This user's guide describes the setup and operation of the TPS2590 evaluation module.

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1 Introduction

This user’s guide describes the features of the TPS2590EVM. The TPS2590 schematic, printed-circuit board (PCB) layout, and bill of materials (BOM) are provided as well as a setup and getting started.

2 Description

The EVM is a 3- to 18-V module using the TPS2590 or TPS2591 hot swap controller with integrated MOSFET. At power on, the output is power limited to control inrush current and protect the MOSFET. On an overcurrent 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.

2.1 Applications

Server:
• Plug-in Circuit Boards
• RAID / Disk Drive

Telecom:
• ATCA
• Micro-ATCA

General Hot Plug

2.2 Features

• 3- to 20-V operation
• Controlled inrush current
• Fast circuit breaker control
• Hardware programmable
  – Operating current
  – Fault current
  – Fault timer to avoid nuisance tripping
  – Latch off or retry. TPS2590 is pin selectable
• LED status display
• A slide switch controls the ENABLE signal
• The area under the TPS2590 is copper pour with vias to the internal ground to take advantage of the power pad package
• On-board transorb for overvoltage input protection
• A common diode at the output prevents a negative spike if the load is removed while powered on
• Test points available to monitor circuit operation
• Design Calculator Tool (http://www.ti.com/product/TPS2590/toolsoftware)
3 EVM Block Diagram

Figure 1 shows the EVM block diagram.

Figure 1. TPS2590EVM Block Diagram
Figure 2 shows the EVM schematic.

**Figure 2. TPS2590EVM Schematic**

**NOTES:**

Do Not Populate. Placeholders for solder terminals.
# 5 Bill of Materials

Table 1 lists the BOM for the EVM.

<table>
<thead>
<tr>
<th>Count</th>
<th>RefDes</th>
<th>Value</th>
<th>Description</th>
<th>Size</th>
<th>Part Number</th>
<th>MFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>C1, C3</td>
<td>0.1uF</td>
<td>Capacitor Ceramic, 25V, X7R, 10%</td>
<td>0603</td>
<td>STD</td>
<td>muRata</td>
</tr>
<tr>
<td>1</td>
<td>C2</td>
<td>1000pF</td>
<td>Capacitor, Ceramic, 25V, X7R, 20%</td>
<td>0603</td>
<td>STD</td>
<td>muRata</td>
</tr>
<tr>
<td>1</td>
<td>C4</td>
<td>.56uF</td>
<td>Capacitor, Ceramic, 10V, X7R, 10%</td>
<td>0805</td>
<td>STD</td>
<td>muRata</td>
</tr>
<tr>
<td>1</td>
<td>C5</td>
<td>1uF</td>
<td>Capacitor, Ceramic, 25V, X7R, 20%</td>
<td>1206</td>
<td>STD</td>
<td>muRata</td>
</tr>
<tr>
<td>1</td>
<td>C6</td>
<td>.1uF</td>
<td>Capacitor Ceramic, 25V, X7R, 10%</td>
<td>0603</td>
<td>STD</td>
<td>muRata</td>
</tr>
<tr>
<td>1</td>
<td>D1</td>
<td>LN1271R</td>
<td>Diode, LED, Red, 20-mA, 0.9-mcd</td>
<td>0.068 x 0.049 inch</td>
<td>LN1271R</td>
<td>Panasonic</td>
</tr>
<tr>
<td>1</td>
<td>D2</td>
<td>MMBZ5229B</td>
<td>Diode, Zener, 4.3V, 350mW</td>
<td>SOT23</td>
<td>MMBZ5229B</td>
<td>Motorola</td>
</tr>
<tr>
<td>1</td>
<td>D3</td>
<td>SMAJ18A</td>
<td>Diode, SMT TVS 400W, 1-A, 18V</td>
<td>SMA</td>
<td>SMAJ18A</td>
<td>Diodes</td>
</tr>
<tr>
<td>1</td>
<td>D4</td>
<td>MBR130LSFT1</td>
<td>Diode, Schottky, 1000-ma, 30-V</td>
<td>SCD123</td>
<td>MBR130LSFT1</td>
<td>STD</td>
</tr>
<tr>
<td>4</td>
<td>J1, J2, J4, J5</td>
<td>7693</td>
<td>Screw Terminal</td>
<td>0.310 x 0.310 inch</td>
<td>7693</td>
<td>Keystone</td>
</tr>
<tr>
<td>1</td>
<td>J3</td>
<td>PEC02SAAN</td>
<td>Header, 2-pin, 100mil spacing</td>
<td>0.100 inch x 2</td>
<td>PEC02SAAN</td>
<td>Sullins</td>
</tr>
<tr>
<td>1</td>
<td>Q1</td>
<td>MMBT3906LT1</td>
<td>Bipolar, PNP, 40-V, 200-mA, 225-mW</td>
<td>SOT23</td>
<td>MMBT3906LT1</td>
<td>On Semi</td>
</tr>
<tr>
<td>1</td>
<td>R1</td>
<td>0</td>
<td>Resistor, Chip, 1/16W, 1%</td>
<td>0603</td>
<td>STD</td>
<td>Vishay</td>
</tr>
<tr>
<td>1</td>
<td>R2</td>
<td>499</td>
<td>Resistor, Chip, 5W, 1%</td>
<td>2512</td>
<td>STD</td>
<td>STD</td>
</tr>
<tr>
<td>1</td>
<td>R3</td>
<td>10K</td>
<td>Resistor, Chip, 1/16W, 5%</td>
<td>0603</td>
<td>STD</td>
<td>Vishay</td>
</tr>
<tr>
<td>1</td>
<td>R4</td>
<td>1K</td>
<td>Resistor, Chip, 1/16W, 1%</td>
<td>0603</td>
<td>STD</td>
<td>Vishay</td>
</tr>
<tr>
<td>1</td>
<td>R5</td>
<td>10K</td>
<td>Resistor, Chip, 1/16W, 1%</td>
<td>0603</td>
<td>STD</td>
<td>Vishay</td>
</tr>
<tr>
<td>1</td>
<td>R6</td>
<td>20K</td>
<td>Resistor, Chip, 1/16W, 5%</td>
<td>0603</td>
<td>STD</td>
<td>Vishay</td>
</tr>
<tr>
<td>1</td>
<td>R7</td>
<td>300</td>
<td>Resistor, Chip, 1/10W, 5%</td>
<td>0805</td>
<td>STD</td>
<td>Vishay</td>
</tr>
<tr>
<td>1</td>
<td>R8</td>
<td>40.2K</td>
<td>Resistor, Chip, 1/16W, 1%</td>
<td>0603</td>
<td>STD</td>
<td>Vishay</td>
</tr>
<tr>
<td>1</td>
<td>R9</td>
<td>49.9K</td>
<td>Resistor, Chip, 1/16W, 1%</td>
<td>0603</td>
<td>STD</td>
<td>Vishay</td>
</tr>
<tr>
<td>1</td>
<td>S1</td>
<td>09-03201-02</td>
<td>Switch, SPDT, Slide, PC-mount, 500-mA</td>
<td>0.400 x 0.100 inch</td>
<td>09-03201-02</td>
<td>EAO</td>
</tr>
<tr>
<td>7</td>
<td>TP1, TP2, TP3, TP4, TP5, TP6, TP9</td>
<td>5012</td>
<td>Test Point, White, Thru Hole</td>
<td>0.125 x 0.125 inch</td>
<td>5012</td>
<td>Keystone</td>
</tr>
<tr>
<td>4</td>
<td>TP10, TP11, TP12, TP13</td>
<td>GND</td>
<td>Test Point, SM, 0.150 x 0.090</td>
<td>0.185 x 0.135 inch</td>
<td>5016</td>
<td>Keystone</td>
</tr>
<tr>
<td>4</td>
<td>TP7, TP8, TP14, TP15</td>
<td>Test Point, 0.062 Hole</td>
<td>0.250 inch</td>
<td>5012</td>
<td>Keystone</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>U1</td>
<td>TPS2590RSA</td>
<td>IC, 3V to 20V Integrated FET Load Switch</td>
<td>QFN-16</td>
<td>TPS2590RSA</td>
<td>TI</td>
</tr>
</tbody>
</table>
Figure 3 through Figure 6 illustrate the board outline drawings.

Figure 3. Component Placement (Top View)

Figure 4. Board Layout (Top View)
Figure 5. Board Layout (Bottom View)

Figure 6. Component Placement (Bottom View)
7 Circuit Description

7.1 Test Points

Table 2 lists the test point descriptions.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIN</td>
<td>Input voltage power supply</td>
</tr>
<tr>
<td>4.3 V</td>
<td>4.3-V reference</td>
</tr>
<tr>
<td>EN</td>
<td>Enable signal, high true</td>
</tr>
<tr>
<td>FLT</td>
<td>Fault signal, low true</td>
</tr>
<tr>
<td>LATCH</td>
<td>Latch signal, high true, low for retry</td>
</tr>
<tr>
<td>VOUT</td>
<td>Output voltage</td>
</tr>
<tr>
<td>CT</td>
<td>Fault timer capacitor</td>
</tr>
<tr>
<td>GND</td>
<td>Scope ground test point</td>
</tr>
<tr>
<td>GND</td>
<td>Scope ground test point</td>
</tr>
<tr>
<td>GND</td>
<td>Scope ground test point</td>
</tr>
<tr>
<td>GND</td>
<td>Scope ground test point</td>
</tr>
</tbody>
</table>

7.2 Connectors

Table 3 lists the connector descriptions.

<table>
<thead>
<tr>
<th>Connector</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1</td>
<td>Main power input, VIN</td>
</tr>
<tr>
<td>J2</td>
<td>Main power ground, GND</td>
</tr>
<tr>
<td>J4</td>
<td>Load</td>
</tr>
<tr>
<td>J5</td>
<td>Load ground, GND</td>
</tr>
</tbody>
</table>

7.3 Jumpers

R1 is used to disconnect the LEDs for test measurement of TPS2590 quiescent current. This 0-Ω resistor is normally installed.

Table 4 provides the jumper description of jumper J3.

<table>
<thead>
<tr>
<th>Jumper</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>J3</td>
<td>TPS2590 Only Off = Latch, On = Retry</td>
</tr>
</tbody>
</table>

7.4 Switches

7.4.1 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.

7.4.2 Indicators

Red LED indicator for FAULT (FLT).
8 EVM Test Setup

8.1 Test Equipment
Voltage Source: The input voltage source, \( V_{\text{IN}} \) is a 20-V variable dc source at 10 A.
Oscilloscope: A digital oscilloscope can be used to monitor the test points.
Current Probe: A current probe is helpful to observe turn-on characteristics of the external load.
Recommended Wire Gauge: Power is limited to 5 W; 18-gage wire, minimum, is recommended.

8.2 Equipment Supplied
The TPS2590EVM module configured with TPS2590 is supplied.

Table 5. EVM Configurations

<table>
<thead>
<tr>
<th>Evaluation Module</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPA490EVM-001</td>
<td>TPS2590</td>
</tr>
</tbody>
</table>

8.3 Recommended Test Setup
Figure 1 illustrates the equipment connections for power up and testing.
• Connect the positive voltage input power supply to J1 and the negative voltage to GND, J2. Connectors J1 and J2 can accept #6 ring or spade lugs.
• Connect the RC load at J4 and the load return at J5. The example here uses 220 \( \mu \text{F}, 15 \Omega \).
• Scope to current probe to measure the load current.
• Scope the \( V_{\text{OUT}} \) and EN.

Note:

Figure 7. Equipment Connections
8.4 Operation

Use the following steps for EVM operation:
1. Turn on the power supply.
2. Trigger the scope on EN low-going edge.
3. Slide the EN to the EN position as screened on the circuit board.

9 Test Results

Observe waveforms similar to Figure 8.
- The current to the load is not constant but increases after the initial inrush. Current is low, initially, because the voltage across the internal MOSFET is initially at its highest level and the controller is power-limiting the MOSFET.
- Although the current limit, I_{\text{FLT}} , is set to 4 A, the start up current never goes above 2.2 A because of the power limiting. However, 4 A is available to the steady state load when the MOSFET is fully enhanced.
- At the end of the capacitor charge time, the current drops to the dc level powering the resistive part of the load, about 0.8 A.

Refer to SLUS960 for more details.

---

Figure 8. Example Scope Trace
## Revision History

### Changes from Original (July 2009) to A Revision

<table>
<thead>
<tr>
<th>Change Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Added Design Calculator tool and link to the list of features.</td>
<td>2</td>
</tr>
<tr>
<td>• Changed device name in title of Figure 1.</td>
<td>3</td>
</tr>
<tr>
<td>• Changed schematic, Figure 2.</td>
<td>4</td>
</tr>
<tr>
<td>• Changed contents of BOM.</td>
<td>5</td>
</tr>
<tr>
<td>• Added Component Placement (Bottom View) image.</td>
<td>6</td>
</tr>
<tr>
<td>• Changed Board Layout (Top View) image.</td>
<td>6</td>
</tr>
<tr>
<td>• Changed Board Layout (Bottom View) image.</td>
<td>7</td>
</tr>
<tr>
<td>• Added Component Placement (Bottom View) image.</td>
<td>7</td>
</tr>
<tr>
<td>• Changed entire content of first paragraph in the Test Points section.</td>
<td>8</td>
</tr>
<tr>
<td>• Changed R9 to R1 in first paragraph of Jumpers section.</td>
<td>8</td>
</tr>
</tbody>
</table>
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