



## dDLC Digital Diode Laser Controller



The MOGLabs Digital Diode Laser Controller is our next-generation controller for precision tunable lasers. It combines the ergonomic ease-of-use of our classic analogue DLC, with the flexibility and performance of a fully digital system.

It offers a combination of impressive performance and ease-of-use, using the front panel with high resolution display, or our comprehensive Windows app, or your own code using the simple text-based command language that MOGLabs is famous for.

The dDLC is designed for the ultimate applications in quantum computing, quantum sensing, time and frequency standards, gas sensing, and spectroscopy.

### Features

- Intuitive controls mimic our analogue DLC
- High-bandwidth FFT spectrum analyser
- Oscilloscope functionality built-in
- Ultra-low noise current source
- Temperature controller
- Demodulator (lock-in amplifier)
- Feedback servos: locking is **included**
- Auto-lock and auto-relock (in development)
- Dual independent piezo drivers
- Modulator driver (dual channel DDS)
- Sweep ramp generator
- TCP/IP, USB2
- LabVIEW, MATLAB and python drivers

# Digital Diode Laser Controller

## Specifications dDLC 1.0 (preliminary)

Current		B1150 single-channel driver
Output current	0 to 1200mA $\pm 5\mu\text{A}$ setpoint (display $\pm 10\mu\text{A}$ ), control $\pm 8\text{nA}$	
Noise*	240pA/VHz @ 1 kHz, 250nA(rms) 1 Hz – 1 MHz	
Stability and accuracy	$\pm 0.2\text{ppm}/^\circ\text{C}$ and 0.1% from setpoint	
Compliance voltage	9 V at 600mA, 7 V at 1200mA	
Current modulation	1. $\pm 25\text{mA}$ Direct analogue, Sweep 2. $\pm 1\text{mA}$ Direct analogue, Dither, Control DAC 1, Control DAC 2 3. $\pm 250\mu\text{A}$ Dither, Control DAC 2 DAC1, DAC2: 16 bits at 3.125MHz	
Current modulation bandwidth	Direct analogue mode: 1.2 MHz ( $-3\text{dB}$ ) DAC control (fast): 3.2 MHz (28-bit depth)	
Temperature		B1180 single-channel TEC driver
Range	7.5 – 49.5°C $\pm 0.001^\circ\text{C}$ resolution	
Stability	Better than $\pm 1\text{mK}$	
TEC power	$\pm 2\text{A}$ , $\pm 12\text{V}$ (24W)	
Sensor	NTC 10k $\Omega$	
Control	PID with variable sample rate, bandwidth 50 Hz	
Protection	PCB over temp, TEC over current, open/short circuit	
Piezo		B1190 dual-channel piezo driver
Piezo output	Two independent channels 0 – 150V, 30mA (charge and discharge)	
Piezo Sweep/Control DAC	Individual Sweep and Control DACs, 16 bits unipolar	
Resolution	Sweep: 2.5mV resolution at maximum range Control: variable gain from 200 $\mu\text{V}$ to 4 $\mu\text{V}$ per LSB	
Noise	80nV/VHz	
Sweep	Internal 0.5 Hz to 62.5 Hz; auxiliary inputs ChA, ChB; programmable	
Monitoring	Output and HV supply for each channel, voltage and current	
Protection	Leakage, PCB over temperature	

**Frequency stabilisation****B1110 core**

Dither for AC locking	0 to 2.5 MHz (initially 250kHz), defined by DDS, 0.058Hz resolution Dither to diode current ( $\pm 250\mu\text{A}$ or $\pm 1\text{mA}$ ) or external ( $\pm 150\text{mA}$ or $\pm 4\text{V}$ )
Bandwidth	3.2 MHz (DAC control)
Phase	0 – 360°, 0.022° resolution
Error signal	32-bits signed, sampling at 6.25 MHz
Post demodulator filter	5 stage IIR and user adjustable response including bypass option
Servo Controls	Slow (piezo) and Fast (current) servo controllers with individual offset
Gain Controls	$\pm 18\text{dB}$ master plus $\pm 18\text{dB}$ on slow, fast channels
Slow Controller Inputs	<ol style="list-style-type: none"> <li>1. Slow Error Signal (after offset and master gain)</li> <li>2. Auxiliary A</li> <li>3. Auxiliary B</li> <li>4. Photodetector DC Input</li> <li>5. Fast controller Output</li> </ol>
Slow Controller Action	PI or PI <sup>2</sup> with $\pm 18\text{dB}$ gain control
Slow Controller Bandwidth	10kHz (default)
Slow Controller Output Selection	<ol style="list-style-type: none"> <li>1. Slow controller decimator output</li> <li>2. Auxiliary A</li> <li>3. Auxiliary B</li> </ol>
Fast Controller Input Selection	<ol style="list-style-type: none"> <li>1. Fast Error Signal (after offset and master gain)</li> <li>2. DC Block Output (AC coupled error signal)</li> </ol>
Fast Controller Action	PI with $\pm 18\text{dB}$ gain control
Fast Controller Bandwidth	750kHz (default)

**Signal input/output****B1120 rear panel**

Signal input/output	6 BNC connectors 1 MOGLabs DVI-D DL socket Option: Toptica DL Pro	4 analogue input 2 analogue output Trigger out Mod out
Analogue inputs (4)	Signal range $\pm 4.096\text{V}$ (protected to $\pm 15\text{V}$ ) <i>Photodetector</i> AC: 12.5 MHz > 150dB dynamic range DC: 1 MHz > 110dB dynamic range <i>Auxiliary A and B</i> : DC 1 MHz > 110dB dynamic range <i>Direct</i> : analogue input direct to diode current modulation	
Analogue outputs (2)	Monitor A and B, 16 user-selectable signals; output range $\pm 4\text{V}$ . Sampling up to 3.25 MHz @ 16 bits / BW 1 MHz Dither Voltage/Current Driver (user selectable): output $\pm 4.096\text{V}$ $\pm 150\text{mA}$ BW 1 MHz	
Digital inputs	TTL compatible, 0 – 6.5 V tolerant and protected, active low <0.8 V: a) 3.5mm stereo jack (external Fast/Slow Lock inputs) b) 3.5mm stereo jack (External Laser1/Laser2 interlocks)	
Digital outputs	TTL compatible, 0 – 6.5 V tolerant and protected, active high >2.4 V: a) Trigger (sweep mid-point) b) 3.5mm stereo jack (Fast/Slow Lock outputs)	

## Front panel user interface

B1118 front panel

Operator controls	1 key switch STANDBY/RUN 6 dedicated rotary encoders: diode current, input offset, frequency, span, slow gain, fast gain, each with press-function 3 dedicated pushbuttons: diode on/off, slow lock, fast lock 1 menu adjust encoder 2 menu step pushbuttons
LED indicators	Four 3-colour LEDs: standby/run, laser diode, slow lock, fast lock
Display	127mm, 800x480 pixels, full colour

## Connectivity

Communications	TCP/IP ethernet (10/100); USB 2.0 Type B
Laser	Standard: MOGLabs DVI-D DL socket; Option: Toptica DLPro
Power out	Photodetector supply (M8-3 Thorlabs-compatible), $\pm 15$ V

## Power and dimensions

IEC input	90 – 264 Vac @ 47 – 63 Hz
Power	28 W (laser off)
Dimensions	19" 2U, 88x422x270 mm (H x W x D), optional rack-mount ears, 3.5kg
Operating Temperature	10 - 35°C

## Features

- Fully digital with high-speed FPGA signal processing.
- Bullet-proof laser operation: can reset the microcontrollers without affecting laser lock.
- Current, temperature and piezo controllers with lowest commercially available noise and drift.
- Internal spectrum analysis with high dynamic range and bandwidth.
- Complex frequency feedback locking via FPGA signal processing.  
Side of fringe, top of fringe locking **included** (auto-relock in development).
- Auto-optimize of feedback servos using live noise spectral analysis.
- Signal display oscilloscope functionality on device, with specific knobs to control key functions (diode current, laser frequency and span, input signal offset, slow and fast gain).
- Completely self-contained: tune and lock to atomic resonance without computer connection.
- Full device control using on-screen menu.
- Sophisticated and intuitive GUI for remote operation via LAN or USB.
- Easy to use text-based control API; no DLL or drivers needed.  
Python, LabVIEW, matlab bindings and examples provided.
- Online user manuals, software updates, app notes; no login details required.