Using the TPS24720EVM-001

User's Guide

Literature Number: SLUU458A
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TPS24720 Hot Swap Controller Evaluation Module

1 Introduction

This User's Guide describes the setup and operation of the TPS24720 System Test Board. The TPS24720EVM-001 User Guide also provides TPS24720EVM-001 Schematic, EVM Assembly and PCB Layout and List of Materials.

2 Description

The EVM is a 3-V to 20-V module using the TPS24720 hot-swap controller with external MOSFET. At power on, the output MOSFET 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, fault current and fault timer settings are hardware programmable. Status signals are Power Good, output fault and FET fault. Actual output current is displayed at the IMON pin.

2.1 Applications

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

2.2 Features

- Jumper selectable latch off (0 V) or re-try (logic high) controller.
- The EVM will be set up for a 12-V, 25-A nominal application.
  (The Applications section of the TPS24720 datasheet has a design example that shows how to change the EVM configuration for other voltage, current, and MOSFET power dissipation levels.)
- The EVM is designed for 50 A maximum.
- 2-ounce copper 4-layer circuit board.
- Input/output out of operating range transient voltage protections.
- On-board enable/input (slide switch).
- IMON output voltage test point for voltage representation of the output current. Set resistors and IMON series resistor set for 25-A full scale.

3 Schematic

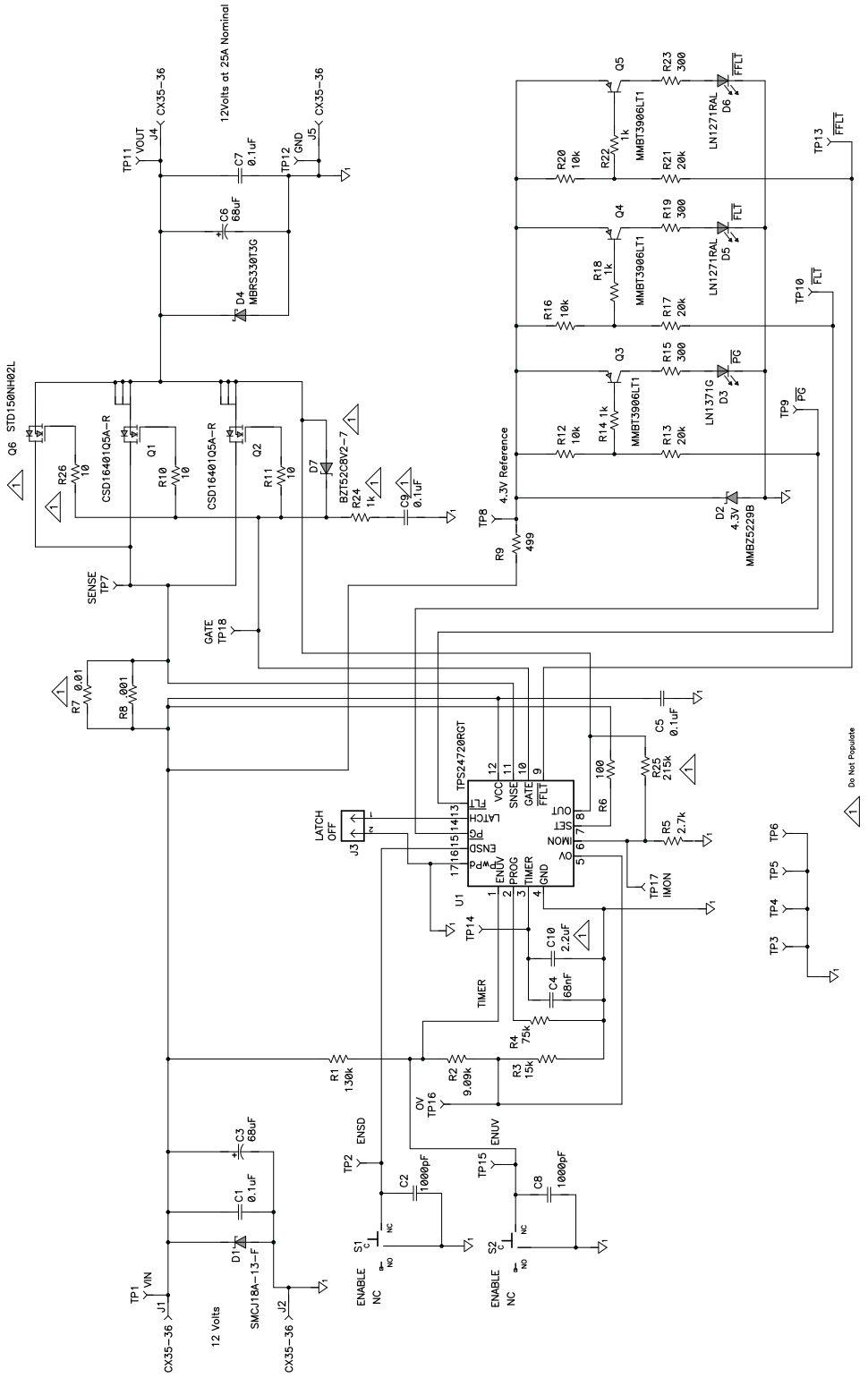

Figure 1. TPS24720EVM-001 Schematic

4 EVM Description

4.1 Overvoltage Protection

Input protection for the TPS2470 and MOSFET consists of a 18-V TVS and 0.1-µF and 68-µF capacitors located close to the V_{IN} pins. The TVS is active at 19.5 V minimum. TVS is Vishay SMAJ18A, SMC package.

Output protection is a fixed 68-µF capacitor and a parallel 0.1-µF capacitor located at the output terminals. A schottky diode on the output clamps negative going transitions. Diode MBRS330T3, 3 A, 100 V is placed on the output to restrict output transients to -0.7 V when the load is disconnected.

4.2 Enable Signal ENUV

Slide switch to operate ENABLE signal. The Enable signal is externally pulled to VIN through a resistor divider to set the UV to 10 volts. A 0.1-µF capacitor is used to help de-bounce the Enable switch.

4.3 Enable Signal ENSD

Slide switch to operate ENABLE signal. The Enable signal is externally pulled to GND to place the device in low current standby. A 0.1-µF capacitor is used to help de-bounce the Enable switch.

4.4 Indicator LEDS

A 4.3-V zener is used to limit the voltage range on the LEDs. A bipolar signal transistor is used to turn on the LED while keeping the $\overline{PG}$, $\overline{FLT}$ and $\overline{FFLT}$ signals less than 0.3 V active. External interface is 0 V to 4.3 V.

Table 1. LED Signal Color

LED COLOR	SIGNAL
$\overline{PG}$	Green
$\overline{FLT}$	Red
$\overline{FFLT}$	Red

4.5 I_{MON}

I_{MON} output to a test point only. R_{IMON} has a screened label for user change.

4.6 Disable Power Limiting

Power limiting can be disabled by leaving the PROG pin open (no programming resistor). The soft-start time can be controlled by a gate capacitor and series 1-kΩ resistor. (See Figure 1)

4.7 Not Installed

- D7 is installed if the VGS needs to be limited by the MOSFET specification. The zener voltage rating sets VGS max.
- R24, C9 installed if the soft start is not controlled by power limiting but by gate current and the selected C9

Where:

$$C = I \times \frac{T}{V} \quad (1)$$

Example, for 10-ms start on a 12-V board

$$C = \frac{30\,\mu A \times 10\,\mu s}{25\,V},\ C = 12\,nF \quad (2)$$

5 Test Points

Test points are located on the board edge.

Table 2. TPS24720EVM-001 Test Points

NAME	DESCRIPTION
ENUV	Enable signal
ENSD	Enable signal
$\overline{PG}$	Power good, signal, low true
$\overline{FLT}$	Fault, signal, low true
$\overline{FFLT}$	FET fault, signal low true
IMON	Output current monitor, .675volts full scale amps
LATCH	Latch signal, high true, low for retry*******
GND	Scope ground test point
GND	Scope ground test point
GND	Scope ground test point
GND	Scope ground test point
VOUT	Output voltage
CT	Fault timer capacitor
PROG	Program voltage
SET	Current limit set point
GATE	Gate signal
VIN	Input voltage power supply

6 Jumpers (J3)

Jumper, J3, selects latch or retry mode. The TPS24720 is in Latch Mode when the jumper is off.

NOTE: The provision provided for dual current sense resistor packages (R7 and R8) can lead to current sensing and power limit accuracy reduction. A simple PCB modification can be made to improve this accuracy as shown in Figure 2.

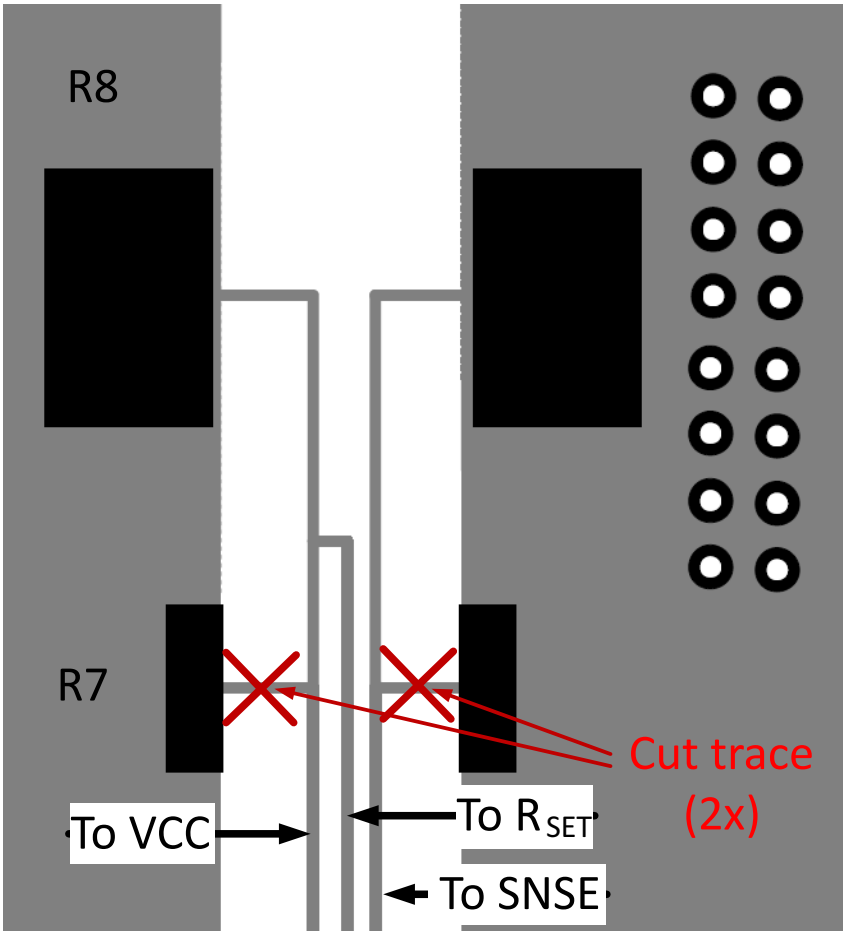

Figure 2. PCB Modification

7 EVM Assembly and PCB Layout

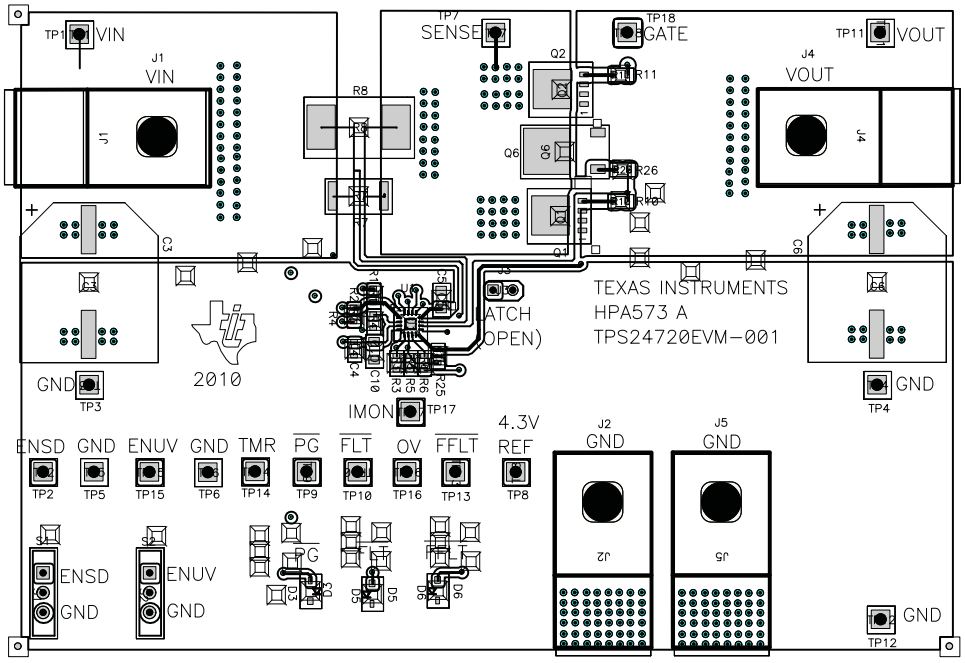

Figure 3. Board Top Side

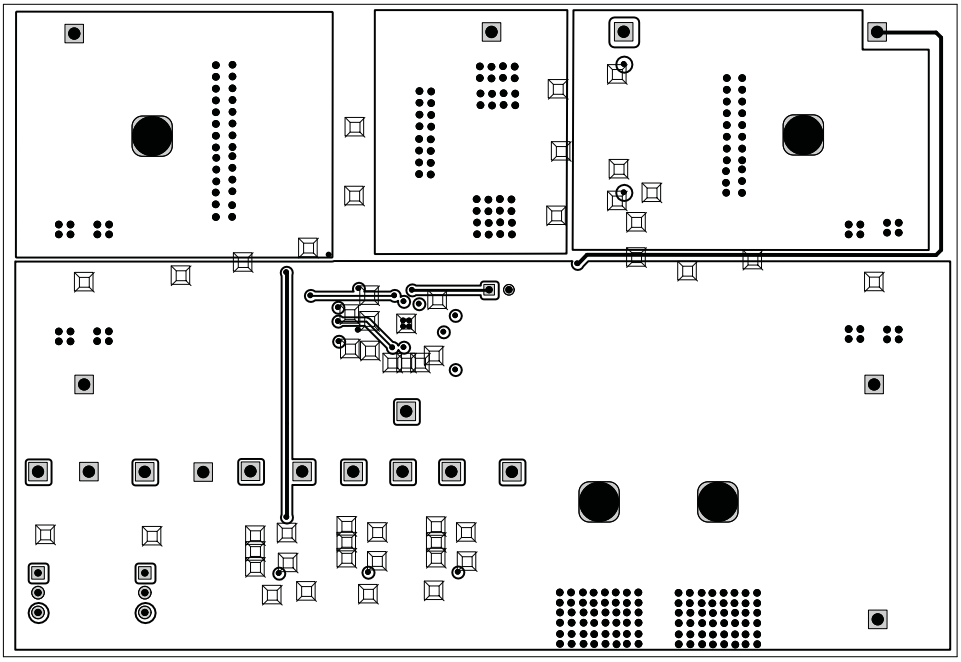

Figure 4. Layer 1

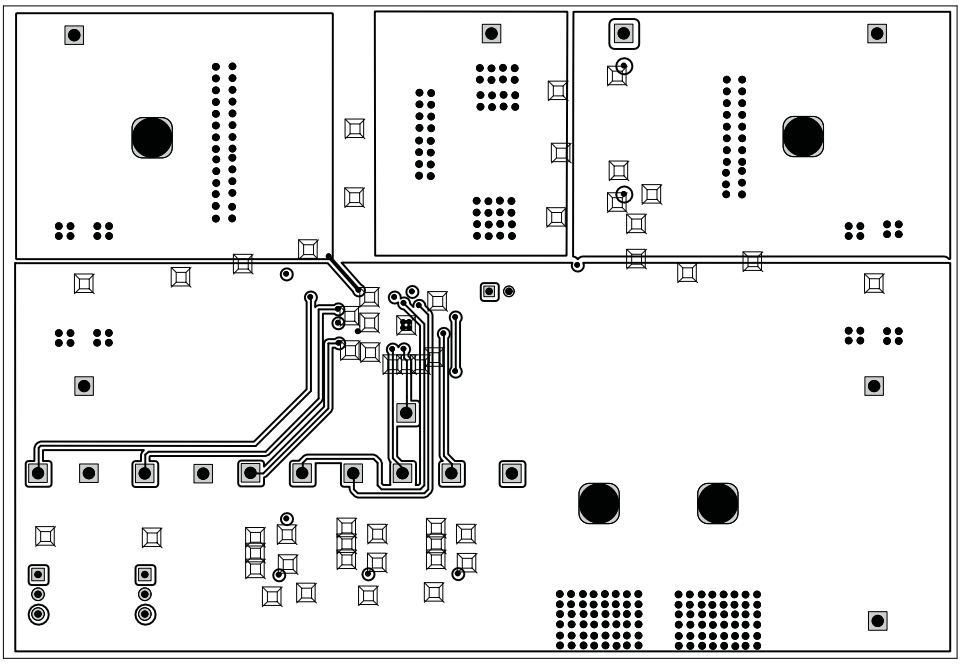

Figure 5. Layer 2

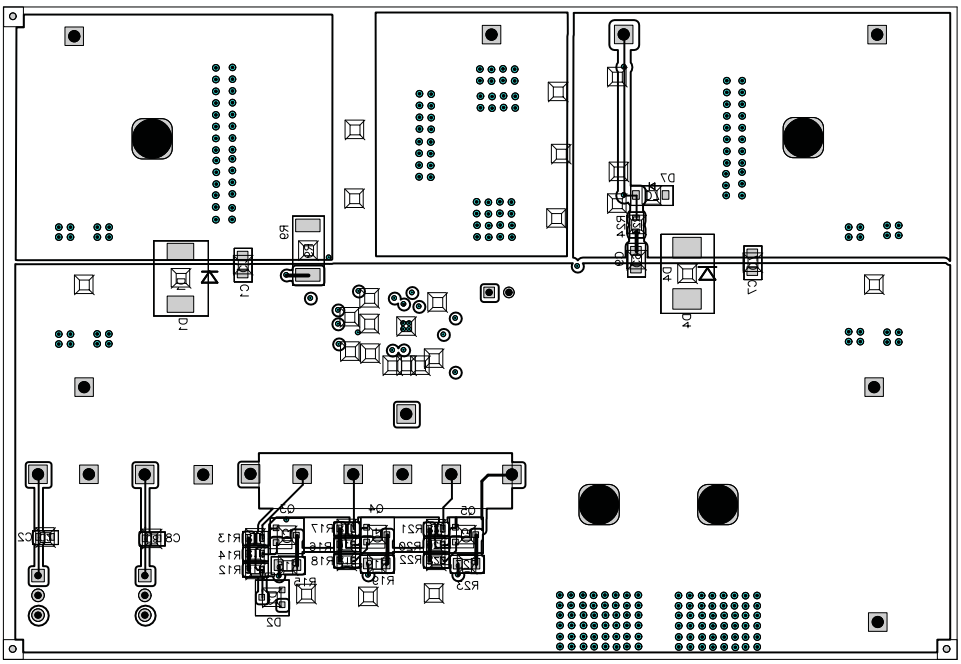

Figure 6. Board Bottom Side

8 List of Materials

Table 3. TPS24720EVM-001 List of Materials

COUNT	REF DES	DESCRIPTION	MFR	PART NUMBER
3	C1, C5, C7	Capacitor, ceramic, 100 V, X7R, 10%, 0.1 µF, 0805	STD	STD
0	C9	Capacitor, ceramic, 100 V, X7R, 10%, 0.1 µF, 0805	STD	STD
2	C2, C8	Capacitor, ceramic, 100 V, X7R, 10%, 1000 pF, 0603	STD	STD
2	C3, C6	Capacitor, aluminum, 100 VDC, ±20% , 68 µF, 0.670 x 0.750 in.	Panasonic	EEVFK1k680Q
1	C4	Capacitor, ceramic, 100 V, X7R, 10%, 68 nF, 0603	STD	STD
0	C10	Capacitor, ceramic, 10 V, X7R, 10%, 2.2 µF, 0805	STD	STD
1	D1	Diode, [uni-]directional TVS, 1500 W, 18 V, SMC	Diodes	SMCJ18A-13-F
1	D2	Diode, Zener, 4.3 V, SOT-23	Motorola	MMBZ5229B
1	D3	Diode, LED, green, 0.114 in. x 0.049 in.	Panasonic	LN1371G
1	D4	Diode, Schottky, 3 A, 40 V, SMC	On Semi	MBRS330T3G
2	D5, D6	Diode, LED, ultra bright red, 0.114 in. x 0.049 in.	Panasonic	LN1271RAL
0	D7	Diode, Zener, planar power, 500 mW, 8.2V, SOD-123	Vishay	BZT52C8V2-7
4	J1, J2, J4, J5	Lug, copper, 35 A, 0.380 in. x 1.020 in.	Panduit	CX35-36
1	J3	Header, male 2 pin, 100-mil spacing, 0.100 in. x 2 in.	Sullins	PEC02SAAN
2	Q1, Q2	MOSFET, N-channel, 25 V, 37 A, 1.3 mΩ , QFN x 6 mm	Ciclon	CSD16401Q5A-R
3	Q3, Q4, Q5	Bipolar, PNP, 40 V, 200 mA, SOT23	On Semi	MMBT3906LT1
0	Q6	MOSFET, N-channel 24 V, 150 A, CLIPPAK (DPAK), 3.5 mΩ	ST Microelectronics	STD150NH02LT4
1	R1	Resistor, chip, 1/16 W, 1%, 130 kΩ, 603	STD	STD
3	R10, R11	Resistor, chip, 1/16 W, 1%, 10 Ω, 603	STD	STD
0	R26	Resistor, chip, 1/16 W, 1%, 10 Ω, 603	STD	STD
3	R12, R1Connector6, R20	Resistor, chip, 1/16 W, 5%, 10 kΩ, 603	STD	STD
3	R13, R17, R21	Resistor, chip, 1/16 W, 5%, 20 kΩ, 603	STD	STD
3	R14, R18, R22	Resistor, chip, 1/16 W, 1%, 1 kΩ, 603	STD	STD
0	R24	Resistor, chip, 1/16 W, 1%, 1 kΩ, 603	STD	STD

Table 3. TPS24720EVM-001 List of Materials (continued)

COUNT	REF DES	DESCRIPTION	MFR	PART NUMBER
3	R15, R19, R23	Resistor, chip, 1/10 W, 5%, 300 Ω, 805	STD	STD
1	R2	Resistor, chip, 1/16 W, 1%, 9.09 kΩ, 603	STD	STD
0	R25	Resistor, chip, 1/16 W, 1%, 215 kΩ, 603	STD	STD
1	R3	Resistor, chip, 1/16 W, 1%, 15 kΩ, 603	STD	STD
1	R4	Resistor, chip, 1/16 W, 1%, 75 kΩ, 603	STD	STD
1	R5	Resistor, chip, 1/16 W, 1%, 2.7 kΩ, 603	STD	STD
1	R6	Resistor, chip, 1/16 W, 1%, 100 Ω, 603	STD	STD
0	R7	Resistor, metal strip, 0.01 Ω, 2 W, 1%, 0.01, 2512	IRC	LCR-LRF2512-01-R010-F
1	R8	Res, power metal strip, 3 W, ±x1%, 0.001, 4527	Vishay Dale	WSR-3 .001ohms
1	R9	Resistor, chip, 0.5 W, 1%, 499, 2512	STD	STD
2	S1, S2	Switch, SPDT, slide, PC mount, 500 mA, 0.400 in. x 0.100 in.	EAO	09-03201-02
18	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18	Test Point, white, thru hole , 0.125 in. x 0.125 in.	Keystone	5012
1	U1	2.5 to 20 V Positive Voltage Power-Limiting Hotswap Controller, QFN	TI	TPS24720RGT

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      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

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      3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

      CAUTION

      This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

      Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

      FCC Interference Statement for Class A EVM devices

      NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

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3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210*

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This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

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Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

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2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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