
Managing Multiple Power Rails With the TPS208x/209x

David Arciniega

Power Distribution

ABSTRACT

Auxiliary power (V_{aux}) applications involve switching from one voltage source to another while maintaining uninterrupted power to the load. The Texas Instruments' TPS208x/9x family of power distribution switches are designed to manage these types of multiple-source applications.

Introduction

Texas Instruments' TPS208x/TPS209x power distribution switches are available in dual and quad configurations with various combinations of active-high and/or active-low switch-enable inputs. This makes them well suited for use in auxiliary-power or V_{aux} applications.

In an auxiliary-power application, two separate voltage sources are connected to the same load, but only one voltage source powers the load at any given time. If one source of power, such as the main battery, is removed, the second source of power (an auxiliary battery, for example) is switched in. Ideally, this transition is seamless, so that as one switch turns on and the other turns off, the output does not droop, or cause current to flow back into either of the voltage sources.

Application

Figure 1 shows the TPS2081 in a V_{aux} application. The two switch inputs are connected to separate voltage sources and the outputs tied to a common load. Because the TPS2081 is designed with complementary enable inputs, these two control lines can be tied together and controlled by the same logic signal. By not introducing different external components to each of the enable inputs, the delays associated with turning one switch off and the other switch on are determined by the internal circuitry of the device.

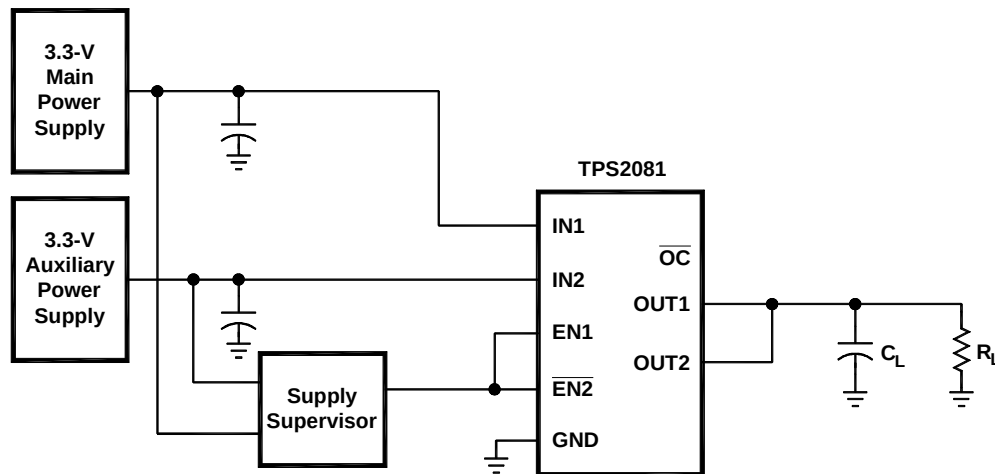


Figure 1. TPS2081 in a V_{aux} Application

In the V_{aux} example of Figure 1, one switch is always enabled and conducting current to the load while the other switch is off. These devices are designed without a parasitic diode from the source-to-drain of the MOSFETs, thereby preventing reverse current flow when a switch is turned off. This feature is an important aspect for making V_{aux} work. Without it, current would flow backward through the disabled switch and into the power source.

During the switch transition time, while one switch is turning on and the other is turning off, a small amount of reverse current flow can occur. This is more evident if one input power source is significantly larger than the other. The waveforms shown in Figure 2 illustrate this reverse current flow. These waveforms were taken using the circuit shown in Figure 1 with IN1 and IN2 set at 3.6 V and 3.0 V, respectively. During the transition time, as switch 1 is turning off and switch 2 is turning on, the higher voltage power source provides additional current while the lower voltage source sinks the additional current. The same is true if IN2 is set to 3.6 V and IN1 is set to 3.0 V. In either case, the higher voltage input sources more current during the transition.

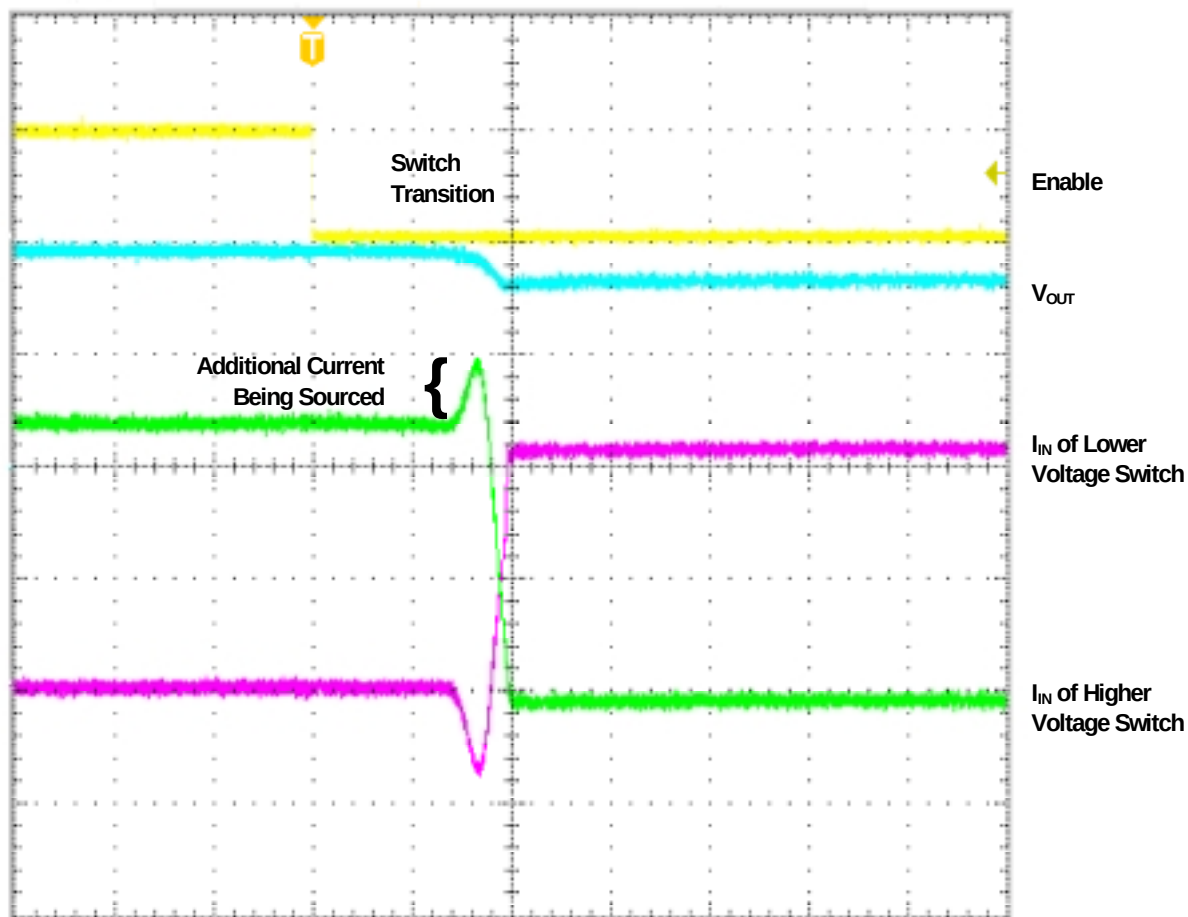


Figure 2. Waveforms Illustrating Reverse Current Flow

Figures 3a and 3b show the system current flow, prior to and during switch transition. With switch 1 closed (IN1 enabled) and switch 2 open (IN2 disabled), current flows from the 3.6-V source through switch 1 and to the load (see Figure 3a). Because the TPS208x/TPS209x family is designed without a parasitic diode from source-to-drain, no current flows back to the lower voltage supply when switch 2 is disabled. As switch 1 turns off (disabled) and switch 2 turns on (enabled), a moment exists when both switches are conducting current (see Figure 3b). Current still flows from the 3.6-V source to the load through switch 1; however, additional current flows from switch 1 through switch 2 and back towards the 3.0-V source. The current waveforms shown in Figure 2 depict the larger voltage source providing the extra current as a result of the lower voltage source now acting as a secondary load. This current back flow is not seen when both sources of power are relatively close in potential (see Figure 4).

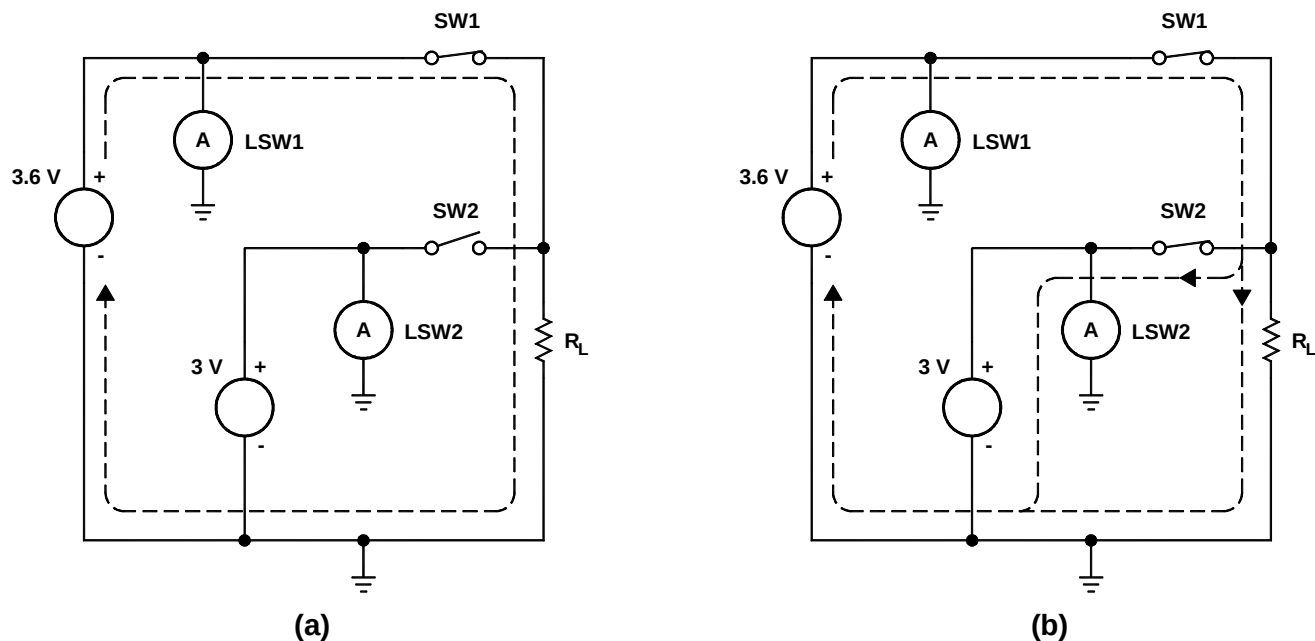


Figure 3. Pictorial Representations of Current Flow (a) Prior to and (b) During Switch Transition

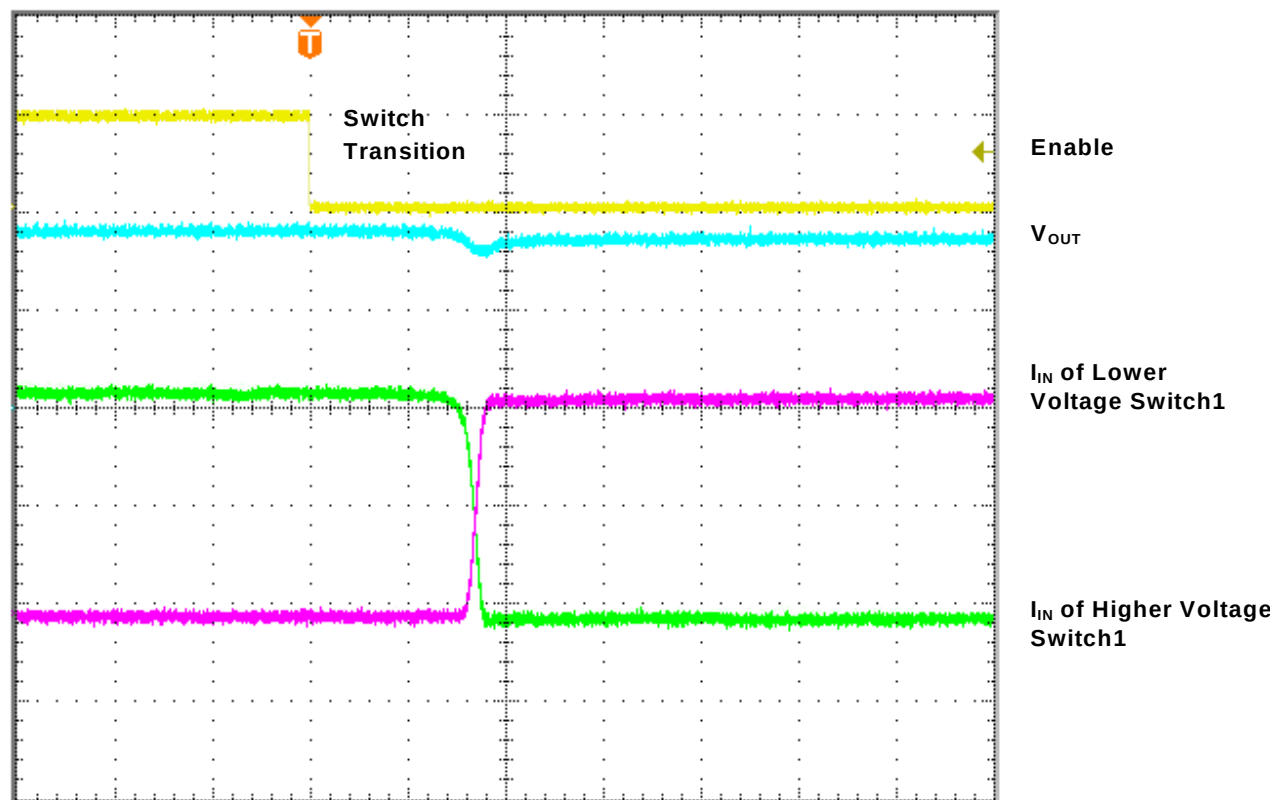


Figure 4. No Reverse Current Flows When Power Sources Have Nearly the Same Potential

In the case where both switch inputs are at approximately the same voltage level (typically less than a 0.2 V difference), the transition from one switch to the other does not create a current back-flow condition. The waveforms shown in Figure 4 were taken with both inputs set at 3.3 V, and without a capacitor on the output (a worst case scenario). After the enable transitions the device from switch 1 to switch 2, the current flowing through switch 1 diminishes while the current through switch 2 starts to ramp up. The slight droop seen on the output is attributed to the absence of a capacitor on the output, and the input voltage being less than 3.6 V. The droop is proportional to the amount of gate drive provided by the internal charge pump (see Figure 5). The lower the voltage, the slower the FET turns on. As the input voltage increases, the gate drive also increases and the FET turns on faster. In this example, setting both input supplies at 3.6 V with no capacitor on the output, eliminated the output droop.

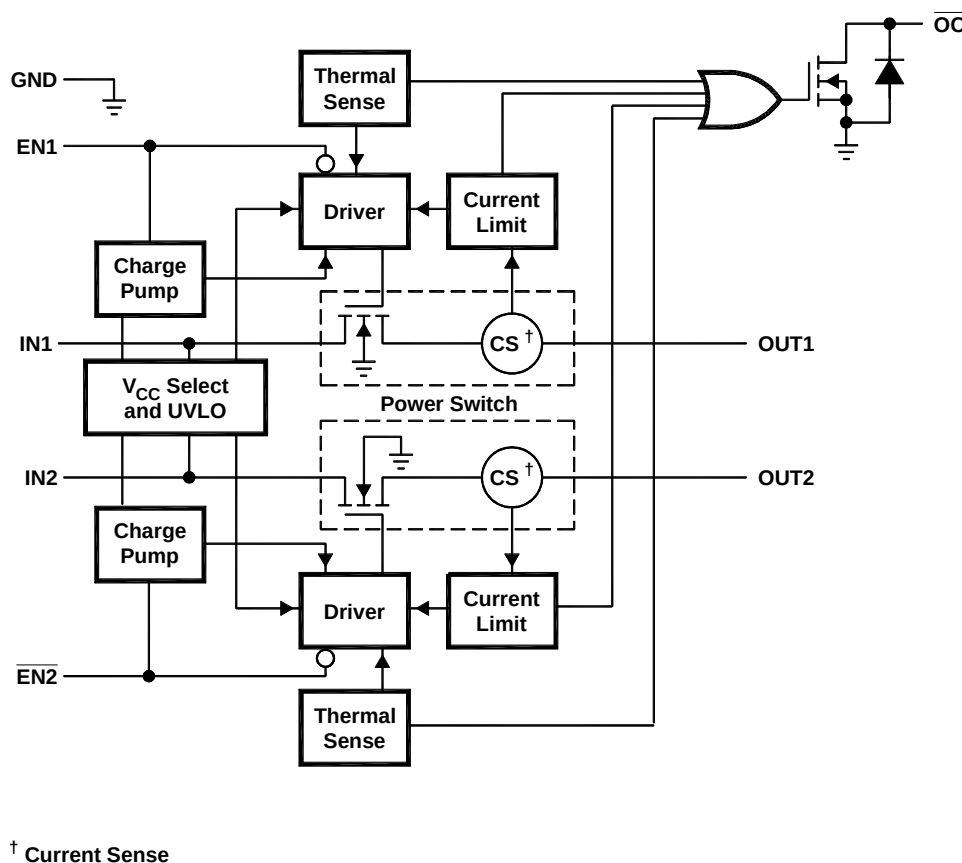


Figure 5. TPS2081 Functional Block Diagram

Reducing current back flow can be accomplished by using a ferrite bead in series with the switch and a low ESR bypass capacitor as shown in Figure 6. The capacitor will absorb a portion of the initial current and the ferrite bead will help slow up the current flowing back to the voltage source. The current back flow will not be completely eliminated, but it can be reduced. Naturally, the type and value of the ferrite bead and the capacitor are factors. The ferrite bead should be a low-Q type, commonly used for power-supply filtering.

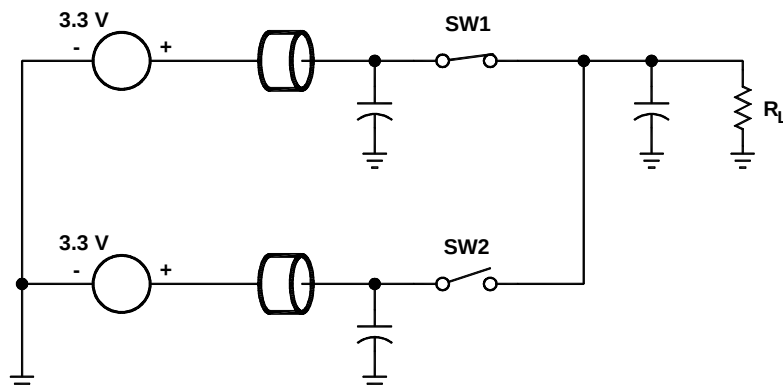


Figure 6. Reducing Current Back Flow With a Ferrite Bead and a Low ESR Bypass Capacitor

Summary

Using the TPS2081 is just one possible solution for switching between multiple power rails. With its complementary enables and its reverse current blocking feature, this device is well suited for these types of applications. Additionally, its low switch resistance provides a simple solution for a variety of low voltage and portable applications.

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Mailing Address:

Texas Instruments
Post Office Box 655303
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