



Operating manual

Laser Controller
C190

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Introduction

Redwave Labs Laser Controller C190 comes with integrated temperature driver and laser driver in one package. TEC control can be done via built-in PI loop or external signal. Laser driver can drive up to 500 mA with. CW and pulse operation set view TTL line. Pulse amplitude control through internal pot or externally.



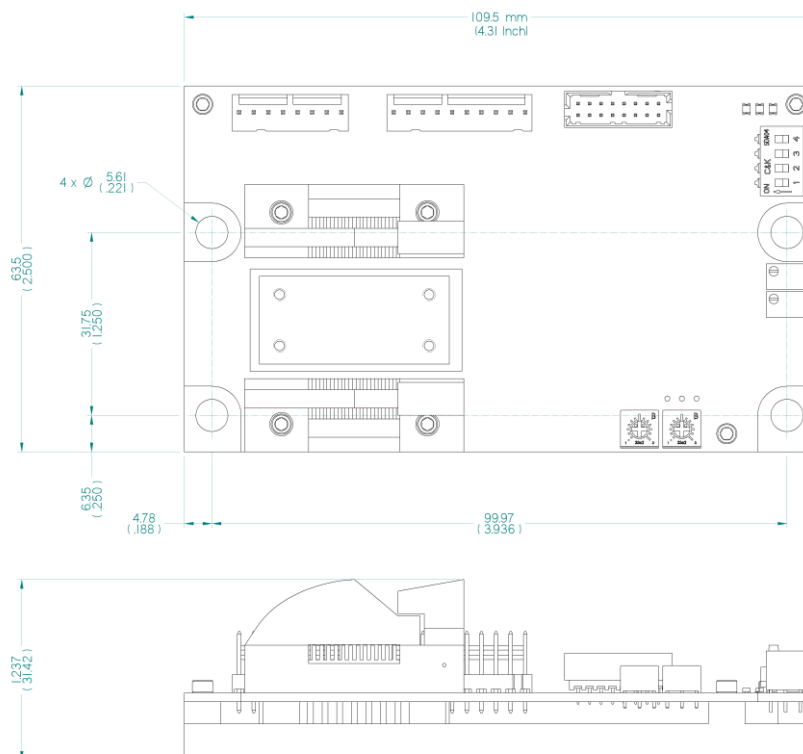
Features	Laser Controller C190 provides full control for semiconductor laser including laser diode control and integrated temperature control.	
Applications	Spectroscopy, Laser, Precision Instrument, OEM applications	
Specifications	Parameter	Value
Power	Dual	+5 V, 1.5 A;
Laser Current Control	Laser current	0 - 500 mA.
	Compliance voltage	0.8- 3.0 V
	Setting accuracy	2 % fs
	Noise (RMS)	<0.5%
	Drift	1 μ s -CW
	Modulation	TTL external
	Current limit	0 - 500 mA
	Setting accuracy of current limit	External and internal
Laser External Control	Voltage range	0 --> 5 V
	Input impedance	10 kOhm
	Modulation coefficient (I const)	100 mA/V
	3dB Bandwidth	3 ns, electrical
	TTL modulation, rise / fall-time	100 ns
	Interlock	Yes
TEC control	TEC current	0 ... +- 1.5A
	TEC voltage	> 3.0 V
	Max output power	4 W
	Current limit	1.5 A
	Input sensor	Thermistor 10 kOhm or 100 kOhm at 25 C
	PID control	Internal PI control or External direct TEC current control
Connectors	Laser	Integrated Azimuth Electronics 14 pin connector with heat sink.
	Power	TBD
	Control	TBD
Dimensions (WxHxD)	105 x 64 x 37 mm	
Weight	350 g	
Storage Temp	-55 to 100 C	
Operating Temp	-40 to 85 C	

RedWave Labs Ltd keeps improving its products and therefore some specifications can vary.

Absolute Maximum Ratings

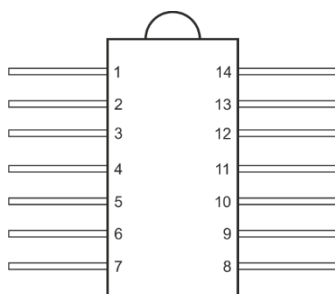
Symbol	Parameter	Ratings	Unit
V_{dd1}	Supply positive voltage / Laser driver and TEC	+5±10%	V
T_{op}	Operational Temperature	-40 to 85	Deg C
T_{st}	Storage Temperature	-55 to 100	Deg C

Mechanical Information



Parameter	Value	Unit
Length	4.31 (109.5)	Inch (mm)
Width	2.5 (63.5)	Inch (mm)
Height	1.237 (31.42)	Inch (mm)
Weight	350	gram

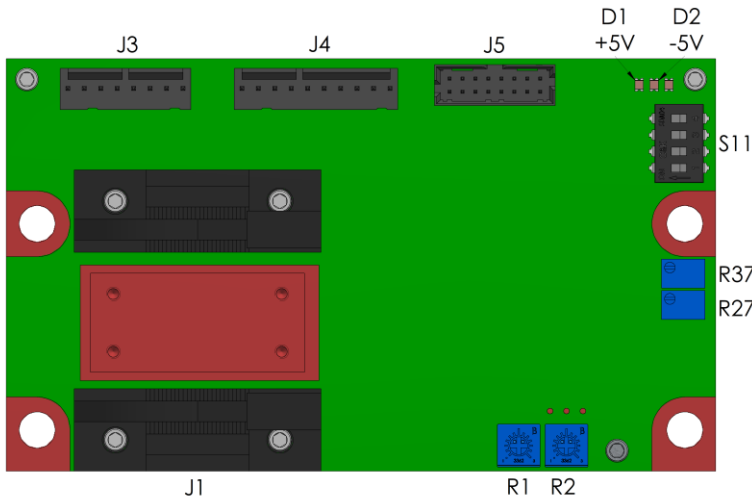
Pin Layout



1	TEC+	14	TEC-
2	TH-	13	GND_LASER_CASE
3	PD+	12	Not in use
4	PD-	11	LD-
5	TH+	10	LD+
6	Not in use	9	Not in use
7	Not in use	8	Not in use

Supporting information

Overview picture: All main connectors, control and indicators are presented in the picture below.



ID	Descriptions	Part Number
J1	Butterfly Laser Connector	AZIMUTH_5253
J3	Header - duplicate connections to J1	0022232081
J4	Power, control and monitor signal	0022232101
J5	Diagnostics connector	0878311620
D1	LED Power rail indicator and TEC	SML-LXT0805I
D2	LED Power rail indicator and TEC	
S1	Switch DIP	SDA04H0SBD
	1 - TEC on/off	
	2 - Thermistor 100/10K	
	3 - TEC limit 1/1.5A	
	4 - KLD current set type	
	Defaults - 0	
R1	Proportional gain resistor	3362R-1-104LF
R2	Integral gain resistor	
R2	Laser Current set resistor	3266W-1-103L
R3	Temperature set resistor	

Electrical Characteristics

Parameter	Comments	Value	Unit
POWER			
Supply positive voltage V_{dd1} / Laser driver and TEC	Positive supply voltage for laser driver, all control circuits and TEC. 2 A minimum is required for single positive power supply	5+/-10%	V
LASER DIODE CONTROL AND MONITOR			
Laser current I_{ld} limit	Hardware laser limit. Can be modified for customized versions	500	mA
Laser Compliance voltage V_{comp}	Minimum voltage across laser diode. Can be change for customized versions.	3.0	V
Current ripple	Peak to peak	0.3	%
Laser current range	Laser current maximum current	500 (for custom version can be up to 1A)	mA
Laser current setting accuracy	Set by components tolerance	2	% of full scale
Laser current set voltage	External transfer function ranges	0-2.5	V
Laser current set voltage impedance		10	kOhm

Parameter	Comments	Value	Unit
Laser current modulation coefficient	Transfer function for laser current modulation	100	mA/V
Laser current TTL modulation rise/fall time	Additional modulation capabilities on top of the analog modulation. Fast ON/OFF switches	100	nS
Laser current monitor	Peak laser current	0-1	V
Laser current interlock	Available laser interlock.		
TEC CONTROL AND MONITOR			
TEC control type	Linear bipolar		
TEC current range	Maximum range can be change with DIP switch S1	0...±1; 0...±1.5	A
TEC compliance voltage	Voltage across TEC element	3	V
Maximum TEC power	Maximum power for 12 V power supply	6	W
TEC current limit	Selected with DIP switch S3	1 of 1.5	A
Input sensor	TEC input sensor. Selected with S2 DIP switch. Configured in bridge mode.	100 or 10	kOhm
PI control	PI analog control loop (internal mode)	Internal	
TEC current monitor	Not implemented	5.0	V/A
TEC disable	TEC current disable function: DIP-Switch S1.		
CONNECTORS			
Connector J3 - Header - duplicate connections to J1	Molex 8 pin Micro Fit connector p/n 0022232081		
Power, Control and Monitor Connector J4	Molex 10 pin Micro Fit connector p/n 0022232101		
Laser connector	Integrated Azimuth Electronics 14 pin connector with heat sink. Sheumann laser pinout. Can be replaced with optional DB15 connector or any other required one.		
Diagnostics Connector J5	Test connector: can be used for diagnostic. Molex p/n 87831-1620		

Power, Control and Monitor Connector J4

PIN#	Abbreviation	Name	Description
1	T_ACTUAL_MON	Actual temperature monitor	It varies from 0.5V to 2.0 V. 1.25 V corresponds to the 25C.
2	LD_ON_OFF	TTL control of laser current	0 V – ON, above 3 V is OFF. Fully TTL compatible. Combined with Pin 5 LASER_EN. For laser to operate Pin 2 and 5 must be low.
3	LD_I_MON	Laser diode monitor	Laser diode current monitor with transfer function 100 mA/V (default) or 1000 mA/V can be used to set up the LD current in standalone operation. Bandwidth of this signal is approximately 500 kHz
4	GND	Ground	Control and Monitor Ground connection. Must not be used for power ground.
5	LASER_EN	TTL control of laser current	Additional pin for laser on and off function. Identical to pin 2. 0 V – ON, above 3 V is OFF. Fully TTL compatible. Combined with Pin 2 LD_ON_OFF. For laser to operate Pin 2 and 5 must be low.
6	PD_I_MON	Built-in photodiode monitor	Transimpedance gain is set to 10 V/ mA.
7	TEC_PWR	TEC power	+5V. Connected on board to pin 8 VCC_5.0C. via a soldered jumper. Pin 7 can power separately from Pin 8 if necessary.
8	VCC_5.0V	Laser Diode power	+5V. Connected on board to pin 7 TEC_PWR via a soldered jumper. Pin 8 can power separately from Pin 7 if necessary.
9	TEC_PGND	TEC ground connection	Connected on board to pin 10 GND via a soldered jumper. Pin 9 can power separately from Pin 10 if necessary.
10	GND	LD ground connection	Connected on board to pin 19 TEC_GND via a soldered jumper. Pin 1 can power separately from Pin 9 if necessary.

The Connector J4 is the main connector for the power, control and monitoring signals. Molex p/n 0022232101. KK Crimp Terminals Series 2759 Molex Number 0050291638 (<https://www.molex.com>) Mating p/n Molex 0050291638 (<https://www.molex.com>).

Connector J3 - Header - duplicate connections to J1

PIN#	Abbreviation	Name	Description
1	PD - / GND	Photodiode negative or direct connection to the GND plane.	Default connection is to GND plane. Can be changes by populating / unpopulating corresponding link resistors.
2	TEC +	TEC element positive connection.	TEC element positive connection.

3	TEC -	TEC element negative connection.	TEC element negative connection.
4	LD -	Laser diode negative connection.	Laser diode negative connection.
5	PD +	Photodiode positive connection	Photodiode positive connection
6	LD +	Laser diode positive connection	Laser diode positive connection
7	TH +	Thermistor positive connection.	Thermistor polarity is kept for overall consistency. TH + and TH - are identical.
8	TH -	Thermistor negative connection.	Thermistor polarity is kept for overall consistency. TH + and TH - are identical.

The Connector J3 is duplicate connector to the DFB package itself. It allows connecting laser package mounted externally and testing all relevant functionalities. Molex p/n 0022232081. Mating p/n Molex 0022012087 (<https://www.molex.com>).

Diagnostics Connector J5

PIN#	Abbreviation	Name	Description
1	LD+	Laser diode positive connection	Directly connected to the Azimuth connector J1 Pin 10
2	LD-	Laser diode negative connection.	Directly connected to the Azimuth connector J1 Pin 11
3	RESERVED		
4	RESERVED		
5	TEC_DISABLE	Laser TEC remote disable	Remote control of Switch S1-1: 0V – TEC Enable; 5V – TEC disable. Remote control overrides S1.
6	THERMISTOR_TYPE-CONTROL	10K/100K remote thermistor selection	Remote control of Switch S1-2: 0V – 100K; 5V – 10K. Remote control overrides S1.
7	LD_CURRENT_CONTROL	Laser diode current Control	Select between 2 types of power stabilization loop. There is no difference between them.
8	RESERVED		
9	TEC_I_LIMIT_CONTROL	TEC current limit control	TEC LIMIT: 0 = 1A; 1 = 1.5A
10	TEC_I_MON	TEC current limit monitor	Current monitor signal $V_{mon} = 2.5V + 1V/A$. For example for negative TEC current of 1A, V_{mon} equal to 1.5V.
11	TH-	Thermistor element negative connection.	Directly connected to the Azimuth connector J1 Pin 2
12	TH+	Thermistor element positive connection.	Directly connected to the Azimuth connector J1 Pin 5
13	TEC_FAULT_1	TEC Fault 1	TEC undervoltage fault
14	TEC_FAULT_0	TEC Fault 0	TEC over temperature fault
15	TEC+	Laser package TEC Positive connection	Directly connected to the Azimuth connector J1 Pin 1
16	TEC-	Laser package TEC Negative connection	Directly connected to the Azimuth connector J1 Pin 14

15	13	11	9	7	5	3	1
16	14	12	10	8	6	4	2

The Connector J5 (pin assignment is on left) is Molex Milli-Grid p/n 87831-1620. Mating connector is Molex Milli-Grid p/n 87568-1694 for ribbon cable. C150 comes without Milli-Grid mating connector. Customized connector arrangement can be used for the remote control of the switch S1. RedWave Labs can be advised on the specific applications when required.

DIP Switch S1

Switch S1 allow to select various settings and controls for C190.

DIP#	Abbreviation	Description
1 (left)	TEC ON OFF	TEC control switch : 0 – ENABLE; 1- DISABLE
2	THERMISTOR	Thermistor selection: 0- 100K; 1-10K
3	TEC CUR LIMIT	Maximum TEC current limit: 0- 1A; 1- 1.5A
4(right)	LD CUR CTRL TYPE	Laser diode current control: 0- voltage; 1 current Both controlled potentiometer R27; Default-0

Status LEDs

Status LEDs are used for fast visual assessment of the C190 status. LEDs are located close to test connector J5. Default LED color is red; this can be varied in customized versions.

LED #	Abbreviation	Name	Description
1 (Top)	+5 V (Top)	V _{dd1}	Supply positive voltage 5 V
2	-5 V	V _{dd2}	Negative voltage generated on the C190
3(Bottom)	TEC LIM		TEC maximum current reached.

Temperature set point and measurement

Laser Controller C190 has single options to control temperature set point via R37. Internal set point: 0.45 to 2.1V set by 11 turn potentiometer. Voltage is increased in CW direction and temperature is decreased CW. With 10K thermistor this range covers from -5C to +60C.

Laser Controller C190 has two modes of temperature measurements. Temperature can be measured using the 10K or 100K thermistor. Selection between modes is made through switch S1-2. C190 uses a high stability voltage reference (V₀ = 2.500 V) on the board and measures the voltage across the thermistor using a bridge scheme. Thermistor voltage can be monitored between pins 1 and 4 of J4.

Temperature can be derived from the voltage across the thermistor using the following formula:

$$1/T = A + B * \ln(R_t) + C * (\ln(R_t))^3$$

$$R_t = V_t / (V_0 - V_t) * R_0$$

Where R₀ = 10.0kOhm for the 10K thermistor and R₀=100K for the 100K thermistor. V_t is the voltage across the thermistor. The 10 μA value of constants A, B and C (A= 1.1280e-03; B=2.3450e-04; C=8.73e-08) should be used to calculate the correct temperature. For example V_t=1.2500 V for T=25 C using 10K thermistor settings and using the 10K thermistor as the temperature measurement element.

Proportional and Integral Gain control for TEC

Laser Controller C190 internal PI control covers the vast majority of systems and the P and I control potentiometers can be adjusted to obtain the optimal PI.

Control	Description
Internal Proportional, R1 (top)	Internal Proportional Gain setting 2-100 A/V with ¾ turn linear potentiometer. Gain is increased in CW direction. Shipped with Proportional Gain=100 A/V.
Internal Integral R2(Bottom)	Internal Integral Gain setting 0.55-5 A/(V*sec)V with ¾ turn linear potentiometer. Gain is increased in CW direction. Shipped with Integral Gain=5.0 A/(V*sec)

Proportional and Integral gains can be measured using 3 test points (Common 'C', Proportional 'P', and Integral 'I') just under of P and I potentiometers. The Proportional gain (A/V) can be calculated using the value of the resistance between 'C' and 'P' test points and expressed in kOhm:

$$G_{prop} = \frac{400 - 2 * R_m}{4 + 1.98 * R_m}$$

where R_m is the measured resistance.

The Integral gain (A/(V*sec)) can be calculated using the same approach:

$$G_{in} = 0.5 + \frac{4.5}{1 + R_m}$$

Laser current settings

Internal current can be monitored via J4-3 (signal) and J4-4 (signal ground). If user applies 5V to J4-2 (laser ON) and measures voltages between J4-3 and J4-4 then the actual current can be calculated using transfer function of 100 mA/V (default) or 1000 mA/V for custom products. Current is set by R27 and increased CCW. TTL ON/OFF signal can be applied from 1 μ s to CW and C190 can handle any combination of pulses.

Certification

RedWave Labs Ltd certifies that: i) the parts and/or materials were produced in conformance with all contractually applicable Government and/or Buyer's specification as referenced in, or furnished with, the above purchase order and ii) all processes required in the production of these parts and/or materials are listed and were performed by a facility or by personnel specifically approved or certified by the seller's cognizant government quality control agency when such approval or certification is required by an applicable specification. RedWave Labs products are not authorized for use in safety-critical applications (such as life support) where a failure of the product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use of the products.

Warranty and returns

C190 Laser Controllers are warranted against defects in materials and workmanship for a period of 180 days from date of shipment. During the warranty period RedWave Labs Ltd will replace or repair products which prove to be defective or damaged. Our warranty shall not apply to defects or damages resulting from: i) misuse of the product or ii) operation beyond specifications detailed in the current manual.

Return procedure

Customer must obtain a valid RMA number by contacting RedWave Labs prior to the return. In all cases the customer is responsible for duty fees incurred on all received shipments and on all international returns for both warranty and non-warranty items; the customer is responsible for any duties, brokers fees or freight charges deemed chargeable to RedWave Labs Ltd.

Revisions

- Revision 2: Connectors J3 and J4 changes to different type (same pitch)
 Laser current external set point is removed
 Pin 5 converted to second logical input and combined with Pin 2
 Two current feedback introduced and can be selected with S1-4
- Revision 2.1: LD_I_MON transfer function changed to 100 mA/V
 PD_I_MON transfer function changed to 10 V/mA
- Revision 2.2: LD_I_MON transfer function can be 100 mA/V or 1000mA/V. 100 mA/V is default option.
- Revision 2.3: LD_I_MON transfer function can be 100 mA/V, 500 mA/V or 1000mA/V. 100 mA/V is default option.