Application Report
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Independent Rail Dual Buck Converter Using TPS51220

Gitesh Bhagwat

ABSTRACT

This application report shows the design and test of a simple circuit to achieve rail independence in TPS51220, which otherwise cannot be used in independent supplies.

The same arrangement can be extended to any supply to ensure supply-rail stability before the device is enabled.

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1 Introduction

1.1 TPS51220

The TPS51220 device is a dual-synchronous buck regulator controller with two LDOs. It is optimized for a 5-V or 3.3-V system controller, enabling designers to cost effectively complete a power supply for a 2-cell to 4-cell notebook system. The TPS51220 supports high-efficiency, fast-transient response and 99% duty cycle operation. It supports supply input voltage ranging from 4.5 to 28 V, and output voltages from 1 to 12 V.

1.2 UVP Operation

When the feedback voltage becomes lower than 70% of the target voltage, the UVP comparator output goes high and an internal UVP delay counter begins counting. After 1 ms, the TPS51220 latches off both high-side and low-side MOSFETs and shuts off another channel. This UVP function is enabled after soft start has completed.

2 Application

This UVP functionality of TPS51220 implies that both the channels are turned off in the event of either of the channel rails getting disconnected. To implement an independent dual supply, the user can disable a channel before the UVP triggers. To do so, the user must ensure that the ENx pin comes high after the corresponding Vin rail comes up, but when turning off, it goes low before the corresponding Vin rail goes low. One way of implementing this is to use Zener diodes to enable the rails. The Zener diodes do not conduct until Zener breakdown occurs. This breakdown happens only when the input rails go above the Zener voltage. This introduces a delay in the enable line during turn on, but not during turn off.

2.1 EVM Modifications

The TPS51220 evaluation board is used to evaluate the performance of the proposed arrangement.

To provide separate inputs to two channels, the drains of high side FETs are separated from the common Vin rail. These drains are then powered up from two different supplies, and Vin for the IC is derived from an ORed output of the two supplies. This keeps the IC powered-up when either of the rails is available.

The two inputs are set to Vin1 = 15 V (for 5-V output) and Vin2 = 12 V (for 3.3-V output).

2.2 Zener Calculations

1. For an input voltage range from 8 to 20 V (EVM specification), the user must make sure that the EN pin voltage is in the range of 0.55 to 6 V (pin specification).
2. This design uses a 6.2-V, SOD123 package Zener diode with a maximum power dissipation of 200 mW. The dissipation value or package can be changed, if required.
3. Izmax is calculated as 200 mW / 6.2 V = 32 mA.
4. The Zener is operating within 10% to 80% of this value in this design.
5. The Zener bias resistor should meet the following conditions:

$$\frac{Vin_{(min)} - Vz}{Rz} > 3.2\ mA$$

$$\frac{Vin_{(max)} - Vz}{Rz} < 26\ mA$$

6. Assuming Rz as 500 Ω, gives $Iz_{(min)}$ as 3.6 mA and $Iz_{(max)}$ = 27.6 mA.
7. Now, the drop across Rz varies from 1.8 to 13.8 V as the Vin varies from 8 to 20 V.

To bring this in the EN pin range of 0.55 to 6 V, the user can split the Rz in the ratio of 1:2.

We use 332 Ω and 162 Ω as a resistor divider to the EN pin, which in series act as the Zener bias resistor.

The circuit in Figure 1 shows an implementation using Zener and ORing diodes.

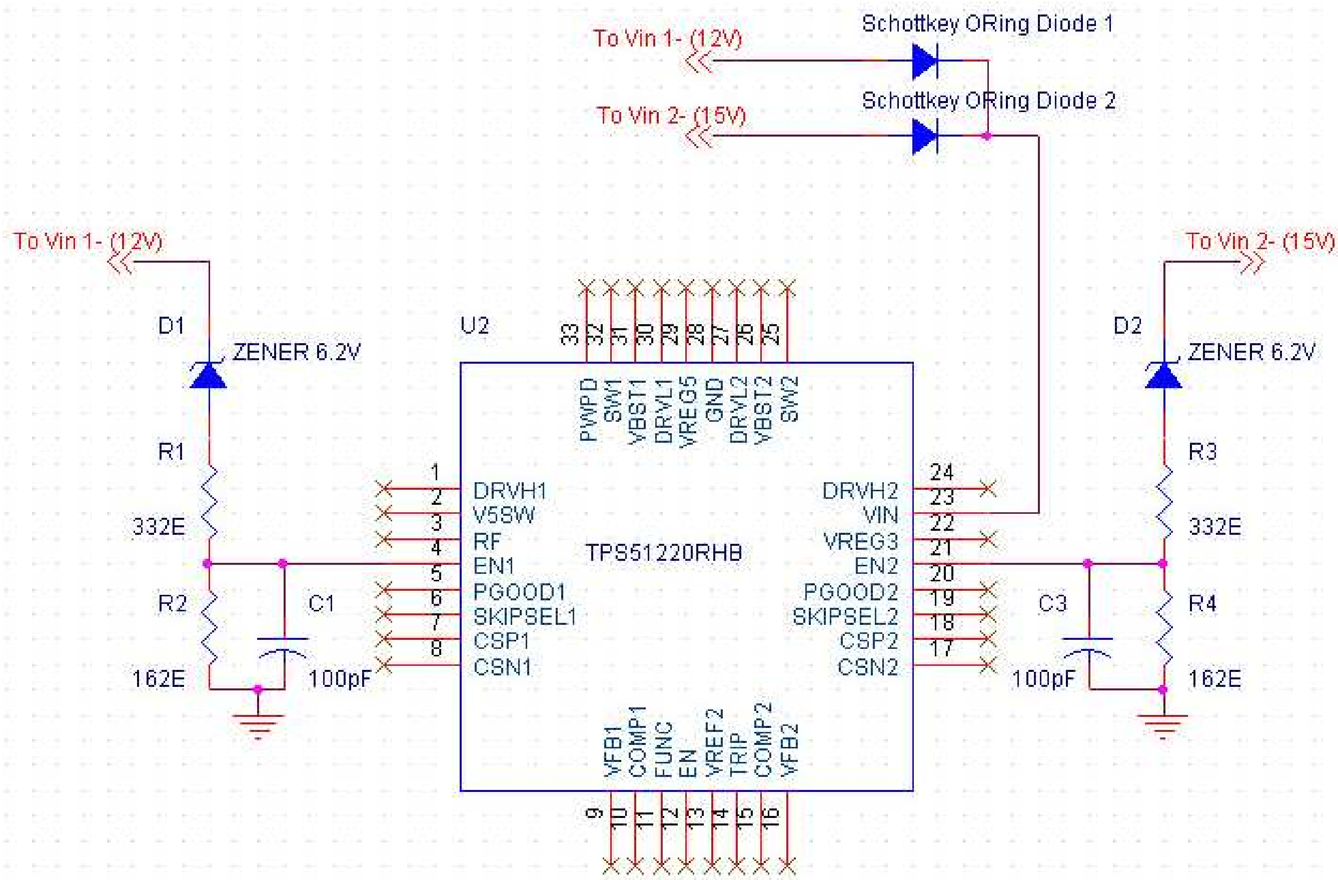


Figure 1. Circuit Implementation Using Zener and ORing Diodes

2.3 Schematic

Figure 2 shows the EVM board schematic.

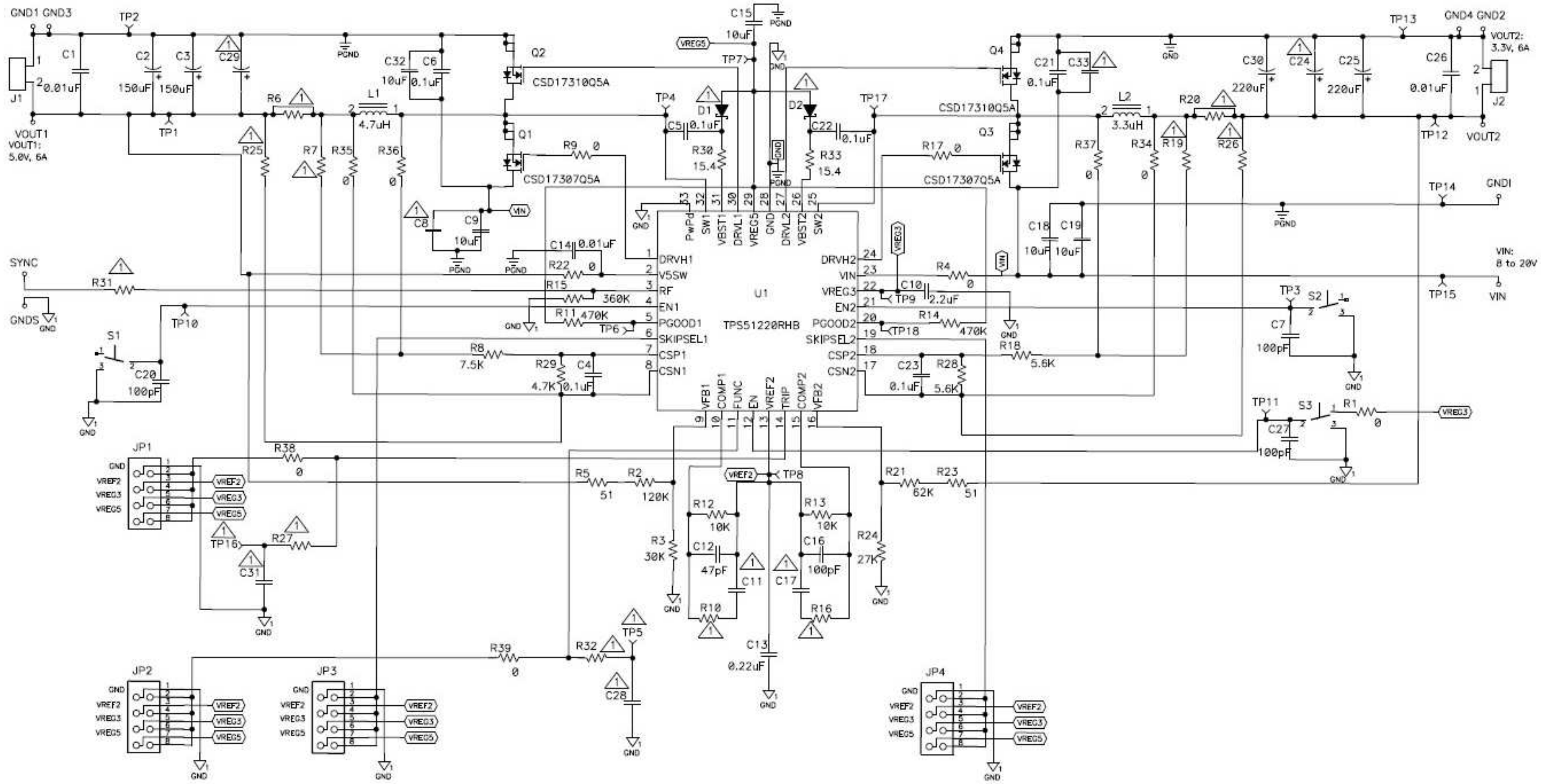
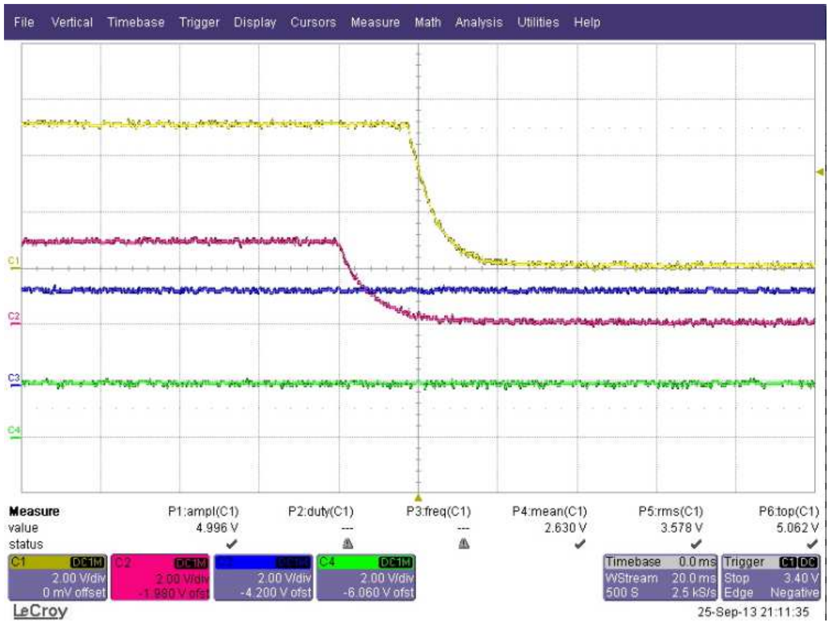


Figure 2. EVM Board Schematic

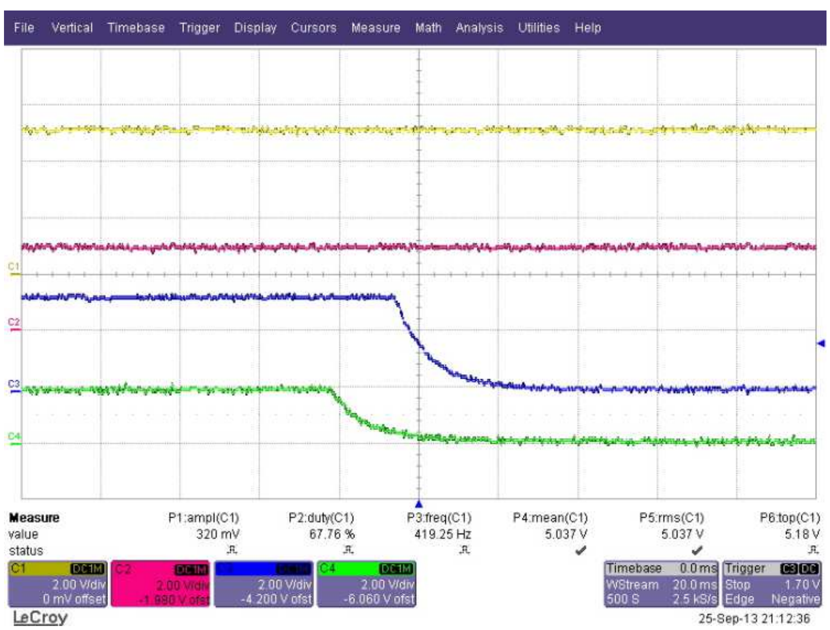
3 Test Results

Figure 3 through Figure 6 show the results with Vin1 = 12 V and Vin2 = 15 V, where the rails are enabled or disabled independently.



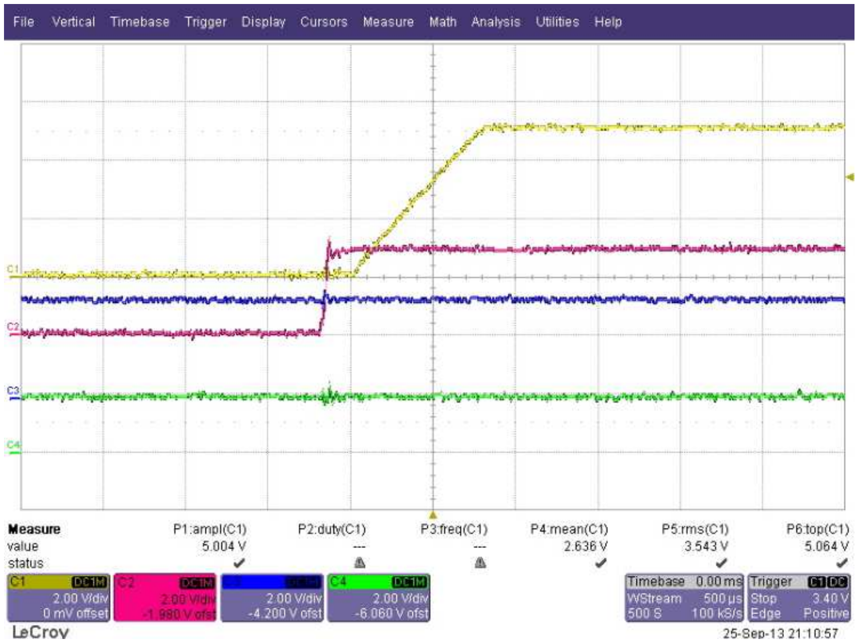
Ch1: Vout1 (5 V)
Ch2: En1
Ch3: Vout2 (3.3 V)
Ch4: En2

Figure 3. 3.3-V Rail Unaffected When the 5-V Rail is Turned Off



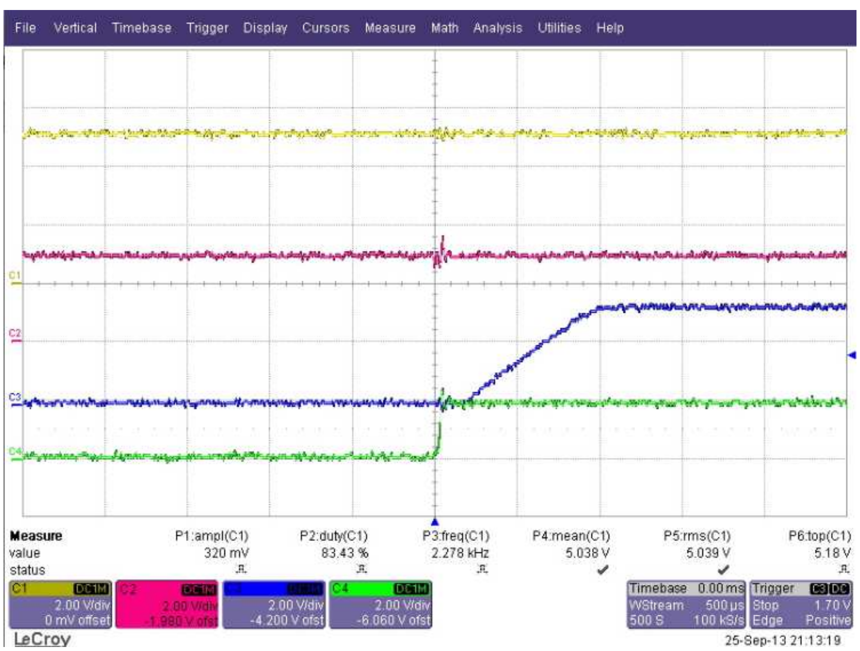
Ch1: Vout1 (5 V)
Ch2: En1
Ch3: Vout2 (3.3 V)
Ch4: En2

Figure 4. 5-V Rail Unaffected When the 3.3-V Supply is Turned Off



Ch1: Vout1 (5 V)
Ch2: En1
Ch3: Vout2 (3.3 V)
Ch4: En2

Figure 5. 3.3-V Rail Unaffected When the 5-V Supply is Turned On



Ch1: Vout1 (5 V)
Ch2: En1
Ch3: Vout2 (3.3 V)
Ch4: En2

Figure 6. 5-V Rail Unaffected When the 3.3-V Supply is Turned On

4 Conclusion

Using the arrangement shown in this report, the TPS51220 can be used to design a dual independent buck converter. The same circuitry can also be used in other designs to ensure supply rail stability before the device enables.

The additional circuitry is simple and effective.

5 References

- TPS51220 data sheet, available on www.ti.com
- TPS51220 EVM user's guide
- TI e2e Forum

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