TEST pin. The registers, RAM and Flash memory can be read and written via this interface. Naturally, this feature can also be used in the target application. However, it's important to bear in mind that the associated pins have dual functions.
For in-circuit programming, you will need a 20-way SOJ test clip (available from 3M, for example) that can grip the pins of the SO IC package in the soldered-in state. A total of eight pins must be connected to the Flash Emulation Kit to allow the microcontroller to be programmed.

It's important to ensure that a High level is applied to the /RST pin for the duration of the programming process, and a supplementary 30-kΩ resistor must be connected to the TEST pin to ensure a well-defined Low level.

(040458-1)

References and software

[1] IAR Embedded Workbench Kickstart Version 3 Rev. D
Document ID: slac050d.zip

[2] MSP430F11X(1) Flash Emulation Tool (US $49)

[3] MSP-FET430 Flash Emulation Tool [http://focus.ti.com/lit/ug/slau138a/slau138a.pdf]

[4] http://www.msp430.com

019 Micropower Voltage Regulator

Reinhold Oesterhaus

This circuit was developed to power an AVR microcontroller from a 12 V lead-acid battery. The regulator itself draws only 14 µA. Of course, there are dedicated ICs, for example from Linear Technology or Maxim, which can be used, but these can be very hard to get hold of and are frequently only available in SMD packages these days. These difficulties are simply and quickly avoided using this discrete circuit.
The series regulator component is the widely-available type BS170 FET. When power is applied it is driven on via R1. When the output voltage reaches 5.1 V, T2 starts to conduct and limits any further rise in the output voltage by pulling down the voltage on the gate of T1. The output voltage can be calculated as follows:

$$U_{OUT} = (U_{LED} + U_{BE}) \times (R4 + R2) / R4$$

where we can set U_{LED} at 1.6 V and U_{BE} at 0.5 V. The temperature coefficients of U_{LED} and U_{BE} can also be incorporated into the formula.

The circuit is so simple that of course someone has thought of it before. The author's efforts have turned up an example in a collection of reference circuits dating from 1967: the example is very similar to this circuit, although it used germanium transistors and of course there was no FET. The voltage reference was a Zener diode, and the circuit was designed for currents of up to 10 A. Perhaps *Elektor Electronics* readers will be able to find even earlier examples of two-transistor regulators using this principle?

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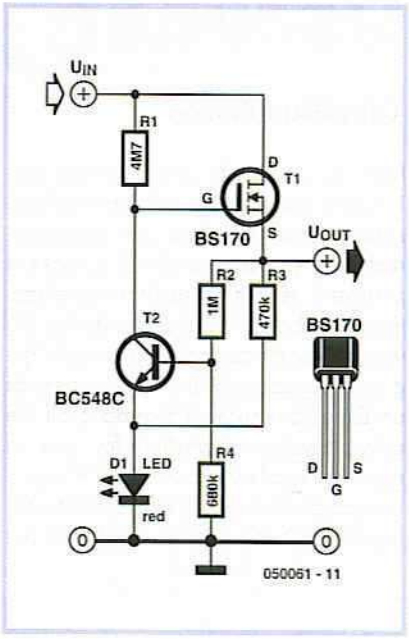

020 Garage Timer

Daniel Lomitzky and Mikolajczak Tyrone

The circuit described here is a testament to the ingenuity of two young designers from a specialist technical secondary school. The 'garage timer' began as a school electronics project and has now made it all the way to publication in our Summer Circuits special issue of *Elektor Electronics*. The circuit demonstrates that the application possibilities for the 555 and 556 timer ICs are by no means exhausted. So what exactly is a 'garage timer'?

When the light switch in the garage is pressed, the light in the garage comes on for two minutes. Also, one minute and forty-five seconds after the switch is pressed, the outside light also comes on for a period of one minute. The timer circuit is thus really two separate timers. Although the circuit for the interior light timer is relatively straightforward, the exterior light timer has to deal with two time intervals. First the 105 second period must expire; then the exterior light is switched on, and after a further 60 seconds the light is turned off. To realise this sequence of events, a type 556 dual timer device, a derivative of the 555, is used. The first of the two timers triggers the second after a period of 105 seconds. The second timer is then active for 60 seconds, and it is this timer that controls the exterior light. The interior light timer is triggered at the same moment as the dual timer. In this case a simple 555 suffices, with an output active for just two minutes from the time when the switch is pressed. Push-button S1 takes over the role of the wall-mounted light switch, while S2 is provided to allow power to be removed from