May, 2014

WTC3293-14001

WTC3243 Thermoelectric Temperature Controller Board with Display

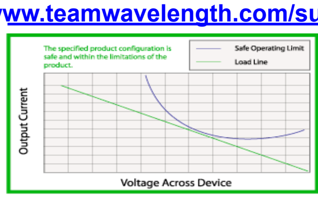

WTC3243 INCLUDED
WEV301 INCLUDED

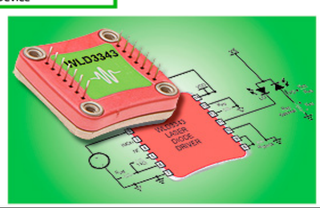
RoHS Compliant

GENERAL DESCRIPTION:

Simply stable temperature control. Wire your thermoelectric cooler and thermistor to the board with the cable provided. Add the appropriate DC power supply and indicate the expected voltage on the jumper. With the output disabled, adjust the on-board 12-turn trimpot and watch the setpoint temperature change on the 4-digit display. Switch to Actual and display your thermistor temperature. Watch the LED tree to see “over / under temperature” or “stable at setpoint” status. Enable the output current and watch the temperature quickly lock in on the setpoint.

Online Design Tools at
www.teamwavelength.com/support/design-tools/





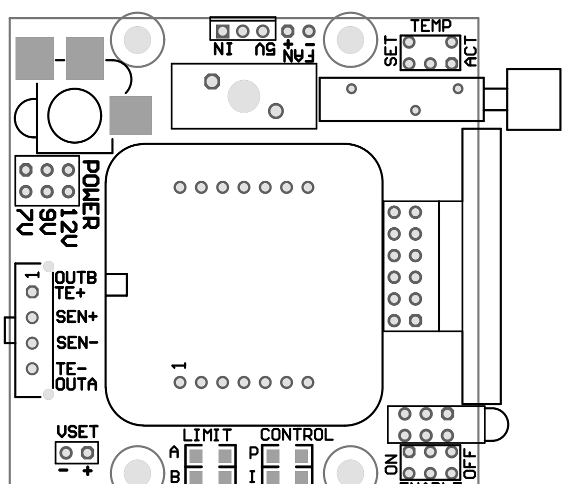
FEATURES:

- Low noise, maximum temperature stability commercially available
- Display thermistor temperature directly - no tables to convert resistance to temperature
- LED indicator shows over temperature, stable at setpoint, or under temperature status
- Adjust setpoint with a 12-turn potentiometer or an external voltage
- Control temperature using a 10 kΩ thermistor
- Fixed resistors set Proportional Gain, Integrator Time Constant, and thermoelectric current limits
- Enable/Disable Output Current Switch
- Includes Output Cable
- Works with a wide range of thermoelectrics

Ordering Information

WTC3293-14001	TEC Controller with Display (WTC3243 & WEV301 included)
PWRPAK-7V	7 V / 2.8 A Power Supply
PWRPAK-9V	9 V / 3 A Power Supply
PWRPAK-12V	12 V / 2.5 A Power Supply

Figure 1
Top View



QUICK REFERENCE -- CONFIGURATION

The display is calibrated for a specific 10 kΩ thermistor, the TCS610:

$$1/T = A + B(\ln R) + C(\ln R)^3$$

where T is in Kelvin; R is in ohms,
A = 1.1279E-3; B = 2.3429E-4; C = 8.7298E-8

Bias Current is also chosen for this thermistor: 100 µA

Control temperature range for the 10 kΩ sensor is 10°C to 50°C.

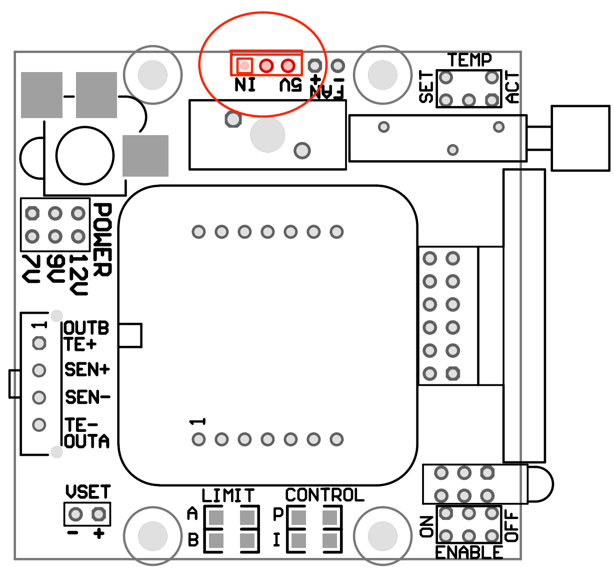
Fuse: For safety, a 3 A fuse is included on the board. Replacement part number is Littelfuse 297 003 (ATO MINI 3A).

Power supply input jack accepts a 2.5 mm diameter plug.

NOTE: The WTC3293-14001 is now designed to operate with the 7 V, 9 V, and 12 V power supplies. It is a direct replacement for the WTC3293-14002.

NOTE: It is normal for the voltage regulator to get hot (~60°C). This regulator is located on the right side of the unit. See Figure 2, below.

Figure 2
Voltage Regulator Location



OPERATING THE WTC3293-14001

1. SELECT POWER SUPPLY VOLTAGE and INSTALL JUMPER

The WTC3293-14001 has been designed to operate at one of three discrete voltages: 7V, 9V, or 12V. The POWER jumper must be installed for the chosen voltage.

To choose the appropriate voltage for your application, use Wavelength's online Safe Operating Area (SOA) calculator for Temperature Controllers:
www.teamwavelength.com/support/design-tools/soa-tc-calculator/.

a. On the calculator page, in the **Product** dropdown menu, click **WTC3293-14**.
b. In the **Max. Heatsink/Enclosure Temperature** text box, type the maximum ambient temperature the controller will experience.
c. In the **Limit Current** text box, type the limit current setting you will use.
d. In the **Load Impedance** text box, type the impedance of the thermoelectric (Vmax / Imax).
e. In the **Supply Voltage** text box, type the power supply voltage you want to use. This number will be 7, 9, or 12.
f. Click **Find SOA Compliance**. A graph showing the Safe Operating Limit and the Load Line is generated. If the calculations are not within the Internal Power Dissipation Safe Operating Area, reduce the power supply voltage until the configuration stays within the SOA.

Install a jumper indicating which power supply you have selected on the header near the DC input plug. NOTE: When you plug in the supply, make sure the Enable Switch is OFF. Do not operate with a voltage less than 7 V.

WHY? The WTC3293-14001 uses the WTC3243 temperature controller, which is designed to drive currents as high as 2.2 Amps. The resistance of the thermoelectric will create a voltage drop across the thermoelectric proportional to the current (Voltage = Current x Resistance). The voltage drop across the WTC3243 will equal the power supply voltage minus the thermoelectric voltage. If the power dissipated by the WTC3243 is too high (Power = Voltage x Current), the WTC3243 will overheat and be destroyed.

2. SELECT HEAT AND COOL CURRENT LIMITS

To protect the thermoelectric from over current damage, set the heat and cool current limits as follows. **The standard product is shipped with 2.00 kΩ resistors for 0.5 A cooling and heating limits.** Resistors should be 5% metal film. Carbon resistors will introduce noise and instabilities.

Table 1

Current Limit Set Resistor vs Maximum Output Current

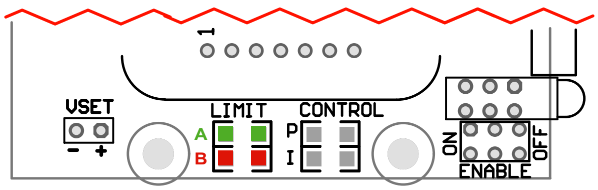
MAXIMUM OUTPUT CURRENT (A)	CURRENT LIMIT RESISTOR (kΩ) R_A or R_B
0.0	1.58
0.1	1.66
0.2	1.74
0.3	1.83
0.4	1.92
0.5	2.01
0.6	2.11
0.7	2.22
0.8	2.33
0.9	2.45
1.0	2.58
1.1	2.71

MAXIMUM OUTPUT CURRENT (A)	CURRENT LIMIT RESISTOR (kΩ) R_A or R_B
1.2	2.86
1.3	3.01
1.4	3.18
1.5	3.36
1.6	3.55
1.7	3.76
1.8	3.98
1.9	4.23
2.0	4.50
2.1	4.79
2.2	5.11

OPERATING THE WTC3293-14001, continued

Figure 3

Current Limit Set Resistor Locations



Note: If you want a wiring diagram with values, use the online WTC3243 design calculator. This can be found at:

www.teamwavelength.com/support/design-tools/wtc-calculator/

To optimize the control loop (minimize overshoot, settling time, avoid cycling, etc.) change the control parameters as described below. If the load doesn't stabilize, contact the factory for troubleshooting advice. Resistors should be 5% metal film. Carbon resistors will introduce noise and instabilities.

3. ADJUSTING THE CONTROL LOOP PROPORTIONAL GAIN

The control loop proportional gain can be adjusted by inserting an appropriate resistor, R_P, into Control P location to set P from 1 to 100. (Shown in green in Figure 4.)

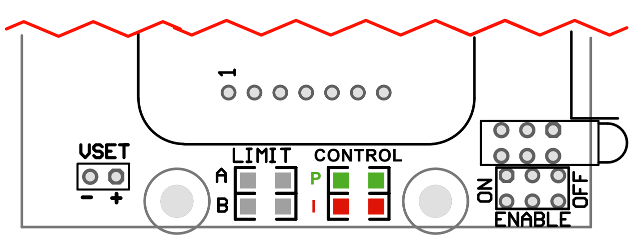
Equation 1 demonstrates how to calculate a value for R_P given a desired proportional gain.

Equation 2 demonstrates how to calculate the proportional gain, P, given a value for R_P.

Table 2 lists the suggested resistor values for R_P versus sensor type and the ability of the thermal load to change temperature rapidly.

Figure 4

Control P and Control I Resistor Locations



Equation 1

Calculating R_P from P

$$R = \left(\frac{100{,}000}{\frac{100}{P} - 1} \right) \ [\Omega]$$

Equation 2

Calculating P From R_P

$$P = \left(\frac{100}{\frac{100{,}000}{R_P} + 1} \right) \ [\text{Amps / Volts}]$$

Table 2

Proportional Gain Resistor R_P vs Sensor Type and Thermal Load Speed

Proportional Gain Resistor, R_P	Proportional Gain, [Amps/Volt]	Sensor Type/ Thermal Load Speed
4.99 kΩ	5	Thermistor/Fast
24.9 kΩ	20	Thermistor/Slow
100 kΩ	50	RTD/Fast
Open	100	RTD/Slow
24.9 kΩ	20	AD590 or LM335/ Fast
100 kΩ	50	AD590 or LM335/ Slow

OPERATING THE WTC3293-14001, continued

4. ADJUSTING THE CONTROL LOOP INTEGRATOR TIME CONSTANT

The control loop integrator time constant can be adjusted by inserting an appropriate resistor, R_I, into Control I location to set I_{TC} from 0.53 to 4.5 seconds. (Shown in red in Figure 4, prior page.)

Equation 3 demonstrates how to calculate a value for R_I given a desired integrator time constant. The integrator time constant, I_{TC}, is measured in seconds.

Equation 4 demonstrates how to calculate the integrator time constant, I_{TC}, given a value for R_I.

Table 3 lists the suggested resistor values for R_I versus sensor type and the ability of the thermal load to change temperature rapidly.

Overshoot with Small Loads

When using the WTC with small, fast loads, the unit has a tendency to overshoot by up to 10˚C. This problem is caused by overcompensation by the integrator and can be solved by taking the integrator term out of the system. This can be done by placing a shorting jumper in the Control I location.

Equation 3

Calculating R_I from I_{TC}

$$R_I = \left(\frac{100{,}000}{(1.89)\, I_{TC} - 1} \right) [\Omega]$$

Equation 4

Calculating I_{TC} from R_I

$$I_{TC} = (0.53) \left(\frac{100{,}000}{R_P} + 1 \right) [\text{Seconds}]$$

Table 3

Integrator Time Constant vs Sensor Type and Thermal Load Speed

Integrator Resistor, R_I	Integrator Time Constant, [Seconds]	Sensor Type/ Thermal Load Speed
21.4 kΩ	3	Thermistor/Fast
13.3 kΩ	4.5	Thermistor/Slow
Open	0.53	RTD/Fast
112 kΩ	1	RTD/Slow
112 kΩ	1	AD590 or LM335/ Fast
13.3 kΩ	4.5	AD590 or LM335/ Slow

5. WIRE OUTPUT CONNECTOR

Connect the Thermoelectric wires to the Red and Black cable wires as shown. If the polarity is reversed, the system will only heat. Connect the thermistor wires to the Green and White cable wires (polarity is not important).

Table 4
OUTPUT CABLE wiring for Thermoelectric

PIN #	Wire Color	Function
1	RED	OUTPUT B - Positive TE wire
2	GREEN	SENSOR +
3	WHITE	SENSOR -
4	BLACK	OUTPUT A - Negative TE wire

Table 5
OUTPUT CABLE wiring for Resistive Heater

PIN #	Wire Color	Function
1	RED	OUTPUT B - One side of RH
2	GREEN	SENSOR +
3	WHITE	SENSOR -
4	BLACK	OUTPUT A - NO CONNECT

Connect other side of RH to V+

Change RLIM A to 1.5 kΩ to limit the cooling curent to ZERO.

Resistive Heater operation assumes NTC sensor.

OPERATING THE WTC3293-14001, continued

6. VIEW THE SETPOINT and ACTUAL TEMPERATURE

The switch next to the setpoint potentiometer determines whether Setpoint or Actual temperature is displayed. When the setpoint is displayed, the rightmost decimal point is lit. The resistance to temperature conversion software assumes the thermistor bias current is 100 μA and the thermistor is characterized by the Steinhart-Hart relationship:

$$1/T = A + B(\ln R) + C(\ln R)^3$$

where T is in Kelvin; R is in ohms, A = 1.1279E-3; B = 2.3429E-4; C = 8.7298E-8 (TCS-610)

If another thermistor or bias current is used, the temperature display will not be properly calibrated. To use another sensor or change the calibration, contact the factory.

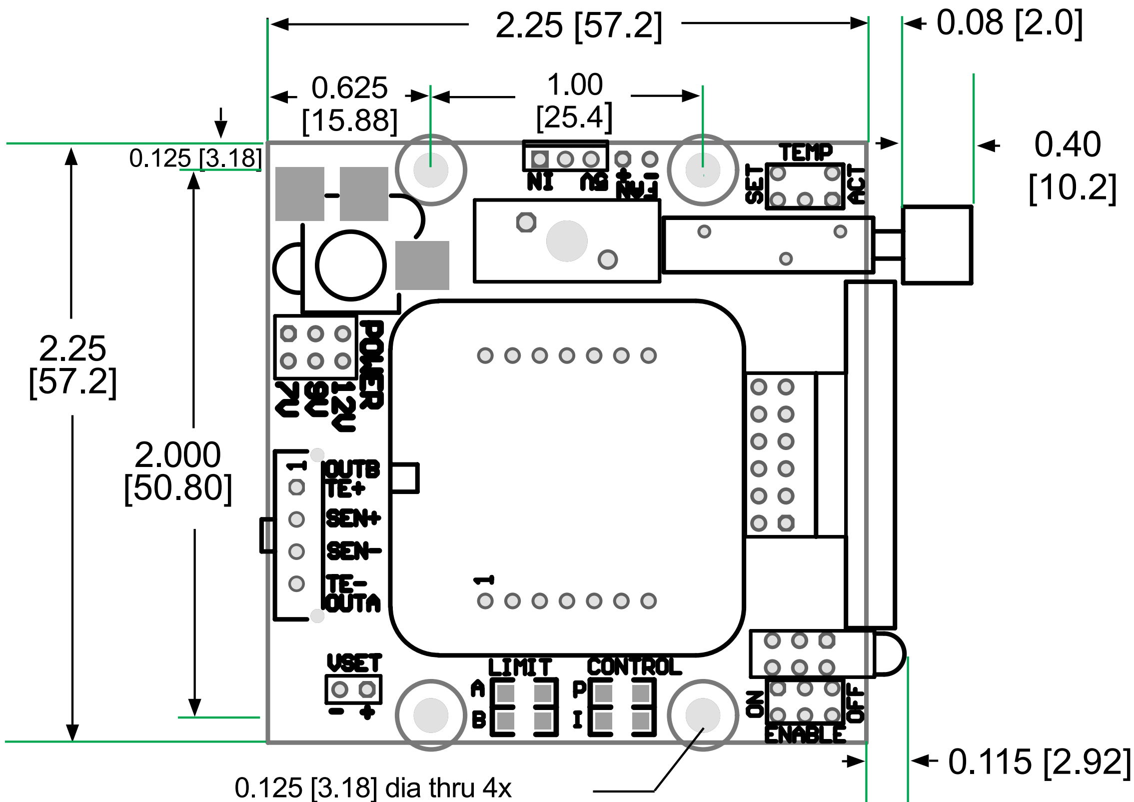
7. ADJUST THE SETPOINT TEMPERATURE

The setpoint temperature can be adjusted from 10 to 65°C either by using the onboard 12-turn potentiometer or an external voltage source.

The VSET wire pads can be used as test points to monitor the potentiometer setting or for connecting an external voltage source (such as a function generator). If an external voltage source is used, set the setpoint potentiometer approximately mid-range (1 to 1.5 V). The input voltage range is 0 to 2.5 V which corresponds to 0 to 25 kΩ of thermistor resistance. [Transfer function is 10 kΩ / V.]

8. ENABLE THE OUTPUT CURRENT & MONITOR IN-RANGE STATUS

The switch next to the In-Range indicator enables and disables current through the thermoelectric. The green LED on the In-Range indicator lights when the actual temperature is within 0.05°C of the setpoint. If the actual temperature exceeds the setpoint, the upper LED will light. If it is below the setpoint temperature, the lower LED will light.



Max height from top side of PCB to fan is 1.50” [38.1 mm]
Standoffs are 0.625” [15.88 mm] tall
Board thickness is 0.60 [15.2” mm]

Allow 0.375” [9.53 mm] clearance from bottom side of PCB for airflow

The WTC3243 connects to the evaluation board by two 7-pin SIP sockets. The socket manufacturer is Aries Electronics, PN 25-0513-10.

Dimensions are inches [mm].
All tolerances are ±5%.

CERTIFICATION AND WARRANTY

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

WARRANTY:
This Wavelength product is warranted against defects in materials and workmanship for a period of 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:
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SAFETY:
There are no user serviceable parts inside this product. Return the product to Wavelength for service and repair to ensure that safety features are maintained.

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

REVISION HISTORY

REVISION	DATE	NOTES
REV. E	Aug-2005	Document Control release
REV. F	31-Aug-09	Updated links to support new website
REV. G	25-May-11	Merged WTC3293-14001 and WTC3293-14002
REV. H	30-Jul-12	Updated Mechanical Specifications
REV. I	25-Jan-13	Added socket manufacturer
REV. J	7-May-14	Extended warranty, updated limit chart, and section 1 of operating instructions