Features

- Negative common-mode range handling for grounded thermocouples (-1.5 - 6V)
- Available for J and K type thermocouples
- Cold-junction compensated
- Protected for high humidity environments
- Wide supply voltage range (7-26V)
- 0-5V output, 4mV / °C output
- +/- 3°C initial accuracy
- -250-1000°C Temperature range
- Ttc = ((Vout –1.0V) / 0.004)°C (see below for nonlinearity information)
- Mini thermocouple connectors standard, other options available upon request
- 5” stub harness for power and output
- Mounting flange for direct mounting
- Small 2.33” x 4.33” footprint
- RoHS compliant

Applications

- Automotive data acquisition (EGT, etc)
- Racing instrumentation
- Industrial and Chemical applications
- Research instrumentation
- Oven temperature measurements
- Brewing

Description

FDQ-10001 analog thermocouple amplifier modules are designed to convert very low voltage signals from J- and K-type thermocouples to a highly-linear, 0.004V/°C output with a 1.0 V offset (0°C = 1V output). The output signal can be read by a multitude of standard measurement devices, including digital multimeters, data acquisition systems, or even analog input on an Arduino.

The standard output signal range of 0-5V covers a -250°C - 1,000°C temperature range with both J- and K-type thermocouples. To get the best accuracy across an extended operating range, non-linearity correction may be desirable. Temperature correction tables are available in this document to enable this.

The wide, 7-26V DC supply voltage range is designed to support a wide variety of applications, from racing and automotive projects to industrial temperature measurement. See Table 1 for the optimized operating range for the different sensor options.

Table 1: Sensor Temperature Ranges

PWF Part No.	Thermo-couple Type	Optimized Temperature Range: Ambient Temperature (board temperature)	Optimized Temperature Range: Measurement Junction
FDQ-10001-J	J	0°C to 50°C	Full J type range
FDQ-10001-K	K	0°C to 50°C	Full K type range

'sensors optimized for ambient environments from 25-100°C available upon request

In addition, analog filtering is included to remove unwanted EMI on the input stage of

the conditioner. Common mode filtering with a cutoff frequency of 1 kHz is included, as well as 50 Hz differential signal filtering. For fault detection, an open input results in an output signal that floats high.

Table 2: Standard Operating Parameters

Parameter	Rating
Supply Voltage	7.0 - 26.0V
Operating Temperature (T_{amb})	0°C to 50°C
Absolute Accuracy (initial)	3°C
Storage Temperature	-40°C to 125°C

Performance Characteristics

The FDQ-10001/X devices are designed to output a linear signal based on an input from J-Type or K-Type thermocouples and include cold-junction compensation. As a result, the output of the SEN-30101/XX can be approximated as linear over a specified window, with degradation of the estimate outside of this window. See Table 3 for details.

Table 3: Sensor Temperature Linearization

PWF Part No.	Thermo-couple Type	Measurement Jcn Temperature Ranges	
		+/- 2°C linearity, no correction applied	Correction tables applied
FDQ-10001-J	J	-35°C to 95°C	Full J type range
FDQ-10001-K	K	-25°C to 400°C	Full K type range

As such, one of two methods should be used to handle the output voltage from the sensors. The method chosen will depend on linearity accuracy requirements as well as the required operational range of the input signal. Absolute accuracy is separate from the linearity accuracy, and can be found in Table 4.

In one application example, if a +/- 2°C linearity accuracy is acceptable and the sensing application will stay within the windows shown in Table 2, temperature conversion is straightforward and calculated based on output voltage with the formula:

Ttc = ((Vout – 1.00) / 0.004)°C

This formula applies for both J-Type and K-type sensors. This formula is also fitting for applications with less stringent linearity accuracy requirements and wider operating ranges. Often, reference measurements or applications where difference between two temperatures are what is important meet this definition. See Figure 1 for accuracy and Figure 2 for sensor response across the input temperature operating range.

If linearity accuracy provided by the formula in the previous example is not acceptable, there is an alternative method that corrects for linearity error. Specifically, correction tables can be used to correct the high-order non-linearity across the sensor's operating range. See Table 5 for this information (calculated based on Analog Devices AN-1087). This correction is directly related to the high-order
response characteristics of the respective thermocouples.

Figure 1: K-Type Temperature Error vs Probe Temperature

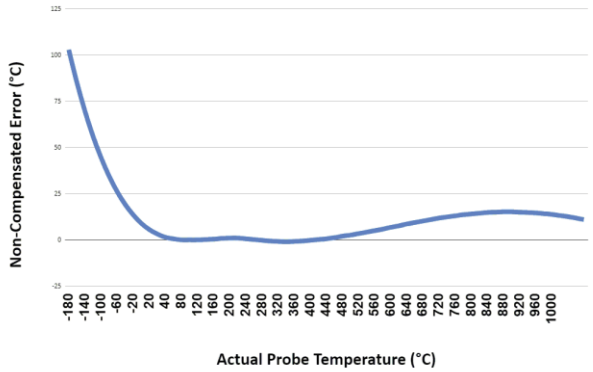
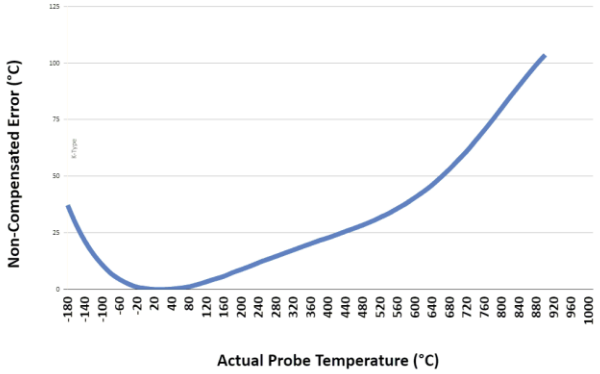


Figure 2: J-Type Temperature Error vs Probe Temperature



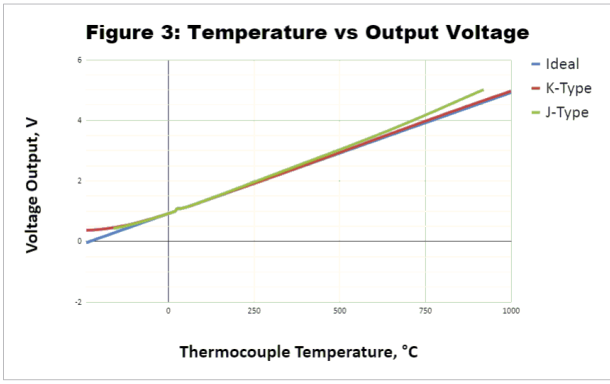


Table 4: Absolute Maximum Ratings

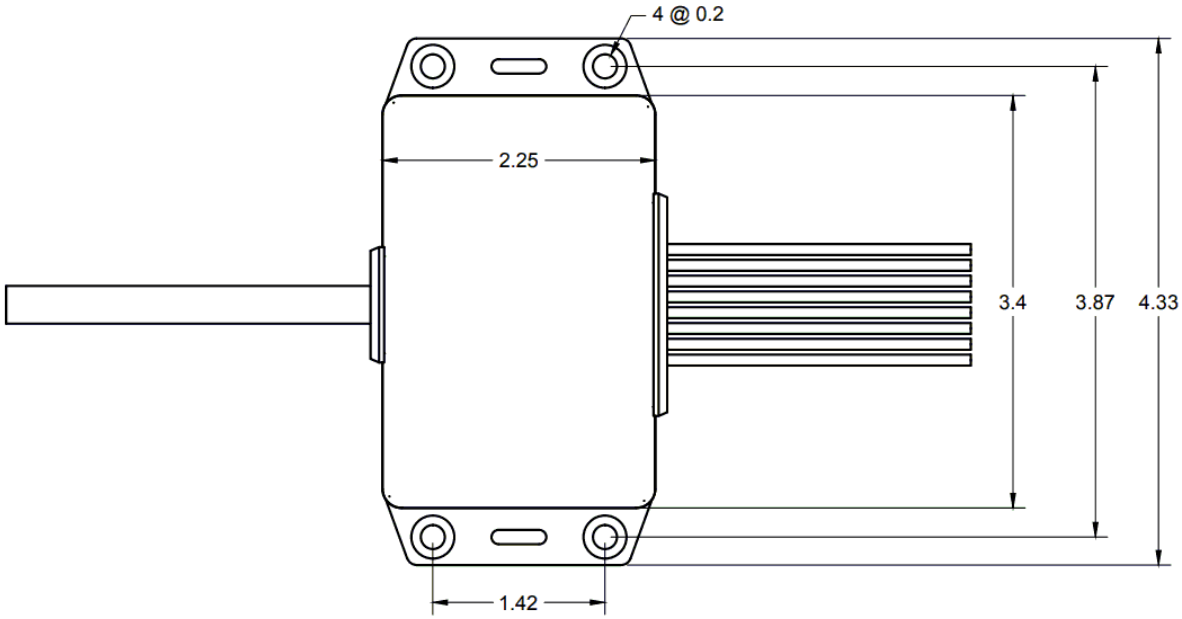
Parameter	Rating
Supply Voltage (peak)	30V (short pulse)
Reverse Supply Protection	-30V across supply pins
Output Short Circuit Duration	Indefinite
Operating Temperature	-25°C to 85°C
Storage Temperature	-40°C to 125°C

Table 5: Correction Tables for FDQ-10001/X Thermocouple Sensors

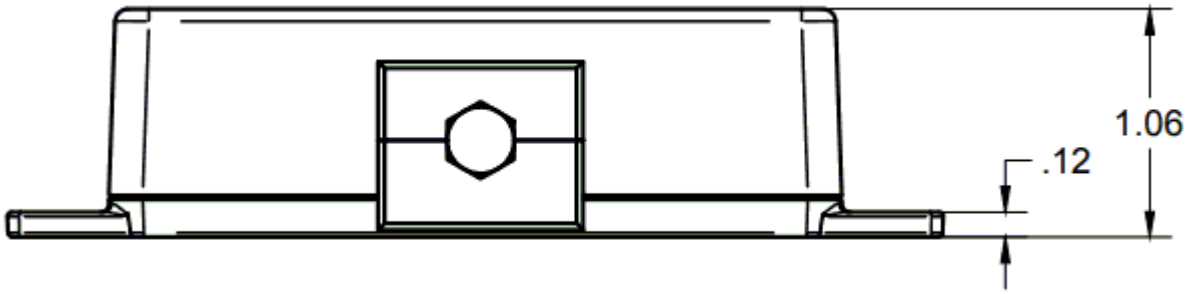
Measurement Junction Temperature (°C)	Ideal Output (V)	Actual Output (V)	
	FDQ-10001/(J/K)	FDQ-10001 K-Type	FDQ-10001 J-Type
-260	-0.04	0.3712	
-240	0.04	0.3808	
-220	0.12	0.3992	
-200	0.2	0.4248	
-180	0.28	0.4584	0.4288
-160	0.36	0.4984	0.4736
-140	0.44	0.5448	0.5248
-120	0.52	0.5968	0.5816
-100	0.6	0.6544	0.6432
-80	0.68	0.716	0.708
-60	0.76	0.7824	0.7776
-40	0.84	0.8528	0.8496
-20	0.92	0.9256	0.924
0	1	1.0024	1.0016
20	1.08	1.08	1.08
25	1.1	1.1	1.1
40	1.16	1.16	1.1608
60	1.24	1.2408	1.2424
80	1.32	1.3216	1.3248
100	1.4	1.4032	1.4088
120	1.48	1.484	1.4936
140	1.56	1.564	1.5784
160	1.64	1.6424	1.6632
180	1.72	1.7208	1.7496
200	1.8	1.7992	1.8352
220	1.88	1.8776	1.9208
240	1.96	1.9568	2.0072
260	2.04	2.036	2.0928
280	2.12	2.1168	2.1784
300	2.2	2.1976	2.264
320	2.28	2.2792	2.3496
340	2.36	2.3608	2.4352
360	2.44	2.4424	2.5208
380	2.52	2.5248	2.6064
400	2.6	2.608	2.6912
420	2.68	2.6904	2.7768
440	2.76	2.7736	2.8624
460	2.84	2.8568	2.948
480	2.92	2.94	3.0336
500	3	3.0232	3.12
520	3.08	3.1072	3.2072
540	3.16	3.1904	3.2944

Measurement Junction Temperature (°C)	Ideal Output (V)	Actual Output (V)	
	SEN30101/K1 SEN30101/J1	SEN30101 /K1 K-Type	SEN30101 /J1 J-Type
560	3.24	3.2744	3.3832
580	3.32	3.3576	3.472
600	3.4	3.4408	3.5624
620	3.48	3.524	3.6528
640	3.56	3.6072	3.7448
660	3.64	3.6896	3.8384
680	3.72	3.772	3.9328
700	3.8	3.8544	4.0288
720	3.88	3.936	4.1248
740	3.96	4.0176	4.2232
760	4.04	4.0992	4.3216
780	4.12	4.18	4.4208
800	4.2	4.2608	4.5208
820	4.28	4.3408	4.6208
840	4.36	4.42	4.72
860	4.44	4.4992	4.8192
880	4.52	4.5784	4.9176
900	4.6	4.6568	5.0144
920	4.68	4.7352	
940	4.76	4.8128	
960	4.84	4.8904	
980	4.92	4.9672	
1000	5	5.044	

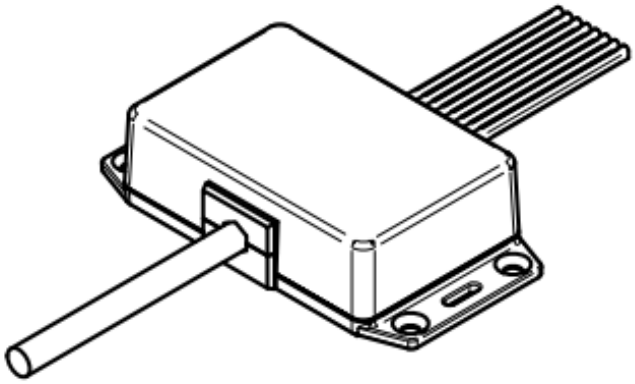
Appendix 1: Mech Drawing (Top View)



Appendix 2: Mech Drawing (Side View)



Appendix 3: Wiring



Notes:

Wiring Bundle

Red:	Vsupply (7-24V)
Black:	Ground
White:	TC1
Blue:	TC2
Yellow:	TC3
Green:	TC4
Gray:	TC5
Purple:	TC6
Orange:	TC7
Brown:	TC8

Wires are stranded 20AWG
Minimum 5" wire stub length
Wire bundle is wrapped with wire braid

Thermocouple Inputs

Mini-style blade connectors installed standard
24AWG stranded TC wire
Minimum 5" TC wire stub length

Revision History

Date	Author	Notes
4/1/2019	J. Steinlage	Original release
6/1/2020	J. Steinlage	Update mechanical data, wire colors.