# DIY KIT K120. DUAL TEMPERATURE METER

**INTRODUCTION**

This kit uses a commercially available 3 ½digit Digital Panel Meter (DPM) from C&C, model PM-128 to display the temperature reading from two separate sensors. A switch is used to select between the two sensors.

The temperature sensors can be connected up to 30 feet (10 metres) from the display using a 3-wire cable. A 2-core screened cable, as used in audio applications, will do nicely. **The user must supply this cable.**

Temperature is measured and displayed in degrees Fahrenheit with the LM34 sensor; degrees centigrade with the LM35 sensor. You can get the data sheets from the National Semiconductor website at **national.com**

The kit is housed in a plastic box with a silk-screened front panel. Overall dimensions are 5.1" x 2.7" x 1.6" (13 x 6.7 x 4 cm). The kit can be powered from either a 9V battery or a 12V DC plug pack.

**HOW IT WORKS**

This discussion also applies to both the LM34 and LM35. The kit is based on a precision temperature sensor from National Semiconductor. Its output voltage is linearly proportional to the Fahrenheit or centigrade temperature at a factor of +10.0mV/°F or +10mV/°C. This means that it can directly drive a digital voltmeter. And it means that one sensor on the kit can be LM34 and the other LM35.

The LM3x does not require any external calibration to provide typical accuracies of ± ½°F at room temperature and ± 1½°F over a full –20 to +199.9° temperature range.

It requires only three connections:

1. DC Voltage (5 to 20 volts)
2. Output
3. Ground

The display used is a 3 ½digit Digital Panel Meter. It is 'ready to go' with just a couple of changes to be made. These are detailed in the 'Assembly Instructions'.

The circuit is quite straightforward. The temperature sensor output is connected to the DPM via switch SW2. This switch selects the temperature reading to display. The DPM is set to a full scale reading of 1.999V with resistors RA and RB.

The sensors and the DPM can be powered from either a 9V battery or an external 12 volt DC supply. A power switch allows the unit to be turned off when not in use.

External power is applied to IC1, an LM317L adjustable regulator. Diode D1 provides reverse polarity protection. The regulator output is set by two resistors, R1 and R2.

The regulator maintains a constant 1.25 volts between the adjust terminal (pin 2) and the output terminal (pin 3). This causes a constant current to flow through R1. This current also flows through R2, producing a constant voltage drop across it. Some current from the adjust terminal also flows through R2 but this is negligible and can be ignored.

Thus, the output voltage is given by

$$V_{OUT} = 1.25(1 + \frac{R2}{R2}) = 9.77V$$

Diode D2 prevents any current flow into the battery and allows the battery to remain connected even when external power is used. Similarly, diode D3 prevents any current flow back into the regulator circuit when only the battery is used.

As mentioned before, you can also use this kit to measure temperature in degrees Celsius. In this case substitute LM35 sensors in place of the LM34s.

**ASSEMBLY INSTRUCTIONS**

Assembly can be broken down into four parts.

1. PCB Assembly
2. Digital Panel Meter modification
3. Temperature probe wiring
4. Final assembly

**PCB Assembly**

Use the component overlay on the PCB to fit and solder the components, in the following order:

- Resistors and diodes
- Capacitors C2 and C3
- Voltage regulator IC1
- Electrolytic capacitor C1. This capacitor is laid over flat on the PCB. Bend the leads at right angles to the body before inserting, noting the positioning of the positive lead before bending.
- Slide switches SW1 and SW2. Make sure they are vertical and sitting right down on the PCB before soldering. This is important so the front panel will fit correctly.
- 9V battery harness. Red wire to '+' , black to '-'
- Cut a piece of red and black hookup wire, about 6" (15cm) long. Strip each end and tin.
- Cut 2 pieces each of red and black hookup wire, about 2" (5cm) long. Strip each end and tin.
- Connect and solder these wires to the PCB as per the wiring diagram on page 3. The longer wires are used for the DC jack.
- Fit the two metal spacers to the top of the PCB and secure from beneath using two screws.

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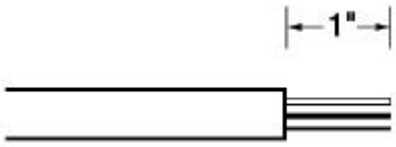
**Digital Panel Meter modification**

The DPM needs to be set to a full scale reading of 1.999V. To do this we need to fit the 300K and 2.7M resistors in the positions marked “RA” and “RB” on the DPM.

Remove the wire links (if any) from RA and RB. Use a desoldering tool or braid to remove any solder from the resistor holes. Bend the resistor leads close to the body and cut to a length of about 1/4” (6mm). Insert the 300K resistor in position RA and the 2.7M resistor in position RB and solder.

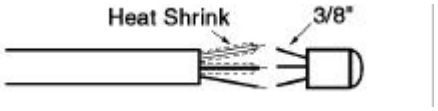
The next step is to set the decimal point to the last position on the display. Insert a wire link (one of the resistor offcuts will do) in position ‘P1’ from the center hole to ‘ON’. Keep the link as small as possible.

**Temperature probe wiring**

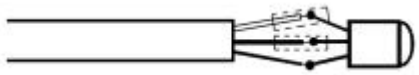



Remove 1” (2.5cm) of outer plastic sheath.

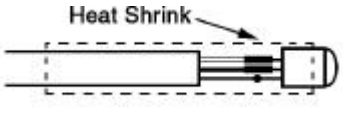
Strip and tin wires



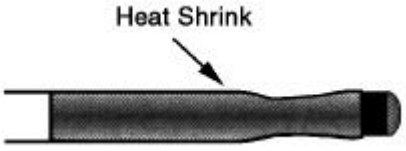

Slide small heatshrink tubing down two of the wires. Cut the LM34 leads to about 3/8” (1cm) long.



Solder the LM34 to the 3 wires. Use the braided wire to connect to the ‘ground’ lead. Slide the heatshrink tubing over the solder joint and apply heat.




Slide the larger heatshrink tubing over the whole assembly and apply heat.




**Final assembly**

First we will fit the display to the front panel. Place the display bezel through the square cutout. Now, from the rear, fit the display to the bezel screws. Make sure the display is the right way round - all four connections to the DPM are immediately next to the K120 PCB. See the photographs at the end of this documentation. Use the plastic nuts to secure the display. If metal nuts are supplied then fit an insulated washer under each nut. In either case do not over-tighten the nuts.

(Note that the VIN GD and the 9V negative cannot be commoned together. So make all four connections as shown. Do not be tempted to only do three connections thinking the VIN GND and the 9V negative are the same.)

On the right side of the plastic box drill two holes just large enough for the temperature probe cables to fit through. A 1/8” (3mm) hole should be OK. The holes should be centered from top to bottom and evenly spaced from side to side.

On the left side of the box, in a central position, drill a 1/4” (6.5mm) hole and fit the DC jack. Looking at the back of the jack with the pins in the 9, 12 and 3 o’clock positions the 12V positive goes to the 9 position and the ground to the 12 position. See the diagram below.

Strip and tin the end of the temperature probe cables, ready for soldering. Insert the cables through the holes into the box and solder into place on the PCB in positions T1 and T2. The LM3x pin designations are marked on the PCB.

Use a cable tie around each cable, inside the box, to provide a strain relief and stop the cable from being pulled out. Allow enough cable slack inside the box before tightening the cable ties.

A piece of double-sided tape is supplied for mounting the 9V battery. Attach the double-sided tape to the battery and clip on the battery harness. Stick the battery inside the box on the bottom.

Use the wiring diagram on page 3 to connect the DC jack and the DPM to the PCB.

Position the front panel into place over the PCB so that the slide switch levers protrude through. Use the remaining two screws to secure it. Make sure the slide switches do not foul against the front panel.

**TESTING**

Apply an external 12V DC supply to the input jack and measure the output of the voltage regulator. It should be approximately 9.77 volts. Measure the voltage at the cathode of one of the diodes. It should be 0.6 volts less.

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Remove the external power supply. The battery should now take over. The voltage at the cathode should now be 0.6V less than the battery voltage.

**CALIBRATING THE DIGITAL PANEL METER**

You will notice that there is a trimpot on the back of the digital panel meter. This is factory set and should not need adjustment. However, you can check it using a digital multimeter set to the 2V range. Measure the voltage input to the DPM (VIN and GND). If needed adjust the trimpot until the readings match, ignoring the decimal point.

Switch off the power and secure the front panel to the box using the four self-tapping screws.

**IF IT DOESN'T WORK**

Poor soldering ("dry joints") is the most common reason for the circuit not working. Check all soldered joints carefully under a good light. Re-solder any that look suspicious. Check that all components are in their correct position. Are the electrolytic capacitors and diodes the right way round? Have you connected the temperature sensors pins to the correct points on the PCB? Is the external power supply jack wired correctly?

**WEB ADDRESS & EMAIL**

You can email us at peter@kitsrus.com if you have any problems or requests. Information on other kits in the range is available from our Web page at:

**http://kitsrus.com**

**PARTS LIST - KIT 120**

**Resistors (0.25W carbon)**

| | | |
|---|---|---|
| 220R | R1 | 1 |
| 1K5 | R2 | 1 |
| 300K | RA | 1 |
| 2M7 | RB | 1 |

**Capacitors**

| | | |
|---|---|---|
| 100nF monobloc | C2,3 | 2 |
| 10uF 25V electrolytic | C1 | 1 |

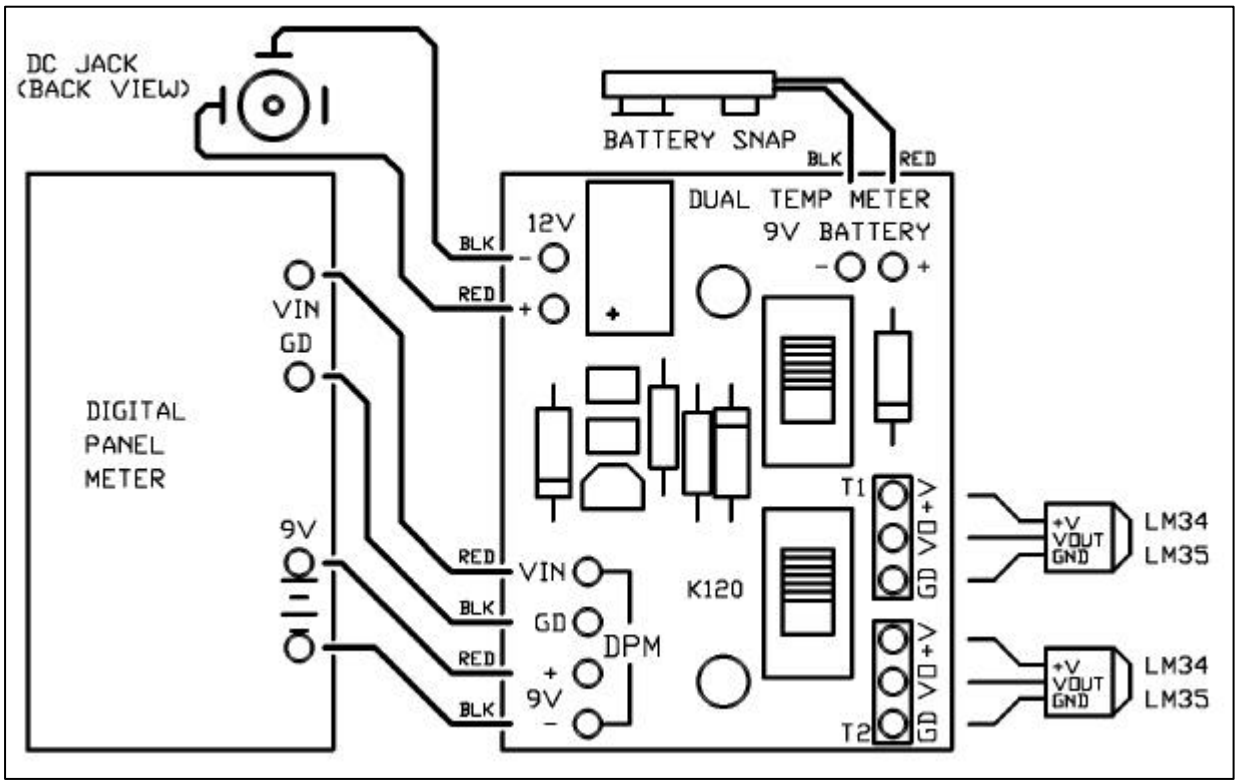
**Semiconductors**

| | | |
|---|---|---|
| 1N4004 | D1-3 | 3 |
| LM317LZ | IC1 | 1 |
| Adjustable regulator, TO-92 package | | |
| LM34 or LM35 | T1,2 | 2 |
| Fahrenheit LM34, centigrade LM35. | | |

**Miscellaneous**

| | | |
|---|---|---|
| Digital Panel Meter 3.5 digit C&C PM-128 | | 1 |
| Slide Switch | SW1,2 | 2 |
| "C&K", 1101-M2-C | | |
| 2.5mm DC jack, panel mounting | | 1 |
| Battery harness, 9V | | 1 |
| Plastic box | | 1 |
| Metal spacer, tapped, 3mm x 10mm long | | 2 |
| Screw, 3mm x 6mm or 4mm long | | 4 |
| Hookup wire, 18" (45cm), Red | | 1 |
| Hookup wire, 18" (45cm), Black | | 1 |
| Heatshrink tubing, 1.5mm x 2cm long | | 2 |
| Heatshrink tubing, 5mm x 4cm long | | 2 |
| Double sided tape, 4cm long stuck on plastic | | 1 |
| Cable ties | | 2 |
| PCB, K120 | | 1 |
| Front Panel, K120P | | 1 |

**Wiring Diagram**



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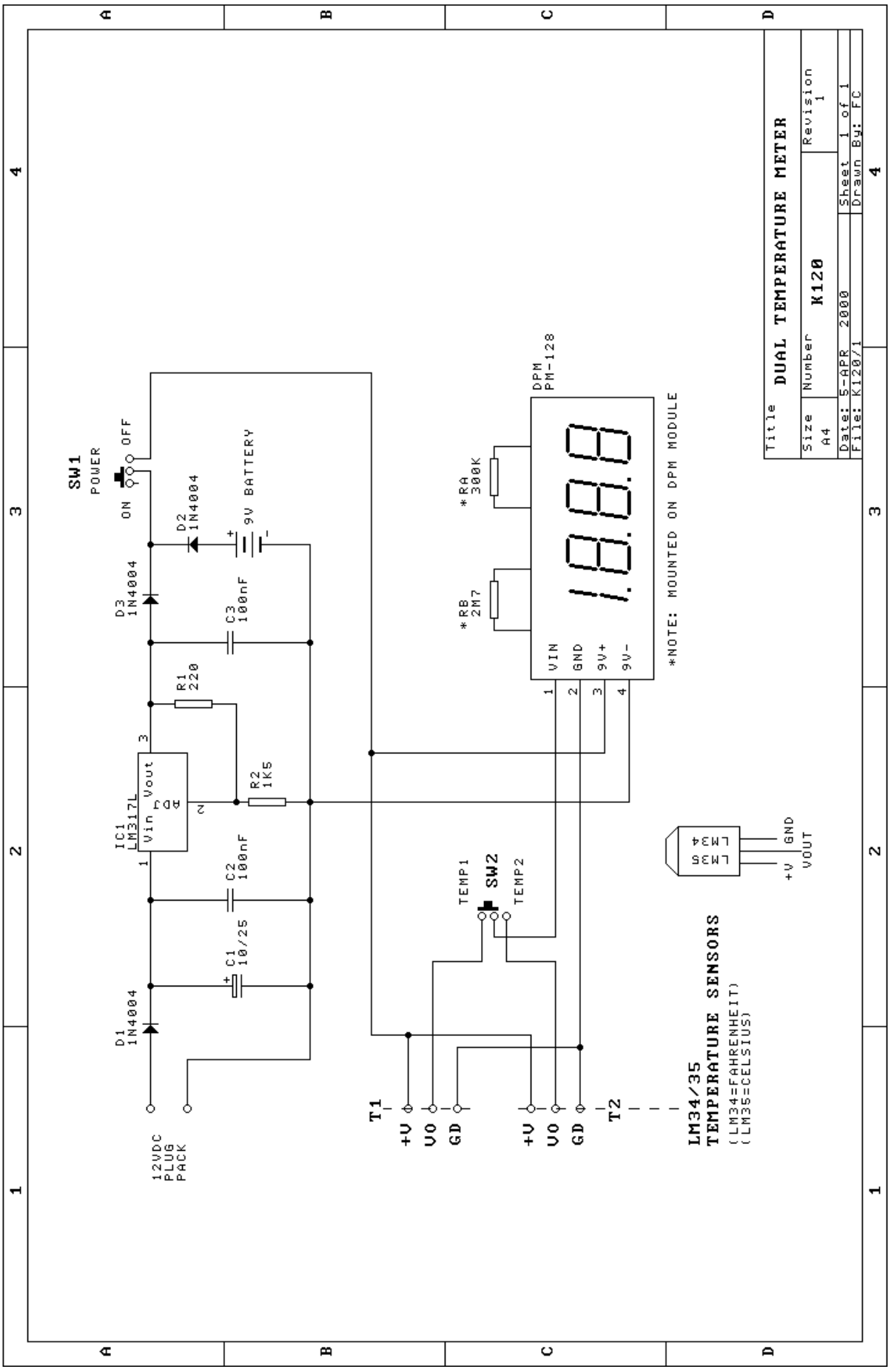

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This is the DPM version you need PM-128. C&C 9V Independent Power Supply Version.