Modular Thermocouple Amplifier

User Manual

Michigan Scientific Corporation

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Modular Thermocouple Amplifier...

- Available with one to nine thermocouple amplifier channels.
- Provides cold junction compensation.
- Amplified signal is at high-level voltage.
- Precision, low noise, differential amplifier.
- Units available in K and T types (other types made by special order).
- Signal is greatly immune to external noise sources.
- Wide signal bandwidth.
- SR-Series Slip Ring Assembly rotors pilot onto the amplifiers.
- Amplifiers are stackable for multiple channel use.

SPECIFICATIONS

Parameter	Specification
Output	Output is not linearized over temperature, if necessary, the output may be linearized externally.
Range	± 10 V Max
Sensitivity at 25 °C TC Temperature	10 mV/°C
Capacitive Load	1000 pF Max
Temperature Error	Includes errors due to cold junction compensator.
Initial at 25 °C Case Temperature	± 2 °C Max
-25°C to +85 °C Case Temperature	± 3 °C Max
-55 °C to +125 °C Case Temperature	± 5 °C Max
Noise	Referred to input of amplifier.
0.01 Hz - 10 Hz	0.8 µV p-p
Dynamic Response	
Frequency Response	1.5 kHz
Slew Rate	0.4 V/µs
Settling Time 0.1% / 0.01%	40 µs/50 µs
Power Requirements	
Voltage	± 15 Vdc
Quiescent Current	± 45 mA Max Total (9 channels)
Environment	
Specification	-25 °C to +85 °C (-13 °F to +185 °F)
Operation	-55 °C to +125 °C (-67 °F to +257 °F)

General Operation

The Modular Thermocouple Amplifier (AMP-TC) must be powered with ± 15 V and a common. See the Installation section for instructions on how to connect these supplies to the proper terminals. The AMP-TC signals should be measured with respect to the common gray terminal.

Current flows in the ground line, so there will be a voltage drop along the length of the conductor. This will create an offset if the signals are measured with respect to the common at the power supply. Michigan Scientific recommends signals should be measured with respect to the common terminal at the amplifier. This can be accomplished by adding a second common line from the amplifier to the recording device.

A thermocouple should be attached to the provided mating connector (Omega® SMP-*-M) and plugged into the connector on the amplifier (Omega® SMP-*-F). If a thermocouple input is left unused or if the thermocouple opens, the output of the amplifier will saturate negatively (near −13.5 V). The amplifier will not be damaged if a thermocouple is left unattached.

The signal from the thermocouple is cold junction compensated and amplified, but not linearized. Linearization polynomials can be found in the Linearization Formulas section.

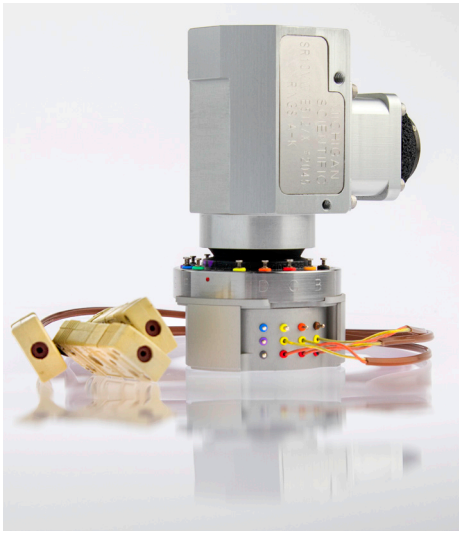
Operation with PS Series Power Supplies

Any Michigan Scientific Power Supply will provide the ± 15 V and common. These Power Supplies have switches that control bridge excitation and shunt calibration. Both switches are used with Michigan Scientific's Strain Gage Amplifiers, and have no impact on the operation of the thermocouple amplifier.

Michigan Scientific Power Supplies reverse the polarity of the ± 15 V terminals when the bridge excitation switch is off. The thermocouple amplifier will continue to work under this condition

Mechanical Installation

Michigan Scientific SR-Series Slip Ring Assemblies are designed to pilot the Modular Thermocouple Amplifiers. The amplifier can mount directly to the rotating shaft, or an adapter may be used to mount the amplifier to the shaft. The pilot for the amplifier should have a minimum depth of 0.05 in [1.3 mm] and be machined for flatness and concentricity so that the adapter properly interfaces with the amplifier. Amplifier drawing specifications can be found in the Appendix.



Three #8 socket head cap screws should be tightened to no more than 45 in·lb to secure the amplifier.

The total indicated runout is <0.003 inches (0.08 mm) per module. Using a pilot will reduce runout better than bolts through the mounting holes alone.

The module is not waterproof. Michigan Scientific does manufacture a slip ring and amplifier cover. Please contact factory for specifications.

Electrostatic Sensitivity

AMP-TC is an electrostatic sensitive device. The terminals should not be touched except during soldering. Soldering should be performed at an electrostatic discharge protected workstation.

Wires attached to terminals should not be touched.

If an electrostatic discharge protected workstation is not available, use a grounded wrist-strap and ground the thermocouple amplifier.

Electrical Installation

Solder terminals on the Modular Thermocouple Amplifier are color coded to help determine which supply or signal corresponds to which terminal.

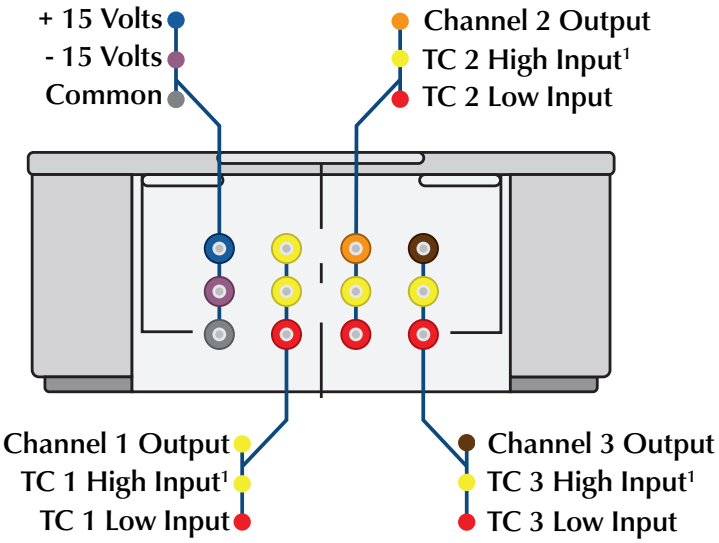
TERMINAL SIGNALS[1]

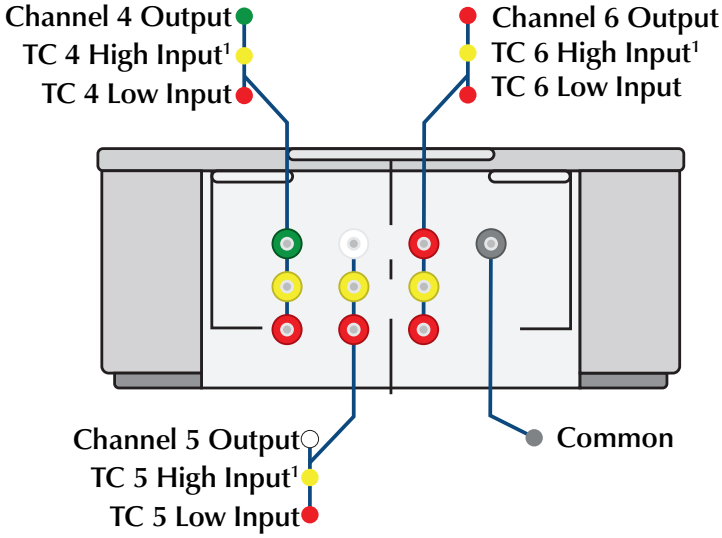
	Signals	Terminals
Power Supply	Positive 15 V	Blue
	Negative 15 V	Violet
	Common	Gray
Slip Ring Connections	Amplifier Out High Channel 1	Yellow
	Amplifier Out High Channel 2	Orange
	Amplifier Out High Channel 3	Brown
	Amplifier Out High Channel 4	Green
	Amplifier Out High Channel 5	White
	Amplifier Out High Channel 6	Red
	Amplifier Out High Channel 7	Black
	Amplifier Out High Channel 8	Yellow
	Amplifier Out High Channel 9	Orange
Thermocouple Connections	Thermocouple Positive[2]	Yellow
	Thermocouple Negative	Red

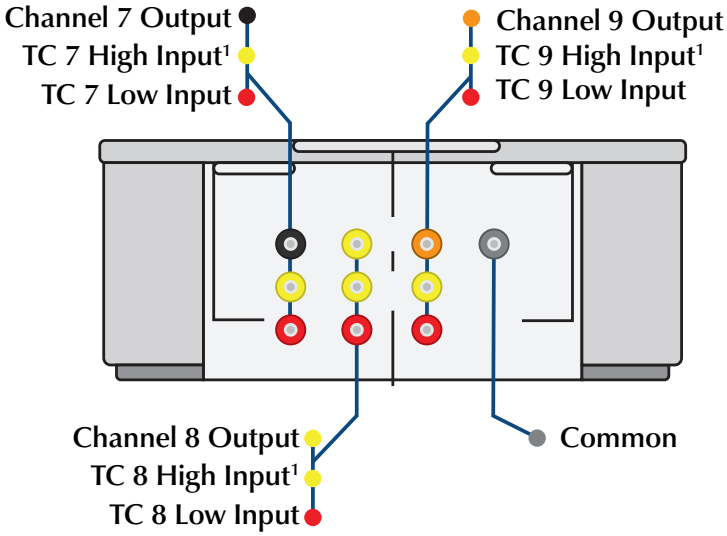
[1] *For a specific thermocouple type, see appendix*

[2] *Yellow for Type K, Blue for Type T*

The output high is measured relative to the common (gray) terminal. There are multiple commons on high channel count amplifiers. Michigan Scientific recommends that a separate wire for signal common be added to one or more of the common terminals to reduce errors from voltage drops along the power common wire. This wire can be added to the stator of a slip ring to decrease the amount of rings needed, but care should be given to physically place the amplifier and slip ring as close as possible to the thermocouple.







[1]Yellow for type K, Blue for Type T

Linearization Formulas

The AMP-TC cold junction compensates and amplifies thermocouple signals but it does not linearize the signals. The polynomials given below use raw voltage from the amplifier as the independent variable and generate temperature in degrees Celsius.

Higher order polynomials are accurate over wider temperature ranges. Reducing the number of significant digits reduces the accuracy. Each of the following formulas are accurate to less than one degree Celsius over the temperature range specified. The cold junction compensator can create an additional error, which is dependent upon the case temperature of the amplifier (see specifications, temperature error). These polynomials are inaccurate outside their specified temperature ranges.

K Type

Temperature Range: 0 °C to 100 °C

$$T = 98.9V + 0.464$$

Temperature Range: -100 °C to 200 °C

$$T = 2.949V^3 - 7.916V^2 + 104.1V + 0.0289$$

Temperature Range: 0 °C to 1370 °C

$$T = 2.5499E\text{-}4V^6 - 1.1161E\text{-}2V^5 + 0.18766V^4 - 1.3957V^3 + 4.0742V^2 + 95.47V + 0.91578$$

T = Temperature in °C

V = Voltage from amplifier

T Type

Temperature Range: -100 °C to 400 °C

$$T= -0.0090V^6 + 0.151V^5 - 1.040V^4 + 4.149V^3 - 13.436V^2 + 105.278V + 0.142$$

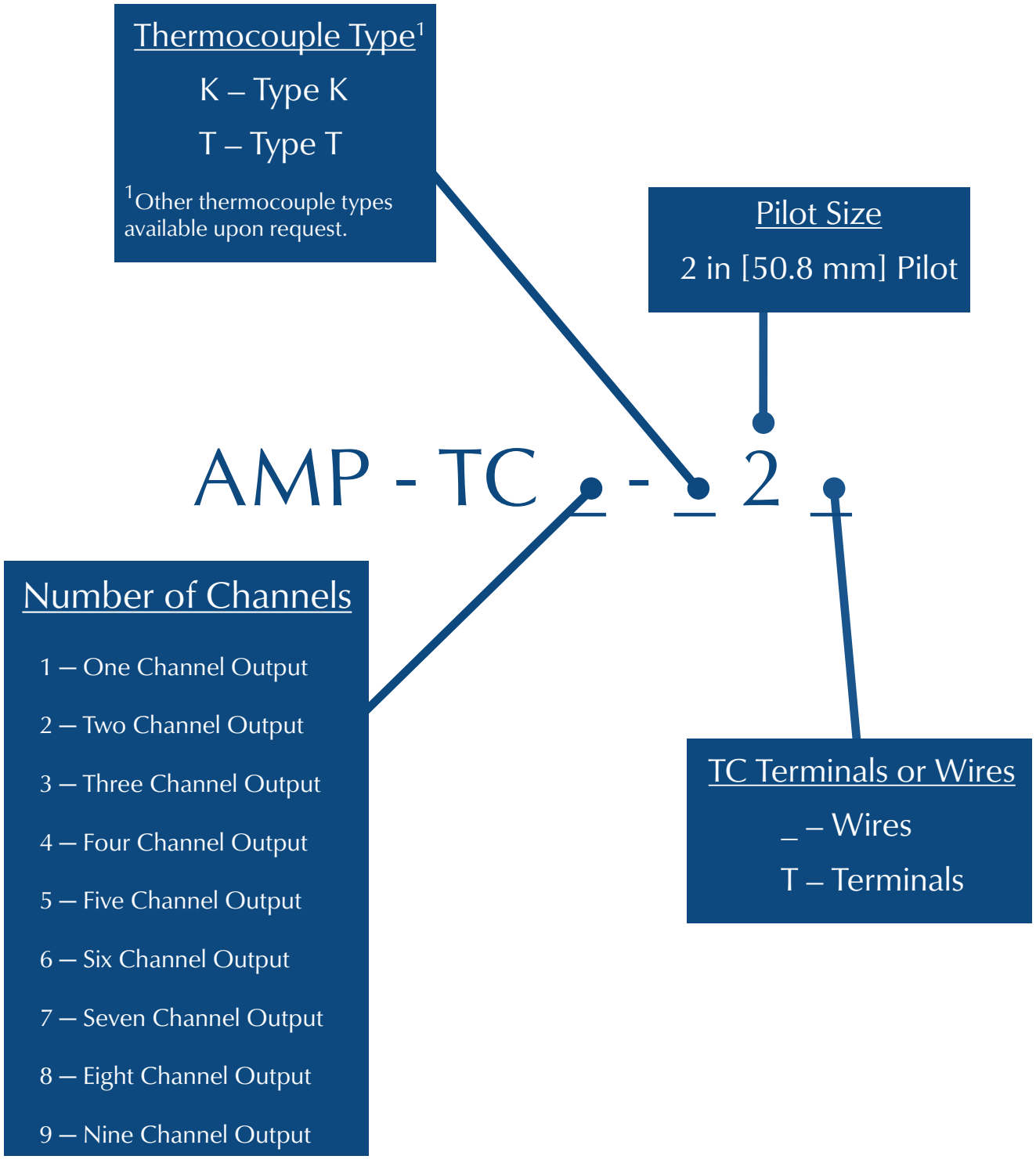
T = Temperature in °C

V = Voltage from amplifier

Troubleshooting

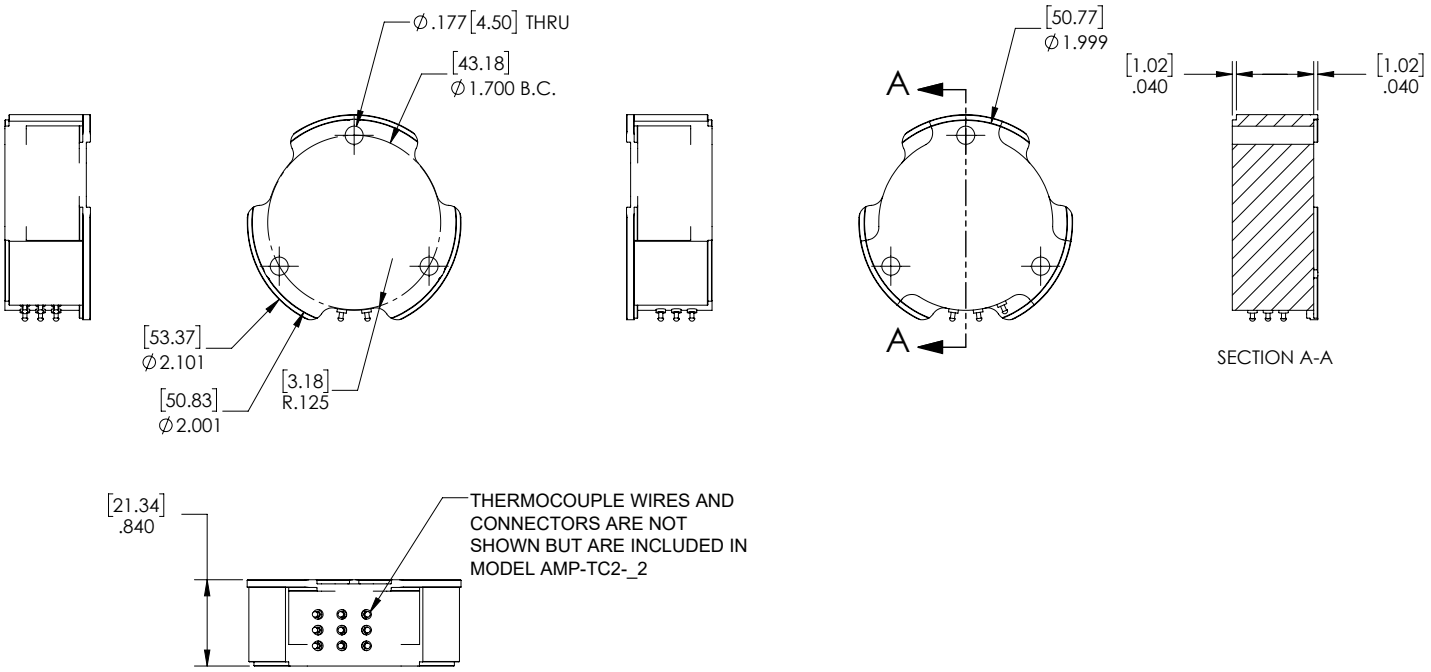
Problem	Potential Cause	Test to Verify Problem	Solution
Output saturated near −13.5 V.	Open thermocouple.	Connect known good thermocouple to amplifier input. If saturated voltage is a result open thermocouple; the output should now be near room temperature.	Repair thermocouple junction.
Output noisy with thermocouple spinning.	Thermocouple could be opening momentarily; frequency response of data acquisition system may be too slow to show complete drop out of signal.	Look at dynamic signal with an oscilloscope.	Repair thermocouple junction Restrain thermocouple better.
Output near 0 V regardless of thermocouple temperature.	Amplifier Out High could be shorted to Common.	With amplifier power off, measure resistance from Amplifier Out High to Common. The resistance should be greater than 1 MΩ.	Remove short.
	Amplifier Out High conductor could be open.	Measure resistance from one end of conductor to the other.	Repair open wire.
Output has an undesired offset.	Voltage drop along Common wire offsets measurement.	Measure voltage from Amplifier Out High to Common at amplifier.	Add a wire from the common at the amplifier. Measure signal relative to this common. There should be minimal current in this conductor.
Output near 11 V when thermocouple is at room temperature.	- 15 V supply is disconnected.	Measure continuity from power supply to amplifier's Violet terminal.	Repair broken wire.
Output near -2.2 V when thermocouple is at room temperature.	+ 15 V supply is disconnected.	Measure continuity from power supply to amplifier's Blue terminal.	Repair broken wire.
Output near -0.5 V when thermocouple is at room temperature.	Common is disconnected.	Measure continuity from power supply to amplifier's Grey terminal.	Repair broken wire.

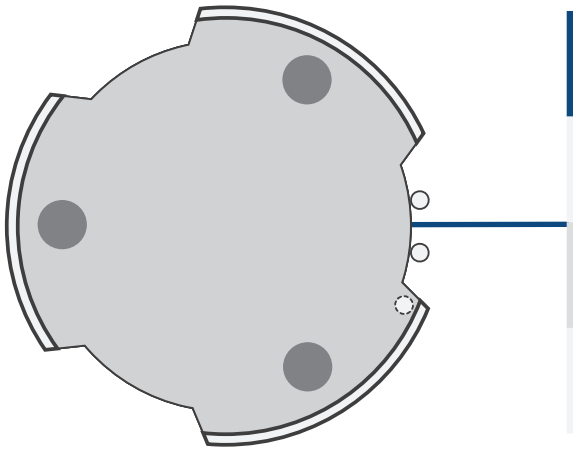
Creating a Model Number



Drawings and Pin Diagrams

AMP-TC2-_2 Customer Drawing

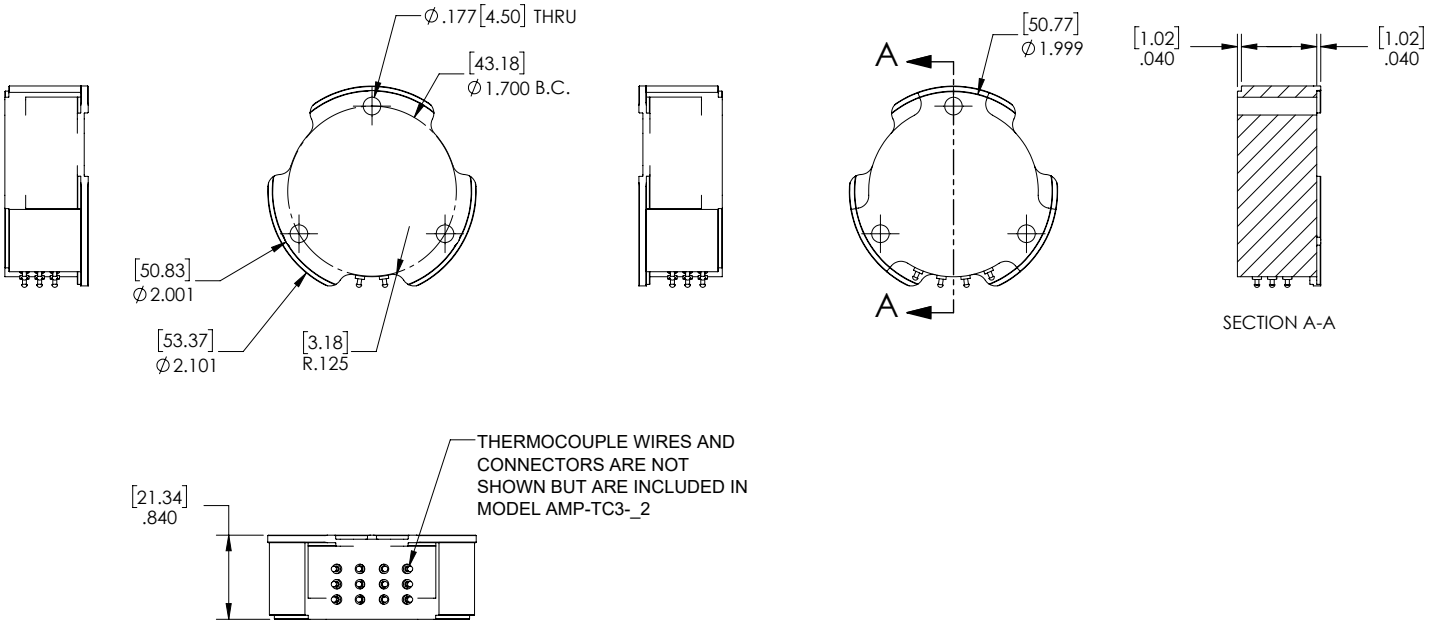


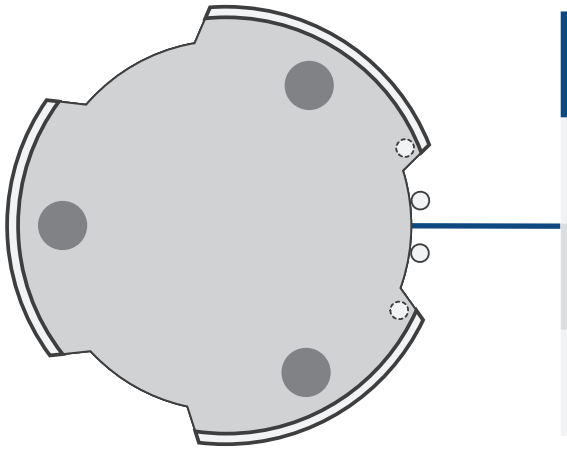


Power Supply	Channel 1	Channel 2
+ 15 Volts	Output	Output
- 15 Volts	High Input[1]	High Input[1]
Common	Low Input	Low Input

[1]Yellow for type K, Blue for Type T

AMP-TC3-_2 Customer Drawing

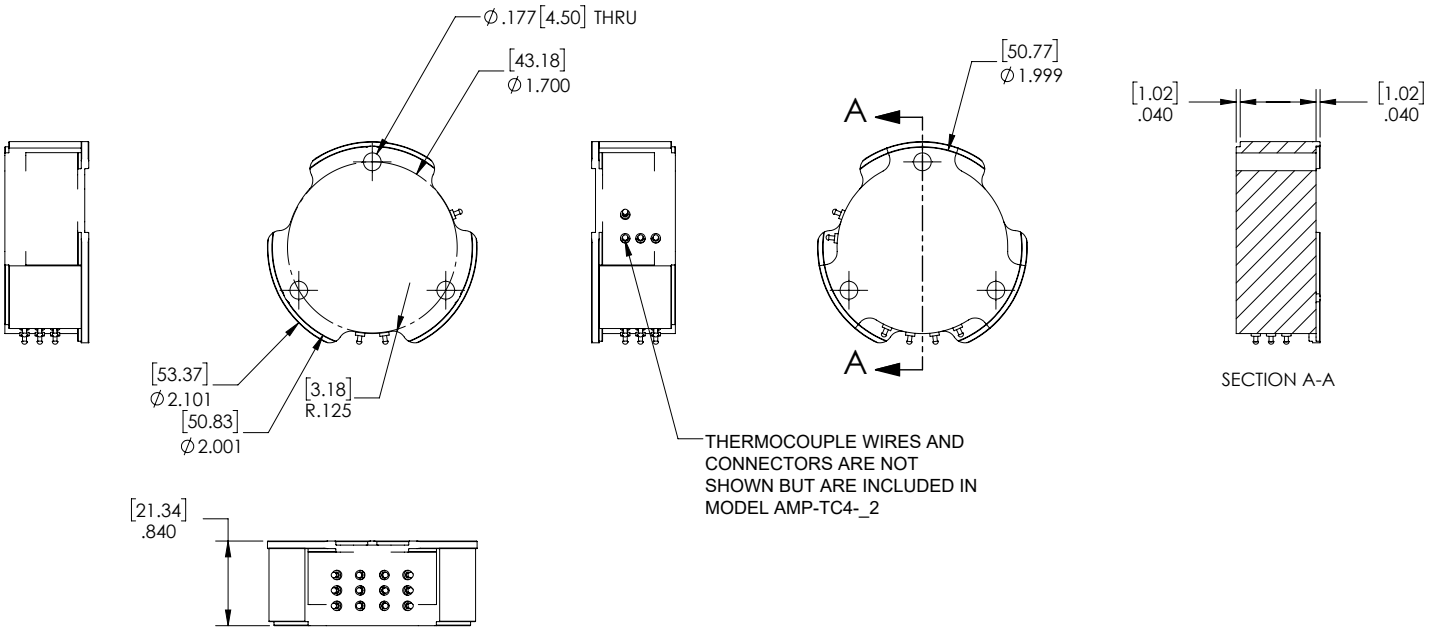




Power Supply	Channel 1	Channel 2	Channel 3
+ 15 Volts	Output	Output	Output
- 15 Volts	High Input[1]	High Input[1]	High Input[1]
Common	Low Input	Low Input	Low Input

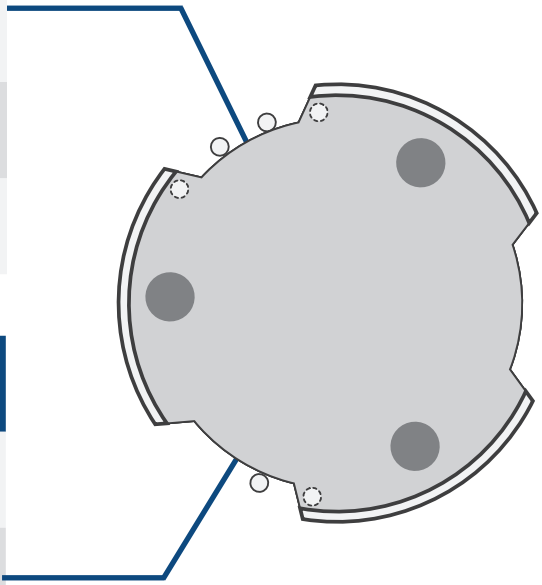
[1]Yellow for type K, Blue for Type T

AMP-TC4-_2 Customer Drawing



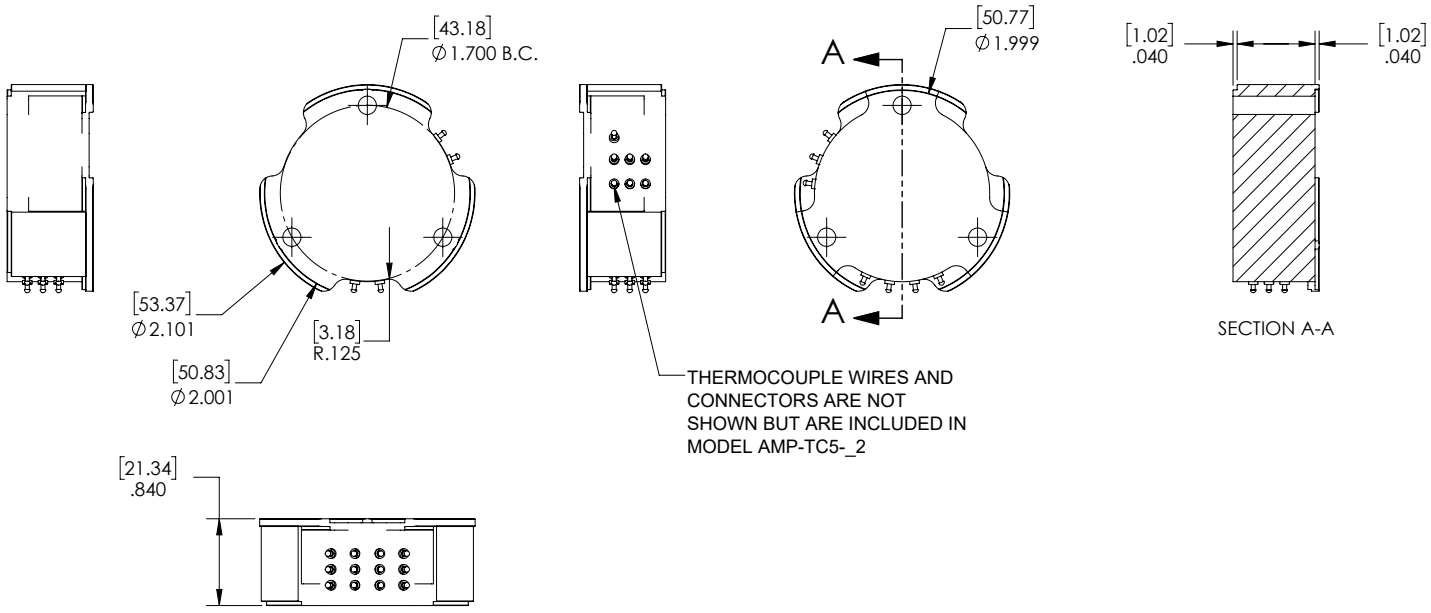
Power Supply	Channel 1	Channel 2	Channel 3
+ 15 Volts	Output	Output	Output
- 15 Volts	High Input[1]	High Input[1]	High Input[1]
Common	Low Input	Low Input	Low Input

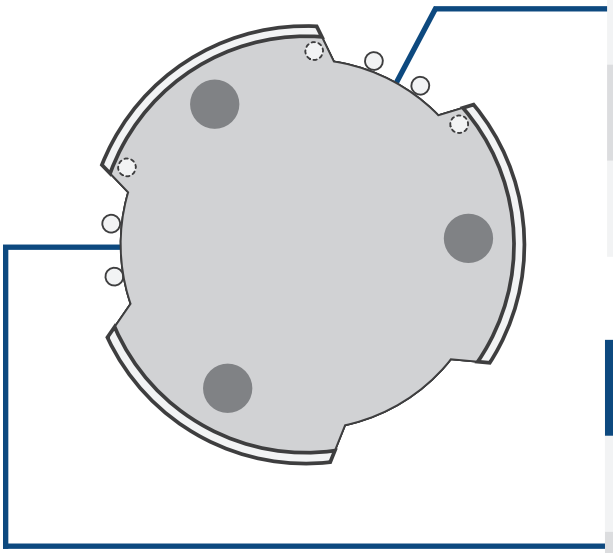
Channel 4	Power Supply
Output	Common
High Input[1]	
Low Input	



[1]Yellow for type K, Blue for Type T

AMP-TC5-_2 Customer Drawing



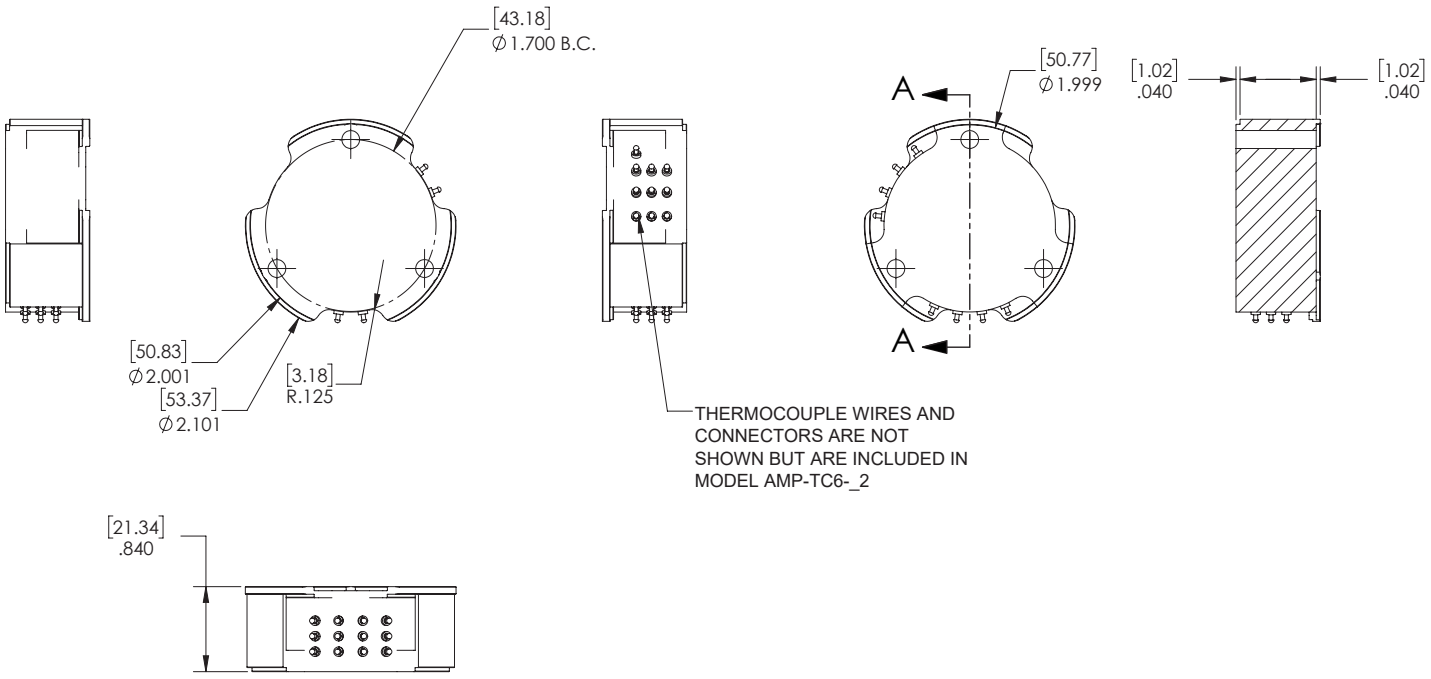


Power Supply	Channel 1	Channel 2	Channel 3
+ 15 Volts	Output	Output	Output
- 15 Volts	High Input[1]	High Input[1]	High Input[1]
Common	Low Input	Low Input	Low Input

Channel 4	Channel 5	Power Supply
Output	Output	Common
High Input[1]	High Input[1]	
Low Input	Low Input	

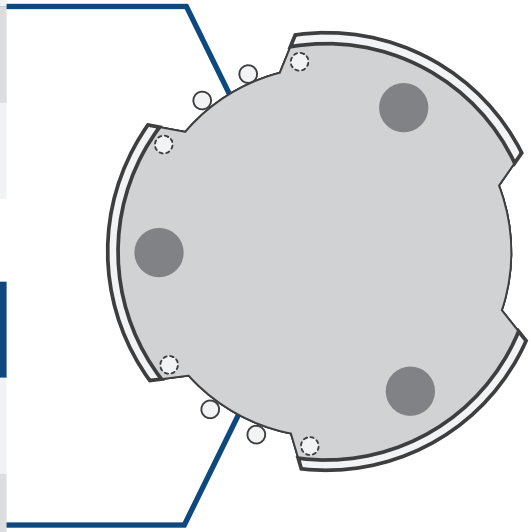
[1]Yellow for type K, Blue for Type T

AMP-TC6-_2 Customer Drawing



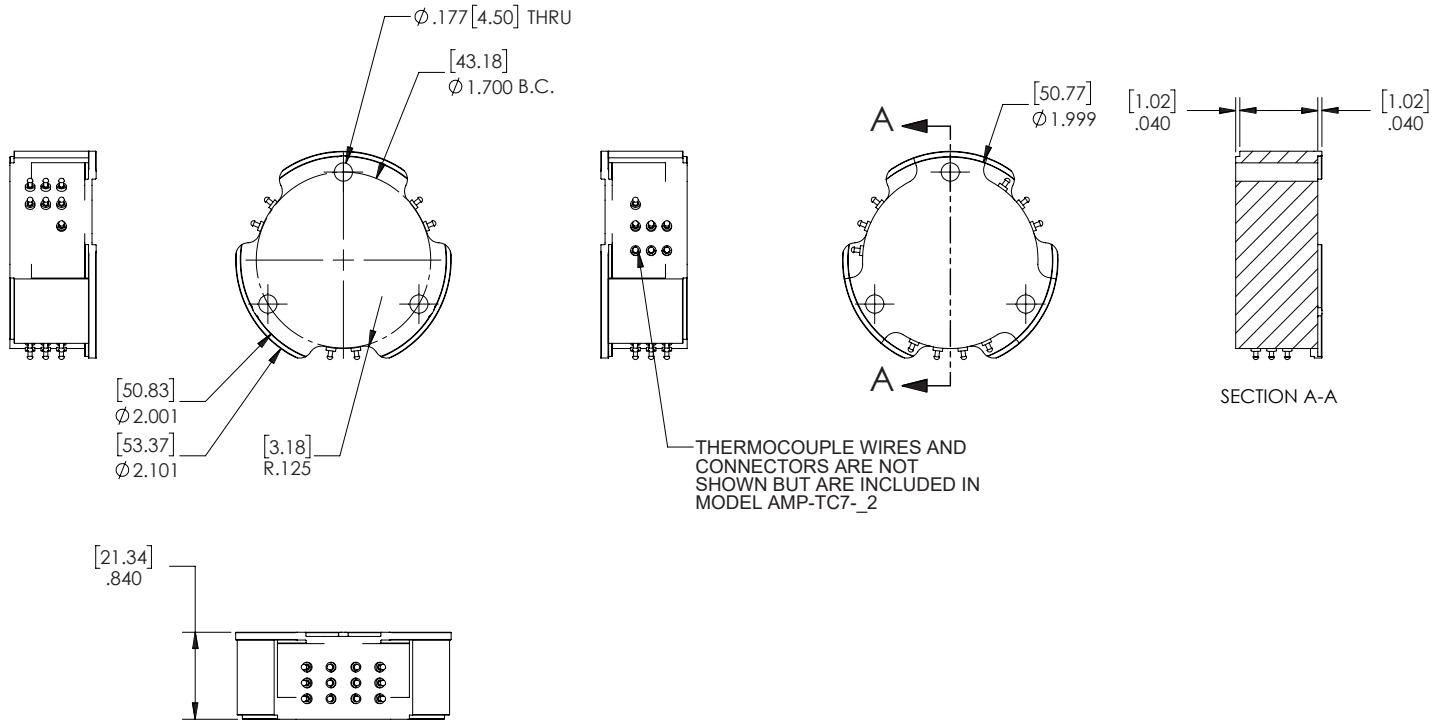
Power Supply	Channel 1	Channel 2	Channel 3
+ 15 Volts	Output	Output	Output
- 15 Volts	High Input[1]	High Input[1]	High Input[1]
Common	Low Input	Low Input	Low Input

Channel 4	Channel 5	Channel 6	Power Supply
Output	Output	Output	Common
High Input[1]	High Input[1]	High Input[1]	
Low Input	Low Input	Low Input	



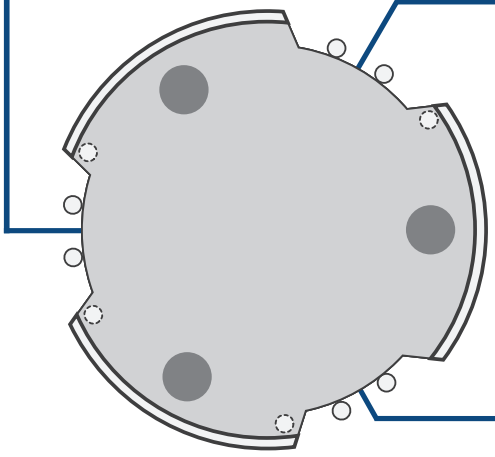
[1]Yellow for type K, Blue for Type T

AMP-TC7-_2 Customer Drawing



Power Supply	Channel 1	Channel 2	Channel 3
+ 15 Volts	Output	Output	Output
- 15 Volts	High Input[1]	High Input[1]	High Input[1]
Common	Low Input	Low Input	Low Input

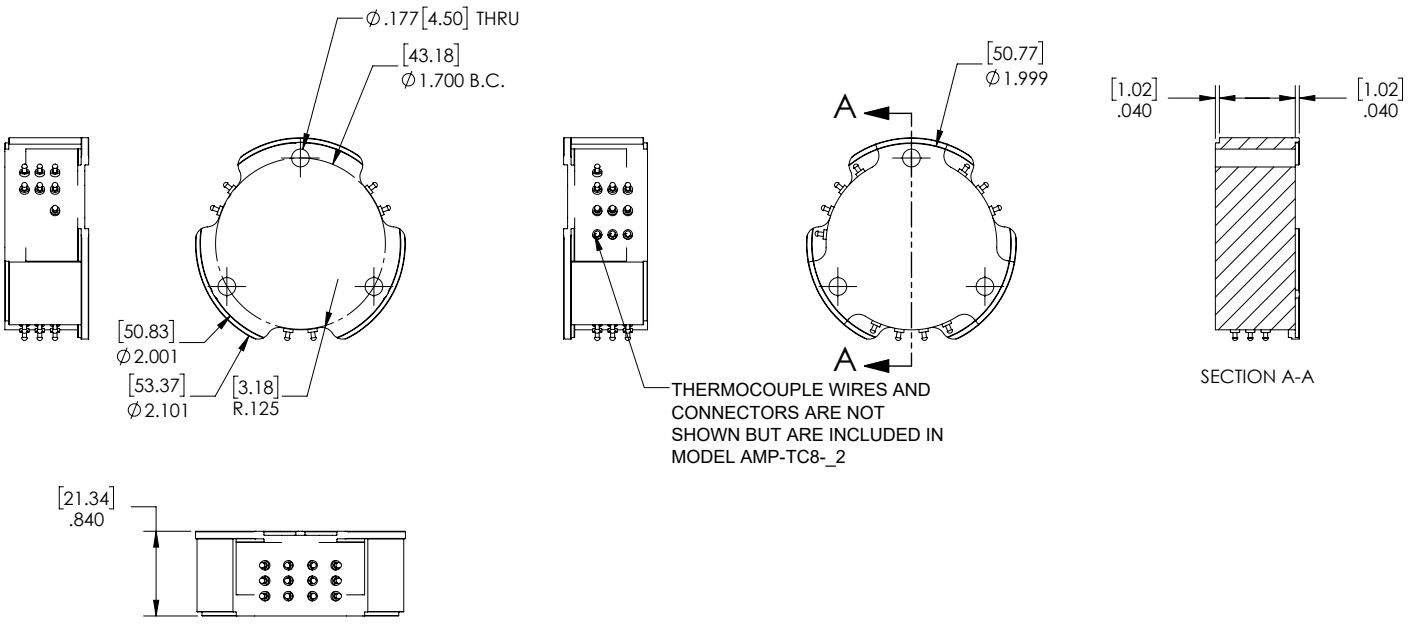
Channel 6	Channel 7	Power Supply
Output	Output	Common
High Input[1]	High Input[1]	
Low Input	Low Input	



Channel 4	Channel 5	Power Supply
Output	Output	Common
High Input[1]	High Input[1]	
Low Input	Low Input	

[1]Yellow for type K, Blue for Type T

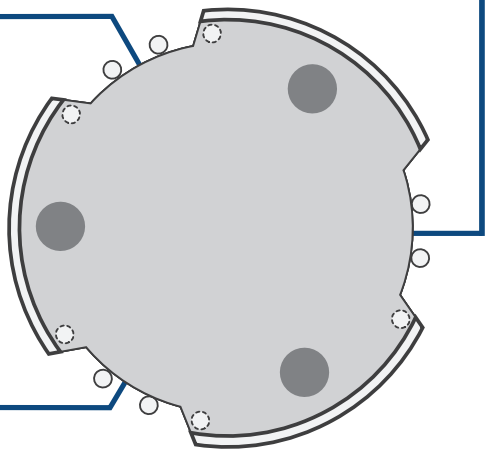
AMP-TC8-_2 Customer Drawing



Power Supply	Channel 1	Channel 2	Channel 3
+ 15 Volts	Output	Output	Output
- 15 Volts	High Input[1]	High Input[1]	High Input[1]
Common	Low Input	Low Input	Low Input

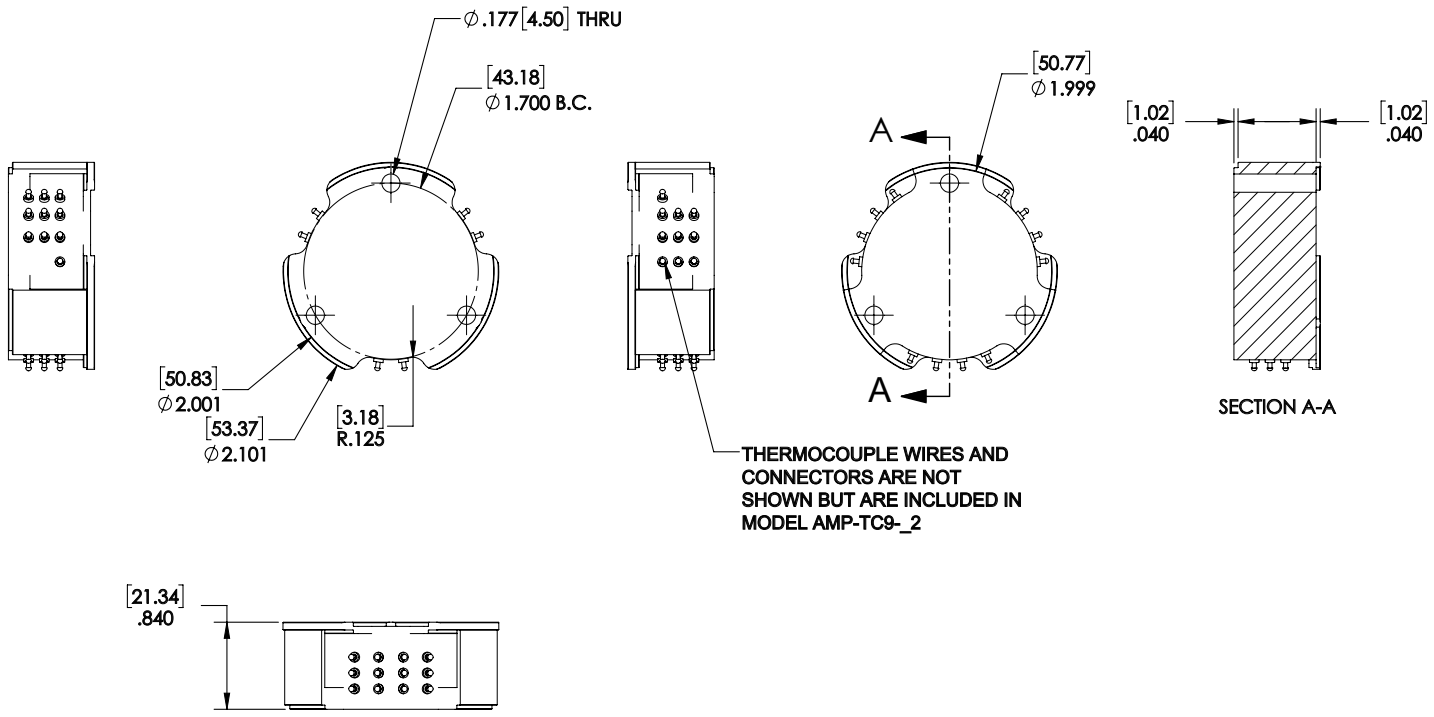
Channel 7	Channel 8	Power Supply
Output	Output	Common
High Input[1]	High Input[1]	
Low Input	Low Input	

Channel 4	Channel 5	Channel 6	Power Supply
Output	Output	Output	Common
High Input[1]	High Input[1]	High Input[1]	
Low Input	Low Input	Low Input	



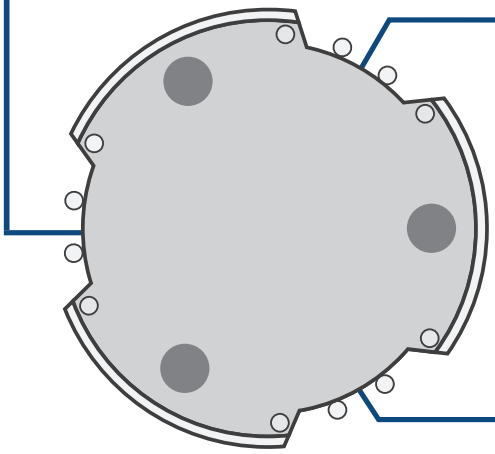
[1]Yellow for type K, Blue for Type T

AMP-TC9-_2 Customer Drawing



Power Supply	Channel 1	Channel 2	Channel 3
+ 15 Volts	Output	Output	Output
- 15 Volts	High Input[1]	High Input[1]	High Input[1]
Common	Low Input	Low Input	Low Input

Channel 7	Channel 8	Channel 9	Power Supply
Output	Output	Output	Common
High Input[1]	High Input[1]	High Input[1]	
Low Input	Low Input	Low Input	



Channel 4	Channel 5	Channel 6	Power Supply
Output	Output	Output	Common
High Input[1]	High Input[1]	High Input[1]	
Low Input	Low Input	Low Input	

[1]Yellow for type K, Blue for Type T