Solar tracker employs two photo cells

This circuit is based on a PIC16F88 microcontroller (IC1), which performs all the necessary control functions so that a solar panel can track the Sun as it moves across the sky.

IC1 is fed with input signals from a pair of low-power photo-sensors which, in the case of the prototype, are miniature photovoltaic panels, similar to the kind typically used in solar-powered calculators. These signals should not exceed 3V and are current-limited by the 2.2kΩ input resistors.

The photo-sensors should be mounted to move with the solar panel so as to point in the same direction as the panel. In addition, a shadow plate should be placed between the photo-sensors, with one sensor placed close to the eastern side of the shadow plate and the other placed close to the western side, such that when the panel is directly facing towards the Sun, the shadow falls between the sensors.

The height of the shadow plate should be 10 times or more the width of the sensors. Trimpot VR2 should be adjusted so that the signal voltages are equal when the full Sun shines equally on both sensors.

The solar panel is driven by a motor and gearbox assembly and a range of motors can be employed since the motor DC supply can be anywhere from 8-30V. The motor is controlled by a pair of P-channel Mosfets, Q1 & Q2, together with a pair of N-channel Mosfets, Q3 & Q4.

Q1 & Q2 are driven by NPN transistors Q5 & Q6 while Mosfets Q3 & Q4 are controlled via a UCC27424 Mosfet driver, IC2. The four Mosfets are connected in an H-bridge configuration with the upper pair used to control the direction of the motor while the lower pair control the speed.

IC2 ensures minimum switching losses in the lower Mosfets, which are pulse-width modulated (PWM). A dedicated driver is not required for the upper Mosfets because these are not pulse-width modulated.

As the Sun moves towards the west, the shadow cast by the shadow plate moves over the photo-sensor on the eastern side. IC1 responds by running the motor until the shadow once again falls between the sensors.

The acceleration and speed of the motor are controlled in the programming to ensure a smooth tracking response. After sunset the motor will automatically return the panel towards the east, in readiness to catch the Sun the following morning.

The motor will not track under cloudy or overcast conditions because it may become erratic due to the resulting low light contrast or due to reflections from clouds. A pair of limit switches (S1 & S2) should be arranged for sensing when the solar panels are facing approximately due east or approximately due west, respectively.

Programmed limits

IC1 is programmed to stop the motor if the latter attempts to move the panel beyond the preset limits set by the switches. This prevents possible damage should something go wrong and the motor otherwise fails to stop.

The motor's current drain is monitored via the 0.1Ω 5W wirewound resistor common to the sources of Mosfets Q3 & Q4. If the motor current rises to excessive levels due to

jamming or running to the limits of the gearbox, the microcontroller reduces the pulse width of the gate drive signals.

IC1's programming allows the motor to be controlled in a manual mode, as well as a tracking mode. Manual mode is selected by closing switch S3; tracking mode is selected by opening the switch.

Manual mode can be handy for setting up and testing. In this mode, the motor is controlled by means of potentiometer VR1. The motor stops when VR1 is set to centre position. Moving VR1 progressively towards 5V from centre position causes the motor to move correspondingly faster in the forward direction.

Conversely, moving VR1 progressively towards 0V from centre position causes the motor to move correspondingly faster in the reverse direction. A fairly wide "neutral zone" around centre position, which is set in the programming, minimises the risk that the motor will start should the potentiometer be bumped. The motor will stop in manual mode, as well as in tracking mode, if it attempts to move the panels beyond the limits set by the limit switches.

Motor duty cycle

The maximum motor duty cycle (in either mode) is set by potentiometer VR3. There are two reasons for this provision. First, maximum motor power may not be required and so limiting the motor duty cycle may help to reduce unnecessary stress on the motor and other parts, particularly in the case of a mechanical failure. Second, if the power source is 24V, for example, and if the motor is rated for 12V, then limiting the duty cycle becomes mandatory to prevent motor damage. In the case of the prototype, a 12V motor was used and this ran quite happily with the controller connected to a 24V power source.

The default operating parameters, such as maximum duty cycle, motor current limit, etc have been optimised for the prototype and should be suitable for most situations. However the parameters can easily be modified in the source code, if necessary, to suit different requirements.

The software, SolarTrak Source Codes.zip, can be downloaded from the Silicon Chip website.

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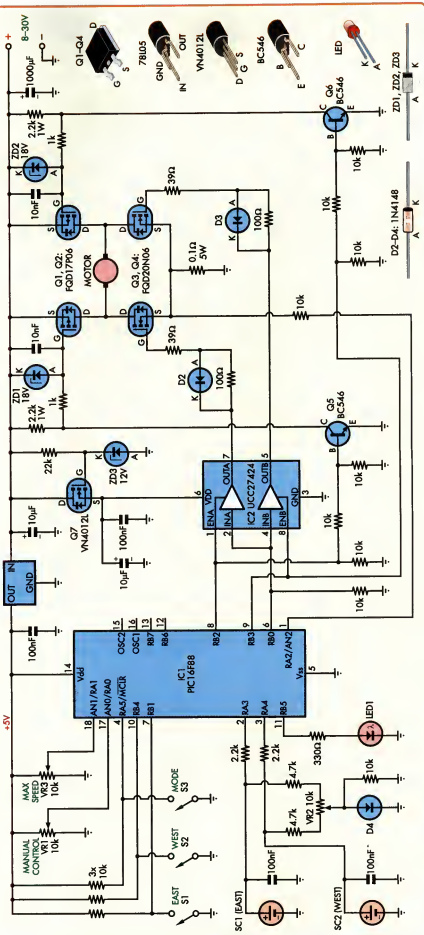

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