Add a grounded-switch feature for Topswitch on/off control

Robert N Buono, Aeolian Audio LLC, Bloomfield, NJ

The Power Integrations Topswitch family (www.powerint.com/topgxproduct.htm) of integrated flyback-regulator ICs provides exceptional performance in small, low-pin-count packages. For the lowest-pin-count packages, the multifunction, or M, pin serves multiple purposes, including on/off control and undervoltage- and overvoltage-input detection. Other package types include an L pin, which also provides this function. The application notes and data sheets show how to implement the various features available at these pins. For example, to allow remote on/off control and still preserve undervoltage and overvoltage functions, the application drawings show an NPN transistor, Q_R, which connects between the M or L pin and the Control pin (**Figure 1**). To turn off the regulator, Q_R must be biased on. To achieve this goal requires a base voltage of 2.6V dc or greater.

The circuit in **Figure 2** provides a new feature that allows you to switch the regulator on or off using a grounded switch that is sometimes more convenient to implement than a switch that references to the Control pin. In the case of a mechanical switch, this circuit would require no external power to implement this function. This feature is important in applications in which the Topswitch power supply is the only source of power. This circuit does not disturb the functioning of the undervoltage and overvoltage functions of the M or L pin. To understand the functioning of the circuit in **Figure 2** requires an explanation of the internal workings of the M or L pin. This pin acts as a constant voltage source at approximately 2V dc and sinks current from the external circuit, which R_{LS} supplies. The internal current-sense thresholds for undervoltage and overvoltage detection are roughly 50 μA

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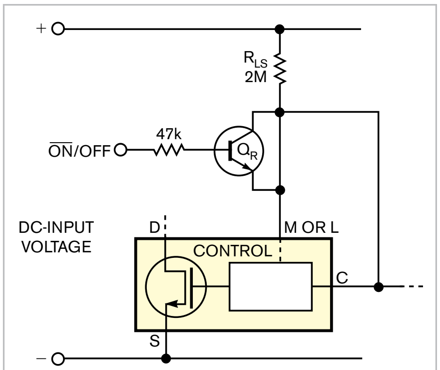

NOTE: Q_R CAN BE AN OPTOCOUPLER OUTPUT OR A MANUAL SWITCH.

Figure 1 Adding transistor Q_R to the L pin of a Topswitch switching power controller enables an on/off-control feature.

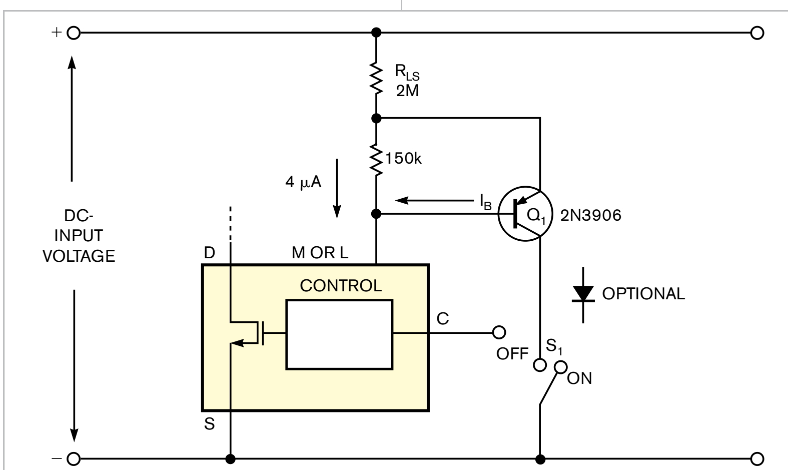

Figure 2 Instead of using just the external transistor to switch a Topswitch on or off, a simple on/off switch provides manual on/off control.

with 30 μA of hysteresis for undervoltage and 225 μA for overvoltage. That is, when the current into the M or L pin is less than 20 μA, or 50−30 μA, the regulator output switches off because of undervoltage. When the current into the M or L pin exceeds 225 μA, the regulator output switches off because of overvoltage. When the current into the M or L pin is 50 to 225 μA, the output is enabled.

The circuit of **Figure 2** works as follows: When the switch in the collector lead of Q_1 is open, Q_1 functions as a simple diode with a 0.6V drop from emitter to base. All the current that R_{LS} supplies flows into the M or L pin through the base-emitter junction of Q_1 and the 150-kΩ resistor. In this mode, the Topswitch IC senses the undervoltage and overvoltage thresholds. However, when the switch to ground closes, Q_1 functions as a nonsaturated transistor with high gain. The circuit siphons off most of the current through R_{LS} to ground as the collector current of Q_1. Only a small base current from Q_1 plus 4 μA through the 150-kΩ resistor flows into the M or L pin. For the values in **Figure 2**, this base current is less than 3.8 μA, even when Q_1 has minimum gain and input voltage is at a maximum of 450V dc. Therefore, 3.8+4 μA, or 7.8 μA, flows into the M or L pin. This low current flowing into the pin "fools" the regulator into "thinking" that the input voltage is undervoltage, and the regulator output switches off.

If another voltage or current source is present, you could replace S_1 with an open-collector switch that sinks current only. If the remote on/off driver can source and sink current, as the output of a logic gate can, then you should insert a diode in the collector lead of Q_1, and the driver must drive the cathode of that diode above 2V dc to turn off the regulator (optional in **Figure 2**). The M pin also allows current-limit-threshold adjustment.EDN

RC lowpass filter expands microcomputer's output port

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It's almost a corollary to Moore's Law: Next year, microcomputers will have more features, and the software team will have bigger ideas. Unfortunately, though, the number of output pins will stay the same. Finding even one spare output for diagnostics, test, or even standard I/O can be a tussle. The single-pin "bus" in **Figure 1** can provide an unlimited number of parallel outputs with simple additional hardware. A microcomputer output with an RC lowpass filter controls serial-to-parallel converter HC164. To enter data into the serial-to-parallel converter, each bit consists of a one-to-zero-to-one transition, which alters the length of the low state. If the low state is longer than the lowpass filter's time constant, a zero shifts into the register. If the low state is short, then a one shifts into the register. The clock and data signals thus combine into one signal. A lowpass filter separates the clock and data signals (**Figure 2**).

Listing 1, a simple "Whip" routine,

LISTING 1 WHIP-ROUTINE OUTPUT FUNCTION

```
Whip                                        ;  the data to transmit is in W
          MOVWF      My_Data
          MOVLW      8
          MOVWF      Bit_Counter            ; set up for eight bits
          BSF        My_Port,  My_Bit       ; ensure output is initially high
B1:
          RLF        My_Data,  F            ; data to send is in CC
          BTFSS      STATUS, CC
          BCF        My_Port,  My_Bit       ; zero, so falling edge is early
          CALL       Delay_10us             ; if a one, pin stays high for 10us
          BCF        My_Port,  My_Bit       ; if a one, edge falls here
          NOP                               ; ensures output pin is low for 0.2us min
          BSF        My_Port,  My_Bit       ; rising edge here clocks data into HC164
          DECFSZ     Bit_Counter
          GOTO       B1

          RETURN
```

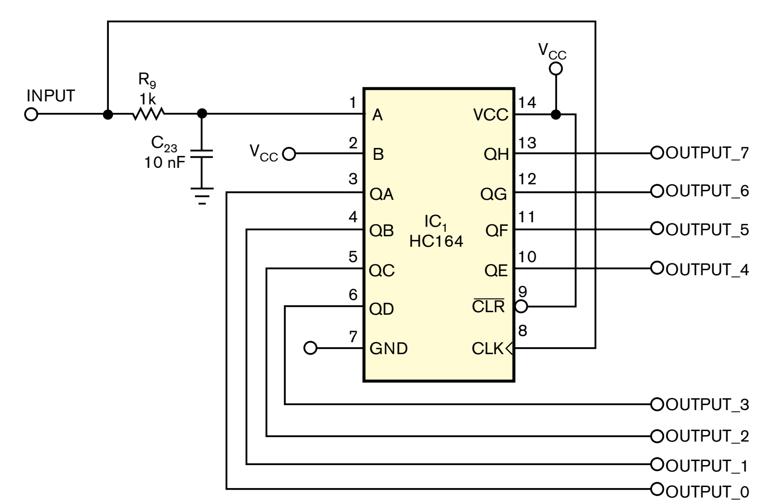

Figure 1 This single-pin "bus" can provide an unlimited number of parallel outputs with simple additional hardware.

performs the output function for eight bits. Assume that the RC time constant is 3 µsec, and the instruction time should be 1 µsec or less at a crystal frequency of 4 MHz or greater. The routine uses bitwise manipulation of output My_Bit of port My_Port.

Although the circuit in **Figure 1** can control slow-reacting devices, such as relays or LCDs, using it with LEDs can give an annoying flicker when the HC164 is writing. To address that problem, the circuit in **Figure 3** uses another serial-in/parallel-out register, the 4094, which has a strobe input to allow simultaneous updates of all outputs without temporary levels. A twin monostable circuit supplies the data and strobe signals. This circuit should be able to control parallel devices, such as display modules based on HD44780 devices. EDN

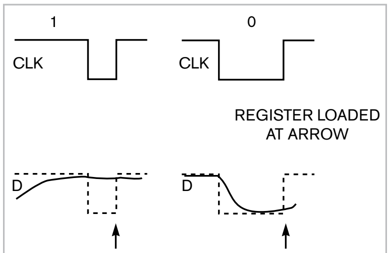

Figure 2 The clock and data signals combine into one signal.

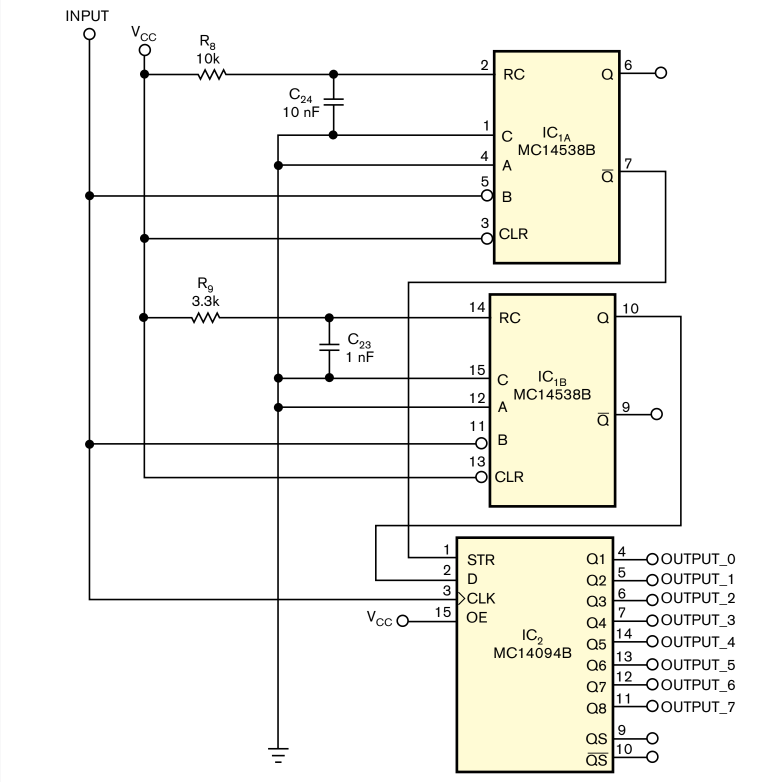

Figure 3 This circuit uses another serial-in/parallel-out register, the 4094, which has a strobe input to allow simultaneous updates of all outputs without temporary levels.

Simple dual constant-current load tests low-current power supplies

John S Lo Giudice, STMicroelectronics, Schaumburg, IL

Today's small electronic appliances, such as washers, dryers, and stoves, use switched-mode power supplies to replace bulky, heavy, linear-power supplies. The engineer testing these power supplies, which range in current from 50 mA to 1A, typically uses resistors or standard off-the-shelf electronic loads. An engineer would employ a variety of high-wattage resistors to verify multiple loading conditions to satisfy a proper design. Most off-the-shelf electronic loads target an average of 300W. When measuring 50 to 300 mA, a display is inaccurate; most of them display 0.1A, but accuracy is questionable at that low range. You can alternatively use the simple dual constant-current-load design in **Figure 1**, which you can build with inexpensive, common parts.

The load current passes through a MOSFET and a 1%, 1Ω sense resistor, R_6. Pin 2 of IC_{1A} compares the voltage drop in the resistor to a reference voltage. IC_1, an LM358 op amp, compares the two inputs and adjusts its output accordingly. The reference voltage at Pin 3 of IC_{1A} comes from a voltage-divider potentiometer, R_2 or R_3, which derives from a TS431 1.25V 1% reference. Because the maximum voltage can be 1.25V and the sense resistor's value is 1Ω, the maximum current per channel can reach 1.25A.

R_2 and R_3 are 15-turn, 1-kΩ potentiometers, which you can finely adjust to the desired load. One can set a minimum current, and the other can set a maximum current. Switch S_1 can then switch between minimum load, no load in the middle position, and maximum load. Furthermore, by attaching a standard DMM (digital multimeter) across R_6, you can directly read the current and adjust it to the proper level.

Input-voltage change does not affect the DMM's reading because it monitors the constant current through sense resistor R_6. The second channel is a duplicate of the first. Each chan-

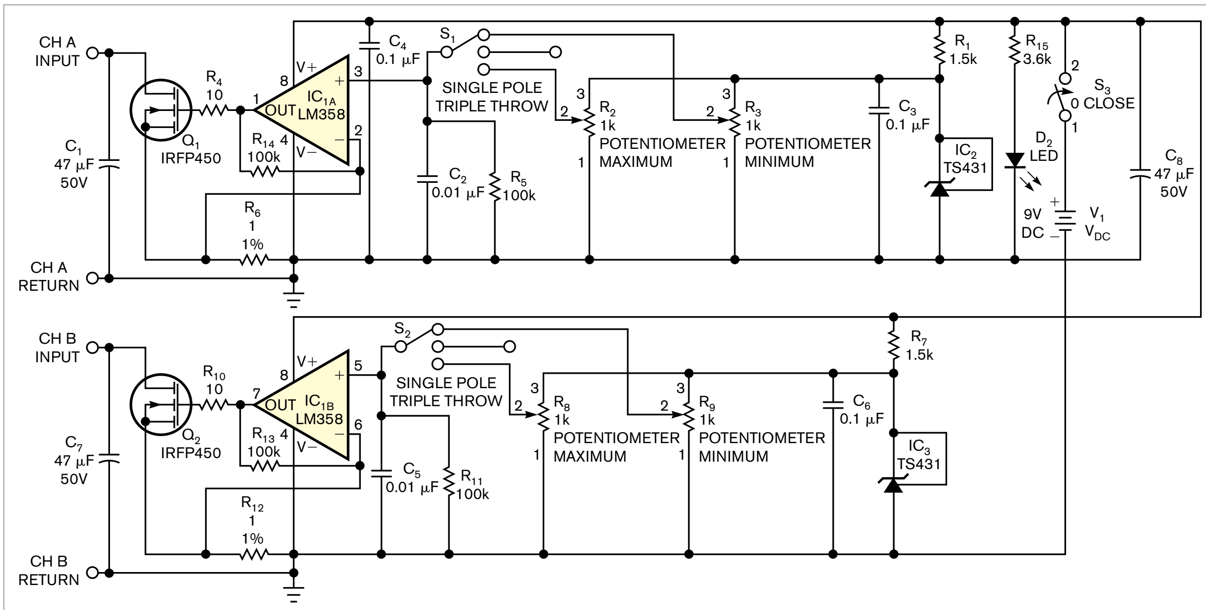

Figure 1 This dual constant-current load can measure the performance of dual power supplies supplying 0 to 1.25A per channel.

nel can control 0 to 1.25A and can handle a voltage of 3 to 50V. The capacitor input and the MOSFET set the upper limit. The two inputs can be in parallel to a load of 2.5A. For a two-output power supply, you can set the minimum and maximum current by precisely reading the level on a multimeter and then quickly testing a matrix of no load, minimum load, and maximum load. A 9V battery powers the unit. EDN

Stepper-motor motion controller and driver fit into a CPLD/FPGA

Stephan Roche, Santa Rosa, CA

This Design Idea further develops a previous one integrating a stepper-motor driver in a CPLD (**Reference 1**). However, this idea integrates not only the driver, but also a simple one-axis stepper-motor motion controller. Depending on the size of the target CPLD, you can implement multiple motion controllers into a single device. For example, a single-axis motion controller fits into a Xilinx (www.xilinx.com) XC95108 using 68 of, or 63% of, the available macrocells. The motion controller rotates the stepper motor clockwise or counterclockwise a given number of steps with a given speed profile versus time. When a motion begins, the controller accelerates until it reaches the cruise speed and then decelerates before stopping (**Figure 1**).

The controller can adjust the motor speed to 16 values, $V=V_{MAX}\times$speed/16, where speed is an integer with a value of one to 16. During the acceleration phase, the speed ramps up by increasing from one to 16; during the cruise phase, speed stays at 16; finally, during the deceleration phase, speed ramps down to one before stopping. If there are insufficient steps for the controller to reach the cruise phase, the controller goes directly from the acceleration phase to the deceleration phase. You can adjust the acceleration/deceleration rate in the program, which you can find at www.edn.com/070621di1 by the constant "accel," which can be one to 255. A high value of accel results in a slow acceleration/deceleration, and a low value results in a fast acceleration/deceleration. The inputs of the CPLD stepper-motor controller are clock, direction, full/half-step, reset, Nstep, start, and stop.

The clock input is active on the positive edge of the clock pulse. The maximum motor speed is one step every 16 clocks. The direction input determines the motor's rotational direction. The motor runs clockwise or counter-

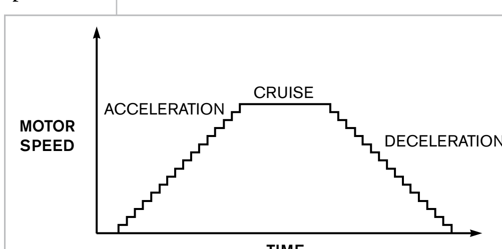

Figure 1 This design can control the motor with 16 speeds. The maximum speed in the cruise phase is such that the motor makes a step or half-step every 16 clock cycles.

clockwise, depending on the level of this input and the motor connections. That value is latched at the first rising clock edge after start goes high. The full/half-step input determines the angular rotation of the motor for each clock pulse. In the low state, the motor makes a full step for each applied clock pulse, and, in the high state, the motor makes a half-step. A high level on the reset input sets the motor in a defined state. The motor ignores any clock pulse when reset is high. The 16-bit Nstep value defines the number of steps the next motion will perform. That value is latched at the first rising clock edge after start goes high. A high level on the start input starts the motion, and a high level on the stop input stops the motion, aborting the current motion.

The outputs of the CPLD stepper-motor driver are A, A_N, B, and B_N (**Figure 2**). The A and A_N outputs control one of the motor's coils through power drivers, and the B and B_N outputs control the motor's second coil through power drivers.

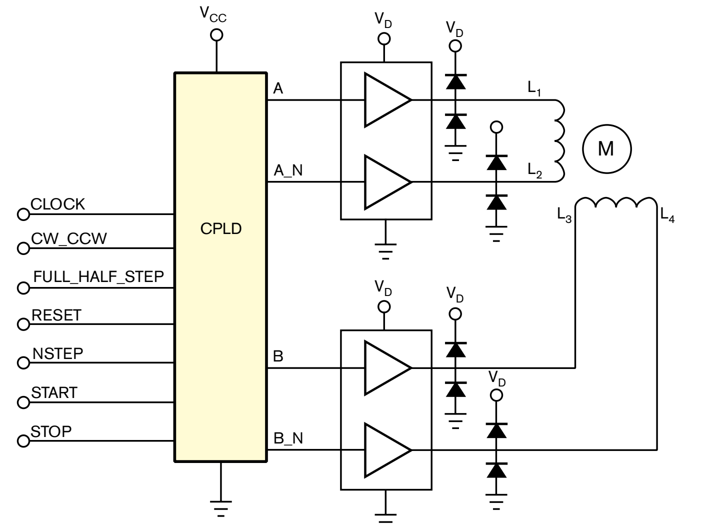

Figure 2 The FPGA/CPLD requires external drivers.

The CPLD/FPGA cannot directly drive the motor, so it requires external drivers. The driver must arrive at the motor's nominal voltage. The Schottky diodes at the output of each driver allow current freewheeling in the motor coils. If you use MOSFET drivers, external Schottky diodes should be unnecessary because MOSFETs have built-in diodes; the Microchip (www.microchip.com) TC4424A dual driver can drive motor coils to 18V and 3A. EDN

REFERENCE

1 Roche, Stephan, "Implement a stepper-motor driver in a CPLD," *EDN*, Feb 15, 2007, pg 90, www.edn.com/article/CA6413791.