KEITHLEY
**Keithley Instruments, Inc.**
28775 Aurora Road
Cleveland, Ohio 44139
(440) 248-0400
www.keithley.com



# Continuous Pulse Mode

In addition to LIV characterization, laser diodes typically require some type of wavelength or spectrum measurement. In these cases, the 2520 can be used as a current pulse generator, driving the laser diode with a current pulse train while a spectrometer or other instrument makes measurements. As a pulse generator, the 2520 provides a fixed pulse current level with control over pulse width and pulse off time to provide a desired duty cycle. As with conventional, single purpose pulse generators, no measurements are made when using the 2520 in the continuous pulse mode. Ensure that the 2520 is using the latest firmware, B06 as of this writing, before using the continuous pulse mode.

## Pulse Test Advantage

Testing in the pulse regime is done to minimize the heating of the diode junction, so duty cycles are typically 1% or less. By minimizing the heating, testing can be performed on the laser diode as soon as the lasing cavity is defined, at the wafer level for VCSELs and at the bar level for edge-emitting laser diodes. This early testing permits pass/fail and other grading decisions to be performed before any additional process or packaging costs are added to the device.

## Duty Cycle

The 2520 supports a wide range of duty cycles. There are two different maximum duty cycles based on the current source level:

For I ≥ 1.00A, Maximum Duty Cycle = 4 %
For I < 1.00A, Maximum Duty Cycle = 99.6 %

The duty cycle (DC) is controlled by adjusting the pulse width (PW) and pulse delay (PD) values. The pulse delay is the pulse off time. This gives:

$$DC\ \% = \frac{PW}{PW+PD} \times 100$$

where: DC = duty cycle (%)
PW = pulse width (s), 500ns to 5ms
PD = pulse delay (s), 20µs to 500ms

For example, the maximum duty cycle (for I < 1 A):

PW = 5ms
PD = 20µs

$$DC\% = \frac{5}{5.02} \times 100 = 99.6\ \%$$

Minimum Duty Cycle
PW = 500ns
PD = 500ms

$$DC\% = \frac{500 \times 10^{-9}}{0.5000005} \times 100 = 0.0001\%$$

# Configuring the 2520 to use Continuous Pulse Mode

## Front Panel

Set up pulse mode and triggering:

1. Press CONFIG key, then TRIG.
2. Select INIT then press ENTER.
3. Select OFF then press ENTER.
4. The 2520 should be at the CONFIGURE TRIGGER MENU. Select COUNT then press ENTER.
5. Select CONTINUOUS-PULSE then press ENTER.

Set the desired Pulse Width:

1. Press the PW key.
2. Use the EDIT keys (◄ ► ▲ ▼) to set the desired pulse width. Press ENTER when finished.

Set the desired Pulse Delay (in other words Pulse off time):

1. Press the DELAY key.
2. Use the EDIT keys (◄ ► ▲ ▼) to set the pulse delay to 000.33ms. Press ENTER when finished.

Set the desired current source value:

1. Press the $I_L$ key.
2. Use the EDIT keys (◄ ► ▲ ▼/) to set the desired current value. Press ENTER when finished.

To turn on the continuous pulse mode:

1. Press ON/OFF OUTPUT key to turn outputs on (blue OUTPUT indicator turns on).
2. Press the TRIG key. The 2520 is now outputting pulses, with the first line of the display reading, "Continuous Pulse."

To turn off the continuous pulse mode:

1. Press EXIT key.
2. Press ON/OFF OUTPUT key to turn outputs OFF.

# Remote configuration over GPIB/IEEE-488

| Command | Comment |
|---|---|
| *RST | Reset 2520 |
| :SOUR1:CURR:MODE FIX | Set source mode to FIXed (not sweep) |
| :SOUR1:CURR 0.2 | Set current pulse amplitude to 200mA |
| :SOUR1:PULS:DEL 0.00033 | Set pulse delay (time between pulses) to 330µs |
| :SOUR1:PULS:WIDT 0.000001 | Sets the pulse width to 1µs |
| :TRIG:COUN CONTINUOUS | Enables continuous pulsing mode |
| :OUTP ON | Turns Output ON |
| :INIT | Begins continuous pulsing |
| :ABORT | Stops continuous pulsing |
| :OUTP OFF | Turns Output OFF |

## Related Modes

There are three choices in the 2520 Trigger Count menu:

1. **Trigger count = Finite** — This mode will output up to 5000 pulses with a fixed source current. Measurements are taken at each pulse, which means that the minimum pulse delay time is about 2 milliseconds ± 400µs. In addition, the minimum pulse delay is constrained by the maximum duty cycle of 4% above 1A source levels. This means that requesting a duty cycle > 4% will cause the pulse delay to be increased to give a duty cycle = 4%. For I < 1A, the maximum duty cycle is about 15%.
2. **Trigger count = Inf** — This mode will output an infinite stream of fixed current pulses. It is different from the Continuous Pulse mode because it offers measurements (VLD, Detector 1 current, Detector 2 current). The measurement process takes additional time, meaning that the minimum pulse delay time is about 2ms.
3. **Trigger count = Continuous Pulse** — This mode is explained above. It is similar to count = Inf, but there are no measurements in this mode and the set pulse width equals the actual pulse width.

# 2520 Pulsed Laser Diode Test System

## LASER DIODE PULSE OR DC CURRENT SOURCE SPECIFICATIONS

| DRIVE CURRENT | | | | | OFF CURRENT[4] | | | |
|---|---|---|---|---|---|---|---|---|
| SOURCE RANGE | PROGRAMMING RESOLUTION | APPROX. ELECTRICAL RESOLUTION | ACURACY[1,6] ± (% rdg. + mA)[2,3] | RMS NOISE (typical) (1kHz-20MHz) | RANGE | PROGRAMMING RESOLUTION | APPROX. ELECTRICAL RESOLUTION | ACURACY[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<br>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 x 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 [19, 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 | RISE/FALL TIME [6,8,9,10] TYPICAL | MAX. |
|---|---|---|---|---|---|
| 500mA | 10Ω ¼ Watt | Fast | 1.0% | 55 ns | 80 ns |
| 500mA | 10Ω ¼ Watt | Slow | 0.1% | 1 µs | 1.3 µs |
| 5.00A | 1.5Ω 1 Watt | Fast | 1.0% | 100 ns | 130 ns |
| 5.00A | 1.5Ω 1 Watt | Slow | 0.1% | 1 µs | 1.3 µs |

## LASER DIODE VOLTAGE MEASURE SPECIFICATIONS

| RANGE | MINIMUM RESOLUTION | ACURACY ± (% rdg. + volts)[1,12] | RMS NOISE (typical)[13] |
|---|---|---|---|
| 5.00 V | 0.33 mV | 0.3% + 6.5 mV | 60 µV |
| 10.00 V | 0.66 mV | 0.3% + 8 mV | 120 µV |

**TEMPERATURE COEFFICIENT (0°-18°C & 28°-50°C):** ±(0.15 x 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 VOLTAGE BIAS SOURCE 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 | ACURACY ± (% 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 x 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 SPECIFICATIONS

**DCFLOATING VOLTAGE:** User may float common ground up to ±10VDC from chassis ground.

**COMMON MODE ISOLATION:** $>10^9\Omega$.

**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).
- **Tlink:** 6 programmable trigger input/outputs.
- **Pulse Trigger Out BNC:** +5V, 50Ω 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.

**WARRANTY:** 1 year.

**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 (3 1/2 in. × 7 in. × 8 1/2 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.

# 2520 Pulsed Laser Diode Test System

## Notes

[1] 1 year, 23°C ±5°C.

[2] If $\sqrt{\text{Duty Cycle}} \cdot 1$ exceeds 0.2, accuracy specifications must be derated with an additional error term as follows:

500mA Range: ±0.1% rdg. · $\sqrt{D} \cdot 1$

5A Range: ±0.3% rdg. · $\sqrt{D} \cdot 1$

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] See Figure 4 for test configuration.

[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 0 amps 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] Shown is the Power Distribution % based on current settings.

[21] Timing Cycle ($^{pw}/_{(pw+pd)}$): 4% max.

Specifications are subject to change without notice.

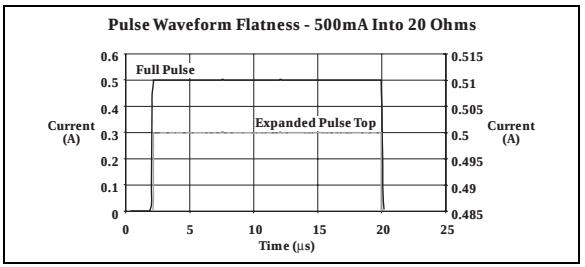


*Figure 1*

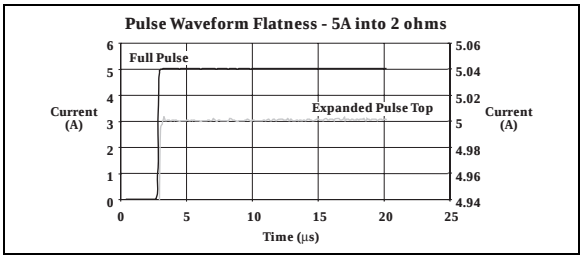


*Figure 2*

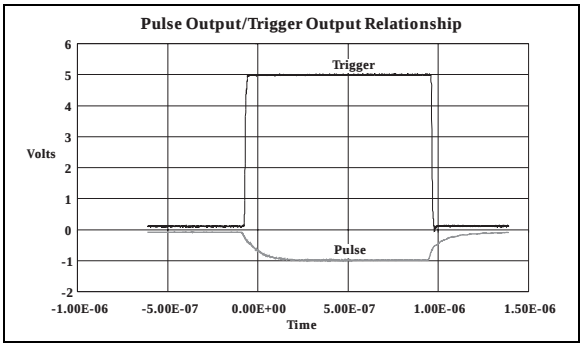


*Figure 3*

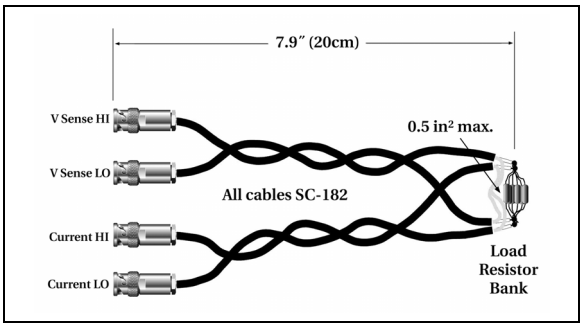


*Figure 4*