

Using the TPS2492/3EVM Hot Swap Controller

User's Guide



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Using the TPS2492/3 Hot Swap Controller

This User's Guide describes the setup and operation of the TPS2492/3 System Test Board.

1 Introduction

This User's Guide describes the features of the TPS2492/3EVM. The TPS2492/3 schematic, layout and List of Materials are provided.

2 Description

The EVM is a 9-V to 80-V module using the TPS2492/3 hot swap controller with external MOSFET. At power on, the output is power limited to control inrush current and protect the MOSFET. On an over-current condition, the controller interrupts power to the load at high speed and signals load status. Operating current, MOSFET power dissipation, and fault timer settings are hardware programmable.

2.1 Applications

- Server
 - Plug-In Circuit Boards
 - RAID / Disk Drive
- Telecom
 - ATCA
 - Micro-ATCA
- General Hot Plug

2.2 Features

- 9-V to 80-V Operation
- Controlled Inrush Current
- Fast Circuit Breaker Control
- Hardware Programmable
 - MOSFET Power Limit
 - Fault Current
 - Fault Timer to Avoid Nuisance Tripping
 - TPS2492 Latch Off or TPS2493 Retry
- LED Status Display
 - FAULT
 - POWER GOOD
- Slide Switch Controlling the ENABLE Signal.
- 25-A Nominal Operation with Thermal Characteristics for Proper MOSFET Operation
- On-Board transorb for Over-Voltage Input Protection
- Common Output Diode Prevents Negative Spiking if the Load is Removed While Powered On.
- IMON Output Signal Voltage Representing Load Current.
- Test Points for Circuit Operation Monitoring

2.3 Equipment supplied

- EVM-491
- The datasheet and this users guide is available on the TPS2492/3 product page at www.ti.com.

2.4 Equipment Required

- Power Supply is able to output twice the steady state current for pulse duration. For the 12-V factory set EVM, steady state power is 25-A nominal.
- Oscilloscope
- Current Probe

2.5 EVM Documentation

The manufacturing and engineering documentation for the EVM is shown in sections 3 to 6. The EVM is orderable in 12-V or 48-V configurations, latched off or retry on fault.

2.6 EVM Configuration

Components may be changed for operation at voltage or current not configured as supplied. The List of Materials, , shows the parts to change to configure the EVM to 48 V at 5-A operation. Configure the circuit board for other operating current to 50 A maximum. Changing the sense resistor, the power limit programming components, and possibly the number of MOSFETs as required.

Use the List of Material as a guide when changing module configurations. The TPS2492/93 datasheet has design example describing how to select parts based on specifications. A calculator tool is also available from the product page at www.ti.com.

2.7 Other EVM Options

There are EVM options not described in the other TPS2492/3 documentation. These are described in this section. They involve the not populated components of the EVM.

2.7.1 Trip Point Trim Resistors

R15 and R16 are added to fine tune the sense current when the required current cannot be achieved with standard sense resistors. These resistors form a divider across the sense main sense resistor to increase the trip point from the main sense setting. These are low power rated components. They should be kept below 100 Ω to minimize the set point error.

For example, to select 30 A nominal,

- Bracket the setpoint. A 0.001- Ω sense resistor selects 50 A and a 0.002 Ω selects 25 A.
- Use the larger value sense resistor. In this case 0.002 Ω .
- At 30 A, the voltage across the 0.002- Ω sense resistor is 60 mV.
- R15 and R16 make a standard voltage divider. Use the formula $(60 \text{ mV} \times R16) / (R15 + R16) = 50 \text{ mV}$.
- Let R16 = 33 Ω , solve for R15. In this case, R15 = 6.6 Ω , use standard value R = 6.55 Ω .

2.7.2 dv/dt Control

When the VPROG calculates below the 0.4 V minimum, one option is to use dv/dt control to start the uncharged output capacitor. In this way, the power limiting is not used on power up. R11 and C4, (see schematic [Figure 2](#) for component reference), are normally not populated and control the power turn on with a dv/dt soft start. Recommendation for R11 is at 1 kΩ. C4 can be calculated by knowing the output capacitor, selecting the charge current and calculating the start time. Calculation is done by the capacitor V I relationship equation, $I = C \, dv/dt$.

- Assume a 12-V system with a 1000-μF output capacitor. Select the charge at 0.5 A. Use the formula to solve for time. $T = CV/I$, $T = 24 \text{ ms}$.
- Since the output FET is a gate follower, the time calculated applies to the gate rise time. Use the same formula to solve for C_t but this time the current is the gate sourcing current in the datasheet specifications section, 22 μA nominal.
- The voltage, again from the datasheet is the output VGS, 14 V.
- $C_t = IT / V = 22 \text{ μA} \times 24 \text{ ms} / 14 = 37.7 \text{ nF}$, use standard value 39 nF.

2.7.3 Disable Power Limit

It's not usually done, but sometimes because of high voltage with high current the power limit may be disabled on over load. TPS2492 can be configured to run in current limit only. To disable power limit remove R3 and install 47 kΩ in R2, (see schematic [Figure 2](#) for component reference). With power limit disabled, dv/dt start outlined in the previous section would be used for power on.

3 EVM Block Diagram TPS2492EVM-491

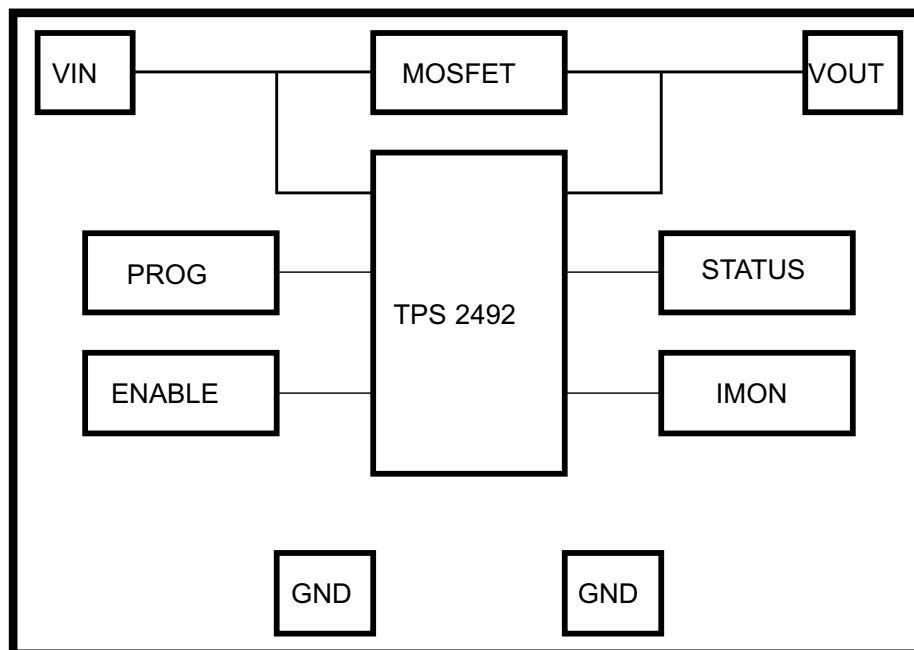


Figure 1. EVM Block Diagram

4 Schematic

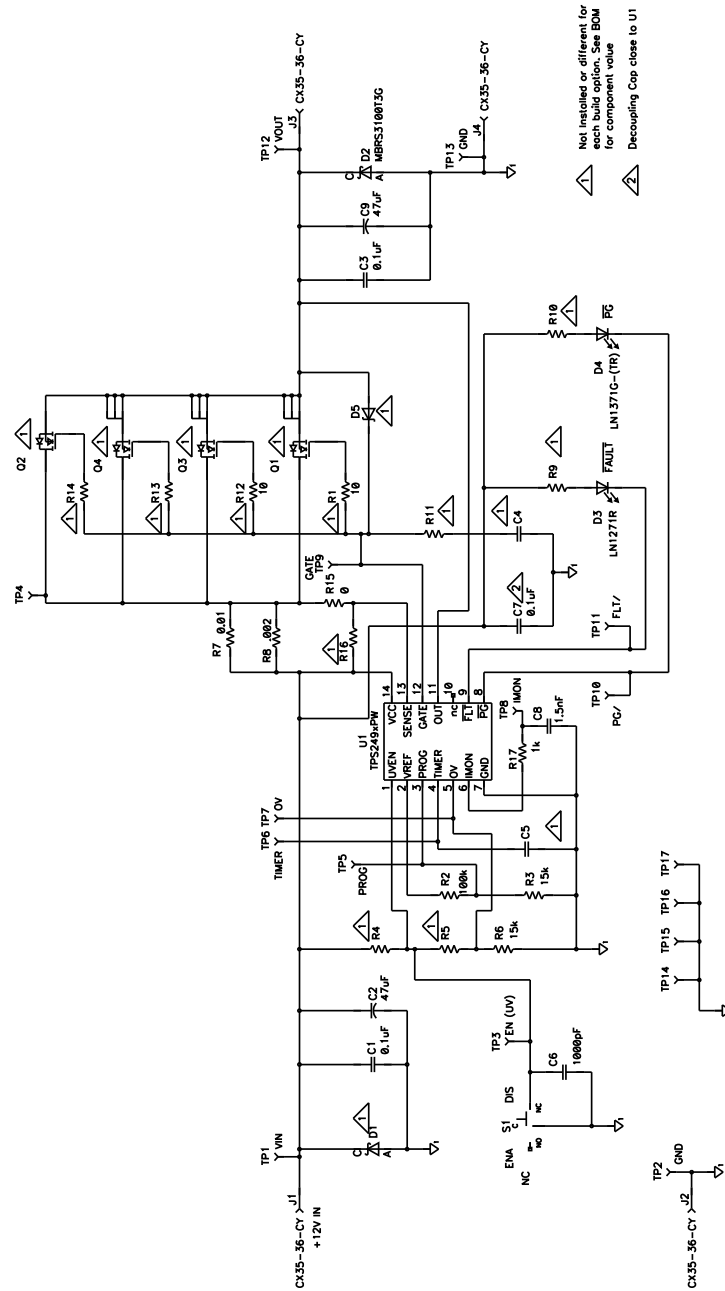


Figure 2. HPA270A Schematic, TPS2420EVM

5 Test Points

Table 1. TPS249xEVM Test Points

TEST POINT	NAME	DESCRIPTION
TP1	VIN	Input voltage power supply
TP2	GND	Ground
TP3	EN-UV	Enable signal, high true (and under-voltage detection)
TP4	None	
TP5	PROG	Program input
TP6	CT	Fault timer capacitor
TP7	OV	Over-voltage detection
TP8	IMON	Output current monitor
TP9	GATE	Gate output
TP10	\overline{PG}	Power good signal, low true
TP11	\overline{FLT}	Fault signal, low true
TP12	VOUT	Output voltage
TP13	GND	Scope ground test point
TP14	GND	Scope ground test point
TP15	GND	Scope ground test point
TP16	GND	Scope ground test point
TP17	GND	Scope ground test point
TP18	SENSE	Low-side sense resistor

6 Connectors

Table 2. Connectors

CONNECTOR	DESCRIPTION
J1	Main power input, VIN
J3	Main power ground, GND
J2	Load
J4	Load ground, GND

7 Jumpers

None.

8 Switches

8.1 Enable Switch, S1

The Enable slide switch turns on the hot plug controller to ramp the output voltage. When the switch is off, the output is off.

9 Indicators

- Green LED indicator for Power Good (PG)
- Red LED indicator for FAULT (FLT)

10 Board Outline

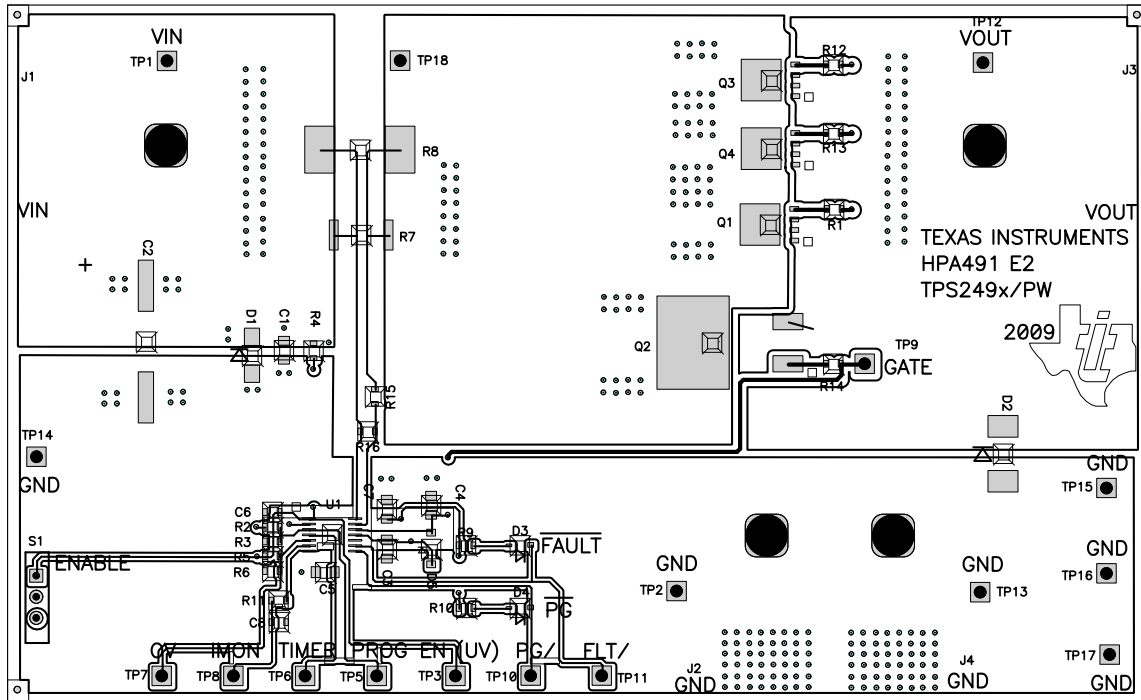


Figure 3. Board Outline (top view)

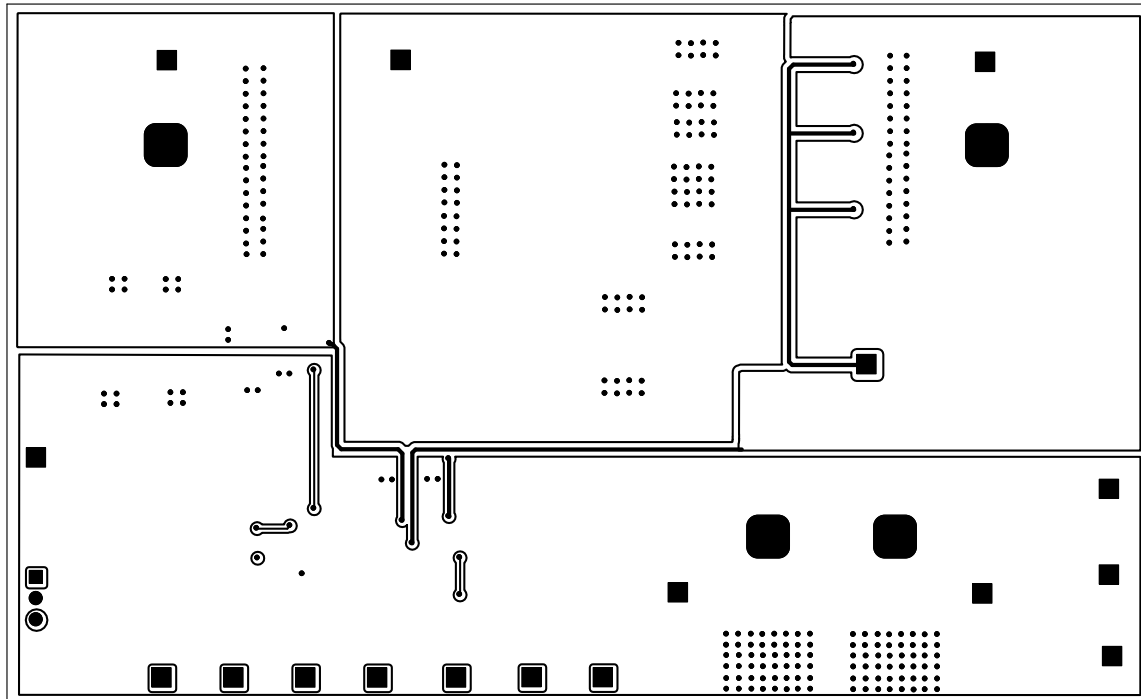


Figure 4. Board Outline (bottom view)

11 List of Materials

11.1 12-V TPS2492EVM-001/TPS2493EVM-002

This is the List of Material for the 12-V TPS2492EVM-001/TPS2493EVM-002.

Table 3. 12-V TPS2492EVM-001/TPS2493EVM-002⁽¹⁾⁽²⁾⁽³⁾⁽⁴⁾

-001	-002	REF DES	DESCRIPTION	PART NUMBER	MFR
3	3	C1, C3, C7	Capacitor, ceramic, 100 V, X7R, 10%, 0.1 μ F, 0805	Std	Std
1	1	C5	Capacitor, ceramic, 25 V, X7R, 10%, 3.3 nF, 0805	Std	Std
2	2	C2, C9	Capacitor, aluminum, 100 VDC, \pm 20%, 47 μ F, 0.670 inch x 0.750 inch	EEVFK2A470Q	Panasonic
1	1	C6	Capacitor, ceramic, 25 V, X7R, 10%, 1000 pF, 0603	Std	Std
1	1	C8	Capacitor, ceramic, 25 V, X7R, 10%, 1.5 nF, 0603	Std	Std
1	1	D1	Diode, SMT TVS 400W, 1 A, 15 V, SMA	SMAJ15A-13F	Diodes
1	1	D2	Diode, Schottky 3 A, 100 V, SMC	MBRS3100T3G	On Semi
1	1	D3	Diode, LED, red, 20 mA, 0.9 mcd, 0.068 inch x 0.049 inch	LN1271R	Panasonic
1	1	D4	Diode, LED, green, 20 mA, 0.9 mcd, 0.068 inch x 0.049 inch	LN1371G-(TR)	Panasonic
4	4	J1, J2, J3, J4	Lug, copper, 35 A, 0.380 inch x 1.020 inch	CX35-36-CY	Panduit
2	2	Q1, Q3	MOSFET, N-channel, 25 V, 37 A, 1.3 m Ω , QFN 5X6 mm	CSD16401Q5A-R	Ciclon
2	2	R1, R12	Resistor, chip, 1/16 W, 1%, 10 Ω , 0603	Std	Std
1	1	R15	Resistor, chip, 1/16 W, 1%, 0 Ω , 0603	Std	Std
1	1	R17	Resistor, chip, 1/16 W, 1%, 1 k Ω , 0603	Std	Std
1	1	R2	Resistor, chip, 1/16 W, 1%, 100 k Ω , 0603	Std	Std
2	2	R3, R6	Resistor, chip, 1/16 W, 1%, 15 k Ω , 0603	Std	Std
1	1	R4	Resistor, chip, 1/16 W, 1%, 143 k Ω , 0603	Std	Std
1	1	R5	Resistor, chip, 1/16 W, 1%, 7.32 k Ω , 0603	Std	Std
1	1	R8	Resistor, power metal strip, 3 W, \pm 1%, 0.002 Ω , 4527	WSR-32L000FE A	Vishay Dale
2	2	R9, R10	Resistor, chip, 1/16 W, 1%, 5.1 k Ω , 0603	Std	Std

⁽¹⁾ These assemblies are ESD sensitive, ESD precautions shall be observed.

⁽²⁾ These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.

⁽³⁾ These assemblies must comply with workmanship standards IPC-A-610 Class 2.

⁽⁴⁾ Ref designators marked with an asterisk (***) cannot be substituted. All other components can be substituted with equivalent MFG's components.

Table 3. 12-V TPS2492EVM-001/TPS2493EVM-002⁽¹⁾⁽²⁾⁽³⁾⁽⁴⁾ (continued)

-001	-002	REF DES	DESCRIPTION	PART NUMBER	MFR
1	1	S1	Switch, SPDT, slide, PC mount, 500 mA, 0.400 inch x 0.100 inch	09.03201.0 2	EAO
17		TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17	Test point, white, thru hole, 5012, 0.125 inch x 0.125 inch	5012	Keystone
1	0	U1	Positive High-Voltage Power-Limiting Hotswap Controller, TSSOP-14	TPS2492P W	TI
0	1	U1	Positive High-Voltage Power-Limiting Hotswap Controller, TSSOP-14	TPS2493P W	TI
4	4		Screw, panhead	#10-32	0.500 inch
4	4		Washer, flat	#10	
4	4		Washer, split	M5	
4	4		Nut, hex	#10-32	
1	1	--	PCB, 5.4 inch x 3.3 inch x 0.06 inch	HPA491	Any
4	4	--	Bumpons, cylindrical, black	SJ5514-0	3M

12 48-V TPS2492EVM-003/TPS2493EVM-004

This is the List of Material for the 48-V TPS2492EVM-003/TPS2493EVM-004.

Table 4. 48-V TPS2492EVM-003/TPS2493EVM-004⁽¹⁾⁽²⁾⁽³⁾⁽⁴⁾

-003	-004	REF DES	DESCRIPTION	PART NUMBER	MFR
3	3	C1, C3, C7	Capacitor, ceramic, 100 V, X7R, 10%, 0.1 μ F, 0805	Std	Std
1	1	C5	Capacitor, ceramic, 25 V, X7R, 10%, 0.1 μ F, 0805	Std	Std
2	2	C2, C9	Capacitor, aluminum, 100 VDC, \pm 20%, 47 μ F, 0.670 inch x 0.750 inch	EEVFK2A470Q	Panasonic
1	1	C6	Capacitor, ceramic, 25 V, X7R, 10%, 1000 pF, 0603	Std	Std
1	1	C8	Capacitor, ceramic, 25 V, X7R, 10%, 1.5 nF, 0603	Std	Std
1	1	D1	Diode, SMT TVS 400 W, 1 A, 70 V, SMA	SMAJ70A-13F	Diodes
1	1	D2	Diode, Schottky 3 A, 100 V, SMC	MBRS3100T3G	On Semi
1	1	D3	Diode, LED, red, 20 mA, 0.9 mcd, 0.068 inch x 0.049 inch	LN1271R	Panasonic
1	1	D4	Diode, LED, green, 20 mA, 0.9 mcd, 0.068 inch x 0.049 inch	LN1371G-(TR)	Panasonic
4	4	J1, J2, J3, J4	Lug, copper, 35 A, 0.380 inch x 1.020 inch	CX35-36-CY	Panduit
1	1	Q2	Transistor, NFET, 100 V, 33 A, 44 m Ω , D2PAK	IRF540NS-PBF	IR
1	1	R14	Resistor, chip, 1/16 W, 1%, 10 Ω , 0603	Std	Std
1	1	R15	Resistor, chip, 1/16 W, 1%, 0 Ω , 0603	Std	Std
1	1	R17	Resistor, chip, 1/16 W, 1%, 1 k Ω , 0603	Std	Std
1	1	R2	Resistor, chip, 1/16 W, 1%, 100 k Ω , 0603	Std	Std
2	2	R3, R6	Resistor, chip, 1/16 W, 1%, 15 k Ω , 0603	Std	Std
1	1	R4	Resistor, chip, 1/16 W, 1%, 604 k Ω , 0603	Std	Std
1	1	R5	Resistor, chip, 1/16 W, 1%, 4.42 k Ω , 0603	Std	Std
1	1	R7	Resistor, metal strip, 0.01 Ω , 2 W, 1%, 0.01, 2512	LRC-LRF2512L F-01-R010-F	IRC
2	2	R9, R10	Resistor, chip, 1/16 W, 1%, 20 k Ω , 0603	Std	Std

⁽¹⁾ These assemblies are ESD sensitive, ESD precautions shall be observed.

⁽²⁾ These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.

⁽³⁾ These assemblies must comply with workmanship standards IPC-A-610 Class 2.

⁽⁴⁾ Ref designators marked with an asterisk (***) cannot be substituted. All other components can be substituted with equivalent MFG's components.

Table 4. 48-V TPS2492EVM-003/TPS2493EVM-004⁽¹⁾⁽²⁾⁽³⁾⁽⁴⁾ (continued)

-003	-004	REF DES	DESCRIPTION	PART NUMBER	MFR
1	1	S1	Switch, SPDT, slide, PC mount, 500 mA, 0.400 inch x 0.100 inch	09.03201.0 2	EAO
		TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17	Test point, white, thru hole, 5012, 0.125 inch x 0.125 inch	5012	Keystone
1	0	U1	Positive High-Voltage Power-Limiting Hotswap Controller, TSSOP-14	TPS2492P W	TI
0	1	U1	Positive High-Voltage Power-Limiting Hotswap Controller, TSSOP-14	TPS2493P W	TI
4	4		Screw, panhead	#10-32	0.500 inch
4	4		Washer, flat	#10	
4	4		Washer, split	M5	
4	4		Nut, hex	#10-32	
1	1	--	PCB, 5.4 inch x 3.3 inch x 0.06 inch	HPA491	Any
4	4	--	Bumpons, cylindrical, black	SJ5514-0	3M

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 9 V to 80 V and the output voltage range of 9 V to 80 V .

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 50° C. The EVM is designed to operate properly with certain components above 65° C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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