

TPS92630-Q1 Evaluation Module (EVM)

User's Guide



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TPS92630-Q1 Evaluation Module (EVM)

The TPS92630-Q1 evaluation module is designed to evaluate the TPS92630-Q1 integrated circuit in a typical LED application. This user's guide provides the connectors and test point description, the schematic, bill of materials and board layout of the EVM.

1 Introduction

The Texas Instruments TPS92630-Q1 EVM evaluation module contains a TPS92630-Q1 integrated circuit (IC), supporting passive components and three output channels, with three OSRAM LEDs in series per channel. The purpose of this EVM is to facilitate evaluation of the TPS92630-Q1 in a typical LED application.

1.1 Description

The Texas Instruments TP92630EVM evaluation module (EVM) helps designers evaluate the operation and performance of the TPS92630-Q1. The TPS92630-Q1 is a three-channel linear LED driver with independent PWM dimming control. It is designed and well suited for driving multiple strings of red LEDs or a single string of white LEDs up to a medium power range. The TPS92630-Q1 IC is capable of operating at input voltages up to 40 V. Due to thermal considerations, the EVM may not allow an input voltage this high.

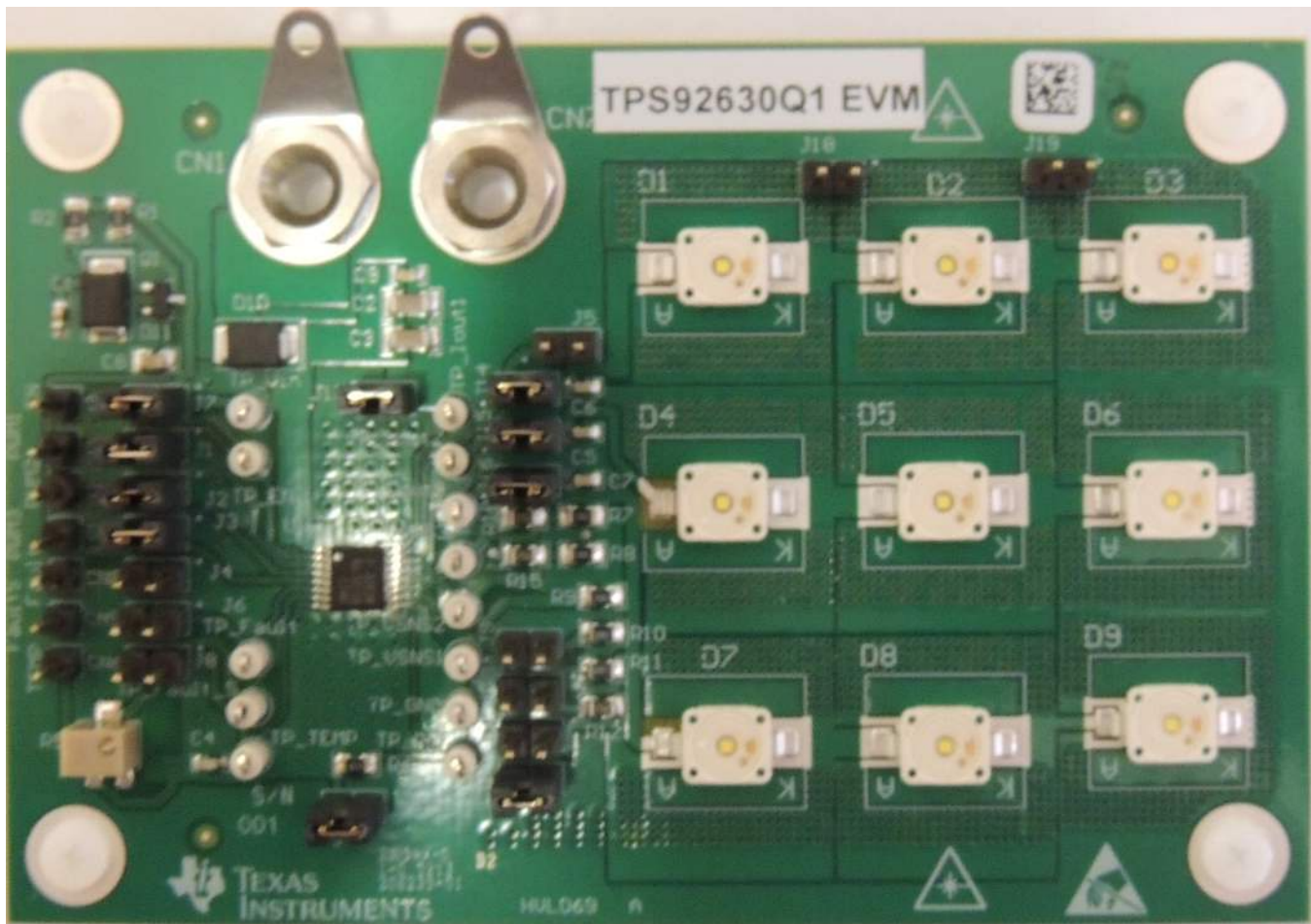


Figure 1. TPS92630-Q1 EVM Board

1.2 Applications

This EVM design describes an application of the TPS92630-Q1 as an LED driver driving a string of three LEDs at 150 mA, and verifies the full diagnostics functionality of the TPS92630-Q1 device.

1.3 Features

- Drives three channels of LEDs with three LEDs per channel
- Verifies that the device diagnostics detect open, short, single-LED short, and REF pin short conditions
- Verifies behavior with the $\overline{\text{FAULT}}$ pin floating or pulled high by an external component

2 TPS92630-Q1 EVM Schematic

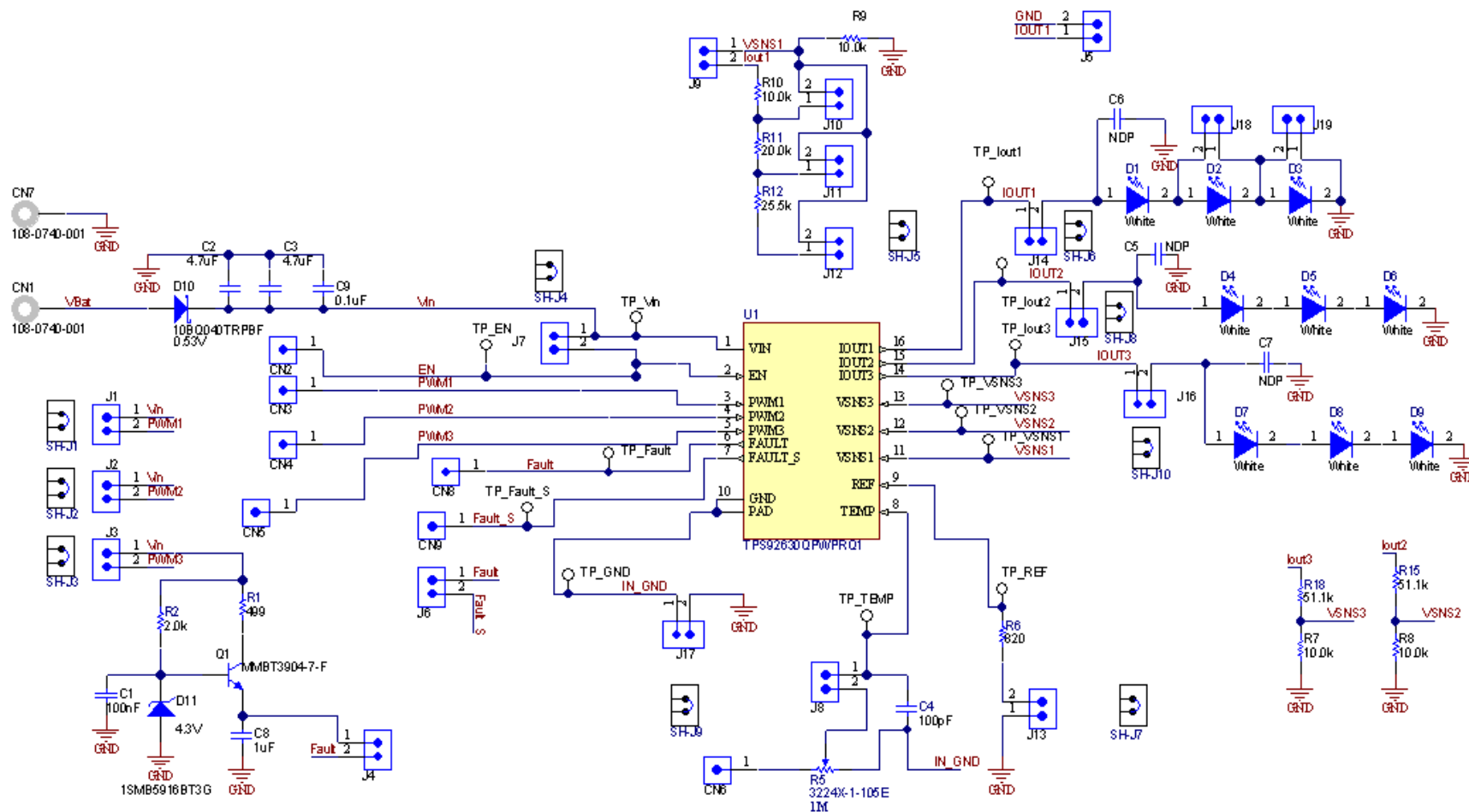


Figure 2. TPS92630-Q1 EVM Schematic

3 Connector and Test Point Descriptions

3.1 Input and Output Jumpers

3.1.1 CN1–Vbat

This is the positive input supply voltage.

3.1.2 CN2–EN

This is the enable pin input for enable and shutdown.

3.1.3 CN3–PWM1

This is the PWM1 input for channel 1 PWM and channel ON or OFF.

3.1.4 CN4–PWM2

This is the PWM2 input for channel 2 PWM and channel ON or OFF.

3.1.5 CN5–PWM3

This is the PWM3 input for channel 3 PWM and channel ON or OFF.

3.1.6 CN6–TEMP

A pull-high voltage source for the TEMP pin. This input provides a voltage source for R5 to generate the thermal foldback threshold, with 5 V, 3.3 V, or GND recommended, depending on the application.

3.1.7 CN7–GND

This is the return connection to the input power supply.

3.1.8 CN8–FAULT

This is an I/O pin, which is the fault-status output of the LED driver on detection of an open-load condition, LED short to GND, LED short to battery, thermal shutdown, or reference resistor open or short. This pin also can be pulled high, depending on application requirements. For details, see the fault table in the TPS92630-Q1 data sheet ([SLVSC76](#)).

3.1.9 CN9–FAULT_S

This is the output pin for single-LED short detection.

3.1.10 J14

When using external LEDs for CH1, connect the anode to J16 pin 1.

3.1.11 J15

When using external LEDs for CH2, connect the anode to J17 pin 1.

3.1.12 J16

When using external LEDs for CH3, connect the anode to J18 pin 1.

3.2 Function of Jumpers

3.2.1 J1

Use this jumper to short PWM1 to Vin when there is no signal to control PWM1.

3.2.2 J2

Use this jumper to short PWM2 to Vin when there is no signal to control PWM2.

3.2.3 J3

Use this jumper to short PWM3 to Vin when there is no signal to control PWM3.

3.2.4 J4

Use this jumper to pull the $\overline{\text{FAULT}}$ pin high, depending on the application.

3.2.5 J5

Use this jumper for the LED+ short-to-GND test.

3.2.6 J6

Use this jumper to connect the $\overline{\text{FAULT_S}}$ pin to the $\overline{\text{FAULT}}$ pin for the fault bus.

3.2.7 J7

Use this jumper to short the EN pin to Vin when there is no signal to control EN.

3.2.8 J8

Use this jumper to connect the TEMP pin with an external voltage source for setting the thermal foldback threshold.

3.2.9 J9

One can use J9 to short VSNS1 to IOUT1, but keep it open during normal operation.

3.2.10 J10, J11, J12

Connect one of these jumpers to set the CH1 single-LED short-threshold voltage.

3.2.11 J13

Connecting this jumper sets the IC working current to $V_{(\text{REF})} / R6 \times 100$. To change the current, remove the jumper and apply an external dc voltage, $V_{(\text{ext})}$, to J13 pin 2. The IC working current then becomes $(V_{(\text{REF})} - V_{(\text{ext})}) / R6 \times 100$.

3.2.12 J14

This jumper connects IOUT1 to LED load string 1 on the application board.

3.2.13 J15

This jumper connects IOUT2 to LED load string 2 on the application board.

3.2.14 J16

This jumper connects IOUT3 to LED load string 3 on the application board.

3.2.15 J17

One can use this jumper, which connects IC GND to board GND, to measure $I_{(quiescent)}$.

3.2.16 J18, J19

One can use these jumpers to short corresponding LEDs, depending on the application and function evaluation.

4 TPS92630-Q1 EVM Assembly Drawings and Layout

Board Design and Layout

Figure 3 through Figure 5 show the design of the TPS92630-Q1 EVM printed-circuit board (PCB). The EVM design uses a two-layer, 2-oz (0.071-mm thick), copper-clad circuit board of 71 mm × 105 mm with all components in an active area on the top side and all active traces on the top and bottom layers to allow the user to view, probe, and evaluate the TPS92630-Q1 control IC easily in a practical double-sided application. Moving components to both sides of the PCB or using additional internal layers can offer additional size reduction for space-constrained systems.

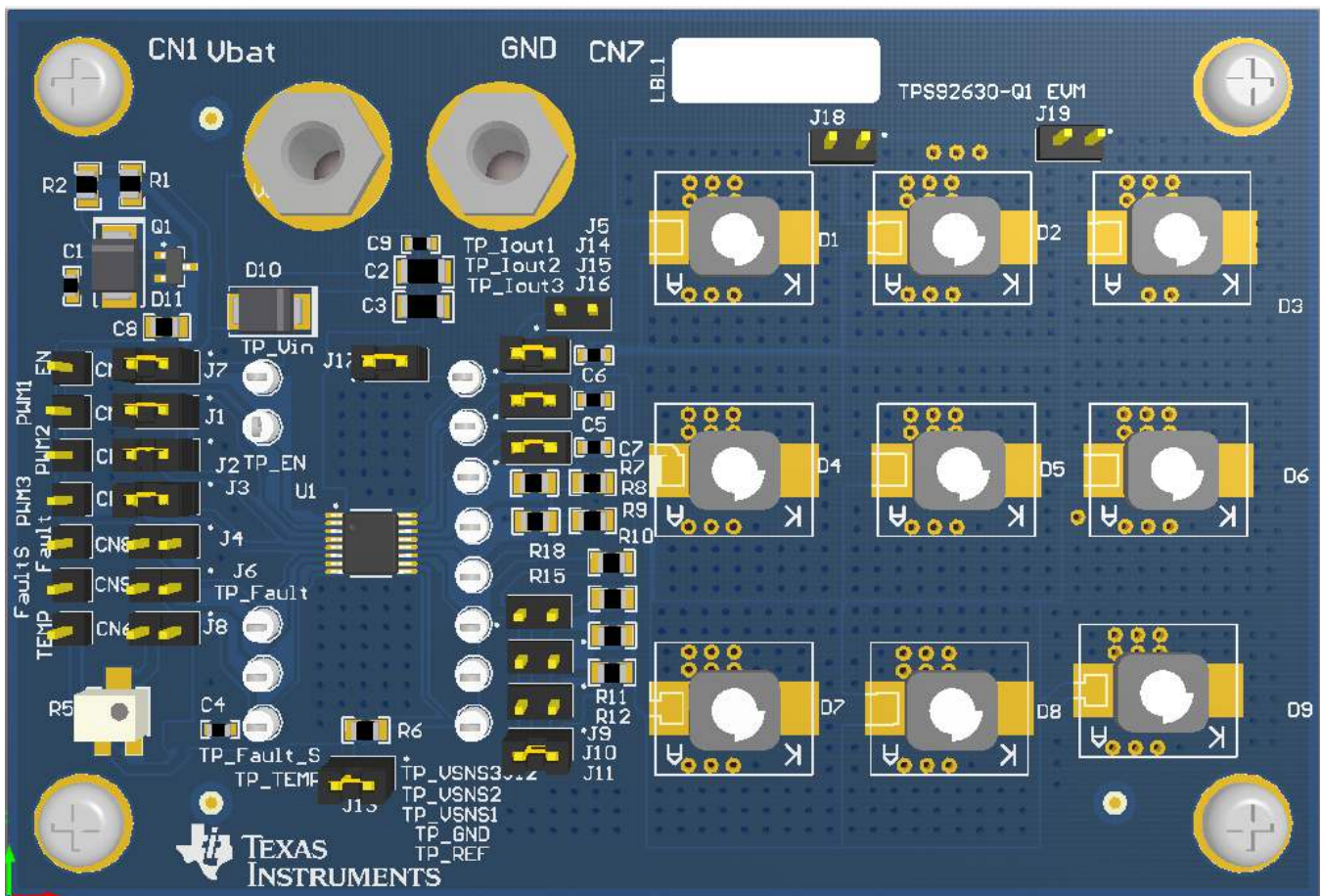


Figure 3. TPS92630-Q1 EVM Component Placement (Viewed From Top)

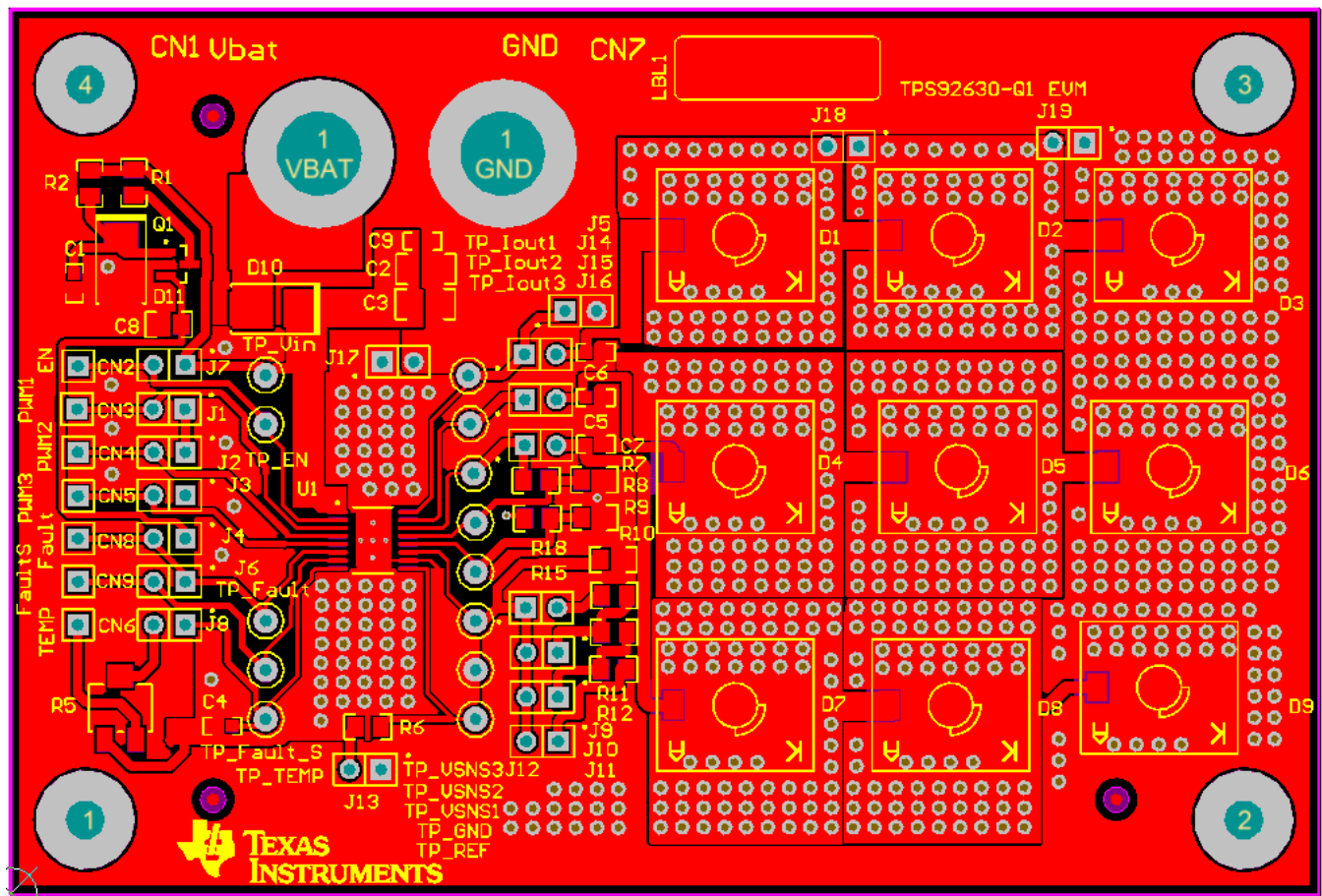


Figure 4. TPS92630-Q1 EVM Top Copper (Viewed From Top)

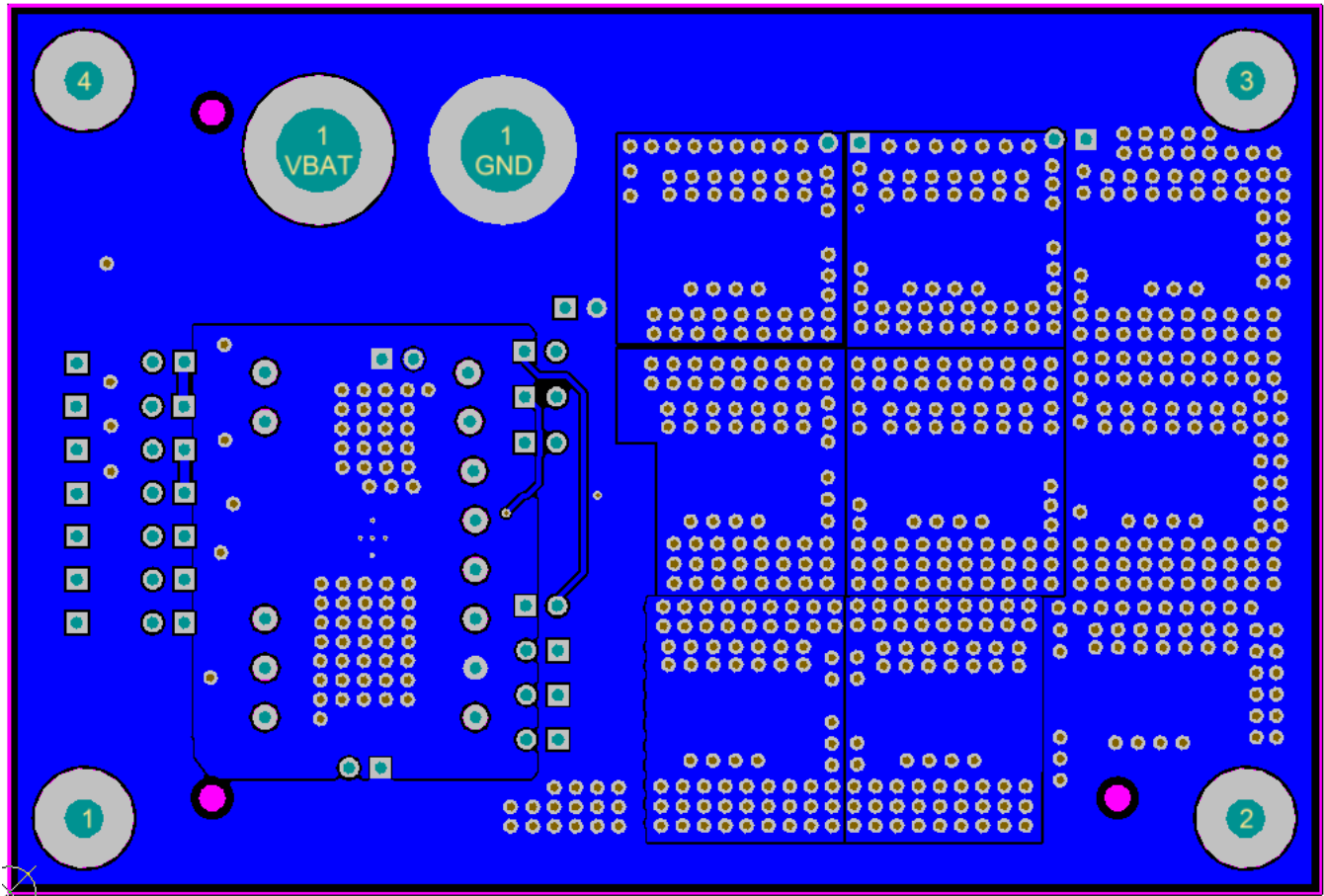


Figure 5. TPS92630-Q1 Bottom Copper (Viewed From Bottom)

4.1 Power Dissipation and Thermal Considerations

Figure 6 and Figure 7 illustrate the thermal performance of the TPS92630-Q1 EVM at 150-mA output current per string and 12-V input. Under these conditions, the maximum temperature on the EVM is 58.4°C at the IC junction. Equation 1 describes the power dissipation of the IC.

$$P_{IC} = V_{IN} \times I_{IN} - n_1 \times V_{LED1} \times I_{LED1} - n_2 \times V_{LED2} \times I_{LED2} - n_3 \times V_{LED3} \times I_{LED3} - V_{REF}^2 / R_{SET} \quad (1)$$

where:

- n_x = Number of LEDs for channel x
- V_{LEDx} = Voltage drop across one LED for channel x
- V_{REF} = Reference voltage, typically 1.24 V
- I_{LEDx} = Average LED current for channel x

Managing the power dissipation necessitates controlling the voltage drop ($V_{IN} - n_x \times V_{LEDx}$) of the IC, especially at high currents. Figure 7 illustrates thermal performance for the EVM when input the voltage is 12 V and the LED current is 150 mA per channel.

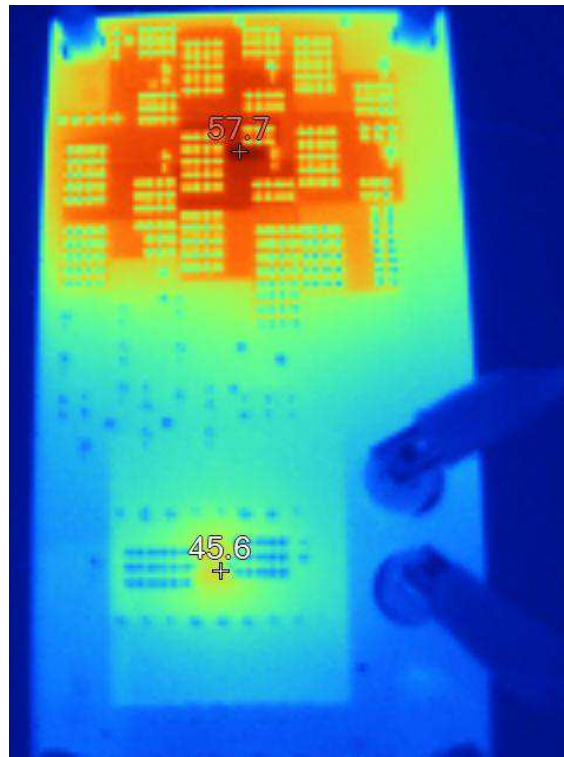


Figure 6. Thermal Performance, Bottom of PCB

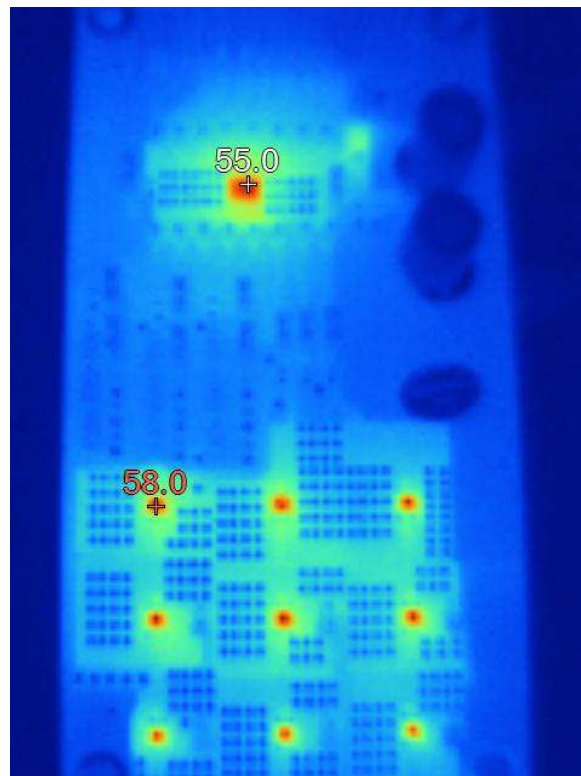


Figure 7. Thermal Performance, Top of PCB

4.2 Thermal Foldback Function

One can adjust the temperature at which the current reduction begins by changing the voltage on the TEMP pin. When TEMP is open, the temperature at which the current reduction begins defines the thermal monitor activation temperature, $T_{(th)}$ (thermal foldback, typically 110°C), which the Electrical Characteristics table of the device data sheet ([SLVSC76](#)) specifies at the 90% current level. $T_{(th)}$ increases with a corresponding reduction in the voltage at the TEMP pin, V_{TEMP} . Equation 2 is an approximate calculation.

$$T_{(th)} = -121.7 V_{(TEMP)} + 228.32 \quad (2)$$

A resistor connected between TEMP and GND reduces $V_{(TEMP)}$ and increases $T_{(th)}$. A resistor connected between TEMP and a reference supply greater than 1 V increases $V_{(TEMP)}$ and reduces $T_{(th)}$.

4.3 Fault Function

One can connect the device fault pins to the MCU for fault reporting. Both fault pins are open-drain transistors with an internal weak pullup. In a case where there is no MCU, one can connect up to 15 TPS92630-Q1 FAULT and FAULT_S pins together. When one or more devices have errors, one or more FAULT pins go low, pulling the connected FAULT bus down. The FAULT pins going low shuts down all device outputs. Figure 8 illustrates the fault line bus connection.

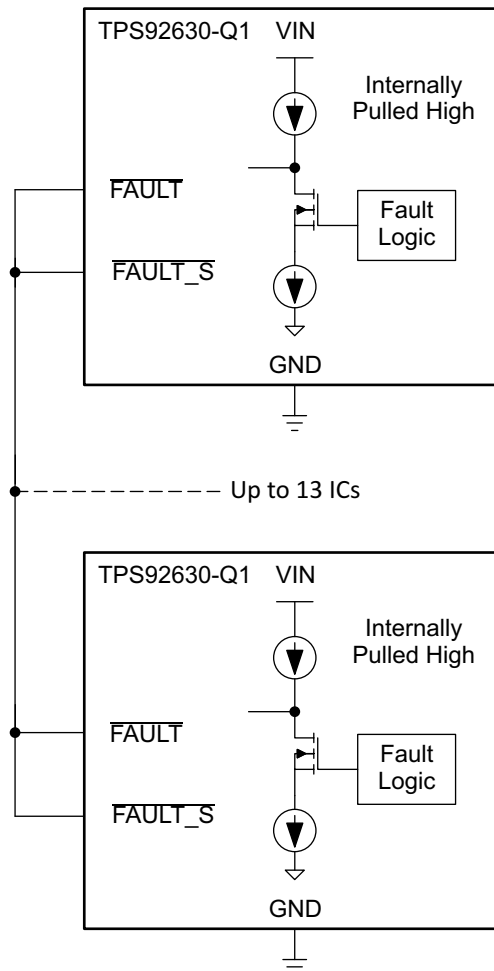


Figure 8. TPS92630-Q1 Fault Bus

Pulling the FAULT pin high with external circuitry, toggling of the EN pin, or a power cycle of the device releases the FAULT bus. In a case where there is no MCU, cycling power is the only way to clear the fault.

The following faults cause the **FAULT** or **FAULT_S** pin to go low: thermal shutdown, open load, output short circuit, and single-LED short. For thermal shutdown or open LED, release of the **FAULT** pin occurs when a thermal shutdown condition or open LED no longer exists. For other faults, the **FAULT** and **FAULT_S** pins remain low even if the condition does not exist; only cycling device power can clear these faults.

5 Bill of Materials

Table 1. Bill of Materials

Designator	Quantity	Description	Package Reference	Part Number
PCB	1	Printed circuit board		PCB
C1	1	Capacitor, ceramic, 0.1- μ F, 25-V, \pm 10%, X7R, 0603	0603	C0603X104K3RACTU
C2, C3	2	Capacitor, ceramic, 4.7- μ F, 40-V, \pm 10%, X5R, 1206	1206	C3216X5R1A475K
C4	1	Capacitor, ceramic, 100-pF, 25-V, \pm 10%, X7R, 0603	0603	C0603X101K3RACTU
C5, C6, C7	0	NC	0603	NC
C9	1	Capacitor, ceramic, 0.01- μ F, 40-V, \pm 5%, X7R, 0603	0603	06031C103JAT2A
C8	1	Capacitor, ceramic, 1- μ F, 16-V, \pm 10%, X5R, 0805	0805_HV	0805YD105KAT2A
CN1, CN7	2	Standard banana jack, uninsulated, 15-A red	108-0740-001	108-0740-001
CN2, CN3, CN4, CN5, CN6, CN8, CN9	7	Header, TH, 100-mil (2,54-mm), 1-pos, gold plated, 230 mil (5,84 mm) above insulator	TSW-101-07-G-S	TSW-101-07-G-S
D1, D2, D3, D4, D5, D6, D7, D8, D9	9	LED, white, SMD	LW-W5SG	LW-W5SG
D10	1	Diode, Schottky, 40-V, 1-A, SMB	SMB	10BQ040TRPBF
D11	1	Diode, Zener, 4.3-V, 550-mW, SMB	SMB	1SMB5916BT3G
FID1, FID2, FID3	3	Fiducial mark. There is nothing to buy or mount.	Fiducial 10-20	Fiducial
H1, H2, H3, H4	4	Machine screw, round, #4-40 x 1/4, nylon, Philips panhead	NY PMS 440 0025 PH	NY PMS 440 0025 PH
H5, H6, H7, H8	4	Standoff, hex, 0.5-inch (12,7-mm) L, #4-40 nylon	Keystone_1902C	1902C
J1, J2, J3, J4, J5, J6, J7, J8, J9, J10, J11, J12, J13, J14, J15, J16, J17, J18, J19	19	Header, TH, 100-mil (2,54-mm), 2x1, gold-plated, 230 mil (5,84 mm) above insulator	TSW-102-07-G-S	TSW-102-07-G-S
LBL1	1	Thermal transfer printable labels, 0.650 inch (1.65 cm) W x 0.200 inch (5,08 mm) H – 10,000 per roll	Label_650x200	THT-14-423-10
Q1	1	Transistor, NPN, 40-V, 0.2-A, SOT-23	SOT-23	MMBT3904-7-F
R1	1	Resistor, 500- Ω , 1%, 0.125-W, 0805	0805_HV	CRCW0805499RFKEA
R2	1	Resistor, 2-k Ω , 5%, 0.125-W, 0805	0805_HV	CRCW08052K00JNEA
R5	1	Trimmer 1-M Ω 0.25-W SMD	3224X-1-105E	3224X-1-105E
R6	1	Resistor, 820- Ω , 1%, 0.125-W, 0805	0805_HV	CRCW08051K62FKEA
R7, R8, R9, R10	6	Resistor, 10-k Ω , 1%, 0.125-W, 0805	0805_HV	CRCW080510K0FKEA

Table 1. Bill of Materials (continued)

Designator	Quantity	Description	Package Reference	Part Number
R11	3	Resistor, 20-k Ω , 1%, 0.125-W, 0805	0805_HV	CRCW080510K0FKEA
R12	1	Resistor, 25.5-k Ω , 1%, 0.125-W, 0805	0805_HV	RG1608P-2552-B-T5
R15, R18	2	Resistor, 51-k Ω , 1%, 0.125-W, 0805	0805_HV	CRCW060351K1FKEA
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10	10	Shunt, 100-mil (2,54-mm), gold plated, black	969102-0000-DA	969102-0000-DA
TP_EN, TP_FAULT, TP_FAULT_S, TP_GND, TP_IOUT1, TP_IOUT2, TP_IOUT3, TP_PWM1, TP_PWM2, TP_PWM3, TP_REF, TP_TEMP, TP_VIN, TP_VSNS1, TP_VSNS2, TP_VSNS3	16	Test point, TH, miniature, white	Keystone 5002	5002
U1	1	Three-channel linear LED driver with analog and PWM dimming, PWP0016F	HTSSOP-16	TPS92630QPWRQ1

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