WAVELENGTH ELECTRONICS

# Low Noise QCL Driver

Minimize spectral drift, center wavelength jitter, and linewidth


RoHS Compliant

## GENERAL DESCRIPTION:

The QCL1500 includes patented circuitry[1] ideal for driving Quantum Cascade Lasers (QCLs) where electronic noise, coupled through the laser, can affect measurements.

This is an OEM controller, designed to be integrated into field deployed systems or used on a benchtop. It operates from dual DC power supplies. Low noise can be achieved even with certain switching power supplies.

An onboard Current Setpoint trimpot allows a DC bias to be set. Its signal sums with a remote Analog Input signal that can be negative or positive.

**Safety:** An onboard trimpot sets the current limit as you monitor the setting - without driving current through the QCL. Brownout, reverse voltage, and overvoltage protection isolates the QCL from power supply failures. An Overtemp Fault signal minimizes the chance of failure due to overheated electronics. An onboard Enable Switch controls when current can flow to the QCL. A remote Enable signal can also be used.

**Applications:** High performance chemical sensing in biomedical, imaging, spectroscopy, remote sensing, military, communications, aerospace and materials processing industries.

To optimize noise performance in your application, current range can be adjusted. Other product variations are available. Please contact the factory with your requirements at 406-587-4910 or quietqcl@teamwavelength.com.

[1]Covered by U.S. Patents 6,696,887; 6,867,644 and 7,176,755. Licensed from Battelle Memorial Institute.

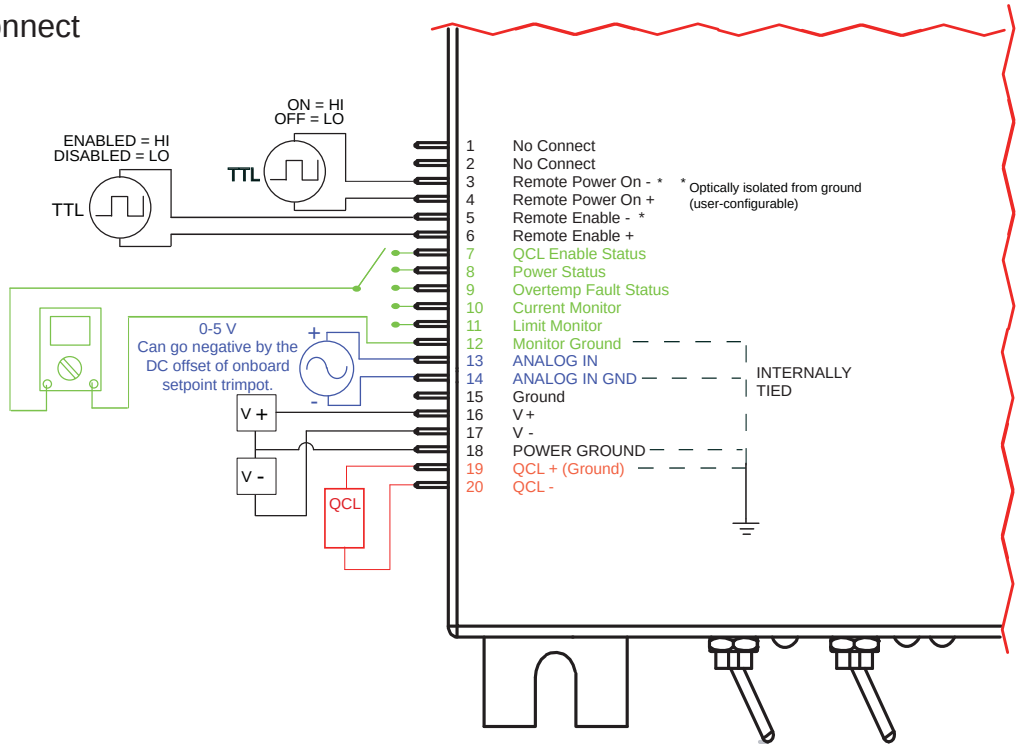
## FEATURES:

- Off the shelf models at 500 mA, 1 A, 1.5 A
- Can be delivered in other current ranges up to 2 A - with noise minimized for your QCL
- Compliance voltage up to 16 V
- Low noise: < 1μA RMS over 100 kHz bandwidth (graphs on page 5)
- Analog Input Setpoint sums with onboard trimpot
- Safety: Current Limit, 1.25 second ON delay with 100 msec current ramp, Remote Enable signal, brown out, reverse & over voltage, overtemp protection circuits
- Remote Power On and Enable signals are TTL compatible and fully isolated
- Adjustable Current Limit with monitor
- Local power & enable / disable switches
- Protection relay shorts output when current is disabled
- Shielded from external interference
- Constant Current Mode operation
- 3 dB bandwidth 2 -3 MHz
- Status Outputs can drive LEDs
- Small Package 6.55 x 5.5 x 2.3”
- Compatible with P/N PTCxxK-CH precision temperature controllers
- Accessories include cables and power supplies to simplify integration.

### *Ordering Information*

| | |
|---|---|
| QCL500 | 500 mA Low Noise QCL Driver |
| QCL1000 | 1 A Low Noise QCL Driver |
| QCL1500 | 1.5 A Low Noise QCL Driver |
| QCL2000 | Product Variations are available up to 2 A |
| QCL-SMA-ADAPT | Convert signal pins to SMA connectors |
| WCB310 | Low Noise Cable: SMA to SMA |
| WCB311 | QCL 20 pin connector with cables |
| WCB312 | QCL Dual Power Supply wiring kit |
| PWRPAK-24V | 24 VDC Switching Power Supply |
| NOISE SCAN | Noise Characterization Scan |

**Figure 1**
Quick Connect

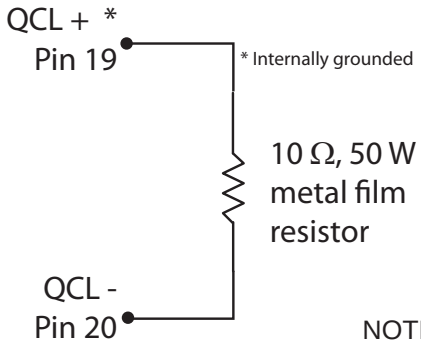



More details (and cautions) are available in the Pin Descriptions and Operating Sections of this datasheet (pages 7 and 8 respectively).

Until you are comfortable with the driver operation, we recommend you use a test load instead of an actual QCL. A resistor, metal film, TO-220, 50 W, is a typical test load. Two vendor numbers are:

Caddock MP850-10.0-1% (Digikey part number MP850-10.0-F-ND) or
Ohmite TCH35P10R0JE (Digikey part number TCH35P10R0JE-ND)

**Figure 2**
Example Test Load




NOTE: At 2 A, output current will be compliance voltage limited with a 10 Ω resistor. Use a 5 Ω resistor such as Caddock MP850-5.00-1% (Digikey part number MP850-5.00-F-ND).

# ELECTRICAL AND OPERATING SPECIFICATIONS

| ABSOLUTE MAXIMUM RATINGS<br>RATING | SYMBOL | VALUE | UNIT |
|---|---|---|---|
| Positive Supply Voltage | V + | + 25 | Volts DC |
| Negative Supply Voltage | V - | - 25 | Volts DC |
| Output Current (See SOA Chart [1]) | $I_{OUT}$ | 500, 1000, 1500 | mA |
| Internal Power Dissipation, +25˚C, no air | $P_{MAX}$ | 10, 16 , 21 | Watts (model dependent) |
| Operating Temperature, case [2] | $T_{OPR}$ | - 40 to + 50 | ˚C |
| Storage Temperature | $T_{STG}$ | - 55 to +125 | ˚C |
| Weight | | 2 | lbs |
| Size | | 5.5 x 6.55 x 2.3<br>(140 x 166 x 59) | inches<br>(mm) |

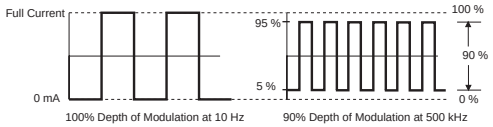
| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|
| **CONSTANT CURRENT CONTROL** | | | | | |
| Short Term Stability, 1 hour | $T_{AMBIENT}$ = 25˚C | 5 | 10 | 15 | ppm |
| Long Term Stability, 24 hours | $T_{AMBIENT}$ = 25˚C | 5 | 10 | 15 | ppm |
| Temperature Coefficient | | 5 | 10 | 15 | ppm |
| Compliance Voltage, Laser Load [3] | - 24 V in | | 16 | | Volts |
| Rise Time | to full scale | | 250 | | nsec |
| Fall Time | to full scale | | 200 | | nsec |
| Slew Rate | | | 30 | | V / µsec |
| Bandwidth, 3 dB | large signal (< 90% full scale) | | 2 | 3 | MHz |
| Delayed start | | | 1.25 | | sec |
| Slow Start ramp | to full scale | | 100 | | msec |
| Depth of Modulation [4] | at 500 kHz | | 90 | | % |
| Leakage Current | | 0.75 | 2 | 3 | mA |
| **NOISE** (graphs on page 5) [5] | | | | | |
| Noise Current (RMS) [1 A model] | $I_{OUT}$= 100mA, 100 kHz bandwidth | | 1 | | µA RMS |
| Noise Current Density | $I_{OUT}$= 100mA, $R_{LOAD}$ = 10 Ω | | 2 | | nA / √Hz |
| **POWER SUPPLY** | | | | | |
| Voltage, V + | | + 22 | + 24 | + 25 | V DC |
| Voltage, V - | | - 22 | - 24 | - 25 | V DC |
| Current, V+ supply, quiescent | | | 250 | | mA |
| Current, V - supply, quiescent | | | 100 | | mA |
| Inrush current requirement [6] | | | 450 | | mA |

[1] SOA: Safe Operating Area - Determine if power dissipated in the QCL Driver with your operating parameters exceeds limits. Online calculator at **http://www.teamwavelength.com/support/calculator/soa/soald.php** . Charts are also available in Appendix A.

[2] Derating begins at 35°C. QCL2000 maximum operating temperature is 35°C. Derating starts at 25°C.

[3] Safety circuits monitor tightly around the nominal 24 V inputs. For a lower input voltage (more efficient for QCLs with lower compliance voltages), contact the factory for a Product Variation.

[4] As frequency increases on the analog input, the peak-to-peak output amplitude diminishes. For example, these graphs show the waveform shape at 10 Hz and 500 kHz. Depth of modulation continues to decrease after 500 kHz.




[5] How noise measurements are made is detailed in WEI's Low Noise Measurement Protocol Technical Note.

[6] Negative power supply must source at least 450 mA. If current to QCL exceeds 450 mA, DC power supply capacity should be QCL current plus quiescent current

## ELECTRICAL AND OPERATING SPECIFICATIONS, continued

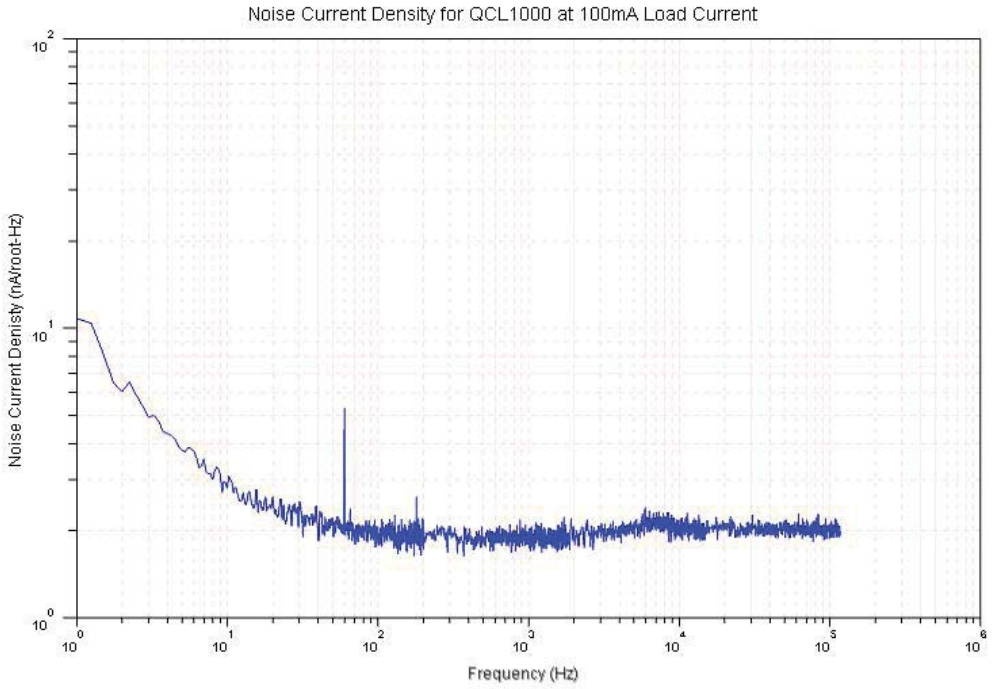
| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|
| **INPUT** | | | | | |
| Analog In | | 0 | | 5 | V |
| Analog In Input Impedance | | | 1 | | kΩ |
| Analog In Damage Threshold | Sum of (trimpot + AI) < 0 V or > 5.5 V | | | | |
| Analog In Transfer Function | QCL500 | | 0.1 | | A / V |
| Analog In Transfer Function | QCL1000 | | 0.2 | | A / V |
| Analog In Transfer Function | QCL1500 | | 0.3 | | A / V |
| Remote Enable / Disable & Remote Power On | TTL compatible (source min of 5 mA) | 0 | | 12 | V |
| Status Outputs | TTL compatible (can source 25 mA) | 0 | | 12 | V |
| **MONITOR** | | | | | |
| Current Monitor Range | | 0 | | 2.5 | V |
| Current Monitor Bandwidth, 3 dB | | | 1.8 | | MHz |
| Current Monitor stability | | | 25 | | ppm |
| Accuracy Current Monitor to Actual | above 10% full scale | | 0.5 | 1 | % |
| Limit Monitor Range | | 0 | | 5.75 | V |
| Accuracy Limit Monitor to Actual | Limit is > 20% of setpoint | | 1 | 4 | % |
| **MONITOR TRANSFER FUNCTION** | | | | | |
| Current Monitor | QCL500 | | 0.2 | | A / V |
| Limit Monitor | QCL500 | | 0.09 | | A / V |
| Current Monitor | QCL1000 | | 0.4 | | A / V |
| Limit Monitor | QCL1000 | | 0.19 | | A / V |
| Current Monitor | QCL1500 | | 0.6 | | A / V |
| Limit Monitor | QCL1500 | | 0.28 | | A / V |
| **THERMAL** | | | | | |
| Pin Solderability | Solder temp @ 260˚C | | 10 | | sec |

## ELECTRICAL AND OPERATING SPECIFICATIONS, continued

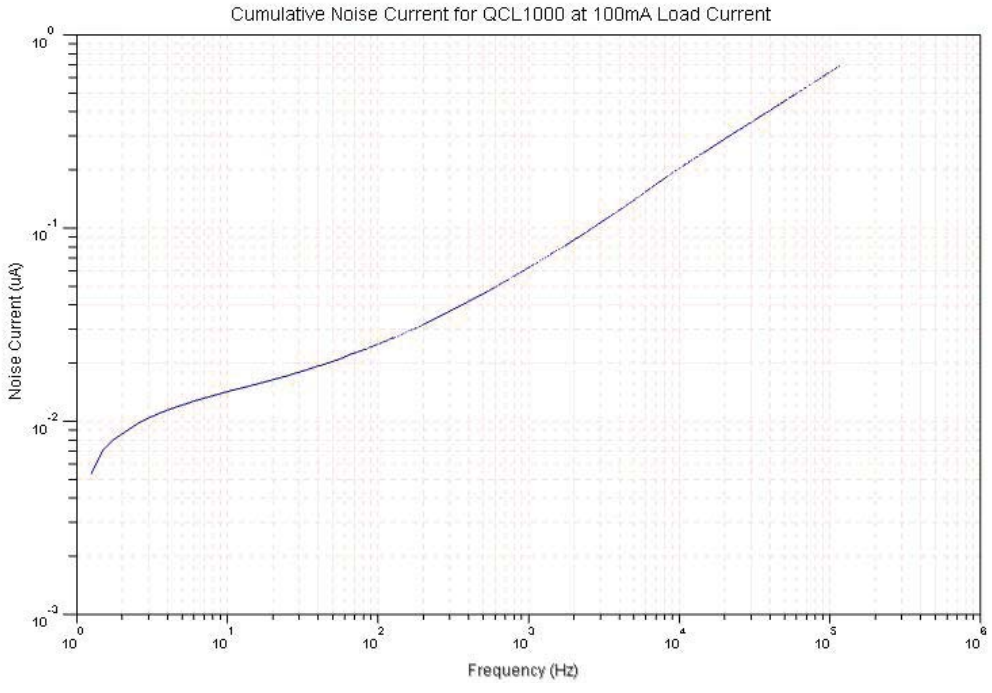
| Model | Average Current Noise Density - nA / √Hz | RMS noise μA (100 kHz BW) |
|---|---|---|
| QCL500 | 1.0 | 0.4 |
| QCL1000 | 2.0 | 0.7 |
| QCL1500 | 3.0 | 1.0 |

How noise measurements are made is detailed in WEI's Low Noise Measurement Protocol Technical Note.

**Figure 3**
Typical Current Noise Density and Cumulative Noise Current (RMS)

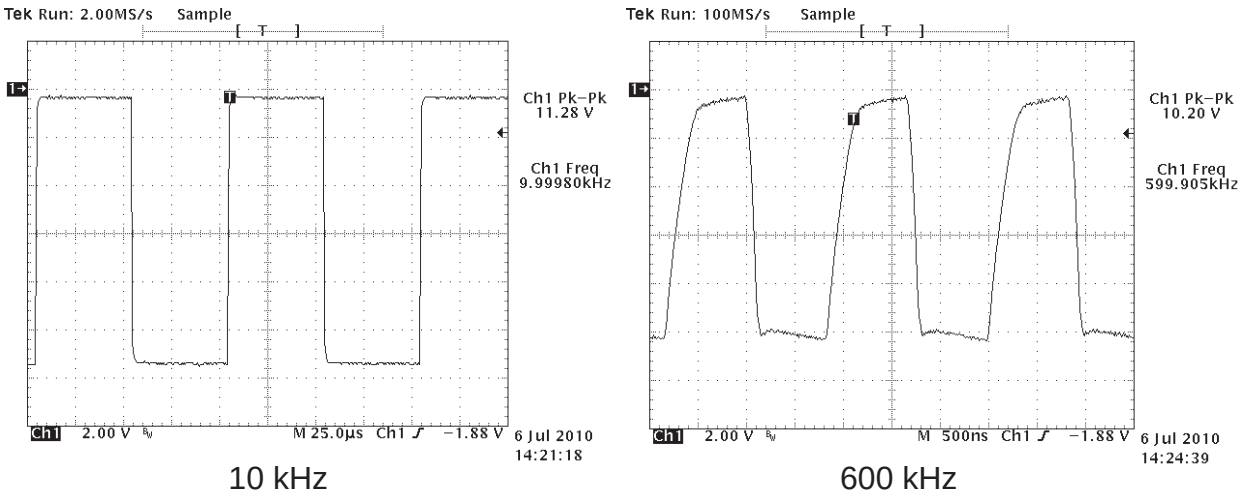



Measured with short cables, on unshielded benchtop, 10 Ω load, chassis grounded



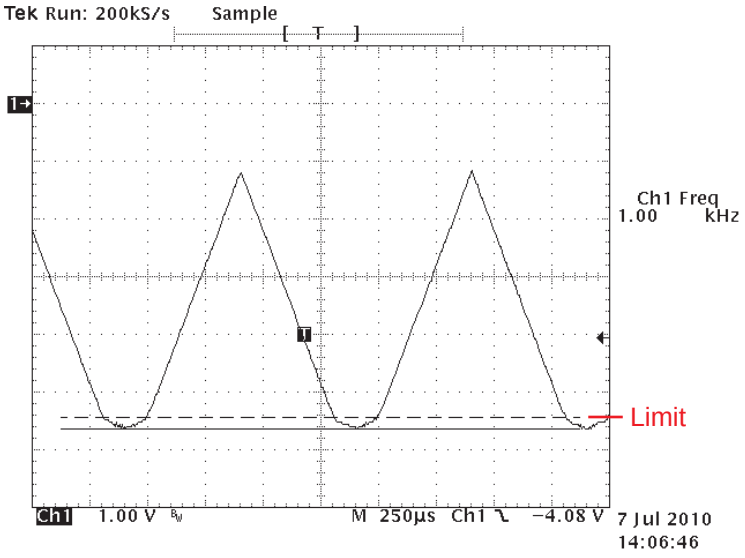
## ELECTRICAL AND OPERATING SPECIFICATIONS, continued

**Figure 4**
Typical Square Wave Response




10 kHz 600 kHz

**Figure 5**
Typical Limit Circuit Response, Limit set well below setpoint




There is a slight (2%) overshoot when the driver is operating in current limit (with the limit value set well below the setpoint). We recommend that you operate with the limit above the setpoint.

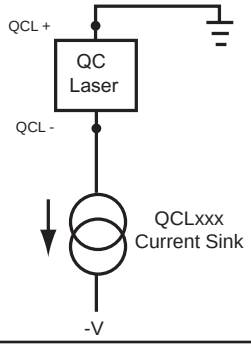
## PIN DESCRIPTIONS (left to right)

| PIN NO. | PIN DESCRIPTION | FUNCTION |
|---|---|---|
| 1 | No connect | Reserved |
| 2 | No connect | Not used |
| 3<br>4 | **Remote Power On -**<br>**Remote Power On +** | Return for Remote Power On signal - optically isolated<br>OFF = LO (< 0.3 V). ON = HI (> 3 V).<br>Toggle to reset a protection circuit error. |
| 5<br>6 | **Remote Enable -**<br>**Remote Enable +** | Return for Remote Enable signal - optically isolated<br>Disable = LO (<0.3 V). Enable = HI (>3 V).<br>Toggle to reset a protection circuit error. |
| 7 | **QCL Enable Status** | HI = Current Enabled. LED drive compatible. Source up to 25 mA, 12 V. |
| 8 | **Power Status** | HI = Power ON. LED drive compatible. Source up to 25 mA, 12 V. |
| 9 | **Overtemp Fault Status** | HI = FAULT triggered. Indicates internal parts are over acceptable temperature. LED drive compatible. Source up to 25 mA, 12 V. |
| 10 | **Current Monitor** | Monitor Output Current level. 0 to 2.5 V. Transfer functions vary with model. |
| 11 | **Limit Monitor** | Monitor Current Limit Setpoint. Output 0 to 5 V. Transfer functions vary with model. |
| 12 | **Monitor Ground** | Monitor Ground - use with Status or Monitors. Not designed for high current return. |
| 13 | **ANALOG IN** | Analog voltage sums with onboard setpoint trimpot - can be positive or negative (Do not drive negative below the DC level set by onboard setpoint trimpot or above 5.5 V) Setpoint range 0 to 5 V. Input impedance is 1 kΩ. |
| 14 | **ANALOG IN GND** | Ground for Analog Input Voltage. Not designed for high current return. |
| 15 | **Ground** | Ground - can be used to ground chassis. |
| 16 | **V+** | Positive DC power to the unit, typically +24 V |
| 17 | **V -** | Negative DC power to the unit, typically -24 V |
| 18 | **POWER GROUND** | GROUND - designed for high current return to the power supplies. |
| 19 | **QCL + (Ground)** | Ground - Source current to QCL (see diagram below) |
| 20 | **QCL -** | Sink current from QCL (see diagram below) |

## Front Panel Connector (left to right)

| PIN NO. | PIN DESCRIPTION | FUNCTION |
|---|---|---|
| 1 | **QCL -** | Sink current from QCL (see diagram below) |
| 2 | **QCL + (Ground)** | Ground - Source current to QCL (see diagram below) |
| 3 | **Ground** | Ground |
| 4 | **ANALOG IN** | Analog voltage sums with onboard setpoint trimpot - can be positive or negative (Do not drive negative below the DC level set by onboard setpoint trimpot or above 5.5 V) Setpoint range 0 to 5 V. Input impedance is 1 kΩ. |
| 5 | **ANALOG IN GND** | Ground for Analog Input Voltage. Not designed for high current return. |

**Figure 6**
QCL wiring polarity and grounding



## 1. Thermal Design

Verify that the Internal Heat Dissipation for your application does not exceed the maximum allowed. The Safe Operating Area chart details the location of this limit.

Online, at **http://www.teamwavelength.com/support/calculator/soa/soald.php**, choose the model of QCL driver you will be using. Enter your power supply and QCL characteristics to determine internal power dissipation with your design. Alternately, you can use the SOA charts in Appendix A and manually draw your system load line. Airflow is required in some cases.

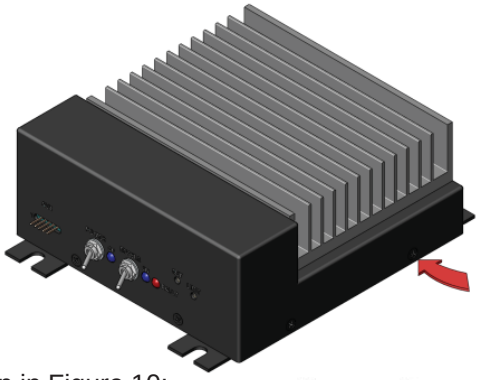
Note that the FAULT LED will light and the output current will be disabled if the internal temperature of the driver exceeds safety limits.

## 2. Configure control for Local Only, Local & Isolated Remote, or Local & Grounded Remote. Wire Remote Signals.

The Remote Power On and Remote Enable signals interact with the onboard switches. A DIP switch on the bottom of the board configures the interaction. Factory default is Local Only.

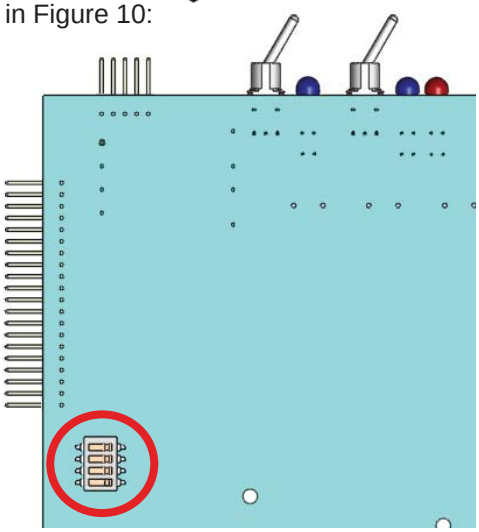
To access the DIP switch, remove the seven screws attaching the baseplate to the shield. Use the mounting tabs to lever the baseplate off the shield. The fit is deliberately tight. Note that the components are Electro-static Discharge (ESD) sensitive. Make these changes in an ESD safe zone.

**Figure 9**
Access to switches

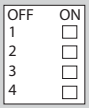
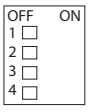
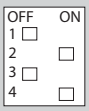



The switch location is given in Figure 10:

**Figure 10**
Switch location



If you prefer a different default from the factory, please contact us at 406-587-4910 or quietqcl@teamwavelength.com

| STATE | SWITCH POSITION | INTERACTION |
|---|---|---|
| **Local Only**<br>All switches to right or ON<br>FACTORY DEFAULT |  | Remote inputs are ignored. Local Switches only. |
| **Local Plus Isolated Remote**<br>All switches to left or OFF |  | If either Remote Signal or Local Switch is OFF or disabled, Power is OFF or Current is DISABLED. Remote signal is optically isolated. Wire to Remote Power ON - & + and Remote Enable - & +. |
| **Local Plus Grounded Remote**<br>Swith 1 & 3 OFF<br>Switch 2 & 4 ON |  | If either Remote Signal or Local Switch is OFF or disables, Power is OFF or Current is DISABLED. Remote signal negative is tied to ground. Wire to Remote Power + and Remote Enable +. |

If you will be using the REMOTE inputs, wire them now. TTL compatible, up to 12 V.

**Pin 3 Remote Power On -, Pin 4 Remote Power On +**

**Pin 5 Remote Enable -, Pin 6 Remote Enable +**

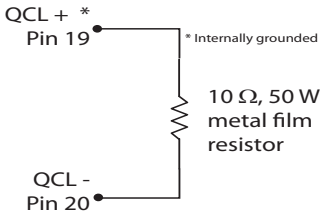
OPERATING PROCEDURES, continued

## 3. Wire Test Load

To become familiar with the QCL driver operation, we recommend that you wire a test load first. This can be as simple as a resistor. We recommend a metal film, TO-220, 50 W, as a typical test load. Two vendor numbers are: Caddock MP850-10.0-1% (Digikey part number MP850-10.0-F-ND) or Ohmite TCH35P10R0JE (Digikey part number TCH35P10R0JE-ND)

The QCL driver is not designed to operate with the QCL pins shorted. Safe Operating Area thermal limits will be exceeded. The following schematic shows an example test load and wiring.

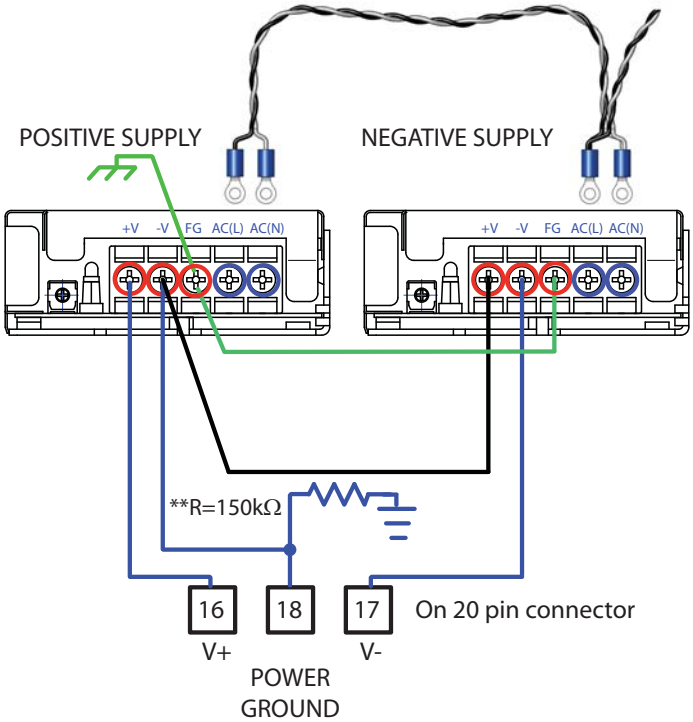
**Figure 7**
Example test load




## 4. Attach dual power supplies

For safety, it is important that your power supply integrate an effective current limit circuit. Ground loops can be avoided by choosing a power supply with the chassis not tied to ground. WEI offers switching power supplies (PWRPAK-24V), a 20 pin cable (WCB311), and a power supply kit (WCB312) to simplify setup. Twist wire pairs to minimize noise. See TDK/Lambda instruction manual for mounting and other design considerations. Here is an example schematic and wiring diagram for power supply setup:

**Figure 8**
Example power supply wiring




** If ground is somewhere tied to earth ground (e.g. at a DAQ card), tie common point to ground through high resistance to avoid triggering safety circuits.

- AC: In to both power supplies
- AC Safety ground #1: Connect two FG terminals
- AC Safety ground #2: Connect FG to AC chassis ground
- Common Ground: Connect between -V of positive supply and +V of negative supply
- Attach to the QCL driver - V+, POWER GROUND, V -

## 5. Setup Monitors

Attach a DVM or other voltage monitoring device to the Current Monitor (Pin 10) and Limit Monitor (Pin 11). Reference to Monitor Ground (Pin 12). Transfer functions are:

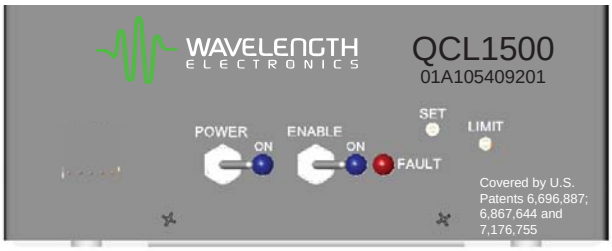
| Model | Current MON | Limit MON |
|---|---|---|
| QCL500 | 0.2 A / V | 0.09 A / V |
| QCL1000 | 0.4 A / V | 0.19 A / V |
| QCL1500 | 0.6 A / V | 0.28 A / V |

Examples:
QCL500 - 2.5 V on the Current Monitor pin, equivalent current is (2.5 V * 0.2 A / V) or 500 mA.
QCL1000 - 1.8 V on the Current Monitor pin, equivalent current is (1.8 V * 0.4 A / V) or 0.72 A.
QCL1500 - 2.0 V on the Current Monitor pin, equivalent current is (2.0 V * 0.6 A / V) or 1.2 A.

QCL500 - 5 V on the Limit Monitor pin, equivalent limit current is (5 V * 0.09 A / V) or 450 mA.
QCL1000 - 2.5 V on the Limit Monitor pin, equivalent limit current is (2.5 V * 0.19 A / V) or 470 mA.
QCL1500 - 3.2 V on the Limit Monitor pin, equivalent limit current is (3.25 V * 0.28 A / V) or 910 mA.

## 6. Power up the unit

Turn on power to the DC supplies. Flip the POWER ON switch to ON. The POWER ON LED lights. If the LED does not power on, review REMOTE vs. LOCAL switch settings (Step 4) and the state of the REMOTE POWER ON signal (Pin 4 referenced to Pin 3).




- Power On: Switch and indicator
- Enable Current: Switch and indicator
- Over Temperature Fault indicator
- Current Setpoint trimpot
- Current Limit Setpoint trimpot

## 7. Set Current Limit & Zero Output Current

Choose Current Limit current to be above the normal setpoint, but below the damage threshold of the QCL. Monitor the Current Limit (between Pin 11 & 12). Rotate the Current Limit Setpoint trimpot clockwise to increase the limit current setting. Example conversions:

QCL500 - Want 425 mA Limit, equivalent voltage is (0.425 A / 0.09 A / V) or 4.7 V.
QCL1000 - Want 750 mA Limit, equivalent voltage is (0.750 A / 0.19 A / V) or 3.9 V.
QCL1500 - Want 1.5 A Limit, equivalent voltage is (1.5 A / * 0.28 A / V) or 5.3 V.

Rotate the SET trimpot on the front panel completely counter clockwise to zero the output current setpoint.

## 8. Enable Output Current & Set Current Setpoint

Flip the ENABLE switch to ON. The ENABLE LED lights. If the LED does not power on, review REMOTE vs. LOCAL switch settings (Step 4) and the state of the REMOTE ENABLE signal (Pin 6 referenced to Pin 5). Rotate the SET trimpot clockwise to increase the current setpoint. Current monitor should now show voltage equivalent to output current.

EXAMPLES:

QCL500 - Want 400 mA Output Current, equivalent voltage is (0.400 A / 0.2 A / V) or 2 V.
QCL1000 - Want 950 mA Output Current, equivalent voltage is (0.950 A / 0.4 A / V) or 2.375 V.
QCL1500 - Want 1.25 A Output Current, equivalent voltage is (1.25 A / 0.6 A / V) or 2.08 V.

Note, wait at least one second between turning POWER ON and enabling current. Allow one hour for best performance.

## 9. Disable Output Current and Power Down the unit

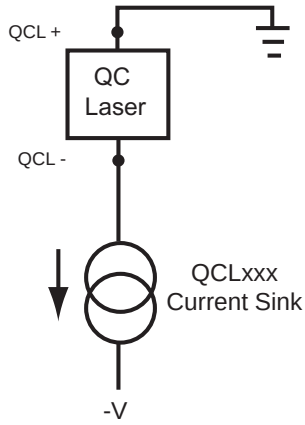
Flip the ENABLE switch to the OFF position (or send a LO voltage to REMOTE ENABLE). The ENABLE LED goes out. After a 9.5 msec delay, the current turn off ramp is 5.5 μsec.

Flip the POWER switch to the OFF position. The POWER LED goes out. Turn off the power to the dual DC power supplies.

## 10. Remove test load and wire in a Quantum Cascade Laser

Wire the QCL for proper current direction. Note that pin 19 (QCL +) is also internally attached to ground.

**Figure 11**
QCL wiring polarity and grounding




## 11. Recovery from a Protection Circuit trip or FAULT error

If the voltage from the dual power supplies to the QCL driver is over or under voltage limits, the protection circuits will trip and latch off. Output Current is disabled. To restart after correcting the cause of the error, disable the current (using switch or remote ENABLE signal) then toggle the Power OFF then ON (signal or switch). Wait 1 second to re-enable current.

If voltage to the QCL driver is reversed, protection diodes go into conduction. The rail is held one diode drop from ground. This condition will continue until power from the power supply is removed or the fuse for that rail blows. To restart after correcting the cause of the error, disable the current (using switch or remote ENABLE signal) then toggle the Power OFF then ON (signal or switch). Wait 1 second to re-enable current.

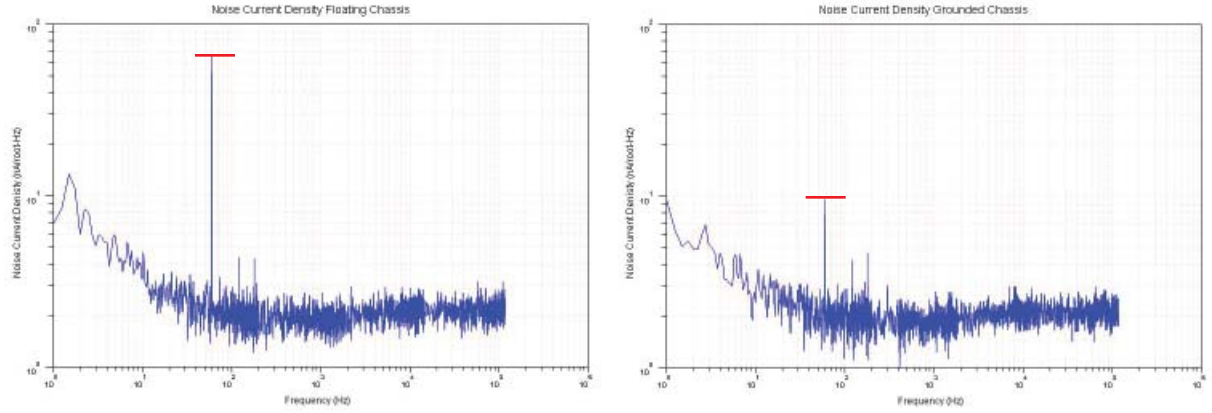
## APPLICATION NOTES

### OPTIMIZE NOISE

Noise is specific to each application. Here are a few suggestions for reducing system noise:

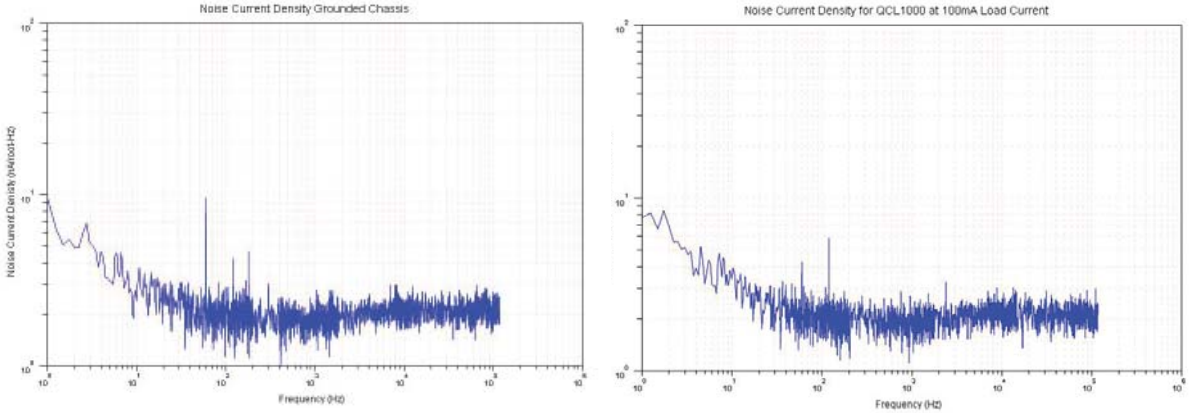
- Buy the right controller for your QCL. The lower the maximum current capacity, the lower the current noise. Contact the factory for a custom range.
- Manage ground loops. Any current flowing through inadvertant ground loops will show as current noise. See “Ground Loop Avoidance” Application Note.
- Keep the ANALOG IN signal clean. Any noise on that input will transfer directly to the output current.
- If possible, tie the QCL driver chassis to ground (without introducing ground loops). This reduces 60 (or 50) Hz peaks. Pin 15 on the 20 pin connector is ground. It can be wired to a screw on the chassis, to the mounting slots, etc. Note that despite the peak at 60 Hz, 0 ot 100 kHz RMS noise for the two graphs is equivalent.

**Figure 12:** 60 Hz noise with chassis floating and chassis grounded




- Choose the right power supply. Wavelength has tested with a switching TDK / Lambda power supply (PWRPAK-24V) as well as linear supplies. The better the switching supply, the better the noise performance. Specifications to look at are minimum noise and maximum load rejection.

**Figure 13:** Example linear and switching power supply noise current density graphs.



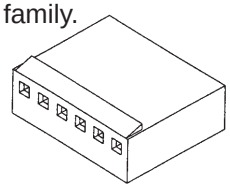

Linear Switching

- Filter the power supply. Use an off-the-shelf EMI filter such as TDK / Lambda’s MAW series.
- Fan wiring. Do not power a fan from the dual supplies. Keep it on a completely different power supply.
- Minimize lead length to the power supply and load. Use twisted pair, shielded cables, or SMAs.

# APPLICATION NOTES

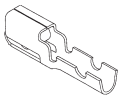
## CABLE ADAPTER

If you will not be mounting the QCL driver on a PCB, you can use Molex high pressure housing 7880 family.



(6 pins shown)

20 pin Molex part number: 10-11-2203.
5 pin Molex part number: 10-11-2053



Crimp Molex part number: 08-50-0005.

WCB311 is a 20 pin connector with cables.

## IMPROVE BANDWIDTH

Minimize cable length to improve bandwidth. Sometimes twisting wires for signal pairs will also improve bandwidth.

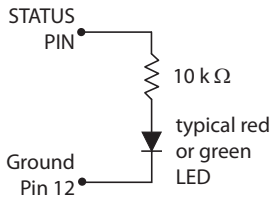
## SET LIMIT MORE PRECISELY

The actual limit will be lower than the equations indicate. If you want a more exact setting, set the setpoint above the limit and monitor actual current instead of current limit as you adjust the limit current trimpot.

## USE STATUS PINS TO DRIVE LEDs

The STATUS pins output 12 V, up to 25 mA. With this typical hookup, we assume 1.5 V forward voltage across LED and 1 mA drive current.

$$\frac{12\ V - 1.5\ V}{10\ k\Omega} \sim 1\ mA$$



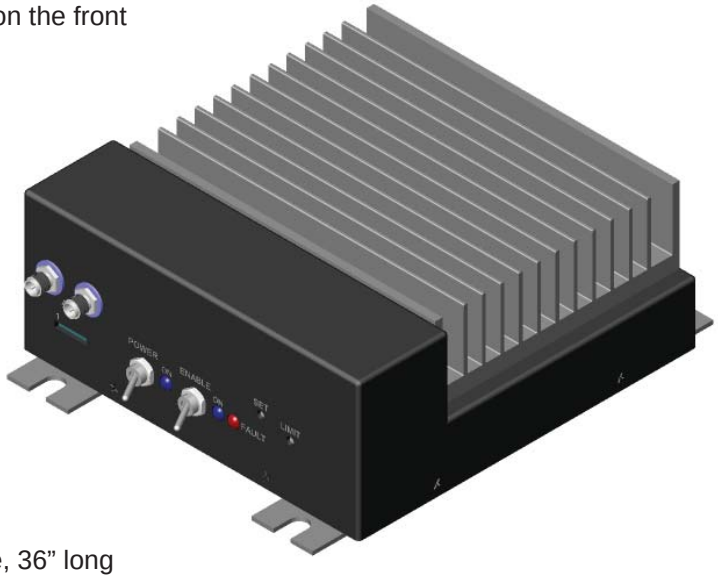

## USE SMA cables for QCL and / or ANALOG IN

If SMA low noise cables are better for your application, order the QCL-SMA-ADAPT. The pins on the front panel are converted to SMA connectors

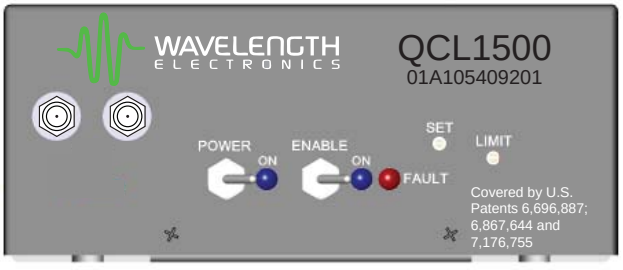
Pinout is (left to right)

**QCL - :** Center Pin
**QCL + :** Shield

**ANALOG IN:** Center Pin
**ANALOG IN GROUND:** Shield



WCB310 is an SMA cable, male to male, 36” long



## APPLICATION NOTES

### FUSE REPLACEMENT

Remove the baseplate to access the fuses. Two 5 A, 5 x 20 mm, SLO-BLOW fuses can be replaced. There are no other user serviceable parts inside the QCL driver. Change fuses in an ESD safe zone.

### WCB311 20 PIN CONNECTOR WIRING DIAGRAM

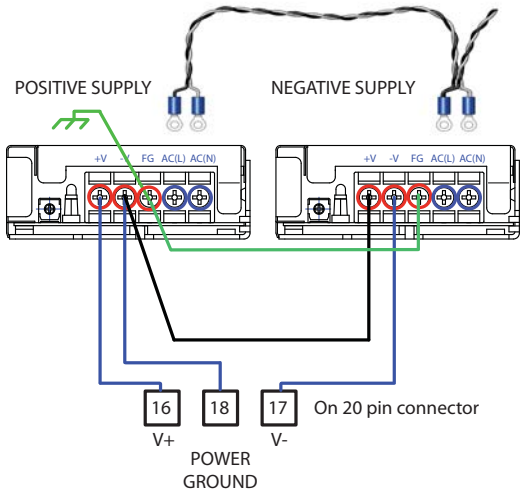
Pin 1 is indicated on the molded plastic connector, or by the lack of wires in Pins 1 & 2. The latching bar is on the side nearest the baseplate.

| PIN NO. | PIN DESCRIPTION | CABLE | WIRE COLOR | CABLE LENGTH |
|---|---|---|---|---|
| 1 | No connect | | | |
| 2 | No connect | | | |
| 3 | **Remote Power On -** | 4 cond | BLK | 36” |
| 4 | **Remote Power On +:** | 4 cond | WHT | |
| 5 | **Remote Enable -** | 4 cond | GRN | |
| 6 | **Remote Enable +** | 4 cond | RED | |
| 7 | **QCL Enable Status** | 6 cond | BLU | 36” |
| 8 | **Power Status** | 6 cond | GRN | |
| 9 | **Overtemp Fault Status** | 6 cond | ORG | |
| 10 | **Current Monitor** | 6 cond | WHT | |
| 11 | **Limit Monitor** | 6 cond | RED | |
| 12 | **Monitor Ground** | 6 cond | BLK | |
| 13 | **ANALOG IN** | 2 cond | RED | 24” |
| 14 | **ANALOG IN GND** | 2 cond | BLK | |
| 15 | **Ground** | 1 cond | BLK | 12” |
| 16 | **V+** | 3 cond | RED | 36” |
| 17 | **V -** | 3 cond | WHT | |
| 18 | **POWER GROUND** | 3 cond | BLK | |
| 19 | **QCL + (Ground)** | 2 cond | BLK | 24” |
| 20 | **QCL -** | 2 cond | RED | |

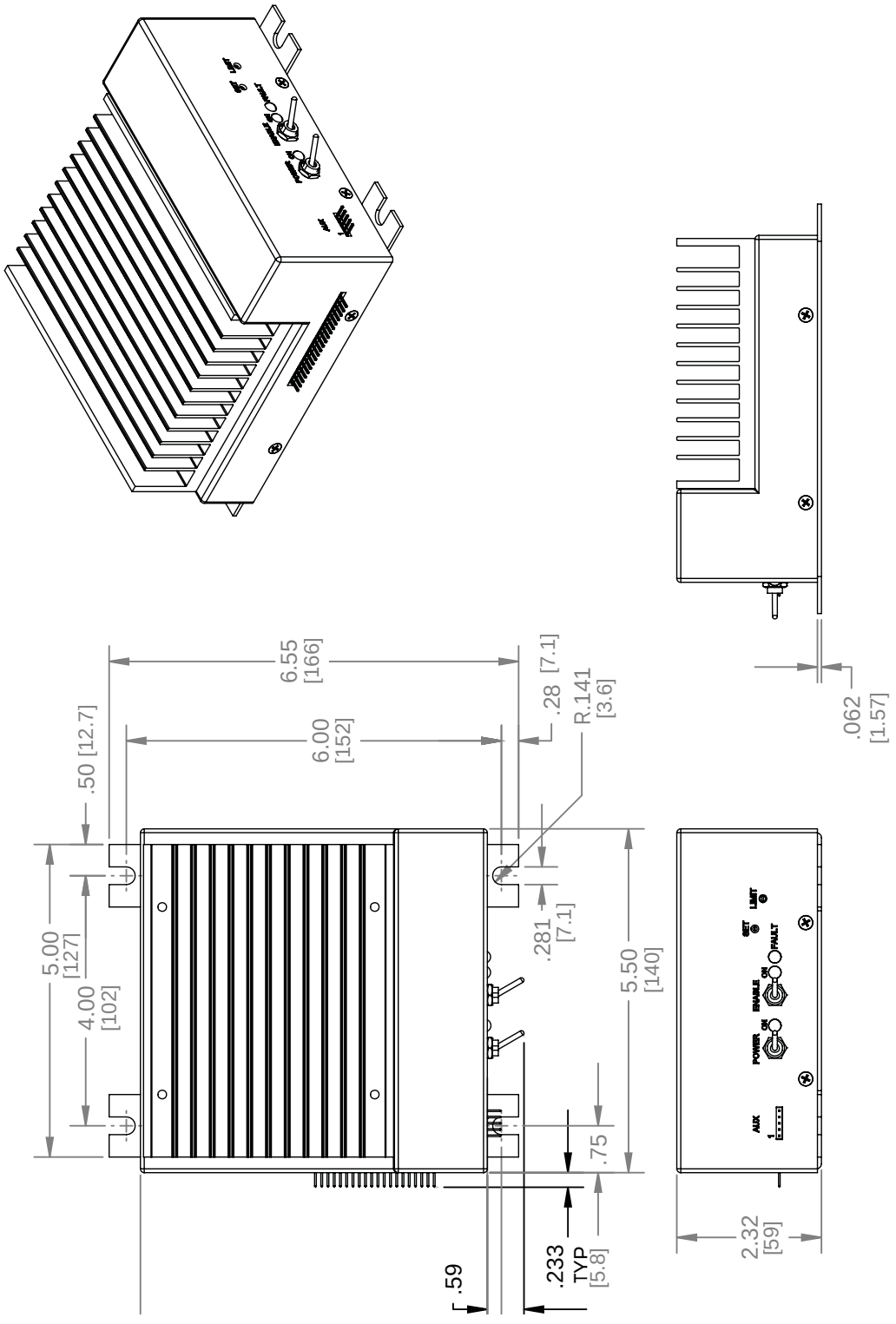
### WCB312 POWER SUPPLY KIT

This kit is available to simplify wiring of the PWRPAK-24V. It includes:

- AC: 2 twisted pair black & white 14 ga 24” wires (blk is intended for line, white for neutral)
- Qty 6 - 14 ga ring terminals to attach the AC wires to the PWRPAK-24V screw terminals
- AC Safety ground #1: 22 ga green wire, 10” with ring terminals on both ends - connect two FG terminals
- AC Safety ground #2: 22 ga green wire, 10” with one ring terminal - connect FG to AC chassis ground
- Common Ground: 24 ga black wire, 10” with ring terminals on both ends - connect between -V of positive supply and +V of negative supply
- Qty 3 - 24 ga ring terminals to attach to the wires from the 3-pin power cable (V+, POWER GROUND, V -)



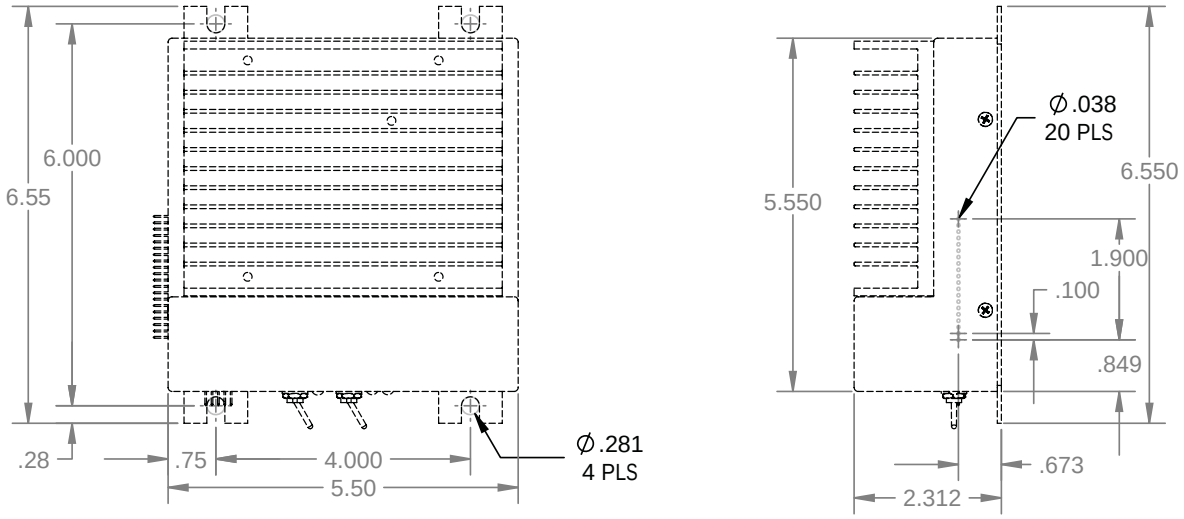
## MECHANICAL SPECIFICATIONS




Dimensions are in inches [mm]. Tolerance is ± 5%.

## PCB MOUNTING GUIDELINES

The QCL driver needs to be mounted by the baseplate mounting holes, not supported by the solder joints. The solder joints are not meant for mechanical support.




To use #8 screws instead of 1/4-20s for mounting, a shoulder washer such as 12SWS1030 from Micro Plastics, Inc. can be used.

# MECHANICAL SPECIFICATIONS PWRPAK-24V

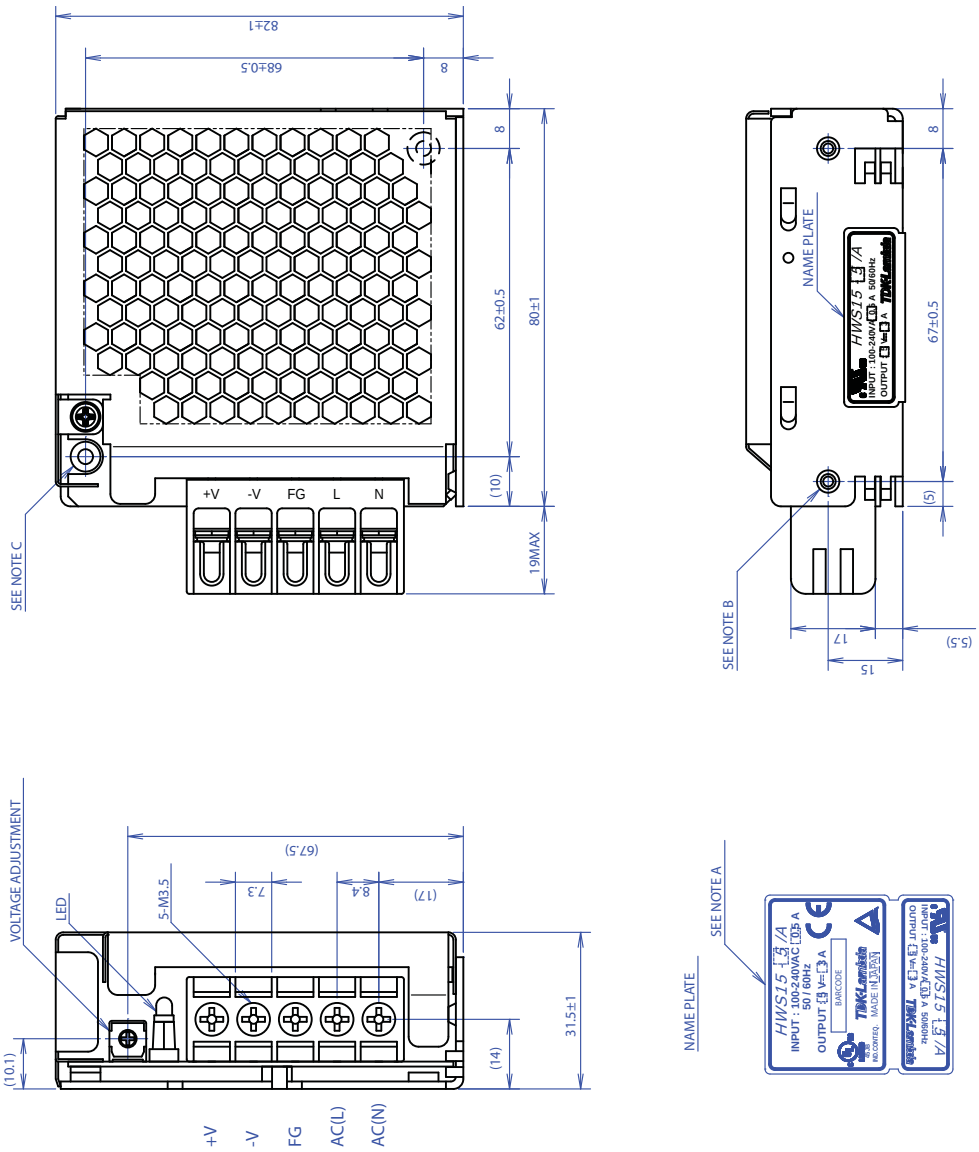



Diagram courtesy TDK-Lambda - data subject to change

Additional use and mounting guidelines are available in the PWRPAK-24V datasheet.

NOTES

A : MODEL NAME, INPUT VOLTAGE RANGE, NOMINAL OUTPUT VOLTAGE, MAXIMUM OUTPUT CURRENT AND COUNTRY OF MANUFACTURE ARE SHOWN HERE IN ACCORDANCE WITH THE SPECIFICATIONS.

B : M3 EMBOSSED, TAPPED AND COUNTERSUNK HOLES (2) FOR CUSTOMER CHASSIS MOUNTING. SCREWS MUST NOT PROTRUDE INTO POWER SUPPLY BY MORE THAN 6m/m.

C : M3 TAPPED HOLES (2) FOR CUSTOMER CHASSIS MOUNTING. SCREWS MUST NOT PROTRUDE INTO POWER SUPPLY BY MORE THAN 6m/m.

APPENDIX A
SAFE OPERATING AREA & AIRFLOW REQUIREMENTS

## Caution:

Do not exceed the Safe Operating Area (SOA). Exceeding the SOA voids the warranty.

**An online tool is available for calculating Safe Operating Area at:**
**http://www.teamwavelength.com/support/calculator/soa/soald.php.**

To determine if the operating parameters fall within the SOA of the QCL driver, the maximum voltage drop across the driver and the maximum current must be plotted on the SOA curves.

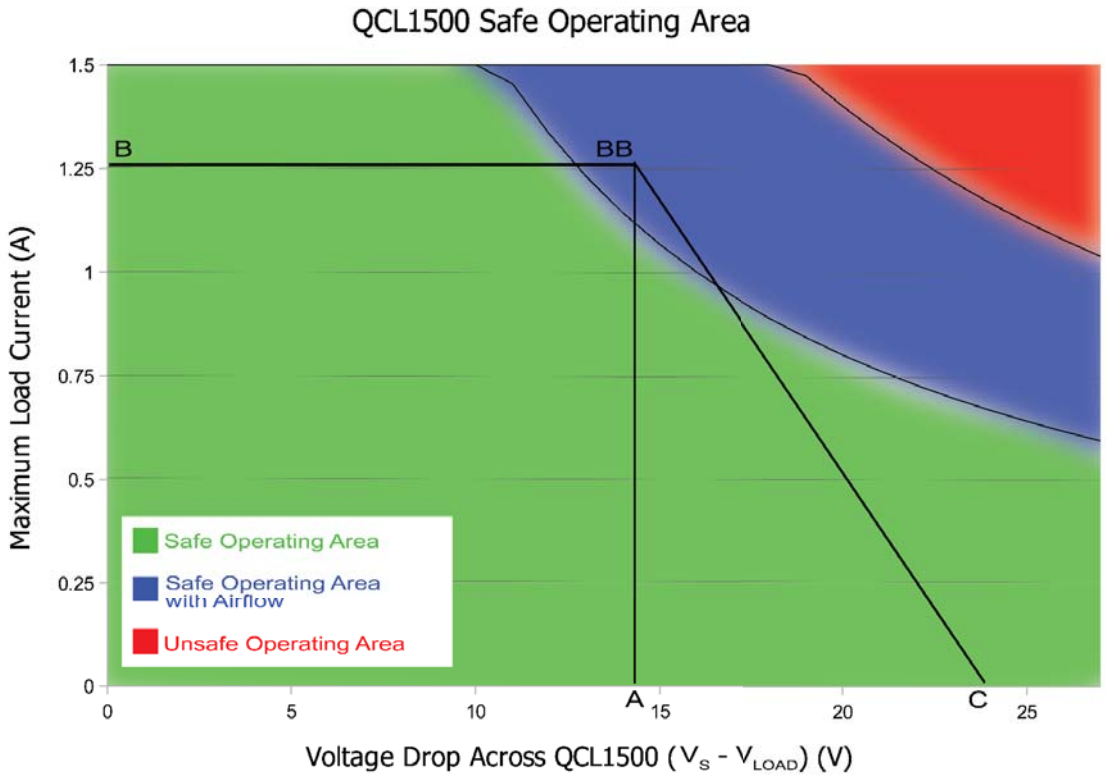
These values are used for the example SOA determination:

Device: QCL1500
V- = 24 Volts
$V_{QCL}$ = 10 Volts
$I_{QCL}$ = 1.25 Amp

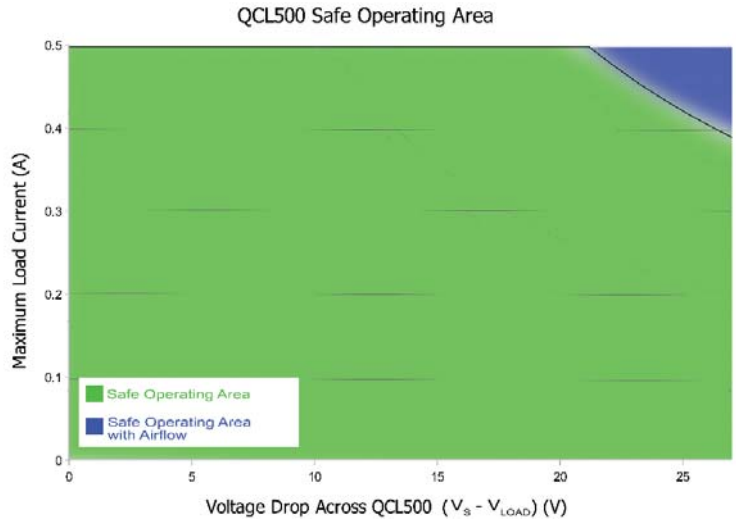
Follow these steps:

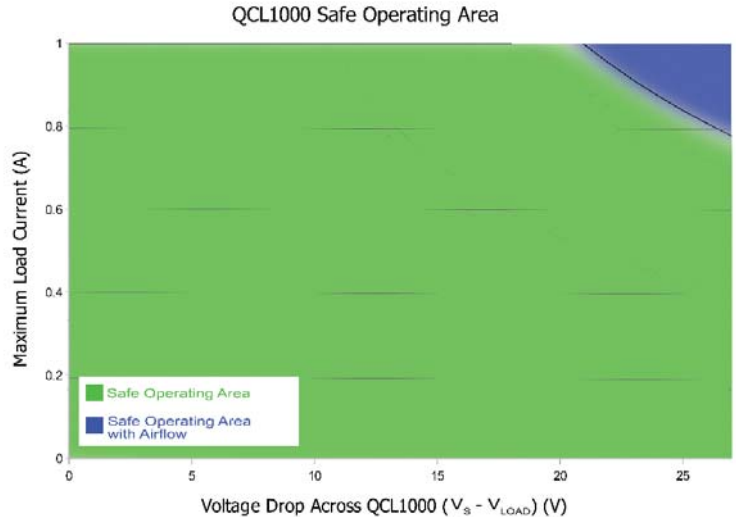
1. Determine the maximum voltage drop across the driver, V- - $V_{QCL}$, and mark on the X axis.
   Example: 24 V - 10 volts = 14 volts, Point A
2. Determine the maximum current, $I_{QCL}$, through the driver and mark on the Y axis:
   (1.25 Amp, Point B)
3. Draw a horizontal line through Point B across the chart. (Line BB)
4. Draw a vertical line from Point A to the maximum current line indicated by Line BB.
5. Mark total supply voltage V- on the X axis. (Point C - 24 V)
6. Draw the Load Line from where the vertical line from point A intersects Line BB down to Point C.

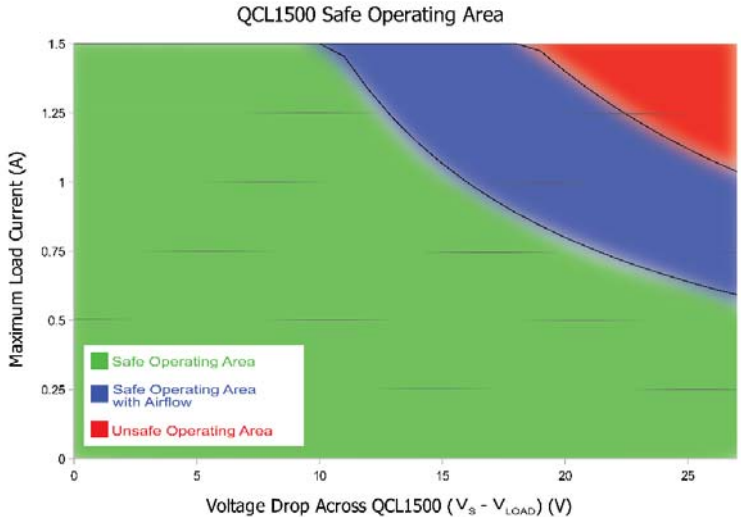
Refer to the chart shown below and note that the Load Line is within the Safe Operating Area for this device, but requires airflow (34 cfm) to maintain safe operation.



The charts on this page can be used to determine if your design falls within the **Safe Operating Area** (SOA) for the QCL series driver that you are using. For an example of how to use these charts, reference the previous page. There is also an online Safe Operating Area calculator available at: http://www.teamwavelength.com/support/calculator/soa/soald.php .



## CERTIFICATION AND WARRANTY

**CERTIFICATION:**
Wavelength Electronics (Wavelength) certifies that this product met it's published specifications at the time of shipment. Wavelength further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by that organization's calibration facilities, and to the calibration facilities of other International Standards Organization members.

**WARRANTY:**
This Wavelength product is warranted against defects in materials and workmanship for a period of 1 year from date of shipment. During the warranty period, Wavelength will, at its option, either repair or replace products which prove to be defective.

**WARRANTY SERVICE:**
For warranty service or repair, this product must be returned to the factory. An RMA is required for products returned to Wavelength for warranty service. The Buyer shall prepay shipping charges to Wavelength and Wavelength shall pay shipping charges to return the product to the Buyer upon determination of defective materials or workmanship. However, the Buyer shall pay all shipping charges, duties, and taxes for products returned to Wavelength from another country.

**LIMITATIONS OF WARRANTY:**
The warranty shall not apply to defects resulting from improper use or misuse of the product or operation outside published specifications.

No other warranty is expressed or implied. Wavelength specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

**EXCLUSIVE REMEDIES:**
The remedies provided herein are the Buyer's sole and exclusive remedies. Wavelength shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

**REVERSE ENGINEERING PROHIBITED:**
Buyer, End-User, or Third-Party Reseller are expressly prohibited from reverse engineering, decompiling, or disassembling this product.

**NOTICE:**
The information contained in this document is subject to change without notice. Wavelength will not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material. No part of this document may be photocopied, reproduced, or translated to another language without the prior written consent of Wavelength.

**SAFETY:**
Other than two fuses, there are no user serviceable parts inside this product. Return the product to Wavelength for service and repair to ensure that safety features are maintained.

**LIFE SUPPORT POLICY:**
As a general policy, Wavelength Electronics, Inc. does not recommend the use of any of its products in life support applications where the failure or malfunction of the Wavelength product can be reasonably expected to cause failure of the life support device or to significantly affect its safety or effectiveness. Wavelength will not knowingly sell its products for use in such applications unless it receives written assurances satisfactory to Wavelength that the risks of injury or damage have been minimized, the customer assumes all such risks, and there is no product liability for Wavelength. Examples of devices considered to be life support devices are neonatal oxygen analyzers, nerve stimulators (for any use), auto transfusion devices, blood pumps, defibrillators, arrhythmia detectors and alarms, pacemakers, hemodialysis systems, peritoneal dialysis systems, ventilators of all types, and infusion pumps as well as other devices designated as "critical" by the FDA. The above are representative examples only and are not intended to be conclusive or exclusive of any other life support device.

**PATENTED TECHNOLOGY**
Covered by U.S. Patents 6,696,887; 6,867,644 and 7,176,755 Licensed from Battelle Memorial Institute.

| REVISION HISTORY | | |
|---|---|---|
| **REVISION** | **DATE** | **NOTES** |
| **REV. A** | 20-Sep-10 | Preliminary Release |
| **REV. B** | 10-Oct-10 | Beta Release |
| **REV. D** | 9-Nov-10 | Product Release |

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