Use a transistor as a heater

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It is common to use transistors fordriving resistive heating elements.However, you can use the heatthat a power transistor dissipates toadvantage in several situations, eliminatingthe need for a separate heatingelement because most transistors cansafely operate at temperatures as high as100°C. A typical example is in a biologicallaboratory, in which the need formaintaining the temperature of samplesin microliter-sized cuvettes is a commonrequirement. The space/geometry constraintand the less-than-100°C upper-temperaturelimit are the basic factorsof the idea.

You can use an N-channel IRF540MOSFET to directly heat and controlthe temperature of a biological samplefrom ambient to 45°C. **Figure 1** showsa simple on/off-type control circuitin which an LM35, IC_1, is the temperaturesensor, whose output a DPM(digital panel meter) can display. IC_2compares the voltage that VR_1 setswith the output of the LM35 to turnon Q_2 accordingly, with the positivefeedback through R_9 providing a smallamount of hysteresis. S_1 switches theDPM between a set value and the actualtemperature readout. You derive thereference voltage from a TL431 shuntregulator (not shown). The LED lightsup when Q_2 is on.

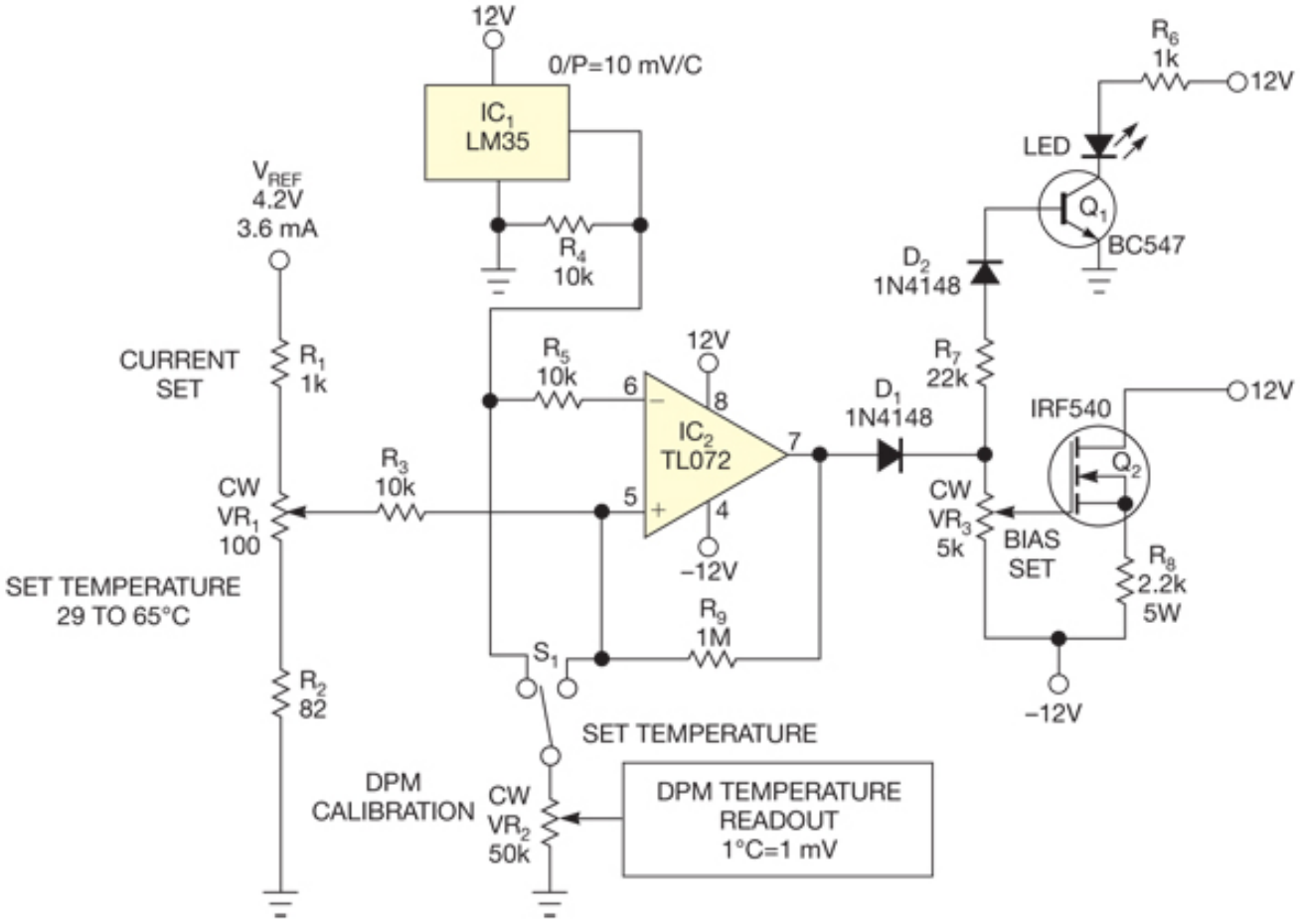

Figure 1 IC_1 senses the temperature of the item that Q_2 heats, and the temperature remains at the level that VR_1 sets.

IC_1 and Q_2 thermally mount on themetal block that forms the sample holder;use thermal grease on both componentsfor maximum heat transfer. Note thatthe mounting tab of the TO-220 packageelectrically connects to the drain,and you may need to insulate it from thecuvette with a thermal pad. Setting biascontrol VR_3 for a Q_2 current of 270 mAis sufficient to hold the cuvette at 45°C.

Be sure to set VR_3 to minimumpower during initial power-up; if youset it for maximum power, you couldapply 24V to Q_2's gate-to-source voltage,which is rated for a maximum ofonly 20V. You can extend the temperaturerange by changing the voltagedivider comprising R_1, R_2, and VR_1. Thedesign includes a safety cutoff circuit(not shown) in case the temperaturegets too high.

Various other options are also possibleapplications for this circuit. Theseapplications include linear control,pulse-width modulation, and the useof a PID (proportional-integral-derivative)controller, to name a few.