April, 2009

PTC-CH Series

Chassis Mount Temperature Controllers

GENERAL DESCRIPTION:

The PTC Series Temperature Controllers are precision controllers in a small, chassis mount package. These linear, bipolar devices are designed to provide excellent temperature stability -- even across ambient. They can drive both TECs and Resistive Heaters. The onboard setpoint is designed to stay stable across the entire operating range.

User adjustments and status indicators are easy to access. Onboard trimpots adjust current limits, setpoint, and Proportional Gain. Sensor bias currents can be configured to maximize feedback signal and sensitivity. An LED indicates when output current is enabled. An external voltage can be used for remote setpoint operation. If the D/A remote setpoint is turned off, unplugged or fails, the PTC automatically sets the temperature control to near ambient. Default is 25°C for a 10 kΩ thermistor (1 V). The remote enable/disable input is TTL-compatible.

This product is ideal for applications where temperature stability is critical and space is tight, such as electro-optical systems, benchtop inspection instruments, and medical diagnostic equipment.

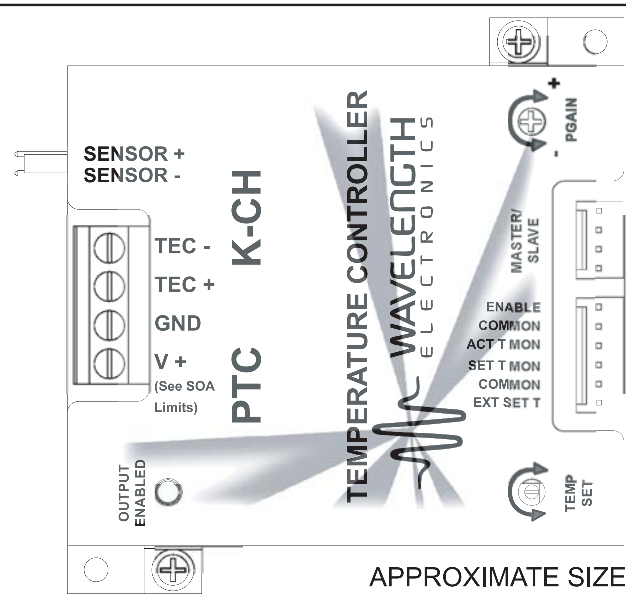
FEATURES:

- 2.5 A, 5 A, 10 A, and 20 A configurations
- Linear Stability: 0.0014°C
- Single Supply Operation from +5 V to +30 V
- Supply TEC or RH drive current
- Remote or onboard temperature setpoint
- Remote or local disable/enable
- Selectable sensor bias current
- Adjustable Current Limit
- Adjustable Proportional Gain
- PI Control with large load / thermal delay circuitry
- Master/Slave Option for up to 20 A
- Failsafe Setpoint default for D/A

Ordering Information

PTC2.5K-CH	2.5 A Temperature Controller
PTC5K-CH	5 A Temperature Controller
PTC10K-CH	10 A Temperature Controller
PTC10K-SL	10 A Slave Unit

Figure 1
Top View and
Pin Descriptions



APPROXIMATE SIZE

Small package size:
3” x 3” x 1.1”
76.2 x 76.2 x 28.2 mm

QUICK CONNECT

Figure 2
External Connections

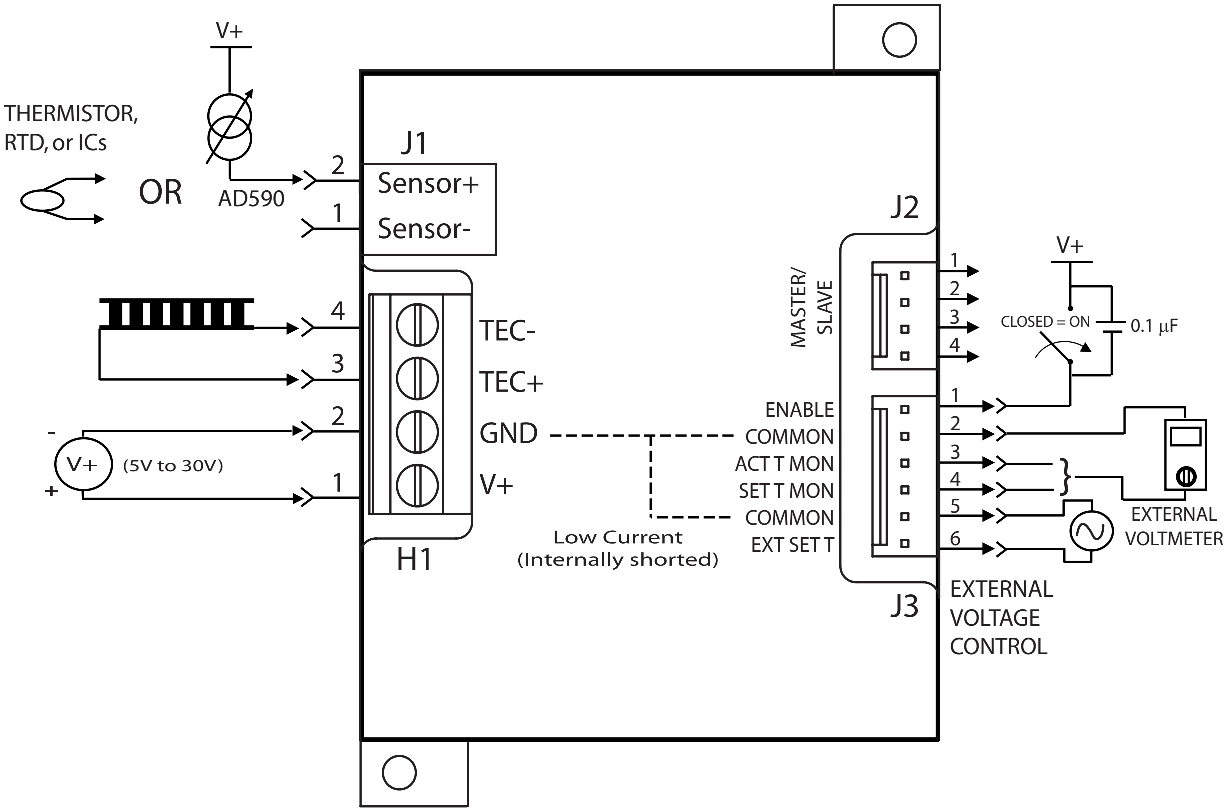
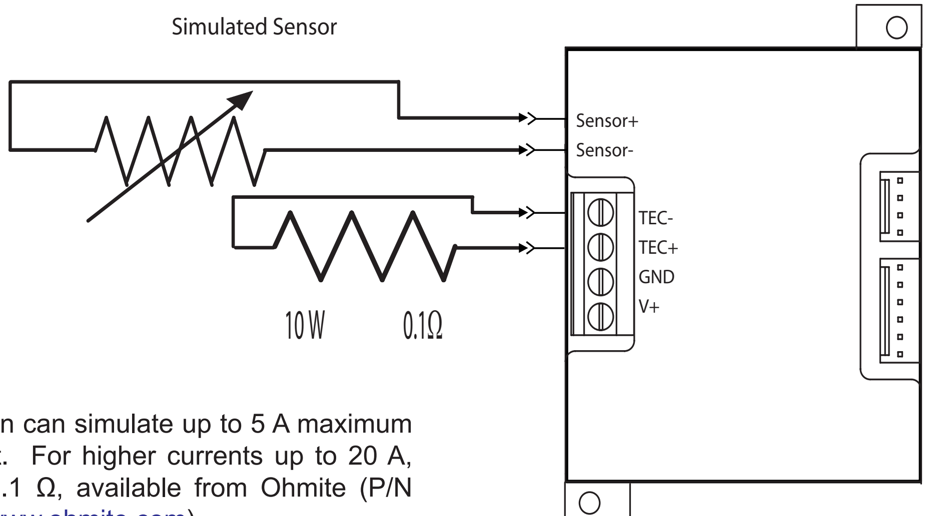


Figure 3
Dummy Load Configuration
(for confirming hookup and settings)



Values shown can simulate up to 5 A maximum drive current. For higher currents up to 20 A, use 50 W 0.1 Ω, available from Ohmite (P/N 850FRI0E, www.ohmite.com).

ELECTRICAL SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS	SYMBOL	VALUE	UNIT
RATING			
Supply Voltage, standard *(See SOA Calculator for all voltage levels)*	V_{DD}	+4.5 to +30	Volts DC
Operating Temperature, case	T_{OPR}	-40 to +85	˚C
Storage Temperature	T_{STG}	-65 to +125	˚C
Size (WxDxH)		3 x 3 x 1.1	inches
Weight		4.3	ounces

PARAMETER	TEST CONDITIONS	MODEL PTC-2.5K	MODEL PTC5K	MODEL PTC10K	UNIT
DRIVE CURRENT					
Operation Mode		Linear Bipolar			
Output Current Range		2.5	5	10	A
Compliance Voltage Loss		$\lvert V_S - 1.5 \rvert$	$\lvert V_S - 2.2 \rvert$	$\lvert V_S - 4.5 \rvert$	V
Current Limit Set by Trimpot	Symmetrically applied heating/cooling	0-2.5	0-5	0-10	A
Master/Slave Capability	Add PTC10K-SL	No	No	20	A
Power Dissipation(1)		60			W
Thermal Resistance	on MULTI-HTSK-HI with 20 cfm fan	0.5			˚C/W
Quiescent Current		50			mA
CONTROLLER					
P (Proportional Gain)	Default = 12	5-40			A / V
I (Integrator Time Constant)	Default	1.7	1.5	1.8	A / V·s
Setpoint Configuration	Jumper selectable	Remote Voltage or 12-turn trimpot			
Short Term Stability (1 hour)(2)	OFF ambient	<0.0012			˚C
ShortTerm Stability (1 hour)(2)	ON ambient	<0.0014			˚C
Long Term Stability (24 hour)(2)	OFF ambient	<0.002			˚C
Temperature Coefficient		<100			ppm/˚C
Setpoint vs. Actual Accuracy(2)		<1			mV
MONITOR SIGNALS					
Setpoint Monitor		0-5			V
Actual Temperature Monitor		0-5			V
Setpoint Monitor Output Impedance		1 K			Ω
Actual Temp Monitor Output Imped.		1 K			Ω
SENSOR		Thermistors, RTDs and Linear Sensors			
Sensor Compliance Voltage		3.7V (V_{DD}=5V) or 5.5V (V_{DD} > 7V)			V
Sensor Bias Current Range		0.01, 0.1, 1, or 10			mA
Sensor Voltage Range		smaller of: 0 to 5 or (V_{DD}-1.4)			V

NOTES

(1) Maximum internal power dissipation. Derating begins at 55 ˚C.

(2) Assumes steady state operation with properly tuned system using a 10 kΩ thermistor. PGain tuned to critical damping point.

POWER SUPPLY AND NOISE

The control electronics are designed for low noise operation. The power supply you select will directly affect the noise performance of the controller. Linear supplies are recommended for optimal performance. However, depending on your requirements, you may be able to use a switching supply.

Power One has a nice selection of power supplies. Contact them at www.power-one.com.
Digi-Key also has a broad range of power supplies. Contact them at www.digikey.com.

PIN DESCRIPTIONS

CONNECTOR	PIN#	PIN	NAME	FUNCTION
H1 Power	1	V_{DD} (V+)	Power Supply	Power supply high side. This pin along with pin 2 (GND) provide power to the control electronics and the TE Cooler output stage. Apply +5 V to +30 V to power the PTC. **Consult the SOA charts on pages 6 & 7 to ensure that supply voltage is within the safe operating range.**
	2	GND	Power Supply Ground	Power supply ground. This pin, along with pin 1 (V+) provides power to the control electronics and TE Cooler output. **This is the only ground connection designed as a high current return.**
	3	TEC+	TEC Positive	Positive side of TEC. **This pin supplies the current to the TE Cooler (when using NTC sensors).** Refer to the operating instructions in this datasheet for proper connections to a TEC or Resistive Heater based on the type of sensor being used.
	4	TEC-	TEC Negative	Negative side of TEC. **This pin sinks the current returned from the TE Cooler (when using NTC sensors).**
J1 Sensor	1	Sensor-	Temp Sensor Negative	Sensor current source return line. Internally connected to ground. **It is at ground potential but should not be used for anything other than sensor current source return.**
	2	Sensor+	Temp Sensor Positive	Positive side of temperature sensor. It is used to source the sensor reference current through the temperature sensor. An internal jumper in the unit will select between a 10 µA, 100 µA, 1 mA, or 10 mA reference current.
J2 Master/Slave	WCB 501	Master/ Slave	Master/Slave Cable Connector	Connect the Master J2 and the slave J2 connectors with cable WCB-501. Ends are interchangeable.
J3 I/O	1	ENABLE	Remote Enable	Remote Enable. Connect to V_{DD} to enable. Voltage range is +5 V to V_{DD}. Disable = LO (<0.3 V). Enable = HI (>3 V). If the external signal is between 0 V and 0.3 V, the setpoint will default to 1 V. It is TTL-compatible with over & reverse voltage protection. Active high enables the output.
	2	Common	Common	Common reference ground. This pin provides ground potential to be used with the monitor inputs (pins 3 & 4). **It is not intended to carry high current.** This ground is starred with the circuit ground to provide the most accurate monitor measurement.
	3	ActT Mon	Actual Temp Monitor	Monitor for the actual temperature sensor voltage. When controlled, the ActT Mon voltage will closely match the voltage set at pin 4 (SetT Mon). (1 kΩ output impedance.)
	4	SetT Mon	Temp Setpoint Monitor	Monitor for the Temperature Setpoint voltage. It is used in setting the temperature setpoint of the sensor. It will range from 0-5 V and should closely match the voltage across the signal when it is at the desired temperature. (1 kΩ output impedance.)
	5	Common	Common	Common reference ground for the ExtSet input signal (Pin 6). **This is not intended to carry high current.**
	6	ExtSet	External Temp Setpoint	Remote Temperature Setpoint voltage. This pin is the analog input and can be used for external voltage control of the Temperature Setpoint. The transfer function is 1 V/V. The remote input voltage is not to exceed V_{DD}.

GROUNDING

CAUTION: If you plan to operate the PTC with a PLD, you may need to use separate power supplies. If the TE cooler or thermistor is connected to the laser diode, you must use two separate power supplies and let each float independent of the other.

Caution:
Do not exceed the Safe Operating Area (SOA). Exceeding the SOA voids the warranty.

An online tool for calculating Safe Operating Area is available at:
http://www.teamwavelength.com/tools/calculator/soa/defaulttc.htm.

To determine if the operating parameters fall within the SOA of the device, the maximum voltage drop across the controller and the maximum current must be plotted on the SOA curves.
These values are used for the example SOA determination:

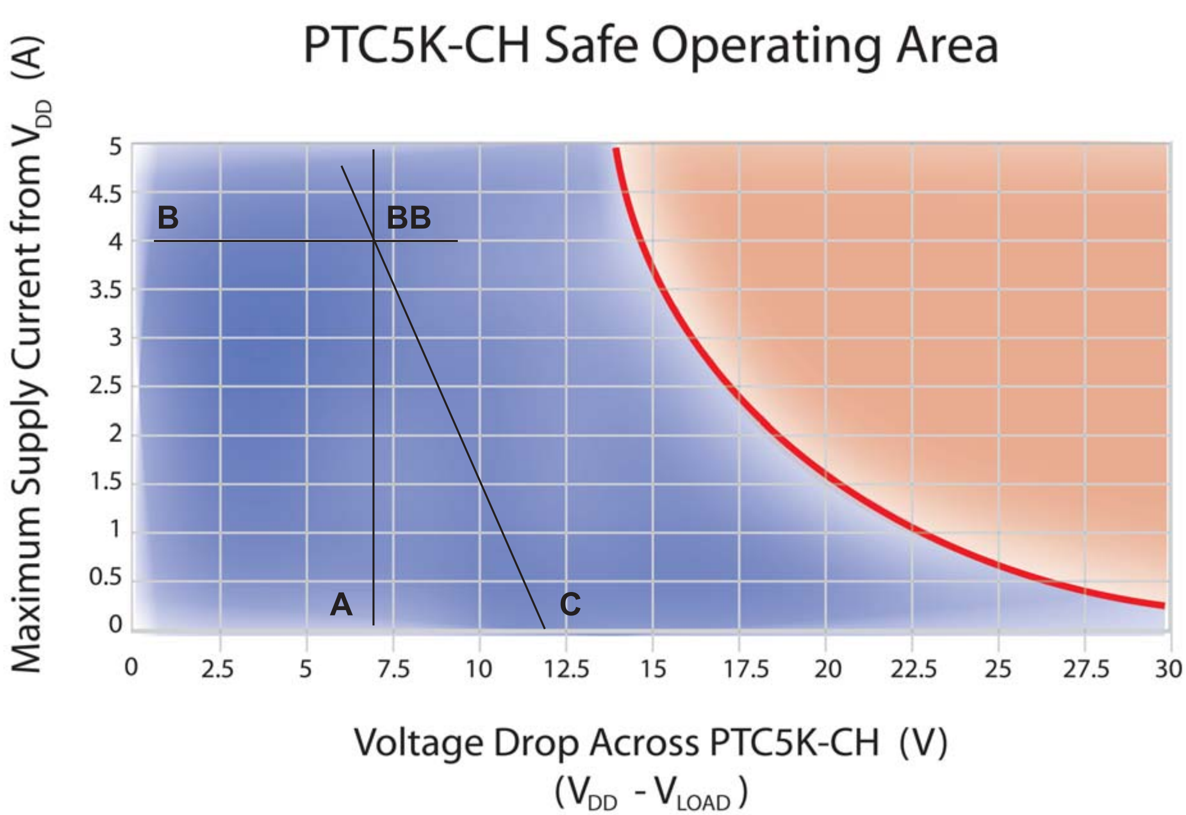
V_{DD} = 12 volts
V_{LOAD} = 5 volts
I_{LOAD} = 4 amps
} These values are determined from the specifications of the TEC or resistive heater

Follow these steps:

1. Determine the maximum voltage drop across the controller, V_{DD} - V_{LOAD}, and mark on the X axis. (12 volts - 5 volts = 7 volts, Point A)
2. Determine the maximum current, I_{LOAD}, through the controller and mark on the Y axis: (4 amp, Point B)
3. Draw a horizontal line through Point B across the chart. (Line BB)
4. Draw a vertical line from Point A to the maximum current line indicated by Line BB.
5. Mark V_{DD} on the X axis. (Point C)
6. Draw the Load Line from where the vertical line from point A intersects Line BB down to Point C.

Refer to the chart shown below and note that the Load Line is in the Safe Operating Areas for this device.

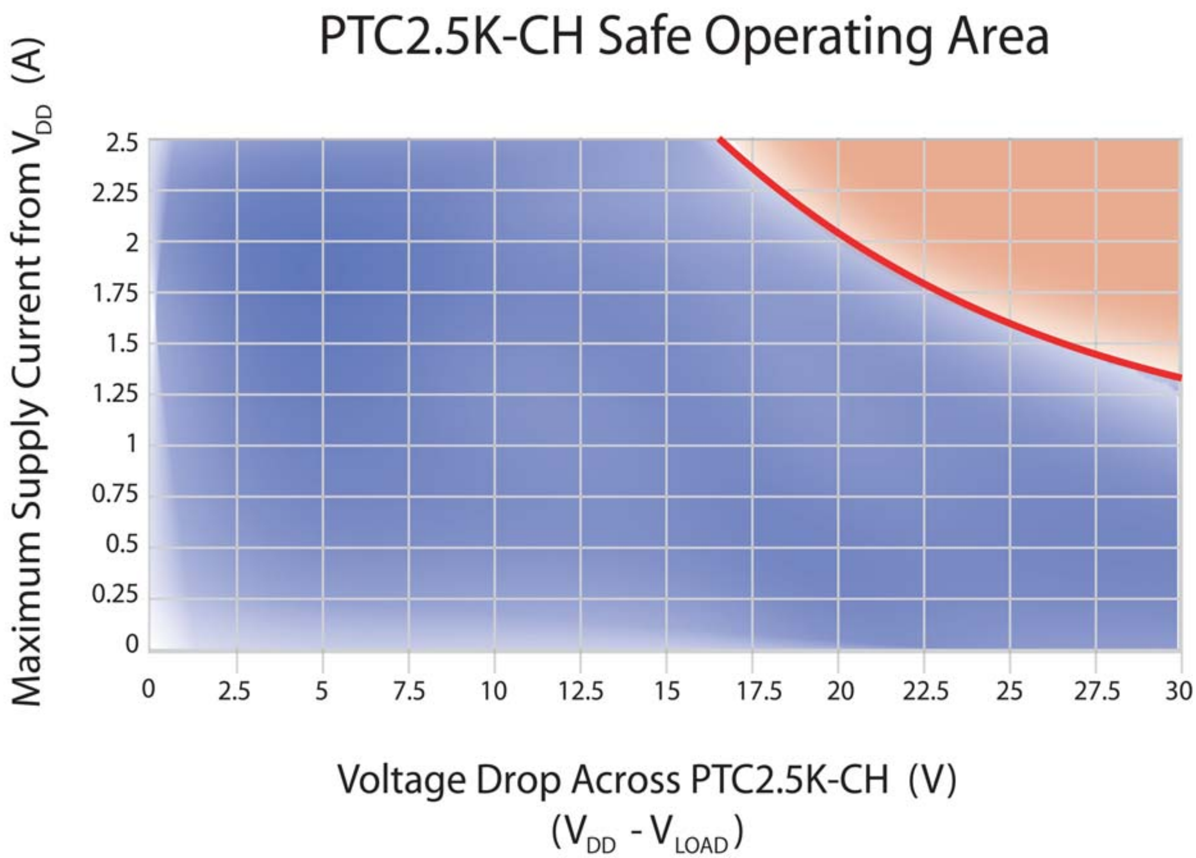
The following page has the Safe Operating Area graphs for the PTC2.5K-CH and PTC10K-CH, on which you can drawn the load line for your particular application.

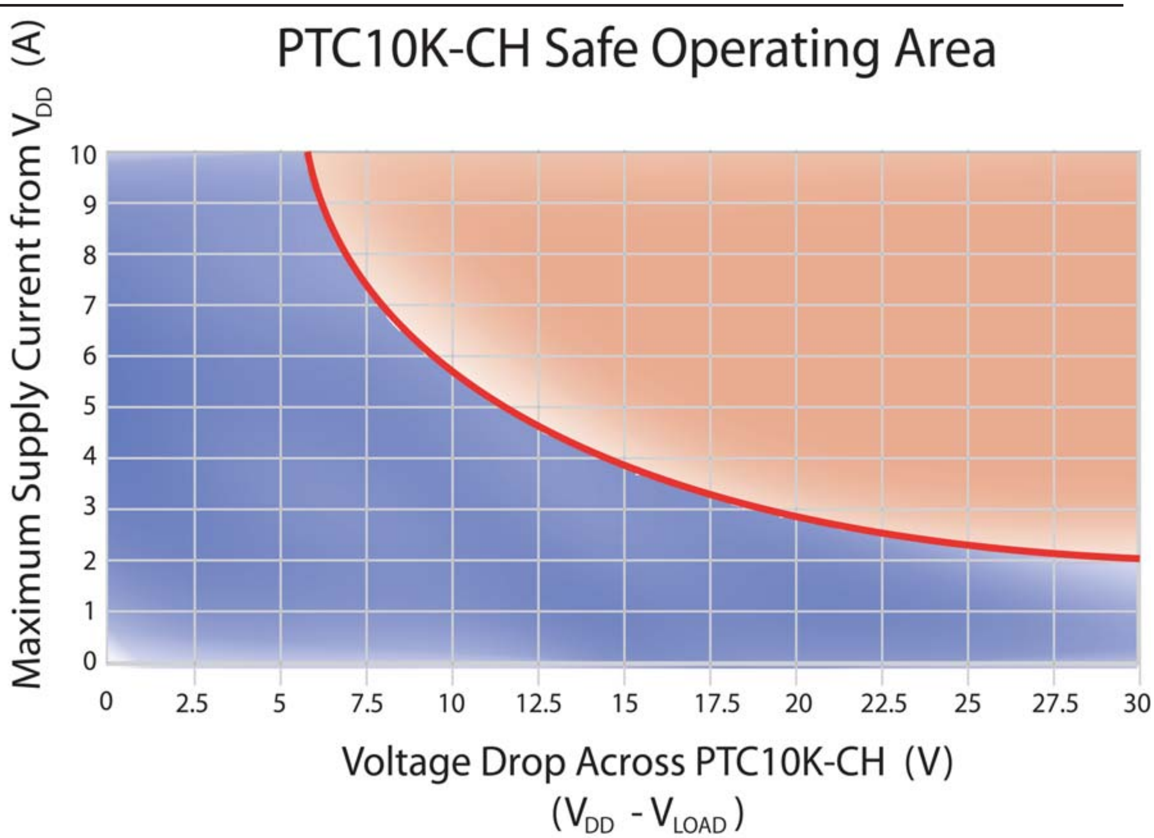


TYPICAL PERFORMANCE GRAPHS

Caution:

Do not exceed the Safe Operating Area (SOA). Exceeding the SOA voids the warranty.





OPERATING INSTRUCTIONS

Remove the cover from the PTC. Then follow the instructions below:

1. SET SENSOR CONFIGURATION JUMPER

Factory default is for operation with Thermistors, RTD, or LM335. If you are using an AD590, move the jumper from “OTHER” to “AD590”. An AD590 must be biased by at least +8 V. If V+ exceeds +8 V, it can be used for bias. Use J1 Pin 2 for the other AD590 connection, and do not connect J1 Pin 1. (See the Quick Connect diagram on page 2.)

2. SET SENSOR BIAS CURRENT JUMPER

The resistance of the sensor you choose, in conjunction with the sensor bias current, must produce a voltage between 0.25 V and 5 V in order to be used in the control loop. The voltage given by the sensor is:

$$V = R_{SENSOR} * I_{BIAS}$$

Select a bias current of 10 μA, 100 μA, 1 mA, or 10 mA, based on the sensor you will use.

- Bias an LM335 using 1 mA.
- Use 10 μA or 100 μA for thermistors.
- Use 10 mA for 100Ω RTDs.

Install the jumper accordingly.

3. SET LIMIT CURRENT

Determine the maximum operating current of your TE module. Based on Table 1, rotate the Current Limit Trimpot to this value.

4. SET REMOTE ENABLE/DISABLE JUMPER

The factory default jumper setting is for External Enable control, as shown in Figure 5.

To always enable current when power is applied, install the jumper in the Internal Enable position to tie the enable pin to V_{DD}.

5. SET REMOTE OR INTERNAL SETPOINT JUMPER

The factory default jumper setting is for Internal Voltage Setpoint (onboard TempSet trimpot).

To use an external analog signal (0-5V) for setpoint, move the jumper to the External Voltage Setpoint position. The onboard trimpot is then disabled.

Figure 4
Internal Settings

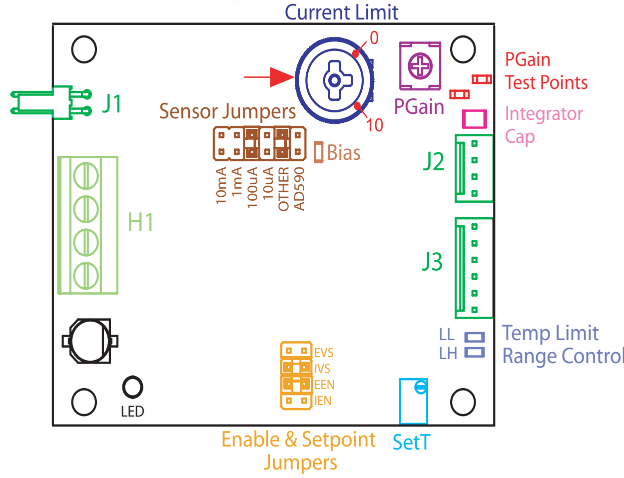
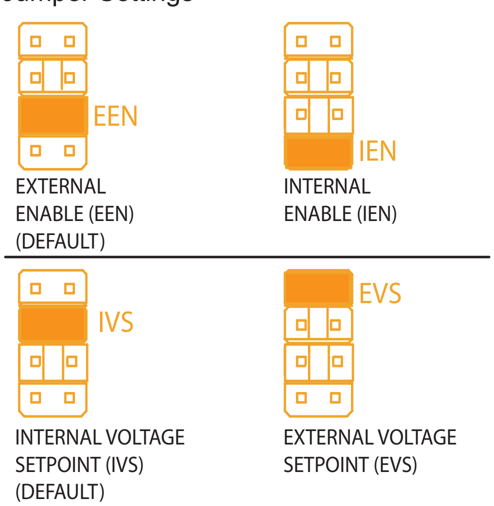


Table 1
Current Limit Trimpot Position

CURRENT LIMIT TRIMPOT POSITION			
	PTC2.5K	PTC5K	PTC10K
0	0 A	0 A	0 A
1	Between 1 and 4, the response is non-linear.		
2			
3			
4	1 A	2 A	4 A
5	1.25 A	2.5 A	5 A
6	1.5 A	3 A	6 A
7	1.75 A	3.5 A	7 A
8	2 A	4 A	8 A
9	2.25 A	4.5 A	9 A
10	2.5 A	5 A	10 A

Figure 5
Jumper Settings



Solid bar indicates jumper location.

OPERATING INSTRUCTIONS -- continued

Replace the cover and continue with setup.

6. CONNECT POWER SUPPLY

Wire V+ and ground to H1 Pin 1 and Pin 2, respectively. V+ can be between +5 V and +30 V. Prior to powering up, verify that you will be operating within the Safe Operating Area of the device. An online tool for calculating Safe Operating Area is available at:

http://www.teamwavelength.com/tools/calculator/soa/defaulttc.htm.

7. SET OPERATING TEMPERATURE

Apply power to the unit. Monitor the setpoint with a voltmeter between J3 Pin 4 (SetT Mon) and J3 Pin 2 (Common). The setpoint voltage range is 0-5 V.

If you installed the setpoint jumper to internal (IVS, Step 5): Turn the onboard trimpot clockwise to increase the setpoint voltage and counter-clockwise to decrease the setpoint voltage. **NOTE:** The setpoint range can be limited by changing two resistors. Contact factory for information.

If you installed the setpoint jumper to external (EVS, Step 5): Apply a 0-5 V signal with the positive lead connected to J3 Pin 6 and the negative lead connected to J3 Pin 5. The transfer function is 1 V / V.

FAILSAFE SETPOINT DEFAULT:
If the voltage set by the external input or the onboard trimpot drops below 0.3 V, the failsafe circuit is triggered and the setpoint defaults to 1 V. This prevents overheating of the load if the input signal fails. The 1 V default is designed for 10 kΩ thermistors (1 V = 25 °C). Contact factory for custom defaults.

Thermistors and RTDs

$V_{SETPOINT} = I_{BIAS} * R$. I_{BIAS} is the bias current selected internally and R is the sensor resistance. I_{BIAS} is in amps and R is in ohms.

"R" equals the resistance value of the sensor at the desired operating temperature. The reference current (I_{BIAS}) is selected by the sensor bias jumper (see Step 2). Default is 100 μA.

LM335 & AD590

$V_{SETPOINT} = 2.730V + (0.010V/°C * T_{DESIRED})$, where $T_{DESIRED}$ is the setpoint temperature in °C. Monitor this setting on J3 Pin 3.

8. WIRE THERMOELECTRIC AND SENSOR

Power down the unit.

SENSOR
Epoxy or otherwise fix the temperature sensor to the load in your application. Connect the sensor to J1 Pin 1 and Pin 2. For sensors where polarity is important, Pin 1 is Sensor- and Pin 2 is Sensor+.

THERMOELECTRIC
Connect the thermoelectric to H1 Pin 3 (TEC+) and H1 Pin 4 (TEC-). Ensure that it is adequately connected to the load and heat sink. Properly transferring heat from the device is imperative. Ensure the heatsink is rated to remove the amount of heat required for your application. If enough heat is not removed from the device, it can go into thermal runaway, where it cannot cool and might be damaged.

NOTE: Current direction is established for Negative Temperature Coefficienct (NTC) sensors. While cooling, current flows from TEC+ (H1 Pin 3) to TEC- (H1 Pin 4). If using an LM335, AD590, or RTD, reverse the TEC leads between Pin 3 and Pin 4. [Current will flow from TEC- to TEC+, so "TEC-" will connect to the positive wire of the TEC, and vice versa.]

9. ENABLE CURRENT

If you have internally tied the enable line to V_{DD} (see Step 4), power on the unit to enable output current.

If you have chosen to use an external enable signal (see Step 4), power on the unit and apply >3 V to the J3 Pin 1, enable line.

10. OPTIMIZE CONTROL

PROPORTIONAL GAIN

The 3/4-turn trimpot adjusts the Proportional Gain for the PTC. Proportional Gain range is 5-40 A / V.

The default is set to P_{GAIN} = 12. This gain value optimizes 90% of the loads. Once you know the optimized setting, you can measure the resistance and repeatedly set it.

TP1 and TP2 test points are located at the edge of the PCB next to the P_{GAIN} adjustment. These test points are labeled and you can clip onto them with or without the cover on.

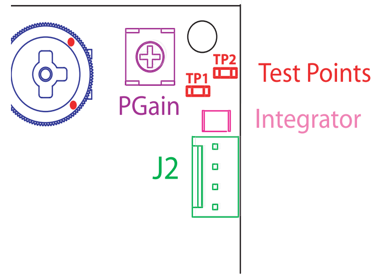
The P_{GAIN} resistance range is 28k to 228 kΩ. Use the following equation and table to calculate the P_{GAIN} setting.

P_{GAIN} CALCULATION

$$P_{GAIN} = \left(\frac{\text{resistance measured between TP1 \& TP2}}{R} \right) \times G$$

MODEL	R	G
PTC2.5K	29 k	4
PTC5K	14 k	2
PTC10K	7 k	1

Figure 6
P_{GAIN} Test Points



INTEGRATOR

The integrator time constant is set by fixed value components. Default values for respective PTC models are as follows:

Model	Range
PTC2.5K-CH	1.7 A / V-sec
PTC5K-CH	1.5 A / V-sec
PTC10K-CH	1.8 A / V-sec

The PTC Series Temperature Controllers include Large Load / Thermal Delay Integrator technology. This allows for faster settling times with less overshoot.

MASTER/SLAVE OPERATION

The PTC Series controllers can be used in a Master/Slave configuration to increase output current. In this configuration the control stage on the Master unit controls the output stages of both units.

The slave unit has slightly different circuitry from the master unit. The PTC10K can be ordered from the factory as a slave unit. The part number for the slave unit is PTC10K-SL.

Follow standard PTC Operating Instructions except for:

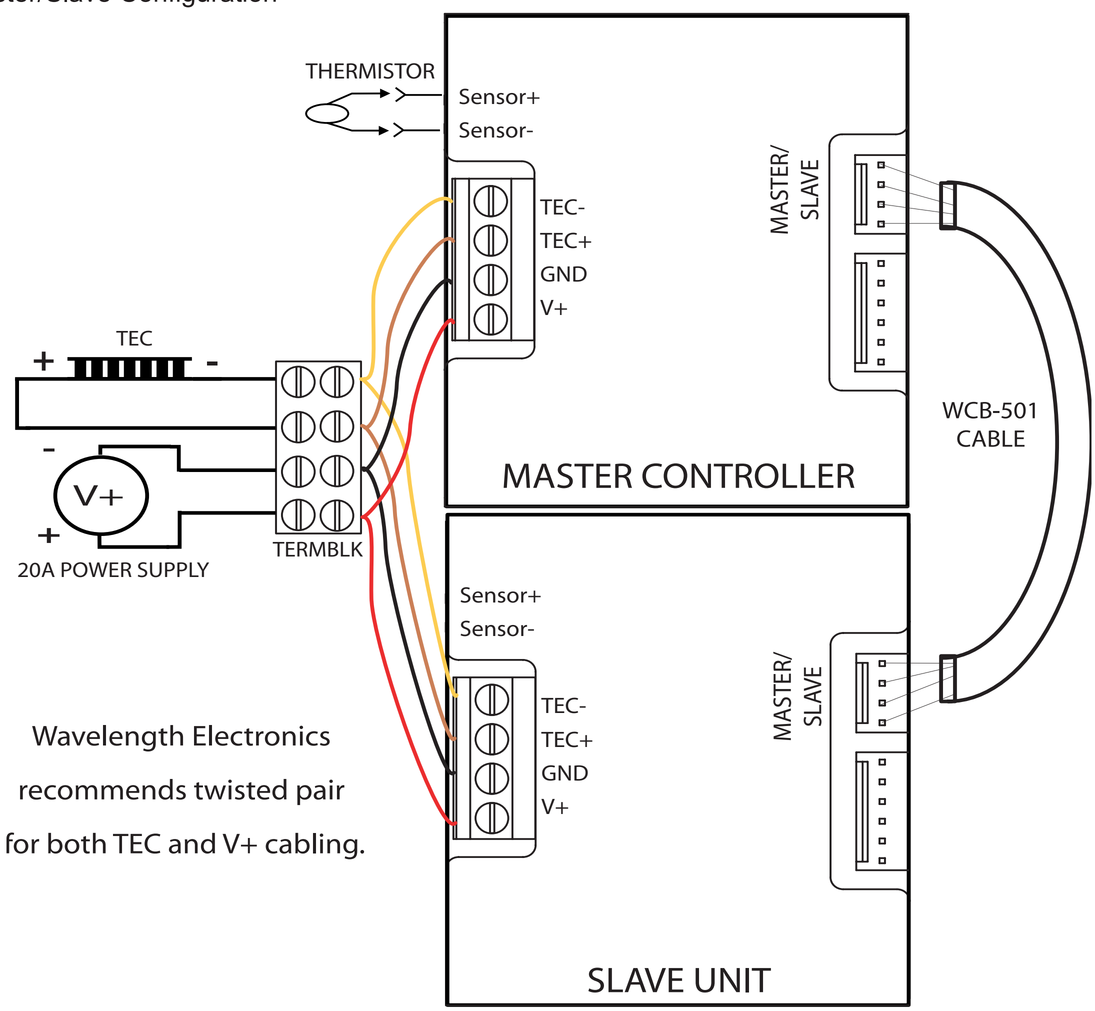
Step 6 -- Connect the supply voltage to both the Master and Slave units.

Step 8 -- Connect both units in parallel to the TEC or Resistive Heater. The total output current will be the sum of the current driven by each unit.

Connect the 4 pin Master/Slave Cable (WCB-501) from J2 of the Master unit to J2 of the Slave unit. Ends are interchangeable.

All jumpers are set only in the Master unit. Current limit is set in the Master unit. The sensor only connects to the Master unit.

Figure 7
Master/Slave Configuration



APPLICATION NOTES -- continued

RESISTIVE HEATER TEMPERATURE CONTROL

To operate the PTC with a Resistive Heater, connect the leads of the heater as shown in Figure 8 or Figure 9, depending on whether you will be using a negative or a positive temperature coefficient sensor.

Operation is otherwise the same as when using the controller with TECs.

Figure 8
Resistive Heater with Negative TC Sensor

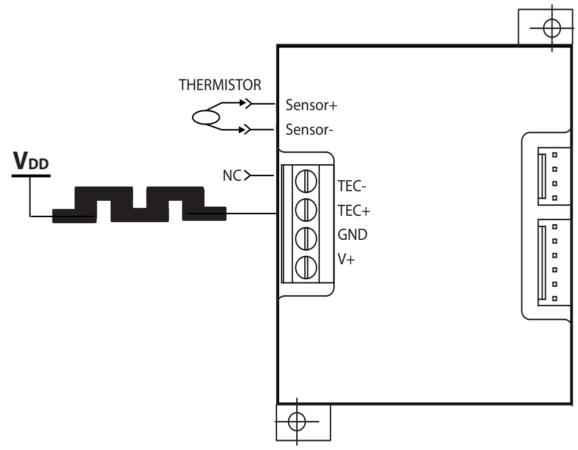
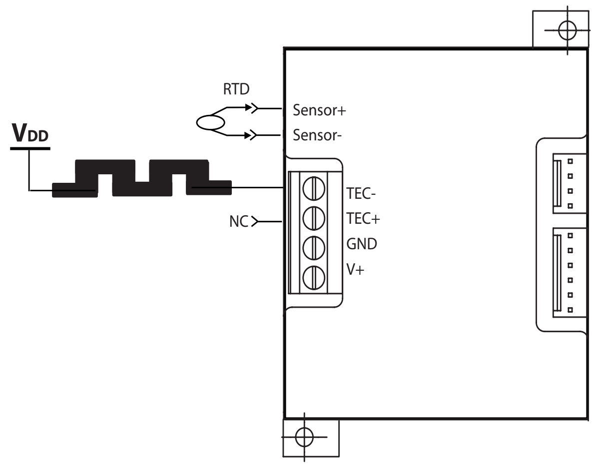


Figure 9
Resistive Heater with Positive TC Sensor

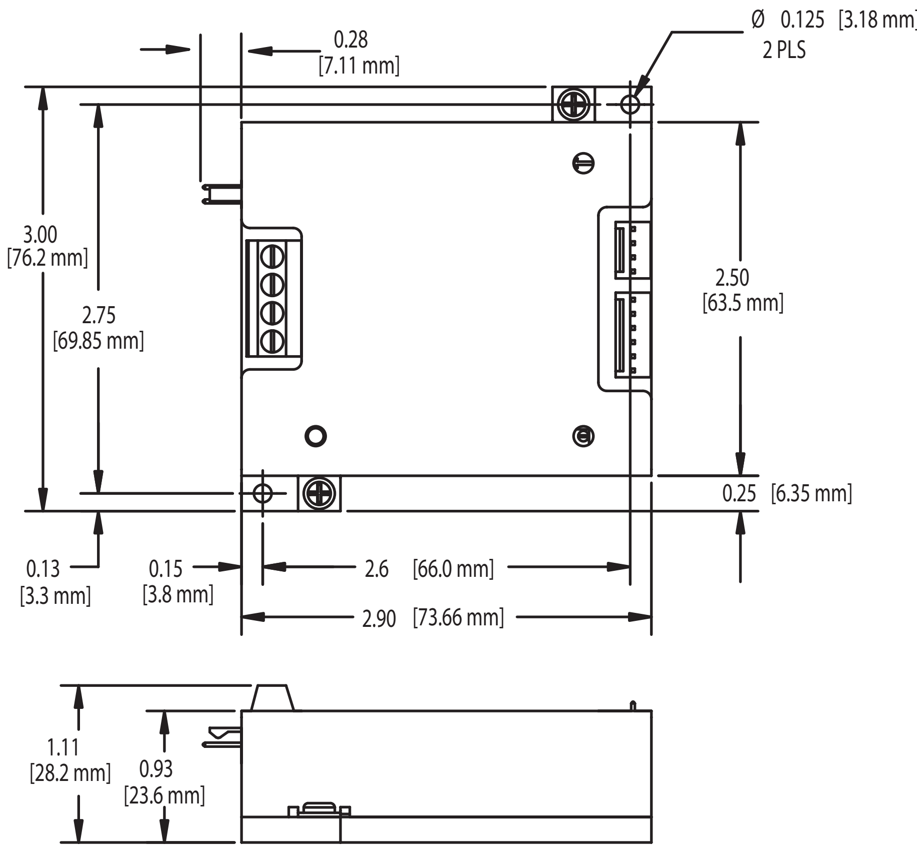


REMOTE SENSOR VOLTAGE INPUT

The sensor bias current can be bypassed so that a remote voltage can be input to J1 Pin 2 (Sensor+).

- This voltage cannot exceed 5 V.
- Remove Sensor Bias jumper.
- Install Sensor Configuration jumper in AD590 position.
- Input impedance is 10 kΩ if AD590 jumper is in place. It can be removed to change it to a high impedance input.

MECHANICAL SPECIFICATIONS

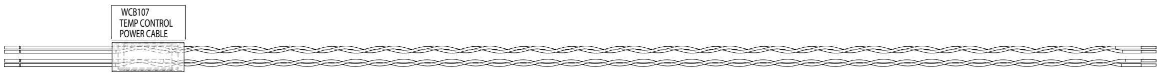


Direction for Recommended Airflow

***All Tolerances are ± 5%**
Dimensions are in Inches [mm]

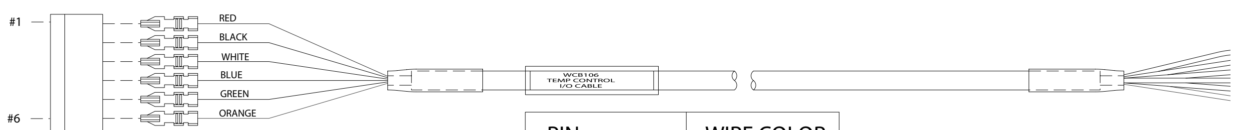
CABLING SPECIFICATIONS

WCB-107
Power Cable, 24”, 14 AWG



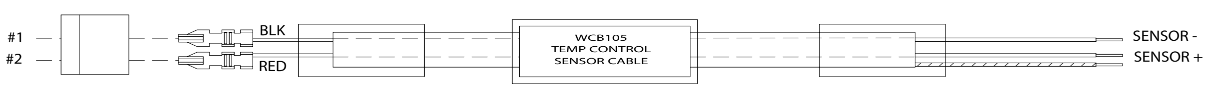
PIN	WIRE COLOR
1 - V_{DD} (V+)	Red
2 - GND	Black
3 - TEC+	Orange
4 - TEC-	Yellow

WCB-106
Input/Output Cable, 36”, 26 AWG



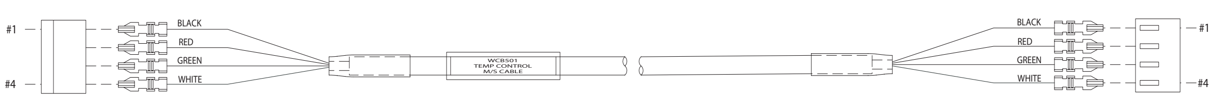
PIN	WIRE COLOR
1 - ENABLE	Red
2 - COMMON	Black
3 - ActT MON	White
4 - SetT MON	Blue
5 - COMMON	Green
6 - ExtSET	Orange

WCB-105
Sensor Cable, 24”, 22 AWG



PIN	WIRE COLOR
1 - SENSOR-	Black
2 - SENSOR+	Red

WCB-501
Master/Slave Cable, 12”



ENDS ARE INTERCHANGEABLE

CERTIFICATION AND WARRANTY

CERTIFICATION:
Wavelength Electronics, Inc. (Wavelength) certifies that this product met it's published specifications at the time of shipment. Wavelength further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by that organization's calibration facilities, and to the calibration facilities of other International Standards Organization members.

WARRANTY:
This Wavelength product is warranted against defects in materials and workmanship for a period of 90 days from date of shipment. During the warranty period, Wavelength will, at its option, either repair or replace products which prove to be defective.

WARRANTY SERVICE:
For warranty service or repair, this product must be returned to the factory. An RMA is required for products returned to Wavelength for warranty service. The Buyer shall prepay shipping charges to Wavelength and Wavelength shall pay shipping charges to return the product to the Buyer upon determination of defective materials or workmanship. However, the Buyer shall pay all shipping charges, duties, and taxes for products returned to Wavelength from another country.

LIMITATIONS OF WARRANTY:
The warranty shall not apply to defects resulting from improper use or misuse of the product or operation outside published specifications.

No other warranty is expressed or implied. Wavelength specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

EXCLUSIVE REMEDIES:
The remedies provided herein are the Buyer's sole and exclusive remedies. Wavelength shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

NOTICE:
The information contained in this document is subject to change without notice. Wavelength will not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material. No part of this document may be photocopied, reproduced, or translated to another language without the prior written consent of Wavelength.

SAFETY:
There are no user serviceable parts inside this product. Return the product to Wavelength for service and repair to ensure that safety features are maintained.

LIFE SUPPORT POLICY:
As a general policy, Wavelength Electronics, Inc. does not recommend the use of any of its products in life support applications where the failure or malfunction of the Wavelength product can be reasonably expected to cause failure of the life support device or to significantly affect its safety or effectiveness. Wavelength will not knowingly sell its products for use in such applications unless it receives written assurances satisfactory to Wavelength that the risks of injury or damage have been minimized, the customer assumes all such risks, and there is no product liability for Wavelength. Examples of devices considered to be life support devices are neonatal oxygen analyzers, nerve stimulators (for any use), auto transfusion devices, blood pumps, defibrillators, arrhythmia detectors and alarms, pacemakers, hemodialysis systems, peritoneal dialysis systems, ventilators of all types, and infusion pumps as well as other devices designated as "critical" by the FDA. The above are representative examples only and are not intended to be conclusive or exclusive of any other life support device.

REVISION HISTORY

REVISION	DATE	NOTES
REV. A	23-Jan-09	Initial release
REV. B	1-Apr-09	Updated to include cabling and additional user info

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