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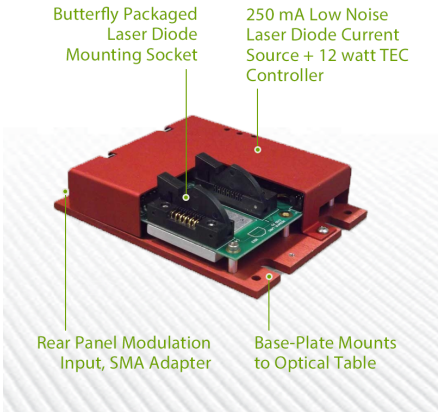


The LD-CONTROLLER-C151 combines a low noise laser diode current source with a high stability TEC controller into a compact, affordable module. The temperature control is fully linear and a separate power supply can be used for the laser TEC if the user wants to optimize for the lowest noise performance. The laser diode current source has an analog modulation bandwidth of 250 kHz. It also offers a separate fast TTL compatible modulation port through an SMA connector.

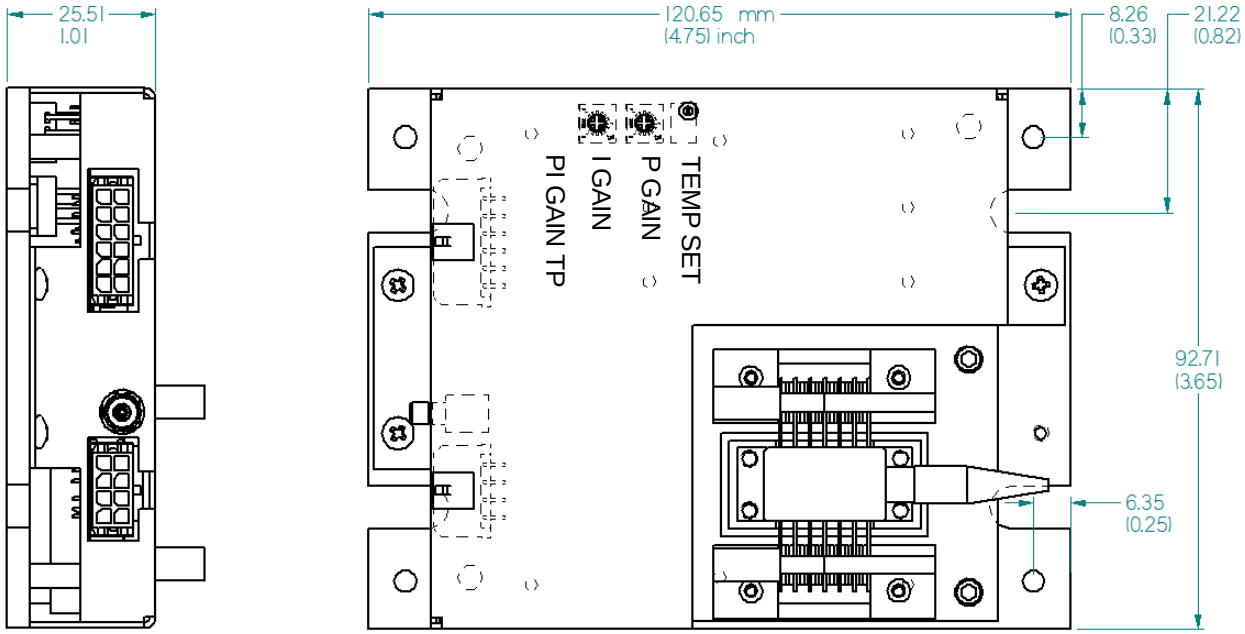
Features	**Laser diode control with integrated temperature control**	
Applications	Spectroscopy, Precision Instruments, OEM applications	
Specifications	Parameter	Value
Power	Dual	Option 1: +12 V/2 A -12 V/0.5 A Option 2: +12V/0.5 A -12V/0.5A +5V /1.5A
Laser Current Control	Laser Current	0 - 250 mA. Hardware limit, can be modified for customised versions
	Compliance voltage	> 4.0 V
	Setting accuracy	2 % fs
	Noise (RMS)	< 2µA
	Drift	< 20 µA
	Temperature coefficient	50 ppm/C
	Current limit	250 mA
	Setting accuracy of current	2 % fs
Laser External Control	Voltage range	0 to 10 V
	Input impedance	10 kOhm
	Modulation coefficient (I constant)	20 mA/V
	3dB Bandwidth	DC ... 250 kHz
	TTL modulation, rise/fall-time	250 ns
	Interlock	Yes
TEC control	TEC current	0 ... +- 1.0 A /1.5A
	TEC voltage	> 8.0 V
	Max output power	12 W
	Current limit	1A or 1.5 A
	Input sensor	Thermistor 10 kOhm or 100 kOhm at 25 C
	PID control	Internal PI or External direct TEC current control
Connectors	Laser	Integrated Azimuth Electronics 14 pin connector with heat sink. NEL DFB laser pinout. Can be replaced with optional DB15 connector
	Power	Molex MicroFit 8 pin
	Control	Molex MicroFit 12 pin
Dimensions	W x H x D	120 x 92 x 30 mm
Weight		350 g
Storage Temp	-55 to 100 °C	
Operating Temp	-40 to 85 °C	

Absolute Maximum Ratings

Symbol	Parameter	Ratings	Unit
V_{dd1}	Supply positive voltage / Laser driver and TEC	+12 ±10%	Volts
V_{dd2}	Supply positive voltage / Separate TEC rail	+5 V +10%; -0%	Volts
V_{ee}	Supply negative voltage / Laser driver and TEC	-12 ±10%	Volts
T_{op}	Operational Temperature	-40 to 85	°C
T_{st}	Storage Temperature	-55 to 85	°C

Mechanical Information

Parameter	Value	Unit
Length	4.75 (120.65)	Inch (mm)
Width	3.65 (92.7)	Inch (mm)
Height	1.01 (25.1)	Inch (mm)
Weight	350	gram



Quick Set-Up Tips:

DC POWER SUPPLY

Standard operation requires a DC power supply with -12V, GND, and +12V connected to the appropriate pins on the J6 connector. For standard operation, the user must connect the +12V supply voltage to Vdd1 on PIN1, connect the -12V to Vee on PIN4, and the ground to PIN2. The user does not need to connect the +5V supply unless he/she wants to use a separate supply for the TEC controller to achieve lower noise performance.

LASER DIODE CURRENT

The laser diode current is set using a voltage signal input to PIN1 on the J4 connector with the signal source GND connected to PIN5. There is not a potentiometer for the laser diode current set point. The control of the laser diode current is facilitate with the transfer function of 20mA/V. 20mA of bias current will be applied to the laser diode per volt on a linear scale up to 12V.

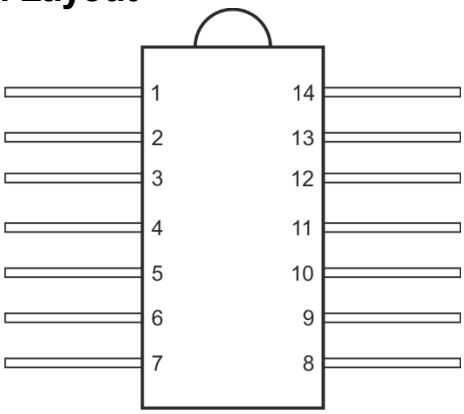
TEC CONTROLLER

The C151 ships with the TEC current limit already set to ±1 amps. This is typically adequate for butterfly packaged laser diodes.

The C151 ships with the TEC input sensor pre-set for a 10 kΩ thermistor. This is typically the temperature sensor for butterfly packaged laser diodes.

The C151 ships with the 11 turn potentiometer temperature pre-set for approximately 25C for a 10 kΩ thermistor.

Pin Layout



1	TEC +	14	TEC −
2	Thermistor +	13	Ground
3	Not in use	12	Not in use
4	Not in use	11	LD −
5	Thermistor −	10	LD +
6	Not in use	9	Not in use
7	Not in use	8	Not in use

Electrical Characteristics

Parameter	Comments	Value	Unit
POWER			
Positive supply voltage V_{dd1} / Laser driver and TEC	Positive supply voltage for laser driver, all control circuits and TEC. 2A minimum required for single positive power supply	12 ±10%	V
Supply positive voltage V_{dd2} / Separate TEC Power	Positive supply voltage for TEC only. 2A minimum required. Designed to use a 5 V rail to minimize overall power consumption and heat dissipation	5 V; +10%; -0%	V
Negative supply voltage V_{ee}	Negative supply voltage for laser driver, all control circuits and TEC	-12 ±10 %	V
LASER DIODE CONTROL AND MONITOR			
Laser current I_{ld} limit	Hardware laser limit. Can be modified for customized versions	250	mA
Laser Compliance voltage V_{comp}	Minimum voltage across laser diode. Can be modified for customized versions.	4	V
Noise (RMS)	Integrated noise (DC-250kHz)	2	µA
Laser current drift	Laser current drift at constant temperature	20	µA
Laser current temperature coefficient	Temperature drift of the reference	50	ppm / °C
Laser current range	Laser current maximum current	250	mA
Laser current setting accuracy	Set by components tolerance	2	% of full scale
Laser current set voltage	External transfer function ranges	0-10	V
Laser current set voltage impedance		10	kΩ
Laser current modulation coefficient	Transfer function for laser current modulation	20	mA/V
Laser current	-3 dB	250	kHz

modulation bandwidth			
Laser current TTL modulation rise/fall time	Additional modulation capabilities on top of the analog modulation. Fast ON/OFF switches	250	nS
Laser current monitor	Monitor averaged laser current	0-10	V
Laser current interlock	Available laser interlock. Can be overridden with DIP-switch		
TEC CONTROL AND MONITOR			
TEC control type	Linear bipolar		
TEC current range	Maximum range can be change with DIP switch S1	0…±1; 0…±1.4	A
TEC power supply	TEC power supply can be selected from +12V and +5V. +5V allow to improve power efficiency for TEC with 1 Ohm and maximum current of 1.5 A.	+5 ; +12	V
TEC compliance voltage	Voltage across TEC element	Vdd-3	V
Maximum TEC power	Maximum power for 12 V power supply	12	W
TEC current limit	Selected with DIP switch S1	1 of 1.4	A
Input sensor	TEC input sensor. Selected with S1 DIP switch. Configured in bridge mode.	100 or 10	kΩ
PI control	PI analog control loop (internal mode) or external loop though J2 connector (pin 3). Selected with S1 DIP-switch.	External or Internal	
TEC current external transfer function	Direct control of TEC. Input range - 10 to +10 Volt	200	mA/V
TEC current monitor	Independent TEC current monitor at pin 4 of J4 connector	200	mA/V
TEC disable	TEC current disable function: DIP-Switch S1.		
CONNECTORS			
Power J6	Molex 8 pin Micro Fit connector p/n 43045-0800		
Control and monitors J4	Molex 12 pin Micro Fit connector p/n 43045-1200		
Laser connector	Integrated Azimuth Electronics 14 pin connector with heat sink. NEL DFB laser pinout. Can be replaced with optional DB15 connector.		
Test connector J1	Test connector: can be used for remote control of the driver. Molex p/n 87831-1620		

Standard operation requires a -12V, GND, and +12V DC power supply:

Power Connector J6

PIN#	Abbreviation	Name	Description
1	V_{dd1}	Positive power +12 V	Electrically connected to Pin 5.
2	GND Main	Ground for V_{dd1}	Ground for the +12/-12 V power supplies
3	V_{dd2}	TEC Power	Positive power for separate TEC power: +5 V. Electrically connected to pin 7
4	V_{ee}	Negative power – 12 V	Electrically connected to Pin 8.
5	V_{dd1}	Positive power +12 V	Electrically connected to Pin 1. (same as PIN1)
6	GND TEC	Ground for V_{dd2}	Ground for the +5 V power supply. Connected to GND Main with 1 Ω resistor at connector.
7	V_{dd2}	TEC Power	Positive power for separate TEC power: +5 V. Electrically connected to pin 3
8	V_{ee}	Negative power – 12 V	Electrically connected to Pin 4.

The power connector J6 (pin assignment shown left) is a Molex Micro-Fit p/n 43045-0800. The mating connector is a Molex Micro-Fit p/n 43025-0800 with crimp pins Molex p/n 43030-0009. The mating connector and the necessary number of crimp pins are included with the C151 Laser controller. The Molex suggested crimping tool p/n 63819-0000 can be purchased from Digikey Inc (www.digikey.com).

Control and Monitor Connector J4

PIN#	Abbreviation	Name	Description
1	LD_I_CTRL	Laser current control	Control laser diode current with transfer function of 20 mA/V
2	LD_ON_OFF	TTL control of laser current	Switches laser current ON/OFF with TTL level (5V) external signal. Electrically connected to J5 (SMB). 0V-LD_ON; 5V – LD_OFF.
3	TEC_I_CTRL_EXT	External control of TEC current	Controls TEC current directly with transfer function of 200 mA/V. Switch S1-3 must be in EXT position. Bandwidth of TEC control is limited to approximately 50 Hz.
4	TEC_I_MON	TEC current monitor	Shows current of the laser TEC with transfer function V_{mon}=Itec ×5.0 V/A.
5	GND	Ground	Control and Monitor Ground connection. Must not be used for power ground.
6	INTERLOCK-	Negative Interlock	Negative interlock connection. Connected to Ground directly
7	T_SET_EXTERNAL	External temperature set point	External temperature set point can be selected with switch S1-4. Transfer function can be calculated as R_{set} = (Vo+0.3119 x V_{set})/(Vo-0.3119 x V_{set}) x R_0 ; R_0 =10K or 100K , Vo=5.000V and $1/T_{set} = A + B \times \ln(R_{set}) + C \times (\ln(R_{set}))^3$. Typical values: A= 1.1280e-03; B=2.3450e-04;C=8.73e-08.

8	LD_I_MON	Laser diode monitor	Monitor average laser diode current with transfer function 50 V/A and bandwidth of approximately 25 kHz.
9	LIMIT_I_FAULT	TEC current limit error	0V – normal operation; +5V if current limit (any side) is reached.
10	GND	Ground	Control and Monitor Ground connection. Must not be used for power ground.
11	T_ACTUAL_MON	Actual temperature monitor	Buffered output of the voltage across the thermistor.
12	INTERLOCK+	Positive Interlock	Positive interlock connection. Can be overridden with S1-6.

The control and monitor connector J4 (pin assignment shown left) is a Molex Micro-Fit p/n 43045-1200. The mating connector is a Molex Micro-Fit p/n 43025-1200 with crimp pins Molex p/n 43030-0009 . The mating connector and the necessary number of crimp pins are included with the C151 Laser controller. The Molex suggested crimping tool p/n 63819-0000 can be purchased from Digikey Inc (www.digikey.com)

Control and Monitor Connector J5 (SMB)

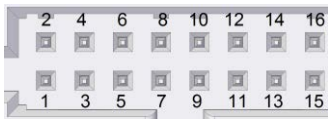
PIN#	Abbreviation	Name	Description
1	LD_ON_OFF	TTL control of laser current	Switches laser current ON/OFF with TTL (5V) level external signal. Electrically connected to J4 Pin 2.

The Laser On/Off connector J5 is a standard SMB connector that allows simple operation.

Test Connector J1

PIN#	Abbreviation	Name	Description
1	LD+	Laser Diode Positive Connection	Directly connected to the Azimuth connector J2 Pins 11 and 13
2	LD-	Laser Diode Positive Connection	Directly connected to the Azimuth connector J2 Pin 12
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	PID_CONTROL	Remote PID control	Remote control of PID loop (S1-3): 0V – External; 5V – Internal (Analog PI loop). Remote control overrides S1.
8	T_SET_CONTROL	Remote control of set temperature	Remote control of S1-4: 0V – Internal; 5V – External. Remote control overrides S1.

9	TEC_I_LIMIT_CONTROL	Remote control of TEC current limit	Remote control of S1-5: 0V – 1A; 5V – 1.4A. Remote control overrides S1.
10	INTERLOCK_CONTROL	Remote control of Interlock function	Remote control of S1-6: 0V – Enable; 5V – Disable (Overridden). Remote control overrides S1.
11	TH-	Laser package Thermistor Negative connection	Directly connected to the Azimuth connector J2 Pin 2
12	TH+	Laser package Thermistor Positive connection	Directly connected to the Azimuth connector J2 Pin 1
13	RESERVED		
14	RESERVED		
15	TEC+	Laser package TEC Positive connection	Directly connected to the Azimuth connector J2 Pin 6
16	TEC-	Laser package TEC Negative connection	Directly connected to the Azimuth connector J2 Pin 7



The test connector J1 (pin assignment shown left) is a Molex Milli-Grid p/n 87831-1620. The mating connector is aMolex Milli-Grid p/n 87568-1694 for ribbon cable. The C151 comes without a Milli-Grid mating connector. Customized connector arrangements can be used for the remote control of the switch S1. RedWave Labs can advise on specific applications.

DIP SwitchS1

S1 can be remotely controlled through J1 except for the TEC power selection (POSITION 8 in table below). This remote control functionality can be used for integration inside spectrometers or other instruments.

POSITION#	Abbreviation	Name	Description
1	TEC_DISABLE	Laser TEC disable	0V (0) – TEC Enable; 5V (1) – TEC disable.
2	THERMISTOR_TYPE_CONTROL	10K/100K thermistor selection	0V (0) – 100K; 5V (1) – 10K
3	PID_CONTROL	PID control	0V (0) – External; 5V (1) – Internal (Analog PI loop).
4	T_SET_CONTROL	Control of set temperature	0V (0)– Internal; 5V (1) – External
5	TEC_I_LIMIT_CONTROL	Control of TEC current limit	0V (0)– 1A; 5V (1) – 1.4A
6	INTERLOCK_CONTROL	Control of Interlock function	0V (0) – Enable; 5V (1) – Disable (Overridden)
7	RESERVED		
8	TEC_POWER_CONTROL	Control of TEC Power	0V (0) – 5 V Power supply; 5V (1) – 12 V Power Supply

Status LED

Status LEDs are used for fast visual assessments of the C151 status. LEDs are located close to test connector J1. The default LED color is red; this can be varied in customized versions.

LED #	Abbreviation	Name	Description
1 (Top)	+12 V (Top)	V_{dd1}	Supply positive voltage V_{dd1} / Laser driver and TEC is ON.
2	+ 5 V	V_{dd2}	Supply positive voltage V_{dd2} / Separate TEC Power is ON
3	- 12 V	V_{ee}	Negative supply voltage V_{ee} is ON
4	TEC I LIM	TEC Current Limit reached	ON: TEC current limit reached. IF LED 4 is ON longer than 10 seconds then laser temperature might be too high or too low to achieve adequate stabilization
5 (Bottom)	INLK OFF (Bottom)	Laser interlock OFF	ON: Laser Interlock is overridden and will not switch the laser off when activated.

Temperature Set Point

The C151 has 2 options to control the temperature set point. These options are: i) internal set point with the 11-turn potentiometer located on the opposite side of laser connector ; ii) external voltage applied to Pin 7 of the J4 connector.

Type	Selection	Position	Description
Internal (11-turn potentiometer)	S1	4 (0)	Internal set point: 0.9 to 4.2V set by 11 turn potentiometer located on the edge opposite to the laser connector. Voltage is increased in clockwise direction. With 10K thermistor this range covers from -5°C to +60°C.
External	S1	4 – (1)	External set point: -10 to +10V applied to Pin7 of J4 connector. Transfer function can be calculated as R_{set} = (Vo+0.3119 x V_{set})/(Vo-0.3119 x V_{set}) x R_0 ; R_0 =10K or 100K , Vo=5.000V and $1/T_{set} = A + B \times \ln(R_{set}) + C \times (\ln(R_{set}))^3$. Typical values: A= 1.1280e-03; B=2.3450e-04;C=8.73e-08. Application of the V_{set} values outside –10 to +10 V could result in board damage.

Temperature Measurements

Laser Controller C151 has two modes of temperature measurements. The temperature can be measured using the 10K or 100K thermistor. Selection between modes is made through switch S1-2. The C151 uses a high stability voltage reference (V_0 = 5.00 V) on the board and measures the voltage across the thermistor using a bridge scheme. The thermistor voltage can be monitored between pins 11 and 12 of J1.
The temperature can be derived from the voltage across the thermistor using the following formula:

$$\frac{1}{T} = A + B \times ln(R_t) + C \times \left(ln(R_t)\right)^3$$

$$R_t = \frac{V_t}{(V_0 - V_t)} \times R_0$$

Where R_0 = 10.0kOhm for the 10K thermistor and R_0=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=2.500 V for T=25 °C using the 10K thermistor settings and using the 10K thermistor as the temperature measurement element.

Note: This voltage is different from T_{set} voltage (see above Temperature Set Point).

PI Control

The C151 has two options to control the temperature feedback loop: Internal and External. Internal PI control covers the vast majority of systems and the P and I control potentiometers can be adjusted to obtain the optimal PI. External PI control can be connected to Pin 3 of J4; this can be used if the user has a digital PID implementation elsewhere. Selection between internal and external control modes is done via S1-3.

Control	Selection	Position	Description
Internal Proportional	S1	3 – (1)	Internal Proportional Gain setting 2-100 A/V with ¾ turn linear potentiometer. Gain is increased in clockwise direction. Shipped with Proportional Gain=100 A/V.
Internal Integral	S1	3 – (1)	Internal Integral Gain setting 0.55-5 A/(V×sec) with ¾ turn linear potentiometer. Gain is increased in clockwise direction. Shipped with Integral Gain=5.0 A/(V×sec)
External	S1	3 – (0)	External control of TEC/heater current through Pin 4 of the J4. Transfer function 200 mA/Volt. The maximum current is limited by the current limit setting (1.0A or 1.5A).

Proportional and Integral gains can be measured using 3 test points (Common 'C', Proportional 'P', and Integral 'I') just under the 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:

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

where R_m is the measured resistance.

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

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

Integral heat sink

The C151 has two options for the laser integrated heat sink ('Low' and 'High').
The 'Low' heatsink is level with Printed Circuit Board (PCB) and allows mounting of a customers' designed laser package enclosure. This option is used when an additional thermal isolation for a DFB butterfly package is required.
The 'High' heatsink is about 2.5 mm higher than PCB and is typically used for direct mounting of butterfly packages. The 2.5 mm elevation provides minimum stress for the package pins.
'Low' and 'High' options are easy interchangeable and relevant heat sinks can be purchased independently.

Power dissipation

C151 laser controllers have been designed to dissipate up to 25 Watt power without heat sink under normal atmospheric conditions. 25 W dissipated heat is the maximum dissipated power. Most common regimes would result in about 15 W heat dissipation. The C151 does not require an external heatsink.

External connections and cables

C151 laser controllers come with mating connectors and a crimp kit for J4 and J6. Cables for J1, J4 and J6 can be purchased separately.

Installation

We recommend a first time use of the C151 with a high power load resistor (at least 10W rating) as TEC load and Laser Diode load. These loads should be connected to the corresponding pins of J1. Such a set-up will allow to check all connections are correct before connecting to the laser temperature controller system and risking potential damage.

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 specifications 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

C151 Laser Controllers are warrantied 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

Customers 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: -Various changes in hardware to improve temperature stability.

Revision 3: -Add 5 V power rail to decrease heat dissipation.
-Changes for Connector J6
-Corrected thermistor 10K/100K marking. Manual Rev 3.1
-Added pinouts for laser diode. Manual Rev 3.1

-Corrected TEC_I_MON transfer function. Manual Rev 3.1
-Added information on LD_ON_OFF. Manual Rev 3.1
-Minor changes to text and formatting. Manual Rev 3.2