APPLICATION NOTE 4545

Flexible Overvoltage/Undervoltage Detector
Monitors Negative and Positive Voltages

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Abstract: Combining a window comparator (MAX6764) with a positive-voltage monitor (MAX6887/MAX6888) enables the circuit to monitor a negative voltage as well, as is often required in telecom systems.

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Multivoltage supply supervisors (such as the MAX6887) provide several voltage-detector inputs for positive voltages, each with factory-set thresholds for undervoltage and overvoltage. The active-low RESET output asserts when any input drops below its undervoltage threshold, or when you assert the manual reset (MR). The active-low OV output asserts when any input exceeds its overvoltage threshold. These capabilities are useful, but telecom applications often require that you monitor a negative supply voltage for the RF circuitry as well.

To monitor negative voltage you can make use of the MAX6887 adjustable-input option (Figure 1), in which a level-shifting circuit connects one side of the resistive divider to a positive level and the other side to the negative voltage. This approach, however, produces inverted output logic. If, for example, you monitor -6V with thresholds at -6.5V and -5.5V, the circuit asserts active-low UV when \( V_{IN} = -6.5V \) and active-low OV when \( V_{IN} = -5.5V \).
The circuit of Figure 2 overcomes this limitation by adding a simple window-detector IC (Figure 3) to monitor the negative supply. The detector’s active-low UV output connects to the multivoltage supervisor’s active-low OV output, and the detector’s active-low OV output connects to the supervisor’s active-low RESET output. Thus, the active-low RESET output goes low when the negative voltage decreases to -5.5V, and the active-low OV output asserts low when the negative voltage increases to -6.5V. Three resistors (R1–R3) set the under- and over-voltage thresholds UV and OV. R1 connects to a positive reference voltage, and R3 connects to the monitored negative voltage.

Figure 1. MAX6887 adjustable input option.

Figure 2. This IC (in SOT23 package) is a simple window comparator that monitors a supply voltage with separate under/overvoltage outputs.
Figure 3. By combining the circuits of Figures 1 and 2, one pair of terminals warns of under- or over-voltage for multiple positive voltages and one negative voltage.

If your system doesn't include a positive reference voltage, you can use the supervisor's 2.55V BP output. To maximize DC accuracy, the sum of R1 + R2 + R3 should draw only a few microamps from the BP output. Using the principle of superposition, you can then calculate the voltages at UVIN and OVIN for any given set of resistor values as follows:

\[
V_{UVIN} = V_{BP} \times \left( \frac{R_2 + R_3}{R_1 + R_2 + R_3} \right) - |V_M| \times \left( \frac{R_1}{R_1 + R_2 + R_3} \right)
\]

\[
V_{OVIN} = V_{BP} \times \left( \frac{R_3}{R_1 + R_2 + R_3} \right) - |V_M| \times \left( \frac{R_1 + R_2}{R_1 + R_2 + R_3} \right)
\]

where \(V_M\) is the monitored negative supply voltage.

Operation of the Figure 3 circuit is illustrated in the scope shot of Figure 4, in which the yellow trace (CH1) represents the monitored negative voltage \(V_M\) as it ranges from 0V to -7V. Other traces are:
R1 (black) = UVIN
CH2 (blue) = MAX6764 active-low UV
CH3 (green) = OVIN
CH4 (pink) = MAX6764 active-low OV

Figure 4. These waveforms illustrate operation of the Figure 3 circuit.

The nominal value for the monitored negative voltage is -6V. Both active-low OV and active-low UV outputs have a 10kΩ pullup to 5V, and the V_{CC} terminals of both ICs connect to a 5V supply. The MAX6764 Output active-low UV (MAX6887 active-low OV Output) goes low at V_M = -6.55V (and goes high at V_M = -6.52V). The MAX6764 output active-low OV (MAX6887 active-low RESET Output) goes low at V_M = -5.53V (and goes high at V_M = -5.55V).

### Related Parts

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