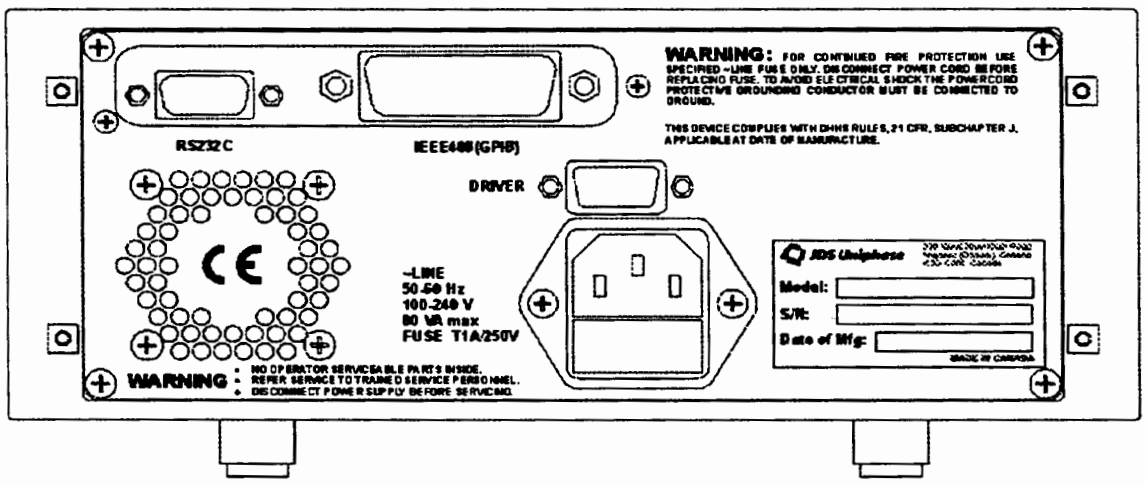


Figure 5: Back of Multimeter

Ports

RS232C	RS232C serial interface port
IEEE488 (GPIB)	GPIB parallel interface port
DRIVER PORT	External relay switch driver port

The GPIB and RS232 ports enable measured values (BR, loss, and so on) to be downloaded to an external computer or printer. The driver enables the use of up to two external sources via a 1x2 switch. On the driver, pin 3 sets the 5 V DC voltage and pin 6 is assigned to the driver (Figure 6). None of the other pins are used.

Figure 6: DriverPort Pins

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Powering Up the Multimeter

The multimeter always powers up in PWR mode and with the internal source selected.

To turn on the multimeter:

1. With the power cord attached, turn the power switch to I (on). All key lamps and status LEDs light momentarily and the software version is briefly displayed. On power-up, the multimeter recalls the dark measurement for PWR mode and all menu settings that were active when the multimeter was last powered off.

2. Allow the unit to warm up for 30 minutes before taking measurements.

Input Settings

Activating Combinations of Input Settings

The input settings need to be set according to the combination of sources and source wavelengths to be used in testing.
Input settings for model with no internal sources (eg. PS3000)

- 1 (external source)
- 2 (external source)
- 3 (external source)

Input settings for model with one internal source (eg. PS3650+25)

- INT (internal source)
- EXT1 (first external source)
- EXT2 (second external source)

Input settings for model with two internal sources (eg. PS3670+25)

- INT1 (first internal source)
- INT2 (second internal source)
- EXT (two external sources) The second external source is activated by holding down the input key for 2-3 seconds.

Each input setting has its own calibration wavelength value and reference values for PDL measurements.

When making measurements at closely spaced wavelengths (for example, within a 5 nm range), it is not necessary to use more than one input setting.

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To activate the input settings:

1. Press the MENU key to set the multimeter to MENU mode, and continue pressing the key to scroll to the # INPUTS display, for example, # INPUTS: 1

2. Press the RANGE HOLD (&) [1] or LCL (%) [2] key to scroll to the required setting code in table 5:

Table 5: Input Settings

Model without an internal source (PS3000 Model)	Models with one internal source	Models with two internal sources
1 = 1	1 = INT	1 = INT1
2 = 1 and 2	2 = INT and EXT1	2 = INT1 and INT2
3 = 1, 2, and 3	3 = INT, EXT1 and EXT 2	3 = INT1, INT2, and EXT1 (EXT2 is activated by holding down the INPUT key for 2-3 seconds)
—	1E = EXT1	1E = EXT1
—	2E = EXT2	2E = EXT1 and EXT2 (EXT2 is activated by holding down the INPUT key for several seconds)

3. Press the PWR, PDL, or RL key to activate the setting and exit MENU mode.

Selecting the Input Setting

To activate the input setting:

1. Press the INPUT key. The corresponding status LED lights to indicate the active input setting. For models with one or two internal sources, the internal optical switch of the multimeter automatically selects either one of the internal laser diode sources (INT1 or INT2) or the IN connector (EXT), depending on the active input setting. The driver (pin 6 of the driver port, as shown in Figure 6) at the back of the multimeter also changes its output with respect to the input setting; for example, for the PS3000 model, it is active for input setting 2 and inactive for input settings 1 and 3. For a model with one internal source, it is active for input setting EXT1 and inactive for input settings INT and EXT2. For a model with two internal sources, it is active for input setting EXT and inactive for input setting INT1 and INT2, in order to facilitate the use of an external wavelength source.

(▲)

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[1] This symbol represents
[2] This symbol represents (▼)

Connecting an External Source

To connect an external source to the multimeter:

1. Connect the external source to the IN port of the multimeter using an FC/APC connector. Insert a spacer inside an FC/PC connection between the source and the multimeter to condition the source.

2. Connect up to two external sources through a 1x2 optical switch that is controlled from the driver (pin 6 of the driver port, as shown in Figure 6) of the multimeter. If this is not done now, then the connections have to be changed when the sources are switched. If a dual wavelength source is to be used with the multimeter, it is possible to use the driver to control the source, depending on the external controls of the source. For example, if pin 6 is set to 0 V, there is a potential difference between this pin and pin 3 (set for 5 V), and the laser source can be chosen using the internal 1x2 switch

To limit wear on the IN connector of the multimeter and on the source connectors, do not disconnect any jumpers connected to the multimeter and to both sources; and change only the connections between the jumpers.

Setting the Calibration Wavelength

The calibration wavelength can be set from 950 nm to 1700 nm (except for PS3x20 model, which operates between 960 and 1060 nm) in 1 nm increments.

The multimeter is designed to operate only within the wavelength range specified in the **Specifications** section.

To set the wavelength calibration:

1. Press the MENU key to set the multimeter to MENU mode, and continue pressing the key to scroll to the SRCE WAVE display, for example, SRCE WAVE:1550nm

2. Press the RANGE HOLD (&) or LCL (%) key to scroll to the required calibration wavelength setting.

3. Press the INPUT key to set the calibration wavelength of the next input setting.

4. Press the RANGE HOLD (&) or LCL (%) key to scroll to the required calibration wavelength setting.

5. Press the PWR, PDL, or RL key to set the input wavelengths and exit MENU mode.

The calibration wavelength of the internal source cannot be changed.

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Connecting to the OUT Port

To connect the DUT to the multimeter:

1. Connect the OUT port of the multimeter to the DUT, using a measurement jumper or pigtail. The type of jumper or pigtail used depends on the type of connection required between the FC/APC connector at the OUT port of the multimeter and the DUT. To ensure high PDL accuracy when measuring pigtailed DUTs, use an FC/APC to FC/PC jumper or oneFC/APC to FC/PC pigtail and one FC/PC to FC/PC pigtail spliced together for the PDL reference measurement, and splice the DUT into the middle of the jumper for the PDL measurement. Ensure that you are using a measurement jumper and not the calibrated jumper.

2. Allow the connection to the OUT port of the multimeter to stabilize for at least 15 minutes before making a reference PDL measurement, or repeat the reference PDL measurement often during the first 15 minutes of testing.

The multimeter calculates and displays the average loss and PDL of the DUT in PDL mode. In RL mode, the output fiber(s) of the DUT must be terminated in order to display the return loss of the DUT.

Measuring and Optimizing the Output Power

In PWR mode, the output power from the multimeter can be measured in order to optimize the source connection to the multimeter and to determine the dynamic range available for measurements:

1. With the unit having been on for at least 30 minutes, connect the intermediate jumper or pigtail to the front-panel detector, using the appropriate detector adapter.

2. Press the PWR key. The calibration wavelength and the measured absolute output power is displayed, for example, 1550 -20.1234dBm

The acceptable power range at the OUT port of the multimeter for PDL measurements is 0 to -50 dBm. Highly accurate measurements of PDL can be obtained for front-panel detector powers as low as -50 dBm, although measurement averaging is usually required at lower power levels. PDL measurements at power levels lower than -50 dBm can have reduced resolution and accuracy.

The acceptable power range at the OUT port of the multimeter for RL measurements is 0 dBm to -50 dBm. The multimeter is designed to measure RL to 60 dB for an OUT port power of -18 dBm, measured in PWR mode (3 dB more output light is obtained in RL mode), although, because of noise, measurement averaging is required at the highest RL levels. Higher output powers make the readings more stable at these levels. If the measured power is lower than -18 dBm, the RL measurement range is reduced from 60 dB by a similar amount. For example, for an output power of -28 dBm, the RL measurement range is 60 dB.

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With a polarized external source such as a laser, the level of output power depends on the position of the fiber between the source and the multimeter because the internal polarization controller has a preferred input polarization state. Typically, it is not necessary to get the absolute most light through the multimeter, but it is desirable to be within approximately 3 or 4 dB of the peak signal.

The flip-in polarization rotating element of the multimeter can be implemented to prevent a large loss due to input polarization mismatch. This element alters the preferred input polarization state of the polarization controller, eliminating the need to optimize the position of the fiber. When the flip-in element is in the beam, the ideal insertion loss increases, although more light can pass through the multimeter, depending on the polarization state of the input light. To implement the rotating element:

1. Ensure that the multimeter is set to PWR mode.

2. Press and hold the REF key for two seconds. The multimeter automatically compares the output power both with and without the flip-in polarization rotating element in the beam. Provided that the fiber between the source and the multimeter is kept stable, the flip-in element remains in the position that provides the most output power, limiting the worst-case output power to approximately 6 to 7 dB below the peak signal. The position of the flip-in element is recalled separately for each input setting.

When the multimeter is powered up, the flip-in polarization rotating element is out of the beam for all input settings.

When measuring low powers (for example, below -35 dBm), make a dark measurement on the front-panel detector.

Taking a Dark Measurement in PWR Mode

A dark measurement is a measurement made with no light from the source. To make a dark measurement from the front-panel detector, all light into the detector must be blocked. The multimeter internally blocks the light from either the IN port or the internal source of the multimeter to the OUT port during the dark measurement, so no disconnections are required if the OUT port is connected through to the front-panel detector. Alternatively, the detector cap can be used to block the light into the detector.

To take a dark measurement:

1. Press the PWR key to set the multimeter to PWR mode.

2. Press the REF key to perform the dark measurement.

Measurement Averaging

Setting the Measurement Averaging Count

The measurement averaging count can be a running average of 5, 10, or 15 measurement cycles or a continuous average (CONT) in which each successive measurement is added to all measurements made immediately after the averaging function is activated.

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To set the averaging count:

1. Press the MENU key to set the multimeter to MENU mode, and continue pressing the key to scroll to the AVG COUNT display, for example, AVG COUNT: 5

2. Press the RANGE HOLD (&) or LCL (%) key to scroll to the required measurement average count, for example, 5, 10, 15, or CONT.

Activating Measurement Averaging

To activate the averaging:

1. Press the AVG key so that the key lamp lights to indicate that the measurement averaging function is on. To turn the function off, press the AVG key again. The key lamp turns off and averaging is disabled.

Measurements are averaged starting with the first measurement cycle made after AVG is pressed and the measurement averaging function is activated. The four loss measurements (one made at each of the generated polarization states) are averaged, for example, loss 1 with loss 1, loss 2 with loss 2, and so on. After each measurement cycle, the average loss and PDL are calculated from the four averaged loss measurements and the display is updated.

Setting the Display Resolution

PWR or PDL Mode

In both PWR and PDL mode, the display resolution can be changed from 0.0001 to 0.001 to 0.01 dB and back to 0.0001 dB. The measurement time increases with increasing resolution as more averaging is used within each measurement.

To set resolution for PWR or PDL mode:

1. Ensure that the multimeter is set to the required operating mode (PWR or PDL).

2. Press the RES key continuously to scroll to the required display resolution setting, for example, 1550 -20.1234 dBm, 1550 -20.123 dBm, 1550 -20.12 dBm, or 1550 -20.1234 dBm.

RL Mode

In RL mode, the display resolution can be changed from 0.01 to 0.1 to 1 dB and back to 0.01 dB:

1. Ensure that the multimeter is set to RL mode.

2. Press the RES key continuously to scroll to the required display resolution setting, for example, 1550 14.8 dB, 1550 15 dB, 1550 14.78 dB, or 1550 14.8 dB.

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Setting the Return Loss Offset

The RL offset is used to compensate for the connection loss of the OUT FC/APC connection and any other components between the DUT and the multimeter. It can also be used to match the displayed RL to a calibrated RL.

When the multimeter is powered up, the RL offset for each input setting is set to a factory-stored value (0.3dB) to compensate for a typical FC/APC connection loss (for example, 0.1 to 0.2 dB). If the connection loss between the multimeter and the DUT is significantly higher than a typical FC/APC connection loss, then the return loss offset is adjusted accordingly; for example, set it to twice the connection loss, as a negative value. For example, if the connection loss is 1 dB, then the return offset is set to -2 dB.

To set the offset:

1. Press the RL key to set the multimeter to RL mode, and hold the key for three seconds to access RL OFFSET mode. The offset and the return loss value measured when RL mode was accessed are displayed, for example, 0.00/ 15.24dB

2. Press the RANGE HOLD (&) or LCL (%) key to scroll to the required return offset value. The return loss value changes together with the return loss offset value to facilitate matching the displayed return loss to a calibrated return loss.

3. Press the INPUT key to set the return loss offset of the next input setting.

4. Press the RL, PWR, PDL, or MENU key to exit RL OFFSET mode.

Terminating Fiber

The recommended technique for terminating single-mode fiber is to wrap the fiber around a rod with a small diameter until the return loss cannot be reduced by further winding. Typical diameters are 8 mm at 1310 nm and 13 mm at 1550 nm. Termination for terminating single-mode can also be performed by index matching a fiber end (although this technique is generally limited to about 50 dB return loss), by angle polishing, or by cleaving a fiber end. The recommended technique for terminating Flexcor[1] 1060 fiber (fiber used in PS3X20 model) is to apply index matching gel directly to the fiber end.

Background Return Loss

The background return loss (RL_0) is the return loss measured out to, but not including, the DUT. Typically, it consists of the return loss of the internal splitter, the OUT FC/APC connection, the connection to the DUT, and the Rayleigh scattering of all the fiber between the internal splitter and the DUT. To ensure accurate RL measurements, the background RL should exceed that of the DUT by at least 10 dB. If the background RL does not exceed that of the DUT by at least 10 dB, store the background RL so that it can be subtracted from the RL measurement. This procedure is outlined here.

One meter of fiber typically has a RL due to Rayleigh scattering of about 70 dB.

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[1] Flexcor is a trademark of Corning [R].

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Displaying the Background Return Loss

To display the loss:

1. Connect the DUT to the measurement jumper connected to the OUT port of the multimeter.

2. Terminate the fiber just before the DUT.

The displayed RL should be at least 10 dB more than the required RL range if the background RL is not stored. If the background RL is stored, the displayed RL should be the maximum range limit, for example, 1550 >60 dB.

Storing the Background Return Loss

To store the loss:

1. Connect the DUT to the measurement jumper connected to the OUT port of the multimeter.

2. Press the RL key to set the multimeter to RL mode.

3. Terminate the fiber just before the DUT.

4. Press the RL_0 key so that the key lamp lights to indicate that the background RL has been stored. To clear the stored background RL, press the RL_0 key. The key lamp turns off and the value is cleared.

A separate background RL value must be stored for each input setting.

Taking the PDL Reference Measurement

In PDL mode, a reference measurement is made to cancel the loss and PDL of the internal optics of the multimeter and of the OUT connection. This reference measurement is made automatically the first time PDL mode is accessed after power-up. After that, a new reference measurement can be made at any time.

The reference measurement function uses the loss values from the last complete set of measurements as the reference values, including averaging if the function is on. Thus, averaging can be used to obtain a more accurate reference measurement.

1. Connect the intermediate jumper between the OUT connector and the front-panel detector of the multimeter.

2. Allow the connection to the OUT port of the multimeter to stabilize for at least 15 minutes.

3. Press the PDL key. The display reads AVG LOSS / PDL followed by 0.0000/ 0.0000.

4. Press the REF key to make the reference measurement.

5. To ensure high accuracy, verify that the average loss and PDL measurements made with the intermediate jumper in different positions do not vary, turn the averaging function on, and allow the reading to stabilize before making the reference measurement.

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After power-up, the first measurement made for each input setting is used as the reference measurement for the average loss and PDL measurements.

Checking the PDL of the Connection into the Front-Panel Detector

To obtain highly accurate measurements, do not angle the connector endface or cleaved fiber connected to the front-panel detector. Typically, there should not be a difference of more than 0.002 dB when using a well-cleaned FC/PC connector and a low coherence length source. However, if a highly coherent source is being used and interference effects are present, then an angled endface is required.

To check the PDL:

1. Measure the PDL with the fiber into the front-panel detector placed in different positions. If the fiber is moved, allow the multimeter to make a new measurement.

2. If the PDL of the connection into the front-panel detector seems high, ensure that the connector endface is clean and, if necessary, recleave the fiber end. The averaging function can be used if the PDL measurement is noisy.

If the fiber end is clean or recleaving does not reduce the PDL, use the internal source of the multimeter to test the PDL stability. If the PDL stability is good, then the high PDL can be caused by the external source. To reduce the coherence length of the source, extra attenuation between the source and the multimeter or a large reflection back into the external source can be required.

Taking PDL Measurements

To take PDL measurements:

1. Connect a jumper between the OUT port and the front-panel detector of the multimeter.

2. Let the OUT connection stabilize for at least 15 minutes.

3. Allow the multimeter to make a new measurement after each time the fiber is moved, and ensure that the PDL reading does not change significantly.

4. Perform a PDL reference measurement with the averaging function on.

5. Connect the DUT between the jumper and the front-panel detector or, for higher accuracy, splice the DUT into the middle of the jumper. The average loss and PDL measurements are displayed, for example, 12.1234/ 0.0034 where 12.1234 is the average loss in dB and 0.0034 is the PDL in dB.

6. Record the average loss and PDL measurements.

After the DUT is measured, the jumper can be spliced back together to make another reference measurement.

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When measuring DUTs that have connectors, any connections beyond the OUT port of the multimeter affect the accuracy of the PDL measurement. When the DUT is installed, there is PDL in the connections as well as in the DUT. The PDL of the connections can add to or subtract from the PDL of the DUT. Some information on the possible range of combined PDLs can be obtained making PDL measurements with the fiber between the connections and the DUT placed in different positions.

Always ensure that moving the fiber near the front-panel detector does not change the PDL significantly. If the PDL does change significantly, clean the connector endface or recleave the fiber end. When performing this test with the DUT connected, do not disturb the fiber from the OUT port of the multimeter to the DUT.

Using the Range Hold Function

The range hold function provides greater accuracy in measuring small changes in optical power or average loss by preventing changes in range during a measurement. The range hold function works in PWR and PDL mode, but not in RL mode. When the function is activated, neither the internal nor the front-panel detector amplifiers change range.

To use the function:

1. Ensure that the multimeter is in PWR or PDL mode.

2. Press the RANGE HOLD key, so that the key lamp lights to indicate that the function is on. To turn the range hold function off, press the RANGE HOLD key. The key lamp turns off and the function is disabled.

To ensure high PDL accuracy, the four loss measurements (one measurement for each polarization state) used in the PDL calculation are always made in the same range.

Taking RL Measurements

To take RL measurements:

1. Connect the DUT to the jumper or pigtail connected to the OUT port of the multimeter.

2. Press the RL key to set the multimeter to RL mode. The measured RL is displayed, for example, 1550 48 dB, where 1550 is the calibration wavelength in nm and 48 is the RL in dB.

To separate the RL of the DUT from other reflections beyond the DUT, terminate the fiber just after the DUT.

An asterisk (*) is displayed between the RL and the decibel abbreviation (for example, 62.93*dB) when the specified range of the multimeter is being exceeded, when the RL exceeds 60 dB (or a lower value if the multimeter output power in PWR mode is less than -18 dBm), or when the measured RL is more than 15 dB above the background RL.

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Taking a Dark Measurement in RL Mode

Each time RL mode is accessed, the multimeter takes a dark measurement on the internal backreflection detector. Typically, subsequent dark measurements are not required because the background RL is higher than the dark signal of the detector. If the output power of the multimeter is quite low (for example, less than -30 dBm) and high RLs are being measured (for example, an asterisk appears in the displayed reading), then update the dark measurement frequently.

To take a dark measurement:

1. Ensure that the multimeter is set to RL mode.
2. Press the REF key. The multimeter internally blocks the light from the source and measures the signal from the internal backreflection detector.

Using the Multimeter as a Power Meter

To take power measurements:

1. Select either the internal or external source as the input setting.
2. Adjust the calibration wavelength to match the source.
3. Connect the appropriate connector adapter to the front-panel detector.
4. Connect the fiber end to be measured into the connector adapter.
5. Press the PWR key. The power is displayed.

Messages and Symbols

Messages are outlined in Table 6.

Table 6: Message Description

Display	Description
RETURN LOSS CAL.	Displayed momentarily during the power-up sequence if the RL key is pressed and held as the multimeter is powered on.
i.e. PSX-XX VX.XX	Software version displayed momentarily during the power-up sequence.
AVG LOSS/PDL	Displayed when the operating mode is changed to PDL mode.
ADD. DETECTOR	Indicates that an external detector is being used.
PANEL DETECTOR	Indicates that the front-panel detector is being used.
LIGHT??	Displayed if light is going into the multimeter as a dark measurement is being made in PWR or RL mode.
RETURN LOSS MEAS	Displayed when the multimeter is set to RL mode from any other operating mode.
MEASURING DARK	Displayed in RL or PWR mode when a reference measurement is being made.

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Display	Description
RL0 NOT ACCEPTED	Indicates that the internal return loss measurement is too high to be stored.
RL0 LOW??	Indicates that the internal return loss measurement is high but can be stored.
RL0 STORED	Indicates that the internal return loss measurement is normal and has been stored.
INPUT LOW!	Displayed momentarily when the laser power is too low.
INPUT HIGH!	Displayed momentarily when the laser power is too high.
*	Displayed when the RL value is within the last 5 dB of range if using RL_0, or above 60 dB if not using BR_0.
<	P or BR is lower than the minimum value.
>	P is greater than the maximum value.
?	No reference value is available.
CAL 1310 xx.xx	Indicates that the user offset to adjust RL calibration is set.
CAL 1550 xx.xx	Indicates that the user offset to adjust RL calibration is set.
ALT CAL xx.xx	Indicates that the user calibration offset for an alternate detector is set.
SRCE WAVE: xxxx	Indicates the user source wavelength.
# INPUTS: xx	Displayed when the input setting is activated.
AVG COUNT: CONT	Displayed when the measurement averaging count is set to continuous.
AVG COUNT: xx	Displayed when the measurement averaging count is set to a value.
DETECTOR: PANEL DETECTOR: ADD DETECTOR: TOGGLE	Displayed when the detector to be used is set.
GPIB ADDR XX	Displayed when the GPIB address is set.
INT WAVE: xxxx	Displayed when the wavelength of the internal source is selected.

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Troubleshooting

If any problem described in this section persists, contact JDS Uniphase or your representative.

Loss Before the DUT

When a DUT is connected to the multimeter, the loss from the connectors affects the RL reading. Because the light is going out from the multimeter and then returning, it goes through the connectors twice, so the effect of the loss is doubled. If the connector loss is low, its effect can be ignored.

Reflections Before the DUT

When a DUT is connected to the multimeter, the reflections of the connectors affect the RL reading. FC/APC connections should have RL levels higher than 60 dB.

Reflections After the DUT

When taking an RL measurement, the fiber after the DUT must be terminated to eliminate the reflections from the end of the fiber. For greatest accuracy when making very high RL measurements, terminate near the DUT to eliminate reflections from the fiber itself.

Front Panel Connectors

Follow the maintenance procedure described in the
Maintaining the Multimeter section to ensure that the internal pigtail connectors are clean and properly connected to the front panel.

Connector Insertion Loss and Return Loss

Ensure that the IL and RL levels of all the connectors are low and stable, complying with the connector specifications.

Internal Return Loss

To confirm proper operation of the multimeter, terminate the internal cable while using the factory-set RL_0 value (RL_0 key lamp is off). The RL reading should be more than 65 dB.

Long Cables

Terminate the cables near the DUTs or connectors being tested in order to eliminate RL from the fiber.

Laser Power

If the message INPUT LOW is displayed, remove the connector panel, connect the internal FC/APC connector to the detector, and press the PWR key. The power reading should have stabilized and should be higher than -10 dBm for full-range capability.

Calibration

If the RL calibration has not been performed properly, set the calibration to 0 dB to restore the factory-set calibration. This should provide reasonably accurate RL measurements.

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Other

Other troubleshooting is outlined in Table 7.

Table 7: Other Troubleshooting

Problem	Possible Cause	Solution
Small PDL fluctuations with AVG ON	Dirty connectors and mating sleeves	Clean all IN and OUT connections inside the feed-through connector plate.
	Dirty detector adapter	Clean detector adapter by blowing with air.
	Loose connections	Ensure all connections are tight.
	Fiber is bent or twisted	Check fiber inside feed-through plate for bends or twists. If an external source is used, ensure that the fiber is laid down properly and, if necessary, tape it flat on the work bench.
Large PDL fluctuations	Bad jumper	Change the measurement jumper cable.
	Unstable external source	Use a small spacer to stabilize the source, or change the source.
INPUT LOW! displayed	Laser source is not powered on or not connected properly	Check that the laser is powered on, and ensure that the input jumper cable is properly connected.
	IN and OUT fiber cables inside the feed-through plate are not properly connected	Refer to the labels on the IN and OUT fiber cables, and ensure that these are properly connected.
INPUT HIGH! displayed	External laser is too powerful	Decrease the internal laser power.
LIGHT?? displayed	Dark measurement is too high because the detector is not blocked	Attach the detector cap to the detector and press the REF key.
*	Return loss measurement is approaching the range limit of the multimeter	Carefully follow the setup and measurement techniques.
>	Return loss range is very limited	Carefully follow the setup and measurement techniques.

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Calibrating the Multimeter



Warning

Devices with malfunctioning lasers must be returned to the manufacturer for repair and calibration.

Calibrate the PS3 multimeter yearly. Return the unit to JDS Uniphase for calibration.

A check or verification of the return loss calibration can be performed at any time, as outlined here.

Verifying the Return Loss Calibration

To verify RL calibration:

1. Turn the multimeter off and then on again to clear any user-set RL offsets.
2. Connect an external source to the multimeter or select its internal source.
3. Enter the source wavelength into the multimeter.
4. Clean and connect the FC/APC end of the calibrated hybrid jumper to the OUT port of the multimeter. Ensure that you are using the calibrated jumper.
5. Press the RL key to access RL mode.
6. Clean the FC/PC connector end.
7. Compare the measured RL with the calibrated value marked on the calibrated jumper.

The RL measurement should agree with the calibrated value to within approximately 0.3 dB. If the measurement and the calibrated value do not agree within the specified range, clean the OUT FC/APC connector on the multimeter and the FC/APC connector of the calibrated jumper and repeat steps 4 through 7.

Any difference greater than 0.3 dB can be the result of high connection loss at the FC/APC connector or of drift in the calibration of the multimeter. A high connection loss causes the multimeter to read a higher RL than expected. The connection loss at the OUT FC/APC connector can be measured using an external power meter (the front-panel detector is not recommended for this purpose because it loses some of the light from the angled end of the FC/APC connector). The procedure is:

1. To gain access to the OUT FC/APC connector, loosen the retaining screws of the connector access panel, and pull the panel out carefully, extending it no more than 10 cm (four inches) from the body of the multimeter.
2. Remove the OUT connector from the bulkhead.
3. Clean and connect the OUT connector to the power meter, and zero the power.

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4. Connect the OUT connector to the bulkhead and to the FC/APC end of the calibrated jumper. Ensure that the connection between the external source and the IN port remains very stable during the measurement.

5. Connect the FC/PC end of the calibrated jumper to the power meter. The loss should be approximately 0.2 dB.

If the OUT FC/APC connector consistently gives high losses even when different jumpers are used, repolish the connector or adjust the return loss calibration to reflect the higher loss of the OUT FC/APC connection.

Adjusting the Return Loss Calibration

To adjust the calibration:

1. Turn the multimeter off.

2. Press the RL key and set the power switch to I (on). The multimeter powers up in MENU mode, and the RL calibration factor at 1310 nm is displayed, for example, CAL 1310
   0.00

3. Press the RANGE HOLD (%) or LCL (&) key to scroll to the required setting.

4. Press the MENU key to display the RL calibration factor at 1550 nm.

5. Press the RANGE HOLD (%) or LCL (&) key to scroll to the required setting. (Both the calibration factor at 1310 nm and at 1550 nm are factory-set to 0.00 dB.)

6. Press the PWR, PDL, or RL key to store the RL calibration factors and exit the calibration function.

At wavelengths between 1310 and 1550 nm, an interpolated RL calibration factor is used.

Maintaining the Multimeter

Warning

Devices with malfunctioning lasers must be returned to the manufacturer for repair and calibration.

Cleaning all connector ends with a lint-free tissue and alcohol before every mating increases the life of the connectors, minimizes insertion loss, and reduces backreflection.

To clean the connector ends:

1. Loosen the retaining screws of the connector access panel.

2. Pull the panel out carefully, extending it no more than 10 cm (4 inches) from the body of the multimeter.

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3. Remove the connectors from the connector bulkheads.

4. Clean the connector ends and the bulkhead mating sleeves with a lint-free tissue and alcohol.

5. Reinstall the connectors into the connector bulkheads.

6. Reinstall the connector access panel, ensuring that the cable/fibers are not stressed.

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*PDL Reference Measurement**

The purpose of this procedure is to take an accurate PDL reference measurement of the internal PDL source located inside the PS3 meter. The measurement will be done at the wavelength of the internal laser. If there are two lasers inside the PS3 meter then two PDL reference measurements can be done using each laser.

Equipment Required for the Measurement

2 Measurement Jumpers (1 jumper FC/PC to FC/APC and 1 jumper FC/PC to FC/PC)

Test Procedure

1. Connect the FC/APC end of the first measurement jumper to the OUT port of the PS3 meter (figure 7).

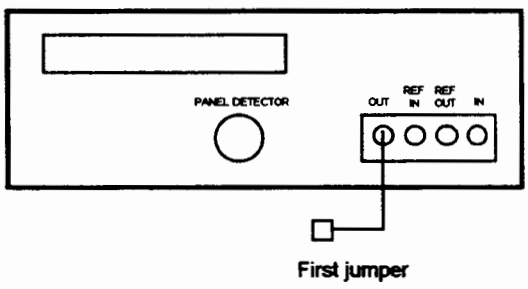


Figure 7: First Step in the PDL Reference Measurement

2. Connect the FC/PC end of the first measurement jumper to the FC/PC end of the second measurement jumper using a FC/PC - FC/PC mating adapter. Connect the other end of the second jumper to the panel detector (figure 8).

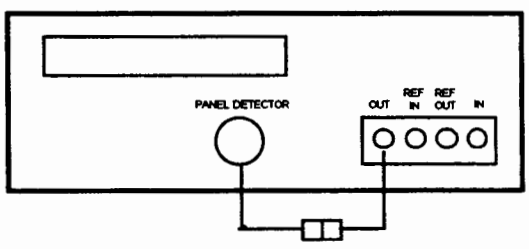


Figure 8: Second Step in the PDL Reference Measurement

3. Turn on the PS3 meter under test.
4. Ensure that the appropriate internal source is selected. If it is not selected, press the input key until the desired source is selected.
5. Press the PDL key and then press the Ref key.

---

* This procedure does not apply for PS3000 model.

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6. Remove the connector end of the first jumper from the FC/PC - FC/PC mating adapter and connect it to the REF IN port (figure 9).

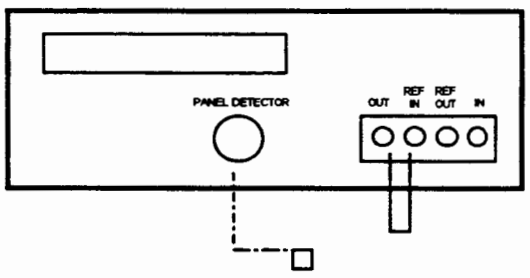


Figure 9: Third Step in the PDL Reference Measurement

7. Remove the connector end of the second jumper from the PC/PC adapter and connect it to the REF OUT port (figure 10).

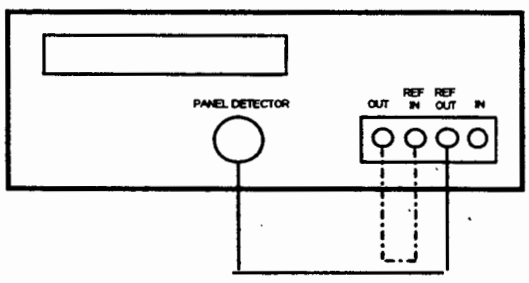


Figure 10: Fourth Step in the PDL Reference Measurement

8. Press the AVG key to turn on the average function.
9. Wait for a stable PDL reading to be displayed. Compare this value to the value written on the label for PDL reference. The reading value should be within (0.005 +5% of PDL)dB of the label value.

Example: Value on display: 0.78dB
Value on label for PDL reference: 0.80dB

(0.005 + 5% of PDL) = (0.005 + [0.05 x 0.78])
= 0.044

Since the value on the display 0.78 dB is between 0.756 (0.8 - 0.044) and 0.844 (0.8 + 0.044), therefore the reference value is still within calibration.

10. Repeat steps 1 - 9 for the second internal laser source if needed.

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Programming Guide

The following programming instructions for the PS3 multimeter are intended for users who are familiar with the GPIB interface and how to send or receive messages over a device. A detailed description of the GPIB interface is contained in *ANSI/IEEE Std. 488.1-1987 IEEE Standard Digital Interface for Programmable Instrumentation* published by the Institute of Electrical and Electronics Engineers.

The multimeter is equipped with a GPIB parallel interface and an RS232C serial interface and can accept the same device dependent commands (the commands that control the instrument). Examples are setting wavelength and reading PDL over either interface using the same commands.

Setting the GPIB Address

To set the GPIB address:

1. Press the MENU key to set the multimeter to MENU mode, and continue pressing the key to scroll to the GPIB ADDR display, for example, GPIB ADDR: 5.

2. Press the RANGE HOLD (&) or LCL (%) key to scroll to the required address.

3. Press the PWR, PDL, or RL key to set the GPIB address and exit MENU mode. The GPIB address is set.

Remote and Local Operation

The multimeter is automatically placed in REMOTE operating mode as soon as it is addressed by the controlling computer. In REMOTE mode, the front-panel keys are disabled.

To exit REMOTE mode and return to LOCAL mode:

1. Press the LCL key, so that its LED is lit. The multimeter returns to LOCAL mode and the front-panel keys are enabled.

The LCL key is disabled if the multimeter has been set to LOCAL LOCKOUT mode.

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GPIB Interface Functions

The GPIB interface functions are outlined in Table 8.

Table 8: GPIB Functions

Mnemonic	Function
SH1	source handshake, complete capability
AH1	acceptor handshake, complete capability
T6	basic talker, serial poll, unaddressed if MLA
L4	basic listener, unaddressed if MTA
SR1	service request capability
RL1	remote/local, complete capability
PP0	parallel poll, no capability
DC1	device clear, complete capability
DT0	device trigger, no capability
C0	controller, no capability
E1	electrical interface, open collector drivers

RS232C Interface Specifications

The RS232 specifications are outlined in Table 9.

Table 9: RS232 Specifications

Name	Symbol	Pin Number	Signal Direction
shield, power gnd	PG	1	
transmitted data	TD	2	out
received data	RD	3	in
request to send	RTS	4	out
clear to send	CTS	5	in
data terminal ready	DTR	20	out
signal ground	SG	7	

The data protocol is permanently set to 1200 baud ASCII character code, with eight bits per character, one stop bit, and no parity bit. The serial port of the controlling computer must be configured with the same settings.

Use a straight-through cable to connect the multimeter to the serial port of a DTE (computer).

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Null Modem Connections for Connecting a 25-Pin PC Serial Port to the Multimeter

The null modem connections for a 25-pin connection are outlined in Table 10.

Table 10: 25-Pin Connections

25-Pin Plug use a 25-pin, D-sub plug (male) connector		PS3 Multimeter use a 25-pin, D-sub plug (male) connector	
SYM	PIN number	PIN number	SYM
PG	1	1	PG
TD	2	2	TD
RD	3	3	RD
RTS	4	4	RTS
CTS	5	5	CTS
SG	7	7	SG

Null Modem Connections for Connecting a 9-Pin PC Serial Port to the Multimeter

The null modem connections for a 9-pin connection are outlined in Table 11.

Table 11: 9-Pin Connections

9-Pin Plug use a 9-pin, D-sub plug (male) connector		PS3 Multimeter use a 25-pin, D-sub plug (male) connector	
SYM	PIN number	PIN number	SYM
PG	1	1	PG
RD	2	2	TD
TD	3	3	RD
SG	5	4	RTS
RTS	7	5	CTS
CTS	8	7	SG

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Operation and Query Commands

Operation and query commands control the instrument functions and are interface independent.

Command Parser Rules

- A command consists of a mnemonic (for example, REF) and, if required, one or more data parameters (for example, REF 1,-10). The mnemonic and the parameter must be separated by at least one space, and each parameter must be separated by a comma (,).

- Parameters can be entered in various formats, for example, 1300 nm, 1.303-6 mm, and 0.0000013M are all recognized as the same value.

- Commands can be sent in uppercase or lowercase characters.

- A command is transmitted in a message, and messages can contain more than one command, each one separated by a semi colon (;). For example, the following message contains three commands:

MODE PDL;INPUT1;MEASREF<CR><LF>

- All GPIB messages must end with the terminating sequence <CR> <LF>.

- All RS232C messages must end with the terminating sequence <CR>.

- The input buffer of the multimeter can hold as many as 50 characters. If the buffer becomes full, the multimeter holds the handshaking line on the GPIB interface until space is available. Similarly, over the RS232C interface, the multimeter sets the Clear To Send line low. Any characters received after the line goes low are ignored.

- Commands are executed as they are parsed; consequently, a command can be executed before the entire message in which it is contained is received.

- A query command is used to extract status information from the multimeter. For example, **RDL? <CR><LF>** returns the latest PDL measurement.

- The query WVL? can include the parameters MIN or MAX. **WVL? MAX**, for example, returns the maximum calibrated wavelength of the multimeter.

- Multiple command messages can contain only one query command. A query must be the last command in the message, for example, **WVL 1500 nm;WVL?<CR><LF>** returns 1.5e-6 because the response to WVL? is generated after WVL 1500nm is executed.

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Common Commands

MODE **Mode Select**

Switches the measurement mode of the multimeter.

- PWR = power mode
- PDL = polarization dependent loss mode
- RL = return loss mode

INPUT **Input Select**

Switches the multimeter between one of the following three input settings:

PS3000 Model
- 1 = 1 (external source)
- 2 = 2 (external source)
- 3 = 3 (external source)

Models with one internal source
- 1 = INT (internal source)
- 2 = EXT1 (external source)
- 3 = EXT2 (external source)

Model with two internal sources
- 1 = INT1 (first internal source)
- 2 = INT1 and INT2 (first and second internal sources)
- 3 = INT1, INT2, EXT1, EXT2 (first and second internal sources and first and second external sources)
- 4 = EXT1 (first external source)
- 5 = EXT1, EXT2 (first and second external sources)

The internal switch of the multimeter automatically switches between the internal source and the external source. Each input setting has a separate set of wavelength and reference parameters that are used in both the PDL and PWR internal calculations.

ENABLE **Input Enable**

Activates the input settings that are to be set.

PS3000 Model
- 1 = 1 (external source)
- 2 = 1 and 2 (first and second external sources)
- 3 = 1, 2, and 3 (first, second and third external sources)

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Models with one internal source

- 1 = INT (internal source)
- 2 = INT and EXT1 (internal source and first external source)
- 3 = INT, EXT1, and EXT2 (internal source and first and second external sources)
- 4 = EXT1 (first external source)
- 5 = EXT1 and EXT2 (first and second external sources)

Models with two internal sources

- 1 = INT1 (first internal source)
- 2 = INT1 and INT2 (first and second internal sources)
- 3 = INT1, INT2, EXT1 and EXT2 (first and second internal sources and first and second external sources)
- 4 = EXT1 (first external source)
- 5 = EXT1 and EXT2 (first and second external sources)

RES **Display Resolution Control**

Sets the number of digits displayed after the decimal point in PWR mode and PDL mode. Valid resolution settings are 2, 3, or 4. In remote mode, four digits are always returned.

RLRES **Display Resolution Control**

Sets the number of digits displayed after the decimal point in RL mode. Valid resolution settings are 0, 1, and 2. In remote mode, three digits are always returned.

RH **Range Hold**

Sets the range hold function of the multimeter on or off. When activated, the current range is held.

- 0 = autorange (default)
- 1 = hold current range

The range hold function is not accessible in RL mode.

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AVG **Averaging Control**

Controls the on/off state of the averaging function. The default setting is off.

- 0 = off
- 1 = on

With averaging function on, all future measurements returned are calculated from the averaging of "I" measurement cycles. "I" is the value set by the **AVGCNT** command.

If averaging is on, sending AVG 1 again resets the average.

AVGCNT **Set Average Count**

Sets the number of measurement cycles to be averaged before the PDL, L_{av}, L_{max}, L_{min}, REF, PWR, and RL readings are updated. The number of averaging cycles that can be selected are 5, 10, 15, and 99 (continuous).

WVL **Wavelength Calibration Value**

Sets the wavelength calibration value of the current input setting. Default units are meters but the multimeter also accepts mm, µm, and nm units.

T **Trigger Mode Enable**

Enables the start of a measurement cycle to be controlled by the TRG commands. The default setting is continuous measurement mode.

- 0 = continuous measurement mode
- 1 = stop current cycle and wait for **TRG** command to trigger the next cycle

TRG **Trigger**

Triggers a measurement cycle. If the averaging function is on, the number of cycles specified by **AVGCNT** is executed and averaged. If **AVGCNT** is set to continuous, the one measurement cycle is completed and added to the cumulative average. The measurement complete bit in the status register is set when the cycle completes.

SRE **Service Request Mask Register**

Sets the service request mask register.

CSB **Clear Status Byte Register**

Clears or resets the status byte register.

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CLR **Clear Device**

Clears the service request mask register and the status byte register.

MODE? **Mode Select**

Returns the active operating mode.

- PWR = power mode
- PDL = polarization dependent loss mode
- RL = return loss mode

INPUT? **Input Setting**

Returns the current input setting.

Model without an internal source

- 1 = 1 (external source)
- 2 = 2 (external source)
- 3 = 3 (external source)

Model with one internal source

- 1 = INT (internal source)
- 2 = EXT1 (external source)
- 3 = EXT2 (external source)

Model with two internal sources

- 1 = INT1 (first internal source)
- 2 = INT1 and INT2 (first and second internal sources)
- 3 = INT1, INT2, EXT1 and EXT2 (first and second internal sources and first and second external sources)

ENABLE? **Input Enable**

Returns the input settings that can be set.

PS3000 Model

- 1 = 1 (external source)
- 2 = 1 and 2 (first and second external sources)
- 3 = 1, 2, and 3 (first, second and third external sources)

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Model with one internal source

- 1 = INT (internal source)
- 2 = INT and EXT1 (internal source and first external source)
- 3 = INT, EXT1, and EXT2 (internal source and first and second external sources)
- 4 = EXT1 (first external source)
- 5 = EXT1 and EXT2 (first and second external sources)

Model with two internal sources

- 1 = INT1 (first internal source)
- 2 = INT1 AND INT2 (first and second internal sources)
- 3 = INT1, INT2, EXT1 and EXT2 (first and second internal sources and first and second external sources)
- 4 = EXT1 (first external source)
- 5 = EXT1 and EXT2 (first and second external sources)

RES? **Display Resolution**

Returns the current display resolution in PWR and PDL modes.

RLRES? **Display Resolution**

Returns the current display resolution in RL mode.

RH **Range Hold**

Returns the range hold status.

- 0 = autorange
- 1 = hold

AVG? **Averaging Control**

Returns the status of the averaging function.

- 0 = off
- 1 = on

AVGCNT? **Average Count Setting**

Returns the average count setting.

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WVL? **Wavelength Calibration Value**

Returns the wavelength calibration value (in nm) of the active input setting. If the parameter MAX or MIN is included, **WVL?** returns the respective wavelength limit of the multimeter.

T? **Trigger Mode Setting**

Returns the trigger mode setting.

- 0 = continuous measurement mode
- 1 = stop current cycle and wait for **TRG** command to trigger the next cycle

SRE? **Service Request Mask Register**

Returns the contents of the service request mask register.

STB? **Status Byte Register**

Returns the contents of the status byte register

CNB? **Condition Register**

Returns the contents of the condition register.

IDN? **Identification**

Returns a string that identifies the manufacturer, the multimeter model number, and the firmware level, for example, JDS Uniphase, PS3650, 1.01.

TST? **Self-test**

Verifies the position of the filter switch. Returns 0 if passed and a non-zero digit if failed (the system error bit in the status byte register is set).

ERR? **Error**

Returns 0 if no error occurred and 1 if an error occurred (the system error bit in the status byte register is set).

LERR? **Last Error**

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Returns the contents of the error queue and then clears it.

OPC? **Operation Complete**

Returns the status of the input buffer.

- 1 = input buffer is not empty, for example, commands are still pending
- 0 = input empty is empty, for example, all commands have been executed

PDL Mode Commands

MEASREF **Reference Measurement**

Makes a reference measurement for each of the four polarization states.

REF **Reference Value**

Sets the reference value in dB for the specified polarization state (1, 2, 3, or 4). An example is REF 1, 3.005.

REF? **Reference Value**

Returns the reference value in dB for the specified polarization state (1, 2, 3, or 4).

PDL? **Polarization Dependent Loss**

Returns the calculated PDL in dB.

LAV? **Average Loss**

Returns the average loss in dB over all polarization states.

LMAX? **Maximum Loss**

Returns the maximum loss in dB over all polarization states.

LMIN? **Minimum Loss**

Returns the minimum loss in dB over all polarization states.

M? **Mueller Matrix Element**

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Returns the value of the Mueller matrix element for each polarization state (1, 2, 3, or 4).

LOSS? **Loss**

Returns the loss in dB measured at the specified polarization state (1, 2, 3, or 4).

PWR Mode Commands

MEASREF **Measurement Cycle**

Makes a dark current measurement on the front-panel detector in PWR mode.

OPT **Flip-in Element**

Controls the flip-in polarization rotating element.

- 0 = optimize element to pass the most light
- 1 = move element out of beam
- 2 = move element into beam

PWR? **Absolute Power**

Returns the absolute power reading in dBm.

OPT? **Flip-in Element**

Returns the state of the flip-in polarization rotating element in front of the polarization controller.

- 0 = optimize function has not been used, element out of beam
- 1 = optimize function has been used, element out of beam
- 2 = optimize function has been used, element in beam

RL Mode Commands

RLREF **Measurement Cycle**

Makes a dark current measurement on the internal detector (DET 3) for return loss measurements.

STRLO **Store Background Return Loss Value**

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Stores the current value of the total background return loss (the RL_0 key lamp lights). The command's mnemonic contains the letter "O" and not the digit "0" as in the abbreviation for background return loss, RL_0.

RLO **Background Return Loss Value**

Makes a background return loss measurement, or clears the stored return loss value. The command's mnemonic contains the letter "O" and not the digit "0" as in the abbreviation for background return loss, RL_0.

- 0 = clears the stored return loss value (the RL_0 key lamp turns off)
- 1 = executes a return loss measurement to measure the background return loss (the RL_0 key lamp lights)

RL? **Return Loss**

Returns the return loss reading in dB.

RLOFF **Return Loss Offset**

Stores the return loss offset.

RDRLO? **Background Return Loss Value**

Returns the total background return loss value as a fraction. This value includes the factory-stored background RL. The command's mnemonic contains the letter "O" and not the digit "0" as in the abbreviation for background return loss, RL_0.

RLOFF? **Return Loss Offset**

Returns the stored return loss offset value.

IL Mode Commands

IL **Insertion Loss**

Command can only be used when the instrument is in PWR mode.

- 1 = turn the IL mode on.
- 0 = turn the IL mode off.

IL? **Insertion Loss**

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Command can only be used when the instrument is in PWR mode and returns 0 or 1.

- 1 = the IL mode is on
- 0 = the IL mode is off.

ILREF **Reference Insertion Loss**

Command can only be used when the instrument is in PWR mode and takes the reference value for the specified input. The input source can be 1,2,3 or4 for meters with two internal sources and one external source.

ILREF? **Reference Insertion Loss**

Command can only be used when the instrument is in PWR mode and returns 0 or 1.

- 1 = when the meter has measured the reference value.
- 2 = when the meter has not measured the reference value.

Status Reporting and Service Request Control
The PS3 multimeter maintains three eight-bit registers that are used for status reporting and for enabling the GPIB service request interrupt:

- Status register
- Condition register
- SRQ mask register

Status Register

The status register records errors and other events that have occurred in the multimeter. When an event occurs, the status logic of the multimeter sets the corresponding bit. This register can be read at any time because the bits stay set until the register is read at least once.

Status Register							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
system error	service request	syntax error	message available	reference measurement complete	measurement complete	not used	parameter error
Bit Values							
128	64	32	16	8	4	2	1

- Bit 7 (system error) is set if a calibration error is detected after power-up or after the self-test query (**TST?**) is executed. At all other times it is 0.
- Bit 6 (service request) is set when the interrupt request logic of the multimeter detects a reason to generate a service request interrup on the GPIB.

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- Bit 5 (syntax error) is set when the parser detects a syntax error in a command mnemonic.
- Bit 4 (message available) is set when a message is available in the output buffer.
- Bit 3 (reference measurement complete) is set when the multimeter completes a reference measurement.
- Bit 2 (measurement complete) is set when the multimeter completes a PDL or PWR measurement.
- Bit 0 (parameter error) is set when a parameter value is out of the range of the multimeter.

The status register can be read with the status register query (**STB?**) or by serial polling the GPIB interface. During power-up, the status register contains 0 and can only be read by serial polling. The clear status byte command (**CSB**) and the clear device command (**CLR**) clear the status register. **STB?** also clears the status register, but only if bit 6 is on.

Condition Register

The condition register monitors the current state of the internal and front-panel detectors. The detectors have seven gain ranges that are automatically selected by the multimeter in order to measure a wide range of optical power. When the range hold function is activated, autoranging is disabled and, consequently, one of the detectors can have too little or too much signal in the current range. The condition register can be used as a warning that the signal is out of range.

Condition Register							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
		External:		Internal:			
not used	not used	under range	over range	under range	over range	not used	not used
Bit Values							
128	64	32	16	8	4	2	1

The condition register can be read with the **CNB?** query.

SRQ Mask Register

The SRQ mask register unmasks specific events in the status register that generate service request interrupts on the GPIB interface. The SRQ mask command (**SRE**) writes to the SRQ mask register. When a bit in the SRQ mask register is set to 1, the interrupt logic of the multimeter monitors the corresponding event bit in the status register. When the bit is set, an SRQ is generated and bit 6 in the status register is also set.

The SRQ mask register can unmask more than one event at a time. The first unmasked event to change from 0 to 1 causes an interrupt. To acknowledge this interrupt, the GPIB interface can be serial polled or the status register can be read with **STB?**. The first time the multimeter is serial polled after an SRQ is generated, bit 6 is on. Subsequent serial polling returns a value

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with bit 6 off. Similarly, **STB?** returns the status register with the SRQ set, but then the logic of the multimeter automatically clears the register. As a result, subsequent **STB?** queries return 0.

The SRQ mask register is cleared by powering up the multimeter, by the clear device command (**CLR**), or by the universal device clear command (**DC1**).

SRQ Mask Register							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
system error	not used	syntax error	message available	reference measurement complete	measurement complete	not used	parameter error
Bit Values							
128	64	32	16	8	4	2	1

GPIB Interface Programming Sample

This section provides a programming sample for controlling the multimeter over the GPIB interface. The sample was written in MS-DOS Qbasic and run on a personal computer equipped with a National Instruments[4] GPIB interface board, with National Instruments Universal Language Interface drivers loaded. The commands that control the GPIB are very similar to Hewlett Packard[5] HP Basic commands. Most other controller board manufacturers provide basic output and input statements for communicating messages to a GPIB instrument.

The GPIB commands provided in this section do not always show the terminating sequence <CR><LF>; however, it is implied.

Before using this sample, ensure that the GPIB address is set to 5.

```
CLOSE
CLS
REM *** Open board for input and output
OPEN "gpib0" FOR OUTPUT AS #1
OPEN "gpib0" FOR INPUT AS #2
PRINT "ABORTING"
PRINT #1, "ABORT"
PRINT #1, "RESET"
PRINT #1, "REMOTE 05"
PRINT #1, "GPIBEOS IN CR LF"
PRINT #1, "GPIBEOS OUT CR LF"

' setting unit to PDL mode
```

[4] National Instruments is a trademark of National Instruments.
[5] Hewlett Packard is a registered trademark of the Hewlett-Packard Co.

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```
PRINT #1, "OUTPUT 05;MODE PDL"

' setting averaging control on and setting the averaging cycle to 5
PRINT #1, "OUTPUT 05;AVG 1;AVGCNT 5"

' clearing status byte register, setting SRQ mask to 4 and holding
' measurements until TRG command sent
PRINT #1, "OUTPUT 05;T 1"

PRINT "CONNECT PS MULTIMETER FOR POLARIZATION REFERENCE MEASUREMENT"
PRINT "PRESS R WHEN READY TO PERFORM MEASUREMENT"
DO
 K$ = INKEY$
LOOP UNTIL (K$ = "R" OR K$ = "r")

' performs a reference measurement cycle on the four polarization states
PRINT #1, "OUTPUT 05;MEASREF"

' triggering one measurement cycle
PRINT #1, "OUTPUT 05;CSB"

' waiting for status byte to clear
DO
 GOSUB SPOLL
LOOP UNTIL (SR1% = 0)

PRINT "CONNECT DUT FOR POLARIZATION MEASUREMENT"
PRINT "PRESS R WHEN READY TO PERFORM MEASUREMENT"
DO
 K$ = INKEY$
LOOP UNTIL (K$ = "R" OR K$ = "r")

PRINT #1, "OUTPUT 05;TRG"

' doing a serial poll until measurement cycle completed
DO
 GOSUB SPOLL
LOOP UNTIL (SR1% AND 4)

' reading the PDL measurement after the measurement cycle
PRINT #1, "OUTPUT 05;PDL?"
PRINT #1, "ENTER 05"
INPUT #2, P$
PRINT "PDL MEASUREMENT IS:"; P$

END

' serial poll subroutine
SPOLL:
```


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```
 PRINT , "SRQ SPOLL"
 PRINT #1, "SPOLL 05"
INPUT #2, SR1%
PRINT , SR1%
RETURN
```

RS232C Interface Programming Sample

This section provides a programming sample for controlling the multimeter over the RS232C interface. The sample was written in MS-DOS Qbasic and run on a personal computer equipped with a serial port. COM port 2 of the computer is designated as the serial port and is connected to the multimeter.

The RS232C commands that appear in this section do not always show the terminating character <CR>; however, it is implied.

```
CLS
REM *** Open RS-232 for input and output
OPEN "COM2:1200,n,8,1" FOR RANDOM AS #3

' setting unit to PDL mode
PRINT #3, "MODE PDL"

' setting averaging control on and setting the averaging cycle to 5
PRINT #3, "AVG 1;AVGCNT 5"

' clearing status byte register, setting SRQ mask to 4 and holding
' measurements until TRG command sent
PRINT #3, "T 1"

PRINT "CONNECT PS MULTIMETER FOR POLARIZATION REFERENCE MEASUREMENT"
PRINT "PRESS R WHEN READY TO PERFORM MEASUREMENT"
DO
 K$ = INKEY$
LOOP UNTIL (K$ = "R" OR K$ = "r")

' performs a reference measurement cycle on the four polarization states
PRINT #3, "MEASREF"

PRINT "CONNECT DUT FOR POLARIZATION MEASUREMENT"
PRINT "PRESS R WHEN READY TO PERFORM MEASUREMENT"
DO
 K$ = INKEY$
LOOP UNTIL (K$ = "R" OR K$ = "r")

PRINT #3, "TRG"

' reading the PDL measurement after the measurement cycle
PRINT #3, "PDL?"
INPUT #3, P$
```


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```
PRINT "PDL MEASUREMENT IS:"; P$

END
```


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