Model 2520 Pulsed Laser Diode Test System

Quick Reference Guide

2520-903-01 Rev. B / March 2003

2520-903-01B

KEITHLEY
A Tektronix Company

WARRANTY

Keithley Instruments, Inc. warrants this product to be free from defects in material and workmanship for a period of 1 year from date of shipment.

Keithley Instruments, Inc. warrants the following items for 90 days from the date of shipment: probes, cables, rechargeable batteries, diskettes, and documentation.

During the warranty period, we will, at our option, either repair or replace any product that proves to be defective.

To exercise this warranty, write or call your local Keithley representative, or contact Keithley headquarters in Cleveland, Ohio. You will be given prompt assistance and return instructions. Send the product, transportation prepaid, to the indicated service facility. Repairs will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days.

LIMITATION OF WARRANTY

This warranty does not apply to defects resulting from product modification without Keithley's express written consent, or misuse of any product or part. This warranty also does not apply to fuses, software, non-rechargeable batteries, damage from battery leakage, or problems arising from normal wear or failure to follow instructions.

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Model 2520
Pulsed Laser Diode Test System
Quick Reference Guide

Manual Print History

The print history shown below lists the printing dates of all Revisions and Addenda created for this manual. The Revision Level letter increases alphabetically as the manual undergoes subsequent updates. Addenda, which are released between Revisions, contain important change information that the user should incorporate immediately into the manual. Addenda are numbered sequentially. When a new Revision is created, all Addenda associated with the previous Revision of the manual are incorporated into the new Revision of the manual. Each new Revision includes a revised copy of this print history page.

Revision A (Document Number 2520-903-01) .... June 2001
Revision B (Document Number 2520-903-01) .... March 2003

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with nonhazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product. Refer to the user documentation for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product warranty may be impaired.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating properly, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the user documentation. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, perform safe installations, and repair products. Only properly trained service personnel may perform installation and service procedures.

Keithley Instruments products are designed for use with electrical signals that are measurement, control, and data I/O connections, with low transient overvoltages, and must not be directly connected to mains voltage or to voltage sources with high transient overvoltages. Measurement Category II (as referenced in IEC 60664) connections require protection for high transient overvoltages often associated with local AC mains connections. Certain Keithley measuring instruments may be connected to mains. These instruments will be marked as category II or higher.

Unless explicitly allowed in the specifications, operating manual, and instrument labels, do not connect any instrument to mains.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30 V RMS, 42.4 V peak, or 60 VDC are present. A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.

Operators of this product must be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 V, no conductive part of the circuit may be exposed.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance-limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, ensure that the line cord is connected to a properly-grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

For safety, instruments and accessories must be used in accordance with the operating instructions. If the instruments or accessories are used in a manner not specified in the operating instructions, the protection provided by the equipment may be impaired.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.

When fuses are used in a product, replace with the same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as protective earth (safety ground) connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If a ⏚ screw is present, connect it to protective earth (safety ground) using the wire recommended in the user documentation.

The ⚠ symbol on an instrument means caution, risk of danger. The user must refer to the operating instructions located in the user documentation in all cases where the symbol is marked on the instrument.

The ⚠ symbol on an instrument means caution, risk of electric shock. Use standard safety precautions to avoid personal contact with these voltages.

The ⚠ symbol on an instrument shows that the surface may be hot. Avoid personal contact to prevent burns.

The ⏚ symbol indicates a connection terminal to the equipment frame.

If this (Hg) symbol is on a product, it indicates that mercury is present in the display lamp. Please note that the lamp must be properly disposed of according to federal, state, and local laws.

The **WARNING** heading in the user documentation explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in the user documentation explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits — including the power transformer, test leads, and input jacks — must be purchased from Keithley Instruments. Standard fuses with applicable national safety approvals may be used if the rating and type are the same. Other components that are not safety-related may be purchased from other suppliers as long as they are equivalent to the original component (note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product). If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean an instrument, use a damp cloth or mild, water-based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., a data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

Safety precaution revision as of January 2013.

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Introduction

This guide is designed to familiarize users with fundamental operation (front panel and remote) of the Keithley Model 2520 Pulsed Laser Diode Test System. For comprehensive information on all aspects of Model 2520 operation, refer to the Model 2520 User's Manual.

Operation information in this guide is divided into four parts; (1) Fundamental source and measure operations, (2) Settings to optimize performance, (3) Features to enhance DUT testing and (4) More testing techniques. This format allows a new user to easily progress from basic simple operation to more complex procedures.

Remote command programming—For the various Model 2520 operating modes covered in this guide, the related SCPI commands for remote operation are summarized in tables. Most commands have a query form. For example, :OUTPut ON turns all three outputs on, while :OUTPut? requests the present state of the outputs. Note that the Model 2520 must be addressed to talk after sending a query command.

For operations where command sequence is important, programming examples are provided. The exact programming syntax will depend on the test program language.

Source and measure capabilities

Laser diode source and measure:

- Source DC current from 10µA to 1A.
- Source current pulses from 10µA to 5A with pulse widths from 500ns to 5ms; pulse delays (time between pulses) from 20µs to 500ms. (Pulse delay and width depend on maximum duty cycle. See specifications.)
- Measure voltage from 0.33mV to 10.5V.
- Maximum current source DC power is 9.9W (1A @ 9.9V).
- Maximum current source pulse power is 45W (5A @ 9V).

Photodiode detector source and measure:

- Source bias voltage on each of two channels from 0V to ±20V.
- Measure current on each of two channels from 0.7µA to 105mA.
- Maximum current for each bias source is 100mA.

Front and rear panels

The front and rear panels of the Model 2520 mainframe and testhead are shown in Figure 1, Figure 2, Figure 3, and Figure 4. The use of the various instrument controls and connectors will be explained throughout this guide.

Figure 1
Mainframe front panel
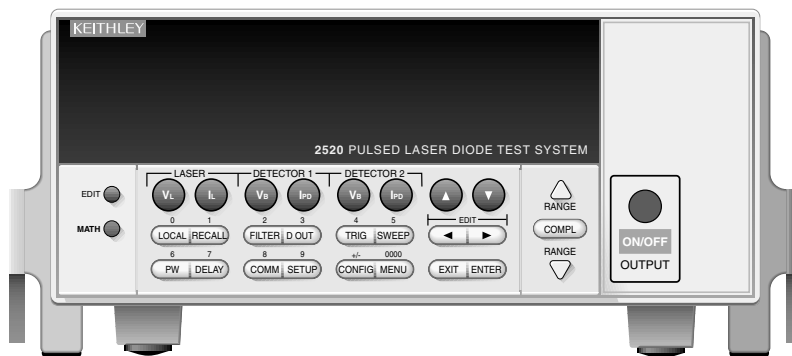
Figure 2
Mainframe rear panel
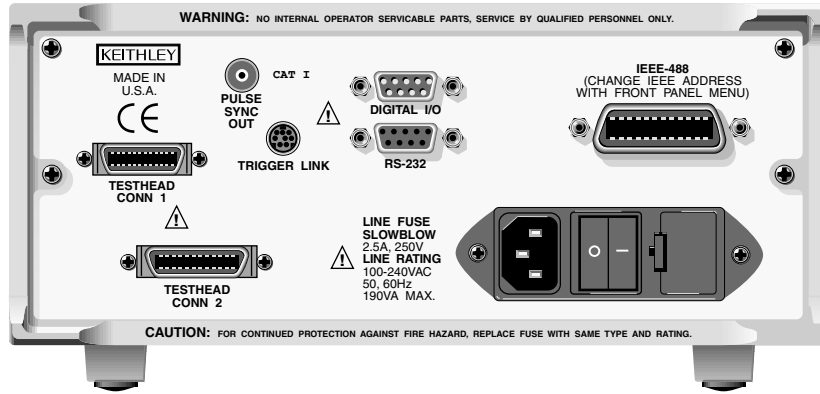
Figure 3
Testhead front panel
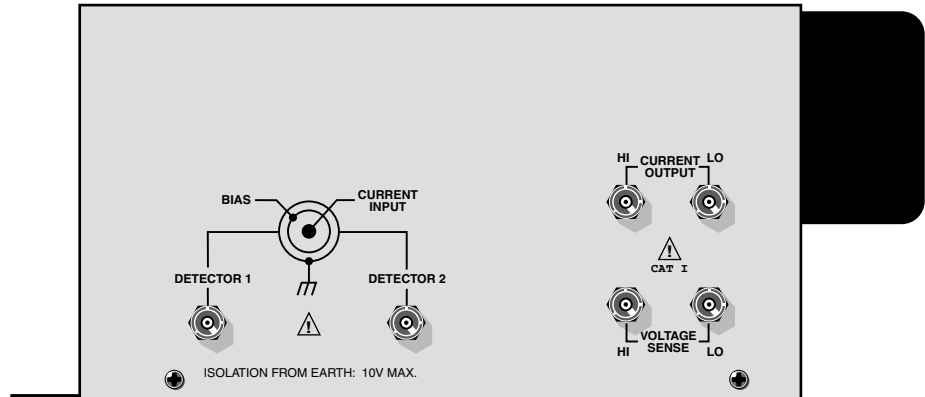
Figure 4
Testhead rear panel
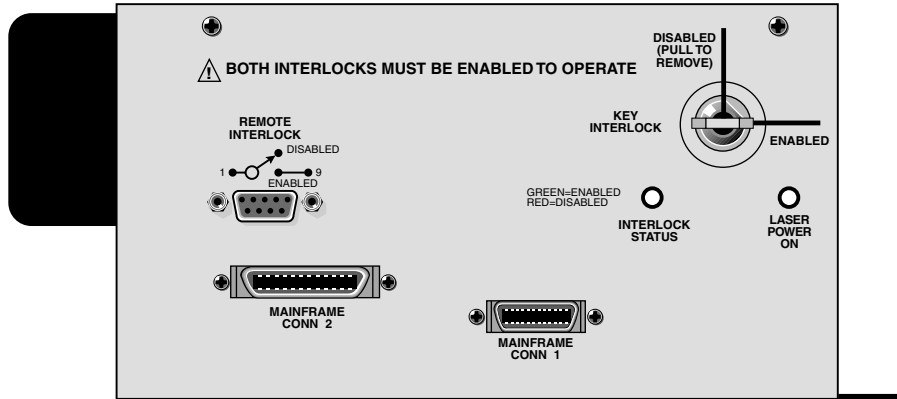
Navigating menus and entering numeric data

Menu navigation

Many operating modes for the Model 2520 are configured using front panel menus. Throughout this guide, menu navigation will be presented as a sequence of key presses and menu item selections. For example, the following sequence selects the current source pulse mode:

Press CONFIG > press LASER I_L > select SHAPE > select PULSE.

The above sequence is explained as follows:

1. Press the CONFIG key.
2. Press the LASER I_L key.
3. Select the SHAPE menu item.
4. Select the PULSE mode.

A menu item is selected by placing the cursor on it and pressing the ENTER key. The EDIT ◄ and ► keys control cursor position.

Numeric data entry (EDIT keys)

Numeric values must be entered for some menu items. Numeric entry is also used to set source and compliance values. The edit keys for numeric entry include the EDIT ◄ and ► keys to control cursor position, EDIT ▲ or ▼ keys to increment or decrement the digit value, and the number keys.

After a value is keyed in, press ENTER to select it. Note that pressing MENU resets a displayed number to its minimum value.

Editing source values

Editing keys

Use the following keys to edit source values:

- LASER I_L, DETECTOR 1 V_B, and DETECTOR 2 V_B selects the laser diode, photodiode #1, or photodiode #2 source for editing.
- EDIT — edits the last selected source. A blinking cursor will appear in the field to be edited, and the EDIT annunciator will turn on while in the edit mode. If no key is pressed within a few seconds, the edit mode will be cancelled automatically.
- COMPL — allows editing of the laser diode current source voltage compliance.
- EDIT ◄ and ► places the display cursor on the display digit to be changed.
- EDIT ▲ or ▼ increments or decrements the source value. Note that pressing either of these keys will automatically enable the source edit mode.
- RANGE ▲ or ▼ selects the laser diode source range (500mA or 5A) while in edit mode.
- ENTER — Completes source editing without waiting for time-out period.
- Numeric keys (0-9) allow you to directly enter source values.
- EXIT — exits the edit mode without waiting for the time-out period.

Configuring laser diode source

The basic procedure for setting up laser diode current source values for both DC and pulse modes is outlined below.

1. Press CONFIG then LASER I_L to access the source configuration menu.
2. Choose POLARITY, then press ENTER.
3. Select POSITIVE or NEGATIVE as desired, then press ENTER. (See Figure 2.)
4. Select SHAPE, then press ENTER.
5. Choose DC or PULSE, then press ENTER.

6. If you chose the PULSE mode, set the following:
    a. Select LOW, then press ENTER.
    b. Set the pulse low amplitude to the desired value, then press ENTER.
    c. Press EXIT to return to normal display.
    d. Press the PW key, then set the pulse width to the desired value.
    e. Press the DELAY key, then set the pulse delay as required.
7. Press EXIT as necessary to return to normal display.
8. Press the LASER I_L key, then press EDIT to enter the edit mode.
9. While in the edit mode, use the RANGE ▲ and ▼ keys to select the desired source range (500mA or 5A).
10. Use the EDIT ▲ and ▼ or numeric keys to set the source amplitude to the desired level. For the pulse mode, this value will be the high pulse level.
11. Press the COMPL key, then set the voltage compliance (limit) to the desired value. Press ENTER to complete your selection and return to normal display.

Setting photodiode detector source values

The basic procedure for editing photodiode detector source values is outlined below.

1. Press the DETECTOR 1 V_B or DETECTOR V_B key, then the EDIT key so the blinking cursor is in the source display field to be edited.
2. To simply increment or decrement the displayed source value, use the EDIT ◄ and ► and ▲ and ▼ keys, or use the numeric keys to enter the value directly. Again, the source value will be updated immediately; you need not press ENTER to complete the process.
3. Repeat steps 1 and 2 for the other photodiode source.

Display format

The Model 2520 display is used primarily to display measured readings and source values. The top line displays source values, and the bottom line shows measured values.

Display example

The following example shows the unit displaying the laser diode source value on the top line, and the laser diode voltage, detector 1 current, and detector 2 current from left to right on the bottom line:

Ipulse:100.00mA

+1.0000 V   +05.000mA   +10.000mA

Display units

Measurement reading information can be displayed using either engineering units or scientific notation in either fixed- or floating-point format. Use the NUMBERS selection of the main MENU to select the display format.

Engineering units example: 12.345mA

Scientific notation example: 1.23e -2A

Basic connections

WARNING   **While the Model 2520 does not incorporate a laser, it is designed to operate (power) laser diode devices. Read all safety precautions listed at the beginning of this manual. The following safety practices must be used to protect operators and other users of this product from potential exposure to laser radiation:**

- **Operators must be protected from radiation and electrical hazards at all times.**

- **The installer must comply with all applicable laws and regulation on laser safety. This requirement includes warning signs and operator training.**

- **The interlock is required for safe operation. The test fixtures must ensure that the interlock circuit is disabled (source outputs inhibited) so that an operator is not exposed to any radiation. The test fixture interlock must not be defeated.**

- **The testhead key control must be used to prevent operation unless authorized by the responsible body. This requirement must be part of the facilities administrative controls for laser safety.**

- **When servicing the test system, any required personnel protection equipment (e.g. laser safety goggles) must be provided by the customer's responsible body.**

- **The customer's laser safety officer (LSO) must review and approve all installations before being put into operation. Any safety concerns must be immediately reported to the customer's LSO.**

- **If at any time, the indicators provided on the testhead for INTERLOCK STATUS or LASER POWER ON should fail to light or properly indicate status, immediately contact a Keithley service representative for repair. Failure to do so may expose the user to hazards without proper warnings. See Interlock status indicator test sequence in Section 9 for details on testing the indicator lights.**

- **Maximum isolation from earth ground is 10V. Exceeding this value may result in a shock hazard.**

- **When making connections, do not leave any exposed connections. Be sure that all external circuits are properly insulated.**

Testhead connections

Figure 5
Testhead connections

Model 2520 Mainframe   **Model 2520 Testhead**

CONN 2 Cable

CONN 1 Cable
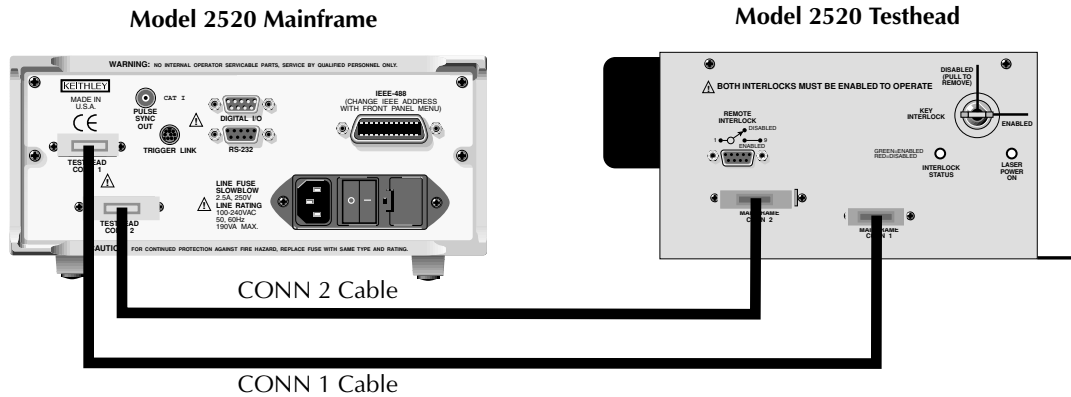
CAUTION **Turn off the mainframe power before connecting or disconnecting the testhead to the mainframe.**

Figure 5 shows connections between the Model 2520 mainframe and the testhead. Using the supplied cables, make connections as follows:

- Connect the mainframe TESTHEAD CONN 1 connector to the testhead MAINFRAME CONN 1 connector.
- Connect the mainframe TESTHEAD CONN 2 connector to the testhead MAINFRAME CONN 2 connector.

Interlock connections

The Model 2520 has two interlock circuits, a remote interlock and a key interlock.

*NOTE   Both interlocks must be enabled to operate; otherwise the source outputs will
         not turn on.*

A remote interlock switch should be wired to pins 1 and 9 of the REMOTE INTERLOCK
connector, as shown in Figure 6. (Connections can also be made between pins 1 and 5).
The switch must be configured to close contacts (ENABLED) to operate. The key must
also be inserted into KEY INTERLOCK and rotated to the ENABLED position to operate
the unit.

*WARNING   **If at any time the indicators provided on the testhead, for
            INTERLOCK STATUS or LASER POWER ON, should fail to light or
            to properly indicate status, immediately contact a Keithley service
            representative for repair. Failure to do so may expose the user to
            hazards without proper warnings.***

Figure 6
Remote interlock connections
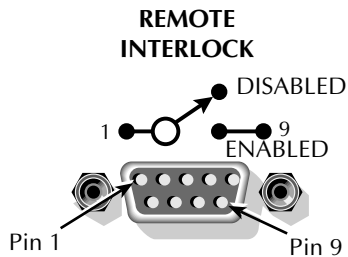
Typical test connections

Figure 7 shows typical connections to the laser diode, the back photodiode detector, and the front photodiode detector in a laser diode test setup (interlock connections are not shown; see Figure 6). Connections are as follows:

- The center conductors of the CURRENT OUTPUT and VOLTAGE SENSE HI and LO terminals connect to the laser diode under test. Current is applied to the laser diode through the CURRENT OUTPUT HI and LO terminals, and voltage across the DUT is measured through the VOLTAGE SENSE HI and LO terminals.
- DETECTOR 1 connects to the back photodiode detector. The CURRENT INPUT (center conductor) is connected to one photodiode terminal while the BIAS terminal (inner shield) is connected to the other photodiode terminal.
- DETECTOR 2 connects to the forward photodiode detector. The CURRENT INPUT (center conductor) is connected to one photodiode terminal while the BIAS terminal (inner shield) is connected to the other photodiode terminal.

Connection considerations

When making connections to the laser diode, observe the following considerations to avoid pulse degradation due to distributed inductance and other effects:

- Use only the supplied 15Ω coaxial cables or equivalent.
- Maximum recommended length for the sum of both cables is 40 cm.
- Connect the four cable shields together at the DUT.
- Carry cable shields as close to the DUT as possible. Minimize the length of exposed (unshielded) signal lines.
- Dress the VOLTAGE SENSE cables as far away from the CURRENT OUTPUT cables to avoid magnetic coupling. Twist the SENSE cables together to further reduce magnetic coupling.
- Connect the VOLTAGE SENSE leads as close to the body of the DUT as possible.

See the specifications in Appendix A and information in Appendix F of the Model 2520 User's Manual for more information.

Laser diode test connections
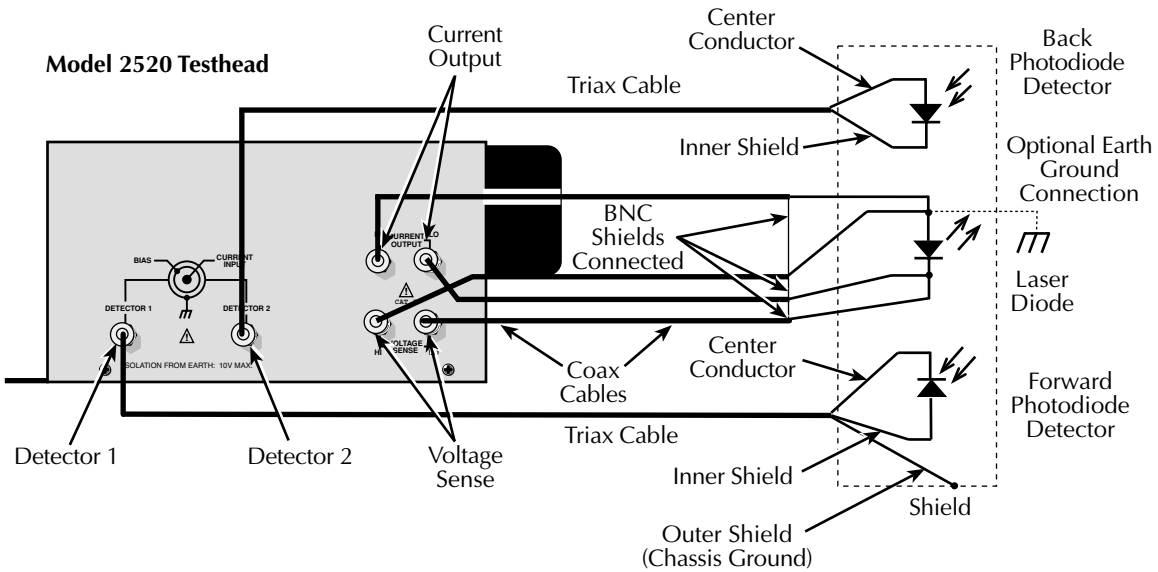
Polarity

Polarity for the laser diode current source, both detector voltage bias sources, and laser diode voltage measurement can be controlled by using the POLARITY selections in the corresponding configuration menus:

Press CONFIG > LASER I_L, LASER V_L, or DETECTOR I_{PD} > select POLARITY.

See Section 3 of the Model 2520 User's Manual for details on polarity.

Remote command programming

Table 1 lists the SCPI commands to select polarity.

Table 1
SCPI commands for selecting polarity

Command	Description
:SENSe[1]:VOLTage:POLarity <polarity>	Set laser diode measure polarity (POSitive or NEGative).
:SENSe2:CURRent:POLarity <polarity>	Set detector #1 measure polarity.
:SENSe3:CURRent:POLarity <polarity>	Set detector #2 measure polarity.
:SOURce[1]:CURRent:POLarity <polarity>	Set laser diode source polarity (POSitive or NEGative).

Basic operation

The basic procedure for laser diode testing is provided in Table 2 . It assumes that the DUTs are already connected to the Model 2520 testhead connectors as explained in "Basic connections," page 8.

Table 2
Basic operating procedure

Procedure	Details
1. Select current source function.	Press CONFIG then LASER I_L. Choose SHAPE, then select DC or PULSE. For PULSE mode only, set LOW current, then use PW and DELAY keys to set pulse width and delay.
2. Set current source level.	Press LASER I_L then EDIT key to enter edit mode. Use RANGE ▲ and ▼ keys to select source range, then use edit keys to key in source value, then press ENTER.
3. Set voltage compliance limit.	Press COMPL, then use edit keys to key in limit value, then press ENTER.
4. Set detector voltage bias levels.	Press DETECTOR 1 or DETECTOR 2 V_B then EDIT key, then use edit keys to set bias voltage.
5. Select measurement ranges.	Press LASER V_L, DETECTOR 1 I_{PD}, or DETECTOR 2 I_{PD}. Use RANGE ▲ and ▼ keys to set range.
6. Turn on outputs.	Press ON/OFF OUTPUT key. OUTPUT indicator on.
7. Trigger and observe readings.	Press TRIG key. Voltage and current readings are displayed.
8. Turn output off when finished.	Press ON/OFF OUTPUT key. OUTPUT indicator off.

Remote command programming

Data string

The :READ? command is typically used to trigger the unit and request the data string. The data string is sent to the computer when the Model 2520 is addressed to talk.

The data string is typically made up of three elements separated by commas. The first element is the voltage reading, the second is the detector #1 current reading, and the third is the detector #2 current reading. The NAN (not a number) value of +9.91e37 is used for a reading that is not available.

Other available data elements include laser diode source current, both bias voltages, a timestamp, and the status word. See Section 14, "FORMat subsystem," of the Model 2520 User's Manual for details on all aspects of the data format.

NOTE   The three element data string is the GPIB default condition.

SCPI commands

SCPI commands for basic laser diode testing are summarized in Table 3.

Table 3
SCPI commands for basic laser diode tests

Command	Description
:OUTPut[1] <state>	Turn all sources on or off (ON or OFF).
:READ?	Trigger and acquire readings.
:SENSe[1]:VOLTage:RANGe <range>	Set laser diode voltage measure range (5 or 10).
:SENSe[1]:VOLTage:POLarity <polarity>	Set laser diode measure polarity (POSitive or NEGative).
:SENSe2:CURRent:RANGe <range>	Set detector #1 measure range (0.01, 0.02, 0.05, 0.1).
:SENSe2:CURRent:POLarity <polarity>	Set detector #1 measure polarity.
:SENSe3:CURRent:RANGe <range>	Set detector #2 measure range (0.01, 0.02, 0.05, 0.1).
:SENSe3:CURRent:POLarity <polarity>	Set detector #2 measure polarity.
:SOURce[1]:CURRent:MODE FIXed	Select fixed (not sweep) laser diode current source mode.
:SOURce[1]:CURRent:RANGe <range>	Select laser diode source range (0.5 or 5).
:SOURce[1]:CURRent <current>	Set laser diode source current (0 to +5.0).[1]
:SOURce[1]:CURRent:POLarity <polarity>	Set laser diode source polarity (POSitive or NEGative).
:SOURce[1]:VOLTage:PROTection <limit>	Set laser source voltage compliance limit (3 to 10.5).
:SOURce[1]:FUNCtion <function>	Select laser diode current source function (DC or PULSe).
:SOURce[1]:PULSe:DELay <delay>	Set laser diode source pulse delay (20e-6 to 0.5).[2]
:SOURce[1]:PULSe:WIDTh <width>	Set laser diode source pulse width (500e-9 to 5e-3).[2]
:SOURce[1]:CURRent:LOW <low_current>	Set low pulse amplitude for pulse mode (0 to 0.015, 500mA range; 0 to 0.150, 5A range).
:SOURce2:VOLTage <voltage>	Set detector #1 source voltage (0 to ±20).
:SOURce3:VOLTage <voltage>	Set detector #2 source voltage (0 to ±20).

[1] 5A maximum pulse mode only. 1A maximum in DC mode.
[2] Minimum and default pulse delay and width values depend on pulse duty cycle. See Model 2520 specifications.

Programming example

Table 4 shows a typical command sequence for basic laser diode testing. This programming example sets up the current and voltage sources, the measurement functions, and triggers and acquires one set of voltage and current readings.

Table 4
Basic laser diode test programming example

Step	Action	Commands[1,2]	Comments
1	Configure laser diode measure.	*RST :SENS1:VOLT:RANG 10 :SENS1:VOLT:POL POS	Restore GPIB defaults. LD measure range = 10V. LD positive polarity.
2	Configure detector measure.	:SENS2:CURR:POL NEG :SENS3:CURR:POL NEG	Det. #1 negative polarity. Det. #2 negative polarity.
3	Configure laser source.	:SOUR1:CURR:RANG 0.5 :SOUR1:CURR 0.5 :SOUR1:VOLT:PROT 5 :SOUR1:CURR:POL POS :SOUR1:FUNC PULS :SOUR1:PULS:DEL 200e-6 :SOUR1:PULS:WIDT 10e-6 :SOUR1:CURR:LOW 10e-3	0.5A LD source range. LD source output = 0.5A. 5V LD source voltage limit. LD source positive polarity. LD source pulse mode. 200μsec pulse delay. 10μsec pulse width. 10mA low current pulse.
4	Configure detector bias sources.	:SOUR2:VOLT 20 :SOUR3:VOLT 10	Det. #1 source output = 20V. Det. #2 source output = 10V.
5	Turn on outputs.	:OUTP1 ON	All source outputs on.
6	Trigger and read data.	:READ?	Get detector readings.
7	Turn off outputs.	:OUTP1 OFF	Outputs off after measuring.

[1] Commands must be sent in order given.
[2] Instrument must be addressed to talk after :READ?, to acquire data.

Settings to optimize performance

Range

To achieve best accuracy, the Model 2520 should be on the lowest possible measurement range. Use the RANGE ▲ and ▼ keys to select the range after pressing the appropriate measurement function key (V_L or I_{PD}). Available detector current measurement ranges are 10mA, 20mA, 50mA, and 100mA, while available laser diode voltage measurement ranges are 5V and 10V.

NOTE   *Basic ranging information (including the SCPI commands for remote operation) is covered in "Basic operation," page 13.*

Filter

Filtering stabilizes noisy measurements caused by noisy input signals. The Model 2520 uses an averaging type filter for all three measurements. The number of readings averaged can be set between 1 and 100. However, the more filtering that is used (higher number of readings averaged), the slower the measurement process becomes.

When the averaging filter is enabled, the unit cycles through the complete delay-pulse cycle for each filter sample measurement. The measurement results for all delay-pulse cycles are then averaged to give one "filtered" reading. If the filter is enabled in sweep mode, each step of the sweep will effectively be repeated for the filter count number of times.

NOTE   *The average filter setting is global and affects all three measurements (laser diode voltage and both detector current measurements).*

Filter configuration

Press CONFIG > FILTER > use edit keys to set COUNT.

Press the FILTER key to enable the filter. The FILT annunciator will be on when the filter is enabled.

Remote filter programming

Table 5 summarizes filter commands.

Table 5
Filter commands

Commands	Description
[:SENSe[1]]:AVERage:COUNt <count>	Set average filter count (1 to 100).
[:SENSe[1]]:AVERage[:STATe] <state>	Enable/disable average filter (ON or OFF).
:SENSe2:AVERage:COUNt <count>	Set average filter count (1 to 100).
:SENSe2:AVERage[:STATe] <state>	Enable/disable average filter (ON or OFF).
:SENSe3:AVERage:COUNt <count>	Set average filter count (1 to 100).
:SENSe3:AVERage[:STATe] <state>	Enable/disable average filter (ON or OFF).

Filter programming example

Table 6 summarizes the command sequence to program filter aspects as follows:

- Average filter on.
- Average filter count 20.

Table 6
Filter programming example

Command	Description
:AVER:COUN 20	Set average count to 20.
:AVER ON	Enable average filter.

Features to enhance DUT testing

Sweep operation

Sweep types

The three available sweep types are linear staircase, logarithmic staircase, and custom (list). Both types of staircase sweeps can be performed from the front panel, but custom sweeps are available only via remote.

Linear staircase sweep

When the sweep shown in Figure 8 is triggered to start, the current source output will go to the start source current level. The output will then change in equal steps until the stop source level is reached. The time duration at each step is determined by the time it takes to perform the measurement, which includes both the pulse width and the pulse delay.

Use the following menu sequence to set the start, stop, and step source levels:

Press CONFIG > press SWEEP > select TYPE > select STAIR.

After selecting STAIR, you will be prompted to enter the START, STOP, and STEP levels.

Figure 8
Linear staircase sweep
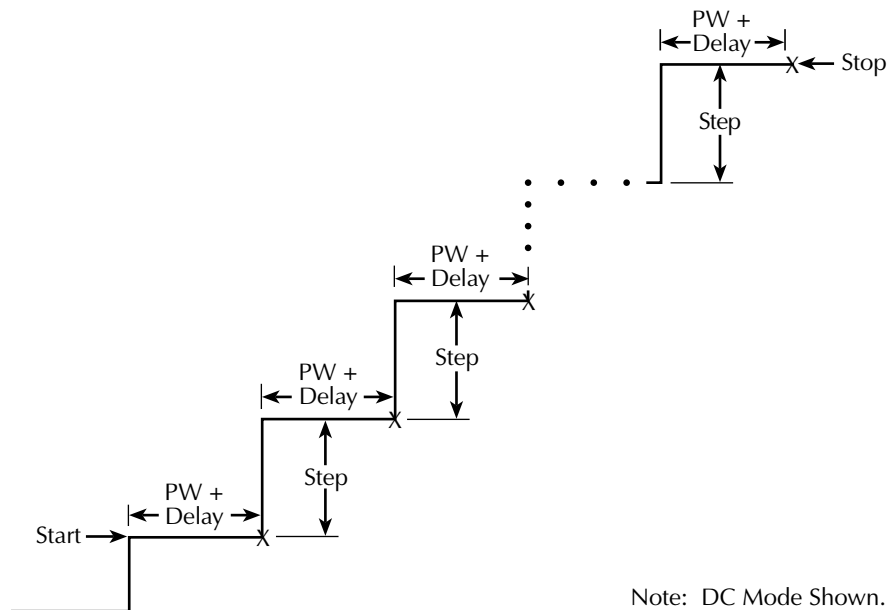
Note: DC Mode Shown.

Logarithmic staircase sweep

This sweep is similar to the linear staircase sweep. The steps, however, are done on a logarithmic scale. The symmetrical log points for the steps are determined by the specified number of sweep points. Figure 9 shows a 5-point log sweep from 1 to 10mA.

With the desired source (V or I) selected, use the following menu sequence to set the start and stop levels, and the number of sweep points (2 to 1000):

Press CONFIG > press SWEEP > select TYPE > select LOG.

After selecting LOG, you will be prompted to enter the START and STOP levels, and the NO OF POINTS.

Figure 9
**Logarithmic staircase sweep (example)**
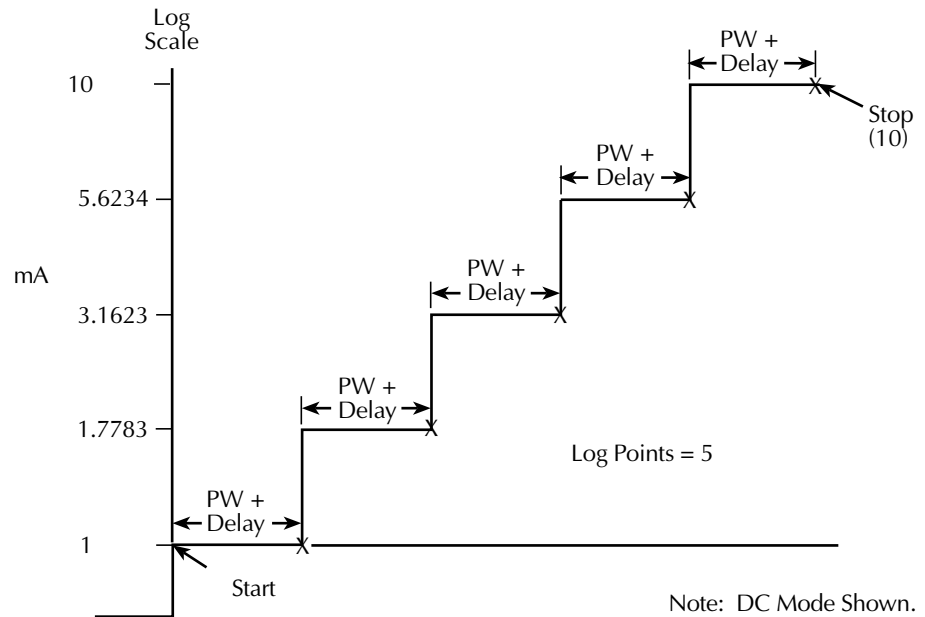
Custom sweep

This sweep type lets you configure a customized sweep (via remote only). Programmable sweep list parameters include the number of measurement points in the sweep, the current source level at each point, pulse width, and pulse delay.

Figure 10 shows an example of a custom sweep. When this sweep is started, the output goes to the first current level in the sweep after the delay period. The pulse period and time between pulses is determined by the programmed pulse and delay parameters. The sweep will continue through the points in the order they were programmed and stop after the last current point.

The size of the current list determines the custom sweep size. Normally, the pulse width list and delay list should be the same size as the current list. However, if the pulse width and/or pulse delay list is shorter than the current list, the last pulse width and/or delay point will be used for all subsequent current values.

Figure 10
Custom pulse sweep (example)
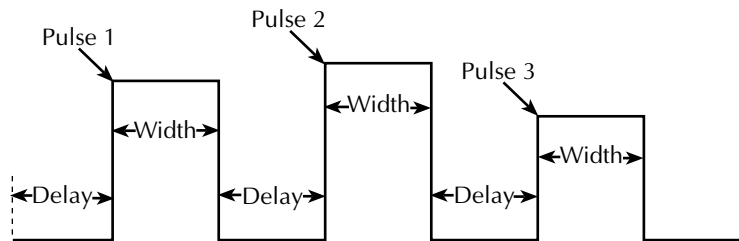
Sweep count

For front panel operation, a sweep can automatically repeat a specified number of times (finite sweep count) or it can repeat continuously (infinite sweep count).

For a finite count sweep, the readings are automatically stored in the buffer. The maximum number of finite sweeps that can be performed is determined as follows:

Maximum finite sweep count = 1000 / # points in sweep.

For an infinite sweep count, the readings are not stored in the buffer.

Use the following menu sequence to set sweep count:

Press CONFIG > press SWEEP > select SWEEP COUNT > select FINITE or INFINITE.

If you select FINITE, you will be prompted to enter the sweep count.

Performing sweeps

Performing a linear staircase sweep

Perform the following steps to run a linear staircase sweep:

1. Configure the laser diode and detector source and measure functions.
2. Configure the linear staircase sweep, including start, stop, and step values, as previously explained.
3. For the current source pulse mode, set the pulse width and delay.
4. Turn the outputs on.
5. Run the sweep by pressing the SWEEP key. When finished, turn the outputs off.

The readings will be stored in the buffer if a finite count sweep was run. Use the RECALL key to access stored readings.

Performing a log staircase sweep

Perform the following steps to run a log staircase sweep:

1. Configure the laser diode and detector source and measure functions.
2. Configure the log staircase sweep, including start and stop values and number of points, as previously explained.
3. For the current source pulse mode, set the pulse width and delay.
4. Turn the outputs on.
5. Run the sweep by pressing the SWEEP key. When finished, turn the outputs off.

The readings will be stored in the buffer if a finite count sweep was run. Use the RECALL key to access stored readings.

Remote sweep programming

SCPI commands

SCPI commands for linear and logarithmic sweeps are listed in Table 7, while Table 8 lists commands for custom sweeps.

NOTE   Table 7 and Table 8 do not provide a complete listing of sweep commands.
        Documentation for all sweep commands can be found in Section 14 of the
        Model 2520 User's Manual.

Table 7
Commands for linear and log staircase sweeps

Command	Description*
:SOURce[1]:CURRent:MODE SWEep	Select staircase sweep mode.
:SOURce[1]:CURRent:STARt <current>	Specify sweep start current (0 to 5).
:SOURce[1]:CURRent:STOP <current>	Specify sweep stop current (0 to 5).
:SOURce[1]:CURRent:STEP <current>	Specify sweep step current (0 to 5).
:SOURce[1]:CURRent:CENTer <current>	Specify sweep center current (0 to 5).
:SOURce[1]:CURRent:SPAN <current>	Specify sweep span current (0 to 5).
:SOURce[1]:SWEep:SPACing <type>	Select staircase sweep type (LINear or LOGarithmic).
:SOURce[1]:SWEep:POINts <points>	Set number of sweep points (2 to 1000).
:SOURce[1]:SWEep:DIRection <direction>	Set sweep direction. UP (sweep start to stop) or DOWN (sweep stop to start).

* Maximum DC mode current is 1A. Maximum pulse mode current is 5A.

Table 8
Custom (list) sweep commands

Command	Description
:SOURce[1]:CURRent:MODE LIST	Select current list (custom) sweep mode.
:SOURce[1]:LIST:CURRent < I-list>	Define I-source list (I1, I2,… In; 0 to 5, 100 max points).[1]
:SOURce[1]:LIST:CURRent:APPend <I-list>	Add I-source list value(s) (I1, I2,…In; 0 to 5, 100 max).[1]
:SOURce[1]:LIST:CURRent:POINts?	Query length of I-source list.
:SOURce[1]:LIST:DELay < D-list>	Define pulse delay (D1, D2,… Dn; 20e-6 to 0.5).[2]
:SOURce[1]:LIST:DELay:APPend <D-list>	Add pulse delay list value(s) (D1, D2,…Dn; 20e-6 to 0.5).[2]
:SOURce[1]:LIST:DELay:POINts?	Query length of pulse delay list.
:SOURce[1]:LIST:WIDTh < W-list>	Define pulse width list (W1, W2,… Wn; 500e-9 to 5e-3).[2]
:SOURce[1]:LIST:WIDTh:APPend <W-list>	Add pulse width list value(s) (W1, W2,…Wn; 500e-9 to 5e-3).[2]
:SOURce[1]:LIST:WIDTh:POINts?	Query length of pulse width list.
:SOURce[1]:LIST:DIRection <direction>	Set sweep direction (UP or DOWN).

[1] 5A maximum pulse mode only. 1A maximum in DC mode.
[2] Minimum and default pulse delay and width values depend on pulse duty cycle. See Model 2520 specifications. If delay and width are not programmed, default values of 1.5ms (delay) and 500ns (width) will be used, but queries will return 0.

Programming examples

The command sequence for a linear staircase sweep is provided in Table 9, while Table 10 lists commands for a custom sweep.

Table 9
Linear staircase sweep programming example

Command	Description
*RST	Restore GPIB default conditions.
:FORM:ELEMVOLT1,CURR2,CURR3	Laser diode voltage, detector current data.
:SENS1:VOLT:RANG 5	5V measure range.
:SOUR1:CURR:RANG 0.5	500mA source range.
:SOUR1:CURR:STAR 10e-3	10mA start current.
:SOUR1:CURR:STOP 100e-3	100mA stop current.
:SOUR1:CURR:STEP 10e-3	10mA step current.
:SOUR1:CURR:MODE SWE	Select staircase sweep mode.[1]
:SOUR1:SWE:SPAC LIN	Select linear staircase sweep.
:SOUR2:VOLT 5	Detector 1 bias = 5V.
:SOUR3:VOLT 5	Detector 2 bias = 5V.
:OUTP1 ON	Turn on source outputs.
:READ?	Trigger sweep, request data.
:OUTP1 OFF	Turn off source outputs.

[1]This command should normally be sent after START, STOP, and STEP to avoid delays caused by rebuilding sweep when each command is sent.

Table 10
Custom sweep programming example

Command	Description
*RST	Restore GPIB default conditions.
:FORM:ELEM VOLT1,CURR2,CURR3	Laser diode voltage, detector current data.
:SOUR1:CURR:MODE LIST	Current list sweep mode.
:SOUR1:LIST:CURR 0.2, 0.1, 0.4, 0.3, 0.5	Set current sweep points.
:SOUR1:LIST:DEL 7e-3, 4e-3, 2e-3, 8e-3, 1e-3	Set pulse delay sweep points.
:SOUR1:LIST:WIDT 10e-6, 50e-6, 35e-6, 20e-6, 60e-6	Set pulse width sweep points.
:SOUR2:VOLT 5	Detector 1 bias = 5V.
:SOUR3:VOLT 5	Detector 2 bias = 5V.
:OUTP1 ON	Turn on source outputs.
:READ?	Trigger sweep, request data.
:OUTP1 OFF	Turn off source outputs.

Math functions

The Model 2520 has built-in math functions to calculate conductance, resistance, MX + B, power, and delta. Conductance, resistance, and power are available only for laser diode voltage measurements. MX + B is available for all three measurement functions (laser diode voltage and both detector current measurements). Delta is available only via remote.

Conductance

This math function computes the conductance from the ratio between the laser diode current source value and the measured voltage:

Conductance $= I_L/V_L$

where: I_L = laser diode source current

        V_L = measured laser diode voltage

Press CONFIG > press MATH> select CHANNEL1 > select I/V.

Press MATH. The laser diode measurement field on the bottom line will display conductance.

Resistance

This math function computes the resistance using the ratio between the measured laser diode voltage and the source current:

Resistance $= V_L/I_L$

where: V_L = laser diode voltage measurement

        I_L = laser diode source current

Press CONFIG > press MATH > select CHANNEL1 > select V/I.

Press MATH. The laser diode measurement field on the bottom line will display resistance.

Power

This math function calculates power using the measured voltage and source current values as follows:

Power $= V_L \times I_L$

where: V_L = laser diode voltage measurement

        I_L = laser diode source current

Press CONFIG > press MATH > select CHANNEL1 > select P.

Press MATH. The laser diode measurement field on the bottom line will display power.

MX + B

This math function multiplies the measured laser diode voltage or photodiode detector current by an offset factor and adds an offset value as follows:

Reading   = MX + B

where: M = gain (slope) factor

                X = measured laser diode voltage (V_L) or photodiode current (I_{PD})

                B = offset value

Press CONFIG > press MATH > select CHANNEL1, CHANNEL2, or CHANNEL1 > select MX +B_UNIT (CHANNEL1 only). Enter M, B, and units at the prompts.

Press MATH. The measurement field(s) on the bottom line will display the MX+B value.

Delta (remote only)

This math function computes the difference between the detector 1 current and the detector 2 current reading:

Delta   = I_{PD1} - I_{PD2}

where: I_{PD1} = detector 1 current

            I_{PD2} = detector 2 current

The calculation is performed point-by-point on individual A/D samples, not on the final current measurements, and it is available only via remote using the CALC4 commands (Table 11).

Remote math functions

Table 11 summarizes commands to control the measurement math functions by remote, while Table 12 shows a programming example.

Table 11
Math function commands

Command	Description
:CALCulate[1]:DATA?	Request laser diode math reading.
:CALCulate[1]:FORMat <function>	Set laser diode math function (MXB[1], CONDuctance[1], POWER[1], or RESistance[1]).
:CALCulate[1]:KMATh:MMFactor <M>	Set laser diode MX + B offset (B) value
:CALCulate[1]:KMATh:MBFactor <B>	Set laser diode MX + B slope (M) value.
:CALCulate[1]:KMATh:MUNits"<units>"	Set 1-character MX + B units suffix.
:CALCulate[1]:STATe <state>	Enable/enable laser diode math (ON or OFF).
:CALCulate2:DATA?	Request detector #1 math reading.
:CALCulate2:KMATh:MBFactor <B>	Set detector #1 MX + B offset (B).
:CALCulate2:KMATh:MMFactor <M>	Detector #1 MX + B slope (M).
:CALCulate2:KMATh:MUNits "<units>"	Set 1-character MX + B units suffix.
:CALCulate2:STATe <state>	Enable/enable detector #1 math. (ON or OFF).
:CALCulate3:DATA?	Request detector #2 math reading.
:CALCulate3:KMATh:MBFactor <B>	Set detector #2 MX + B offset (B).
:CALCulate3:KMATh:MMFactor <M>	Detector #2 MX + B slope (M).
:CALCulate3:KMATh:MUNits "<units>"	Set 1-character MX + B units suffix.
:CALCulate3:STATe <state>	Enable/enable detector #2 math. (ON or OFF).
:CALCulate4:DATA?	Request delta reading (I_{PD1}-I_{PD2}).
:CALCulate4:STATe <state>	Enable/enable delta (ON or OFF).
:INIT	Trigger CALC readings (must use before sending CALCn:DATA?).

Table 12
Math function programming example

Command	Description
:CALC1:FORMPOWER1	Select laser diode power function.
;CALC1:KMAT:MUN 'W'	Set "W" math units.
:CALC1:STAT ON	Enable laser diode math.
:CALC2:KMAT:MBF 5e-3	Detector #1 MX + B offset (B) = 5e-3.
:CALC2:KMAT:MMF 0.5	Detector #1 slope (M) =0.5.
:CALC2:STAT ON	Enable detector #1 math.
:OUTP1 ON	Turn on outputs.
:INIT	Trigger math readings.
:CALC1:DATA?	Request laser diode power result.
:CALC2:DATA?	Request detector #1 MX + B result.
:OUTP1 OFF	Outputs off.

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