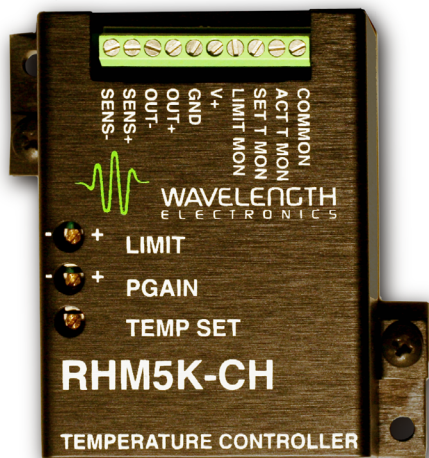


# DATASHEET AND OPERATING GUIDE

# RHM5K-CH

## Precision Unipolar Temperature Controller



### FEATURES

- 5 A Drive Current
- Single Supply Operation: +5 V to +30 V
- < 0.001°C stability (1 hour)
- < 0.003°C stability (24 hours)
- Voltage limit
- > +27 V compliance with +30 V input
- Supports Thermistors, IC sensors or RTDs
- Temperature Setpoint, Proportional Gain, and Voltage Limit are user adjustable
- Small package: 2.1" x 2.1" x 0.77"

### PRECISION, STABILITY & VERSATILITY

The RHM5K-CH is a 5 A precision temperature controller in a small, chassis mount package. Operating from a single DC supply, the RHM5K-CH can be used to achieve control at off-ambient temperatures in heating or cooling applications. It uses a PID control loop to drive resistive heaters or thermoelectric coolers (TECs). The RHM5K-CH offers a high level of stability and can drive up to 5 A with a small footprint.

On-board 12-turn trimpots control temperature setpoint, proportional gain, and output voltage limit. A single 10-pin terminal strip provides easy access to the DC supply, sensor, resistive heater, and measurement connections.

### LEADING EDGE APPLICATIONS

The RHM5K-CH is suited for applications where heating or cooling (not both) is required. This product is ideal where temperature stability is critical and space is tight and setpoint is off ambient by at least 10°C, such as heated optics (non-condensing circumstances), CCDs, preheated liquids and chamber stabilization.

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### ORDERING INFORMATION

PART NO	DESCRIPTION
RHM5K-CH	5 A Resistive Heater Controller
WCB-108	4-Pin Unterminated Cable
WCB-109	6-Pin Unterminated Cable
TCS10K5	10 kΩ Thermistor – 5 pack
TCS610	10 kΩ Thermistor – 10 pack
TCS620	20 kΩ Thermistor – 10 pack
TCS650	50 kΩ Thermistor – 10 pack
TCS651	100 kΩ Thermistor – 10 pack
THERM-PST	Thermal Paste



406-587-4910

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# QUICK CONNECT GUIDE

RHM5K-CH Quick Connect Diagram  
 RHM5K-CH Pin Layout  
 RHM5K-CH Test Loads

page 2  
 page 3  
 page 3

Figure 1 is the Quick Connect schematic for the RHM5K-CH. Figure 2 shows the pin layout and descriptions for the RHM5K-CH Temperature Controller.



TO ENSURE SAFE OPERATION OF THE RHM5K-CH TEMPERATURE CONTROLLER, IT IS IMPERATIVE THAT YOU DETERMINE THAT THE UNIT WILL BE OPERATING WITHIN THE INTERNAL HEAT DISSIPATION SAFE OPERATING AREA (SOA).

Visit the Wavelength Electronics website for the most accurate, up-to-date, and easy to use SOA calculator:

[www.teamwavelength.com/support/design-tools/soa-tc-calculator/](http://www.teamwavelength.com/support/design-tools/soa-tc-calculator/)

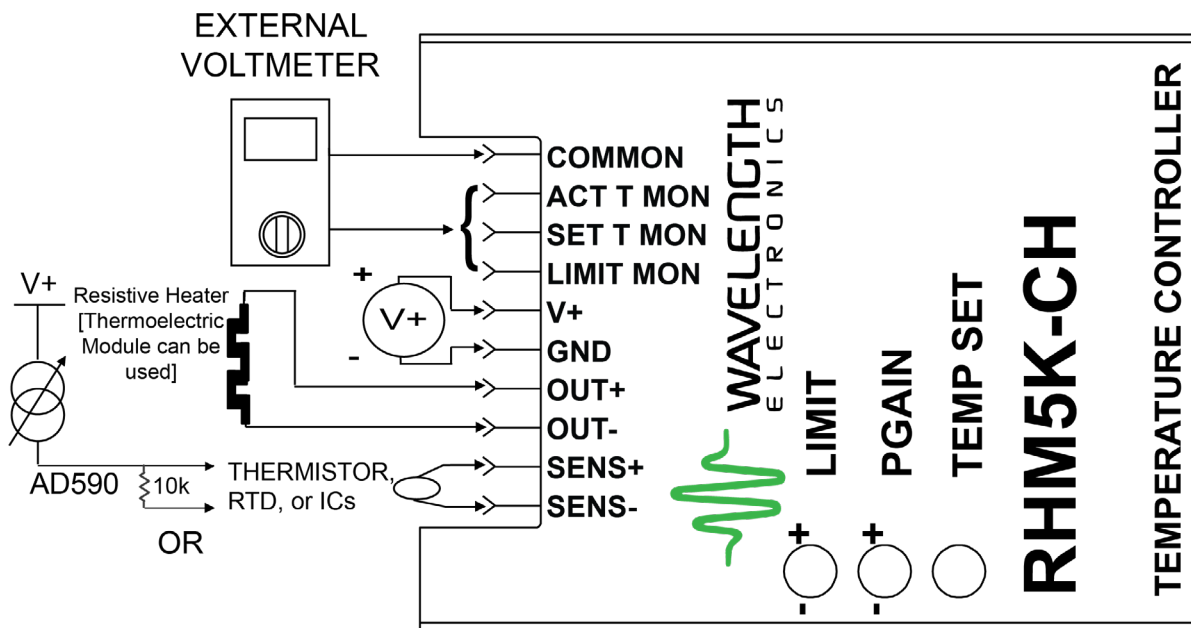


Figure 1. RHM5K-CH Quick Connect

QUICK CONNECT LEGEND		
FUNCTION	NAME ON MODULE	INSTRUCTION LOCATION
Voltage Limit	Limit (Trimpot)	STEP 2 on page 8
Proportional Gain Parameter	PGAIN (Trimpot)	STEP 5 on page 9
Sensor	SENS+ & SENS-	STEP 4 on page 8
Temperature Setpoint	TEMP SET (Trimpot)	STEP 6 on page 9

## QUICK CONNECT GUIDE, cont'd

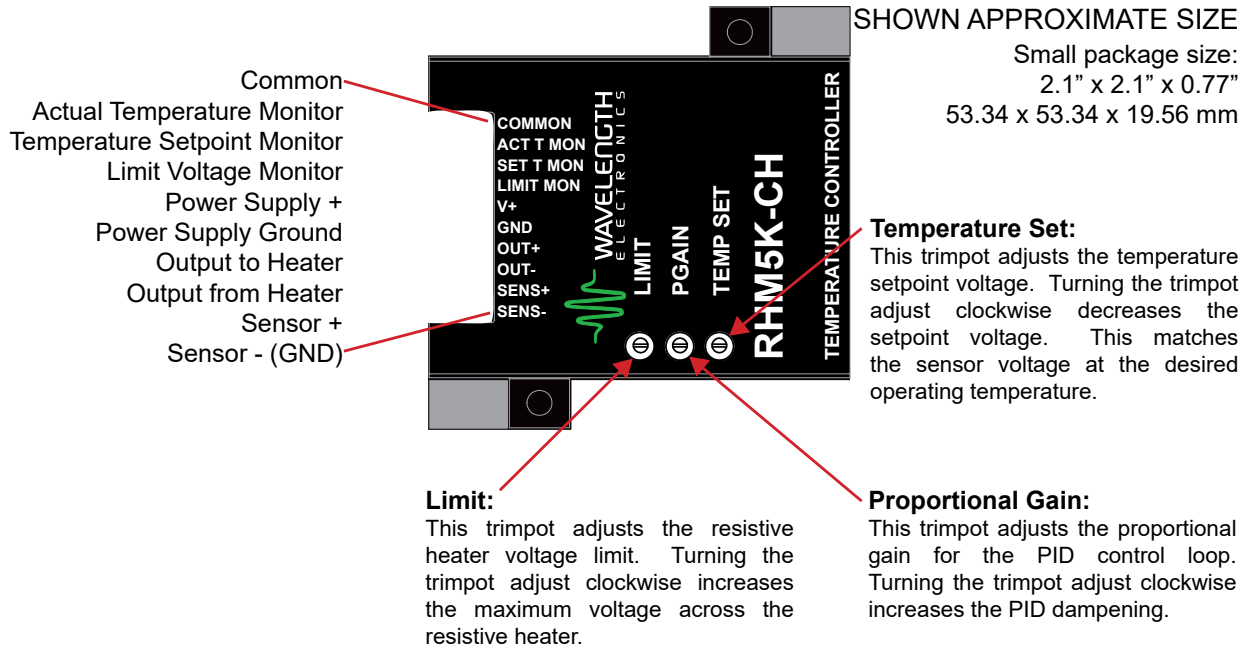


Figure 2. RHM5K-CH Pin-out, Top view

## RECOMMENDED TEST LOAD

A test load can be used for initial configuration of the RHM5K-CH. The following guidelines should be considered.

**Load Resistor** - Connect a power resistor between OUT+ and OUT-. Use the online Safe Operating Area (SOA) Calculator at: [www.teamwavelength.com/support/design-tools/soa-tc-calculator/](http://www.teamwavelength.com/support/design-tools/soa-tc-calculator/) to ensure that the value of the resistor allows for safe operation of the RHM5K-CH. The maximum achievable current through the resistor is  $(V+ - 2V) / R_{LOAD}$ . The power rating on the resistor should be sufficient to handle the maximum current.

**Sensor Resistor** - Connect a resistor between SENS+ and SENS-. A potentiometer can be used if desired to simulate a changing sensor resistance. The voltage produced by the resistor will be equal to the resistance multiplied by the bias current selected by the internal jumpers. The resistor value should be chosen to produce a sensor voltage of 0.2 to 5.0 volts.

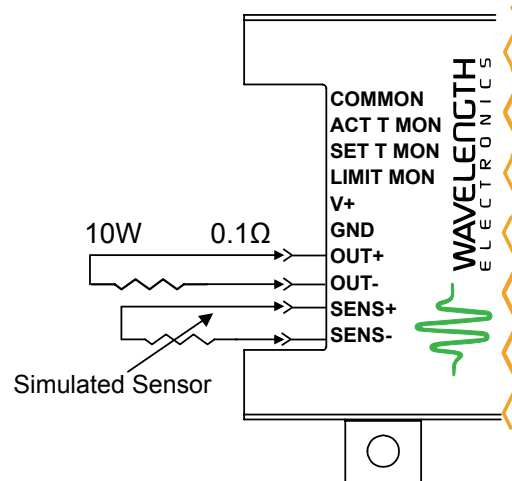


Figure 3. Test Load Configuration

## PIN DESCRIPTIONS

Table 1. RHM5K-CH Temperature Controller Pin Descriptions

PIN	PIN	NAME	PIN DESCRIPTION
1	<b>COMMON</b>	Common	This pin provides ground potential to be used with the monitor outputs, Pins 2-4. This ground is starred with the circuit ground to provide the most accurate monitor measurement. This pin is at ground potential, but should not be used for anything other than the monitors.
2	<b>ACT T MON</b>	Actual Temperature Monitor	This output is used to monitor the voltage, and therefore temperature, of the sensor. When controlled, the ACT T MON voltage will closely match the voltage set at Pin 3 (SET T MON).
3	<b>SET T MON</b>	Setpoint Temperature Monitor	This output is used in setting the temperature setpoint of the sensor. This voltage will range from 0-5 V and should match the voltage across the sensor when it is at the desired temperature. The maximum voltage will be (V+ - 1.2 V) for supply voltages less than 6.3 V.
4	<b>LIMIT MON</b>	Monitor Limit	This voltage is the maximum voltage between Pins 7 and 8 (OUT+ and OUT-). The voltage limit potentiometer can be adjusted to produce voltages on Limit Mon of 0 V to (V+ - 1.25 V), but the effective range of output voltages is 2 V to (V+ - 3 V).
5	<b>V+</b>	Power Supply	This pin along with Pin 6 (GND) provides power to the control electronics and the output stage.
6	<b>GND</b>	Ground	This pin, along with Pin 5 (V+) provides power to the control electronics as well as the resistive heater. This is the only ground connection designed as a high current return.
7	<b>OUT+</b>	Output Out	This pin sources the current to the resistive heater or TEC. See <b>Table 2 on page 8</b> for orientation.
8	<b>OUT-</b>	Output In	This pin sinks the current returned from the resistive heater or TEC. See <b>Table 2 on page 8</b> for orientation.
9	<b>SENS+</b>	Sensor Out	This pin is used to source reference current through the temperature sensor. An internal jumper in the unit will select between a 100 $\mu$ A, 1 mA, or 10 mA reference current. The bias current should be configured based on the sensor chosen. Typical sensors include, but are not limited to, thermistors, RTDs, LM335, and AD590.
10	<b>SENS-</b>	Sensor In (GND)	This pin is used as the bias current source return pin. This pin is at ground potential but should not be used for anything other than the sensor current source return.

## ELECTRICAL SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS	SYMBOL	RHM5K-CH	UNIT
Supply Voltage, standard (see SOA calculator for all voltage levels)	V <sup>+</sup>	+5 to +30	Volts DC
Operating Temperature, case	T <sub>OPR</sub>	0 to +70	°C
Storage Temperature	T <sub>STG</sub>	-40 to +150	°C
Size (WxDxH)		2.1 x 2.1 x 0.77 53.3 x 53.3 x 19.6	inches mm
Weight		4	ounces

OPERATING PARAMETER OUTPUT	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage		+4.5		+30	V
Output Current Range <sup>1</sup>		0		5	A
Voltage Limit Range <sup>2,3</sup>		(V+ - 2.4)		(V+ - 1.25)	V
Compliance Voltage <sup>4</sup>		(V+ - 3)		(V+ - 2.5)	V
Internal Power Dissipation <sup>5</sup>				20	W
Maximum Output Power	Load resistance of 5.4 Ω			135	W

TEMPERATURE CONTROL					
P (Proportional Gain)		9		100	A / V
I (Integrator Time Constant) <sup>6</sup>			1		sec
D (Differentiator Time Constant)			6		msec
Short Term Stability (1 hour)	10 kΩ Thermistor @ 17°C	0.0005		0.002	°C
Long Term Stability (24 hours)	10 kΩ Thermistor @ 17°C	0.002		0.005	°C
Temperature Coefficient	10 kΩ Thermistor @ 25°C		20		ppm / °C

MONITOR SIGNALS					
Setpoint Monitor <sup>7</sup>		0		5.0	V
Quiescent Current			< 10		mA
Setpoint Monitor Output Impedance			41.5		kΩ
Actual Temp Monitor Output Imped.			400		kΩ
Setpoint vs. Actual Accuracy			16		mV
Sensor Voltage vs. ACT T			4		mV

SENSOR					
Bias Current	100 μA, 1 mA, or 10 mA				

- Maximum Output Current is dependent on the supply voltage and the resistance of the sensor. Care should be taken not to exceed the maximum internal power dissipation of 20 W. Please review the online Safe Operating Area (SOA) Calculator at: <https://www.teamwavelength.com/support/design-tools/soa-tc-calculator/> to ensure safe operation.
- The voltage limit potentiometer can be adjusted to produce voltages on Limit Mon of 0 V to (V+ - 1.25 V), but the effective range of output voltages is 2 V to (V+ - 3 V).
- The limit current is equal to the limit voltage divided by the load resistance of the resistive heater or thermoelectric.
- Maximum Output Voltage will vary depending on input voltage. A maximum compliance voltage of 27 V will be obtained with +30 V input. A maximum compliance voltage of 2.5 V will be obtained with a 5 V input.
- Maximum internal power dissipation. Derating begins at 40°C ambient temperature. See the online Safe Operating Area (SOA) Calculator at: <https://www.teamwavelength.com/support/design-tools/soa-tc-calculator/> for details.
- Integrator Time Constant capacitor is set at 1 μF (correlating to a value of 1 second) at the factory. This ITERM value can be changed with a capacitance range of 1 to 10 μF (correlating to values of 1 to 10 seconds).
- Range is dependent on input supply voltage, and bias current and sensor choice. The maximum sensor range will be (V+ - 1.2 V) for supply voltages less than 6.3 V.

## SAFETY INFORMATION

### SAFE OPERATING AREA – DO NOT EXCEED INTERNAL POWER DISSIPATION LIMITS



TO ENSURE SAFE OPERATION OF THE RHM5K-CH THERMOELECTRIC CONTROLLER, IT IS IMPERATIVE THAT YOU DETERMINE THAT THE UNIT WILL BE OPERATING WITHIN THE INTERNAL HEAT DISSIPATION SAFE OPERATING AREA (SOA).

Visit the Wavelength Electronics website for the most accurate, up-to-date, and easy to use SOA calculator:

[www.teamwavelength.com/support/design-tools/soa-tc-calculator/](http://www.teamwavelength.com/support/design-tools/soa-tc-calculator/)

For more information on Safe Operating Area, see our Application Note [AN-LDTC01: The Principle of the Safe Operating Area](#) and our SOA video: [How to use the Safe Operating Area \(SOA\) Calculator](#).

### PREVENT DAMAGE FROM ELECTROSTATIC DISCHARGE

Before proceeding, it is critical that you take precautions to prevent electrostatic discharge (ESD) damage to the controller and your load. ESD damage can result from improper handling of sensitive electronics, and is easily preventable with simple precautions.

For more information regarding ESD, see Application Note [AN-LDTC06: Basics: Electrostatic Discharge \(ESD\)](#).

We recommend that you always observe ESD precautions when handling the RHM5K-CH controller.

## THEORY OF OPERATION

The RHM5K-CH is a analog Proportional, Integral, Differential (PID) control loop that delivers unidirectional current to resistive heaters or thermoelectric coolers.

The fundamental operating principle is that the controller adjusts the TEC drive current in order to change the temperature of the sensor that is connected to the thermal load. The goal is to make the voltage across the sensor match the setpoint voltage, and then keep them equal in spite of changes to ambient conditions and variations in thermal load.

The controller measures the load temperature by driving a current through the temperature sensor and measuring the voltage drop across it. Changing the setpoint temperature will change the setpoint voltage, creating a difference with the actual sensor voltage.

While the output is enabled the controller continuously compares the setpoint voltage and the actual sensor voltage. If there is a difference between the two signals the controller adjusts the output current—thereby driving the TEC or heater to change temperature—until the difference is zero.

Once the actual sensor voltage equals the setpoint voltage, the controller makes minor adjustments to the output current in order to keep the difference at zero. If the ambient temperature changes, for example, the controller will adjust the drive current accordingly.

The controller includes features that help protect the load from damage. These features are explained in detail in **Operating Instructions on page 7**.

- **Voltage limit:** Heating or cooling voltage limits avoid over-driving and damaging the TEC or heater.
- **Onboard temperature setpoint control:** for prototyping and benchtop applications the temperature setpoint can be adjusted with the onboard trimpot.
- **Control loop:** the controller employs a smart Proportional-Integrating-Differentiator control loop to adjust the drive current.

# OPERATING INSTRUCTIONS

## NECESSARY EQUIPMENT

The following equipment is required to configure the RHM5K-CH for basic operation.

- RHM5K-CH Temperature Controller
- Digital multimeter, 4-½ digit resolution recommended
- Thermistor or other temperature sensor
- Peltier-type thermoelectric cooler or resistive heater
- Optional: test load
- Minimum 16 gauge wiring to TEC
- Power Supply (see below)
- Thermal solution kit: heatsink, thermal paste, and fan if the RHM5K-CH dissipates more than 5 W of power

## SYSTEM DESIGN DECISIONS

Before the RHM5K-CH can be configured, several decisions must be made:

- What sensor is being used?
- What is the operating maximum current and maximum voltage?
- Will the controller be heating or cooling?
- Will the system, as designed, fit within the Safe Operating Area (SOA)?

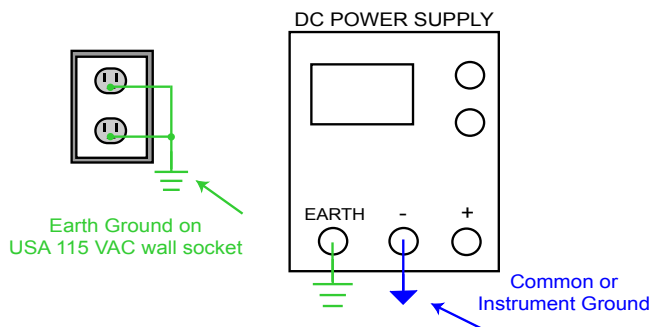
## POWER SUPPLY REQUIREMENTS

The RHM5K-CH operates from a single power supply. The recommended operating voltage is between +4.5 and +30 V. The voltage available to the thermoelectric or resistive heater is the “Compliance Voltage.” Compliance voltage varies with the input voltage. See Compliance Voltage section in the **Electrical Specifications on page 5**.

See **Figure 1** for Quick Connect Configuration Wiring.

A heatsink is required to properly dissipate heat from the RHM5K-CH mounting surface. Maximum internal power dissipation is 20 Watts for the RHM5K-CH.

## GROUNDING



Unless Earth and Instrument Ground are connected via the power supply, Instrument Ground is floating with respect to Earth Ground

Special attention to grounding will ensure safe operation. Some manufacturers package devices with one lead of the sensor or thermoelectric connected to the metal enclosure or in the case of laser diodes, the laser anode or cathode.

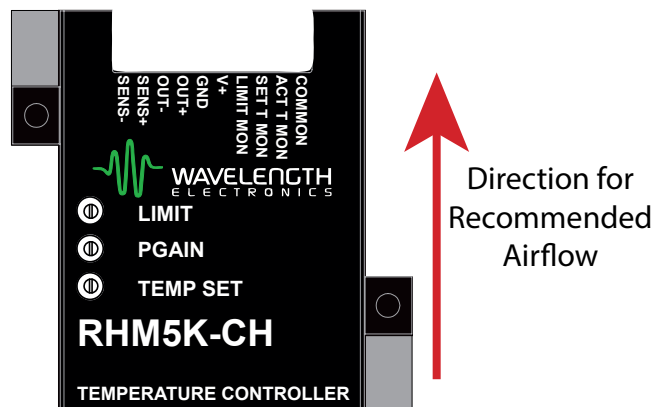
## OPERATION INSTRUCTIONS

### STEP 1 Heatsink Mounting & Fan

When the RHM5K-CH must dissipate more than 5 W of power, a heatsink must be properly attached to the base plate to maintain internal power dissipation within a safe range. An online Safe Operating Area (SOA) Calculator is available at: <https://www.teamwavelength.com/support/design-tools/soa-tc-calculator/> to determine internal power dissipation for your specific application. An SOA chart at the end of this datasheet can be used for manual calculations.

Thermally conductive grease should be used between the heatsink and the module for optimum performance.

**Figure 4** shows the direction of airflow from a fan.



**Figure 4. Recommended Airflow Direction**

**STEP 2 Select Sensor Bias Current**

The jumpers can be accessed with the cover removed. See **Figure 5** for jumper locations. The optimal sensor voltage range is 200 mV to (V+ - 2.7 V) with an absolute maximum of 7 V.

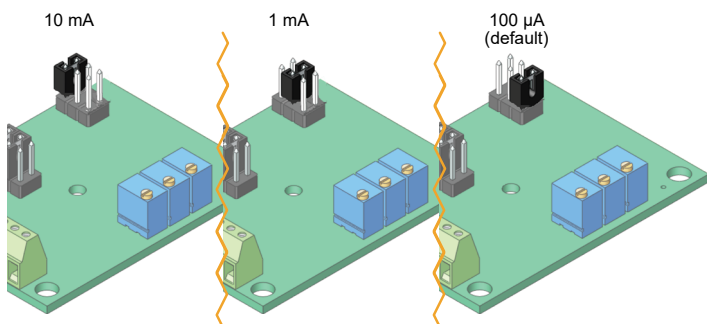
**NOTE:** Although the compliance voltage of the ACT T MON may be as high as 7 V, the maximum range of the setpoint voltage is 5 V. With this in mind, the sensor bias current jumper should be configured as follows:

**Resistive Sensors (Thermistors & RTDs):**

The bias current jumper should be configured so that the bias current multiplied by the resistance of the sensor is within the acceptable range.

**LM335:** Configure the jumper for a bias current of 1 mA.

**AD590:** Remove the sensor bias jumper. Attach a 10 kΩ resistor between Sensor+ and Sensor-. Attach the AD590 between V+ and Sensor+. The sensor voltage generated will be 10 mV / K.



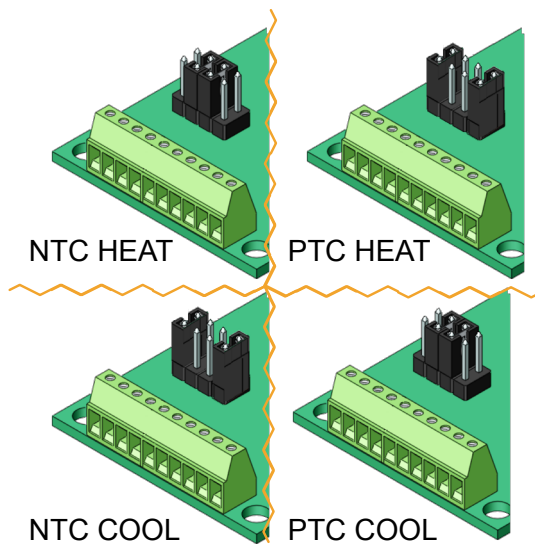
**Figure 5. Sensor Current Settings (Jumper Set 1)**

**STEP 3 Place Loop Direction Jumper**

The loop direction can be changed to accommodate heating or cooling operation with PTC or NTC sensors. **Figure 6** shows the options for configuring the loop direction jumpers. The jumpers can be accessed with the cover removed.

The resistance or voltage for an NTC sensor increases as the temperature decreases. To configure the RHM5K-CH to cool with NTC sensors place the jumpers in the outside positions. For heating operation with NTC sensors, place the jumpers in the inside positions.

The resistance or voltage for a PTC sensor increases as the temperature increases. To configure the RHM5K-CH to cool with PTC sensors place the jumpers in the inside positions. For heating operation with PTC sensors, place the jumpers in the outside positions.



**Figure 6. Loop Direction Settings (Jumper Set 2)**

**STEP 4 Choose a Sensor - Terminal Pin 9 & 10**

Epoxy or otherwise affix the temperature sensor to the device being heated in your application. Connect the sensor to Pins 9 and 10. For sensors where polarity is important, Pin 9 is SENS+, and Pin 10 is SENS-. Thermistors, RTDs, LM335, and AD590 sensors can be used.

**STEP 5 Connect Thermoelectric & Resistive Heater - Terminal Pin 7 & 8**

**Thermoelectric:** The polarity of the thermoelectric connections to OUT+ and OUT- may need to be reversed depending on the sensor type and whether the device is configured for heating operation or cooling operation. The chart in **Table 2** details when the leads should be reversed. The standard connection is assumed to be the thermoelectric positive connection attached to OUT+ and negative connection to OUT-.

**Table 2. TEC Settings**

	POLARITY	
	OUT+ Pin 7	OUT- Pin 8
NTC Cool NTC Heat	Standard Reversed	
PTC Cool PTC Heat	Reversed Standard	

**Resistive Heater:** For resistive heater operation polarity is not important for the connections to OUT+ and OUT-. The loop direction jumpers do need to be configured as detailed in step 3 for proper operation (heating with NTC or PTC sensor).



## STEP 6 Connect Power Supply

Connect a positive voltage to V+ (Pin 5) and GND (Pin 6). Ensure the power supply has sufficient current capacity for the requirements of the load. The power supply should be carefully selected so that the internal power dissipation for the RHM5K-CH is not exceeded. A Safe Operating Area (SOA) Calculator is available online at [www.teamwavelength.com/support/design-tools/soa-tc-calculator/](http://www.teamwavelength.com/support/design-tools/soa-tc-calculator/) to ensure that the maximum power specification is not exceeded with your application. The supply voltage should also be chosen so that the controller does not exceed the maximum current specification of 5 A. The maximum output current will be  $(V+ - 2 V) / R_{LOAD}$ .

## STEP 7 Set Voltage Limit - Terminal Pin 4

After connection power to the device (see **Power Supply Requirements Section** on **page 7**), monitor the voltage on Pin 4. Turning the LIMIT trimpot clockwise (CW) increases the maximum allowable voltage between OUT+ and OUT-. The voltage limit measurement on Pin 4 can be adjusted from 0 V to (V+ - 1.25 V), but the effective range of output voltages is 2 V to (V+ - 3 V). Use the COMMON connection on Pin 1 for all monitors.

**Note:** When using a variable power supply, the voltage limit must be adjusted to compensate for increases or decreases in the supply voltage.

The maximum output current will be limited by the voltage limit divided by the resistance of the resistive heater ( $R_{RH}$ ):

$$I_{OUTMAX} = \frac{V_{LIMIT}}{R_{LOAD}}$$

Check the Safe Operating Area (SOA) chart in this datasheet to ensure that the maximum power dissipation specification is not exceeded. An online SOA Calculator is available at: [www.teamwavelength.com/support/design-tools/soa-tc-calculator/](http://www.teamwavelength.com/support/design-tools/soa-tc-calculator/)

## STEP 8 Set Temperature Setpoint - Terminal Pin 3

The setpoint voltage can be increased by adjusting the TEMP SET potentiometer CCW. It has a range of 0 to 5 V. If the supply voltage is less than 6.3 V, the setpoint range is 0 to (V+ - 1.2 V). Measure the voltage from Pin 3 (SET T MON) while adjusting the potentiometer.

Decrease the voltage by rotating the TEMP SET potentiometer clockwise. Watch the ACT T MON (Pin 2) voltage approach the setpoint voltage with a time lag.

This voltage will depend on the sensor selected. Use one of the following equations based on the sensor type you will be using.

### Thermistors and RTDs:

$V_{SETPOINT} = I_{REF} \times R$  ( $I_{REF}$  in amps, R in ohms) where “R” equals the resistance value of the sensor at the desired operating temperature. The reference current ( $I_{REF}$ ) will be 10 mA, 1 mA, or 100  $\mu$ A.

### LM335 & AD590:

$V_{SETPOINT} = 2.730 V + (0.010 V / ^\circ C \times T_{DESIRED})$  where  $T_{DESIRED}$  is the setpoint temperature in  $^\circ C$ .

## STEP 9 Set Proportional Gain

The factory setting for the proportional gain is 29. This gain can be adjusted from 1 to 100 to optimize the system for overshoot and settling time. Turning the PGAIN 12-turn trimpot clockwise increases the gain.

The PGAIN adjustment is non-linear and adjusts more quickly as the potentiometer is turned further clockwise. The chart in **Table 3** shows approximate PGAIN values versus number of turns clockwise, starting with a fully counterclockwise adjustment.

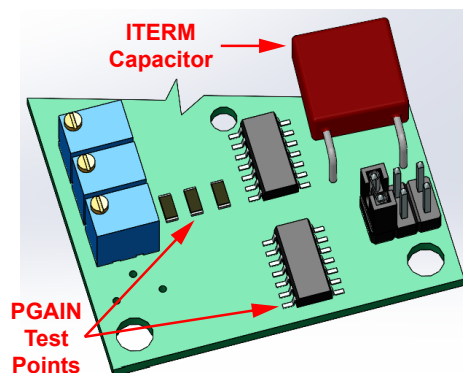
With the unit powered off, the resistance of the potentiometer can also be measured at the test points shown in **Figure 7** to more accurately set the proportional gain. The proportional gain can be calculated as follows:

$$PGAIN = 200 \text{ k}\Omega / R_{MEASURED}$$

Further information on tuning the control parameters for temperature control systems is contained in the Tech Note at: [www.teamwavelength.com/download/applicationnotes/tn-tc01.pdf](http://www.teamwavelength.com/download/applicationnotes/tn-tc01.pdf)

**Table 3. PGAIN Adjustments & ITERM Typical Range**

Potentiometer Adjustment	Fully CCW	3 Turns	6 Turns	9 Turns	10 Turns	11 Turns	12 Turns	13 Turns
PGAIN	9	10	13	23	29	38	67	100
ITERM Capacitor Range	1 $\mu$ F - 10 $\mu$ F (Factory set at 1 $\mu$ F)							
ITERM	1 sec - 10 sec (Factory set at 1 sec)							



**Figure 7. PGAIN Test Points & ITERM Location**

**STEP 10      Monitor Actual Temperature - Terminal  
Pin 2**

The actual temperature can be monitored on Pin 2 of the output connector. Based on the sensor equations in Step 8, the sensor voltage should begin at ambient temperature and move in the direction of the setpoint temperature.

## SAFE OPERATING AREA

The Safe Operating Area of the RHM5K-CH controller is determined by the amount of power that can be dissipated within the output stage of the controller. If that power limit is exceeded permanent damage can result.



DO NOT EXCEED THE SAFE OPERATING AREA (SOA). EXCEEDING THE SOA VOIDS THE WARRANTY.

Refer to the Wavelength Electronics website for the most up-to-date SOA calculator for our products. The online tool is fast and easy to use, and also takes into consideration operating temperature.

[www.teamwavelength.com/support/design-tools/soa-tc-calculator/](http://www.teamwavelength.com/support/design-tools/soa-tc-calculator/)

SOA charts are included in this datasheet for quick reference, however we recommend you use the online tools instead. See our SOA video: [How to use the Safe Operating Area \(SOA\) Calculator](#).

An example SOA calculation for the RHM5K-CH with heatsink and fan is shown in **Figure 8** where:

$V_{+} = 8$  Volts (Point C)       $V_{LOAD} = 5$  Volts  
 $I_{LOAD} = 4$  Amp (Point B)       $V_{DROP} = 8V - 5V = 3$  V (Point A)

Follow these steps to determine if the controller will be operating within the SOA.

- Refer to the thermoelectric datasheet to find the maximum voltage ( $V_{LOAD}$ ) and current ( $I_{LOAD}$ ) specifications
- Calculate the voltage drop across the controller:  
 $V_{DROP} = V_{+} - V_{LOAD}$  ( $V_{+}$  is the power supply voltage)
- Mark  $V_{DROP}$  on the X-axis, and extend a line upward
- Mark  $I_{LOAD}$  on the Y-axis, and extend a line (Line BB) to the right until it intersects the  $V_{DROP}$  line
- On the X-axis, mark the value of  $V_{+}$
- Extend a diagonal line from  $V_{+}$  to the intersection of the  $V_{DROP}$  and  $I_{LOAD}$  lines; this is the Load Line
- If the Load Line crosses the Safe Operating Area line at any point, the configuration is not safe

If the SOA Calculator indicates the RHM5K-CH will be outside of the Safe Operating Area, the system must be changed so that less power is dissipated within the controller. See Wavelength Electronics Application Note [AN-LDTC01: The Principle of the Safe Operating Area](#) for information on shifting the Load Line.

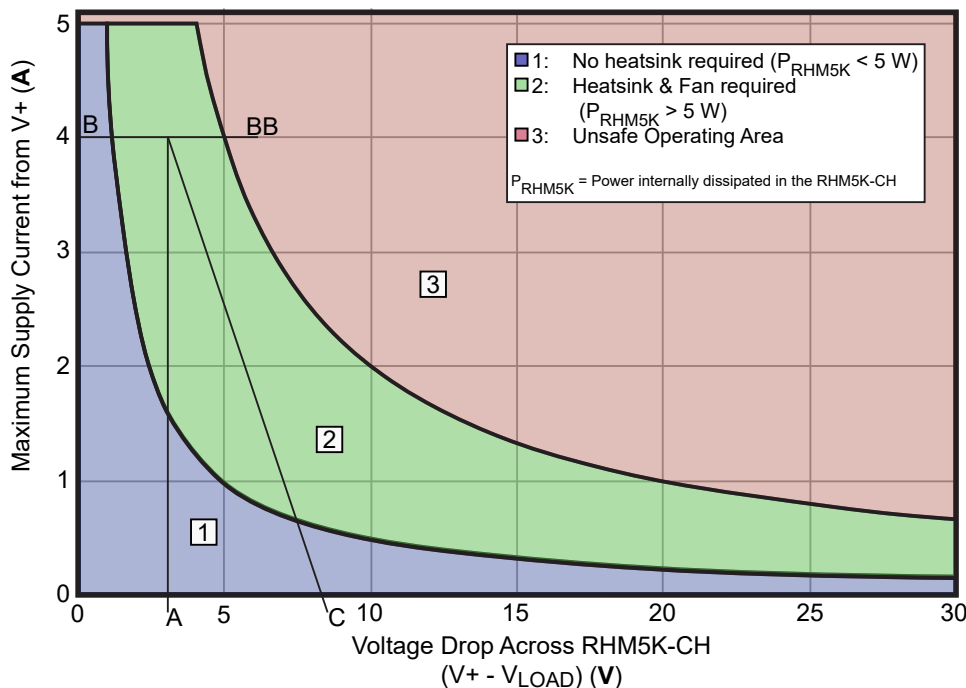
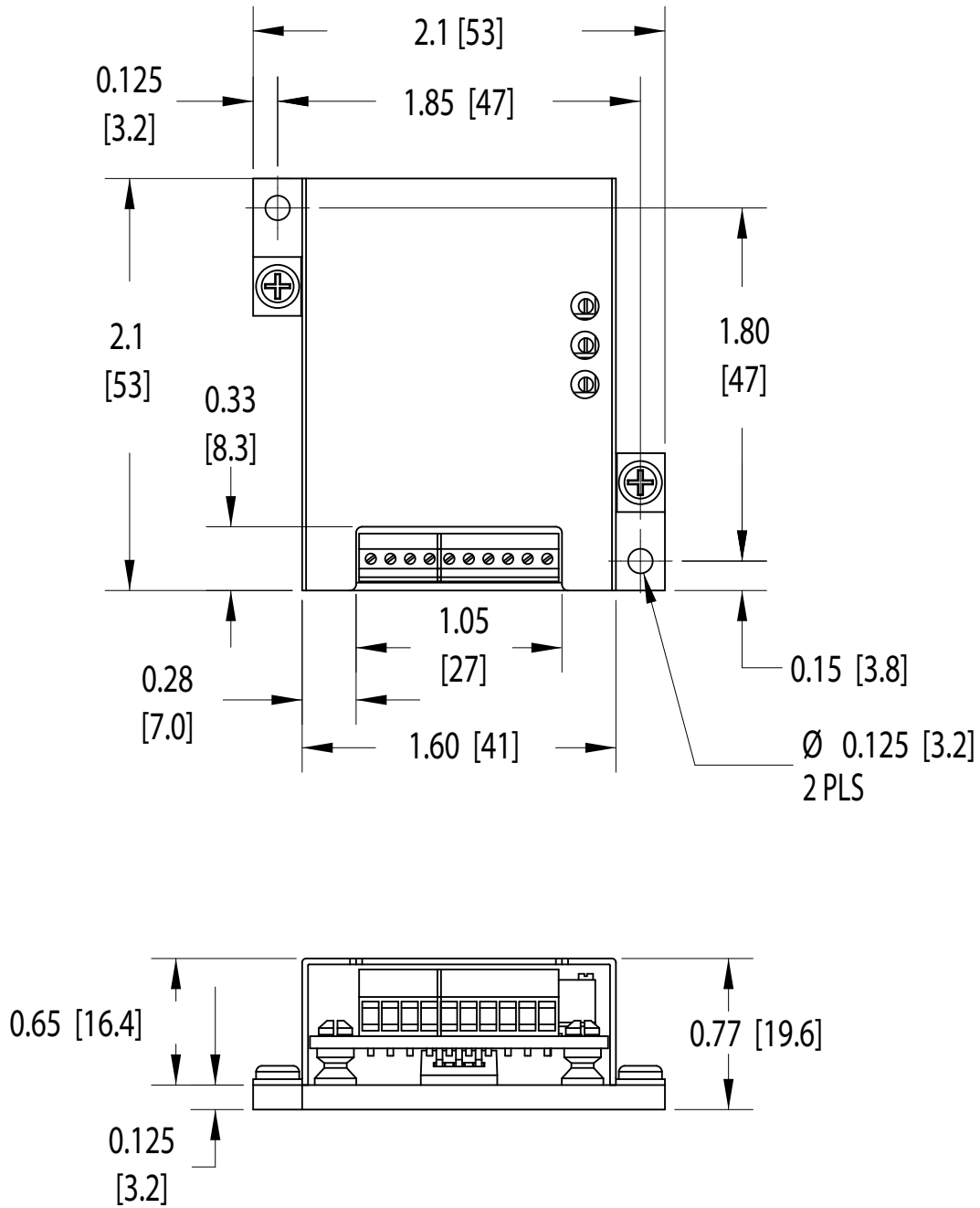


Figure 8. RHM5K-CH SOA

## TROUBLESHOOTING

PROBLEM	POTENTIAL CAUSES	SOLUTIONS
Temperature is decreasing when it should be increasing  -OR-  Temperature is increasing when it should be decreasing	The TEC may be connected backwards to the RHM5K-CH  Loop direction jumper may be backwards	The convention is that the red wire on the TEC module connects to TEC+ (OUTB) and the black wire to TEC- (OUTA). If your TEC is connected in this manner and the problem persists, the TEC module itself may be wired in reverse. Switch off power to the system, reverse the connections to the RHM5K-CH, and then try again to operate the system.  TEC wiring polarity is dependent on the temperature sensor type (NTC vs. PTC). Verify that the polarity is correct for the sensor type you are using (see <b>Table 2 on page 8</b> ).  The loop direction jumper is set depending on the type of sensor used. See Step 3 on <b>page 7</b> for heating or cooling operation jumper settings.
Temperature increases beyond setpoint and will not come down	The heatsink may be inadequately sized to dissipate the heat from the load and the TEC module or RH, and now the system is in <b>thermal runaway</b>	Increase the size of the heatsink, add a fan to blow air over the heatsink, and/or reduce the ambient air temperature around the heatsink.
	The TEC or RH and heatsink are not adequately sized for the thermal load	The heat being generated by the load may be too great for the TEC or RH to pump to the heatsink; a larger TEC or RH may be needed. Consult our Technical Note <a href="#">TN-TC01: Optimizing Thermoelectric Temperature Control Systems</a> and Application Note <a href="#">AN-TC09: Specifying Thermoelectric Coolers</a> .
Temperature does not stabilize very well at the setpoint	There may be poor thermal contact between components of the thermal load	Use thermal paste or washers between the load / TEC and the TEC / heatsink interfaces. Ensure the temperature sensor is in good thermal contact with the load.
	Unit may be operating outside the ideal region of the temperature sensor	The sensor type and bias current should be selected to maximize sensitivity at the target temperature. Thermistors provide the best performance, particularly for applications where a single setpoint temperature must be accurately maintained. For example, at 25°C a 10 kΩ thermistor has a sensitivity of 43 mV / °C, whereas an RTD sensor has a sensitivity of 4 mV / °C.
	Proportional control term may be set too high	Reduce the value of the proportional term. For more information, reference our Technical Note <a href="#">TN-TC01: Optimizing Thermoelectric Temperature Control Systems</a> .
	Heatsink may not be sized correctly or may not have adequate airflow	Ambient temperature disturbances can pass through the heatsink and thermoelectric and affect the device temperature stability. Choosing a heatsink with a larger mass and lower thermal resistance will improve temperature stability. Adding a fan across the thermoelectric's heatsink may be required.
Temperature does not reach the setpoint	Current driven to the TEC or heater may be insufficient	Increase the current limit – but DO NOT exceed the specifications of the TEC or heater.
	The controller may not have sufficient compliance voltage to drive the TEC or heater	Increase the power supply voltage; be certain to verify that the controller is within the Safe Operating Area with Wavelength's Temperature Controller SOA calculator: <a href="http://www.teamwavelength.com/support/design-tools/soa-tc-calculator/">www.teamwavelength.com/support/design-tools/soa-tc-calculator/</a>
	The sensor may not have good contact with the heatsink and load	Use thermal paste or washers between the load / TEC and the TEC / heatsink interfaces. Contact the thermoelectric manufacturer for their recommended mounting methods.
Temperature is slow to stabilize and is not within the specifications with Resistive Heaters	Setpoint temperature is set close to the ambient temperature	Set the temperature at least 10°C above ambient when using a resistive heater. A resistive heater is unable to precisely maintain temperatures near ambient. Once the temperature overshoots the setpoint, the controller turns off and relies on ambient temperature to cool the load.

MECHANICAL SPECIFICATIONS

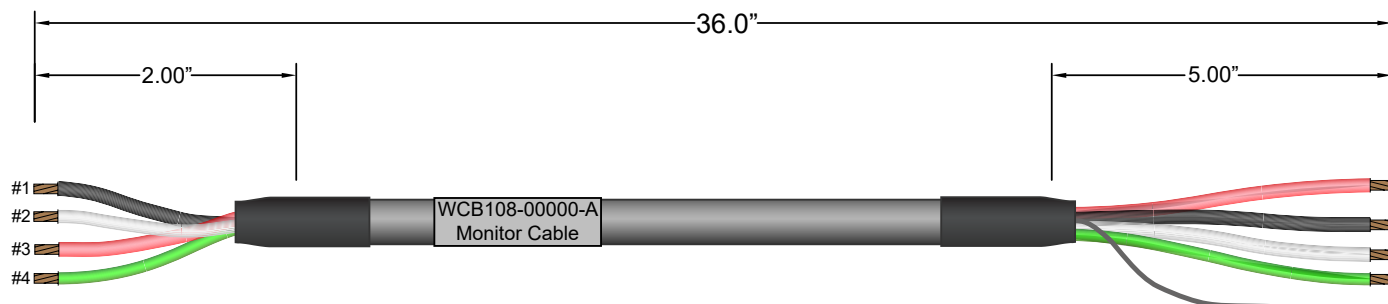


**All Tolerances are  $\pm 5\%$   
Dimensions are in Inches [mm]**

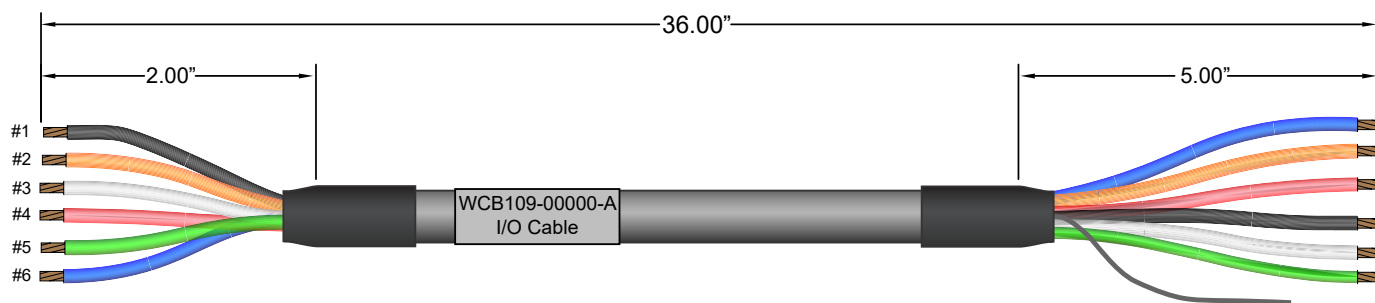
## CABLING SPECIFICATIONS

The following cables are offered separately as accessories to facilitate RHM5K-CH connection and integration.

### WCB-108 4-WIRE MONITOR CABLE



### WCB-109 6-WIRE I/O CABLE



**All Tolerances are  $\pm 5\%$**   
**Dimensions are in Inches [mm]**

## CERTIFICATION AND WARRANTY

### CERTIFICATION

Wavelength Electronics, Inc. (Wavelength) certifies that this product met its 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 one (1) year 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.

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Buyer, End-User, or Third-Party Reseller are expressly prohibited from reverse engineering, decompiling, or disassembling this product.

### NOTICE

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### SAFETY

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

### LIFE SUPPORT POLICY

This important safety information applies to all Wavelength electrical and electronic products and accessories:

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

DOCUMENT NUMBER: RHM5K-CH-00400

REV.	DATE	CHANGE
A	Dec. 2010	Initial Release
B	Oct. 2020	Transferred to new format
C	Mar. 2023	Added ITERM location and typical range



**WAVELENGTH  
ELECTRONICS**

51 Evergreen Drive  
Bozeman, Montana 59715

406-587-4910 (tel)

406-587-4911 (fax)

Sales & Tech Support

[sales@teamwavelength.com](mailto:sales@teamwavelength.com)

[techsupport@teamwavelength.com](mailto:techsupport@teamwavelength.com)

