

# TEMPERATURE SENSORS AND CONTROLLING TEMPERATURE

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There are three types of temperature sensor that are readily available and easy to use. These are:

- thermistors
- thermocouples
- LM35 IC (integrated circuit).

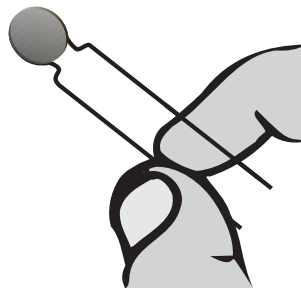
When you select a temperature sensor, you should consider:

• Its characteristics	How does the value change with temperature? Is the relationship linear?
• Ease of use	What circuit do you need? Are there limitations? Are there any special precautions?
• Cost	
• Response time	How quickly does it react?

## THERMISTORS

These are devices that change their resistance as the temperature changes.

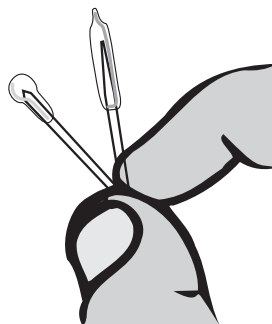
You can use either a **general purpose disc thermistor** or a **bead thermistor**:



Disc thermistor

## THERMOCOUPLES

These consist of a junction of two different metals which produces a small voltage. The value of this voltage changes with temperature.



Bead thermistor

## LM35

This is an integrated circuit (IC). The output voltage changes with temperature.

### INVESTIGATING THERMISTORS

#### **You will need:**

- 10 k $\Omega$  disc thermistor  
(temperature range -30 to +125 $^{\circ}$ C) RS 256-073.
- 10 k $\Omega$  bead thermistor  
(temperature range +10 to +100 $^{\circ}$ C) RS 256-045.
- Multimeter to measure resistance.
- Water bath and heater.
- A -10 to +110 $^{\circ}$ C thermometer.

There are two things to investigate:

- The way the resistance changes with temperature.
- How quickly the value of resistance settles down.

To investigate the second of these, you need to be able to keep the temperature in the water bath constant.

Plan your investigation carefully.

Think about:

- What you will change and what you will keep the same.
- What you need to measure.
- How you will record your data.
- How you will present your data.

### INVESTIGATING A THERMOCOUPLE

#### **You will need:**

- General purpose thermocouple  
RS 159-001 (-50 to + 200 $^{\circ}$ C).
- Multimeter to measure mV.
- Water bath and heater.
- -10 to +110 $^{\circ}$ C thermometer.

You need to find out:

- The way the voltage produced changes with temperature.
- How quickly the value settles down.

Plan your investigation carefully.

Think about:

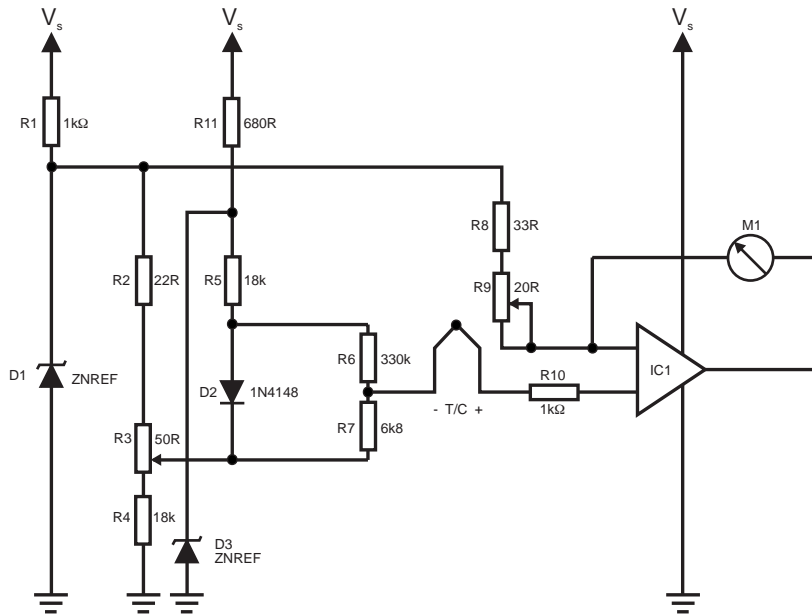
- What you will change and what you will keep the same.
- What you need to measure.
- How you will record your data.
- How you will present your data.

# TECHNOLOGY STUDY FILE 10

The circuit you need to use for a thermocouple is quite complicated.

Here is a typical circuit:

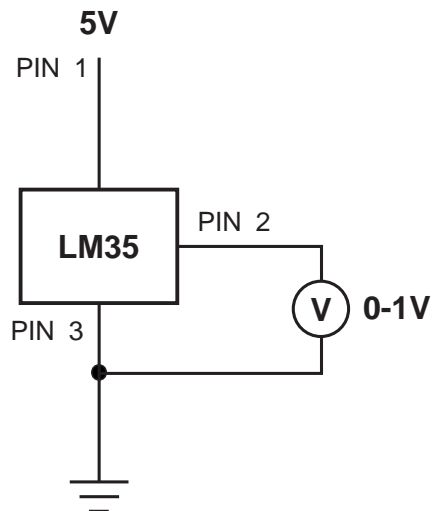
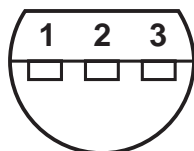
**Temperature measurement circuit**



## INVESTIGATING AN LM35

The LM35 is an integrated circuit. It contains the temperature sensor and the circuit needed to process the signal. To use it to measure temperature, connect it like this:

- PIN1 +Vs Supply Voltage
- PIN2 Vout Output
- PIN3 GND Ground



**You will need:**

- An LM35 DZ - this can be used for the range 0° C to 100° C.
- 0 - 1 V voltmeter (you may need a 0 - 100 mV meter for lower temperatures).
- A 5 V DC power supply.
- A heater in a container (the 12 V 24 W lamp and model house you used before is ideal).
- A 12 V power supply for the lamps leads.
- A -10 to 100° C thermometer.

In this investigation, you want to find the characteristics of the LM35.

What do you need to measure?

- the temperature in the room?
- the output of the LM35?

How will you change the temperature?

Do you need to let the temperature become constant before taking a reading?

Plot a graph of your results.

What are the advantages of an LM35?

### SELECTING A TEMPERATURE SENSOR

Copy and complete the table on the next page for each sensor.

Use this information to help you select the sensor you need.

You will find additional information in catalogues.

e.g. RS, Rapid Electronics, Maplin.

Factor	Questions	Your findings:		
		Thermistors	Thermocouple	LM35
Its characteristics	How does the value change with temperature?			
Ease of use	What circuit do you need? Are there limitations? Are there any special precautions?			
Cost				
Response time	How quickly does it react?			

**CONTROLLING TEMPERATURE**

To control the temperature, you need to think about all of the stages in the system. This means the input, the process and the output.

**Input: Selecting a sensor**

The sensor you select depends on the situation.

Things to think about:

- Do you need a linear relationship? In other words, do you need the output to change uniformly with temperature?
- Do you need a fast response?
- What is the reliability like?
- What is the cost?
- When you have selected your sensor, what else do you need? For example, the thermistor needs to be connected as part of a potential divider.

**Output**

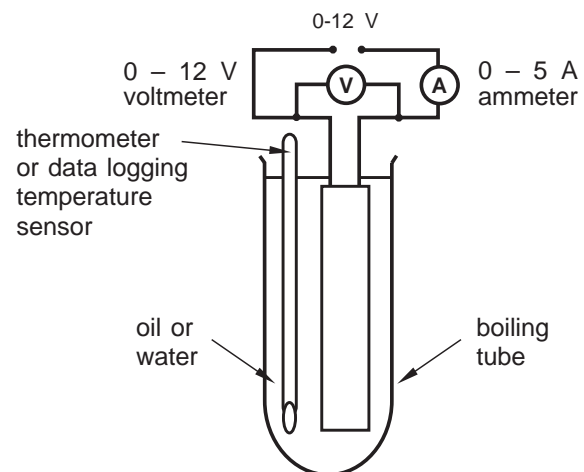
Suitable heaters for a given situation might be:

- A 12 V aquarium heater.
- A 12 V immersion heater.

Investigate how the heat output depends on supply voltage and current.

You will need:

- 0 - 12 V variable power supply.
- 0 - 12 V or 0 - 25 V voltmeter.
- 0 - 5 A ammeter leads.
- Heater.
- Boiling tube and oil if required.



Why do you think oil might be used?

You need to measure and record

- Voltage and current.
- Temperature.

Do you need to let the temperature become constant before taking a reading?

**Process**

- Do you need to control the temperature continuously or control the heater ON and OFF?
- What are the minimum and maximum temperatures?
- Do you need to be able to set the temperature at different takeover levels?