Exhaust Gas Technologies Thermocouple Amplifier Datasheet

Single Channel
Dual Channel
Quad Channel

Overview

The EGT Thermocouple Amplifier conditions and amplifies the signal from an ungrounded Type K thermocouple into a useful 0 - 5V signal which can be used by a variety of instruments and microcontrollers. The thermocouple output of the amplifier is 4mV per degree Celsius. The amplifier can operate on a minimum of 5V with a reduced thermocouple temperature reading range of 0°C to 300°C. It is recommended to operate the amplifier at a minimum of 14.5V but no more then 32V to achieve the full temperature reading range of 0°C to 1250°C. For best results the amplifier should be mounted in a location without large temperature fluctuations while in operation. While the thermocouple connected to the amplifier can measure up to 1250°C, the amplifier should be mounted to a location that does not exceed 80°C or the plastic enclosure will suffer damage.

Connection Information

The amplifier has 3, 4, or 6 wires depending on if the amplifier is a single channel, dual channel, or quad channel amplifier. Use the table below for connecting the amplifier. The thermocouple leads for dual channel and quad channel amplifiers have a colored plastic indicator corresponding to the channel that the thermocouple is connected to.

Wire Color	Function	Notes
Red	Power	
Black	Ground	
White	Thermocouple Output A	Thermocouple lead will have white plastic indicator[1]
Blue	Thermocouple Output B	Thermocouple lead will have blue plastic indicator
Yellow	Thermocouple Output C	Thermocouple lead will have yellow plastic indicator
Green	Thermocouple Output D	Thermocouple lead will have green plastic indicator

[1] Single Channel Amplifiers have no colored indicator as there is only one thermocouple lead

Each thermocouple lead consists of two wires, a positive yellow Chromel wire and a negative Red Alumel wire. The terminal of the Chromel wire is stamped with "CR" and the terminal of the Alumel wire is stamped with "AL".

Thermocouple Lead Wire Color	Function	Notes
Yellow	Ungrounded Thermocouple Positive (+)	Chromel Alloy wire. Terminal stamped with "CR"

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Red	Ungrounded Thermocouple Negative (-)	Alumel Alloy wire. Terminal stamped with "AL"

Note: Use standard Type K thermocouple wire to extend the thermocouple leads or inaccurate measurements will result. Standard copper wire is not suitable as an extension wire.
Note: Use only ungrounded thermocouples sensors with the amplifier. Grounded thermocouple sensors are not suitable for use with the amplifier.

Bench Test Procedure

Clip the ends of the thermocouple leads together securely to form a temporary thermocouple junction if no thermocouple is connected. Apply 5V power and ground to the amplifier. Use a multimeter to measure the output of the thermocouple with reference to ground. An open thermocouple will measure at close to maximum temperature. A room temperature junction should measure roughly 80mV (15°C/ 59°F) to 120mV (35°C/95°F). The output of the amplifier should read roughly ±5°C of room temperature.

Electrical Characteristics

Absolute Maximum Ratings

Parameter	Max	Units
Maximum Operating Temperature	80	°C
Maximum Storage Temperature	80	°C
Maximum Voltage[2]	36	V
Thermocouple output shorted to ground	Indefinite	

[2] Maximum transient voltage

DC Characteristics

Parameter	Min	Max	Units
Power Voltage	5.0	32.0	V
Recommended Power Voltage	14.5	32.0	V
Thermocouple Output Voltage	0.0	5.0	V
Maximum Current		10	mA

The maximum measurable thermocouple temperature is dependent on the power voltage applied to the amplifier. Use the chart below to estimate the maximum measurable temperature based on the power voltage applied. Any power voltage greater then 14.5V will allow the amplifier to measure the full thermocouple temperature range of 0°C to 1250°C

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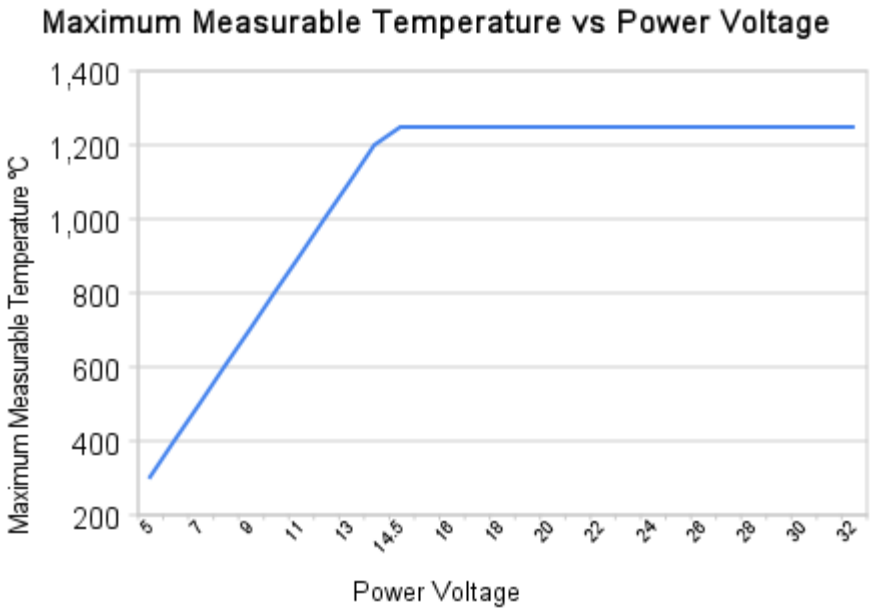

Temperature Measurement

Parameter	Min	Max	Units
Temperature Measurement Range	0	1250[3]	°C
Nominal Scale	4	4	mv/ °C
Nominal Amplifier Gain Error	-1.5	+1.5	%
Recommended resistance of ADC connected to Thermocouple Output	500[4]		kOhm
Samples per Second	Continuous	Continuous	

[3] Requires minimum of 14.5V power

[4] Lower resistance ADCs can be used with a slightly different nominal scale. To compute the approximate new nominal scale in mv/°C use the formula [nominal scale] = 51 / (126 + 382500 / R) where R is the ADC resistance in ohms

Temperature Measurement Speed

The internal thermocouple amplifier continuously amplifies the thermocouple signal which effectively gives an infinite number of samples per second. When used with the majority of Type-K thermocouples the slew rate of the amplifier is at least an order of magnitude higher then the response slew rate of the thermocouple itself, so response time is limited by the thermocouple sensor and not the amplifier.

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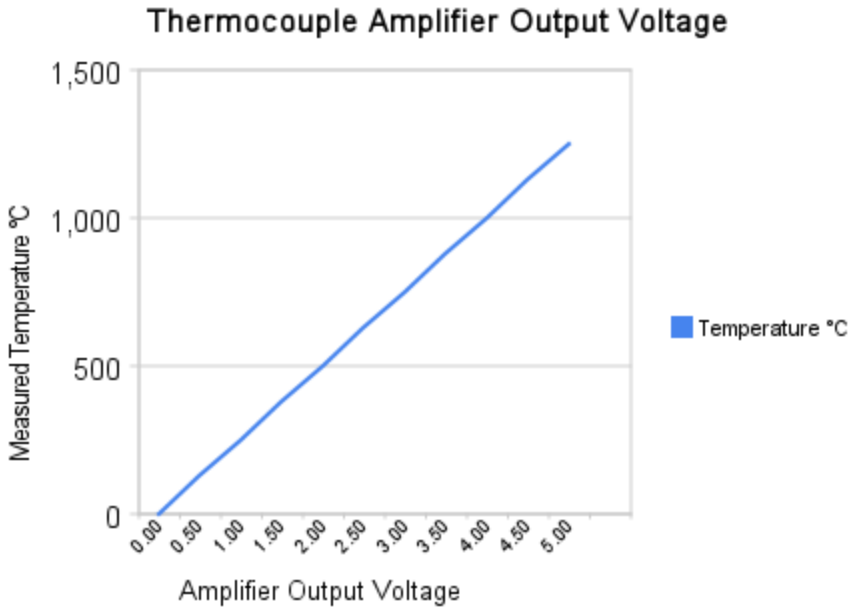

Worst Case Error Measurements

Parameter	Min	Max	Units
Offset[5]	-4	+4	°C
Amplifier Gain Error	-2.11	+3.28	%
Temperature Stability	-0.05	+0.05	°C / °C

[5] Measured at hot junction temperature of 175°C and cold junction temperature of 60°C

High Accuracy Calibration

It is possible to achieve much higher accuracy readings from the thermocouple amplifier if the conversion function or lookup table of the instrument reading the thermocouple amplifier can be calibrated to the specific errors of the attached thermocouple amplifier. If the offset error and amplifier gain error are considered constant throughout the temperature measurement range and are measured accurately for the thermocouple amplifier then the errors can be compensated for in the instrument and high accuracy readings can be obtained.

To measure the offset error, place the thermocouple in ice water (0 °C) and read the temperature the thermocouple amplifier reports. It should nominally report 0 °C, the actual reading the thermocouple amplifier reports is the offset error. For example if the thermocouple amplifier reports a temperature of +1 °C instead of 0 °C then the offset error is +1 °C.

To measure the amplifier gain error, place the thermocouple in boiling water (100 °C) and read the temperature the thermocouple amplifier reports. Subtract the offset error from the reported temperature and divide by 100. The result is the amplifier gain error. For example if the thermocouple amplifier reports 103 °C, subtract the offset error (+1 °C in this example), the result is 102 °C, then divide by 100, the result is 1.02 so the amplifier gain error is +2%

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With the offset error and the amplifier gain error now known, a new voltage to temperature function can be calculated and used in the instrument to convert the voltage reported by the thermocouple amplifier to an actual temperature measured by the thermocouple. The function can be written as

Temperature °C = (Voltage / (0.004 * (1 + amplifier gain error))) - offset error

where the 0.004 in the function is the nominal 4mv / °C

In our example the amplifier gain error was 2% and the offset error was +1 °C so our calibrated temperature function would be

Temperature °C = (Voltage / (0.004 * (1 + 0.02))) - 1

Multiple Channel Temperature Discrepancies

When using the dual and quad channel amplifiers with the thermocouples of different channels attached to the same object to be measured it will be noticed that even though the actual temperature of the object is identical at the point where the thermocouples are attached, the thermocouple amplifier may report slightly different temperatures for each channel. This is normal behavior because each channel of the thermocouple amplifier has slightly different error characteristics caused by tolerances in the laser trimming calibration of the amplifier and differing tolerances in the components used external to the amplifier, along with any error tolerances in the thermocouples themselves. Be assured that although each channel may report a slightly different temperature, all of the channels should be within the error tolerances stated in this datasheet.

Some multichannel thermocouple amplifiers from other manufacturers try to guess when multiple channels are measuring the same object and fake the output of the channels so that the channels appear to always report the same temperature even though internally the channels are reporting different temperatures. This is not done with the EGT thermocouple amplifier because locking the channels together to show the same output may be visually pleasing and give a false sense of accuracy, but is deceiving the user as to the real temperature of the probes.

Mechanical Dimensions

Height 20mm
Width 35mm
Length 68mm
Mounting Slot Spacing 57.8mm

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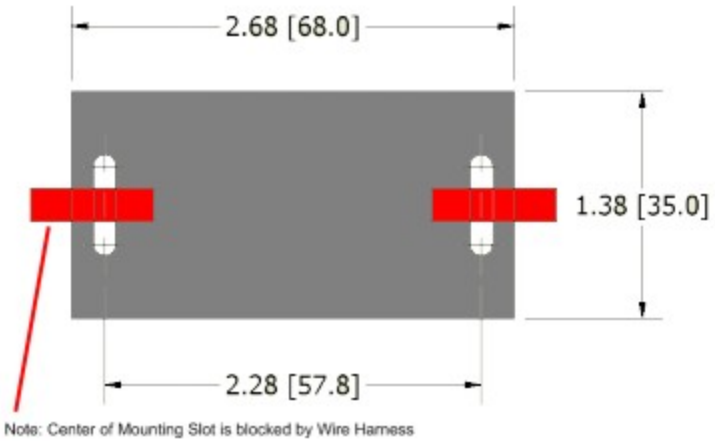
Mounting Diagram



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