PHASE 1 INSTRUMENTS

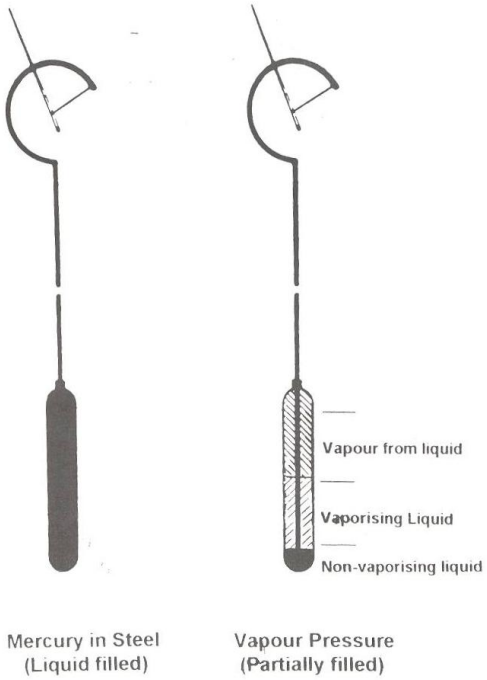
Project Write-up

Name:…… Group:……

Module Title: Temperature Measurement MODULE NO: I-8

PROJECT DESCRIPTION: Filled System Thermometers

Project No: T1 Objective Nos: 3, 4



PROJECT WRITE UP SHEET

Principle/Theory of Operation

What are the bulb and capillary made of in a filled system thermometer?

Where is it difficult to use a glass thermometer?

What is the approximate range of a mercury in glass thermometer?

What could be used to create a temperature alarm on a basic glass thermometer?

PHASE 1 INSTRUMENTS

Project Write-up

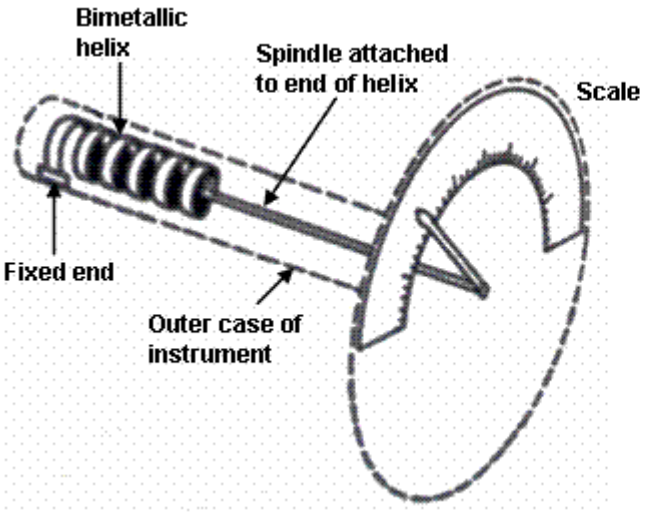
Name:…… Group:……

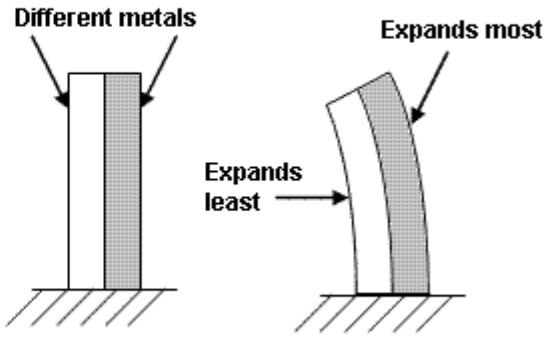
Module Title: Temperature Measurement MODULE NO: T1 001 1

PROJECT DESCRIPTION: Solid Expansion Thermometers (Rototherm)

Project No: T2 Objective Nos: 3, 4

SOLID EXPANSION





PROJECT WRITE UP SHEET

Principle/Theory of Operation

What is not the same for all metals?

What is the major advantage of this type of indicator?

How inaccurate can they be?

Name three items in a normal household that contain a bimetallic strip?

PHASE 1 INSTRUMENTS

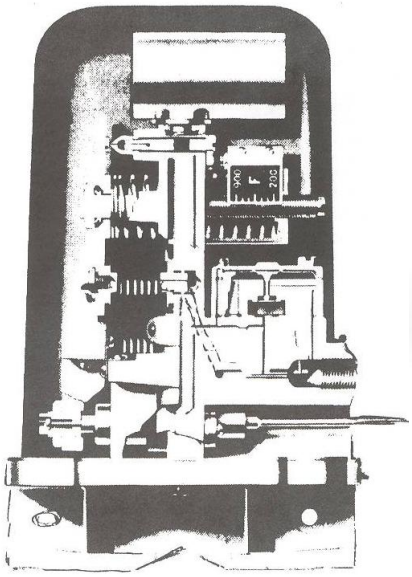
Project Write-up

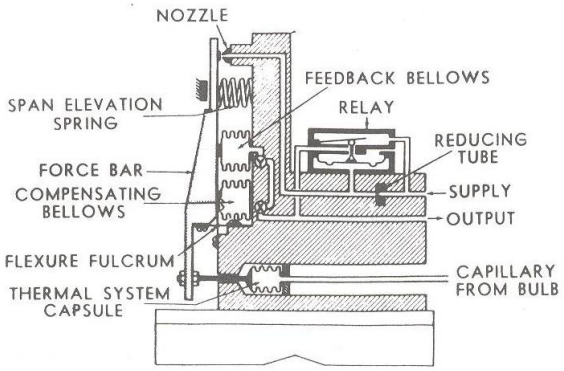
Name:…… Group:……

Module Title: Temperature Measurement MODULE NO: T1 001 1

PROJECT DESCRIPTION: Pneumatic Temperature Transmitter

Project No: T3 Objective Nos: 10





PROJECT WRITE UP SHEET

Principle/Theory of Operation

What principle does the relay work on?

If the supply was on to the transmitter but there was no output whatsoever, what might the problem be?

PHASE 1 INSTRUMENTS

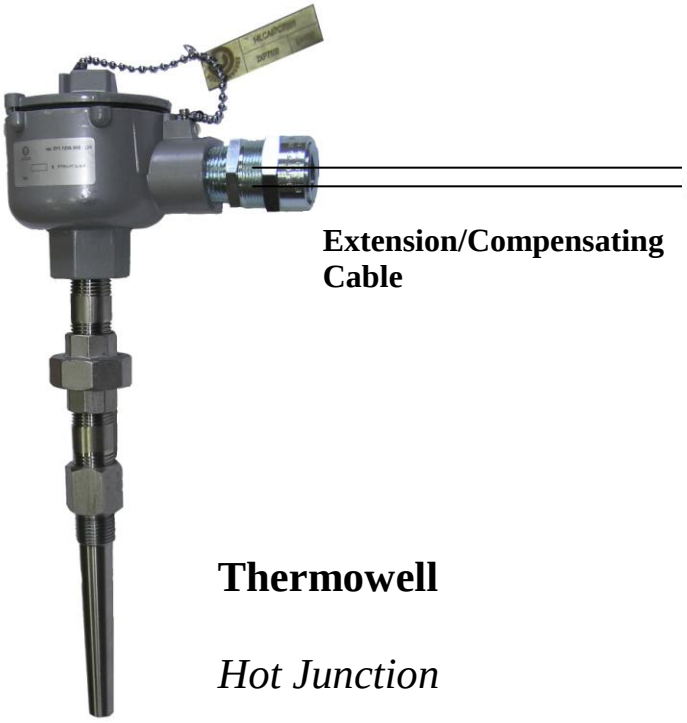
Project Write-up

Name:…… Group:……

Module Title: Temperature Measurement MODULE NO: T1 001 1 T

PROJECT DESCRIPTION: Thermocouples (T/C's) Transmitter

Project No: T4 Objective Nos: 5, 6, 7, 11.



Cold Junction

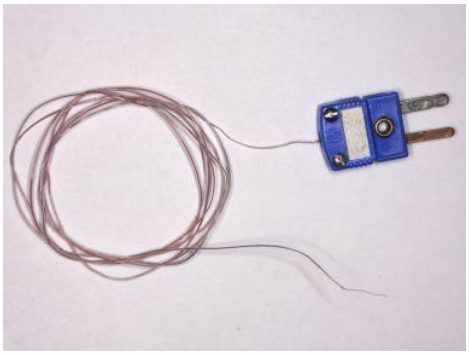
Extension/Compensating Cable

Receiver

Thermowell

Hot Junction

Transmitter Head



PROJECT WRITE UP SHEET

Principle/Theory of Operation

Name six types of metal used in thermocouples?

What is the range of a type J thermocouple?

Who discovered the effect of a thermocouple and when?

What is the measuring junction normally referred to as?

PROJECT WRITE UP SHEET

What is the millivoltage created by a thermocouple actually the product of?

What is the reference junction also known as?

With regards to a type K thermocouple, what is the mV range or fundamental interval?

What mnemonic could be used to assist when checking a thermocouple installation?

Who are the most common manufacturers of temperature to current convertors? 2 required

PHASE 1 INSTRUMENTS

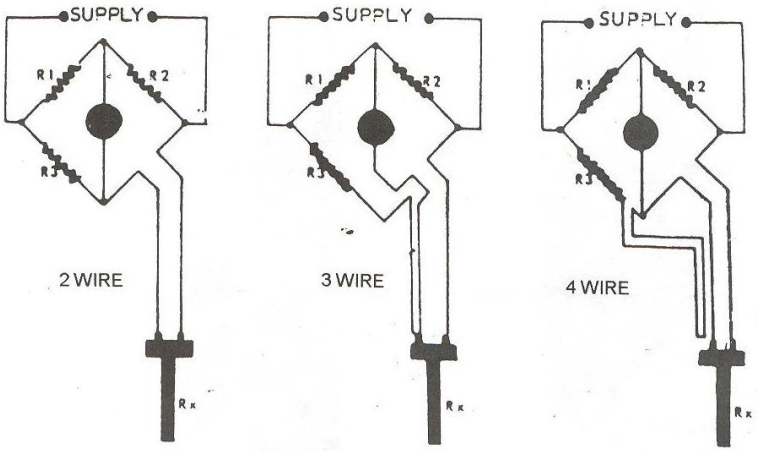
Project Write-up

Name:…… Group:……

Module Title: Temperature Measurement MODULE NO: T1 001 1

PROJECT DESCRIPTION: Resistance Thermometers (RTD's)

Project No: T5 Objective Nos: 8, 9, 10, 11.



TRANSMITTING HEAD

PROJECT WRITE UP SHEET

Principle/Theory of Operation

What is the most commonly used metal for RTD's up to 900 degC?

What is the difference in construction between a RTD and a Thermister?

What are Thermisters good for?

What are Thermisters also known as?

PT100 Resistance Table

°C	0	1	2	3	4	5	6	7	8	9	°C
-200.00	18.52										-200.00
-190.00	22.83	22.40	21.97	21.54	21.11	20.68	20.25	19.82	19.38	18.95	-190.00
-180.00	27.10	26.67	26.24	25.82	25.39	24.97	24.54	24.11	23.68	23.25	-180.00
-170.00	31.34	30.91	30.49	30.07	29.64	29.22	28.80	28.37	27.95	27.52	-170.00
-160.00	35.54	35.12	34.70	34.28	33.86	33.44	33.02	32.60	32.18	31.76	-160.00
-150.00	39.72	39.31	38.89	38.47	38.05	37.64	37.22	36.80	36.38	35.96	-150.00
-140.00	43.88	43.46	43.05	42.63	42.22	41.80	41.39	40.97	40.56	40.14	-140.00
-130.00	48.00	47.59	47.18	46.77	46.36	45.94	45.53	45.12	44.70	44.29	-130.00
-120.00	52.11	51.70	51.29	50.88	50.47	50.06	49.65	49.24	48.83	48.42	-120.00
-110.00	56.19	55.79	55.38	54.97	54.56	54.15	53.75	53.34	52.93	52.52	-110.00
-100.00	60.26	59.85	59.44	59.04	58.63	58.23	57.82	57.41	57.01	56.60	-100.00
-90.00	64.30	63.90	63.49	63.09	62.68	62.28	61.88	61.47	61.07	60.66	-90.00
-80.00	68.33	67.92	67.52	67.12	66.72	66.31	65.91	65.51	65.11	64.70	-80.00
-70.00	72.33	71.93	71.53	71.13	70.73	70.33	69.93	69.53	69.13	68.73	-70.00
-60.00	76.33	75.93	75.53	75.13	74.73	74.33	73.93	73.53	73.13	72.73	-60.00
-50.00	80.31	79.91	79.51	79.11	78.72	78.32	77.92	77.52	77.12	76.73	-50.00
-40.00	84.27	83.87	83.48	83.08	82.69	82.29	81.89	81.50	81.10	80.70	-40.00
-30.00	88.22	87.83	87.43	87.04	86.64	86.25	85.85	85.46	85.06	84.67	-30.00
-20.00	92.16	91.77	91.37	90.98	90.59	90.19	89.80	89.40	89.01	88.62	-20.00
-10.00	96.09	95.69	95.30	94.91	94.52	94.12	93.73	93.34	92.95	92.55	-10.00
0.00	100.00	99.61	99.22	98.83	98.44	98.04	97.65	97.26	96.87	96.48	0.00
0.00	100.00	100.39	100.78	101.17	101.56	101.95	102.34	102.73	103.12	103.51	0.00
10.00	103.90	104.29	104.68	105.07	105.46	105.85	106.24	106.63	107.02	107.40	10.00
20.00	107.79	108.18	108.57	108.96	109.35	109.73	110.12	110.51	110.90	111.29	20.00
30.00	111.67	112.06	112.45	112.83	113.22	113.61	114.00	114.38	114.77	115.15	30.00
40.00	115.54	115.93	116.31	116.70	117.08	117.47	117.86	118.24	118.63	119.01	40.00
50.00	119.40	119.78	120.17	120.55	120.94	121.32	121.71	122.09	122.47	122.86	50.00
60.00	123.24	123.63	124.01	124.39	124.78	125.16	125.54	125.93	126.31	126.69	60.00
70.00	127.08	127.46	127.84	128.22	128.61	128.99	129.37	129.75	130.13	130.52	70.00
80.00	130.90	131.28	131.66	132.04	132.42	132.80	133.18	133.57	133.95	134.33	80.00
90.00	134.71	135.09	135.47	135.85	136.23	136.61	136.99	137.37	137.75	138.13	90.00
100.00	138.51	138.88	139.26	139.64	140.02	140.40	140.78	141.16	141.54	141.91	100.00
110.00	142.29	142.67	143.05	143.43	143.80	144.18	144.56	144.94	145.31	145.69	110.00
120.00	146.07	146.44	146.82	147.20	147.57	147.95	148.33	148.70	149.08	149.46	120.00
130.00	149.83	150.21	150.58	150.96	151.33	151.71	152.08	152.46	152.83	153.21	130.00
140.00	153.58	153.96	154.33	154.71	155.08	155.46	155.83	156.20	156.58	156.95	140.00
150.00	157.33	157.70	158.07	158.45	158.82	159.19	159.56	159.94	160.31	160.68	150.00
160.00	161.05	161.43	161.80	162.17	162.54	162.91	163.29	163.66	164.03	164.40	160.00
170.00	164.77	165.14	165.51	165.89	166.26	166.63	167.00	167.37	167.74	168.11	170.00
180.00	168.48	168.85	169.22	169.59	169.96	170.33	170.70	171.07	171.43	171.80	180.00
190.00	172.17	172.54	172.91	173.28	173.65	174.02	174.38	174.75	175.12	175.49	190.00
200.00	175.86	176.22	176.59	176.96	177.33	177.69	178.06	178.43	178.79	179.16	200.00
210.00	179.53	179.89	180.26	180.63	180.99	181.36	181.72	182.09	182.46	182.82	210.00
220.00	183.19	183.55	183.92	184.28	184.65	185.01	185.38	185.74	186.11	186.47	220.00
230.00	186.84	187.20	187.56	187.93	188.29	188.66	189.02	189.38	189.75	190.11	230.00
240.00	190.47	190.84	191.20	191.56	191.92	192.29	192.65	193.01	193.37	193.74	240.00
250.00	194.10	194.46	194.82	195.18	195.55	195.91	196.27	196.63	196.99	197.35	250.00
260.00	197.71	198.07	198.43	198.79	199.15	199.51	199.87	200.23	200.59	200.95	260.00
270.00	201.31	201.67	202.03	202.39	202.75	203.11	203.47	203.83	204.19	204.55	270.00
280.00	204.90	205.26	205.62	205.98	206.34	206.70	207.05	207.41	207.77	208.13	280.00
290.00	208.48	208.84	209.20	209.56	209.91	210.27	210.63	210.98	211.34	211.70	290.00
300.00	212.05	212.41	212.76	213.12	213.48	213.83	214.19	214.54	214.90	215.25	300.00
310.00	215.61	215.96	216.32	216.67	217.03	217.38	217.74	218.09	218.44	218.80	310.00
320.00	219.15	219.51	219.86	220.21	220.57	220.92	221.27	221.63	221.98	222.33	320.00

SUPPLEMENTARY QUESTIONS

Module I-8 Temperature Control

The successful completion of these questions provides the additional competencies required for Module

---

1. State the difference between heat and temperature.

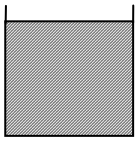
2. Convert 68^0F into ^{0}C and 30^0 C into ^{0}F

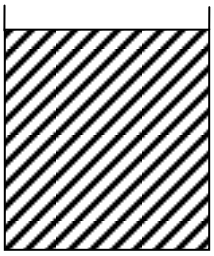
3. Name two advantages of using a thermowell or pocket in conjunction with temperature sensing devices.

4. Draw and describe how temperature readings may be effected when using a thermowell.

5. What might you consider in order to minimize this effect?

6. Which contains the most heat?

a) 100^0C 

b) 40^0C 

Expansion Types

1. Give two practical uses of the bi-metallic strip and state how they are wound.

2. What is the main advantage of bi-metallic elements?

3. Would they be used where extreme accuracy was required?

4. Other than liquid filled, name two other types of filled system thermometers:

   a) Liquid filled

   b)

   c)

5. What are the main disadvantages/limitations of the liquid expansion glass thermometer?

Electrical Methods – Thermocouples

1. a) What is 'Fundamental Interval' (or FI) ?

   b) How does this relate to the EMFs produced by a thermocouple?

2. If a thermocouple had an FI of 10 mV and the temperature at the cold junction was 20^0C , what EMF would be produced with a hot junction temperature of 100 ^{0}C?

3. What is the difference between:

   a) Thermocouple extension cable
   b) Compensating cable

4. When using thermocouple reference tables, the tables always assume the cold junction to be at which temperature?

5. When connecting extension or compensating cable to a thermocouple, list some of the things you must always be careful of.

6. What would be the effect on the temperature readings if you failed to observe the above?

7.

Electrical Methods – Resistance Thermometers (RTDs)

1. Describe the Fundamental Interval for an RTD and give the exact figures for a standard PT 100.

2. Draw a 4-wire system

3. Draw a 3-wire system and label leads 1, 2 and 3

4. Which of the above is the most accurate?

5. From your previous diagram for Q3, which lead would you suspect was broken if you had a high reading?

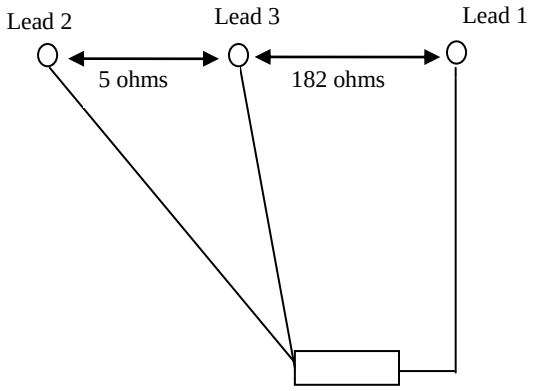
   a) Lead 1

   b) Lead 2

   c) Lead 3

6. If we used only a two wire system, explain why we would get highly inaccurate readings.

7. With reference to your 3-wire drawing, if you measured a line resistance of 5ohms on the compensating leg and a resistance of 182 ohms on the measuring leg, what is the temperature being measured?



Temperature Exercise 1

Calibration using mV injector

Required items:-

Mv (thermocouple) to current converter head

DVM

Mv injector

Compensating Cable

Connect the DVM to measure the 4-20 mA output signal from the converter using the 24vDC. Remember polarity of power supply and how items are connected in series. See notes for information on how to connect up the circuit

Refer to type K thermocouple table and inject mv equivalent to 0% of the temperature converter head. Remember to subtract the cold junction temperature from the value that you inject. Make a note of the output reading and if required alter the zero if available.

Refer to type K thermocouple table and inject mV equivalent to 100% of the temperature converter head. Remember to subtract the cold junction temperature from the value that you inject. Make a note of the reading and alter the span adjustment if required/available.

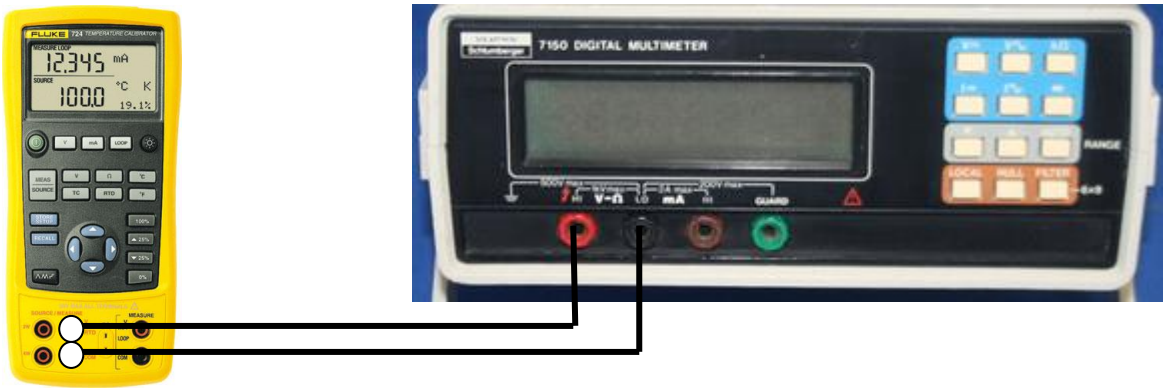
Temperature Exercise 2

mV difference with temperature injector

Required items:-

Fluke Temperature Loop Calibrator

Mains operated Electronic Volt Meter



Connect calibrator to voltmeter as shown above.

Switch on the loop calibrator and press the MEAS/SOURCE key to select SOURCE and the TC key to select type K thermocouple.
Press the 0% key and using the arrow keys, set to 0 degC.
Press the 100% key and using the arrow keys set to 900 degC.

Using the Electronic Voltage Meter, measure the actual voltage input to the display unit. Refer to the type K thermocouple table and determine from the table what temperature the millivoltage refers too. Why is it not equal to the temperature shown on the display?

Temperature Exercise 3

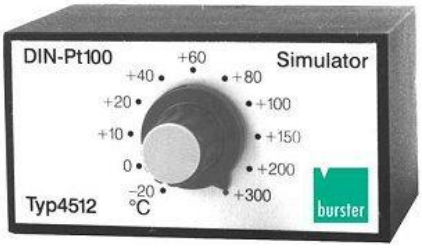
Calibration using Pt100 injector

Required items:-

Rt (resistance) to current converter head

DVM

PT100 Simulator or similar



Connect the DVM to measure the 4-20 mA output signal from the converter using the 24vDC. Remember polarity of power supply and how items are connected in series.

Refer to the PT100 resistance tables and simulate 0% of the temperature converter head. Check the output of the unit and calibrate the zero point if required.

Refer to the PT100 resistance tables and simulate 100% of the temperature converter head. Check the output of the unit and calibrate the span point if required.

Check that the zero and span values are correct and then connect up a PT100 probe as shown in the Temperature Notes. Do not touch the end of the probe but leave in the surrounding air in order for it to settle to the ambient temperature.

Check that the measured temperature is the same as the display in the workshop by back calculating the input resistance and referring to the PT100 tables.

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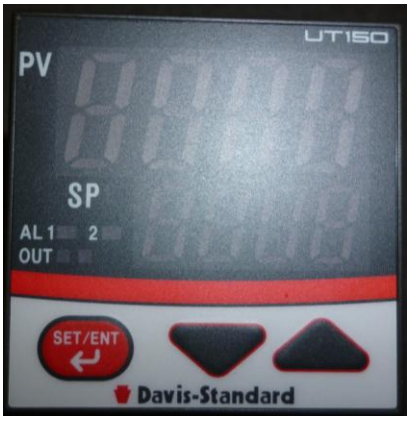
Temperature Exercise 4

Program Temperature Controller



Required items:-

UT150 Temperature Controller

240v plug and lead

PT100 Temperature Sensor

Before any equipment is plugged into the 240V outlet sockets it must be checked by the T.O. !

Connect the 240v lead and the PT100 sensor to the connections as shown on the following diagram.

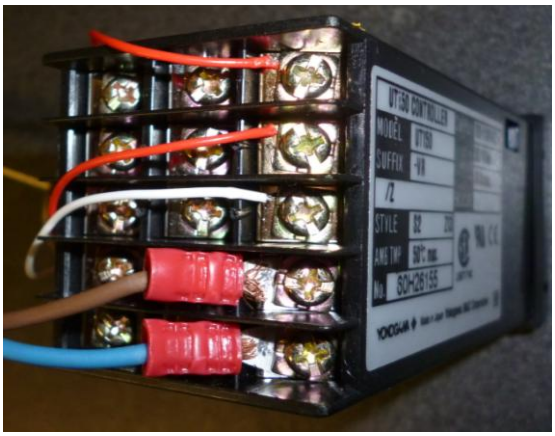
Short

Short

Sensor

Live

Neutral



After the connections have been checked, switch on and wait for the display to stabilise.

Hold the SET/ENT button for at least 3 seconds until CTL is displayed. Press the SET/ENT button repeatedly until LOC is displayed. Press the down arrow key to display -1 and then press SET/ENT key again.

‘ In’ should now be displayed. Refer to the input range table and select the required range. Use the up/down keys to select required number then press the SEL/ENT key.

Press the SEL/ENT key for at least 3 seconds to revert back to the normal display. The unit will now measure and display the measured temperature.

Hold the SET/ENT button for at least 3 seconds until CTL is displayed. This indicates that the controller in the ON/OFF control mode. That means that when the measured temperature varies above or below a ‘Set Point’ the output will be on or off to control a heater unit.

Press the SEL/ENT key until HYS is displayed. This parameter determines how far off the setpoint the measured variable has to alter before the output changes state. Set this value to 0.5 using the up/down keys. Press the SEL/ENT to enter value. Press the SEL/ENT key for at least 3 seconds to revert back to the normal display.