

# QCL OEM Series

## Low-Noise QCL Driver



### FEATURES

- Output current of 500 mA, 1 A, 1.5 A, 2 A
- Low noise: <math><1 \mu\text{A}</math> RMS up to 100 kHz (typical)
- Compliance voltage up to 16 V (standard)  
Up to 20 V with factory modification
- Feature-rich for OEM applications
  - » On-board power and enable switches
  - » Analog current setpoint input
  - » TTL-compatible Power-On & Output Enable
  - » Status outputs can drive front-panel LEDs
  - » Optional 5 V output drives alignment LEDs
  - » Small Package 6.55" x 5.5" x 2.3"
- Safety features protect your QCL investment
  - » Adjustable Soft-Clamp Current Limit, with Brick-Wall Never-Exceed circuitry
  - » 1.25 second turn-on delay
  - » 100 msec current ramp
  - » Brown-out, reverse-voltage, & over-voltage protection
  - » Driver over-temperature protection circuit
  - » Relay shorts output when current is disabled
- Constant Current Mode operation
- 3 dB bandwidth 2 - 3 MHz; 250 nsec rise time
- $\pm 24$  VDC power supply required
- Custom product variations available
  - » Operation from lower voltage power supply
  - » Additional current ranges up to 2 A

### THE LOWEST-NOISE DRIVER AVAILABLE

These Low Noise QCL Drivers have the lowest current noise density of any commercially available driver. Powering your QCL with this patented<sup>1</sup> driver will enable better performance—at lower cost and in less time—than otherwise possible.

This is the right driver for lasers that require a high-precision and ultra-low noise current source. The 500 mA QCL driver exhibits noise performance of 0.4  $\mu\text{A}$  RMS to 100 kHz, and an average current noise density of 1 nA /  $\sqrt{\text{Hz}}$ —the lowest available today.

### ULTRA-NARROW QCL LINEWIDTH

In order to maintain their characteristically tight center linewidths and minimize jitter, quantum cascade lasers must be powered by drivers with exceptionally low current noise density. Our customers have reported achieving narrower linewidths with these drivers than any other they've used.

### HIGHEST MODULATION BANDWIDTH

The high modulation bandwidth and fast rise-time maintains modulation waveform integrity so you can shape the laser output profile exactly as your application requires.

### DESIGNED FOR RAPID INTEGRATION

The robust design and simple operation of our drivers allows you to take your revolutionary QCL application from the test bench to market quickly and efficiently, using the same driver throughout the entire process. You can focus your efforts on the demanding technical aspects of the system.

### REVERSE POLARITY NOW AVAILABLE

Often, with epi-down configurations of a QCL, the exit lead is attached to the case and it is desirable to ground it. Now, the reverse polarity driver, a current source, is also available in the OEM package: QCL500 OEM(+), QCL1000 OEM(+), QCL1500 OEM(+), and QCL2000 OEM(+).

### PROTECT YOUR QCL INVESTMENT

All the essential control and monitor functions you expect in a Wavelength product are incorporated into this QCL driver, along with protection circuitry to safeguard your QCL from minor power source faults, over-temperature conditions, and electrical faults.

The soft-clamping current limit can be set without enabling the driver output, and uses a brick-wall never-exceed limit circuit to protect the QCL from potentially damaging over-current situations.

<sup>1</sup> Covered by U.S. Patents 6,696,887; 6,867,644 and 7,176,755.  
Licensed from Battelle Memorial Institute.

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 **WAVELENGTH**  
ELECTRONICS

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## Low-Noise QCL Driver

### LOW NOISE FOR ULTRA-NARROW LINEWIDTHS

Two key characteristics of quantum cascade lasers make them popular for precision sensing and spectroscopy applications: 1) the wavelength can be custom-tailored to mid- and long-wavelength IR, and 2) the extremely narrow linewidth allows for faster, higher-precision, and more repeatable measurements than competing technologies.

Quantum cascade laser linewidth is key to precision sensing applications, and trace gas concentration measurement sensitivity in the parts-per-trillion can be achieved with careful system design. All aspects of the detection system must be designed and executed with precision in order to achieve such capability, and the QCL driver and supporting electronics play a particularly important role.

Figure 1 illustrates the noise spectrum of the QCL1000 over a 100 kHz bandwidth, at an output current of 500 mA, and compares it to a typical bench-top laser diode driver. A 10  $\Omega$  test load is used in order to operate the driver at a higher compliance voltage, a more stringent test of noise performance.

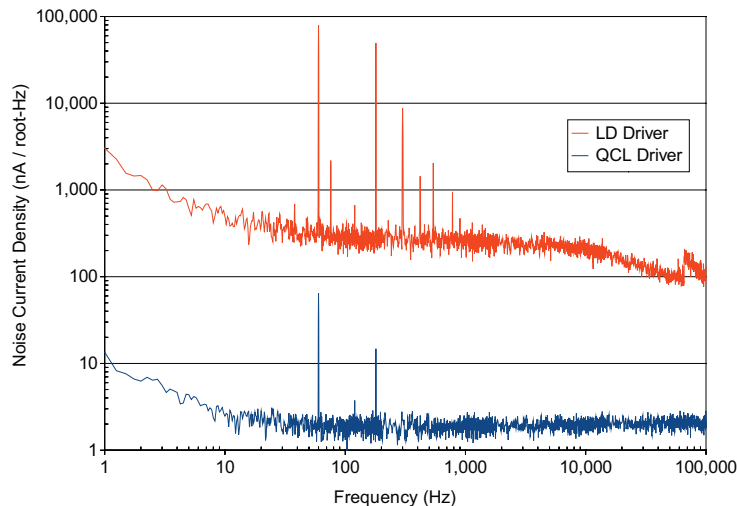


Figure 1. Noise Density – QCL vs. Laser Diode Driver

Laser emission wavelength and linewidth are both partly a function of current density, and therefore drive current noise and jitter manifest directly as broadened linewidth and wavelength jitter. Broadening the center wavelength by a fraction of a  $\text{cm}^{-1}$  can reduce measurement sensitivity by an order of magnitude or more, so it is critical to approach the entire design process with an attitude towards eliminating noise.

During manufacturing, we test spectral noise density across a wide bandwidth using a load that effectively simulates a QCL. This test is more stringent than stating a single RMS noise value, and provides a more meaningful statement of noise performance. This attention to detail guarantees the driver meets or exceeds our own strict internal specifications.

Figure 2 shows the cumulative noise density, determined by integrating the noise data from Figure 1. To determine the cumulative noise over a 1 Hz – 11 kHz bandwidth, for example, simply refer to the noise value at 11 kHz. The QCL exhibits 0.3  $\mu\text{A}$ , while the laser diode driver exhibits 60  $\mu\text{A}$  over the same bandwidth.

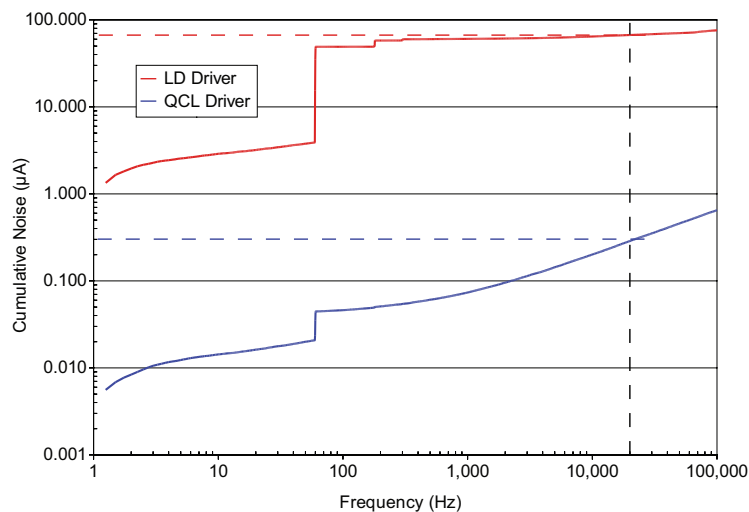


Figure 2. Cumulative Noise – QCL vs. Laser Diode Driver

### ULTRA-STABLE OUTPUT CURRENT

With trace gas detectors, overall system repeatability hinges on the stability of the current source. Figure 3 illustrates stability on the order of  $\pm 10$  ppm over 1 hour, tested with the unit on a bench and subject to ambient temperature fluctuations. The QCL driver maintains this level of stability even over a 24-hour test cycle.

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## Low-Noise QCL Driver

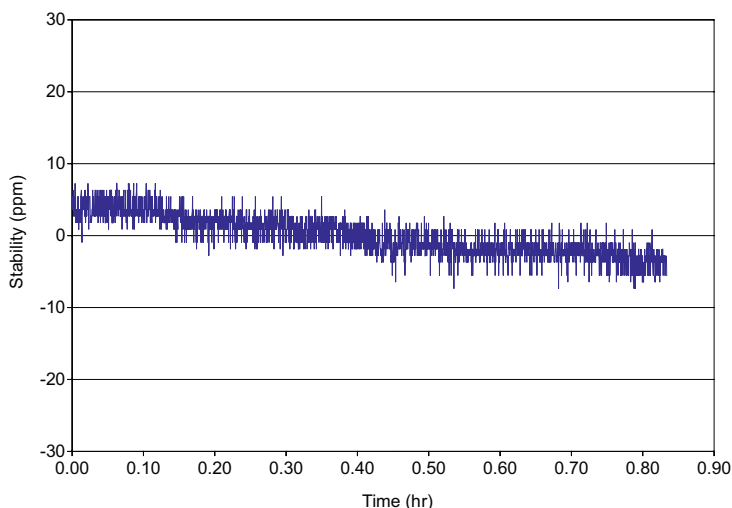


Figure 3. Short Term Output Stability

output monitors allow you to integrate a control loop based on external feedback signals into your control system. An optional 5 VDC output can be used to drive an alignment LED or other low-noise electronics up to 500 mA.

The built-in heatsink is sized for maximum efficiency and small form factor. And if your application requires changes to the driver package, Wavelength's in-house engineering team is able to quickly and efficiently address your needs.

### REAL-WORLD SUCCESS

Results with the ultra-low noise QCL drivers are impressive: customers report laser noise reduction of three orders of magnitude, and have achieved trace gas detection sensitivity in the parts-per-trillion range. The ultra-low noise driver directly enables such performance by minimizing laser line broadening and jitter, and outstanding stability means industry-leading accuracy and repeatability.

### PROTECT YOUR INVESTMENT

Carefully designed safety features—brown-out, reverse-voltage, and over-voltage—protect the laser from power supply faults. A built-in over-temperature detection circuit switches off the QCL driver if the internal temperature exceeds the safe operating point due to environmental conditions. The remote enable feature can be integrated with the temperature controller so the QCL is switched off if it exceeds a safe temperature.

The current limit circuit employs a soft-clamping limit, backed by a brick-wall never-exceed characteristic to provide maximum protection to the laser.

These features are designed to protect your QCL investment, and make your system more reliable and robust in real-world environments.

### ENABLE LEADING-EDGE PERFORMANCE

Enable your QCL application with the most capable driver available. Whether you are at the prototype stage or ready to integrate a driver with your laser and optics, Wavelength's QCL driver delivers performance that sets your system apart.

Wavelength Electronics is committed to helping you be successful.

Call our experienced Sales and Applications Engineers at  
406-587-4910 to discuss your QCL driver requirements.

This outstanding stability is maintained when the current is modulated to sweep the laser wavelength, providing sweep-to-sweep repeatability that enables unprecedented measurement and detection accuracy. Coupled with a temperature coefficient of 10 ppm / °C, the Wavelength QCL drivers are among the most stable available for OEM or benchtop applications.

### DESIGNED FOR OEM INTEGRATION

The QCL driver family is designed to take you from the test bench to production efficiently and with minimal electronics design on your part. Benchtop operation is simplified with on-board Power and Enable switches, and easily-accessed trim pots can be used to adjust the drive current and current limit.

When it's time to integrate the driver into your laser system, you can control the Power-On and Enable functions via TTL-compatible inputs on the side connector. The analog

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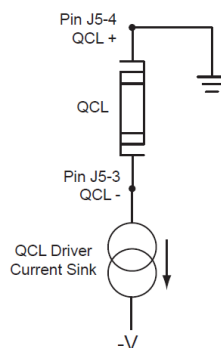
### QCL DRIVER SPECIFICATIONS

DRIVER OUTPUT CURRENT	MIN	TYP	MAX	UNIT	NOTE
Output Current	0.5, 1.0, 1.5, 2.0			A	
RMS Noise Current	0.4	1	1.3	μA RMS	QCL1000 OEM at 500 mA output, 100 kHz test bandwidth
Noise Current Density	1	2	4	nA / √Hz	QCL1000 OEM at 500 mA output, 10 Ω test load
Short Term Stability, 1 hr	5	10	15	ppm	25°C ambient
Long Term Stability, 24 hr	5	10	15	ppm	25°C ambient
Temperature Coefficient	5	10	18	ppm / °C	
Compliance Voltage (at ± 24 VDC power supply voltage)	11		16	V	Compliance voltage is dependent on negative supply voltage. Compliance can be increased to 20 V with factory modification.
Modulation Bandwidth		2	3	MHz	sinewave
Rise/Fall Time	250 / 200			nsec	to full scale
Slew rate		30		V / μsec	
Depth of Modulation		90		%	at 500 kHz
Slow Start Ramp		100		msec	to setpoint
Leakage Current	0.75	2	3	mA	
POWER SUPPLY REQUIREMENTS	MIN	TYP	MAX	UNIT	NOTE
Bipolar Power Supply Input	± 22	± 24	± 25	VDC	Supply voltage range can be modified at the factory. Other operation specs will be affected, such as Compliance Voltage.
Quiescent Current, V+ Supply		250		mA	
Quiescent Current, V- Supply		100		mA	
Inrush Current		450		mA	Negative power supply must source > 450 mA; if QCL draws > 450 mA then negative supply must source (QCL Current + Quiescent Current)
ABSOLUTE MAXIMUM RATINGS	VALUE			UNIT	NOTE
Positive Supply Voltage	25.0			VDC	
Negative Supply Voltage	-25.0			VDC	
Internal Power Dissipation	16			W	
Case Operating Temperature	-40 to 50			°C	Derating begins at 25°C; QCL2000 OEM Max Operating Temp is 35°C
Weight	32			oz	0.9 kg
Size	5.5 x 6.55 x 2.3			inches	140 x 166 x 59 mm

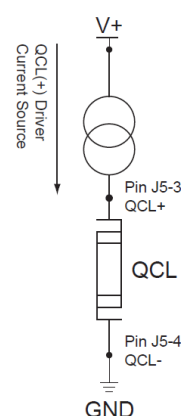
### ORDERING INFORMATION

PART NUMBER	DESCRIPTION
QCL500 OEM	500 mA QCL Driver
QCL1000 OEM	1.0 A QCL Driver
QCL1500 OEM	1.5 A QCL Driver
QCL2000 OEM	2.0 A QCL Driver
QCL OEM(+) Series	All current models available with positive polarity
WCB310	Low Noise SMA-SMA Cable
55-110014	Low Noise SMA-BNC Cable
WCB311	14-Pin I/O Cable
WCB312	Dual Power Supply Wiring Kit
WCB313	QCL Power Cable
WCB314	QCL Load Cable
PWRPAK-24V	24 VDC Switching Power Supply (2x Required)
NOISESCAN	Noise Characterization Scan
QCL TEST LOAD	Diode Test Load with Heatsink

#### QCL STANDARD



#### QCL(+)



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