Boosting Supply Select Hysteresis on the TPS2350

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ABSTRACT

This Application Note describes a method for increasing hysteresis in the TPS2350 supply select comparator. Hysteresis greater than the default value of 400 mV might be required due to dynamic loads, poorly regulated supplies, resistive supply lines, or simply to reduce switching between primary and back-up supply. The example given shows how to increase the hysteresis in a −48-V system from 400 mV up to 3.2 V.

Theory of Operation and Application

Figure 1 shows a typical TPS2350 application which has been modified with six additional components to set the hysteresis at a value greater than the nominal 400 mV. The additional components are R4 – R7, Q4, and Q5.

The four resistors are configured as a pair of identical voltage dividers. Matching the voltage dividers provides for the same hysteresis regardless of which supply is turning on. Connecting the low end of the dividers to source ensures that at least one input of the supply select comparator will be less than 6 V above source. This is necessary for proper operation of the TPS2350.

Since the supply select comparator inside the TPS2350 has a threshold of 400 mV the resistors are chosen to present 400 mV to the supply select comparator when the voltage difference between supplies reaches the desired switch level. The input impedance to the supply select comparator is approximately 400 kΩ to 1.3 V above \( V_{\text{SOURCE}} \) for the on channel, and 315 kΩ to 1.3 V above \( V_{\text{SOURCE}} \) for the off channel.

Using the standard 400-mV hysteresis, the Q2 and Q3 body diodes would never be forward biased by more than 400 mV, which is not sufficient to turn them on. In this extended hysteresis configuration blocking diodes are required and that is the purpose of Q4 and Q5. They prevent current from flowing in the off channel even if the voltage difference between source and \( V_{\text{A(input)}} \), or source and \( V_{\text{B(input)}} \) is sufficient to turn on the body diode of Q2 or Q3.

Design of extended hysteresis circuits for the TPS2350 must ensure that the hysteresis does not become greater than the threshold voltages (\( V_{\text{TH}} \)) of the FETs being used. Were that to occur the channel which is supposed to be off could start conducting.
Component Selection

Selecting the resistors for a specific hysteresis is accomplished using the following formulae;

- \( R4 = R5 \)
- \( R6 = R7 \)
- \( 30 \, \text{k}\Omega < (R4 + R6) < 200 \, \text{k}\Omega \)
- \( V_{HYST} < V_{TH} \)
- \( R4 = (V_{HYST} \times R6)/.4 – R6 \)
- \( V_{TH} = \text{FET Threshold Voltage (V}_{GS} \)
- \( V_{HYST} = \text{Desired Hysteresis Level} \)

These equations neglect the finite input impedance of the supply select comparator but as long as \( (R4 + R6) < 200 \, \text{k}\Omega \), it does not significantly affect accuracy. Examination of the resistor selection process and experimental data in Graph 1 show that by keeping \( (R4+R6) \) less than 200 kΩ, it is possible to ignore the input circuitry of the TPS2350.

Figure 1. TPS2350 Configured With Boosted Hysteresis
Summary

A method for increasing supply select hysteresis from 0.4 V to any value less than the threshold voltages of the external FETs has been presented. Two additional external FETs and four additional resistors are required.
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