Technical Article

Tips and Tricks for Optimizing Your Voltage Supervisor

Michael Hartshorne

Voltage supervisors have provided analog voltage monitoring to digital circuits for decades. Texas Instruments released the original TL7705 in 1983; it consumed 1.8mA, came in a plastic dual-inline package (PDIP) and you can still purchase it today. Newer supervisors come with a wide range of options, from ultra-low current (TPS3839), tiny packages (TPS3831), dual channel (TPS3779/80) and high accuracy (TPS3702) to multichannel, feature-rich power monitors (TPS38600). In addition to choosing from these options, there are some simple circuit additions that you can make to help optimize the voltage-supervisor function; here are a few of those additions.

Add a Resistor to Increase Hysteresis

Some applications require a wider-voltage hysteresis than what is typically available with standard supervisors. One way to increase hysteresis on an adjustable supervisor is to add an additional resistor between the output pin and the input resistor divider.

In the normal configuration shown in Figure 1, R1 and R2 set the threshold voltage and R4 is a pull-up resistor. Adding R3 gives a feedback path from the output (V_{OUT}) to the divider voltage, allowing for adjustable hysteresis with proper resistor selection.

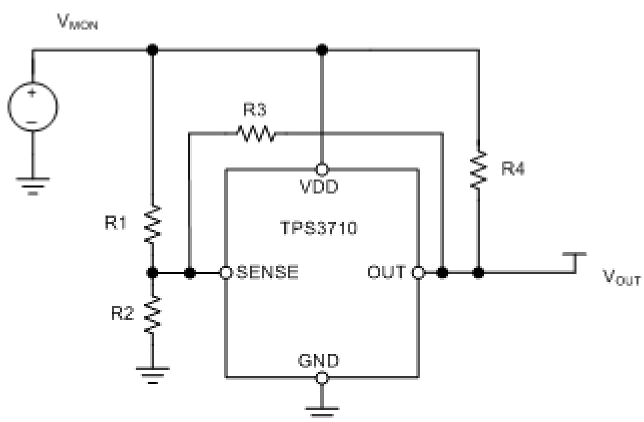

Figure 1. TPS3710 With Resistors Added for Hysteresis

Equations 1 and 2 calculate the rising and falling thresholds for the circuit in Figure 1:

$$V_{TH\text{-}RISING} = \frac{R_1 + R_2 \,||\, R_3}{R_2 \,||\, R_3} \bullet 0.400$$

$$V_{TH\text{-}FALLING} = \frac{((R_3 + R_4) \,||\, R_1) + R_2}{R_2} \bullet 0.395$$

Sense a Negative Voltage

Monitoring a negative voltage can be tricky because most systems have ground-referenced logic signals, requiring level shifting to enable communication. One way to accomplish the necessary level shifting is to use open-drain outputs. Figure 2's schematic shows how to use the TPS3700 in a negative rail with the outputs level-shifted up to give positive logic.

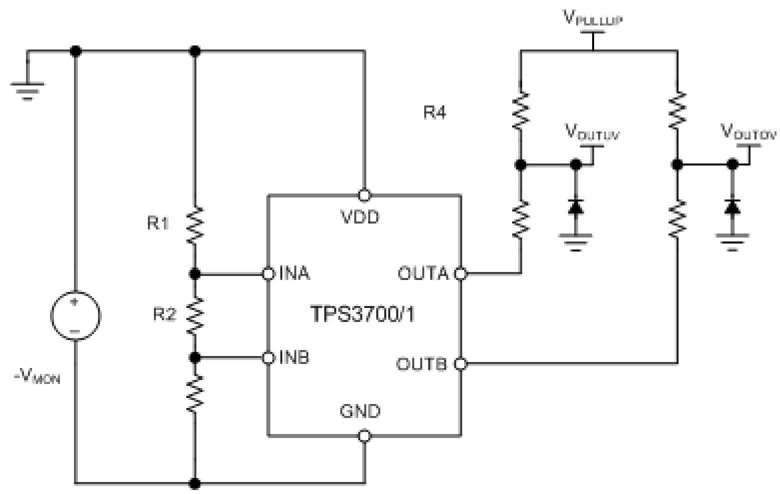

Figure 2. TPS3700/1 Configured for Negative Voltage Sensing

In Figure 2, the monitored voltage (V_{MON}) is a negative voltage relative to ground. You can program the overvoltage and undervoltage limits with R1, R2 and R3 in the same way as for the positive voltage (see product data sheets for more information). The open-drain outputs of the TPS3700 or TPS3701 are independent of VDD, which means that V_{PULLUP} can be a positive voltage that enables a positive ground-referenced logic voltage to interface with any microcontrollers or processors.

Sensing a negative voltage using the previously described method requires additional diodes and resistors on the output. Another trick for sensing a negative voltage that will have fewer additional components is to use a positive voltage to shift up the resistor-divider voltages so that the divided threshold voltage is positive relative to ground. The four-channel TPS386000 supervisor makes this easy by providing a reference voltage to which you can connect the resistor chain. See Figure 3.

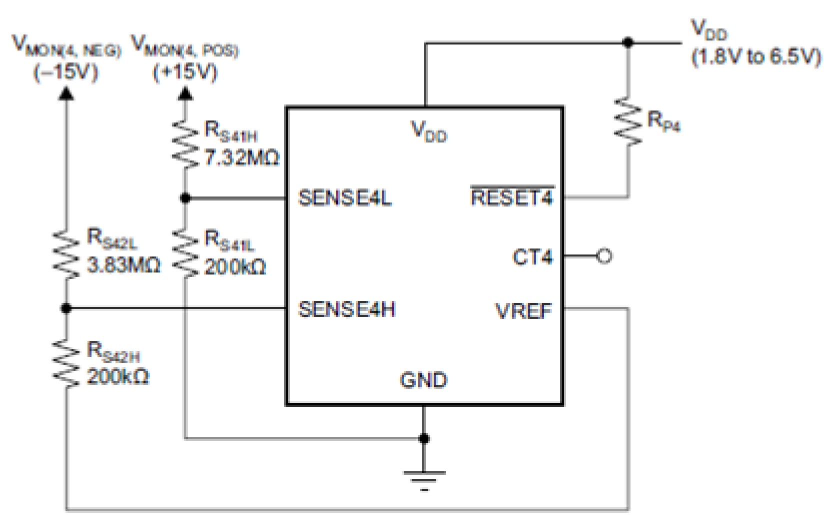

Figure 3. Using an External Voltage Reference to Sense a Negative Voltage

In Figure 3, the $V_{MON(4,NEG)}$ node represents the negative monitored voltage and $V_{MON(4,POS)}$ the positive monitored voltage. Negative monitoring is possible because the resistor divider is referenced to the V_{REF} pin (a 1.2V output) instead of ground-referenced, as in the positive channel. The RESET output will go high in Figure 3 when the negative channel falls below -14.92V and the positive channel rises above 15.04V, nominally.

Add a P-type JFET to Remove False Low-voltage Output Signals

Most supervisors require a certain amount of voltage on VDD before the device's output can give an accurate output. This voltage is typically around 800mV – below this voltage, the supervisor has no way to control the internal circuitry that's pulling the output low or high. As a result, the output will rise up with the pull-up voltage until there is enough headroom for the device to pull it back down. Many times you can ignore this; however, in the cases where you cannot, you can add a P-channel junction field effect transistor (JFET) to ensure that the output stays low even when VDD is not sufficient to provide power to the supervisor. Figure 4 shows an example.

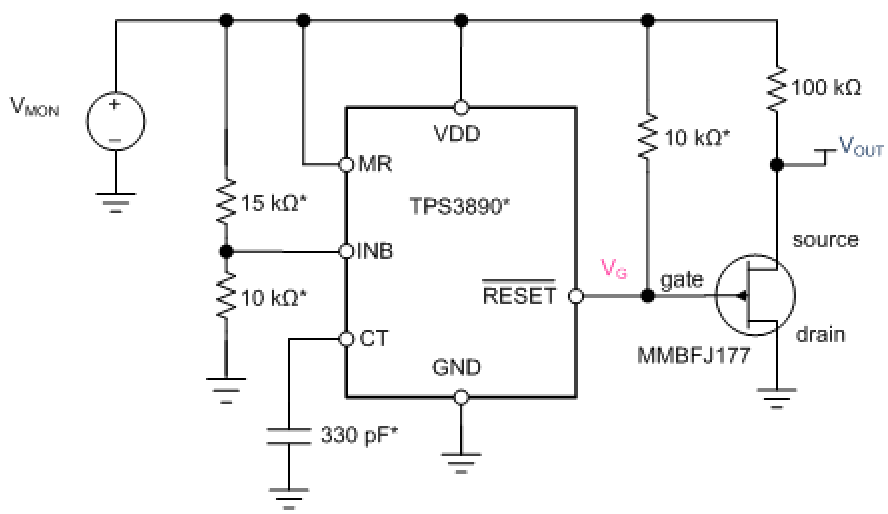

Figure 4. Adding a JFET to Remove Output Voltage Rise with Low VDD

In Figure 4, the normal output of the TPS3890 is represented as V_G. When V_{MON} (the monitored voltage) rises, the voltage at V_G also rises briefly, to around 0.5V. By adding a standard JFET configured in a source-follower configuration, the voltage at the source (labeled as V_{OUT}) will track the voltage at V_G minus the threshold voltage of the JFET. This results in an approximate 1V drop between V_G and V_{OUT}, and eliminates the 0.5V rise on V_G. Figure 5 shows the effect of using a JFET on the output of the TPS3890.

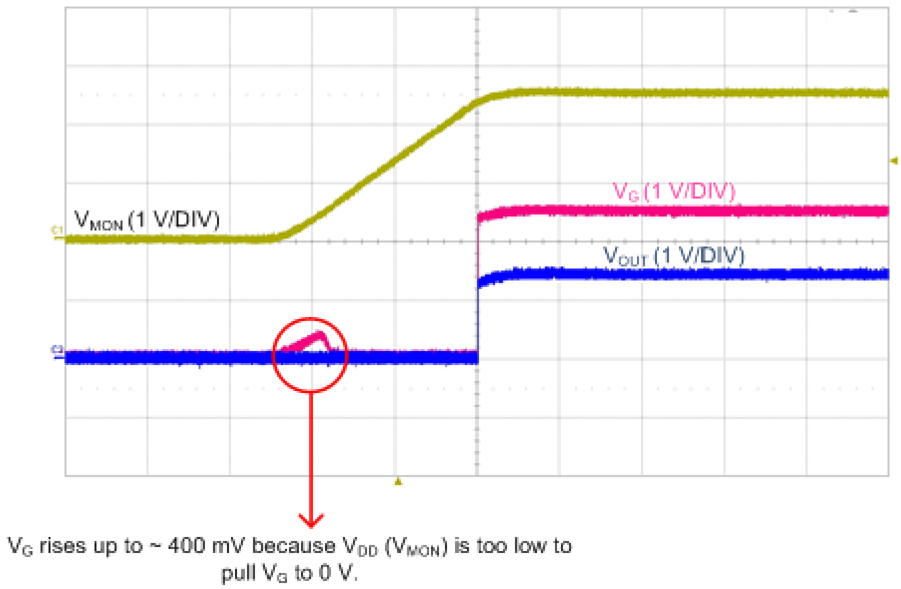

Figure 5. TPS3890 Startup with and without a JFET on the Output

Supervisors are necessary in a wide range of applications and systems. While most standard configurations don't require any additional components beyond a resistor or two, there are some applications that require additional functionality. Hopefully this blog helps give a few ideas on how to solve these unique cases. For more information on the circuits mentioned here, see the links below, or visit ti.com.

Additional Resources

- Get more information on supervisors and supervisor application circuits.
- For more details on sensing a negative voltage, read the application report, "Using the TPS3700 as a Negative Rail Over- and Undervoltage Detector."
- Download the TPS386000 data sheet.