

TEMPERATURE GAUGE

by Ian Miller

- * Temperature range -10°C to 100°C
- * Indication by multicolour LED array
- * 100°C warning

This thermometer gives a visual indication of temperature in approximately 10°C intervals from -10°C to 100°C. It uses the LM335Z temperature sensor and the LM3914 bargraph display driver. The latter converts the sensor's output to drive LED indicators which are formed in a block display.

The design presented is for a general purpose temperature gauge, being hand-held with the sensor on a flying lead. However, in response to many requests, information for adaptation to a car thermometer is given.

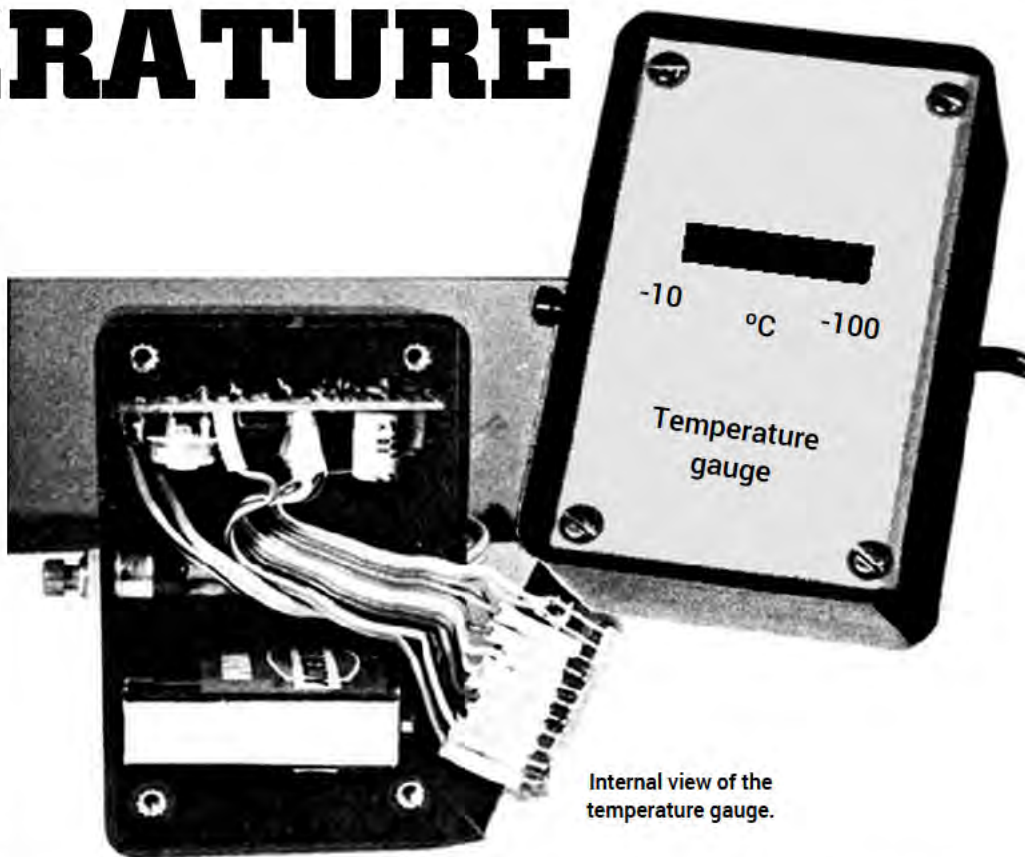
Circuit

The circuit, which is mounted on a piece of Veroboard measuring 10 strips by 20 holes, is shown in Figure 1. The LM335Z sensor, IC1 acts similarly to a zener diode where the breakdown voltage is directly proportional to the absolute temperature. It gives an output of 2.63 volts at -10°C and 3.73 volts at 100°C and has three terminals: +ve, -ve and adjust. The adjust is used for calibration purposes but as it is accurate to 2°C without calibration this facility is not used.

The sensor requires a current of between 400µA and 5 mA. This is supplied via the 10 kilohm resistor R1 which is connected to the 9 volts supply.

The LM3914 bargraph display driver IC2 has a buffer input stage, a potential divider chain, comparator and a precise 1-2 volts reference source. The resistor chain divides the input voltage from the sensor to drive the LEDs wired to the outputs. The driver is used in the dot mode where the outputs are sequentially switched 'on' with an increasing input voltage.

The total voltage change of the sensor is 1.1 volts which is close enough to the 1.2 volts reference source to make the



biasing circuit fairly simple. The zener diode D1 reduces the 9 volts supply to 2-7 volts and is connected to the low reference terminal, pin 4 of IC2. The 5 kilohms preset VR1 is used to adjust this voltage to exactly 2.63 volts, the minimum temperature sensor output, at calibration.

The high reference terminal pin 6 is connected to the 1-2 volts reference source pin 7 and through R2 to the low reference pin 4. Thus the total sensor range is divided across the resistor chain of IC2 so that at -10°C the first output is 'on' and at 100°C the tenth output is 'on'.

The outputs of IC2 are connected directly to the display LEDs except the

tenth which is taken to IC3, an LM3909 LED flasher. This drives two LEDs, D11 and D12 which are the 100°C warning indication. The frequency of oscillation of the flasher is determined by the capacitor C1.

All the LEDs are the rectangular type and in the version built D1 to D4 are green, D5 to D9 red and D10 to D12 yellow, thus signifying the change from cold to warm to hot. These colours are a matter of choice; you may have your own ideas for a particular application.

The gauge is powered by a single PP3 9 volt battery which is wired via the push button switch S1. This switch is biased 'off'

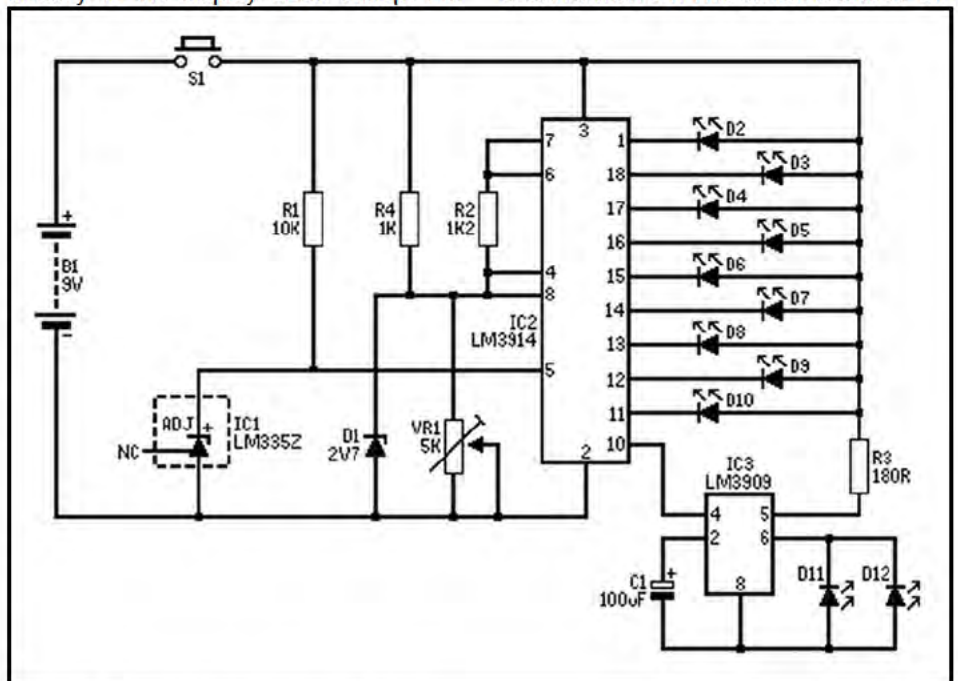


Figure 1. Temperature gauge circuit diagram.

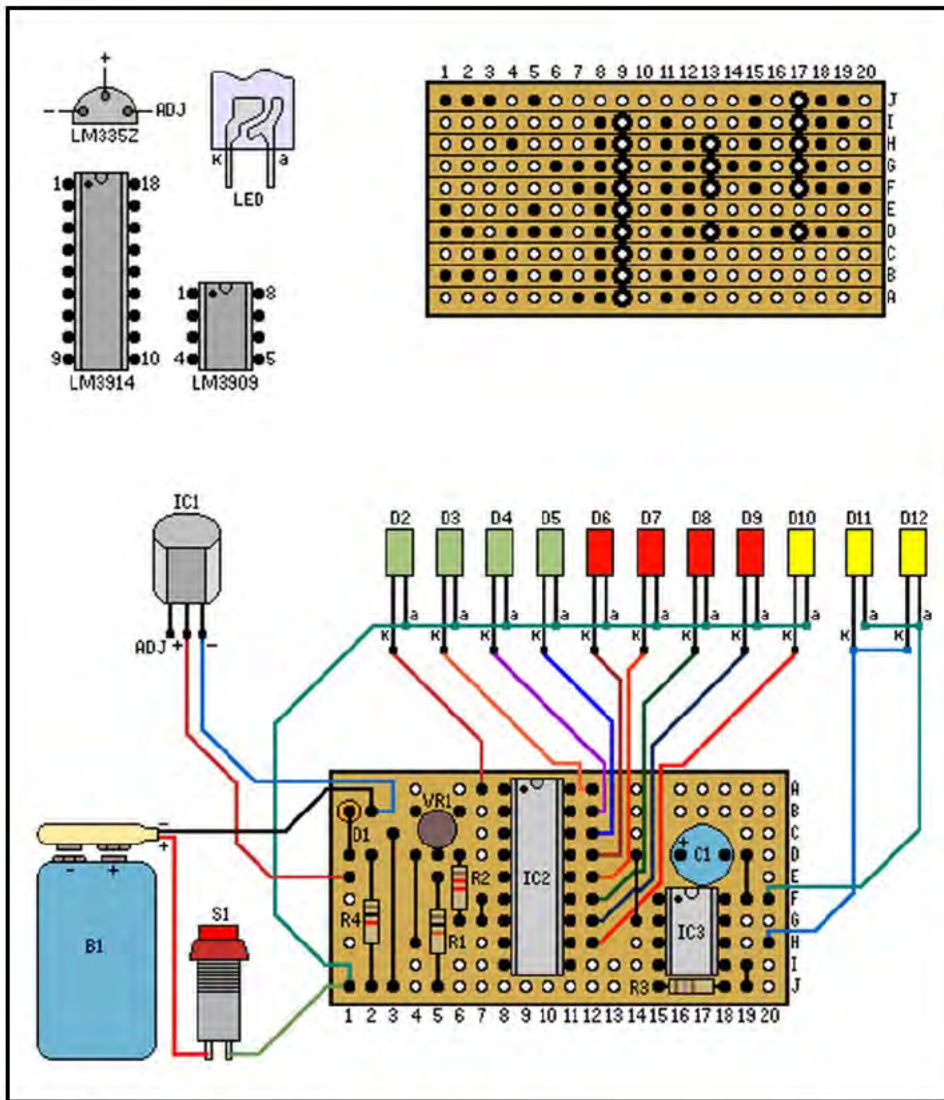


Figure 2. Temperature gauge layout and wiring diagram.

front panel 32 mm from the top edge. Insert the LED block into the slot with the low temperature LEDs at the left and glue them in place.

Mount the push button midway along one of the long sides of the box. Directly opposite this drill a hole for the flying lead.

The battery and connector will conveniently locate at the bottom of the box if two sets of vanes are removed from one side of the box with a modelling knife.

To form the sensor, solder and sleeve the flying lead as shown in the wiring diagram, Figure 2 using small twin cable. Cut a square hole the same size as the sensor's flat face in a push-on connector cover. Insert the sensor so that the flat face is exposed and, if liquid temperatures are to be measured, seal the sensor in place with an epoxy adhesive. However, ensure that the exposed face remains clean so that the reaction time of the sensor is not lengthened.

Finally wire all the components according to Figure 2 using a small length of ribbon cable for the LEDs. The Veroboard slots into the top set of box vanes.

Calibration

Connect a voltmeter to the input and 0 volt terminals and insert the sensor into the freezer compartment of a fridge. When the voltmeter registers 2-63 volts adjust the preset VR1 so that D1 is just 'on'.

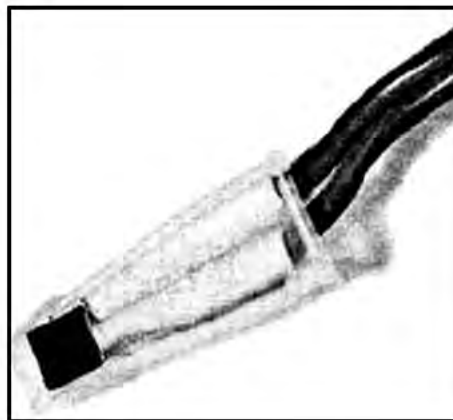
Check this setting at the high temperature end by holding the sensor over the spout of a boiling kettle, when the voltmeter registers 3-73 volts LEDs D11 and D12 should be flashing.

Adaptation to a car thermometer

This can be carried out in various ways but in all cases the sensor must be attached to the water cooling system. The simplest method of doing this is to glue the sensor to the thermostat housing. Another way would be to obtain an old car temperature element, which would replace the one at present in the car's engine and drill a hole along its centre large enough for the LM335Z. Glue the LM335Z in place and swap elements.

Now carry out one of the following methods of adaptation:

- (1) Having mounted the sensor, change the push button switch for an on/off type and use the gauge as previously described.
- (2) As above, but instead of using the battery the supply is taken from the car's 12 volts supply via the ignition switch, thus eliminating the on/off switch.
- (3) As in (2) but instead of using the LED block use a single digit 7-segment display with a diode encoding matrix as used on the Digital Petrol Gauge featured in the July issue of E&MM. Note that in this circuit the LED flasher is retained but drives two ordinary LEDs for the 100°C warning.



Temperature gauge sensor.

so that as a hand-held device the push button must be held in whilst monitoring a temperature.

Construction

Begin construction by mounting all the components on the Veroboard according to the layout shown in Figure 2. Take care with the orientation of IC2 and 3. Having decided upon the colour display you require glue the LEDs together using a contact adhesive to form a solid block.

A plastic box with an aluminium front panel is used. Cut a 27 x 5 mm slot in the

PARTS LIST FOR THE TEMPERATURE GAUGE

Resistors - all ¼ watt 5% carbon

R1	10K	Brown Black Orange
R2	1K2	Brown Red Red
R3	180R	Brown Grey Brown
R4	1K	Brown Black Red
VR1	5K	Cermet Preset

Capacitors

C1	100µF 10V PC Electrolytic
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Semiconductors

D1	BZY88C2V7 Zener Diode
D2, D3	
D4, D5	Rectangle LED Green (4 off)
D6, D7,	
D8, D9	Rectangle LED Red (4 off)
D10, D11,	
D12	Rectangle LED Yellow (3 off)
IC1	LM335Z
IC2	LM3914
IC3	LM3909

Miscellaneous

S1	Push Switch
B1	PP3 Battery and Connector Box
	Veroboard 10 strips x 20 holes
	Ribbon Cable 10-way