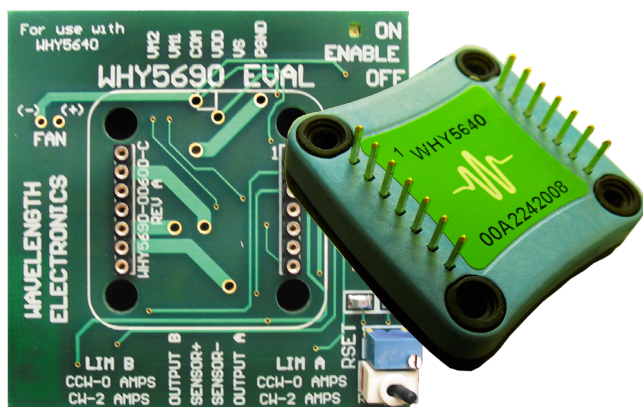# DATASHEET AND OPERATING GUIDE
WHY5640 & WHY5690
Low Profile Temperature Controller & Evaluation Board
DISCONTINUED - USE THE WHY56ND

FEATURES

- Small Package Size
- +5 to +26 V Control Electronics Supply
- +4.5 to +30 V Power Drive Supply
- Low Cost
- 0.005ºC Stability (typical)
- Linear PI Temperature Control
- High ±2.2 A Output Current
- Control Above and Below Ambient
- Master/Booster Operation
- Temperature Setpoint, Heat and Cool Current Limits, Proportional Gain, and Integrator Time Constant are set with external components.

PRECISION, STABILITY & VERSATILITY

The advanced and reliable circuitry of the WHY5640 Temperature Controller achieves 0.005ºC temperature stability with thermistors. Its small, low profile package is ideal for designs with space constraints. The linear, PI (Proportional, Integrator) control loop offers maximum stability and efficiency.

The WHY5640 is a general purpose analog PI control loop for use with thermoelectrics or resistive heaters. The WHY5640 maintains precision temperature regulation using an active resistor bridge circuit that operates directly with thermistors or RTD temperature sensors. (AD590 and LM335 sensors require external circuits.) Supply up to ±2.2 A of heat and cool current to your thermoelectric from a single +5 V power supply.

BUILT-IN SAFETY

To protect the device, heat and cool limits can be set independently. This safety feature guarantees that your thermoelectric cooler will never be driven beyond your specified limits.

Connect two or more WHY5640 units together and drive higher output currents.

LEADING EDGE APPLICATIONS

Onboard switches, connectors, and trimpots make configuration and operation simple with the WHY5690 evaluation board. The WHY5640 has proven reliable in such diverse fields as electro-optical systems, airborne instrumentation, spectroscopic monitors, and medical diagnostic equipment.

CONTENTS

ORDERING INFORMATION

PART NO	DESCRIPTION
WHY5640	±2.2 A Temperature Controller
WHY5690	Evaluation PCB for WHY5640
WEV300	Thermal Solution Kit
WEV301	Thermal Solution Kit with +5 V Fan
WEV302	Thermal Solution Kit with +12 V Fan
WTW002	Thermal Washer for Wxx Controllers
WHS302	Heatsink for Wxx Controllers
WXC303	+5 V Fan
WXC304	+12 V Fan
WXC305	Screw Kit

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WAVELENGTH
ELECTRONICS

QUICK CONNECT GUIDE

⚠️ TO ENSURE SAFE OPERATION OF THE WHY5640 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/

Figure 1 shows the pin layout and descriptions for the WHY5640 Temperature Controller.
Figure 2 is the Quick Connect schematic for the WHY5640.

NOTE: If you are upgrading from the WHY5640 to the WTC3243: The position of Pin 1 on the WHY5640 is reversed (or mirrored) relative to the position of Pin 1 on the WTC3243.
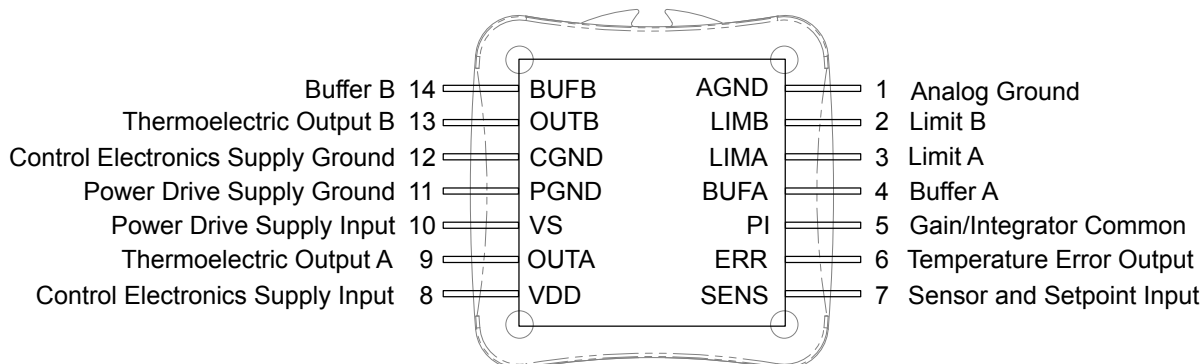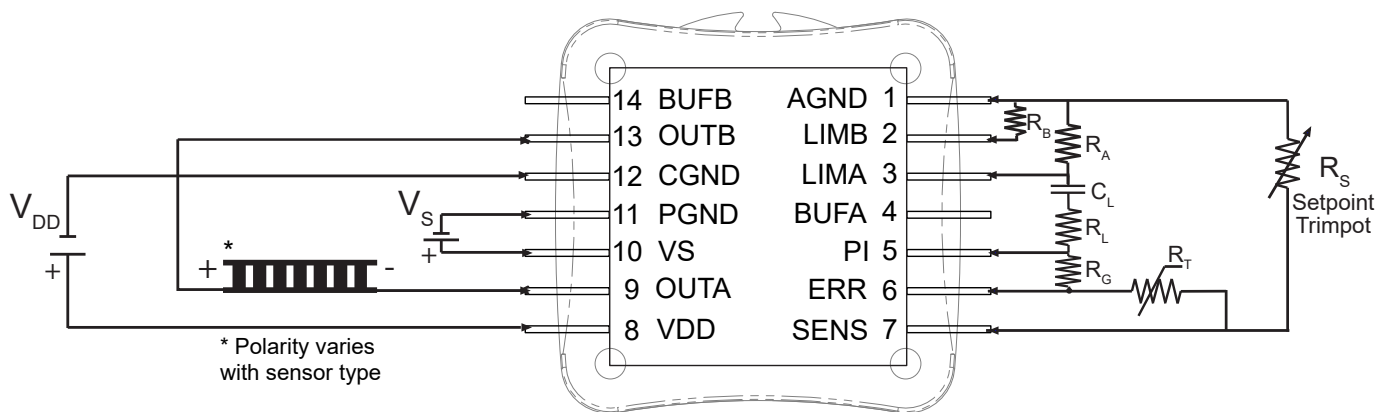

Figure 1. WHY5640 Pin Layout - Top View

Figure 2. WHY5640 Quick Connect

QUICK CONNECT LEGEND				
FUNCTION	WHY5640 Alone		WHY5640 & WHY5690 EVAL BOARD	
Current Limits	R_A & R_B	**STEP 1 on page 8**	LIM A & LIM B	**STEP 2 on page 15**
Control Parameters Proportional Gain & Integrator Time Constant	R_L	**STEP 4 on page 10**	P GAIN	**STEP 6 on page 15**
	C_L & R_G	**STEP 4 on page 10**	I TERM	**STEP 6 on page 15**
Setpoint	R_S	**STEP 3 on page 9**	R_{SET}	**STEP 7 on page 16**
Sensor	R_T	**STEP 3** on **page 9**	SENSOR+ & SENSOR-	**STEP 4 on page 15**

**NOTE:** V_S and V_{DD} may be separate supplies or a single supply.

QUICK CONNECT GUIDE, cont'd

RECOMMENDED TEST LOAD

For setup and configuration, we recommend using a test load in place of the Thermoelectric Cooler (TEC) or resistive heater, connected directly to Pin 9 and Pin 13 on the controller, as shown in **Figure 3**.

NOTE: Use a max of +5 V power supply with the test load shown. Values shown can simulate any load up to the WHY5640 maximum of 2.2 A. Always check the SOA Calculator before operating the WHY5640 controller.

Thermal Test Load   Simulated Thermistor

OUTB R_{LOAD} ERR   R1

OUTA   SENS
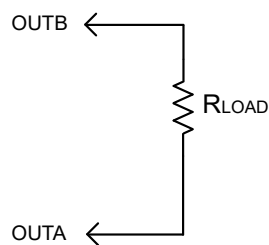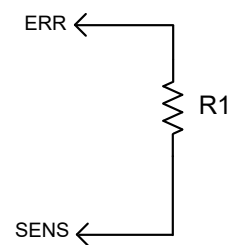
R_{LOAD} = 1 Ω, Rated >25 W   R1 = 10 kΩ, ¼ W resistor

Figure 3. Test Load Configuration

PIN DESCRIPTIONS

Table 1. WHY5640 Temperature Controller Pin Descriptions

PIN	NAME	PIN DESCRIPTION
1	AGND	**Analog Ground**. This is internally connected to Pins 11 and 12 (the power supply ground connections) and eliminates grounds loops for stable operation of the sensor amplifier bridge and limit current resistors.
2	LIMB	**Limit B**. A resistor connected between Pin 2 (LIMB) and Pin 1 (AGND) sets the maximum output current drawn from the Pin 10 (V_S) supply input and delivered to Pin 13 (OUTB). This is cooling current limit when used with NTC sensors.
3	LIMA	**Limit A**. A resistor connected between Pin 3 (LIMA) and Pin 1 (AGND) sets the maximum output current drawn from the Pin 10 (V_S) supply input and delivered to Pin 9 (OUTA). This is heating current limit when used with NTC sensors.
4	BUFA	**Buffer A**. Connect Pin 4 (BUFA) to Pin 3 (LIMA) of another WHY5640 when operating the devices in a master/booster configuration.
5	PI	**Proportional Gain and Integrator Time Constant**. When using the WHY5640 as a standard PI controller, connect one end of the proportional gain resistors R_G and R_L to Pin 5 (PI). R_L will also connect in series with C_L to Pin 3 (LIMA). R_G will also connect to Pin 6 (ERR).
6	ERR	**Temperature Error Input**. When using the WHY5640 as a standard PI controller, connect one end of the proportional gain resistor R_G to Pin 6 (ERR) and the other end to Pin 5 (PI).
7	SENS	**Sensor and Setpoint Input**. Pin 7 (SENS) is the common sensor bridge amplifier connection for the sensor, R_T, and setpoint, R_S, resistors.
8	VDD	**Control Electronics Supply Input**. Power supply input for the WHY5640's internal control electronics. Supply range input for this pin is +5 to +26 VDC.
9	OUTA	**Thermoelectric Output A**. Connect Pin 9 (OUTA) to the negative terminal on your thermoelectric when controlling temperature with Negative Temperature Coefficient thermistors. OUTA provides the heating current when using a NTC sensor. Connect Pin 9 (OUTA) to the positive thermoelectric terminal when using Positive Temperature Coefficient RTDs.
10	VS	**Power Drive Supply Input**. Provides power to the WHY5640 H-Bridge Power Stage. Supply range input for this pin is +4.5 to +30 VDC. The maximum current drain on this terminal should not exceed 2.5 A.
11	PGND	**Power Drive Supply Ground**. Connect the V_S power supply ground connection to Pin 11 (PGND). Pin 11 (PGND) and Pin 12 (CGND) are internally connected.
12	CGND	**Control Electronics Supply Ground**. Connect the V_{DD} supply ground connection to Pin 12 (CGND). Pin 12 (CGND) and Pin 11 (PGND) are internally connected.
13	OUTB	**Thermoelectric Output B**. Connect Pin 13 (OUTB) to the positive terminal on your thermoelectric when controlling temperature with Negative Temperature Coefficient thermistors. OUTB provides the cooling current when using a NTC sensor. Connect Pin 13 (OUTB) to the negative thermoelectric terminal when using Positive Temperature Coefficient RTDs.
14	BUFB	**Buffer B**. Connect Pin 14 (BUFB) to Pin 2 (LIMB) of another WHY5640 when operating the devices in a master/booster configuration.

NOTE: If you are upgrading from the WHY5640 to the WTC3243: The position of Pin 1 on the WHY5640 is reversed (or mirrored) relative to the position of Pin 1 on the WTC3243.

Table 2. WHY5690 Evaluation Board Pin Descriptions

SILKSCREEN LABEL	NAME	FUNCTION
LIMA	Limit A Trimpot	Sets the maximum output current drawn from the V_S supply input and delivered to OUTPUTA. This is heating current limit when used with NTC sensors.
LIMB	Limit B Trimpot	Sets the maximum output current drawn from the V_S supply input and delivered to OUTPUTB. This is cooling current limit when used with NTC sensors.
P GAIN	Proportional Gain	Sets the proportional gain constant for the control loop and can be adjusted to optimize the control parameters of the system using the P GAIN trimpot. Turning the trimpot counter-clockwise will increase the value, while turning it clockwise will decrease the value.
I TERM	Integrator Time Constant	Sets the integrator time constant for the control loop and can be adjusted to optimize the control parameters of the system using the I TERM trimpot. Turning the trimpot counter-clockwise will decrease the value, while clockwise will increase the value.
RSET	Setpoint Resistance Trimpot	Sets the resistance value of the thermistor at the desired operating temperature. The resistance can be monitored using the two test points (see **Figure 12**) while turning the trimpot. The RSET switch needs to be in the SET position while setting the resistance.
RSET SWITCH	Run / Set Switch	Sets whether the evaluation board is running (RUN position) or parameters are being set (SET position). When adjusting the RSET trimpot, the RSET switch must be in the SET position. Once the resistance is set, the switch can be moved to the RUN position.
SENSOR+	Sensor +	Positive connection to the sensor.
SENSOR-	Sensor -	Negative connection to the sensor.
OUTPUTA	Output A	Connect OUTPUTA to the negative terminal on your thermoelectric when controlling temperature with Negative Temperature Coefficient thermistors. OUTPUTA provides the heating current to the TEC for NTC sensors. Connect OUTPUTA to the positive thermoelectric terminal when using Positive Temperature Coefficient RTDs. Resistive heaters can be connected either way for quick connection. See **Table 8** for output configuration for maximum voltage connection.
OUTPUTB	Output B	Connect OUTPUTB to the positive terminal on your thermoelectric when controlling temperature with Negative Temperature Coefficient thermistors. OUTPUTB provides the cooling current to the TEC for NTC sensors. Connect OUTPUTB to the negative thermoelectric terminal when using Positive Temperature Coefficient RTDs. Resistive heaters can be connected either way for quick connection. See **Table 8** for output configuration for maximum voltage connection.
VS	Power Drive Supply Input	Provides power to the WHY5640 H-Bridge Power Stage. Supply range input for this pin is +4.5 to +30 VDC. The maximum current drain on this terminal should not exceed 2.5 A.
VDD	Control Electronics Supply Input	Power supply input for the WHY5640's internal control electronics. Supply range input for this pin is +5 to +26 VDC.
PGND	Power Drive Supply Ground	Connect the V_s power supply ground connection to PGND. Pin 11 (PGND) and Pin 12 (CGND) are internally connected on the WHY5640.
VM1 & VM2	Voltage Monitor 1 & 2	Provides monitor voltages referenced to the COM terminal. Externally monitor the WHY5640 setpoint resistance and the actual temperature sensor resistance levels by monitoring voltages produced from the sensor bridge circuit. VM1 and VM2 can be used to calculate the thermistor resistance using **Equation 7.**
COM	Common	Reference monitor voltages to this Common terminal. Do not connect the power supply ground to this terminal.
ENABLE ON/OFF	Enable on / off switch	Enables and disables the WHY5640 output current. The green ON LED indicator will light when the output current is enabled. ENABLE switch should be set to the OFF position when connecting power to the WHY5690 Evaluation Board.

ELECTRICAL SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS	SYMBOL	WHY5640	UNIT
Supply Voltage 1 (Voltage on Pin 8)	V_{DD}	+5 to +26	VDC
Supply Voltage 2 (Voltage on Pin 10)	V_S	+4.5 to +30	VDC
Output Current (See SOA Chart)	I_S	±2.2	A
Power Dissipation, $T_{AMBIENT}$ = +25ºC	P_{MAX}	9	W
Operating Temperature, case	T_{OPR}	-40 to +85	ºC
Storage Temperature	T_{STG}	-65 to +150	ºC

OPERATING PARAMETER TEMPERATURE CONTROL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Short Term Stability (1-hr)	T_{SET} = 25ºC using 10 kΩ thermistor	0.001	0.005	0.01	ºC
Long Term Stability (24-hr)	T_{SET} = 25ºC using 10 kΩ thermistor	0.003	0.008	0.01	ºC
CONTROL LOOP		P	PI		
P (Proportional Gain)		1		100	A / V
I (Integrator Time Constant)		0		10	sec
Setpoint vs. Actual T Accuracy			<1%		%
OUTPUT, THERMOELECTRIC					
Current, peak (see SOA chart)			±2.0	±2.2	A
Compliance Voltage, Pin 9 to Pin 13	Full Temp. Range, I_S = 100 mA	| V_S - 0.7 |	| V_S - 0.5 |		V
Compliance Voltage, Pin 9 to Pin 13	Full Temp. Range, I_S = 1 A	| V_S - 1.2 |	| V_S - 1.0 |		V
Compliance Voltage, Pin 9 to Pin 13	Full Temp. Range, I_S = 2 A	| V_S - 1.6 |	| V_S - 1.4 |		V
POWER SUPPLY					
Voltage, V_S		4.5		30	V
Voltage, V_{DD}		5		26	V
Current, V_S supply, Quiescent			45	90	mA
Current, V_{DD} supply, Quiescent			10	15	mA
INPUT					
Offset Voltage, Initial	Pins 5 and 7		1	2	mV
Bias Current	Pins 5 and 7, $T_{AMBIENT}$ = 25ºC		20	50	nA
Offset Current	Pins 5 and 7, $T_{AMBIENT}$ = 25ºC		2	10	nA
Common Mode Range	Pins 5 and 7, Full Temp. Range	0		V_{DD}-1.5	V
Common Mode Rejection	Full Temperature Range	60	85		dB
Power Supply Rejection	Full Temperature Range	60	80		dB
Input Impedance			500		kΩ
THERMAL					
Heatspreader Temperature Rise	$T_{AMBIENT}$ = 25ºC	28	30	33	ºC / W
Heatspreader Temperature Rise	With WHS302 Heatsink, WTW002 Thermal Washer	18	21.5	25	ºC / W
Heatspreader Temperature Rise	With WHS302 Heatsink, WTW002 Thermal Washer, and 3.5 CFM Fan	3.1	3.4	3.9	ºC / W
Pin Solderability Time ❶ (Solder Temperature 260ºC)			10		sec

❶ Not compatible with aqueous cleaning processes.

SAFETY INFORMATION

SAFE OPERATING AREA — DO NOT EXCEED INTERNAL POWER DISSIPATION LIMITS

To ensure safe operation of the WHY5640 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/

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 WHY5640 controller.

THERMAL MANAGEMENT KITS

The WHY5640 has many thermal management accessories. They include thermal washers, heatsinks, and fans. These products are available either as individual accessories, or bundled together in kits. The use of these thermal management accessories helps ensure that the WHY5640 will remain in the SOA during operation.

THEORY OF OPERATION

The WHY5640 is a analog Proportional, Integral (PI) control loop for use in thermoelectric or resistive heater temperature control applications. The WHY5640 maintains precision temperature regulation using an active resistor bridge circuit that operates directly with thermistors or RTD temperature sensors.

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 resistance of the sensor match the setpoint resistance, and then keep them equal in spite of changes to ambient conditions and variations in thermal load.

The controller measures the load temperature by the resistance of the sensor as well as the difference between resistances of the sensor and the setpoint resistor.

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

Once the actual sensor resistance equals the setpoint resistance, 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 — Standalone on page 8**.

- **Current limit:** Independent heating and cooling current limits avoid over-driving and damaging the TEC or heater.

- **External or Onboard temperature setpoint control:** for prototyping and benchtop applications the temperature setpoint can be adjusted with the onboard trimpot on the evaluation board. When the controller is integrated into an automated control system, the temperature setpoint can be adjusted by an external voltage signal.

- **Local Enable on WHY5690 Evaluation Board:** the controller can be configured so that the output is always on whenever power is applied to the unit.

- **Control loop:** the controller employs a smart Proportional-Integrating control loop to adjust the drive current.

OPERATING INSTRUCTIONS — STANDALONE

NECESSARY EQUIPMENT

The following equipment is required to configure the WHY5640 for basic operation.
- WHY5640 Temperature Controller
- Thermistor or other temperature sensor
- Peltier-type thermoelectric cooler or resistive heater
- Optional: test load
- Minimum 22 gauge wiring to TEC
- Power Supply (see below)
- Thermal solution kit: heatsink, thermal washer, and fan

SYSTEM DESIGN DECISIONS

Before the WHY5640 can be configured, several decisions must be made:
- What sensor is being used?
- What is the operating maximum current and maximum voltage?
- Will the system, as designed, fit within the Safe Operating Area (SOA)?

GROUNDING

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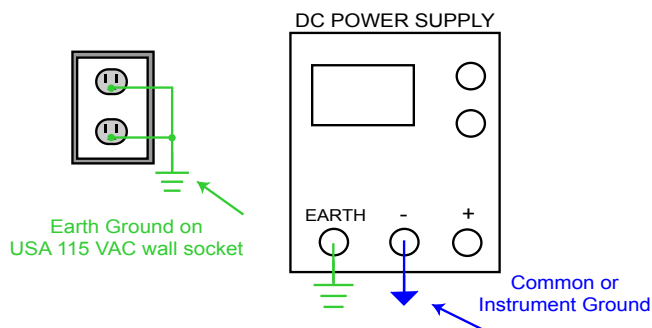
Unless Earth and Instrument Ground are connected via the power supply, Instrument Ground is floating with respect to Earth Ground

POWER SUPPLY REQUIREMENTS

The recommended operating voltage is between +5 to +26 VDC for V_{DD} and +4.5 to +30 VDC for V_S. 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 6.**

The V_{DD} power supply is used to power the WHY5640 internal control electronics and must be capable of supplying 100 mA of current. The V_S power supply is used to power the WHY5640 output H-Bridge and must be capable of supplying a current greater than the LIMA and LIMB current limit settings.

See **Figure 2** for Quick Connect Configuration Wiring.

A heatsink is required to properly dissipate heat from the WHY5640 mounting surface. Maximum internal power dissipation is 9 Watts for the WHY5640.

OPERATION WITH THERMOELECTRICS

STEP 1   Limit Output Current - Pins 1 - 3

Connect resistors or trimpots to Pins 1, 2, and 3 for fixed heating and cooling current limits or independently adjustable heating and cooling current limits. **Figure 4** shows the circuit for correct connections.
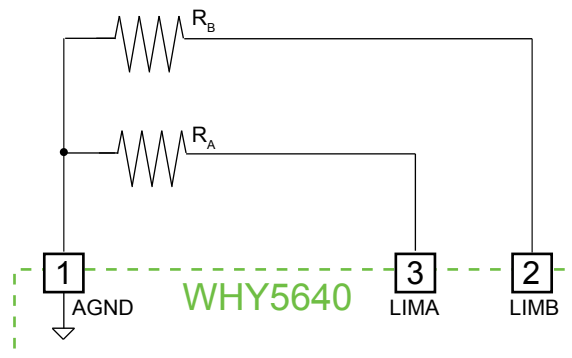

Figure 4. Fixed Heat and Cool Current Limits

Refer to **Table 3** or **Figure 5** to select appropriate resistor values for R_A and R_B.
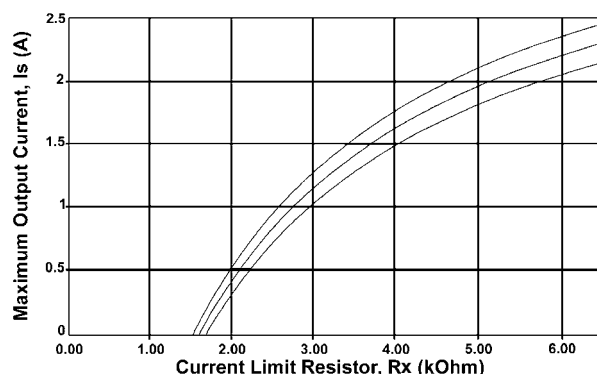

Figure 5. Resistor Value vs. Output Current

Figure 5 shows the relationship between current limit resistor R_X (either R_A or R_B) and maximum output current of the controller. **Table 3** shows these values.

Table 3. Current Limit Set Resistor vs Maximum Output Current

Maximum Output Current (Amps)	Current Limit Set Resistor (kΩ) R_A, R_B
0.0	1.60
0.1	1.69
0.2	1.78
0.3	1.87
0.4	1.97
0.5	2.08
0.6	2.19
0.7	2.31
0.8	2.44
0.9	2.58
1.0	2.72
1.1	2.88
1.2	3.05
1.3	3.23
1.4	3.43
1.5	3.65
1.6	3.88
1.7	4.13
1.8	4.42
1.9	4.72
2.0	5.07
2.1	5.45
2.2	5.88
2.3	6.36

Figure 6 shows the circuit for adjustable current limits.
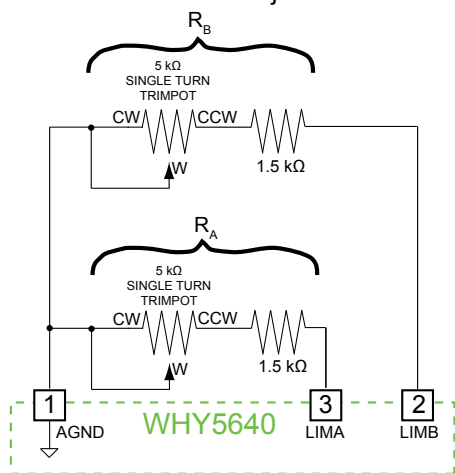
Figure 6. Independently Adjustable Heat and Cool Current Limits

STEP 2   Disabling Output Current - Pins 1 - 3

Use a Double Pole-Single Throw (DPST) switch to enable and disable the output current as shown in **Figure 7**.
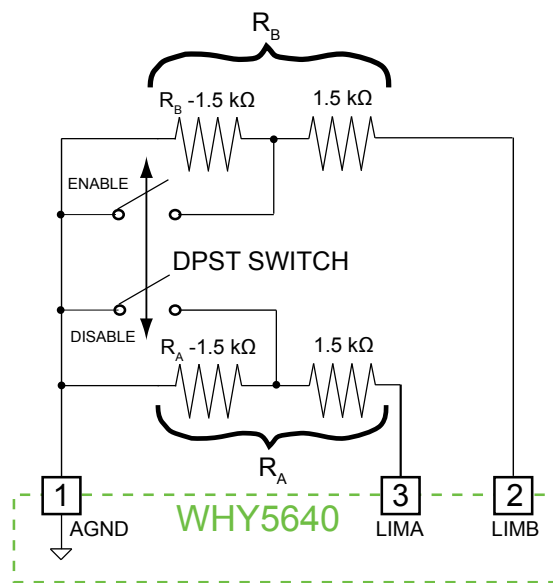

Figure 7. Enable/Disable Output Current Circuit

STEP 3   Sensors - Pins 1, 6, & 7

Use one of the sensors in the sections listed below:

SENSOR SELECTION

Select a temperature sensor that is responsive around the desired operating temperature. The temperature sensor should produce a large sensor output for small changes in temperature. Sensor selection should maximize the voltage change per ºC for best stability.

Table 4 compares temperature sensors versus their ability to maintain stable load temperatures with the WHY5640.

Table 4. Temperature Sensor Comparison of voltage change per degree Celsius

SENSOR	Thermistor	RTD	AD590	LM335
RATING	Best	Poor	Good	Good

Operating instructions for external voltage setpoint using the previously described sensors can be found in the **Additional Technical Information on page 17**.

THERMISTOR

Connect a setpoint resistor, R_S, (or trimpot) across Pins 1 (AGND) and 7 (SENS). Connect a NTC (Negative Temperature Coefficient) thermistor, R_T across Pins 6 (ERR) and 7 (SENS). **Figure 8** shows the thermistor operation circuit.
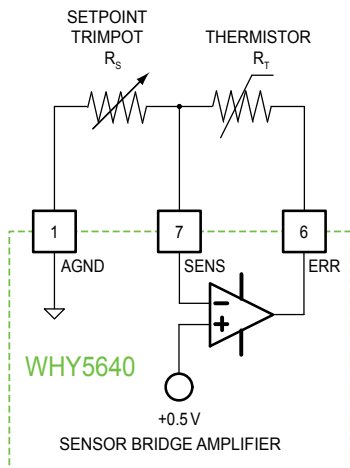
Figure 8. Thermistor Operation Circuit

Select setpoint resistor, R_S, equal to the thermistor resistance at the desired operating temperature.

When the setpoint resistor, R_S, and thermistor, R_T, are equal resistance values, the Sensor Bridge Amplifier is balanced and the voltage on Pin 6 (ERR) will equal 1 V with reference to Pin 1 (AGND).

If the setpoint resistor, R_S, is larger than the thermistor resistance, R_T, then the control loop will produce a cooling current (OUTB) since the temperature sensed by the thermistor is above (hotter than) the setpoint temperature.

If the setpoint resistor, R_S, is smaller than the thermistor resistance, R_T, then the control loop will produce a heating current (OUTA) since the temperature sensed by the thermistor is below (cooler than) the setpoint temperature.

RTDs

Figure 9 illustrates how to connect the WHY5640 for operation with PTC (Positive Temperature Coefficient) RTD sensors. Resistors, R_2, should be chosen large enough to prevent self heating of the RTD due to the current flowing through it. Most applications generally only require R_2 to be double the resistance of the RTD.
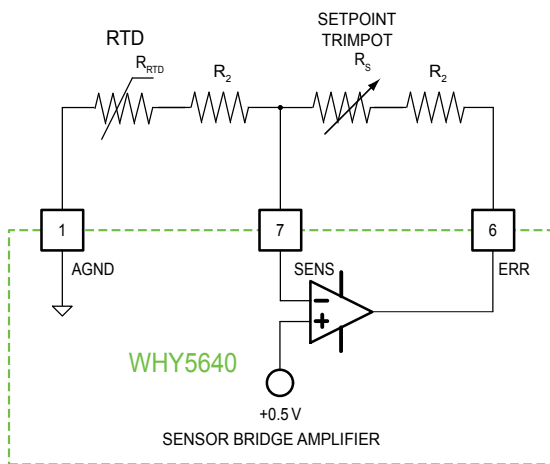

Figure 9. RTD Operation Circuit

Select setpoint resistor, R_S, equal to the RTD resistance, R_{RTD}, at the desired operating temperature.

When the setpoint resistor, R_S, and RTD, R_{RTD}, are equal in value, the Sensor Bridge Amplifier is balanced and the voltage on Pin 6 (ERR) will equal 1 V with reference to Pin 1 (AGND).

If the setpoint resistor, R_S, is larger than the RTD resistance, R_{RTD}, then the control loop will produce a heating current since the temperature sensed by the RTD is below (cooler than) the setpoint temperature.

If the setpoint resistor, R_S, is smaller than the RTD resistance, R_{RTD}, then the control loop will produce a cooling current since the temperature sensed by the RTD is above (hotter than) the setpoint temperature.

LM335s AND AD590s
Operating instructions can be found in the **Additional Technical Information on page 17**.

TEMPERATURE SENSOR MOUNTING
The temperature sensor should be in good thermal contact with the device being temperature controlled. This requires that the temperature sensor be mounted using thermal epoxy or some form of mechanical mounting and thermal grease.

Avoid placing the temperature sensor physically far from the thermoelectric. This is typically the cause for long thermal lag and creates a sluggish thermal response that produces considerable temperature overshoot.

STEP 4 Control Loop Proportional Gain & Integrator Time Constant - Pins 1, 3, 5, & 6
Adjust the control loop parameters by setting the values of the two resistors and capacitors (R_G, R_L, and C_L; refer to **page 2**). All three components interact to set the proportional gain and the integrator time constant.

Recommended values for the three components are shown in **Table 5** for common sensor and load combinations. A "fast" load can change temperature quickly; conversely a "slow" load is slower to respond to temperature change commands.

Equations for determining the proportional gain and integrator time constant are also provided in order to tune the controller to a variety of load conditions not covered in **Table 5**.

The relationship between the three components is summarized by the gain-integrator product, k_T, in **Equation 3**.

Table 5. Recommended Gain and Integrator Values

Sensor Type/ Thermal Load Speed	Gain [k_P]	Integrator Time Constant [t_C, seconds]	R_G	R_L	C_L
Thermistor / Fast	5	3	800 kΩ	1.0 MΩ	15 µF
Thermistor / Slow	20	4.5	400 kΩ	2.0 MΩ	47 µF
RTD / Fast	50	0.53	144 kΩ	1.8 MΩ	15 µF
RTD / Slow	100	1	88 kΩ	2.2 MΩ	47 µF
AD590 or LM335 / Fast	20	1	400 kΩ	2.0 MΩ	10 µF
AD590 or LM335 / Slow	50	4.5	320 kΩ	4.0 MΩ	15 µF

When calculating component values, keep in mind these points:

- As k_T becomes larger, choosing component values becomes more difficult because larger C_L values are required.
- Keep R_L as small as possible. Higher values of R_L are more noisy, and values above 4 MΩ will impact temperature control stability.
- As R_L becomes smaller, C_L must be larger. Use a non-polarized capacitor for C_L.

Use Equation 1 to calculate the Proportional Gain, k_P

$$k_P = 4 \left(\frac{R_L}{R_G} \right) \; amps / volt \qquad (1)$$

Use Equation 2 to calculate the Integrator Time Constant, t_C

$$t_C = \left(\frac{R_G C_L}{4} \right) \; seconds \qquad (2)$$

Use Equation 3 to calculate the relationship between k_P, t_C, and k_T.

$$k_T = k_P t_C \; amp \cdot seconds / volt \qquad (3)$$

Use Equations 4, 5 , and 6 to relate k_T to component values.

$$k_T = C_L R_L \; amp \cdot seconds / volt \qquad (4)$$

$$R_G = \left(\frac{4R_L}{k_P} \right) \; ohms \qquad (5)$$

$$R_G = \left(\frac{4t_C}{C_L} \right) \; ohms \qquad (6)$$

STEP 5 Fine Tuning R_G, R_L, and C_L

The R_G, R_L, and C_L component values can be fine-tuned experimentally. Start with component values from **Table 5**, and operate the temperature controller system to determine if the load temperature settling time is satisfactory. If it is not, then follow these steps to fine-tune the component values.

1. Short C_L to remove the integrator term.
2. Increase the proportional gain k_P by increasing R_L until the temperature begins to oscillate; this is the Critical Gain value of the system. Measure the period of the oscillation in seconds.
3. Decrease R_L by half.
4. Use Equation 2 to calculate R_G and C_L so that the value of t_C is slightly greater than the oscillation period measured above.

STEP 6 [OPTIONAL] Monitoring Setpoint & Actual Sensor Voltages - Pins 1, 3, 5 - 7

Configure the WHY5640 to monitor the setpoint and actual sensor voltages externally illustrated in **Figure 10**.
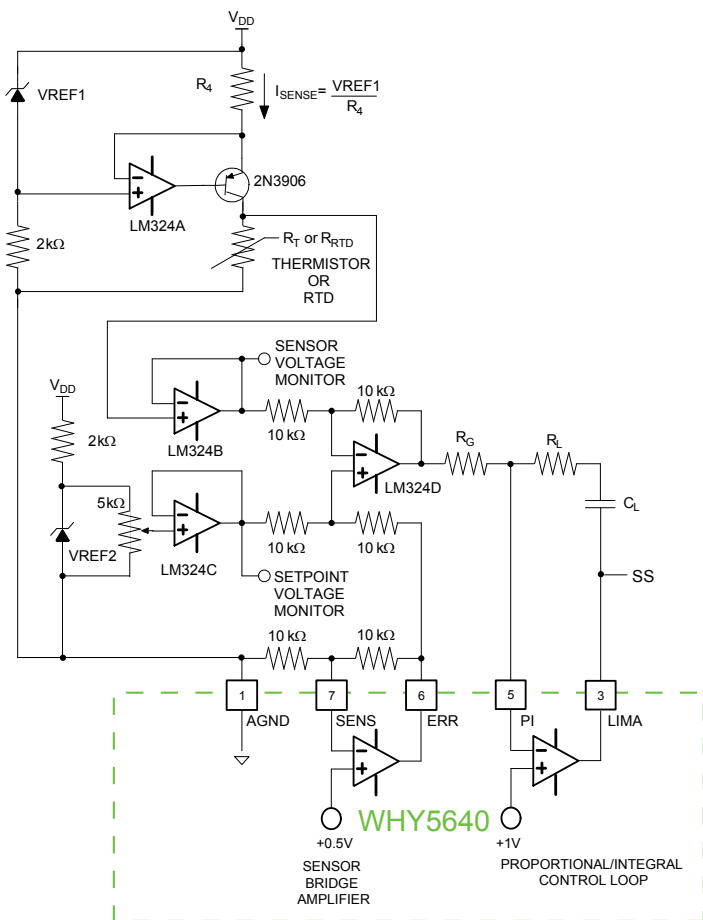

Figure 10. Monitor Setpoint and Actual Sensor Voltages Circuit

The WHY5640 internal sensor bridge amplifier becomes balanced (or Pin 6 (ERR) equals 1 V) when the sensor voltage equals the setpoint voltage in **Figure 10**.

The circuit shown in **Figure 10** uses a constant current source to produce a sensing current through the resistive temperature sensors resulting in a sensor voltage. A typical sensing current for 20 kΩ and lower thermistors is 100 µA. For thermistors higher than 20 kΩ use 10 µA. RTDs require a sensing current of 1 mA.

NOTE: PTC (Positive Temperature Coefficient) sensors such as RTD sensors, the AD590, and the LM335 require that the output Pins 9 (OUTA -) and 13 (OUTB +) be reversed from the connection diagram on page 2 (Figure 2) to produce the proper cooling and heating currents through the thermoelectric.

When using a 10K Thermistor, per **Figure 10**, connect the TEC as follows:

OUTPUT B+ → TEC +
OUTPUT A - → TEC -

OPERATION WITH RESISTIVE HEATERS

The WHY5640 can operate resistive heaters by disabling the cooling output current. When using resistive heaters with NTC thermistors, connect Pin 3 (LIMA) to Pin 1 (AGND) with a 1.5 kΩ resistor.

Connect Pin 2 (LIMB) to Pin 1 (AGND) with a 1.5 kΩ resistor when using RTDs, LM335 type and AD590 type temperature sensors with a resistive heater.

Connect the resistive heater to Pins 9 and 13 to operate.

INCREASING OUTPUT CURRENT DRIVE

The WHY5640 is specifically designed to operate in a master/booster output current boosting configuration. Two or more WHY5640 controllers can be coupled to boost the output current.

Figure 11 shows how to connect two WHY5640 controllers together to increase the output current drive to 4.4 A.

Pin 4 (BUFA) and Pin 14 (BUFB) provide buffered outputs of Pin 3 (LIMA) and Pin 2 (LIMB), respectively. The booster controller is controlled by the master controller by connecting Pin 4 (BUFA) of the master unit to Pin 3 (LIMA) of the booster unit. Similarly, Pin 14 (BUFB) of the master unit then connects to Pin 2 (LIMB) of the booster unit.

Each successive booster unit uses its buffered outputs, Pins 4 and 14, to drive the next booster units output drive section via its Pins 3 and 2. The master controller sets the current limits for all successive booster controllers connected to the master controller, requiring only one set of heat and cool limit resistors.

Use **Table 6** to determine the limit setting resistors, R_A and R_B, based on the number of WHY5640 controllers paralleled together.
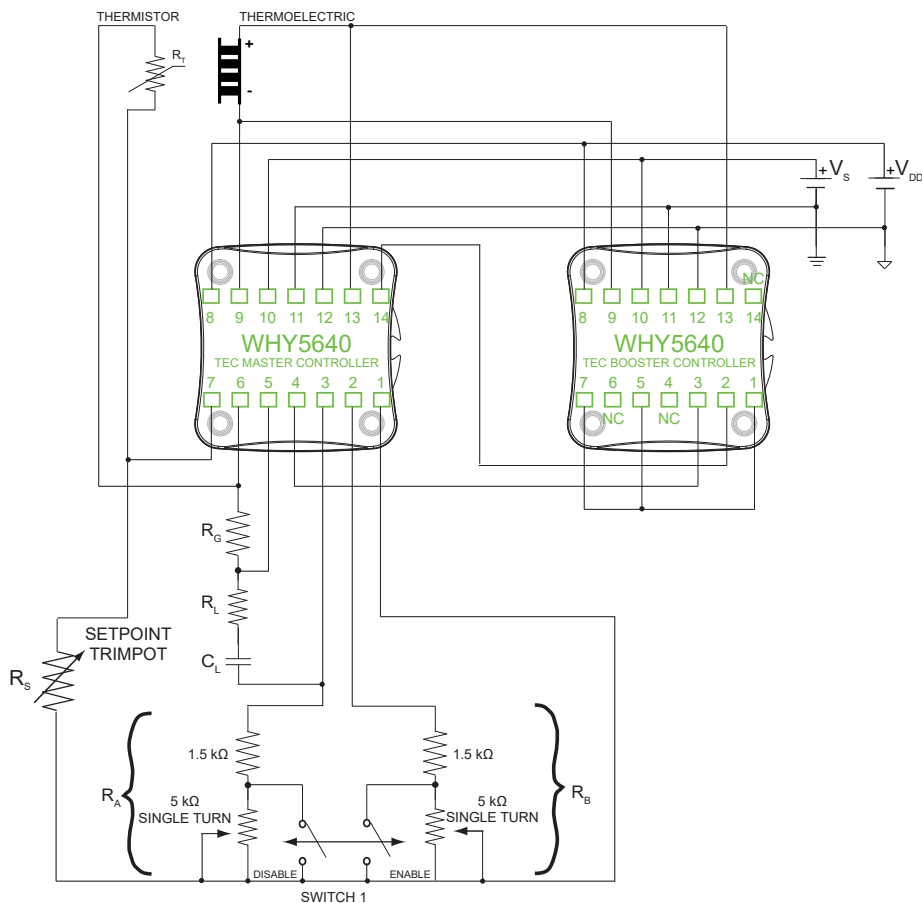
Figure 11. Boosting Output Current Drive

Table 6. Maximum Output Current (Amps) - NOTE: Do not use more than five controllers together

1 WHY5640 CONTROLLER	2 WHY5640 CONTROLLERS	3 WHY5640 CONTROLLERS	4 WHY5640 CONTROLLERS	5 WHY5640 CONTROLLERS	CURRENT LIMIT SET RESISTOR (KΩ) R_A, R_B
0	0	0	0	0	1.60
0.1	0.2	0.3	0.4	0.5	1.69
0.2	0.4	0.6	0.8	1.0	1.78
0.3	0.6	0.9	1.2	1.5	1.87
0.4	0.8	1.2	1.6	2.0	1.97
0.5	1.0	1.5	2.0	2.5	2.08
0.6	1.2	1.8	2.4	3.0	2.19
0.7	1.4	2.1	2.8	3.5	2.31
0.8	1.6	2.4	3.2	4.0	2.44
0.9	1.8	2.7	3.6	4.5	2.58
1.0	2.0	3.0	4.0	5.0	2.72
1.1	2.2	3.3	4.4	5.5	2.88
1.2	2.4	3.6	4.8	6.0	3.05
1.3	2.6	3.9	5.2	6.5	3.23
1.4	2.8	4.2	5.6	7.0	3.43
1.5	3.0	4.5	6.0	7.5	3.65
1.6	3.2	4.8	6.4	8.0	3.88
1.7	3.4	5.1	6.8	8.5	4.13
1.8	3.6	5.4	7.2	9.0	4.42
1.9	3.8	5.7	7.6	9.5	4.72
2.0	4.0	6.0	8.0	10.0	5.07
2.1	4.2	6.3	8.4	10.5	5.45
2.2	4.4	6.6	8.8	11.0	5.88
2.3	4.6	6.9	9.2	11.5	6.36

OPERATION INSTRUCTIONS – EVALUATION BOARD

WHY5640 WITH WHY5690 EVAL BOARD

Operate the WHY5640 quickly using the WHY5690. See **page 17** for mounting instructions

NECESSARY EQUIPMENT

The equipment is the same as on **page 8** with the addition of the WHY5690 Evaluation Board and a Digital multimeter, 4-½ digit resolution recommended.

SYSTEM DESIGN DECISIONS

Before the WHY5640 can be configured, several decisions must be made:
- NTC thermistor or RTD sensor?
- What is the operating maximum current and maximum voltage?
- Will the system, as designed, fit within the Safe Operating Area (SOA)?

Follow the next nine steps sequentially to safely operate the WHY5690. Complete steps 1 through 4 before applying power to the board. For online Safe Operating Area Calculations (SOA) see: https://www.teamwavelength.com/support/design-tools/soa-tc-calculator/.

Before proceeding with configuration of the WHY5640 and the WHY5690, it is critical that you verify that the controller will be within the Safe Operating Area.

To ensure safe operation of the WHY5640 Thermoelectric Controller, it is imperative that you determine that the unit will be operating within the internal heat dissipation Safe Operating Area (SOA).

STEP 1   INSTALL WHY5640 ON THE WHY5690 WITH HEATSINK AND FAN

- Match up the notch (**Figure 12**) on the WHY5640 with the silkscreen on the PCB
- Align the pins with the sockets, ensuring that all pins are lined up in their respective sockets.
- Press firmly to seat the WHY5640. **Make sure that none of the pins were bent during insertion before continuing.**
- Attach the snap-in standoffs (**Figure 15**).

See **Additional Technical Information on page 17** for further details and an assembly diagram.

The WHY5690 is designed to handle currents as high as ±2.0 A. Refer to the SOA calculator to determine proper thermal solution and operation for your application. WEV300, WEV301, and WEV302 Thermal Solutions Kits include: heatsink, thermal washer, fan (not included in WEV300), and screw fasteners.
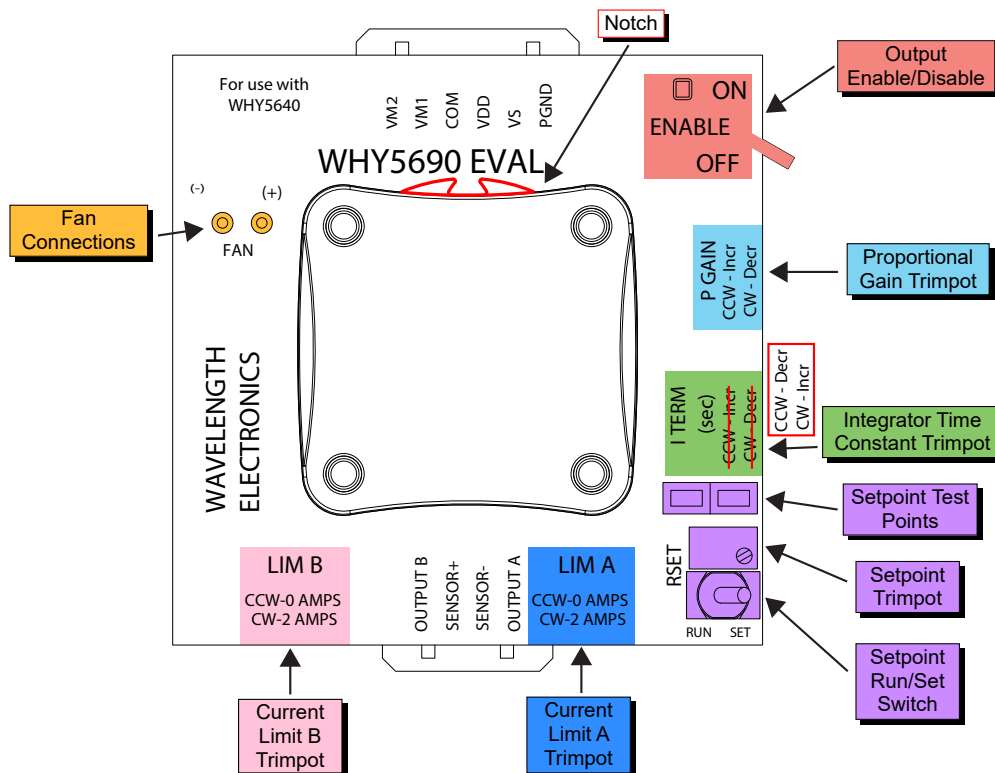

Figure 12. WHY5690 Evaluation Board Top View

STEP 2 CONFIGURE THE HEAT AND COOL CURRENT LIMITS

Adjust the current limits using the LIMA and LIMB trimpots on the WHY5690. The evaluation board's LIMA and LIMB trimpots independently adjust the heat and cool current limits from zero to a full 2.0 A. Clockwise turns will increase the limit, and counter-clockwise turns will decrease the current limit value. Use **Table 7** to adjust the heat and cool current limits. **Do not exceed SOA limits**.

Table 7. LIMA and LIMB Current Limit Trimpot Configuration

SENSOR TYPE	LOAD TYPE	LIMA TRIMPOT	LIMB TRIMPOT
Thermistor	Thermoelectric	Cool Current Limit	Heat Current Limit
Thermistor	Resistive Heater	Turn Fully CCW	Heat Current Limit

STEP 3 CONNECT THE THERMAL LOAD

Connect the WHY5690 outputs (OUTPUT A or OUTPUT B) to your thermoelectric or resistive heater using **Table 8** as a guide.

Table 8. Output Configuration

SENSOR TYPE	LOAD TYPE	OUTPUT A	OUTPUT B
Thermistor	Thermo-electric	Negative TEC Terminal	Positive TEC Terminal
Thermistor	Resistive Heater	**Quick Connection:** Simply connect the resistive heater to OUTA and OUTB. Adjust the cooling current limit to zero by turning the LIMA trimpot fully counterclockwise. **Maximum Voltage Connection:** Connect one side of the resistive heater to OUTB and the other side to the voltage source V_S.	
RTD	Resistive Heater	**Maximum Voltage Connection:** Connect one side of the resistive heater to OUTA and the other side to the voltage source V_S. NOTE: Adjust the cooling current limit to zero by turning the LIMB trimpot fully counterclockwise.	

STEP 4 CONNECT YOUR TEMPERATURE SENSOR

Connect the temperature sensor to the Sensor+ and Sensor- leads on the 4-wire output cable. The default configuration of the WHY5690 allows for operation of the board with NTC thermistors in the range of 0 - 20 kΩ.
NOTE: Contact Wavelength Electronics to use the WHY5690 with other sensors or ranges.

STEP 5 ATTACHING THE V_{DD} AND V_S POWER SUPPLIES

Ensure that the controller can be safely operated by checking the SOA Calculator website. The V_{DD} power supply is used to power the WHY5640 internal control electronics and must be capable of supplying 100 mA of current. The V_S power supply is used to power the WHY5640 output H-Bridge and must be capable of supplying a current greater than the LIMA and LIMB current limit settings. For simple operation tie V_{DD} to V_S. A separate V_S power supply allows the H-Bridge to operate at a voltage different from the 4.5 V required by the V_{DD} supply. Select V_S approximately 2.5 V above the maximum voltage drop across OUTA and OUTB to reduce the power dissipation in the WHY5640 component and minimize your heatsinking requirements. Set the ENABLE Switch to OFF before powering the WHY5640. Connect both power supplies via the PGND line in the input connector. For high impedance resistance loads, a higher voltage V_S power supply may be required.

THE COMMON (COM) TERMINAL ON THE WHY5690 IS NOT INTENDED TO ACT AS A POWER CONNECTION, BUT AS A LOW NOISE GROUND REFERENCE FOR MONITOR SIGNALS.

ONCE POWER IS CONNECTED TO THE EVALUATION BOARD, ALL CONTROL ELECTRONICS ARE POWERED, HOWEVER THERE IS NO DRIVE CURRENT AVAILABLE TO OTHER COMPONENTS UNTIL THE WHY5640 ENABLE SWITCH IS ON.

STEP 6 ADJUST THE LOOP COMPENSATION PROPORTIONAL GAIN AND INTEGRATOR TIME CONSTANT

Adjust the two trimpots named "P GAIN" and "I TERM" to change the proportional gain and integrator time constant for the control loop to optimize the control parameters of your system. The "I TERM" adjustment affects both the proportional and integrator parameters while the proportional setting affects only the proportional gain.

For a better explanation of how the I term and P term trimpots affect the parameters of the control system, see **STEP 4** on **page 10**. The I term adjusts R_G in the equations on **page 10**, while the P term adjusts R_L. C_L and R_L are both related to R_G in **Equation 5** and **Equation 6**.

STEP 7   ADJUST THE SETPOINT TEMPERATURE

Adjust the RSET trimpot to change the setpoint temperature. With the RUN/SET switch in the "SET" position, measure the resistance between the two test points next to the RSET trimpot. Adjust the RSET trimpot to change this resistance to the resistance value of the thermistor at the desired operating temperature. Once the RSET resistance is set to the desired level, return the RUN/SET switch to the "RUN" position. **Figure 12** shows the location of the RUN/SET switch and test points.

STEP 8   ENABLING AND DISABLING THE OUTPUT CURRENT

Enable and disable the WHY5640 output current using the onboard toggle switch. The output is enabled when the green ON LED indicator is lit.

NOTE: Before enabling the output, make sure the RUN/SET switch is set to the "RUN" position. When enabled with this switch in the "SET" position, the controller will run at the cooling current limit regardless of the temperature setpoint, which can cause damage to the controller or your thermal load.

STEP 9   MONITOR SETPOINT AND ACTUAL TEMPERATURE VOLTAGES

Use VM1 and VM2 to monitor voltages referenced to the COMMON terminal of the setpoint temperature and the actual temperature. The input connector includes three lines for externally monitoring the WHY5640 setpoint resistance and the actual temperature sensor resistance levels by monitor voltages produced by the sensor bridge circuit. By monitoring VM1 and VM2, you can calculate the thermistor resistance using the following equation.

$$R_T = \left(\frac{VM2-VM1}{VM1}\right)R_{SET} \qquad (7)$$

ADDITIONAL TECHNICAL INFORMATION

WHY SERIES: FAN & HEATSINK MOUNTING

To mount the WHY5640 Series to the heatsink and fan (**Figure 13**) and optional evaluation PCB, refer to the drawings and instructions below:
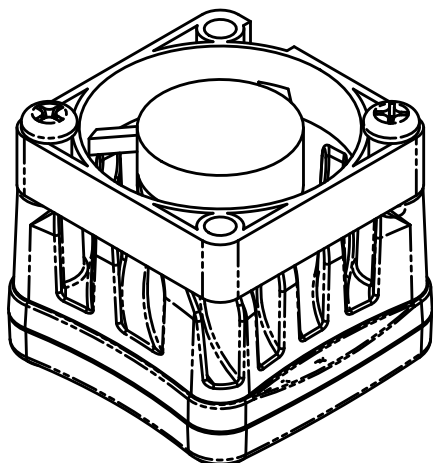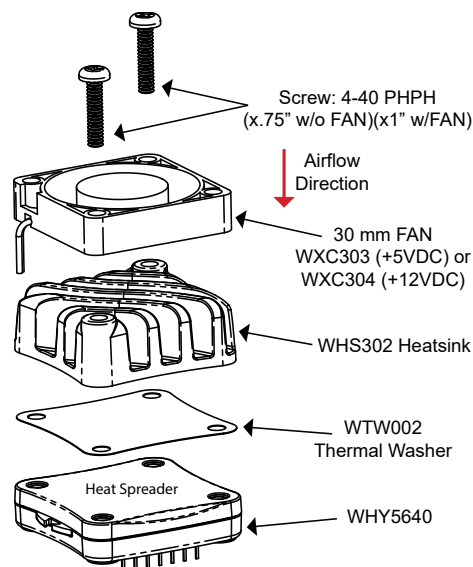

Figure 13. WHY5640 Assembled with Heatsink & Fan

ASSEMBLY INSTRUCTIONS

Refer to **Figure 14**.

- Clean all mating surfaces on the electronics module and heatsink. It is important to remove particulates and foreign materials from the mating faces.
- Apply the WTW002 Thermal Washer to the WHS302 Heatsink surface, aligning the thermal washer holes with the heatsink holes.
- Secure the WHS302 Heatsink and the WXC303/304 Fan (if used) to controller with two screws. (Actual fan wire configuration may be different than shown. Fan can be rotated on the WHY so the location of the wires matches custom PCB.)

WHY5640 and WHY5690 assembly instructions (**Figure 15**)

- Match up the notch (shown in **Figure 12**) on the WHY5640 with the silkscreen on the PCB
- Align the pins with the sockets, ensuring that all pins are lined up in their respective sockets.
- Press firmly to seat the WHY5640. **Make sure that none of the pins were bent during insertion before continuing.**
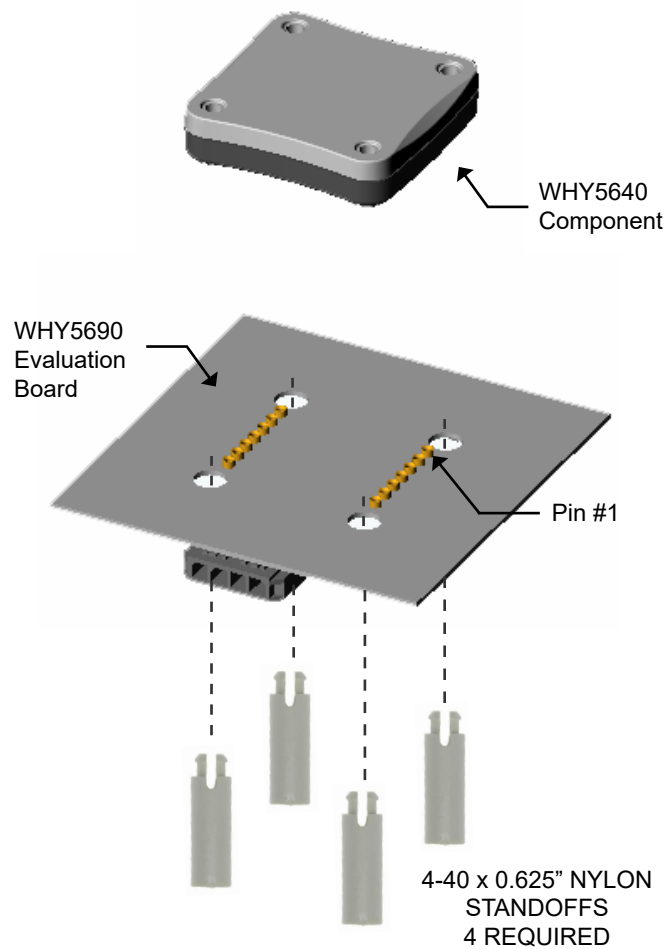- Attach the snap-in standoffs.

Figure 14. WHY5640, Heatsink, and Fan Mounting

Figure 15. WHY5640 and WHY5690 Assembly

Configuration for External Setpoint Voltage with Thermistor Sensors - Pins 1, 6, & 7

Use an external setpoint voltage to control the desired operating temperature of the WHY5640 with NTC (Negative Temperature Coefficient) thermistors. **Figure 16** illustrates an effective circuit. This setup is useful when operating the WHY5640 in a DAC controlled system.
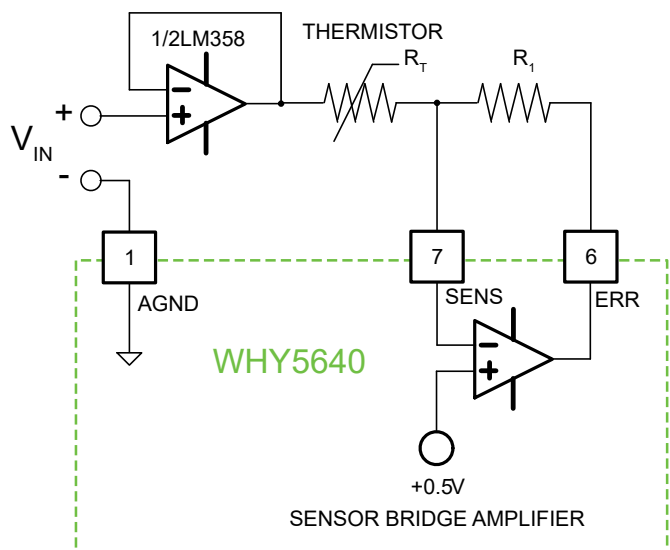

Figure 16. External Voltage Control Using Thermistor Sensors

Equation 7 illustrates how to determine the setpoint voltage, V_{IN}, given a desired thermistor resistance (temperature).

$$V_{IN} = 0.5 - \frac{R_T}{2R_1} \qquad \textbf{(8)}$$

Resistor, R_1, is a fixed resistance value that can be used to scale or adjust the setpoint voltage, V_{IN}, allowing control above and below the ambient temperature. In most applications select resistor R_1 equal to two times the desired operating thermistor resistance, R_T. For example, for a 10 kΩ thermistor operating at 25ºC, choose R_1 to be 20 kΩ.

NOTE: Pin 9 (OUTA) is the heating current sink and Pin 13 (OUTB) is the cooling current sink.

Figure 17 demonstrates an example of how to use an external voltage setpoint to control a 10 kΩ thermistor from a range of 20 kΩ to 0 kΩ.
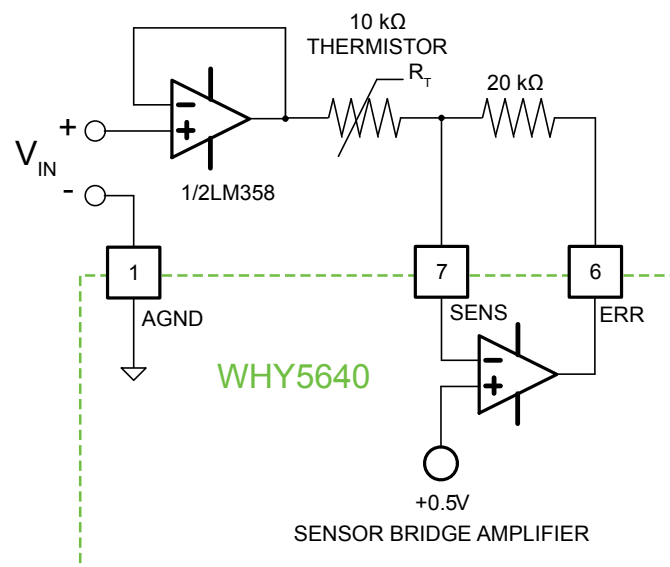

Figure 17. Example Using a 10kΩ Thermistor with External Voltage Control

Configuration for External Setpoint Voltage with RTD Sensors - Pins 1, 6, & 7

Use an external setpoint voltage to control the desired operating temperature of the WHY5640 with PTC (Positive Temperature Coefficient) RTDs. This setup is useful when operating the WHY5640 in a DAC controlled system. **Figure 18** illustrates an effective circuit.
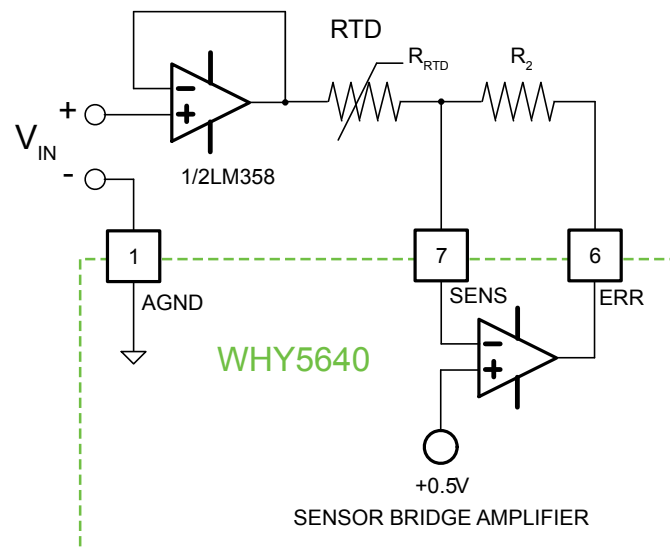

Figure 18. External Voltage Control Using RTD Sensors

Equation 8 illustrates how to determine the setpoint voltage, V_{IN}, given a desired RTD resistance (temperature).

$$V_{IN} = 0.5 - \frac{R_{RTD}}{2R_2}$$

$$\textbf{(9)}$$

Resistor, R_2, is a fixed resistance value that can be used to scale or adjust the setpoint voltage, V_{IN}, allowing control above and below the ambient temperature. In most applications select resistor, R_2, equal to two times the desired operating RTD resistance, R_{RTD}.

Figure 19 demonstrates an example of how to use an external voltage setpoint to control a 100 Ω RTD from a range of 0 Ω to 200 Ω.
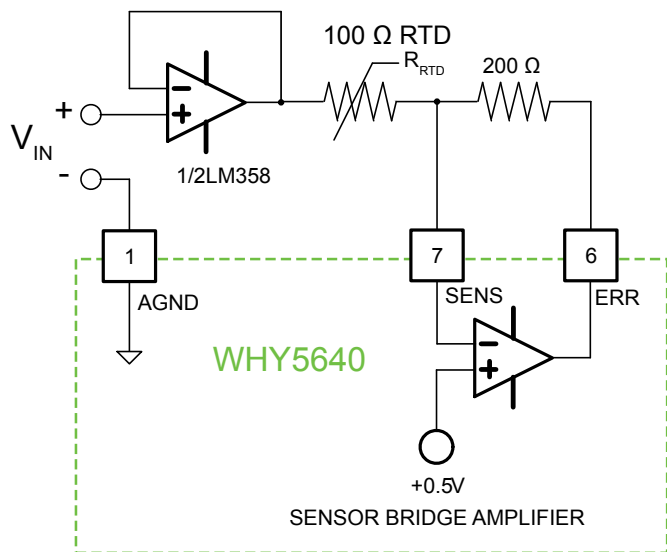

Figure 19. Example Using a 100 Ω RTD with External Voltage Control

Operation with AD590 & LM335 Sensors - Pins 1, 6, & 7

Use an AD590 and LM335 Sensor to operate the WHY5640 controller. **Figure 20** illustrates how to connect the WHY5640 for operation with PTC (Positive Temperature Coefficient) linear sensors AD590 or LM335. Choose one of the top circuits (LM335 or AD590 sensor) to use with the bottom circuit.

Equation 9 illustrates how to determine the setpoint resistance, R_S, given a desired operating temperature measured in Celsius.

$$R_S = 2R_3[0.5 - (273.15 + T_{Celsius})(1mV / K)] \qquad \textbf{(10)}$$

Resistor, R_3, is a fixed resistance value that can be used to scale or adjust the setpoint resistor, R_S. Select resistor R_3 equal to 10 kΩ for most applications.

Figure 21 demonstrates an example of how to use an AD590 to control from -50ºC to +150ºC.

Figure 22 illustrates the setpoint resistance, V_{IN}, versus AD590 temperature for the example in **Figure 21**.
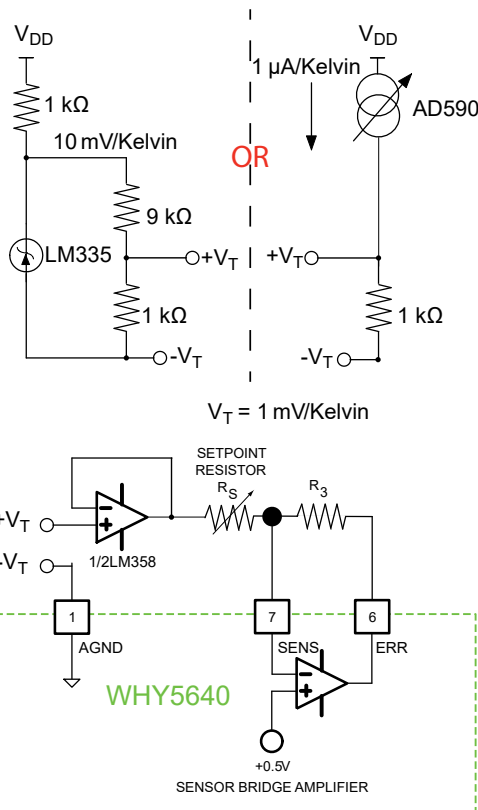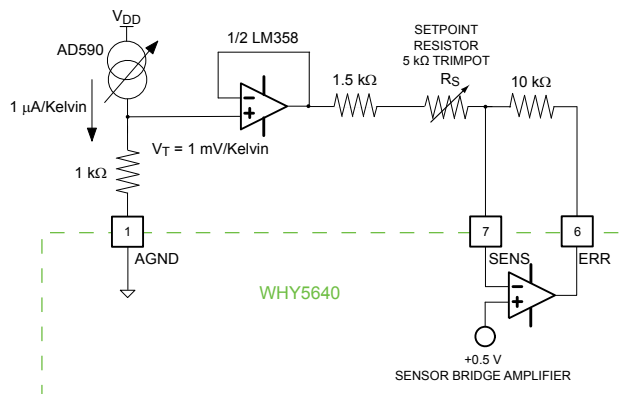

Figure 20. AD590 & LM335 Operation Circuit
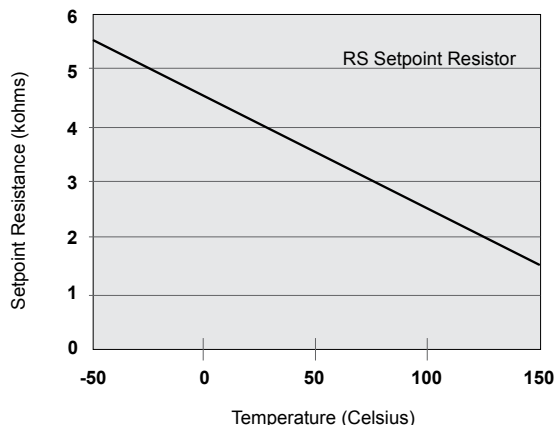

Figure 21. Example Using AD590 Sensor

Figure 22. Example Setpoint Resistance vs. AD590 Temperature

SAFE OPERATING AREA

The Safe Operating Area of the WHY5640 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/

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.

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: $V_{DROP} = V_S - V_{LOAD}$ (V_S 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_S
- Extend a diagonal line from V_S 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 WHY5640 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.

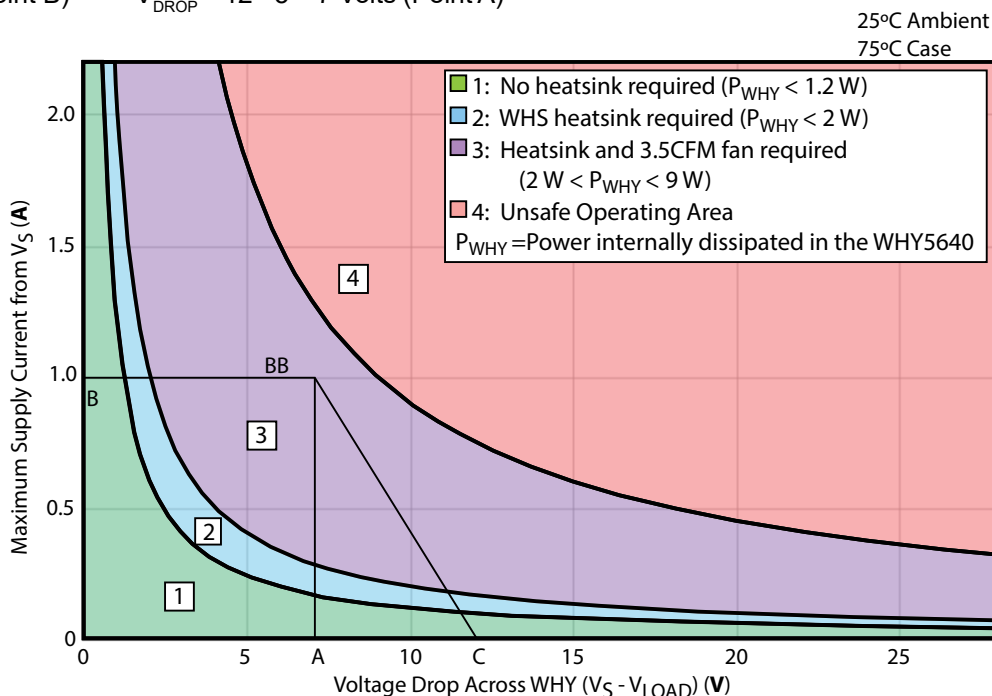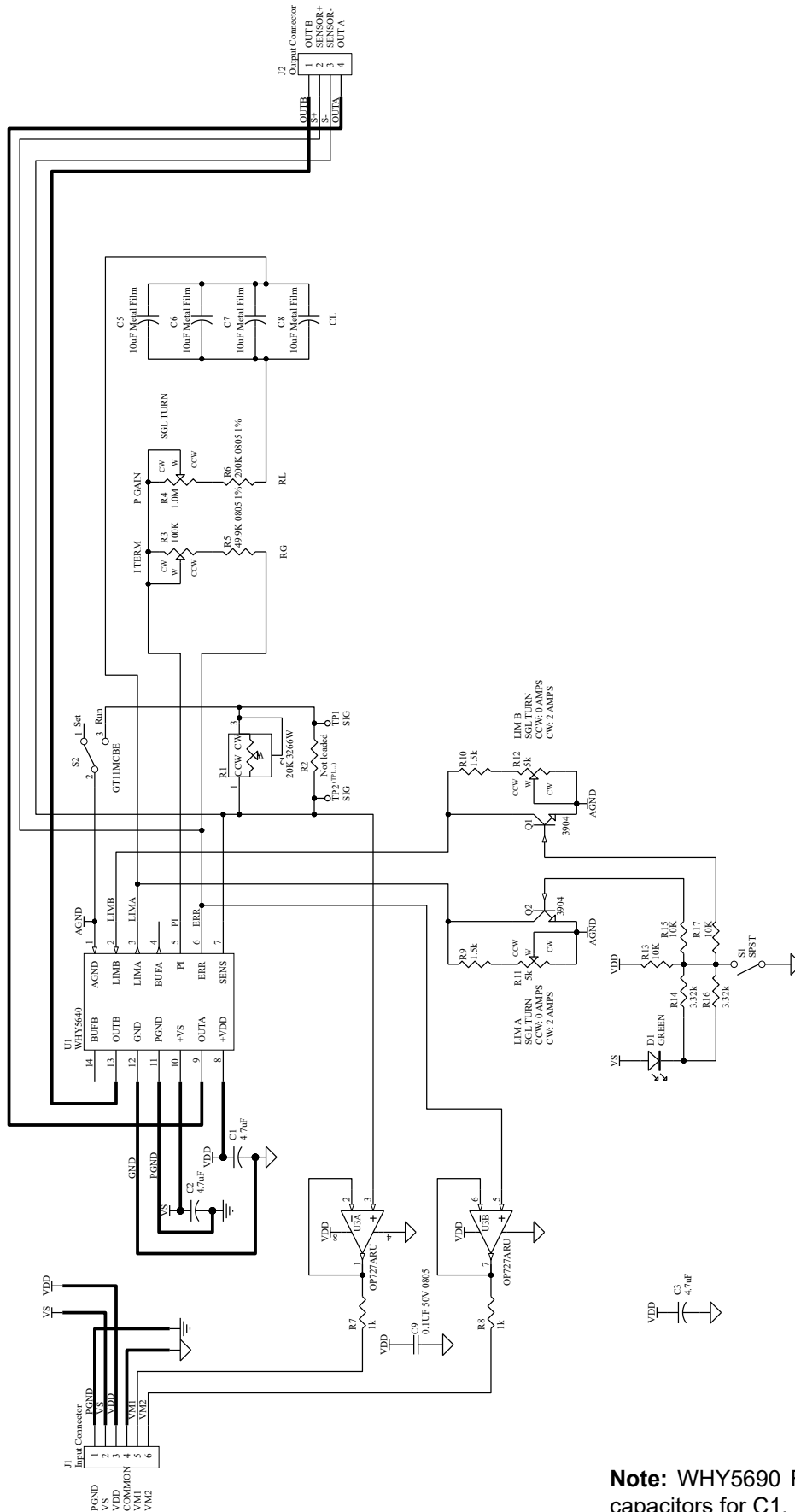An example SOA calculation for the WHY5640 with heatsink and fan is shown in **Figure 23** where:

V_S = 12 Volts (Point C) V_{LOAD} = 5 Volts
I_{LOAD} = 1 Amp (Point B) V_{DROP} = 12 - 5 = 7 Volts (Point A)

Figure 23. WHY5640 SOA

WHY5690 EVALUATION BOARD SCHEMATIC

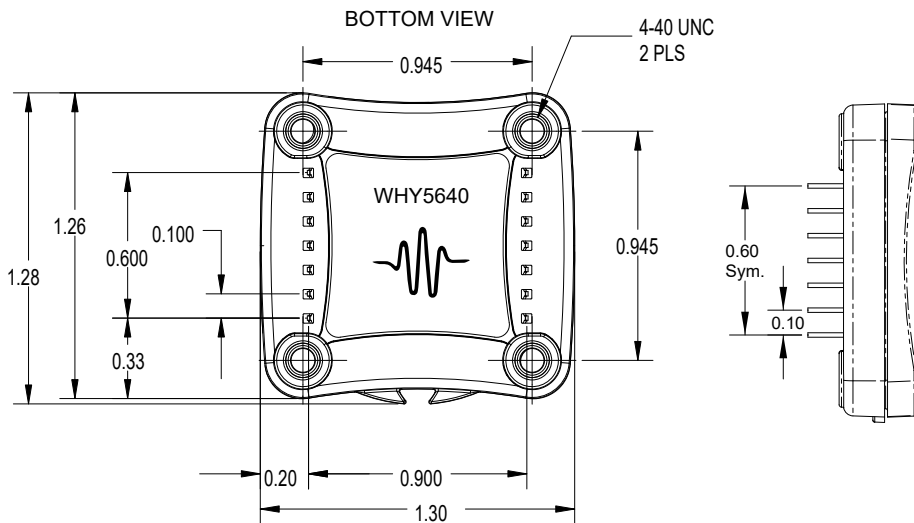**Note:** WHY5690 Revision A uses 68µF capacitors for C1, C2, and C3

TROUBLESHOOTING

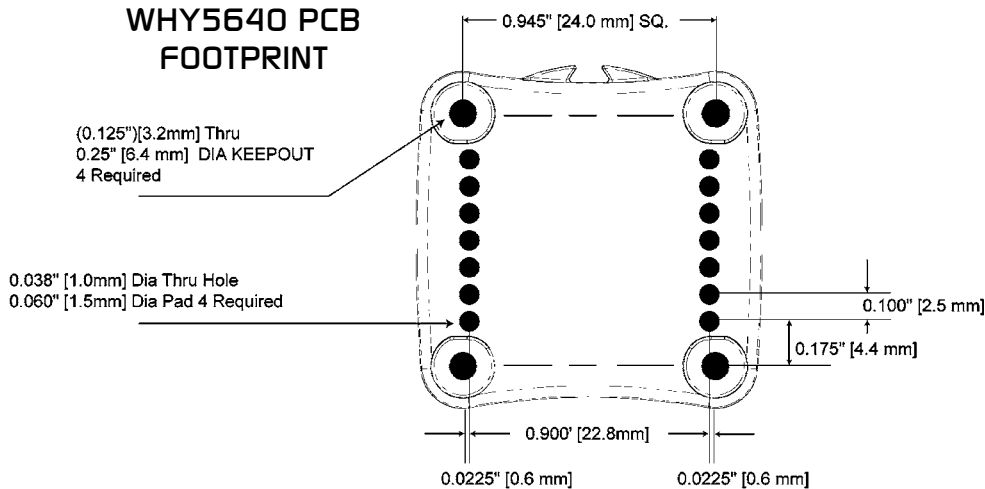| PROBLEM	POTENTIAL CAUSES	SOLUTIONS
Temperature is decreasing when it should be increasing -OR- Temperature is increasing when it should be decreasing	The TEC may be connected backwards to the WHY5640	The convention is that the red wire on the TEC module connects to TEC+ (OUTB) and the black wire to 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 WHY5640, 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 **Table 8 on page 15**).
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, and now the system is in **thermal runaway**	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 and heatsink are not adequately sized for the thermal load	The heat being generated by the load may be too great for the TEC to pump to the heatsink; a larger TEC may be needed. Consult our Technical Note *TN-TC01: Optimizing Thermoelectric Temperature Control Systems* and Application Note *AN-TC09: Specifying Thermoelectric Coolers*.
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. Contact the TEC manufacturer for recommended mounting methods.
	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 25ºC a 10 kΩ thermistor has a sensitivity of 43 mV / ºC, whereas an RTD sensor has a sensitivity of 4 mV / ºC.
	Proportional control term may be set too high	Reduce the value of the proportional term. For more information, reference our Technical Note *TN-TC01: Optimizing Thermoelectric Temperature Control Systems*.
	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: www.teamwavelength.com/support/design-tools/soa-tc-calculator/
	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.
The WHY5690 is not producing current	Improperly configured Enable ON / OFF Switch	Make sure that the Enable ON / OFF switch is set to the ON position.
	The High Limit may be turned all the way counter clockwise (CCW)	Turn the Limit trimpot (LIMA or LIMB) clockwise to adjust the current limit.
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 10ºC 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. If setting the temperature 10ºC or more above ambient is not possible, then choose a thermoelectric controller, which can alternately heat and cool the load to maintain a more precise setpoint temperature.

MECHANICAL SPECIFICATIONS

with heatsink and fan

Airflow Direction

0.07
0.40
0.48
0.01
0.31
1.27

with heatsink

0.87
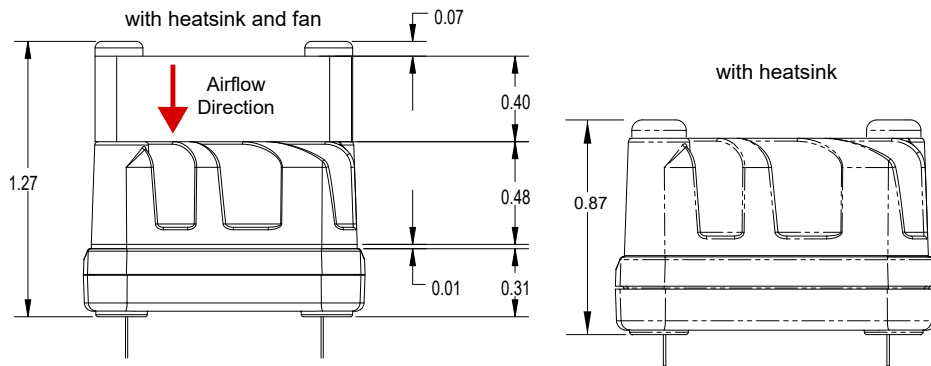
WEIGHTS	
WHY5640	0.6 oz
WHS302 Heatsink	0.5 oz
WXC303/4 Fan	0.3 oz

BOTTOM VIEW

4-40 UNC
2 PLS

0.945

WHY5640

1.26
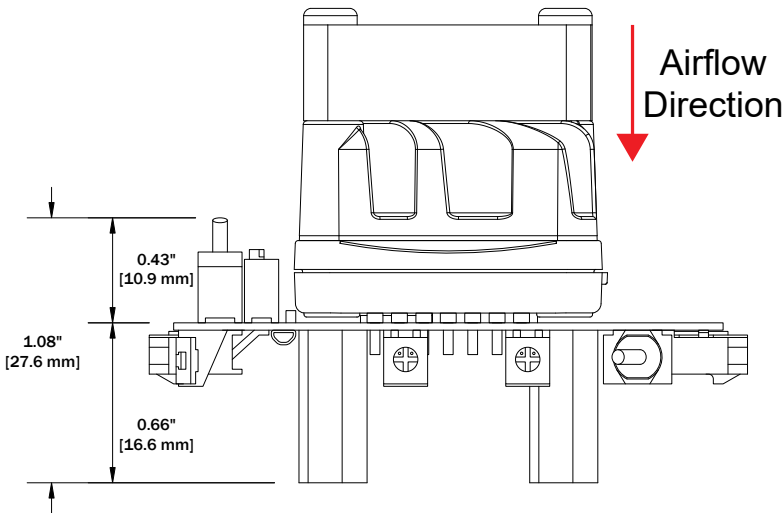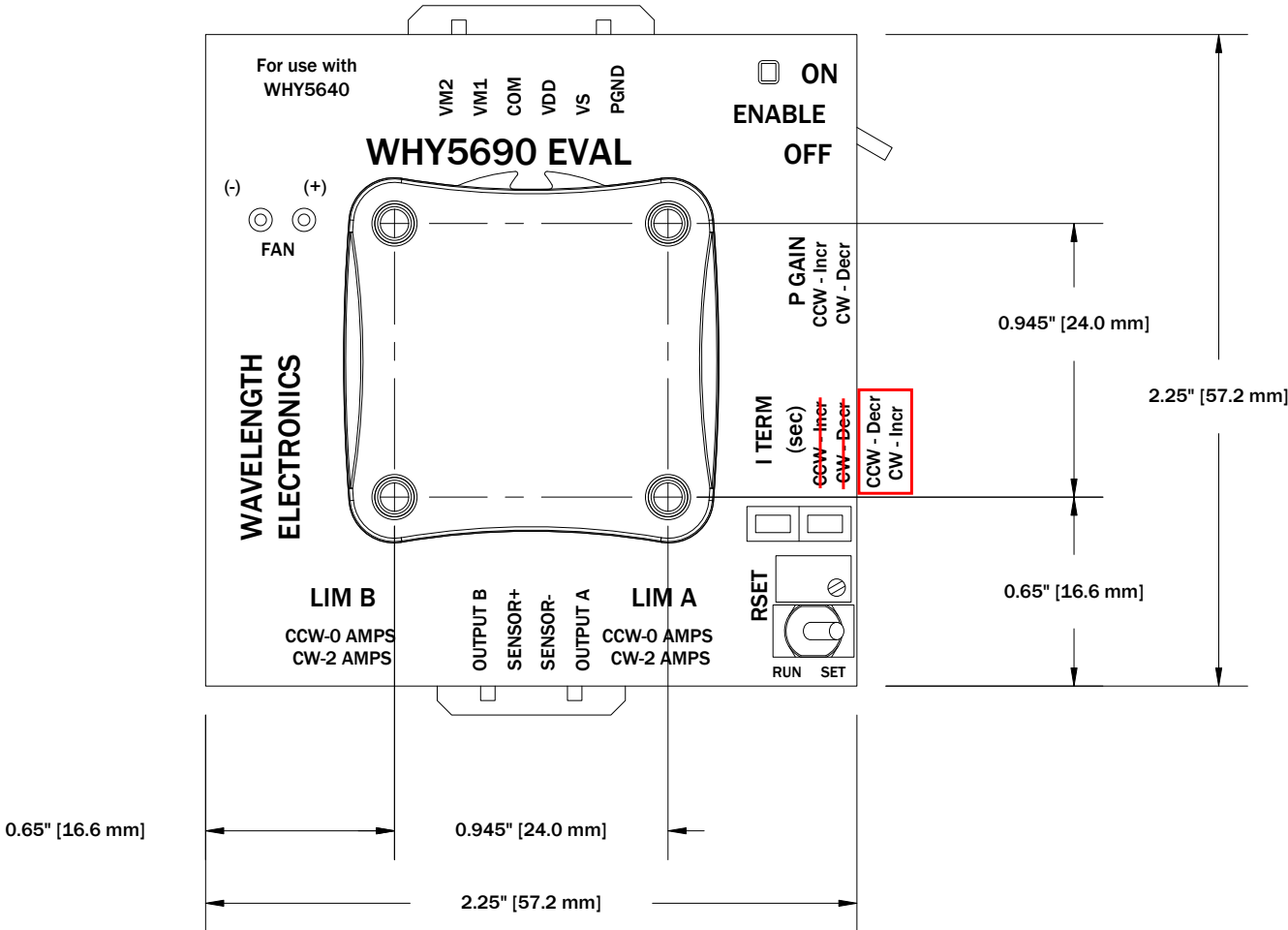1.28
0.100
0.600
0.33

0.945

0.20   0.900
1.30

0.60 Sym.
0.10

PIN DIAMETER: 0.020"
PIN LENGTH: 0.157" ±12%
PIN MATERIAL: Nickel Plated Steel
HEAT SPREADER: Aluminum with Matte
    Black E-Coat Finish
PLASTIC COVER: LCP Plastic
ISOLATION: 1200 VDC any pin to case
THERMAL WASHER: WTW002
HEATSINK: WHS320
FANS: WXC303   (+5VDC)
          or WXC304 (+12VDC)

All Tolerances are ±5%
unless noted

WHY5640 PCB FOOTPRINT

0.945" [24.0 mm] SQ.

(0.125")[3.2mm] Thru
0.25" [6.4 mm] DIA KEEPOUT
4 Required

0.038" [1.0mm] Dia Thru Hole
0.060" [1.5mm] Dia Pad 4 Required

0.100" [2.5 mm]

0.175" [4.4 mm]

0.900' [22.8mm]

0.0225" [0.6 mm]   0.0225" [0.6 mm]

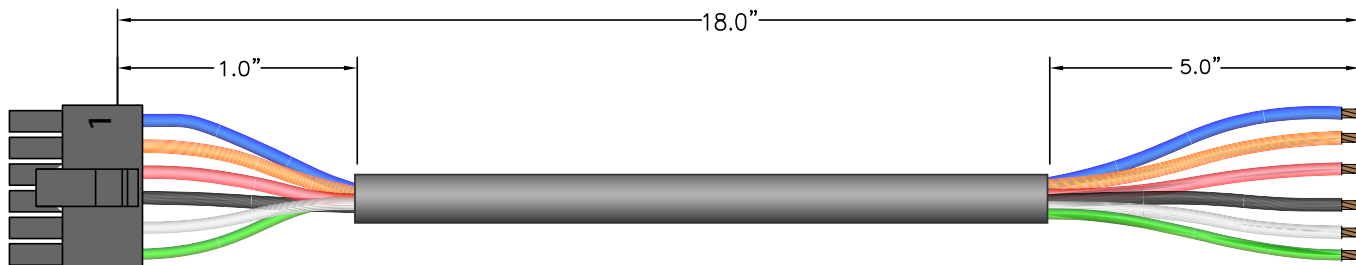## MECHANICAL SPECIFICATIONS — WHY5690 EVALUATION BOARD

All Tolerances are ±5%

CABLING SPECIFICATIONS

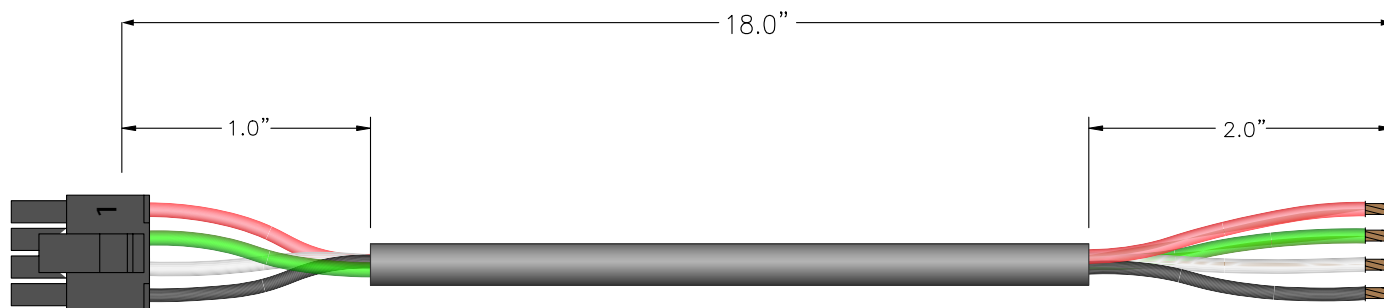These cables are included with the WHY5690 Evaluation Board.

WTC3293-00101   INPUT CABLE

MOLEX #43645-0600
MICRO-FIT 6 CIRCUIT
SINGLE ROW RECPT

PIN #	COLOR	FUNCTION
1	BLUE	PGND
2	ORANGE	VS
3	RED	VDD
4	BLACK	COM
5	WHITE	VM1
6	GREEN	VM2

WTC3293-00102   OUTPUT CABLE

MOLEX #43645-0400
MICRO-FIT 4 CIRCUIT
SINGLE ROW RECPT

PIN #	COLOR	FUNCTION
1	RED	OUTPUT B
2	GREEN	SENSOR +
3	WHITE	SENSOR -
4	BLACK	OUTPUT A

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.

REVERSE ENGINEERING PROHIBITED

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: WHY5640-00400

REV.	DATE	CHANGE
O	September 2020	Transferred to new format and combined WHY5640 & WHY5690, Updated silkscreen

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