

TCM-320 - Thermocouple Adapter

TCM-320

General Description

The TCM-320 Thermocouple Adapter allows most Wavelength Electronics temperature controller instruments to control temperature with J (Iron-Constantan) and K (Chromel-Alumel) thermocouples. It provides an ice point reference and amplifier to produce a high level output signal from a thermocouple (10 mV / °C or 10 mV / Kelvin).

Using an external power supply, the TCM-320 can be configured to operate with any Wavelength Electronics temperature control component.

Features

- Control temperature with J or K thermocouples
- Output 10 mV / °C or 10 mV / Kelvin
- Measurement range:
 - J: -200°C to +750°C
 - K: -200°C to +1250°C
 (Consult instrument manual for control range)
- Includes J and K mating connectors
- Stability to < 0.5°C
- Accuracy ± 1.0°C
- Protection from reverse supply operation
- Two Year Warranty

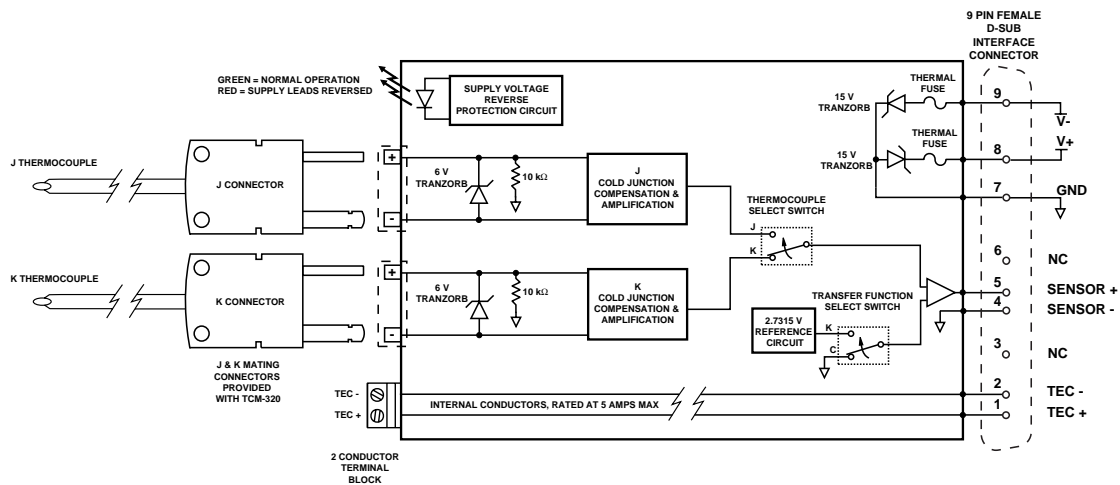
Prior to using the TCM-320, check the list of supplied items:

- Four 1/4 - 20 mounting screws
- One J type thermocouple plug (black)
- One K type thermocouple plug (yellow)
- This Manual

Ordering Information

TCM-320	J and K Thermocouple Adapter
CALL FACTORY	Interface cables are available. Contact the factory for the model number specific to your instrument

Functional Diagram



Electrical Specifications

TCM-320

MODEL NUMBER	TCM-320
Temperature Range ① J (Iron / Constantan) Thermocouple K (Chromel / Alumel) Thermocouple	-200°C to +750 °C -200°C to +1250°C
Temperature Control Control Range with LFI-3751 Control Range with LFI-3500 series	$\pm 199.9^{\circ}\text{C}$ 0 to +199.9°C or 273 to 950 Kelvin
Long Term Stability, 24 hr. ② Accuracy	$< 0.5^{\circ}\text{C}$ $\pm 1.0^{\circ}\text{C}$
Maximum Thermoelectric Current ③	$\pm 5 \text{ A}$
Compatible Thermocouple Types ④	J or K (E or T)
Switch Selectable Output	10 mV / °C or 10 mV / Kelvin

- ① TCM-320 output is dependent on supply voltage input. Maximum sensor voltage (measured from pin 5 to pin 4) is less than the supply voltage by 2.5 V: ($V+ - 2.5 \text{ V}$ or $V- + 2.5 \text{ V}$). For example, with +5 VDC input, maximum sensor voltage is +2.5 V. At 10 mV / °C, maximum TCM-320 output equates to 250°C.
- ② Stability quoted for an exposed junction J or K thermocouple.
- ③ The maximum current through the 9 pin D-sub pins and TCM-320 internal traces.
- ④ You can use an E thermocouple in the J connector. You can use a T thermocouple in the K connector. An error is introduced by the dissimilar materials when using E or T thermocouples. Wavelength suggests that the TCM-320 Thermocouple Adapter be characterized with an independent temperature reference when using E or T thermocouples.

General Specifications

Power Requirements

Single Supply Operation: $+5 \text{ V} < V+ < +30 \text{ VDC}$

Dual Supply Operation: $+5 \text{ V} < V+ < +15 \text{ VDC}$
 and
 $-15 \text{ V} < V- < -5 \text{ VDC}$

Maximum voltage $V+$ to $V-$ is 30 VDC

Maximum supply current is 50 mA

Connectors

- 9 pin D-sub receptacle
- J thermocouple connector
- K thermocouple connector
- 2 conductor screw terminal block
 (accepts 18 to 24 AWG)

Operating Temperature

0 to +50°C

Storage Temperature

- 40 to +70°C

Warm-up

1 hour to rated accuracy

Weight

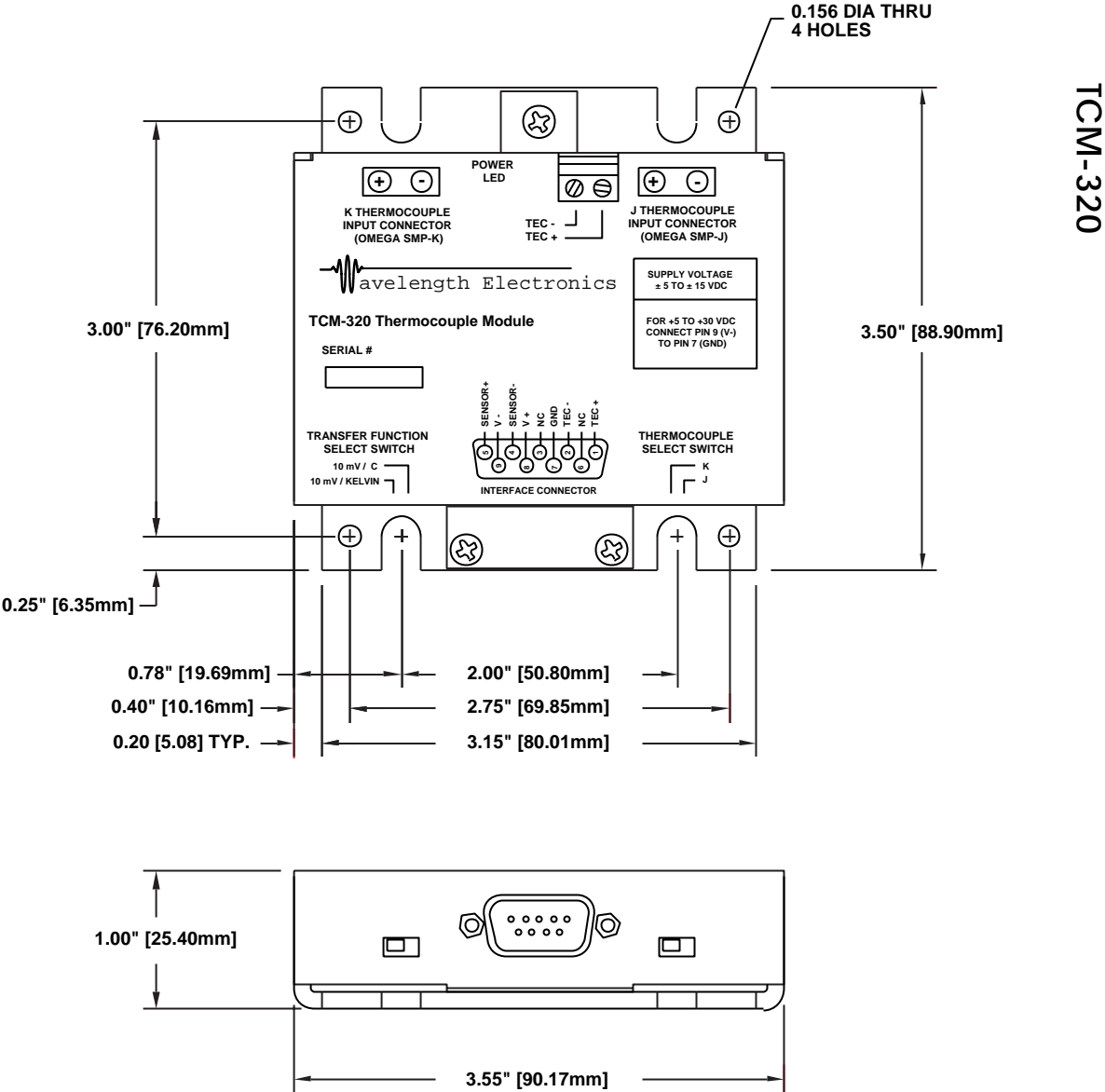
< 0.4 lbs.

Size (H x W x D)

1" x 3.55" x 3.5" [25.4 x 90.2 x 88.9 mm]



Mechanical Specifications



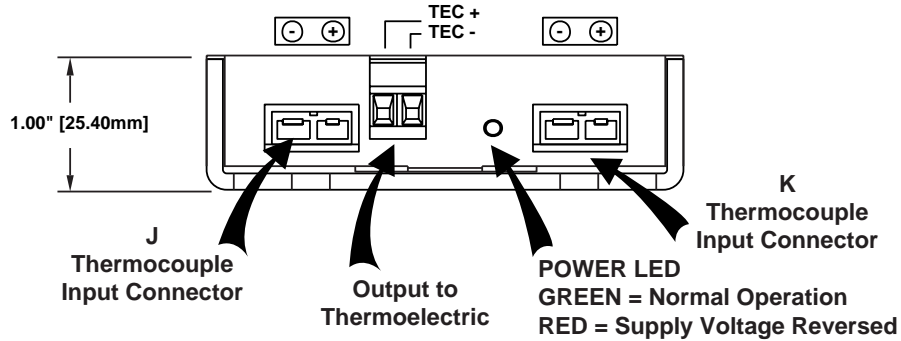
Plugs to connect thermocouples to the TCM-320

Plugs for J & K thermocouples are supplied with the TCM-320. If additional plugs are required, order them from OMEGA (1-800-826-6342). The J type plug is SMP-J-M. The K type plug is SMP-K-M.

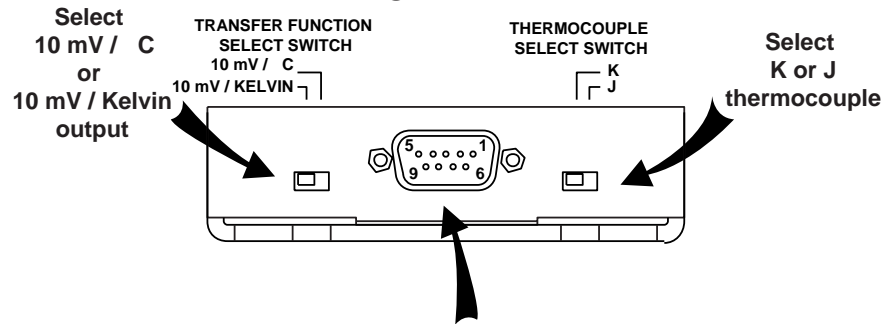


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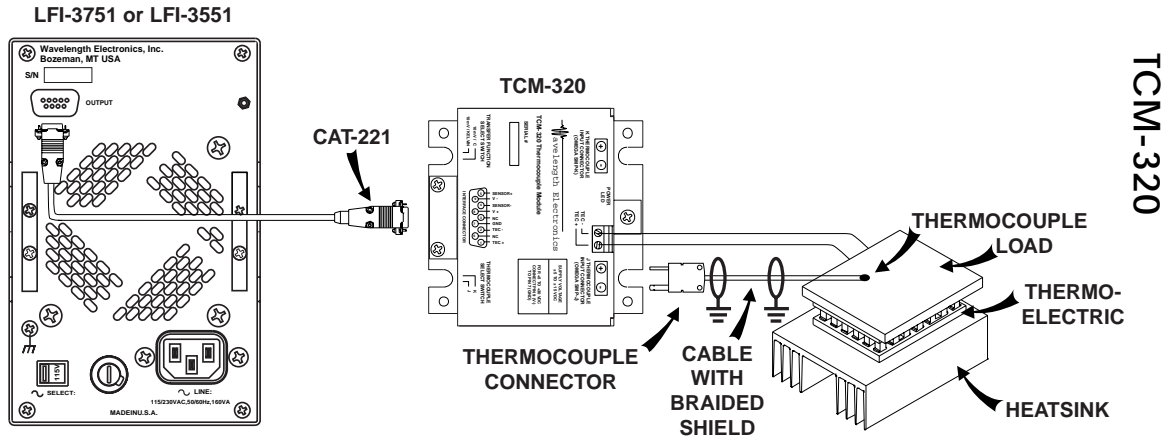
REAR VIEW



FRONT VIEW



9 Pin Female D-sub Interface Connector		
1	TEC+	TEC+ and TEC- supply current from the temperature controller to the two conductor screw terminal block near the J Thermocouple Connector Input. Maximum TE current is +/- 5 Amps.
2	TEC-	
3	NC	No Connection
4	Sense -	The TCM-320 supplies an output from Sense + to Sense - of 10 mV / C or 10 mV / Kelvin. NOTE: Sense - must connect to the temperature controller's low impedance ground.
5	Sense +	
6	NC	No Connection
7	Ground	Power Supply Ground. Use with pins 8 and 9. Positive Supply Voltage Input: Single Supply Operation: +5 V to +30 VDC Dual Supply Operation: +5 V to +15 VDC Negative Supply Voltage Input: Single Supply Operation: Connect pin 9 to pin 7 Dual Supply Operation: -5 V to -15 VDC
8	V+	
9	V-	



Operating Instructions for a TCM-320 with an LFI-3751 (Temperature Range: $\pm 199.9^{\circ}\text{C}$)

A Wavelength Electronics CAT-221 double terminated cable can be purchased separately to interface the TCM-320 to the LFI-3751.

1. With the LFI-3751 powered "OFF", connect the CAT-221 cable to the LFI-3751 *Output Connector* and the TCM-320 *Interface Connector*.
2. On the TCM-320, select the 10 mV / $^{\circ}\text{C}$ transfer function with the *Transfer Function Select Switch*.
3. Wire the thermoelectric to the two conductor *Screw Terminal Block* on the TCM-320. (18 AWG wire is recommended for 5 Amp operation.)
4. Connect the thermocouple to the appropriate plug provided. The "J" plug is black. The "K" plug is yellow. Note that the wider terminal is the negative input as is the red conductor from the thermocouple. Insert the plug into the appropriate J or K input connector. Both the thermocouple plug and connector are made of the same metals to minimize error. Using the "J" plug with the "K" input (or "K" with "J") or using a different plug could affect the performance of the TCM-320.
5. Select the proper thermocouple using the *Thermocouple Select Switch*.
6. Power on the LFI-3751. The *Power Indicator* on the TCM-320 will light green. Set the instrument sensor type to (4, 4) to indicate thermocouple sensor type. Refer to the LFI-3751 manual for operating instructions for a thermocouple.

NOTE: Pins 7 & 8 on the *Output Connector* of the LFI-3751 can drive a fan or the TCM-320, not both, simultaneously.



**Operating Instructions for a TCM-320 with an LFI-3551 series
(Temperature Range: 0 to +199.9°C or 273 to 950 Kelvin)**

A Wavelength Electronics CAT-221 double terminated cable can be purchased separately to interface the TCM-320 to the LFI-3551.

1. With the instrument powered "OFF", connect the CAT-221 cable to the instrument's *Output Connector* and the TCM-320 *Interface Connector*. If you build your own cable, and the V+ and Ground pins are reversed, the instrument will be damaged.
2. On the TCM-320, using the *Transfer Function Select Switch*, choose the 10 mV / °C transfer function to display temperature in Celcius. Choose the 10 mV / Kelvin transfer function to display temperature in Kelvin.
3. Wire the thermoelectric to the two conductor *Screw Terminal Block* on the TCM-320. (18 AWG wire is recommended for 5 Amp operation.)
4. Connect the thermocouple to the appropriate plug provided. The "J" plug is black. The "K" plug is yellow. Note that the wider terminal is the negative input as is the red conductor from the thermocouple. Insert the plug into the appropriate J or K input connector. Both the thermocouple plug and connector are made of the same metals to minimize error. Using the "J" plug with the "K" input (or the "K" with the "J") or using a different plug could affect the performance of the TCM-320.
5. Select the proper thermocouple using the *Thermocouple Select Switch*.
6. Power on the instrument. The *Power Indicator* on the TCM-320 will light green. Follow the operating instructions in the instrument manual for AD590 sensors. Rotate the *Display Select Switch* to LINEAR - KELVIN to monitor the sensor temperature in Kelvin or Celcius. Rotate the *Display Select Switch* to 10 μ A - k Ω to gain one decimal point of accuracy when displaying temperature in Celcius.

The Control and Display Range is 0 to +199.9°C or 273 to 999 Kelvin. The LFI-3500 series cannot operate thermocouples below 0°C.

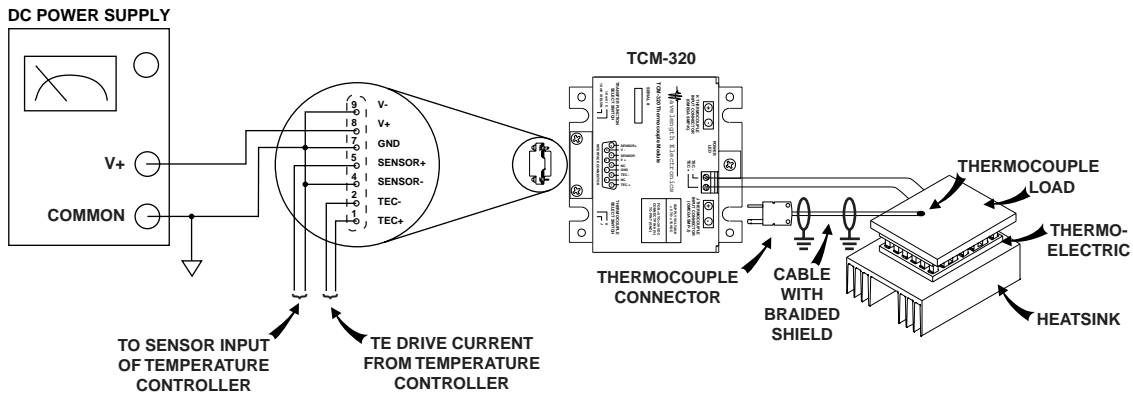
NOTE: Older models of the LFI-3500 series connected pin 9 of their *Output Connector* to chassis ground. Connect pin 9 to pin 7 on the TCM-320 9-pin female D-sub connector for proper operation.

NOTE: Pins 7 & 8 on the *Output Connector* of the LFI-3500 series can drive a fan or the TCM-320, not both simultaneously.



Operating the TCM-320 using an External Power Supply

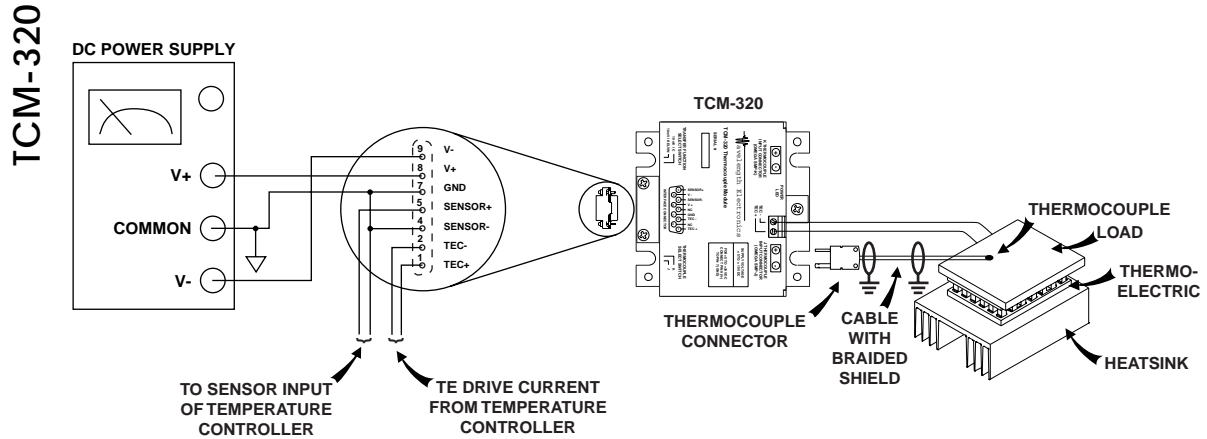
Single Supply Operation (above 0°C only)



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1. Connect the TCM-320 to an external power supply. The *Power Indicator* will light green under normal operation. If the supply leads are reversed, the *Power Indicator* will light red. If you do not operate below 0°C, you can use a single supply +5 V to +30 VDC. Wire pin 8 to V+ and pins 7 & 9 to GROUND.
2. Connect SENSOR+ (pin 5) and SENSOR- (pin 4) to the temperature controller sensor inputs. Also connect SENSOR- (pin 4) to GROUND (pin 7). Configure your temperature controller to use an AD590 when possible, or select the thermistor 10 μ A sensor bias current.
3. On the TCM-320, using the *Transfer Function Select Switch*, choose the 10 mV / °C transfer function to control temperature in Celcius. Choose the 10 mV / Kelvin transfer function to control temperature in Kelvin.
4. Connect the thermoelectric leads to your temperature controller. Either wire them directly to the controller or connect the controller outputs to the TCM-320 *Interface Connector* (9 pin D-Sub) and the thermoelectric leads to the two conductor *Screw Terminal Block* on the TCM-320. **If your controller can only be configured for Negative Temperature Coefficient (NTC) temperature sensors, reverse the polarity of the thermoelectric leads.**
5. Connect the thermocouple to the appropriate plug provided. The "J" plug is black. The "K" plug is yellow. Note that the wider terminal is the negative input as is the red conductor from the thermocouple. Insert the plug into the appropriate J or K input connector. Both the thermocouple plug and connector are made of the same metals to minimize error. Using the "J" plug with the "K" input (or the "K" with the "J") or using a different plug could affect the performance of the TCM-320.
6. Select the proper thermocouple using the Thermocouple Select Switch.
7. Turn the TCM-320's external power supply ON before attempting to control a load's temperature. The TCM-320 *Power Indicator* will be green.

Dual Supply Operation (above or below 0°C)



1. Connect the TCM-320 to an external power supply. The *Power Indicator* will light green under normal operation. If the supply leads are reversed, the *Power Indicator* will light red. If your sensor will operate below 0°C, use a bipolar power supply $\pm 5\text{ V}$ to $\pm 15\text{ VDC}$. Wire pin 8 to V+, pin 7 to GROUND, and pin 9 to V-.
2. Connect SENSOR+ (pin 5) and SENSOR- (pin 4) to the temperature controller sensor inputs. Also connect SENSOR- (pin 4) to GROUND (pin 7). Configure your temperature controller to use an AD590 when possible, or select the thermistor 10 μA sensor bias current.
3. On the TCM-320, using the *Transfer Function Select Switch*, choose the 10 mV / °C transfer function to control temperature in Celcius. Choose the 10 mV / Kelvin transfer function to control temperature in Kelvin.
4. Connect the thermoelectric leads to your temperature controller. Either wire them directly to the controller or connect the controller outputs to the TCM-320 *Interface Connector* (9 pin D-Sub) and the thermoelectric leads to the two conductor *Screw Terminal Block* on the TCM-320. **If your controller can only be configured for Negative Temperature Coefficient (NTC) temperature sensors, reverse the polarity of the thermoelectric leads.**
5. Connect the thermocouple to the appropriate plug provided. The "J" plug is black. The "K" plug is yellow. Note that the wider terminal is the negative input as is the red conductor from the thermocouple. Insert the plug into the appropriate J or K input connector. Both the thermocouple plug and connector are made of the same metals to minimize error. Using the "J" plug with the "K" input (or the "K" with the "J") or using a different plug could affect the performance of the TCM-320.
6. Select the proper thermocouple using the Thermocouple Select Switch.
7. Turn the TCM-320's external power supply ON before attempting to control a load's temperature. The TCM-320 *Power Indicator* will be green.

Non-linearity and Thermocouples

A thermocouple's output voltage is nonlinear with respect to temperature. The TCM-320 linearly amplifies the signal. The following transfer functions are used to determine the actual output voltages. The output voltages compared to temperature are detailed in the table on the following page.

$$\text{TCM-320 output (mV)} = [\text{Type J voltage} + 16 \mu\text{V}] \times 193.4$$

$$\text{TCM-320 output (mV)} = [\text{Type K voltage} + 11 \mu\text{V}] \times 247.3$$

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What to expect with a thermocouple

Thermocouples generate extremely small voltages which are proportional to temperature. A J thermocouple output changes about $57 \mu\text{V} / ^\circ\text{C}$. A K thermocouple output changes about $41.4 \mu\text{V} / ^\circ\text{C}$. Compared to thermistors, thermocouples are not very sensitive. Stability of $\pm 0.5^\circ\text{C}$ can be achieved given proper supply grounding, sensor shielding, and proper sensor placement. TCM output voltage as a function of temperature is detailed on the following page.

To maximize stability:

1. Place the TCM-320 as close to the thermocouple sensing junction as possible to keep the thermocouple wire short.
2. Use a braided shield to protect the thermocouple wire from electro-magnetic interference. Thermocouple signals are very small. Connect the braid to earth ground at both ends of the cable.
3. Earth ground all metal parts around or near the thermocouple sensing junction, as allowed.
4. Earth ground the TCM-320's metal chassis. This can be accomplished through the *Interface Connector* shell or the TCM-320's mounting holes. If you are using the LFI-3751 or LFI-3551, the CAT-221 cable connects the TCM-320 *Interface Connector* shell to earth ground.
5. The TCM-320 provides a voltage on its sensor output. The maximum cable length from the TCM-320 to the temperature controller is three meters with a braid-shielded cable using 22 AWG conductors. If your cable is not shielded or uses smaller conductors, reduce the cable length from TCM-320 to the controller.



Chart of TCM-320 Output Voltage vs. Temperature

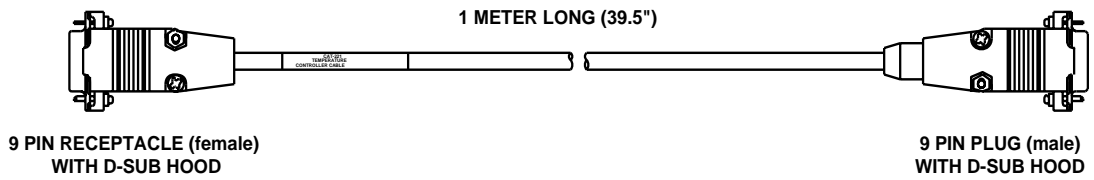
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Temperature °C	TCM-320 Output Voltage (mV)		Temperature °C	TCM-320 Output Voltage (mV)	
	J Thermocouple	K Thermocouple		J Thermocouple	K Thermocouple
-200	-1523	-1454	500	5300	5107
-180	-1428	-1370	520	5517	5318
-160	-1316	-1269	540	5736	5529
-140	-1188	-1152	560	5956	5740
-120	-1046	-1021	580	6179	5950
-100	-893	-876	600	6404	6161
-80	-729	-719	620	6632	6371
-60	-556	-552	640	6862	6581
-40	-376	-375	660	7095	6790
-20	-189	-189	680	7332	6998
-10	-94	-94	700	7571	7206
0	3.1	2.7	720	7813	7413
10	101	101	740	8058	7619
20	200	200	750	8181	7722
25	250	250	760	-	7825
30	300	300	780	-	8029
40	401	401	800	-	8232
50	503	503	820	-	8434
60	606	605	840	-	8636
80	813	810	860	-	8836
100	1022	1015	880	-	9035
120	1233	1219	900	-	9233
140	1445	1420	920	-	9430
160	1659	1620	940	-	9626
180	1873	1817	960	-	9821
200	2087	2015	980	-	10015
220	2302	2213	1000	-	10209
240	2517	2413	1020	-	10400
260	2732	2614	1040	-	10591
280	2946	2817	1060	-	10781
300	3160	3022	1080	-	10970
320	3374	3327	1100	-	11158
340	3588	3434	1120	-	11345
360	3801	3641	1140	-	11530
380	4015	3849	1160	-	11714
400	4228	4057	1180	-	11897
420	4441	4266	1200	-	12078
440	4655	4476	1220	-	12258
460	4869	4686	1240	-	12436
480	5084	4896	1250	-	12524



CAT-221 Wiring Diagram

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PIN	WIRE COLOR	LFI-3500	LFI-3751	TCM-320
1	RED	TEC+	TEC+	TEC+
2	BLACK	TEC-	TEC-	TEC-
3	BROWN	AUX SENS+	AUX SENS+	NC
4	GREEN	SENS-	SENS-	SENS-
5	WHITE	SENS+	SENS+	SENS+
6	ORANGE	AD590+	AD590+	NC
7	YELLOW	GROUND	GROUND	GROUND
8	BLUE	+12 V	+12 V	V+
9	PURPLE	GROUND	-12 V	V-
SHELL	SLATE	Chassis Ground	Chassis Ground	Chassis Ground

For proper connection with the device, the cable connection must be:

9 pin Male D-Sub	9 pin Male D-Sub	9 pin Female D-Sub
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CUSTOMER SERVICE & WARRANTY

If you have any questions or comments, please call our technical staff at (406) 587-4910. Our hours are 8:00 a.m. to 5:00 p.m. MT.

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Wavelength Electronics warrants this product for two years against defects in materials and workmanship when used within published specifications. This warranty extends only to purchaser and not to users of purchaser's products. If Wavelength receives written notice of such defects during the warranty period, we will either repair or replace products which prove to be defective. Wavelength makes no warranty concerning the fitness or suitability of its products for a particular use or purpose; therefore, it is purchaser's responsibility to thoroughly test any product and independently conclude its satisfactory performance in purchaser's application. No other warranty exists either expressed or implied, and consequential damages are specifically excluded. Wavelength Electronics reserves the right to change circuitry and specifications without notification at any time.

All products returned must be accompanied by a Return Material Authorization (RMA) number obtained from the Customer Service Department. Returned product will not be accepted for credit or replacement without our permission. Transportation charges or postage must be prepaid. All returned products must show invoice number and date and reason for return.

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