Thermocouple Pod (Model EP306)

- Plug and play installation with **e-corder** units
- Use with either a K- or T-type thermocouple probe
- –270 °C to 485 °C (K-type probe)
- –270 °C to 385 °C (T-type probe)
- Offset mode for relative measurements
- Raw signal corresponds to NIST ITS-90 thermoelectric emf values for easy calibration

Description

A compact signal conditioner for use with an **e-corder** unit, enabling continuous monitoring and recording of temperature from K- or T-type thermocouple probes. It can be used in offset mode to monitor small variations around a fixed temperature. Please be familiar with the basic features of the Chart recording software before attempting to use the Pod.

Thermocouple Compatibility

The Thermocouple Pod can be used with most K-type and T-type thermocouples. Suitable thermocouple probes include:

- ET405 K-type Thermocouple Probe
- ET1400 T-type Thermocouple Probe

Applications

With a suitable probe the Pod can be used as a general purpose laboratory thermometer for both research and teaching use, including melting and boiling point determinations, measurements of heats of reaction, and calorimetric kinetic experiments.

Theory of Operation

The Thermocouple Pod provides cold junction compensation optimized for an ambient temperature of 20 °C and a primary signal gain of 100. Secondary gain is provided by the **e-corder** unit, giving range settings shown in Table 1. A block diagram is shown in Figure 1.

The raw signal from the Pod corresponds to the thermoelectric emf values for K- or T-type thermocouples as described by the NIST ITS-90 thermocouple database, available at:

http://srdata.nist.gov/its90/main/

An abridged set of emf/temperature values is shown in Table 2.

Bandwidth of the signal from the Pod is limited by a 30 Hz low pass filter which maintains a fast response time for small probes. Additional filter settings of 1, 2, 5, 10, and 20 Hz are provided by the **e-corder** unit.

An 'offset' operating mode is provided so that small changes in temperature can be monitored accurately.

Operating Instructions

Connect the thermocouple probe to the connector on the rear panel of the Thermocouple Pod. Connect the 8-pin DIN connector cable from the Pod to an **e-corder** Pod port. Start the Chart software and locate the Thermocouple Pod command in the appropriate channel menu, which accesses the Thermocouple Pod control window, Figure 2. Select an appropriate temperature range and filter setting for your experiment. The signal will be recorded in units of millivolts until calibrated by one of the methods outlined over the page.

Caution

Do not connect other devices such as eDAQ Amps or other instruments to the corresponding BNC connector on the **e-corder** channel used by the Pod.

Probe Error

Thermocouple probes are gauged against the ITS-90 tables of thermoelectric emf values, Table 2.

Standard NIST K-type thermocouples can have an error of 0.75% (above 0 °C), 2.0% (below 0 °C) or ±2.2 °C, whichever is greater. 'Special limits' K-type thermocouples have an error of 0.4% or ±1.1 °C, whichever is greater.

Standard NIST T-type thermocouples can have an error of 0.75% (above 0 °C), 1.5% (below 0 °C) or ±1.0 °C, whichever is greater. 'Special limits' T-type thermocouples can have an error of 0.4% or ±0.5 °C, whichever is greater.

Also, some probes conform more closely to the NIST tables and thus can have greater accuracy over specified temperature ranges. For example, the ET1400 T-type thermocouple probe has an error of less than ±0.1 °C between 0 – 50 °C.

If smaller errors are required it is necessary to calibrate the probe with accurately known temperature sources.

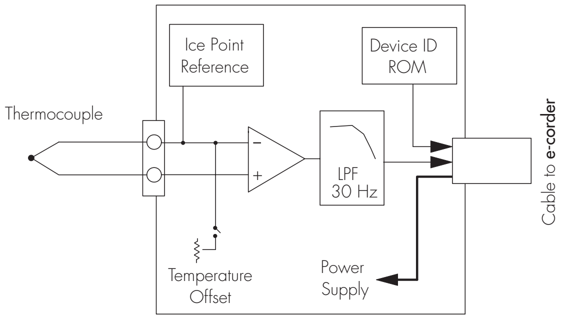

Figure 1. Thermocouple Pod block diagram

Methods of Probe Calibration

For most applications, accuracy is limited by the probe rather than the Pod itself. You can calibrate the probe for direct temperature readings in one of four ways:

- use the Chart Thermocouple extension which applies a polynomial correction (down to −200 °C) according to the ITS-90 thermoelectric emf tables for K- and T-type thermocouples to provide a signal calibrated in units of °C, °F, or K. This method is very convenient, resulting in a calibration to the uncertainty limits (error) of the probe. If used with the ET1400 T-type Thermocouple Probe, an accuracy of ±0.1 °C can be expected over the range 0 – 50 °C. You can obtain the extension by downloading it from http://www.edaq.com.

- use two accurately known temperature sources and the Units Conversion feature of the Chart software. This results in accurate calibration over small temperature ranges (<10 °C).

- use up to 12 known temperature sources, using the Multipoint Calibration extension of Chart software. This can result in highly accurate calibration of the probe over an extended temperature range, as long as accurately known temperature sources are used. You can obtain the extension by downloading it from http://www.edaq.com.

- use the Multipoint Calibration extension (download it from http://www.edaq.com) to apply a series of known emf/temperature calibration points, from Table 2, across the range of interest. This method is largely superseded by the use of the Thermocouple extension, above. If used with the ET1400 T-type Thermocouple Probe, and calibration values from Table 1, an accuracy of ±0.1 °C can be expected over the range 0 – 50 °C.

For best results the Pod itself should be maintained at an ambient temperature of 15 – 25 °C where the cold junction compensation is optimized.

Calibration using Offset Mode

The Pod can be operated in offset mode to monitor small temperature fluctuations accurately. First determine the probe temperature as above. Then tick the Offset check box in the Thermocouple control window, Figure 2, and use the offset knob to zero the signal.

To calibrate the signal:

- use the Units Conversion feature and enter 0 = 0 as the first calibration point. Then use the Seebeck coefficient at that temperature, Table 2, to enter the second calibration point. For example with a T-type probe, if the initial temperature is 25 °C, use 0.0406 mV = 1 °C (i.e., at 25 °C, a one degree change in temperature will produce a 0.0406 mV change in the signal)

- use the Chart Thermocouple extension which will apply a polynomial correction based on the ITS-90 tables. This method should give adequate accuracy even over the larger ranges (10 and 25 °C) available in the offset mode.

Response time

The response time of the Pod is ultimately determined by its maximum bandwidth of 30 Hz, which is greater than virtually all commercially available thermocouple probes.

Larger probes will take longer to reach thermal equilibrium with their surroundings. Small, exposed thermocouple junctions will provide fastest response.

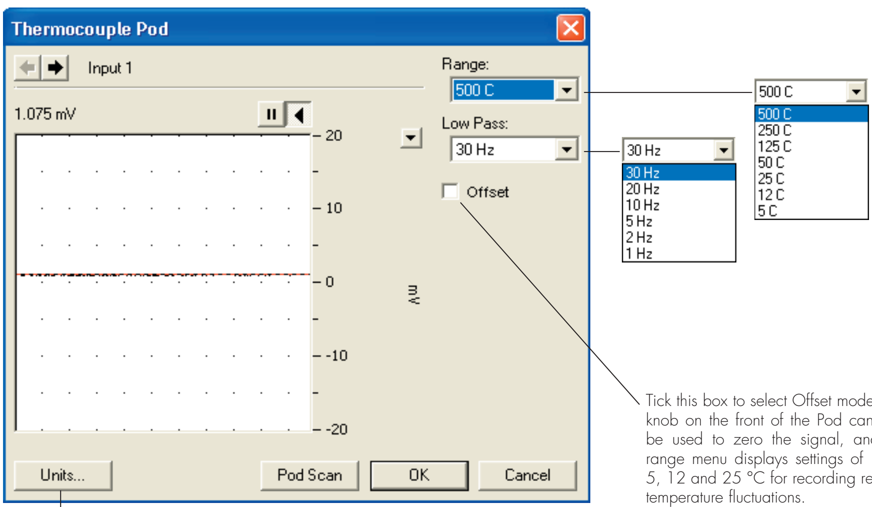

Figure 2. Thermocouple Pod control window

Tick this box to select Offset mode. The knob on the front of the Pod can then be used to zero the signal, and the range menu displays settings of 1, 2, 5, 12 and 25 °C for recording relative temperature fluctuations.

Click this button to access the Units Conversion dialog box.

Table 1. Thermocouple Pod temperature ranges.

Range setting (°C)	Actual range (mV)	Total gain	Actual range K-type (°C)	Actual range T-type (°C)
500	±20	x500	485	385
250	±10	x1000	246	213
125	±5	x2000	122	112
50	±2	x5000	50	50
25	±1	x10000	25	25
12	±0.5	x20000	12.5	12.5
5	±0.2	x50000	5	5

Specifications

Input impedance:	~1 kΩ
Gain:	x100
Range settings:	5, 12, 25, 50, 125, 250, 500 °C (±0.2, 0.5, 1, 2, 5, 10, 20 mV)
Offset mode ranges:	±1, 2, 5, 12, 25 °C (±0.05, 0.1, 0.2, 0.5, 1 mV)
Extent of offset:	–50 °C to 385 °C (T-type), or 485 °C (K-type)
Output signal:	±2 V maximum
Cold junction compensation:	Optimized at an ambient temperature of 20 °C, 40.3 µV/°C
Accuracy:	0.1%
DC drift:	2 µV/°C
Low pass filter settings:	1, 2, 5, 10, 20, 30 Hz
Response time (@ 30 Hz):	~13 ms for 0 – 90% of final value. Probe size will limit response time.
Amplifier noise:	1 µV p-p (0.1 to 10 Hz)
Input connector:	Miniature thermocouple socket
Dimensions (l x w x h):	108 x 58 x 35 mm
Weight:	~200 g

eDAQ Pty Ltd reserves the right to alter these specifications at any time.

Stacking and Unstacking Pods

Pods stack by clicking into place on top of each other. To separate stacked Pods, push the top Pod towards the back and then pull them apart from the back.

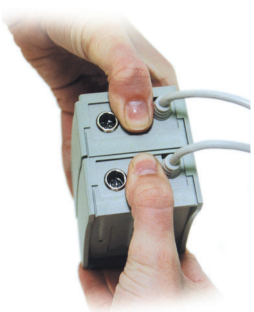

Table 2. Thermoelectric emf values† and Seebeck coefficients* for K- and T-type thermocouples.

Temperature (°C)	K-type emf (mV)	Seebeck Coeficient (µV/°C)	T-type emf (mV)	Seebeck Coeficient (µV/°C)
–250	–6.404	4.8	–6.180	6.3
–200	–5.891	15.2	–5.603	15.7
–150	–4.913	23.6	–4.648	22.3
–100	–3.554	30.5	–3.379	28.4
–50	–1.889	35.8	–1.819	33.9
–10	–0.392	38.9	–0.383	37.8
–5	–0.197	39.2	–0.193	38.3
0	0.000	39.5	0.000	38.8
5	0.198	39.7	0.195	39.1
10	0.397	39.9	0.391	39.4
15	0.597	40.1	0.589	39.9
20	0.798	40.3	0.790	40.3
25	1.000	40.5	0.992	40.6
30	1.203	40.7	1.196	41.1
35	1.407	40.9	1.403	41.6
40	1.612	41.0	1.612	42.0
45	1.817	41.1	1.823	42.4
50	2.023	41.3	2.036	42.8
55	2.230	41.3	2.251	43.2
60	2.436	41.4	2.468	43.6
65	2.644	41.5	2.687	44.1
70	2.851	41.5	2.909	44.5
75	3.059	41.6	3.132	44.9
80	3.267	41.5	3.358	45.3
85	3.474	41.5	3.585	45.6
90	3.682	41.5	3.814	46.1
95	3.889	41.4	4.046	46.5
100	4.096	41.4	4.279	46.7
105	4.303	41.3	4.513	47.1
110	4.509	41.2	4.750	47.5
150	6.138	40.2	6.704	50.2
200	8.138	39.9	9.288	53.2
250	10.153	40.7	12.013	55.8
300	12.209	41.5	14.862	58.1
350	14.293	41.9	17.819	60.2
400	16.397	42.2	20.872	61.8
450	18.516	42.5	–	–
500	20.644	42.6	–	–

† Values from NIST ITS-90 data base at http://srdata.nist.gov/its90/main/
* Seebeck coefficients determined for ±5 °C about the nominal temperature.

WARRANTY: eDAQ Hardware units are supported by a one year warranty

www.eDAQ.com
E-mail: info@edaq.com

Document Number: U-EP306-0104