

TI Designs: Verified Design

Soft-Start Isolated Power Supply



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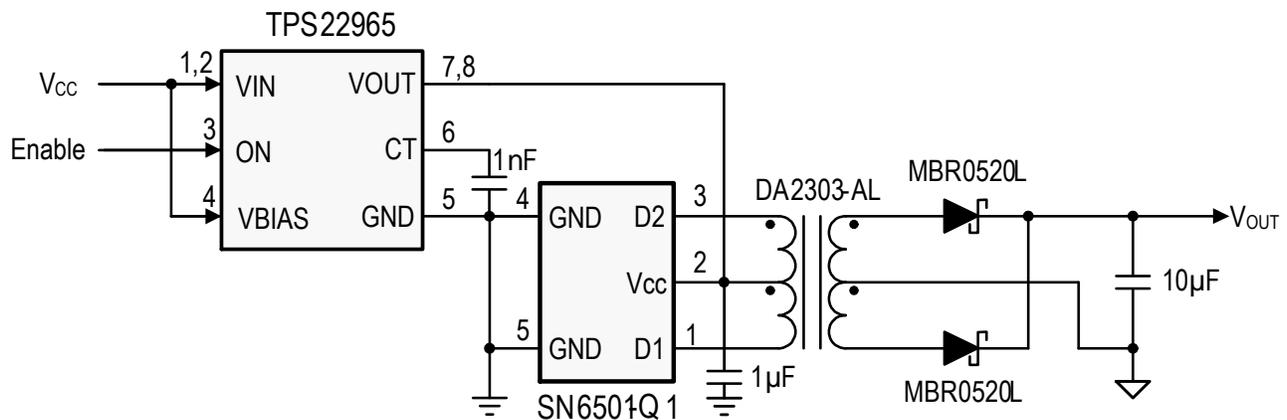
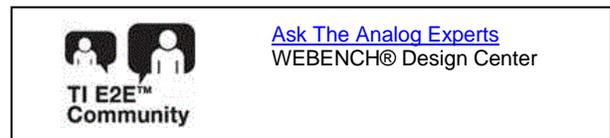
Circuit Description

This reference design demonstrates a Soft-Start Isolated Power Supply. It utilizes a TPS22965 Load-Switch and SN6501 Transformer Driver to slew-rate limit the ramp-up power on the primary supply, and utilizes a Transformer plus a full-wave rectifier to generate the isolated secondary power.

Design Resources

[Design Archive](#)
[TPS22965](#)
[SN6501](#)

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1 Design Summary

This solution provides the following features:

- Operates with 3.3-V \pm 10% and 5-V \pm 10% Primary Supplies
- Low Quiescent Current (50 μ A) of the Load Switch
- High Primary-Side Current Drive:
 - 350 mA (MAX) with 5-V supply
 - 150 mA (MAX) with 3.3-V supply
- Primary Side Rise Time = ~2 ms

2 Design Considerations

2.1 TPS22965

The TPS22965 is a single channel load switch that provides configurable rise time to minimize inrush current. The device contains an N-channel MOSFET that can operate over an input voltage range of 0.8 V to 5.7 V and can support a maximum continuous current of 6 A. The switch is controlled by an on/off input (ON), which is capable of interfacing directly with low-voltage control signals. In the TPS22965, a 225- Ω on-chip load resistor is added for quick output discharge when switch is turned off.

2.2 SN6501-Q1

The SN6501 is a monolithic oscillator/power-driver, specifically designed for small form factor, isolated power supplies in isolated interface applications. The drives a low-profile, center-tapped transformer primary from a 3.3-V or 5-V DC power supply. The secondary can be wound to provide any isolated voltage based on transformer turns ratio.

2.3 Theory of Operation

The SN6501-Q1 transformer driver is a square-wave oscillator with two power FET output stages whose complementary output signals drive the primary of a center-tapped transformer, commonly used in isolated, push-pull, dc-to-dc converter designs.

To implement a soft-start function for the SN6501-Q1, you can use the TPS22965 load switch, whose output rise time is adjustable through the application of an external transition capacitor, CT. Figure 1 shows a 5V design where the output of the TPS22965 provides the input voltage for the SN6501-Q1.

Capacitor CT is chosen with 1nF yielding a ramp-up time at the load-switch output of approximately 2 ms. The output of the push-pull converter starts ramping when the SN6501 reaches its start-up voltage at about 1.6V. During power-down the converter output tracks the load-switch output over a ramp-down time of approximately 1 ms.

3 Measurements

3.1 Test Circuit

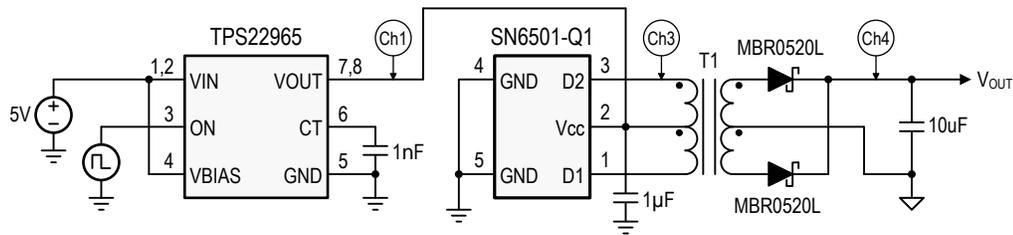


Figure 1: Soft-starting the SN6501-Q1 transformer driver with the TPS22965 load-switch

3.2 Power On (Enable TPS22965 "ON")

Channel1 (YELLOW) = TPS22965 VOUT Voltage

Math1 (ORANGE) = SN6501-Q1 D1-D2 Voltage

Channel4 (GREEN) = Rectified VOUT Voltage

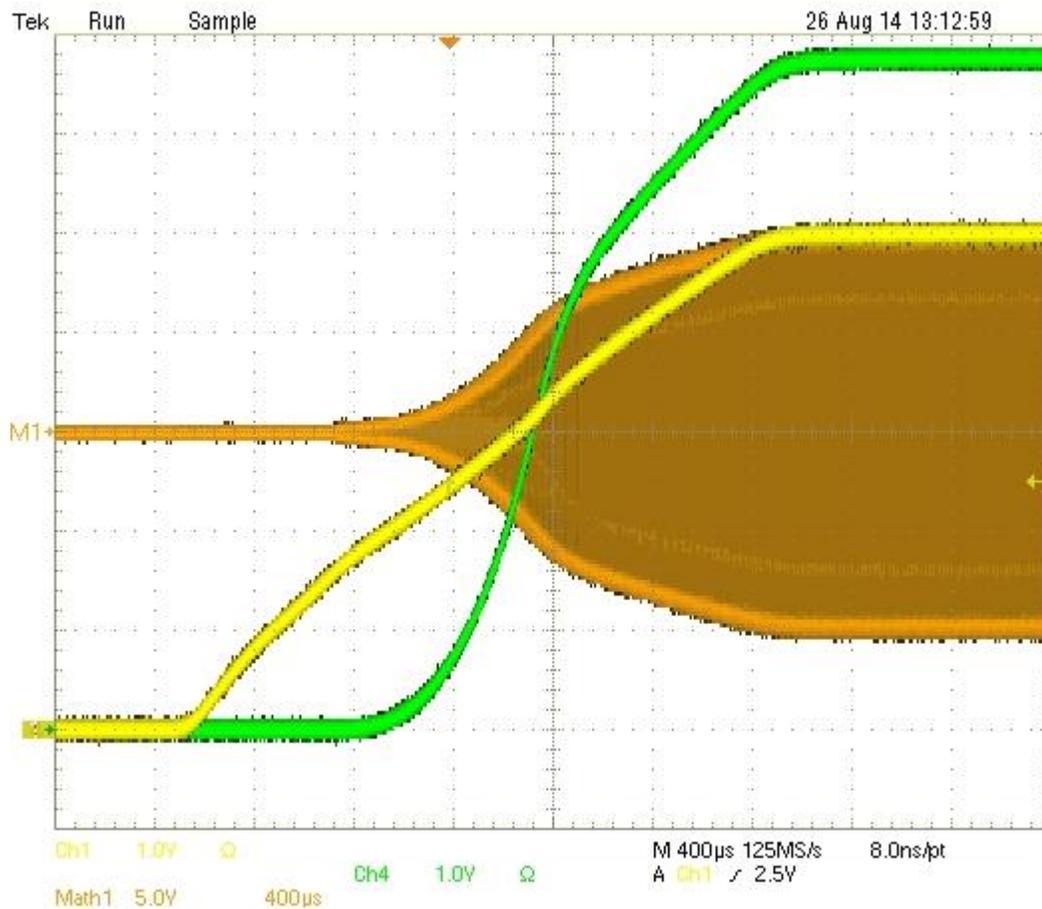


Figure 2: Soft-starting the SN6501-Q1 transformer driver with the TPS22965 load-switch

3.3 Power Off (Disable TPS22965 "ON")

Channel1 (YELLOW) = TPS22965 VOUT Voltage

Math1 (ORANGE) = SN6501-Q1 D1-D2 Voltage

Channel4 (GREEN) = Rectified VOUT Voltage

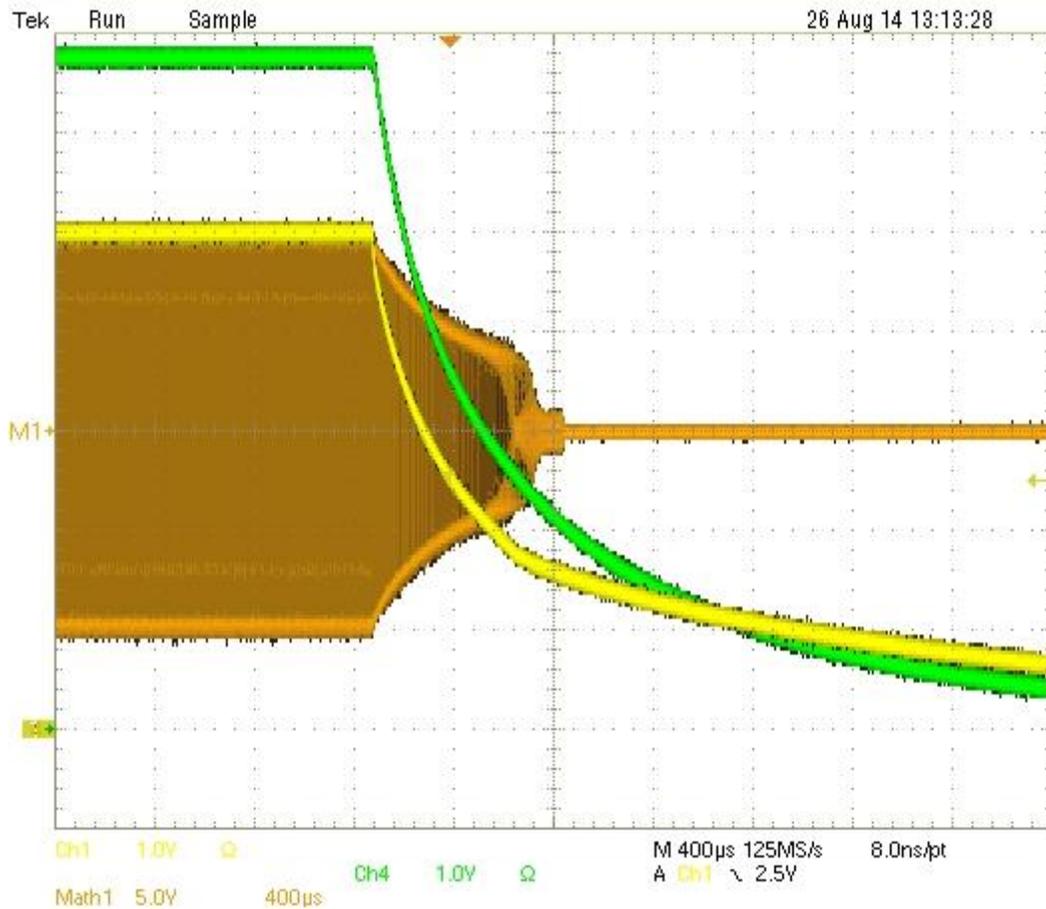


Figure 3: SN6501-Q1 during soft turn-off

4 References

1. TPS22965 Datasheet, [SLVSBJOB](#)
2. SN6501-Q1 Datasheet, [SLLSEF3A](#)

5 Appendix

5.1 Schematic

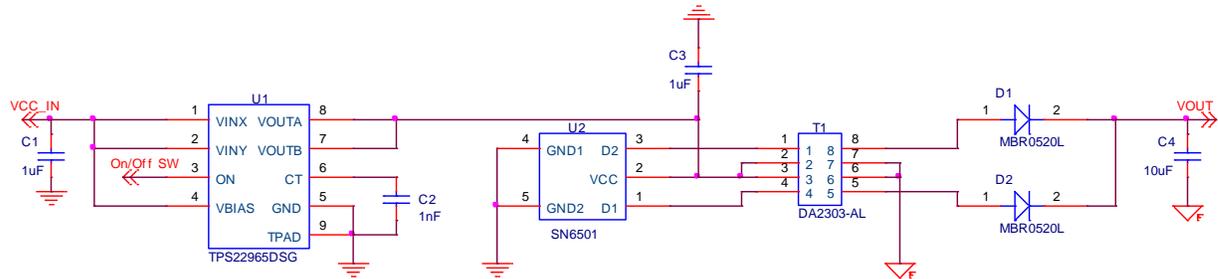


Figure 4: Soft-start isolated power supply schematic

5.2 Bill of Materials

Table 1: Soft-Start Isolated Power Supply Bill of Materials

Item	Quantity	Reference	Part	Footprint	Manufacturer	Manufacturer Part Number
1	1	U1	TPS22965DSG	WSON-8	Texas Instruments	TPS22965DSG
2	2	U2	SN6501DBV	SOT-23-5	Texas Instruments	SN6501DBV
3	3	T1	1:1.5	SMT	Coilcraft	DA2303-AL
4	2	D1, D2	MBR0520LT1G	SOD-123	ON Semiconductor	MBR0520LT1G
5	2	C1, C3	1.0 μ F	0805		
6	1	C2	1.0nF	0805		
7	1	C4	10uF	0805		

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