Controller Maps Auto's Electric Drive Voltage To Existing Thermal Fuel Gauge

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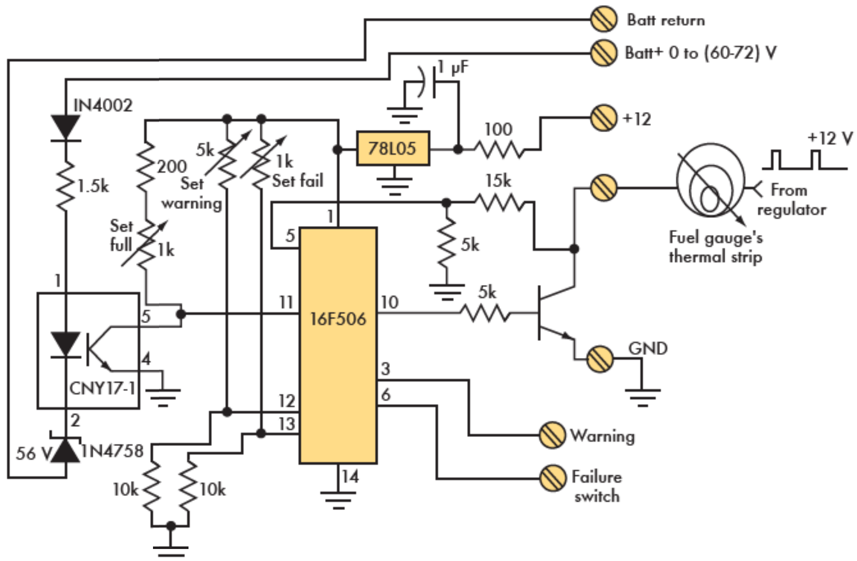
While converting an older Volkswagen to electric power, we wanted to display the battery voltage on the existing fuel gauge. The gauge used an electromechanical regulator to resistively control the heating of a bi-metallic thermal strip. The regulator is periodically pulsed by the vehicle's 12-V battery power. The conversion application provides a proportional control uniquely coded to synchronize and scale into the vehicle regulator's proportional-controlled power output.

Although proportional control doesn't require a controller *("Driver Offers Proportional Solenoid Control Without PLC, Microcontroller,"* Electronic Design, *Aug. 14, 2008, p. 73)*, the circuit we used is a good example of the added value provided by a controller. It also served as a nice solution to my relatively unique problem.



This circuit was used in the conversion of an old Volkswagen to electric power. It modified the standard fuel gauge to measure the battery voltage.

In our application, isolating and monitoring the motor's dc voltage and converting it to a chassis-based voltage was part of the problem. We used an opticoupler to provide the isolated interface for the battery-to-chassis-based 12-V system power *(see the figure)*.

The controller, a Microchip 16F506, monitors this re-referenced battery voltage at pin 11. It also manipulates the delivered regulated power to the fuel indicator's bi-metallic strip, at pin 10, by synchronizing and width-modulating the regulator's pulse signal. The controller provides an empty warning and battery cut-out status when the battery voltage drops to below limits set by the user.

The 16F506, with its three 8-bit analog-to-digital converters (ADCs), measures the user-settable empty warning and battery fail limits on power-up. It then monitors the power pulse's width at pin 5.

Measurement of the power pulse-width input and pulse-width-modulation (PWM) output control uses equally delayed, coded timing loops of about 1 ms. By repeating the two measurements on each cycle, the application accommodates variations in the 12-V battery voltage reflected in the vehicle's regulator power pulse's width and period. The code for the application can be found at *www.electronicdesign.com*, ED Online 20236.

The Zener diode voltage is set at 56 V, about 3 V below the desired "empty battery" voltage. The opticoupler was selected for its small transfer gain and minimum variation over temperature. Absolute linearity isn't a requirement. The "Set full" potentiometer allows adjustment to accommodate variations in the opticoupler's transfer characteristic. The other adjustments shown in the schematic help increase flexibility during development. One or both may be hard-coded into the controller as constants.

The 1-ms timing loops are simple, 8-bit register-based, cascaded counters. In this application, the regulator's pulse period isn't measured. Instead, only the power pulse's active time is measured, during which power is available to the fuel gauge's thermal strip.

This circuit accommodates power PWM periods up to 255 ms, with a usable minimum of about 32 ms, or power pulse periods of 2 to about 30 Hz. The base loop period can be reduced by changing a single variable constant in the code to accommodate higher active period measurements of the regulator's pulse power.

The battery warning and failure control status outputs will likely require additional buffer drivers, depending on whether they're used to drive a warning light from pin 3 or a battery-disconnect relay using pin 6.

WILLIAM GRILL, senior electrical engineer, received a BSEE from the University of Colorado, Boulder. He has published over a dozen application design ideas and articles.