July 2003

WTC3243

Ultrastable Temperature Controller

(BOTTOM VIEW)

GENERAL DESCRIPTION

The WTC3243 is an analog PI (Proportional, Integral) control loop hybrid circuit for use in ultrastable temperature control applications. The WTC3243 maintains precision temperature regulation using an adjustable sensor bias current and error amplifier circuit that operates directly with thermistors, RTDs, AD590 and LM335 type temperature sensors. Supply up to 2 Amps of heat and cool current to your thermoelectric from a single +5 to +12 Volt power supply. Operate resistive heaters by disabling the cooling current output.

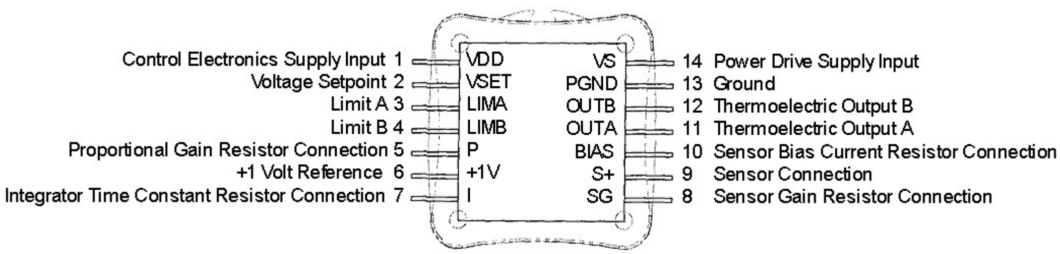
FEATURES

- Small Package (1.30” x 1.26” x 0.313”)
- Ultrastable PI Control
- High ±2 Amps Output Current
- Control Above and Below Ambient
- Voltage Controlled Setpoint
- Adjust Sensor Bias Current Source
- Adjustable Sensor Gain
- Independent Heat and Cool Current Limits

Figure 1

Top View Pin Layout and Descriptions

TOP VIEW



IF YOU ARE UPGRADING FROM THE WHY5640: The position of Pin 1 on the WHY5640 is reversed relative to the position of Pin 1 on the WTC3243.

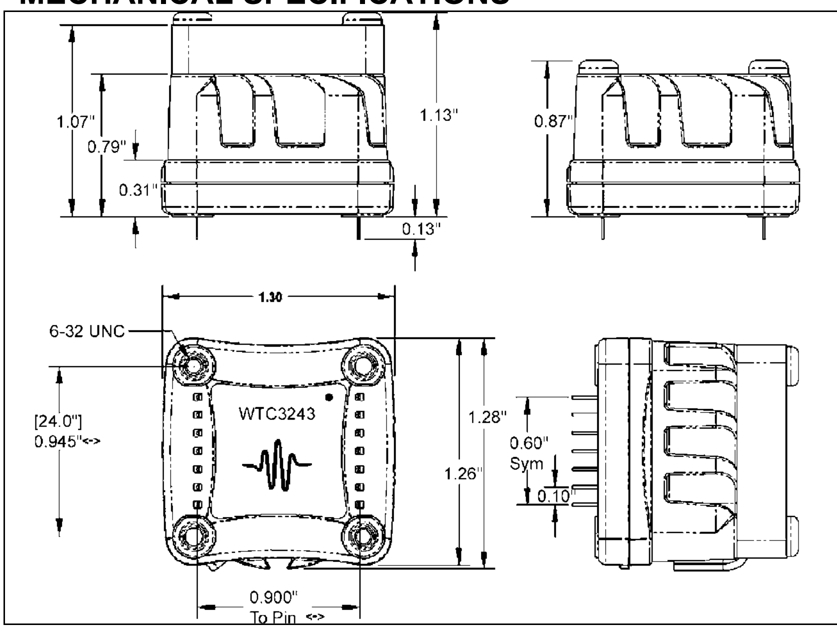
ABSOLUTE MAXIMUM RATINGS		SYMBOL	VALUE	UNIT
Supply Voltage 1 (Voltage on Pin 1)		V_{DD}	+4.5 to +30	Volts DC
Supply Voltage 2 (Voltage on Pin 14)		V_S	+4.5 to +30	Volts DC
Output Current	**(Refer to Datasheet SOA Chart)**	I_{OUT}	±2.5	Amps
Operating Temperature, case		T_{OPR}	-40 to +85	°C
Storage Temperature		T_{STG}	-65 to +150	°C

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Stability, 1 Hour	T_{SET} = 25°C using 10kΩ Thermistor	0.001	0.005	0.010	°C
Stability, 24 Hour	T_{SET} = 25°C using 10kΩ Thermistor	0.003	0.008	0.010	°C
Proportional Gain		1		100	A/V
Integrator Time Constant		0.75		4.5	Sec.
Setpoint Accuracy	T_{SET} = 25°C using 10kΩ Thermistor		<1%		
Output Current	Requires Heatsink and Fan	±2	±2.2	±2.5	Amps
Compliance Voltage	Full. Temp Range, I_{OUT} = 2.0 Amps	$\|V_s - 3.3\|$	$\|V_s - 2.6\|$		Volts
Supply Voltage, V_{DD}		4.5		28	Volts
Supply Voltage, V_S		4.5		28	Volts

PIN DESCRIPTIONS

PIN #	PIN	FUNCTION
1	VDD	Control Electronics Power Supply Input – Connect +4.5V to +28V from pin 1 to pin 13
2	VSET	Voltage Setpoint – Apply a voltage from pin 2 to pin 13 to adjust the control temperature
3	LIMA	Limit A – Place a resistor from pin 3 to pin 13 to limit the output current drawn into pin 11 (OUTA)
4	LIMB	Limit B – Place a resistor from pin 4 to pin 13 to limit the output current drawn into pin 12 (OUTB)
5	P	Proportional Gain – Place a resistor from pin 5 to pin 6 to adjust the P GAIN setting
6	+1V	+1 Volt – A reference output used with pin 5 and pin 7
7	I	Integrator Time Constant – Place a resistor from pin 7 to pin 6 to adjust I TERM setting
8	SG	Sensor Gain – Place a resistor from pin 8 to pin 13 to adjust the sensor gain
9	S+	Sensor Connection – Connect the temperature sensor from pin 9 to pin 1
10	BIAS	Sensor Bias Current – Place a resistor from pin 10 to pin 13 to adjust the sensor bias current
11	OUTA	Output A – Negative thermoelectric connection when using thermistors, positive thermoelectric connection for all other sensors
12	OUTB	Output B – Positive thermoelectric connection when using thermistors, negative thermoelectric connection for all other sensors
13	GND	Ground – Wire ground connections to pin 13 separately
14	VS	Power Drive Supply Input – Connect +4.5V to +28V from pin 14 to pin 13

MECHANICAL SPECIFICATIONS



Material Information

PIN DIAMETER: 0.028”
PIN LENGTH: 0.126”
PIN MATERIAL: Nickel Plated Steel
HEAT SPREADER: Nickel Plated Aluminum

PLASTIC COVER: LCP Plastic

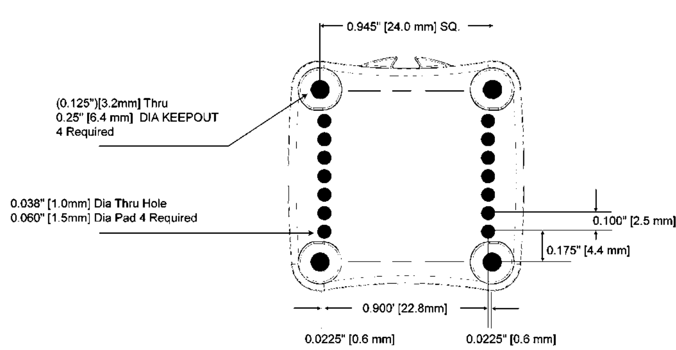
ISOLATION: 1200 VDC any pin to case

THERMAL WASHER: WTW002

HEATSINK: WHS302

FANS: WXC303 (+5VDC)
or WXC304 (+12VDC)

PCB Footprint



Caution:

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

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

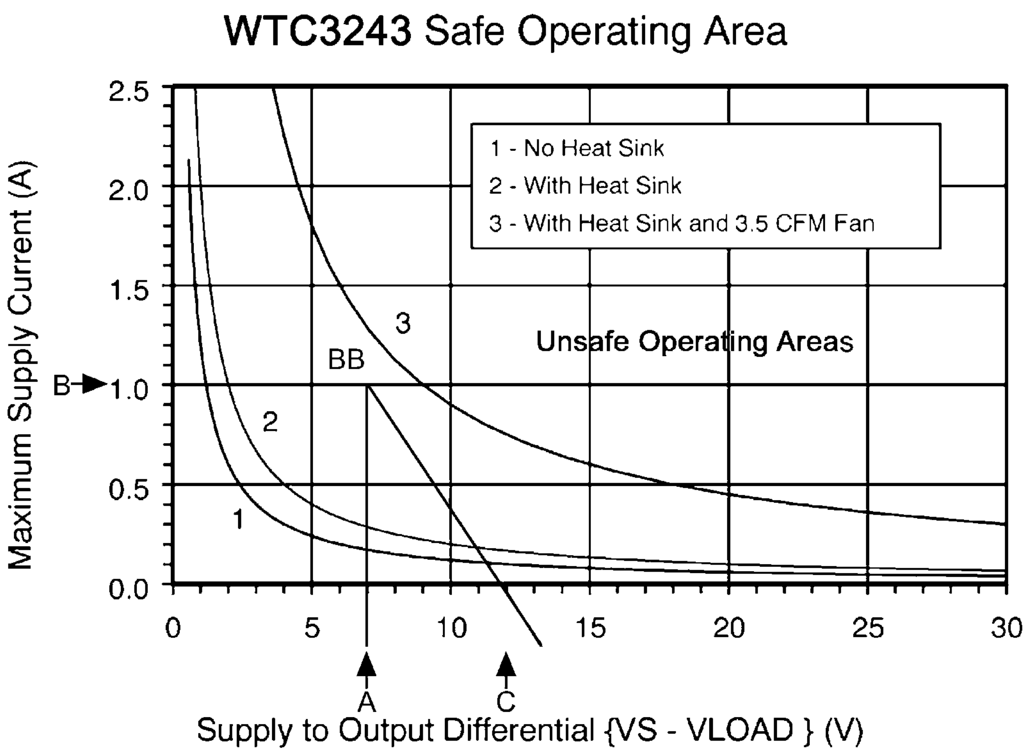
Vs = 12 volts
Vload = 5 volts
ILoad = 1 amp

} These values are determined from the specifications of the TEC or resistive heater.

Follow these steps:

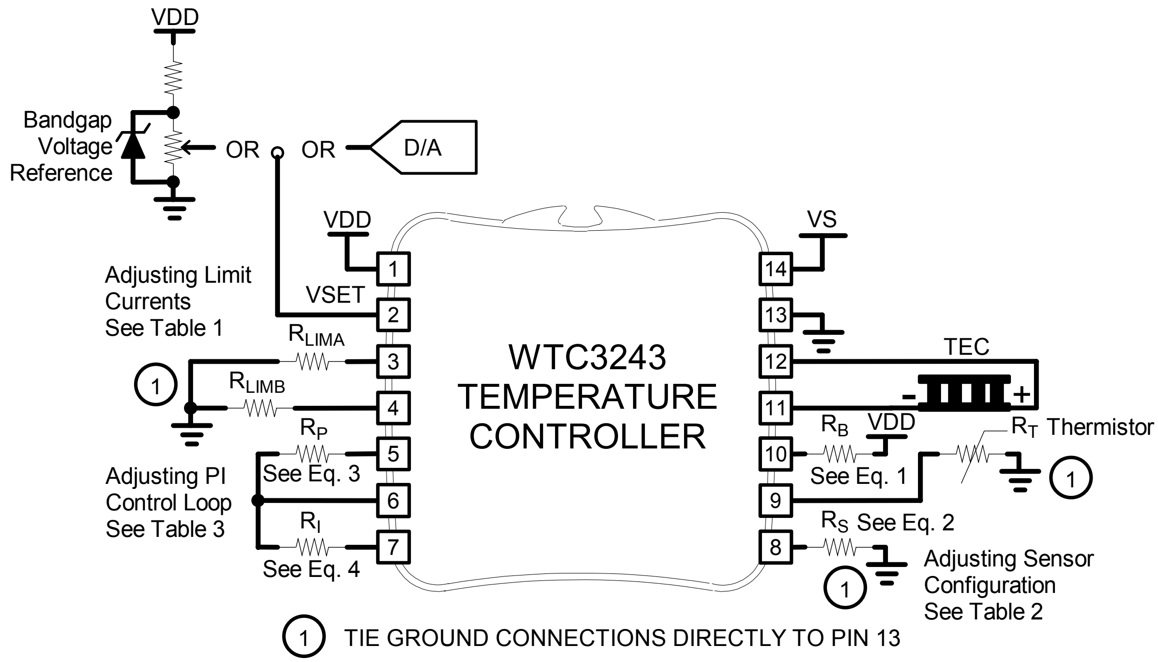
1. Determine the maximum voltage drop across the controller, Vs – Vload , and mark on the X axis. (12 volts – 5volts = 7 volts, Point A)
2. Determine the maximum current, Iload, through the controller and mark on the Y axis: (1amp, Point B)
3. Draw horizontal line through Point B across the chart (Line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

Refer to the chart shown below and note that the Load Line is the Unsafe Operating Areas for use with no heatsink (1) or the heatsink alone (2), but is outside of the Unsafe Operating Area for use with heatsink and Fan (3).

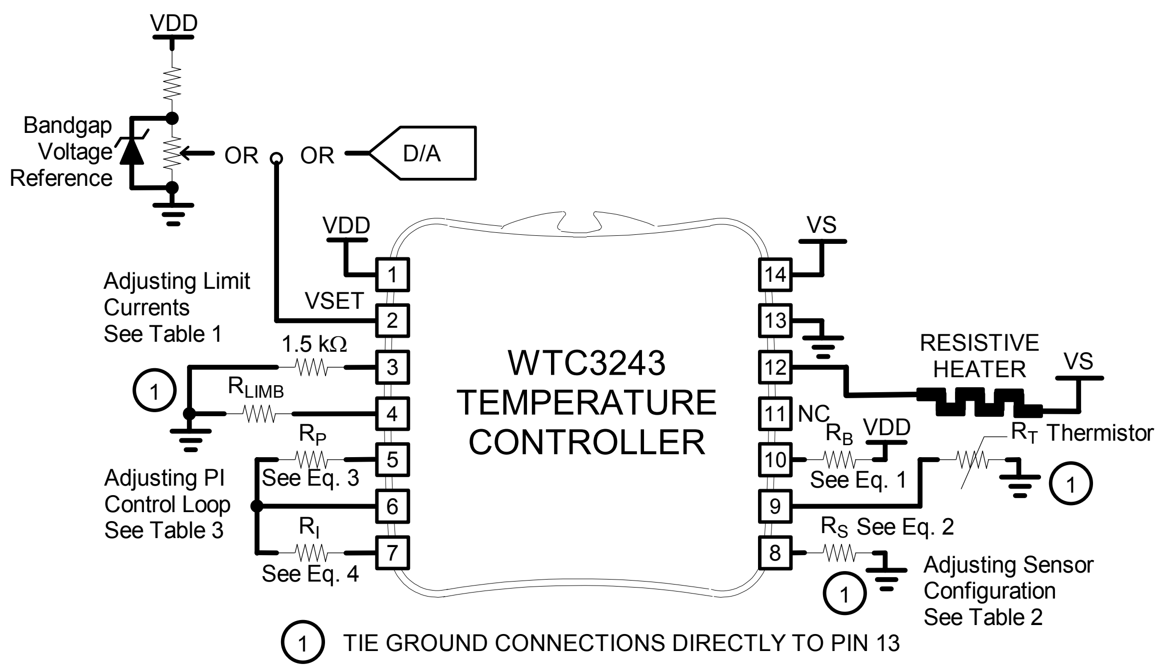


CONNECTION DIAGRAMS

THERMISTOR / THERMOELECTRIC OPERATION – TOP VIEW



THERMISTOR / RESISTIVE HEATER OPERATION – TOP VIEW



IF YOU ARE UPGRADING FROM THE WHY5640:

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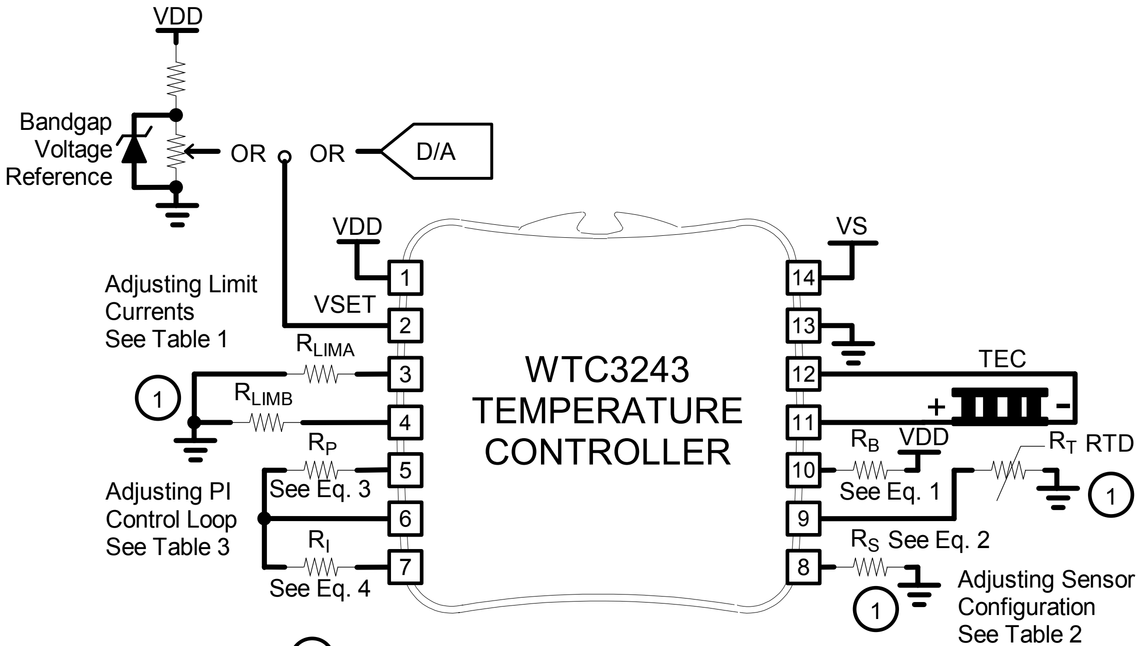
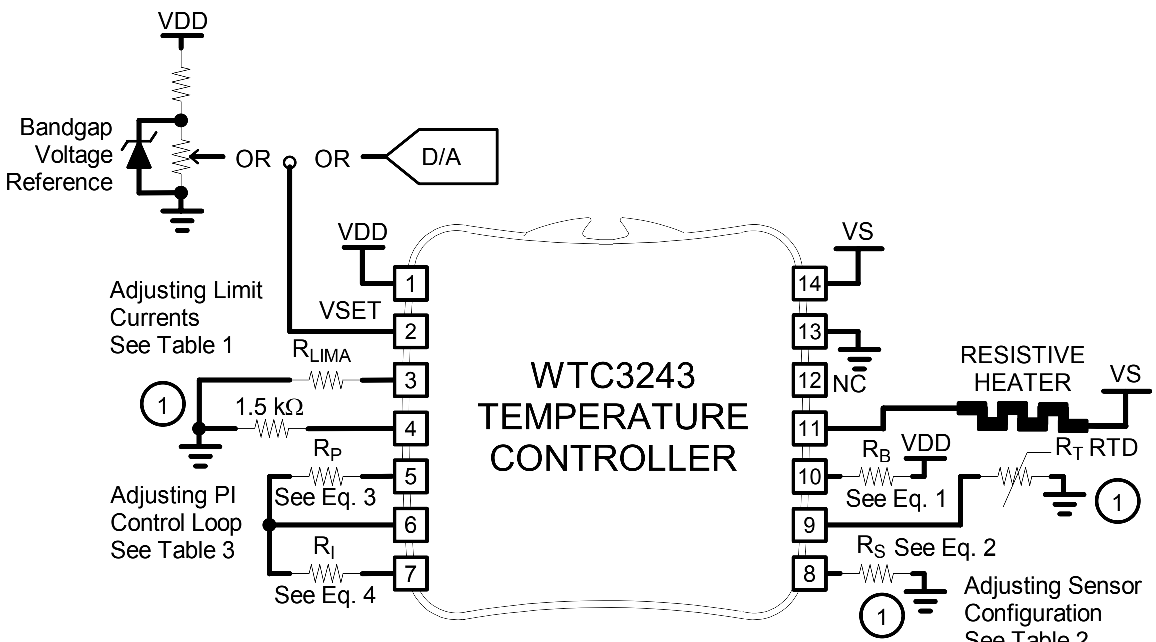
CONNECTION DIAGRAMS

RTD / THERMOELECTRIC OPERATION – TOP VIEW



(1) TIE GROUND CONNECTIONS DIRECTLY TO PIN 13

RTD / RESISTIVE HEATER OPERATION – TOP VIEW



(1) TIE GROUND CONNECTIONS DIRECTLY TO PIN 13

IF YOU ARE UPGRADING FROM THE WHY5640:

The position of Pin 1 on the WHY5640 is reversed (or mirrored) relative to the position of Pin 1 on the WTC3243.

See WTC3243 Datasheet for more information on other sensor connection diagrams.

Table 1 – Current Limit Set Resistor R_{LIM} vs Maximum Output Current

Maximum Output Current (Amps)	Current Limit Set Resistor, R_{LIM} (kΩ)	Maximum Output Current (Amps)	Current Limit Set Resistor, R_{LIM} (kΩ)
0	1.6	1.2	3.05
0.1	1.69	1.3	3.23
0.2	1.78	1.4	3.43
0.3	1.87	1.5	3.65
0.4	1.97	1.6	3.88
0.5	2.08	1.7	4.13
0.6	2.19	1.8	4.42
0.7	2.31	1.9	4.72
0.8	2.44	2	5.07
0.9	2.58	2.1	5.45
1	2.72	2.2	5.88
1.1	2.88	2.3	6.36

Table 2 – Sensor Configuration

Sensor Type	R_{BIAS}	I_{BIAS}	R_S	Sensor Gain
2.252 kΩ Thermistor	2 kΩ	1 mA	Open	1
5 kΩ Thermistor	10 kΩ	200 μA	Open	1
10 kΩ Thermistor	20 kΩ	100 μA	Open	1
20 kΩ Thermistor	40 kΩ	50 μA	Open	1
50 kΩ Thermistor	100 kΩ	20 μA	Open	1
100 kΩ Thermistor	200 kΩ	10 μA	Open	1
500 kΩ Thermistor	1 MΩ	2 μA	Open	1
100 Ω Platinum RTD	2 kΩ	1 mA	Short	10
1 kΩ Platinum RTD	2 kΩ	1 mA	Open	1
LM335	2 kΩ	1 mA	Open	1
		R_{BIAS}		
AD590	Open	10 kΩ	Open	1

Table 3 – PI Control Loop Configuration

P Gain [A/V]	R_P	I Term [Sec]	R_I	Sensor / Load Type
20	24.9 kΩ	4.5	20 kΩ	Thermistor / Slow
5	4.99 kΩ	3	33.3 kΩ	Thermistor / Fast
100	Open	1	300 kΩ	RTD / Slow
50	100 kΩ	0.75	Open	RTD / Fast
50	100 kΩ	4.5	20 kΩ	LM335, AD590 / Slow
20	24.9 kΩ	1	300 kΩ	LM335, AD590 / Fast

Equation 1 – Calculating R_{BIAS}

$$R_{BIAS} = \frac{2}{I_{BIAS}}[\Omega]$$; I_{BIAS} = Sensor Bias Current

Equation 2 – Calculating R_S

$$R_S = \left(\frac{90{,}000}{(G_{SENSOR} - 1)} - 10{,}000\right)[\Omega]$$; G_{SENSOR} = Sensor Gain

Equation 3 – Calculating R_P

$$R_P = \left(\frac{100{,}000}{\frac{100}{P} - 1}\right)[\Omega]$$; P = Proportional Gain

Equation 4 – Calculating R_I

$$R_I = \left(\frac{100{,}000}{\frac{4}{3} I_{TC} - 1}\right)[\Omega]$$; I_{TC} = Integrator Time Constant

Selecting a Temperature Sensor
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 8C for best stability.

Following table compares temperature sensors versus their ability to maintain stable load temperatures with the WTC3243.

Sensor	Thermsitor	RTD	AD590	LM335
Rating	Best	Poor	Good	Good

Mounting the Temperature Sensor
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.

Hint: Resistive temperature sensors and LM335 type temperature sensors should connect their negative termination directly to Pin 13 (GND) to avoid parasitic resistances and voltages effecting temperature stability and accuracy.

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

Mounting the Thermoelectric
The thermoelectric should be in good thermal contact with its heatsink and the device being temperature controlled. Contact your thermoelectric manufacturer for their recommended mounting methods.

Heatsink Notes
If your device stabilizes at temperature but then drifts away from the setpoint temperature towards ambient, you are experiencing a condition known as thermal runaway. This is caused by an insufficient heat removal from the thermoelectric's hot plate and is most commonly caused by an undersized thermoelectric heatsink.

Ambient temperature disturbances can pass through the heatsink and thermoelectric and affect the device temperature stability. Choosing a heatsink with larger mass will improve temperature stability.

Reducing Noise

The WTC3243 case is isolated from ground. By grounding the case the overall signal to noise ratio can be maximized.

If fan is used to dissipate the heat produced by the WTC3243, the power supplies can be separated to eliminate the noise produced by the fan.

The power supply selected should be linear and have a ripple and noise specification of less than 5mV.

Application Notes:

For more helpful information and application notes may go to our website at:

www.teamwavelength.com

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

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For warranty service or repair, this product must be returned to the factory. 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. However, the Buyer shall pay all shipping charges, duties, and taxes for products returned to Wavelength from another country.

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