

## Quantum Cascade Laser Current Controller Description and Specifications

The evolution of the quantum cascade laser (QCL)<sup>1</sup> over the last decade has prompted the development of a new breed of laser current controller. QCLs require drive currents and compliance voltages that are considerably larger than their laser diode counterparts. Despite their larger power needs, QCLs are also highly frequency and amplitude stable devices when operated at well-defined temperatures, and provided with clean power. Additionally, QCLs can respond rapidly to deep modulations and work well in pulsed mode. To take advantage of all these attributes, an effective QCL current controller must be quiet, stable and agile.



The QCLx series of current controllers developed at PNNL has been designed to achieve this combination of attributes. The QCL5 and QCL6N are the latest models of this series currently in use in the IR Sensing Group. (Full specifications shown below.) Both these models exhibit output noise levels close to the calculated theoretical, can be swept 90% of their full current ranges at rates up to 100 kHz, and have modulation bandwidths out to 10 MHz, with usable responses out to 70 MHz. They have also been demonstrated to be more stable long term than most commercial units available today. The QCL6N, being the later model with more output power, also incorporates safety features such as a master current limit, thermal shutdown and laser interlock for class IIIb laser operation.

<sup>1</sup> “Quantum cascade transmitters for ultrasensitive chemical agent and explosives detection,” John F. Schultz, Matthew S. Taubman, Warren W. Harper, Richard M. Williams, Tanya L. Myers, Bret D. Cannon, David M. Sheen, Norman C. Anheier, Paul J. Allen, S.K. Sundaram, Bradley R. Johnson, Pamela M. Aker, Ming C. Wu, Irwin K. Lau, in Proc. SPIE 4999, Bellingham, WA, 2003

<b><i>QCL Current Controller Specifications<sup>2</sup></i></b>		
<b><i>Specification, Operating Parameter</i></b>	<b><i>QCL5</i></b>	<b><i>QCL6N</i></b>
<b><i>Output</i></b>		
<i>Current Range</i>	0 to 1000 mA	0 to 2000 mA
<i>Compliance Voltage</i>	>10V @ I <sub>MAX</sub>	>15V @ I <sub>MAX</sub>
<b><i>Monitor</i></b>		
<i>Output Function</i>	1.00 ± 0.05 V/A	
<i>Response</i>	50 kHz	1 MHz
<b><i>Modulation: Slow Inputs</i></b>		
<i>Sensitivity, Input 1</i>	20 mA/V	40 mA/V
<i>Impedance, Input 1</i>	10 kΩ	
<i>Sensitivity, Input 2</i>	100 mA/V	200 mA/V
<i>Impedance, Input 2</i>	2 kΩ	
<i>Full Amplitude Response</i>	100 kHz, Square Wave 200 kHz, Sine Wave	50 kHz, Square Wave 100 kHz, Sine Wave
<i>Small Signal Response</i>	1 MHz, 3 dB 5 MHz, 14 dB	
<b><i>Modulation: Fast Inputs</i></b>		
<i>Sensitivity</i>	20 mA/V	
<i>Impedance</i>	50Ω	
<i>Response</i>	10 MHz, 3 dB 70 MHz, 14 dB	
<b><i>Output Noise</i></b>		
<i>Spectral Density Floor</i>	1.7 nA/√Hz	3.4 nA/√Hz
<i>Spectral Density Knee</i>	20 Hz	20 Hz
<i>1/f @ 10 Hz</i>	3 nA/√Hz	6 nA/√Hz
<i>1/f @ 3 Hz</i>	10 nA/√Hz	20 nA/√Hz
<i>RMS with standard filter</i>	4.2 μA <sub>RMS</sub>	8.4 μA <sub>RMS</sub>
<i>RMS 1 Hz to 100 kHz</i>	620 nA <sub>RMS</sub>	1300 nA <sub>RMS</sub>
<b><i>Long Term Stability</i></b>		
	< 20 ppm peak-to-peak over 14 hrs	
<b><i>Safety Features</i></b>		
<i>Interlock</i>	No	Yes
<i>Master Current Limit</i>	No	Yes
<i>Thermal Shutdown</i>	No	Yes

<sup>2</sup>These specifications are the result of measurements performed using specific prototype units. These are only to be taken as a guide to the performance of any given QCL5 or QCL6N current controller, which can vary unit to unit. Specifications and performance figures are subject to change without notice.