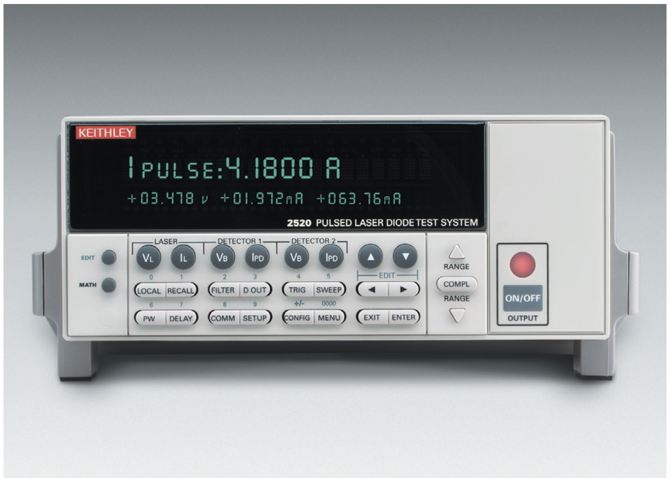
2520 Pulsed Laser Diode Test System

Datasheet



Remote Electrical Test Head included

KEITHLEY
A Tektronix Company

The Model 2520 Pulsed Laser Diode Test System is an integrated, synchronized system for testing laser diodes early in the manufacturing process, when proper temperature control cannot be easily achieved. The Model 2520 provides all sourcing and measurement capabilities needed for pulsed and continuous LIV (light-currentvoltage) testing of laser diodes in one compact, half-rack instrument. The tight synchronization of source and measure capabilities ensures high measurement accuracy, even when testing with pulse widths as short as 500ns.

Key Performance Specifications

- Simplifies laser diode LIV testing prior to packaging or active temperature control
- Integrated solution for in-process LIV production testing of laser diodes at the chip or bar level
- Sweep can be programmed to stop on optical power limit
- Combines high accuracy source and measure capabilities for pulsed and DC testing
- Synchronized DSP based measurement channels ensure highly accurate light intensity and voltage measurements
- Programmable pulse on time from 500ns to 5ms up to 4% duty cycle
- Pulse capability up to 5A, DC capability up to 1A
- 14-bit measurement accuracy on three measurement channels (VF, front photodiode, back photodiode)
- Measurement algorithm increases the pulse measurement's signal-tonoise ratio
- Up to 1000-point sweep stored in buffer memory eliminates GPIB traffic during test, increasing throughput
- Digital I/O binning and handling operations
- IEEE-488 and RS -232 interfaces

Applications

Production testing of:

- Telecommunication laser diodes
- Optical storage read/write head laser diodes
- Vertical Cavity Surface-Emitting Lasers (VCSELs)
- Thermal impedance
- Junction temperature response

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LIV Test Capability

The Model 2520 can perform pulsed LIV testing up to 5A and continuous LIV testing up to 1A. Its pulsed testing capability makes it suitable for testing a broad range of laser diodes, including the pump laser designs for Raman amplifiers. The instrument's ability to perform both DC and pulsed LIV sweeps on the same device simplifies analyzing the impact of thermal transients on the LIV characteristics of the laser diode.

Maximize Throughput and Eliminate Production Bottlenecks

By working in cooperation with leading laser diode manufacturers, Keithley designed the Model 2520 specifically to enhance chip- and bar-level test stand yield and throughput. Its integrated design, ease of use, high speed, and high accuracy provides a complete solution to help laser diode manufacturers meet their production schedules. Producers of laser diodes face constant pressure to increase test throughput and optimize return on investment for their capital equipment used in production testing. Until recently, these producers were forced to use relatively slow and cumbersome test stands for testing laser diodes at the chip and bar level, which often led to production bottlenecks.

Higher Resolution for Higher Yields

To achieve the required signal-to-noise ratio, traditional chip- and bar-level LIV testing solutions have required the use of boxcar averagers or test system control software modifications to allow averaging several pulsed measurements. The resolution of these measurements is critical for the "kink" test and threshold current calculations. With earlier test system designs, particularly when performing the kink test, low resolution and poor linearity of the analog digitizer made it extremely difficult to discriminate between noise in the measurement and an actual device kink. The Model 2520's unique DSP-based measurement approach automatically identifies the settled region of the pulsed waveforms measured. This means the Model 2520 stores only that portion of the pulse that is "flat" and contains meaningful data. All measurements made in the flat portion of the pulse are averaged to improve the Signal-to-Noise ratio still further. If greater resolution is required, the Model 2520 can be programmed to perform several pulse and measure cycles at the same pulse amplitude. By making it possible to conduct more thorough testing at the bar or chip level, the Model 2520 also eliminates the wasted time and costs associated with assembling then scrapping modules with non-compliant diodes.

Simple, One-Box Test Solution

The Model 2520 offers three channels of source and measurement circuitry. All three channels are controlled by a single digital signal processor (DSP), which ensures tight synchronization of the sourcing and measuring functions. The laser diode drive channel provides a current source coupled with voltage measurement capability. Each of the two photodetector channels supplies an adjustable voltage bias and voltage compliance, in addition to current measurement capability. These three channels provide all the source and measure capabilities needed for full LIV characterization of laser diodes prior to integration into temperature controlled modules. By eliminating the need for GPIB commands to perform test sweeps with multiple separate instruments, the Model 2520's integrated sourcing and measurement allows a significant improvement in throughput.

Ordering Information

2520	Pulsed Laser Diode Test System with Remote Test Head

Accessories Supplied

User's Manual, Quick Reference Guide,
Triax Cables (2), BNC 10W Coaxial Cables (4)

Accessories Available

7007-1	Double Shielded GPIB Cable, 1m (3.3 ft.)
7007-2	Double Shielded GPIB Cable, 2m (6.6 ft.)
KPCI-488LPA	IEEE-488 Interface/ Controller for the PCI Bus
KUSB-488B	IEEE-488 USB-to-GPIB Adapter for USB Port

Services Available

2520-3Y-EW	1-year factory warranty extended to 3 years from date of shipment
C/2520-3Y-DATA 3	(Z540-1 compliant) calibrations within 3 years of purchase*

*Not available in all countries

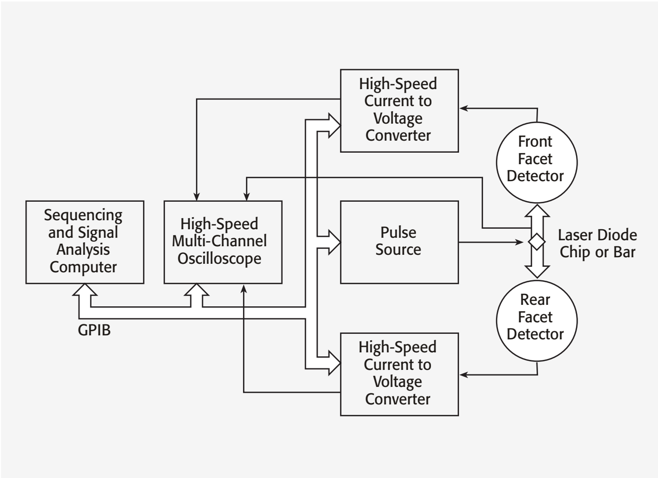

FIGURE 1. This schematic reflects the current testing practices of major laser diode manufacturers. Note that the use of discrete test components increases the integration and programming effort, while severely limiting the flexibility of the test system.

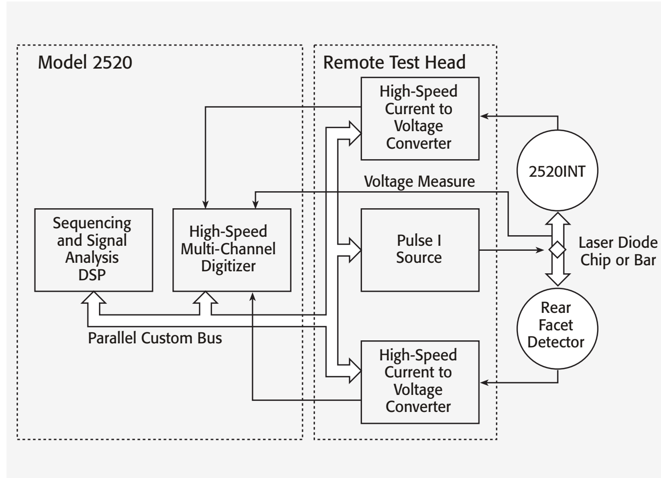

FIGURE 2. The Model 2520 integrates synchronization, source, and measure capabilities in a single half-rack instrument (with remote test head) to provide maximum flexibility and test throughput.

Remote Test Head Maximizes Signal-to-Noise Ratio

The mainframe and remote test head architecture of the Model 2520 is designed to enhance pulsed measurement accuracy, even at the sub-microsecond level. The remote test head ensures the measurement circuitry is located near the DUT, mounted on the fixture, minimizing cable effects. As the schematic in **Figure 1** shows, traditional semi-custom systems typically employed in the past require significant integration. The architecture of the Model 2520 **(Figure 2)** offers a far more compact and ready-to-use solution.

High Speed Pulse and Measure to Minimize Thermal Effects

The Model 2520 can accurately source and measure pulses as short as 500 nanoseconds to minimize unwanted thermal effects during LIV testing. Users can program the pulse width from 500ns to 5ms and pulse off time from 20µs to 500ms. There is a software duty cycle limit of 4% for currents higher than 1A. To ensure greater accuracy, the instrument provides pulse width programming resolution levels of 10µs (off time) and 100ns (on time).

Prior to the introduction of the Model 2520, test instrument limitations often placed barriers on test performance. However, with the Model 2520, the limiting factor is not the test instrument, but the physics of the connections to the device. Keithley's optoelectronics applications engineers have addressed these issues by studying and documenting the optimum cable configuration to enhance measurement accuracy with extremely fast pulses. **Figure 3** illustrates the results of a typical pulse LIV sweep test with the Model 2520. In this test, a 100-point pulsed LIV sweep using a 1µs pulse width, at 1% duty cycle, was completed in just 110ms (including data transfer time), several orders of magnitude faster than existing, semi-custom test systems.

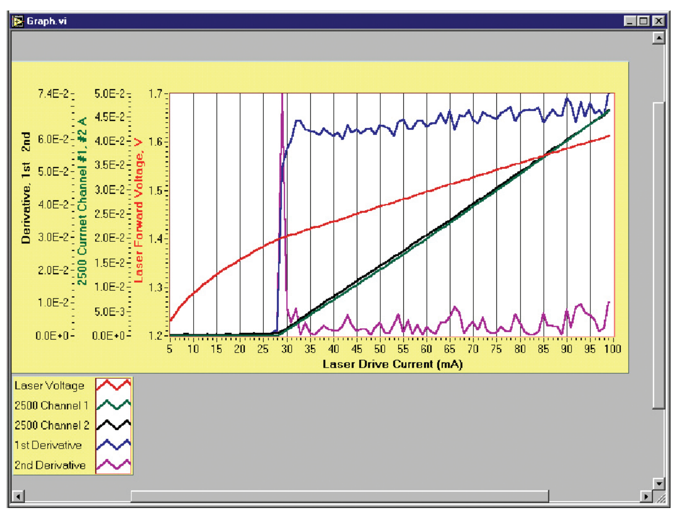

FIGURE 3. This plot illustrates the Model 2520's pulsed LIV sweep capability. The sweep was programmed from 0 to 100mA in 1mA steps. Pulse width was programmed at 1µs at 1% duty cycle, providing for a complete sweep in just 10ms (excluding data transfer time).

ESD Protection

A laser diode's material make-up, design, and small size make it extremely sensitive to temperature increases and electrostatic discharges (ESDs). To prevent damage, prior to the start of the test and after test completion, the Model 2520 shorts the DUT to prevent transients from destroying the device. The instrument's 500 nanosecond pulse and measure test cycle minimizes device heating during test, especially when a short duty cycle is used.

Test Sequencing and Optimization

Up to five user-definable test setups can be stored in the Model 2520 for easy recall. The Model 2520's built-in Buffer Memory and Trigger Link interface can reduce or even eliminate time-consuming GPIB traffic during a test sequence. The Buffer Memory can store up to 1000 points of measurement data during the test sweep. The Trigger Link combines six independent software selectable trigger lines on a single connector for simple, direct control over all instruments in a system. This interface allows the Model 2520 to operate autonomously following an input trigger. The Model 2520 can be programmed to output a trigger to a compatible OSA or wavelength meter several nanoseconds prior to outputting a programmed drive current value to initiate spectral measurements.

Accessories and Options

The Model 2520 comes with all the interconnecting cables required for the main instrument and the remote test head. Production test practices vary widely (automated vs. semi-automated vs. manual), so the cable assemblies from the remote test head to the DUT can vary significantly. To accommodate these differing requirements, Keithley has developed the Model 2520 RTH to DUT Cable Configuration Guide to help customers determine the proper cable assemblies to use to connect the remote test head (RTH) to the DUT.

FIGURE 4. Model 2520 Remote Test Head

Interface Options

The Model 2520 provides standard IEEE-488 and RS-232 interfaces to speed and simplify system integration and control. A built-in digital I/O interface can be used to simplify external handler control and binning operations.

Laser Diode Pulse or DC Current Source Specifications

Drive Current					Off Current[4]			
Source Range	Programming Resolution	Approx. Electrical Resolution	Accuracy[1, 6] ±(%rdg. + mA)[2, 3]	RMS Noise (typical) (1kHz–20MHz)	Range	Programming Resolution	Approx. Electrical Resolution	Accuracy[1] ±(%rdg. + mA)
0–500 mA	10 µA	8 µA	0.2 + 0.45	70 µA	0–15 mA	1 µA	7 nA typ.	0.2 + 0.45
0–1.0 A DC 0–5.0 A Pulse	100 µA	80 µA	0.2 + 4.5	800 µA	0–150 mA	10 µA	70 nA typ.	0.2 + 4.5

TEMPERATURE COEFFICIENT (0°–18°C & 28°–50°C): ±(0.15 × accuracy specification)/°C.
PULSE ON TIME[19]: 500ns to 5ms, 100ns programming resolution.
PULSE OFF TIME[19]: 20µs to 500ms, 10µs programming resolution.
PULSE DUTY CYCLE[20, 21]: 0 to 99.6% for ≤1.0A; 0 to 4% for >1.0A.
VOLTAGE COMPLIANCE: 3V to 10V, 10mV programming resolution[5].
POLARITY: 1 quadrant source, polarity reversal available through internal relay inversion.
OUTPUT OFF: <200mΩ short across laser diode; measured at Remote Test Head connector.

Setting and Range	Load[7]	Pulse Mode	Pulse Overshoot Max.[6, 8, 9]	Rise/Fall Time[6, 8, 9, 10]	
				Typical	Max.
500 mA	10 Ω 1/4 Watt	Fast	1.0%	70 ns	95 ns
500 mA	10 Ω 1/4 Watt	Slow	0.1%	1.2 µs	1.5 µs
5.00 A	1.5 Ω 1 Watt	Fast	1.0%	100 ns	130 ns
5.00 A	1.5 Ω 1 Watt	Slow	0.1%	1.2 µs	1.5 µs

Laser Diode Voltage Measure Specifications

Range	Minimum Resolution	Accuracy ±(%rdg. + volts)[1, 12]	RMS Noise (typical)[13]
5.00 V	0.33 mV	0.3% + 6.5 mV	90 µV
10.00 V	0.66 mV	0.3% + 8 mV	180 µV

TEMPERATURE COEFFICIENT (0°–18°C & 28°–50°C): ±(0.15 × accuracy specification)/°C.
MAX. LEAD RESOLUTION: 100Ω for rated accuracy.
INPUT IMPEDANCE: 2MΩ differential, 1MΩ from each input to common.
Input bias current ±7.5µA max.

Photodiode Current Measure Specifications (each channel)

RANGE: 0 to ±20VDC.
PROGRAMMING RESOLUTION: 10mV.
ACCURACY: ±(1% + 50mV).
CURRENT: 160mA max. with V-Bias shorted to I-Measure.
RMS NOISE (1kHz to 5MHz): 1mV typical.

Photodiode Current Measure Specifications (each channel)

Range	Minimum Resolution[4]	DC Input Impedance	Accuracy ±(%rdg. + current)[1, 2]	RMS Noise (typical)[3]
10.00 mA	0.7 µA	< 10 Ω	0.3% + 20 µA	90 nA
20.00 mA	1.4 µA	< 6 Ω	0.3% + 65 µA	180 nA
50.00 mA	3.4 µA	< 3 Ω	0.3% + 90 µA	420 nA
100.00 mA	6.8 µA	< 2.5 Ω	0.3% + 175 µA	840 nA

TEMPERATURE COEFFICIENT (0°–18°C & 28°–50°C): ±(0.15 × accuracy specification)/°C.
INPUT PROTECTION: The input is protected against shorting to the associated channel's internal bias supply. The input is protected for shorts to external supplies up to 20V for up to 1 second with no damage, although calibration may be affected.

System Speeds

Reading Rates (ms)[15, 16]

Number of Source Points[17]	To Memory	To GPIB
1	5.3	6.8
10[18]	9.5	18
100[18]	48	120
1000[18]	431	1170

General

DC FLOATING VOLTAGE: User may float common ground up to ±10VDC from chassis ground.

COMMON MODE ISOLATION: >10⁹Ω.

OVERRANGE: 105% of range on all measurements and voltage compliance.

SOURCE OUTPUT MODES:
- Fixed DC Level
- Fixed Pulse Level
- DC Sweep (linear, log, and list)
- Pulse Sweep (linear, log, and list)
- Continuous Pulse (continuous – low jitter)

PROGRAMMABILITY: IEEE-488 (SCPI-1995.0), RS-232, 5 user-definable power-up states plus factory default and *RST.

DIGITAL INTERFACE:

Safety Interlock: External mechanical contact connector and removable key switch.

Aux. Supply: +5V @ 300mA supply.

Digital I/O: 2 trigger input, 4 TTL/Relay Drive outputs (33V @ 500mA max., diode clamped).

Trigger Link: 6 programmable trigger input/outputs.

Pulse Trigger Out BNC: +5V, 50W output impedance, output trigger corresponding to current source pulse; pulse to trigger delay <100ns. See Figure 3.

MAINS INPUT: 100V to 240V rms, 50–60Hz, 140VA.

EMC: Conforms to European Union Directive 89/336/EEC (EN61326-1).

SAFETY: Conforms to European Union Directive 73/23/EEC (EN61010-1) CAT 1.

VIBRATION: MIL-PRF-28800F Class 3, Random.

WARM-UP: 1 hour to rated accuracy.

DIMENSIONS, WEIGHT:

Main Chassis, bench configuration (with handle & feet): 105mm high × 238mm wide × 416mm deep (4 1/8 in. × 9 3/8 in. × 16 3/8 in.). 2.67kg (5.90 lbs).

Remote Test Head: 95mm high × 178mm deep (with interlock key installed) × 216mm wide (3½ in. × 7 in. × 8½ in.). 1.23kg (2.70 lbs).

ENVIRONMENT:

Operating: 0°–50°C, 70% R.H. up to 35°C. Derate 3% R.H./°C, 35°–50°C.

Storage: –25° to 65°C.

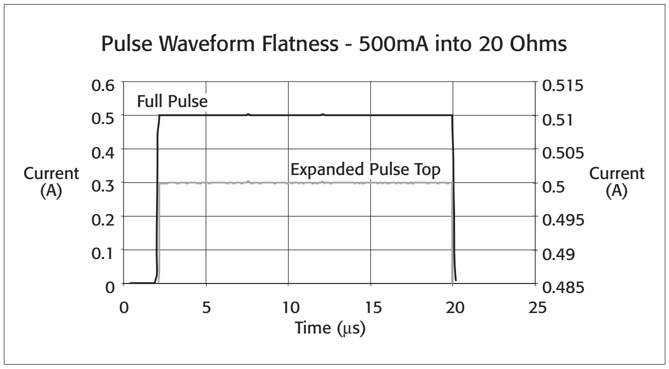

FIGURE 1

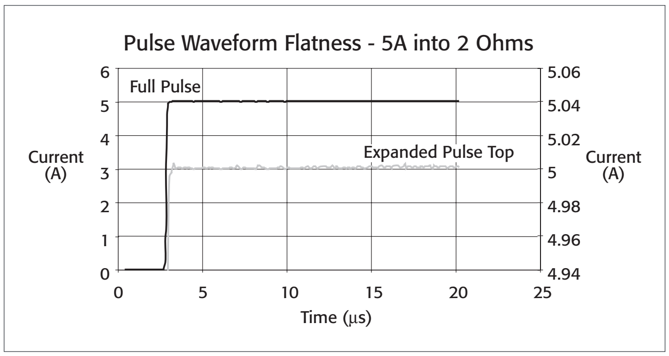

FIGURE 2

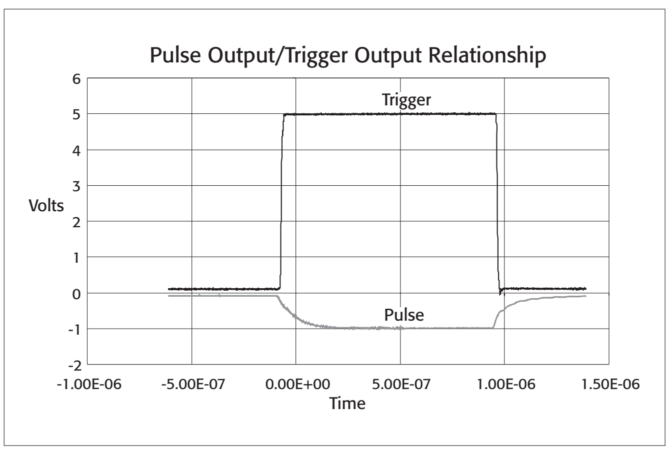

FIGURE 3

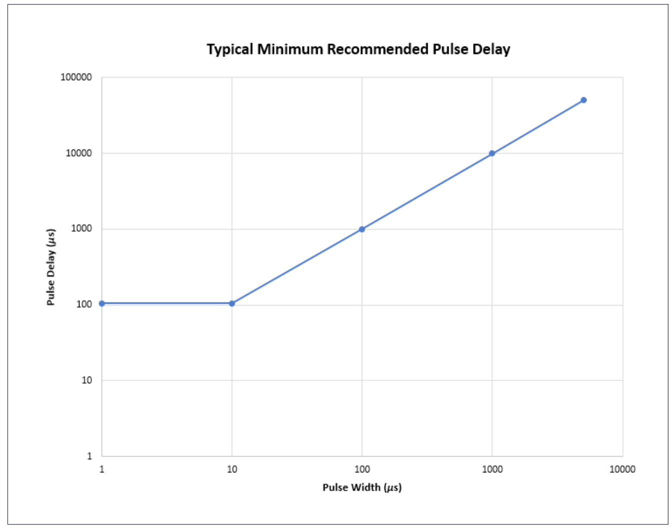

FIGURE 4

Notes

1. 1 year, 23°C ±5°C.
2. If $\sqrt{\text{Duty Cycle}} \cdot I$ exceeds 0.2, accuracy specifications must be derated with an additional error term as follows:

   500mA Range: $\pm 0.1\%$ rdg. $\cdot \sqrt{D} \cdot I$

   5A Range: $\pm 0.3\%$ rdg. $\cdot \sqrt{D} \cdot I$

   where: I = current setting

   D = duty cycle

   This derating must also be applied for a period equal to the time that $\sqrt{D} \cdot I$ was ≥0.2.
3. Not including overshoot and setting time.
4. Pulse mode only.
5. Output: 500mA DC on 500mA range and 1A DC on 5A range.
6. Refer to Model 2520 Service Manual for test setup of current accuracy.
7. **Figures 1 and 2** are typical pulse outputs into resistive loads.
8. Typical.
9. Per ANSI/IEEE Std 181-1977.
10. Per ANSI/IEEE Std 181-1977 10% to 90%.
11. DC accuracy ±700mV @ output terminal. 0.2Ω typical output impedance.
12. At DC, 10µs measurement pulse width, filter off.
13. Standard deviation of 10,000 readings with 10µs pulse width, filter off, with I source set to 0A DC.
14. The A/D converter has 14 bit resolution. The useful resolution is improved by reading averaging. The useful resolution is:

$$\text{Useful Resolution} = \frac{\text{Range}}{2^{14}} \cdot \frac{1}{\sqrt{\frac{\text{Pulse Width (ns)} - 400\text{ns}}{100\text{ns}} \cdot \text{Averaging Filter Setting}}}$$

15. Excluding total programmed (Pulse ON time + Pulse OFF time).
16. Front panel off, calc off, filter off, duty cycle <10%, binary communications.
17. Returning 1 voltage and 2 current measurements for each source point.
18. Sweep mode.
19. Valid for both continuous pulse and sweep modes.
20. Duty Cycle = (pw/(pw+pd))
21. Valid for continuous pulse mode only. For all other modes, as the pulse width becomes large relative to the pulse delay, the actual pulse delay may be longer than the programmed pulse delay due to time required for measurement processing. Typical minimum pulse delay settings for a given pulse width can be seen in the graph in **Figure 4**.

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2510
2510-AT

TEC SourceMeter® SMU Instrument
Autotuning TEC SourceMeter SMU Instrument

The Models 2510 and 2510-AT TEC SourceMeter SMU instruments enhance Keithley's CW (Continuous Wave) test solution for high speed LIV (light-current-voltage) testing of laser diode modules. These 50W bipolar instruments were developed in close cooperation with leading manufacturers of laser diode modules for fiber-optic telecommunications networks. Designed to ensure tight temperature control for the device under test, the Model 2510 was the first in a line of highly specialized instruments created for telecommunications laser diode testing. It brings together Keithley's expertise in high speed DC sourcing and measurement with the ability to control the operation of a laser diode module's Thermo-Electric Cooler or TEC (sometimes called a Peltier device) accurately.

The Model 2510-AT expands the capability of the Model 2510 by offering autotuning capability. P, I, and D (proportional, integral, and derivative) values for closed loop temperature control are determined by the instrument using a modified Zeigler-Nichols algorithm. This eliminates the need for users to determine the optimal values for these coefficients experimentally. In all other respects, the Model 2510 and Model 2510-AT provide exactly the same set of features and capabilities.

Ordering Information

2510 **TEC SourceMeter**

2510-AT **Autotuning TEC SourceMeter SMU Instrument**

Accessories Supplied

User's Manual, Input/Output Connector

The SourceMeter Concept

The Model 2510 and Model 2510-AT draw upon Keithley's unique SourceMeter concept, which combines precision voltage/current sourcing and measurement functions into a single instrument. SourceMeter SMU instruments provide numerous advantages over the use of separate instruments, including lower acquisition and maintenance costs, the need for less rack space, easier system integration and programming, and a broad dynamic range.

Part of a Comprehensive LIV Test System

In a laser diode CW test stand, the Model 2510 or Model 2510-AT can control the temperature of actively cooled optical components and assemblies (such as laser diode modules) to within ±0.005°C of the user-defined setpoint. During testing, the instrument measures the internal temperature of the laser diode module from any of a variety of temperature sensors, then drives power through the TEC within the laser diode module in order to maintain its temperature at the desired setpoint.

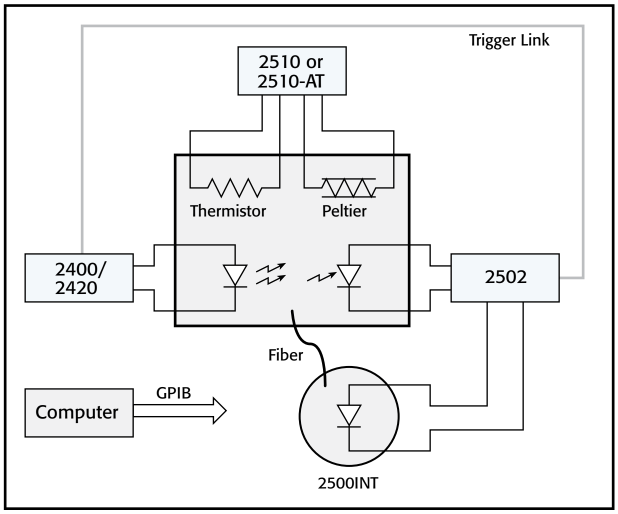

Figure 1. The capabilities of the Models 2510 and 2510-AT are intended to complement those of other Keithley instruments often used in laser diode module LIV testing, including the Model 2400 and 2420 SourceMeter SMU instruments, the Model 2502 Dual Photodiode Meter, and the Model 2500INT Integrating Sphere.

Precision temperature control for TECs with autotuning PID for optimal performance

SEMICONDUCTOR

Precision temperature control for TECs with autotuning PID for optimal performance

2510
2510-AT

TEC SourceMeter® SMU Instrument
Autotuning TEC SourceMeter SMU Instrument

- **50W TEC Controller combined with DC measurement functions**
- **Fully digital P-I-D control**
- **Autotuning capability for the thermal control loop (2510-AT)**
- **Designed to control temperature during laser diode module testing**
- **Wide temperature setpoint range (–50°C to +225°C) and high setpoint resolution (±0.001°C) and stability (±0.005°C)**
- **Compatible with a variety of temperature sensor inputs—thermistors, RTDs, and IC sensors**
- **Maintains constant temperature, current, voltage, and sensor resistance**
- **AC Ohms measurement function verifies integrity of TEC**
- **Measures and displays TEC parameters during the control cycle**
- **4-wire open/short lead detection for thermal feedback element**
- **IEEE-488 and RS-232 interfaces**
- **Compact, half-rack design**

APPLICATIONS

Control and production testing of thermoelectric coolers (Peltier devices) in:

- **Laser diode modules**
- **IR charge-coupled device (CCD) arrays and charge-injection devices (CID)**
- **Cooled photodetectors**
- **Thermal-optic switches**
- **Temperature controlled fixtures**

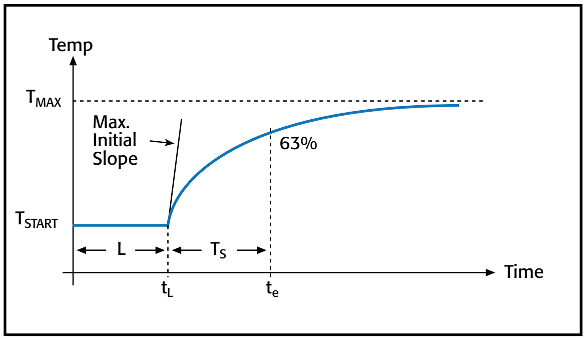

Figure 2.

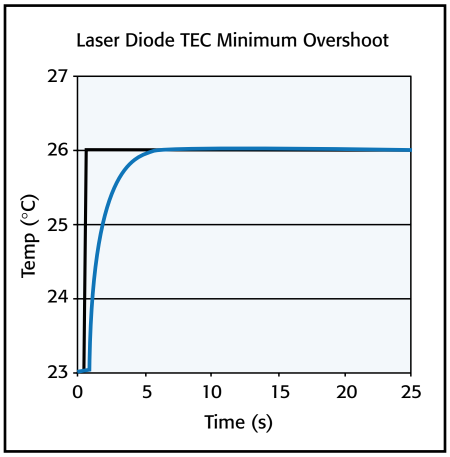

Figure 3.

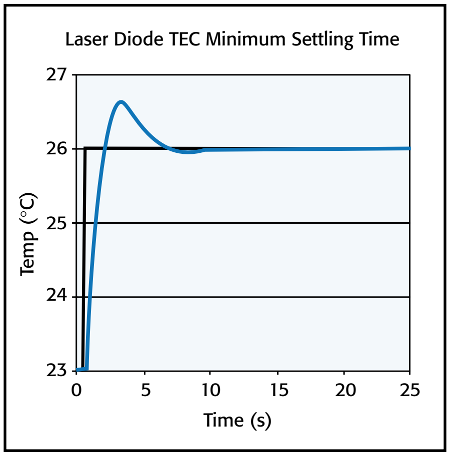

Figure 4.

Active temperature control is very important due to the sensitivity of laser diodes to temperature changes. If the temperature varies, the laser diode's dominant output wavelength may change, leading to signal overlap and crosstalk problems.

Autotuning Function

The Model 2510-AT Autotuning TEC SourceMeter SMU instrument offers manufacturers the ability to automatically tune the temperature control loop required for CW testing of optoelectronic components such as laser diode modules and thermo-optic switches. This capability eliminates the need for time-consuming experimentation to determine the optimal P-I-D coefficient values.

The Model 2510-AT's P-I-D Auto-Tune software employs a modified Ziegler-Nichols algorithm to determine the coefficients used to control the P-I-D loop. This algorithm ensures that the final settling perturbations are damped by 25% each cycle of the oscillation. The autotuning process begins with applying a voltage step input to the system being tuned (in open loop mode) and measuring several parameters of the system's response to this voltage step function. The system's response to the step function is illustrated in **Figure 2**. The lag time of the system response, the maximum initial slope, and the TAU [63% (1/e)] response time are measured, then used to generate the Kp (proportional gain constant), Ki (integral gain constant), and Kd (derivative gain constant) coefficients.

The autotuning function offers users a choice of a minimum settling time mode or a minimum overshoot mode, which provides the Model 2510-AT with the flexibility to be used with a variety of load types and devices. For example, when controlling a large area TEC in a test fixture optimized for P, I, and D values, minimum overshoot protects the devices in the fixture from damage (**Figure 3**). For temperature setpoints that do not approach the maximum specified temperature for the device under test, the minimum settling time mode can be used to speed up the autotuning function (**Figure 4**).

50W Output

As the complexity of today's laser diode modules increases, higher power levels are needed in temperature controllers to address the module's cooling needs during production test. The 50W

SEMICONDUCTOR

2510
2510-AT

TEC SourceMeter® SMU Instrument
Autotuning TEC SourceMeter SMU Instrument

(5A @ 10V) output allows for higher testing speeds and a wider temperature setpoint range than other, lower-power solutions.

High Stability P-I-D Control

When compared with other TEC controllers, which use less sophisticated P-I (proportional-integral) loops and hardware control mechanisms, this instrument's software-based, fully digital P-I-D control provides greater temperature stability and can be easily upgraded with a simple firmware change. The resulting temperature stability (±0.005°C short term, ±0.01°C long term) allows for very fine control over the output wavelength and optical power of the laser diode module during production testing of DC characteristics. This improved stability gives users higher confidence in measured values, especially for components or sub-assemblies in wavelength multiplexed networks. The derivative component of the instrument's P-I-D control also reduces the required waiting time between making measurements at various temperature setpoints. The temperature setpoint range of –50°C to +225°C covers most of the test requirements for production testing of cooled optical components and sub-assemblies, with a resolution of ±0.001°C.

Before the introduction of the Model 2510-AT, configuring test systems for new module designs and fixtures required the user to determine the best combination of P, I, and D coefficients through trial-and-error experimentation. The Model 2510-AT's autotuning function uses the modified Zeigler-Nichols algorithm to determine the optimal P, I, and D values automatically.

Adaptable to Evolving DUT Requirements

The Model 2510 and Model 2510-AT are well suited for testing a wide range of laser diode modules because they are compatible with the types of temperature sensors most commonly used in these modules. In addition to 100Ω, 1kΩ, 10kΩ, and 100kΩ thermistors, they can handle inputs from 100Ω or 1kΩ RTDs, and a variety of solid-state temperature sensors. This input flexibility ensures their adaptability as the modules being tested evolve over time.

Programmable Setpoints and Limits

Users can assign temperature, current, voltage, and thermistor resistance setpoints. The thermistor resistance setpoint feature allows higher correlation of test results with actual performance in the field for laser diode modules because reference resistors are used to control the temperature of the module. Programmable power, current, and temperature limits offer maximum protection against damage to the device under test.

Accurate Real-Time Measurements

Both models can perform real-time measurements on the TEC, including TEC current, voltage drop, power dissipation, and resistance, providing valuable information on the operation of the thermal control system.

Peltier (TEC) Ohms Measurement

TEC devices are easily affected by mechanical damage, such as sheer stress during assembly. The most effective method to test a device for damage after it has been incorporated into a laser diode module is to perform a low-level AC (or reversing DC) ohms measurement. If there is a change in the TEC's resistance value when compared with the manufacturer's specification, mechanical damage is indicated. Unlike a standard DC resistance measurement, where the current passing through the device can produce device heating and affect the measured resistance, the reversing DC ohms method does not and allows more accurate measurements.

Open/Short Lead Detection

Both models of the instrument use a four-wire measurement method to detect open/short leads on the temperature sensor before testing. Four-wire measurements eliminate lead resistance errors on the measured value, reducing the possibility of false failures or device damage.

Interface Options

Like all newer Keithley instruments, both models of the instrument include standard IEEE-488 and RS-232 interfaces to speed and simplify system integration and control.

Optional Resistive Heater Adapter

The Model 2510-RH Resistive Heater Adapter enables either model of the instrument to provide closed loop temperature control for resistive heater elements, rather than for TECs. When the adapter is installed at the instrument's output terminal, current flows through the resistive heater when the P-I-D loop indicates heating. However, no current will flow to the resistive heater when the temperature loop calls for cooling. The resistive element is cooled through radiation, conduction, or convection.

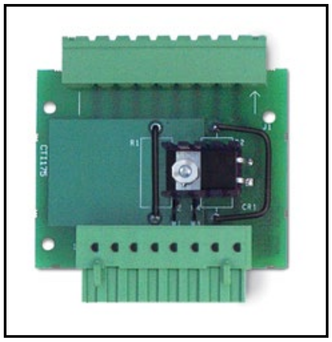

Figure 6. Optional heater adapter

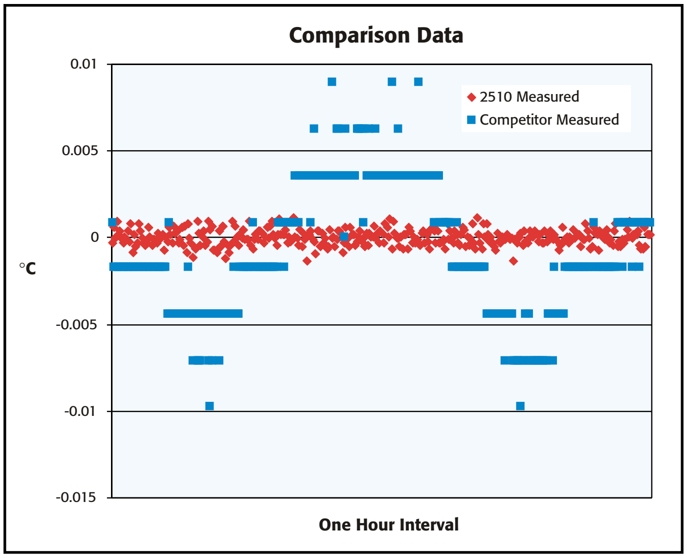

Figure 5. This graph compares the Model 2510/2510-AT's A/D converter resolution and temperature stability with that of a leading competitive instrument. While the competitive instrument uses an analog proportional-integral (P-I) control loop, it displays information in digital format through a low-resolution analog-to-digital converter. In contrast, the Model 2510/2510-AT uses a high-precision digital P-I-D control loop, which provides greater temperature stability, both over the short term (±0.005°C) and the long term (±0.01°C).

2510
2510-AT

TEC SourceMeter® SMU Instrument
Autotuning TEC SourceMeter SMU Instrument

SPECIFICATIONS

The Models 2510 and 2510-AT TEC SourceMeter SMU instruments are designed to:

Control the power to the TEC to maintain a constant temperature, current, voltage, or thermistor resistance.

Measure the resistance of the TEC.

Provide greater control and flexibility through a software P-I-D loop.

CONTROL SYSTEM SPECIFICATIONS

SET: Constant Peltier Temperature, Constant Peltier Voltage, Constant Peltier Current. Constant Thermistor Resistance.

CONTROL METHOD: Programmable software PID loop. Proportional, Integral, and Derivative gains independently programmable.

SETPOINT SHORT TERM STABILITY: ±0.005°C rms[1,6,7].

SETPOINT LONG TERM STABILITY: ±0.01°C[1,6,8].

SETPOINT RANGE: –50°C to 225°C.

UPPER TEMPERATURE LIMIT: 250°C max.

LOWER TEMPERATURE LIMIT: –50°C max.

SETPOINT RESOLUTION: ±0.001°C, <±400µV, <±200µA 0.01% of nominal (25°C) thermistor resistance.

HARDWARE CURRENT LIMIT: 1.0A to 5.25A ±5%.

SOFTWARE VOLTAGE LIMIT:±0.5 to 10.5V ±5%.

TEC OUTPUT SPECIFICATIONS

OUTPUT RANGE: ±10VDC at up to ±5ADC.[15]

OUTPUT RIPPLE: <5mV rms[9].

AC RESISTANCE EXCITATION: ±(9.6mA ± 90µA).[14]

TEC MEASUREMENT SPECIFICATIONS[3]

Function	1 Year, 23°C ±5°C
Operating Resistance [2, 10, 11, 12]	±(2.0% of rdg + 0.1Ω)
Operating Voltage [2,10]	±(0.1% of rdg + 4mV)
Operating Current[10]	±(0.4% of rdg + 8mA)
AC Resistance [2, 18]	±(0.10% of rdg + 0.02Ω)

OPEN SHORTED THERMOELECTRIC DETECTION

LOAD IMPEDANCE: Stable into 1µF typical.

COMMON MODE VOLTAGE: 30VDC maximum.

COMMON MODE ISOLATION: >10[9]Ω, <1500pF.

MAX. VOLTAGE DROP BETWEEN INPUT/OUTPUT SENSE TERMINALS: 1V.

MAX. SENSE LEAD RESISTANCE: 1Ω for rated accuracy.

MAX. FORCE LEAD RESISTANCE: 0.1Ω.

SENSE INPUT IMPEDANCE: >400kΩ.

THERMAL FEEDBACK ELEMENT SPECIFICATIONS[3]

Sensor Type	RTD		Thermistor				Solid State	
	100 Ω	1 kΩ	100 Ω	1 kΩ	10 kΩ	100 kΩ	Current Output (I_{ss})	Voltage Output (V_{ss})
Excitation[13]	2.5 mA 4 V max	833 µA	2.5 mA 8 V max	833 µA 8 V max	100 µA 8 V max	33 µA 6.6 V max	+13.5 V 833 µA	2.5 mA 15.75V max
Nominal Resistance Range	0–250 Ω	0–2.50 kΩ	0–1 kΩ	0–10 kΩ	0–80 kΩ	0–200 kΩ		
Excitation Accuracy[1,3]	±1.5%	±2.9%	±2.9%	±2.9%	±2.9%	±2.9%	±12%	±2.9%
Nominal Sensor Temperature Range	–50° to +250°C	–50° to +250°C	–50° to +250°C	–50° to +250°C	–50° to +250°C	–50° to +250°C	–40° to +100°C	–40° to +100°C
Calibration	α, β, δ settable	α, β, δ settable	A, B, C settable	A, B, C settable	A, B, C settable	A, B, C settable	Slope & offset	Slope & offset
Measurement Accuracy[1,3] ±(% rdg + offset)	0.04 + 0.07 Ω[2]	0.04 + 0.04 Ω[2]	0.04 + 0.07 Ω[2]	0.04 + 0.4 Ω[2]	0.02 + 3 Ω	0.04 + 21 Ω	0.03 + 100 nA	0.03 + 500 µV

THERMISTOR MEASUREMENT ACCURACY[19]

Nominal Thermistor Resistance	Accuracy vs. Temperature 0°C	25°C	50°C	100°C
100 Ω	0.021°C	0.035°C	0.070°C	0.27°C
1 kΩ	0.015°C	0.023°C	0.045°C	0.18°C
10 kΩ	0.006°C	0.012°C	0.026°C	0.15°C
100 kΩ	0.009°C	0.014°C	0.026°C	0.13°C

OPEN/SHORTED ELEMENT DETECTION

SOFTWARE LINEARIZATION FOR THERMISTOR AND RTD

Common Mode Voltage: 30VDC.

Common Mode Isolation: >10[9]Ω, <1000pF.

Max. Voltage Drop Between Input/Output Sense Terminals: 1V.

Max. Sense Lead Resistance: 100Ω for rated accuracy.

Sense Input Impedance: >10[8]Ω.

GENERAL

NOISE REJECTION:

SPEED	NPLC	NMRR[16]	CMRR[17]
Normal	1.00	60 dB	120 dB[1]

SOURCE OUTPUT MODES: Fixed DC level.

PROGRAMMABILITY: IEEE-488 (SCPI-1995.0), RS-232, 3 user-definable power-up states plus factory default and *RST.

POWER SUPPLY: 90V to 260V rms, 50–60Hz, 75W.

EMC: Complies with European Union Directive 98/336/EEC (CE marking requirements), FCC part 15 class B, CTSPR 11, IEC 801-2, IEC 801-3, IEC 801-4.

VIBRATION: MIL-PRF-28800F Class 3 Random Vibration.

WARM-UP: 1 hour to rated accuracies.

DIMENSIONS, WEIGHT: 89mm high × 213 mm high × 370mm deep (3½ in × 8⅜ in × 14⁹⁄₁₆ in). Bench configuration (with handle and feet): 104mm high × 238mm wide × 370mm deep (4⅛ in × 9⅜ in × 14⁹⁄₁₆ in). Net Weight: 3.21kg (7.08 lbs).

ENVIRONMENT: Operating: 0°–50°C, 70% R.H. up to 35°C. Derate 3% R.H./°C, 35°–50°C. **Storage:** –25° to 65°C.

NOTES

1. Model 2510 and device under test in a regulated ambient temperature of 25°C.
2. With remote voltage sense.
3. 1 year, 23°C ±5°C.
4. With I_{Load} = 5A and V_{Load} = 0V.
5. With I_{Load} = 5A and V_{Load} = 10V.
6. With 10kΩ thermistor as sensor.
7. Short term stability is defined as 24 hours with Peltier and Model 2510 at 25°C ±0.5°C.
8. Long term stability is defined as 30 days with Peltier and Model 2510 at 25°C ±0.5°C.
9. 10Hz to 10MHz measured at 5A output into a 2Ω load.
10. Common mode voltage = 0V (meter connect enabled, connects Peltier low output to thermistor measure circuit ground). ±(0.1% of rdg. + 0.1Ω) with meter connect disabled.
11. Resistance range 0Ω to 20Ω for rated accuracy.
12. Current through Peltier > 0.2A.
13. Default values shown, selectable values of 3µA, 10µA, 33µA, 100µA, 833µA, 2.5mA. Note that temperature control performance will degrade at lower currents.
14. AC ohms is a dual pulsed measurement using current reversals available over bus only.
15. Settable to <400µV and <200µA in constant V and constant I mode respectively.
16. For line frequency ±0.1%.
17. For 1kΩ unbalance in LO lead.
18. Resistance range 0Ω to 100Ω for rated accuracy.
19. Accuracy figures represent the uncertainty that the Model 2510 may add to the temperature measurement, not including thermistor uncertainty. These accuracy figures are for thermistors with typical A,B,C constants.