

Features

- Available for J and K type thermocouples (K std, J upon request / 1 wk lead)
- Cold-junction compensated
- Wide supply voltage range (5-32V)
- 0-10V output (max range)
- +/- 3°C initial accuracy
- Measures full range of thermocouples (K: -260-1380°C; J: -180-1200°C)
- $T_{tc} = ((V_{out} - 2.05) / 0.005)^\circ C$ (see below for nonlinearity information)
- Mini thermocouple connectors
- Screw blocks for power and output signals
- LED indicators for power supply status
- 4 mounting holes sized for 4-40 screws
- Small 1.7" x 2.7" footprint
- RoHS compliant

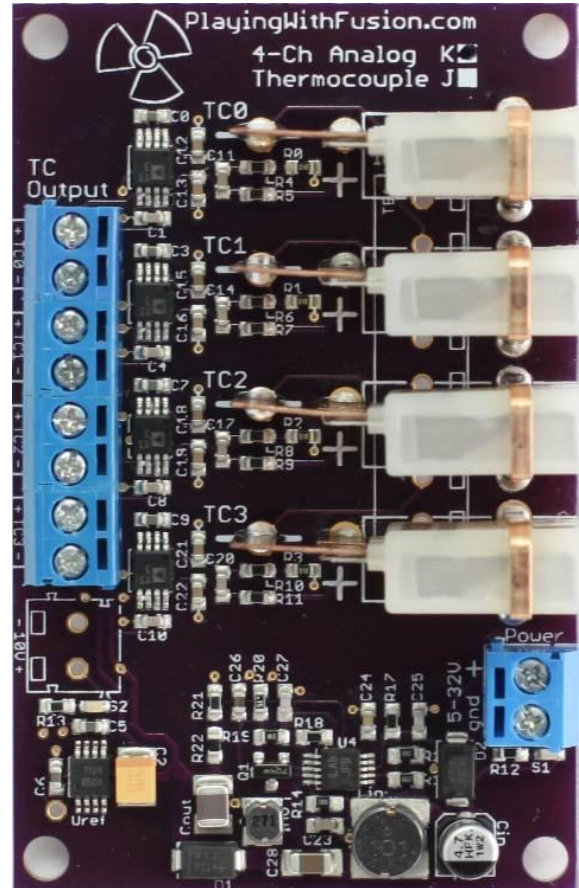
Applications

- Automotive data acquisition (exhaust, coolant, brakes, etc)
- Industrial instrumentation
- Oven temperature measurements
- Home brew setups
- Celsius thermometer
- Full range of hobby projects
 - 5V supply range allows use with Arduino power source
 - Build a reflow oven or kegerator!

Description

The SEN-30101K1/J1 series are analog thermocouple amplifier devices based on the AD849x series from Analog Devices, successor of the AD597. These quad-channel thermocouple boards convert very low voltage signals from K and J-type thermocouples to a highly-linear, 0.005V/°C output with 2.05V offset (0°C = 2.05V output) that is cold-junction compensated. The output signal can be read by a multitude of standard measurement devices, including digital multimeters, data acquisition systems or an analog input on an Arduino (with input range limiting). See Appendix for application info.

The standard output signal range is within 0-10V that covers the entire standard operating range of the different thermocouples (K: -260–1380°C; J: -180–1200°C), with correction tables available to accommodate non-linearity at very low and very high temperatures. The wide supply voltage range is



designed to support a wide variety of applications, from hobbyist projects (Arduino, homebrew) to automotive and 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)	Measurement Junction
SEN-30101/J1	J	0°C to 50°C	Full J type range
SEN-30101/K1	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. Included in the input stage is a 1 MΩ resistor that is connected to the negative input line. This is to minimize any common-mode voltage without injecting any additional measurement errors.

Performance Characteristics

The SEN-30101/XX devices are designed to output a linear signal based on an input from J-Type or K-Type thermocouples. This is accomplished by the integration of an operational amplifier and cold-junction compensation within the AD849x series ICs. 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 2 for details.

Table 2: Sensor Temperature Linearization

PWF Part No.	Thermocouple Type	Ranges	
		+/- 2°C linearity, no correction applied	Correction tables applied
SEN-30101/J1	J	-35°C to 95°C	Full J type range
SEN-30101/K1	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 straight forward and calculated based on output voltage with the formula:

$$T_{tc} = ((V_{out} - 2.05) / 0.005)^\circ\text{C}.$$

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. 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: Temperature Error vs Probe Temperature

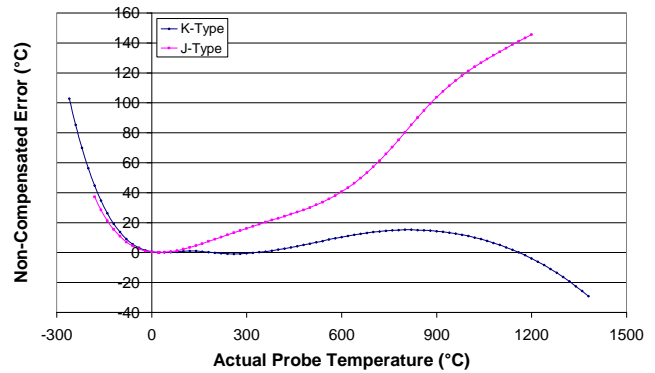


Figure 2: Temperature vs Output Voltage

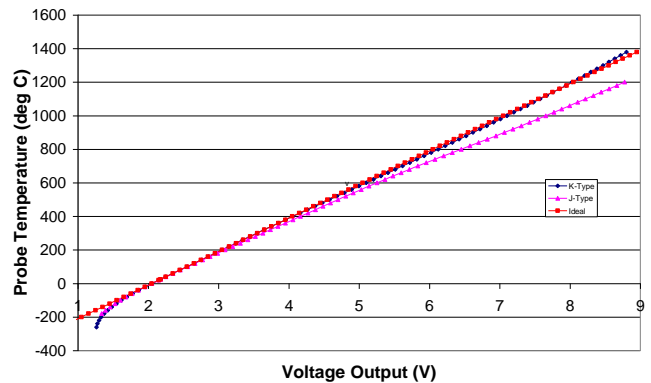


Table 3: Absolute Maximum Ratings

Parameter	Rating
Supply Voltage (operational)	4.75V to 32V
Reverse Supply Protection	-32V across supply pins
Output Short Circuit Duration	Indefinite
Operating Temperature	-25°C to 85°C
Storage Temperature	-40°C to 125°C

Table 4: Optimized Operating Characteristics

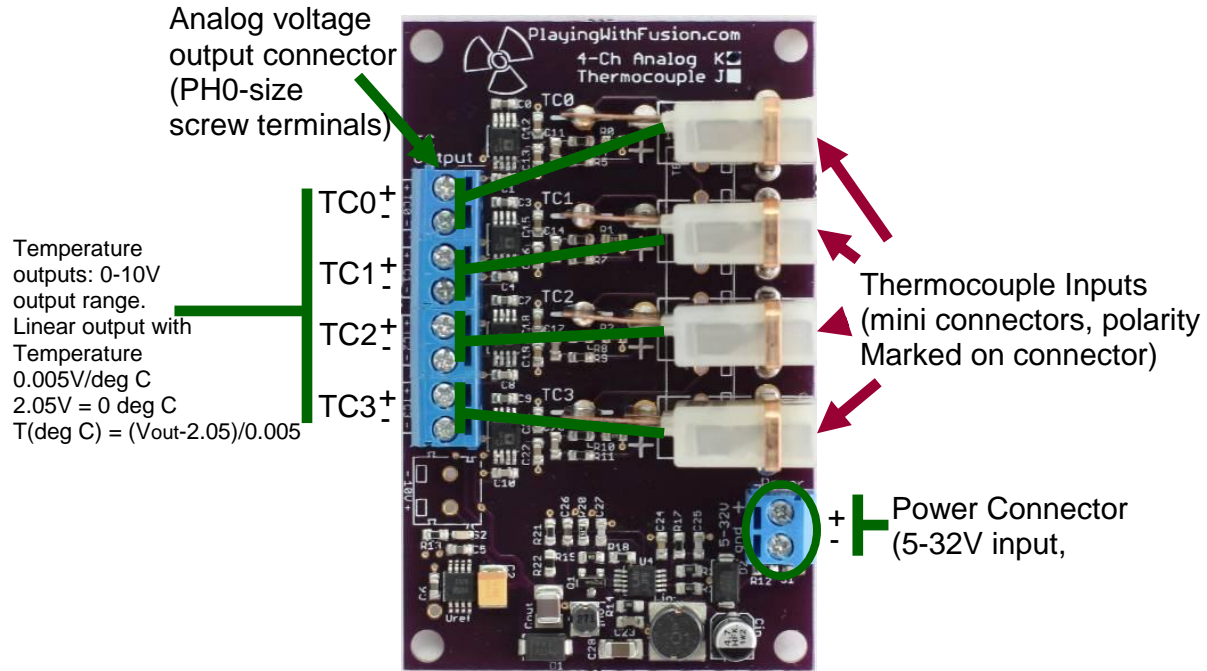
Parameter	Rating
Supply Voltage	5.0V to 32V
Operating Temperature (T _{amb})	0°C to 50°C
Absolute Accuracy (initial)	3°C
Storage Temperature	-40°C to 125°C

Table 5: Correction Tables for SEN-30101/XX Thermocouple Sensors

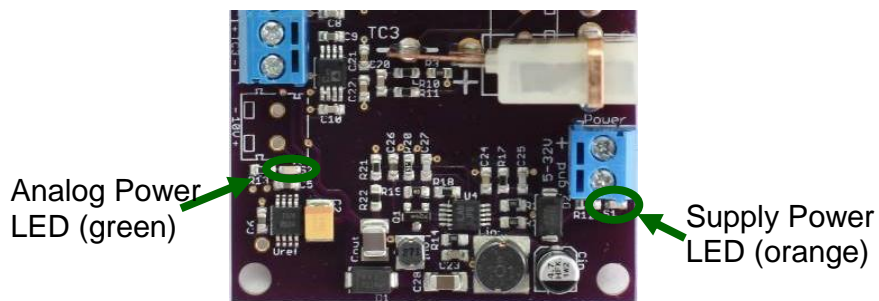
Measurement Junction Temperature (°C)	Ideal Output (V)	Actual Output (V)	
	SEN30101/K1 SEN30101/J1	SEN30101 /K1 K-Type	SEN30101 /J1 J-Type
-260	0.75	1.264	
-240	0.85	1.276	
-220	0.95	1.299	
-200	1.05	1.331	
-180	1.15	1.373	1.336
-160	1.25	1.423	1.392
-140	1.35	1.481	1.456
-120	1.45	1.546	1.527
-100	1.55	1.618	1.604
-80	1.65	1.695	1.685
-60	1.75	1.778	1.772
-40	1.85	1.866	1.862
-20	1.95	1.957	1.955
0	2.05	2.053	2.052
20	2.15	2.15	2.15
25	2.175	2.175	2.175
40	2.25	2.25	2.251
60	2.35	2.351	2.353
80	2.45	2.452	2.456
100	2.55	2.554	2.561
120	2.65	2.655	2.667
140	2.75	2.755	2.773
160	2.85	2.853	2.879
180	2.95	2.951	2.987
200	3.05	3.049	3.094
220	3.15	3.147	3.201
240	3.25	3.246	3.309
260	3.35	3.345	3.416
280	3.45	3.446	3.523
300	3.55	3.547	3.63
320	3.65	3.649	3.737
340	3.75	3.751	3.844
360	3.85	3.853	3.951
380	3.95	3.956	4.058
400	4.05	4.06	4.164
420	4.15	4.163	4.271
440	4.25	4.267	4.378
460	4.35	4.371	4.485
480	4.45	4.475	4.592
500	4.55	4.579	4.7
520	4.65	4.684	4.809
540	4.75	4.788	4.918

Measurement Junction Temperature (°C)	Ideal Output (V)	Actual Output (V)	
	SEN30101/K1 SEN30101/J1	SEN30101 /K1 K-Type	SEN30101 /J1 J-Type
560	4.85	4.893	5.029
580	4.95	4.997	5.14
600	5.05	5.101	5.253
620	5.15	5.205	5.366
640	5.25	5.309	5.481
660	5.35	5.412	5.598
680	5.45	5.515	5.716
700	5.55	5.618	5.836
720	5.65	5.72	5.956
740	5.75	5.822	6.079
760	5.85	5.924	6.202
780	5.95	6.025	6.326
800	6.05	6.126	6.451
820	6.15	6.226	6.576
840	6.25	6.325	6.7
860	6.35	6.424	6.824
880	6.45	6.523	6.947
900	6.55	6.621	7.068
920	6.65	6.719	7.188
940	6.75	6.816	7.307
960	6.85	6.913	7.424
980	6.95	7.009	7.54
1000	7.05	7.105	7.656
1020	7.15	7.2	7.77
1040	7.25	7.295	7.883
1060	7.35	7.389	7.996
1080	7.45	7.482	8.108
1100	7.55	7.575	8.22
1120	7.65	7.667	8.332
1140	7.75	7.759	8.444
1160	7.85	7.85	8.555
1180	7.95	7.941	8.666
1200	8.05	8.03	8.777
1220	8.15	8.119	
1240	8.25	8.208	
1260	8.35	8.295	
1280	8.45	8.382	
1300	8.55	8.468	
1320	8.65	8.553	
1340	8.75	8.637	
1360	8.85	8.721	
1380	8.95	8.804	

Appendix 1: Application Information



Appendix 2: Power Indicators



Appendix 3: Connection to DataQ-149

