# TPS23754EVM-420 EVM: Evaluation Module for TPS23754

This User's Guide describes the TPS23754 EVM (TPS23754EVM-420). TPS23754EVM-420 contains evaluation and reference circuitry for the TPS23754. The TPS23754 is an IEEE 802.3at compliant powered device (PD) controller and power supply controller optimized for isolated converter topologies. TPS23754EVM-420 is targeted at 25W, synchronous flyback converter applications.

**Contents**



**List of Figures**



**List of Tables**

# 1 Description

TPS23754EVM-420 will allow reference circuitry evaluation of the TPS23754. It contains input and output power connectors and an array of on board test points for circuit evaluation. An active clamp, 12V, 30W EVM is also available, see SLVU304.

## 1.1 Features

- Efficient, general market design
  - Self driven, synchronous rectified secondary
  - 25W output power from power over ethernet (PoE), 30W output power from a 48V adapter
  - Operates from either PoE or external adaptors (24 and 48V)
  - 5V output voltage

## 1.2 Applications

- Voice over Internet Protocol – IP telephones
- Wireless LAN – Wireless Access Points
- Security – Wired IP cameras

# 2 Electrical Specifications

**Table 1. TPS23754EVM-420 Electrical and Performance Specifications**

| Parameter | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **POWER INTERFACE** | | | | | | |
| Input Voltage | Applied to the power pins of connectors J1 or J3 | | 0 | | 57 | V |
| Operating Voltage | After start up | | 30 | | 57 | V |
| Input UVLO | Rising input voltage | | | | 36 | V |
| | Falling input voltage | | 30 | | | |
| Detction voltage | At device terminals | | 1.6 | | 10 | V |
| Classification voltage | At device terminals | | 10 | | 23 | V |
| Classification current | Rclass = 63.5 Ω | | 36 | | 44 | mA |
| Inrush current-limit | | | 100 | | 180 | mA |
| Operating current-limit | | | 850 | | 1100 | mA |
| **DC/DC CONVERTER** | | | | | | |
| Output voltage | 21.6V ≤ Vin ≤ 57 V, ILOAD ≤ ILOAD (max) | 5 V output | 4.75 | 5.00 | 5.25 | V |
| Output current | 21.6V ≤ Vin ≤ 57 V | 5 V output | | | 5 | A |
| Output ripple voltage, peak-to-peak | Vin = 44 V, ILOAD = 5 A | 5 V output | | 50 | | mV |
| Efficency, end-to-end | Vin = 44 V, ILOAD = 5 A | 5 V output | | 85% | | |
| Switching frequency | | | 225 | | 275 | kHz |

# 3 Schematic

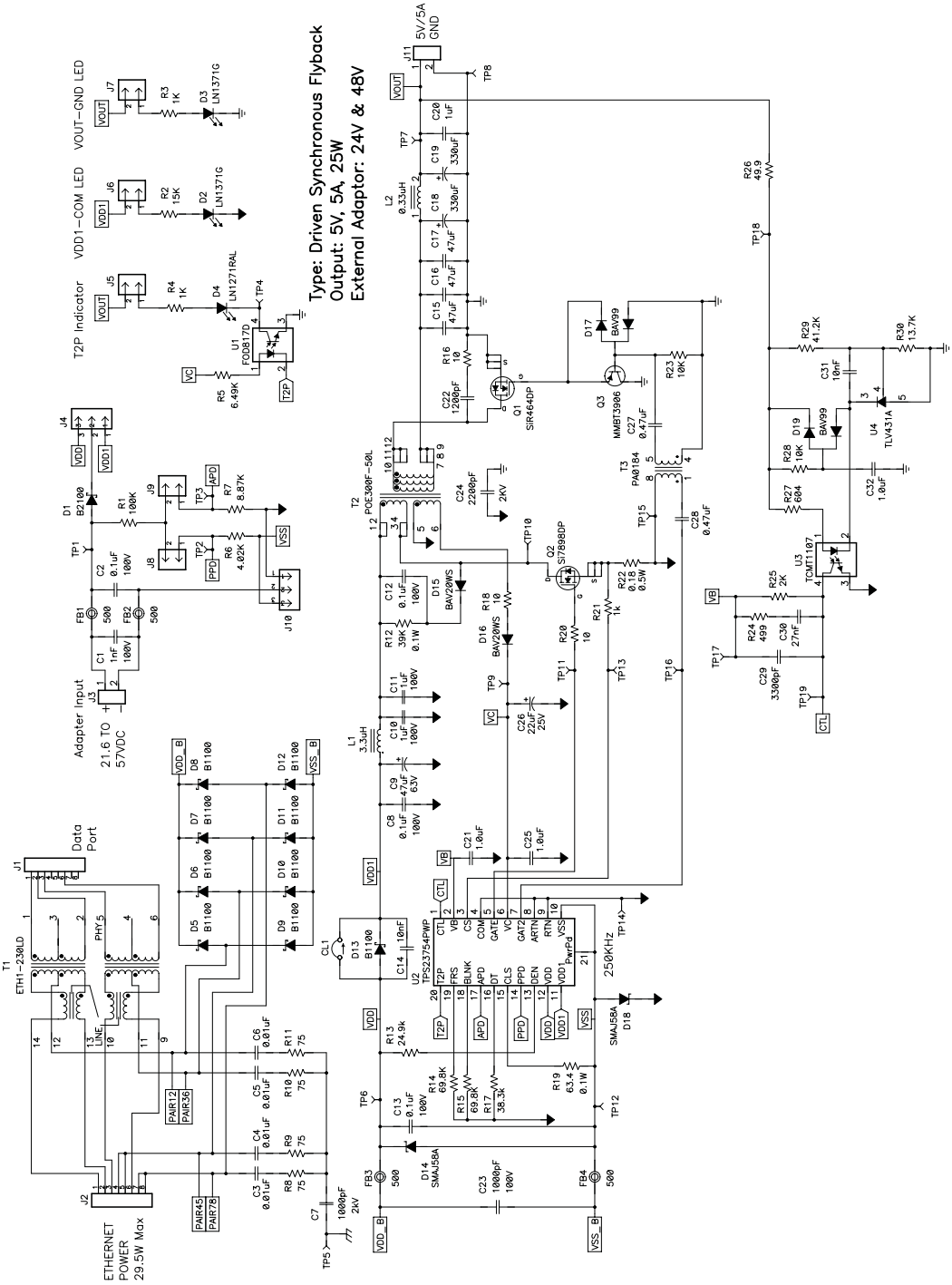


**Figure 1. TPS23754EVM-420 Schematic**

# 4 General Configuration and Description

## 4.1 Physical Access

Table 2 lists the TPS23754EVM-420 connector functionality and Table 3 describes the test point availability.

**Table 2. Connector Functionality**

| Connector | Label | Description |
|---|---|---|
| J3 | ADAPTER | External adapter input. J10 (low side) and J4 (high side) can select weather the adapter is at the PD controller input (VDD to VSS) or at the converter input (VDD1 to COM). J9 is installed to select APD function and J8 is installed to select the PPD function. |
| J11 | VOUT | Output voltage connector |
| J2 | Ethernet Power | Ethernet power input connector. |
| J1 | Ethernet Data | Ethernet data port connector |
| TP5 | Earth GND | Earth GND connection |

**Table 3. Test Points and Indicators**

| Test Point | Color | Label | Description |
|---|---|---|---|
| TP8 | BLK | GND | Secondary side (output) grounds (GND) |
| TP9 | RED | VC | DC/DC converter bias supply |
| TP10 | ORG | DRAIN | Drain terminal of the primary side switching MOSFET |
| TP12 | BLK | VSS | PoE input, low side |
| TP14, TP15 | BLK | COM | DC/DC converter return |
| TP18 | ORG | LOOP | Can be used with TP7 for overall feedback loop measurements. |
| TP7 | RED | VOUT | DC/DC converter output voltage. |
| TP19 | WHT | CTL | Control loop input to the pulse width modulator |
| TP13 | WHT | CS | DC/DC converter primary side switching MOSFET current sense (device side). |
| TP17 | RED | VB | Bias voltage regulator |
| TP11 | WHT | GATE | Gate drive for the primary side switching MOSFET |
| TP16 | WHT | GAT2 | Gate drive for the secondary side MOSFET |
| TP6 | RED | VDD | PD controller high side voltage. |
| TP1 | RED | ADPV | Adapter input voltage |
| TP4 | WHT | T2P | Type 2 PSE output from TPS23754 |
| TP2 | WHT | PPD | Connected to PPD pin of TPS23754 |
| TP3 | WHT | APD | Connected to APD pin of TPS23754 |
| TP5 | WHT | Earth GND | Earth GND common termination point for chassis terminators |
| D4 | RED | T2P | Type 2 PSE indicator. Remove the shunt on J5 to inhibit the T2P indicator. |
| D2 | GRN | COM | VDD1-COM voltage present. Remove the shunt on J6 to inhibit the COM indicator. |
| D3 | GRN | OUT | Output power indicator. Remove the shunt on J7 to inhibit the output power indicator. |
| CL1 | NA | CL1 | CL1 provides a connection between VDD and VDD1 shorting out D13. Removing the short at CL1 allows certain power source priority schemes to be tested. |

## 5 Test Setup

Figure 2 shows a typical test setup for TPS23754EVM-420. Input voltage can be applied as described in Table 2.

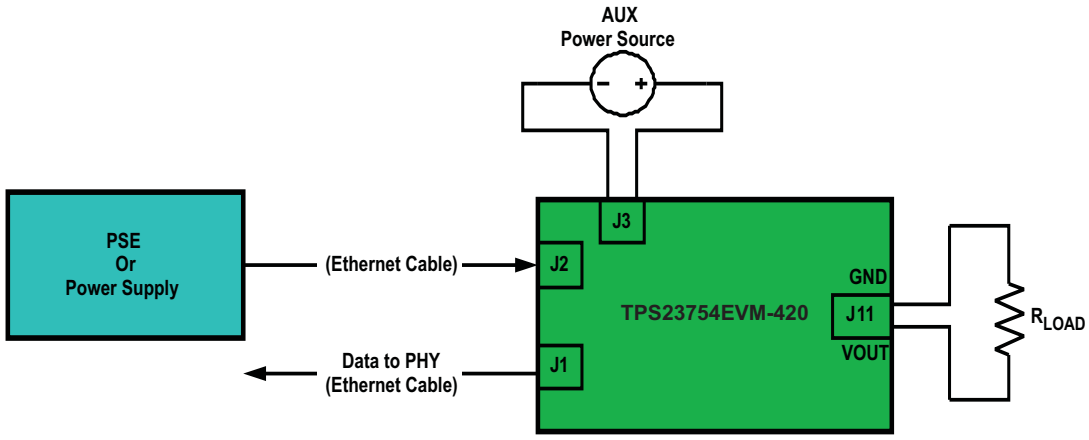


**Figure 2. Typical TPS23754EVM-420 Test Setup**

## 6 TPS23754EVM-420 Typical Performance Data

### *6.1 5V DC/DC Efficiency*

Figure 3 illustrates three different 48VDC input efficiency plots:

1. PoE, 48V from J2
2. Converter only 48V
3. Adapter 48V from J3

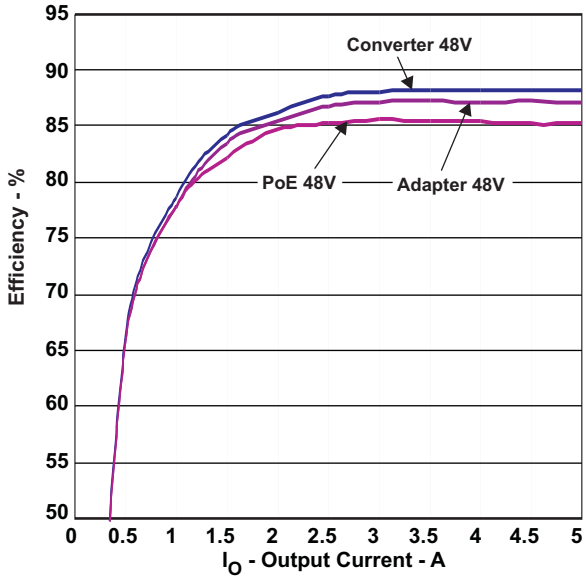


**Figure 3. TPS23754EVM-420 Efficiency With 5V Output**

# 7 EVM Assembly Drawings and Layout Guidelines

## 7.1 PCB Drawings

Figure 4 and Figure 5 shows component placement and layout.

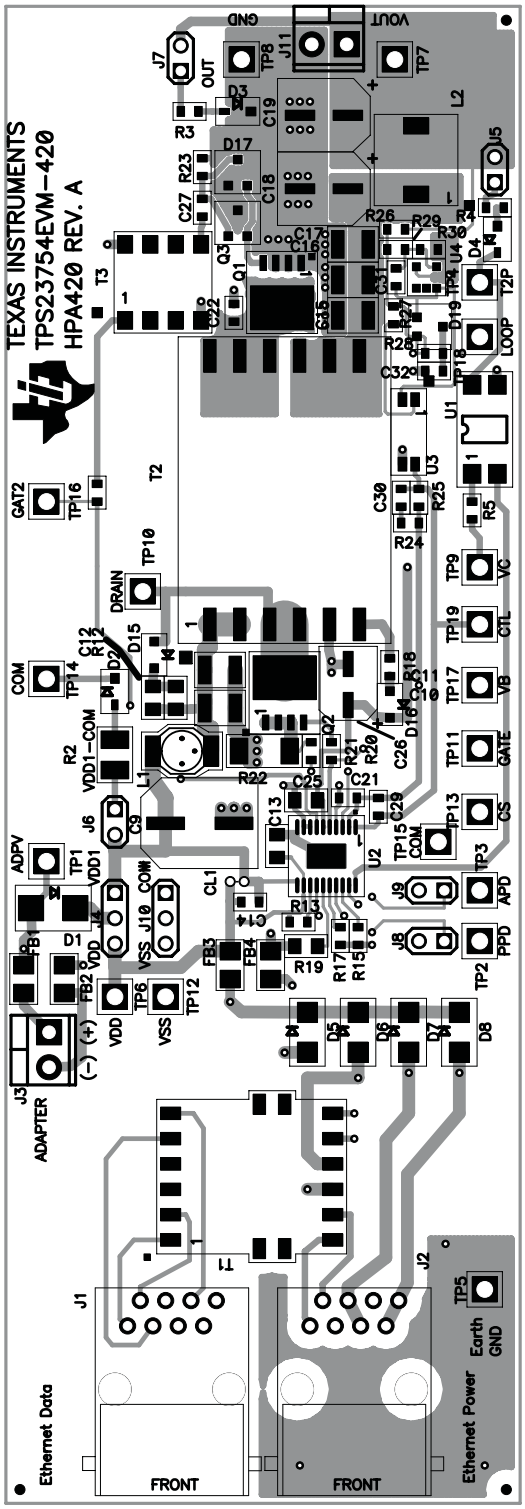


Figure 4. Top Side Layout

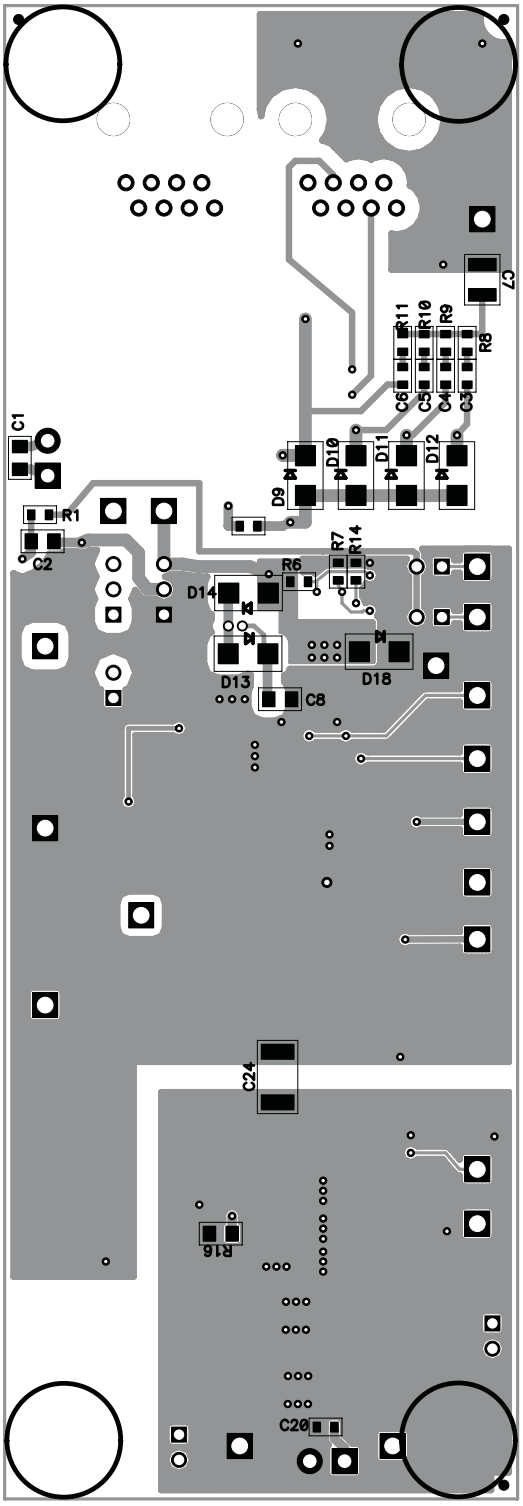

Figure 5. Bottom Side Layout

## 7.2 Layout Guidelines

The layout of the PoE front end should follow power and EMI/ESD best practice guidelines. A basic set of recommendations include:

- Parts placement must be driven by power flow in a point-to-point manner; RJ-45, Ethernet transformer, diode bridges, TVS and 0.1-µF capacitor, and TPS23754 converter input bulk capacitor.
- All leads should be as short as possible with wide power traces and paired signal and return.
- There should not be any crossovers of signals from one part of the flow to another.
- Spacing consistent with safety standards like IEC60950 must be observed between the 48-V input voltage rails and between the input and an isolated converter output.
- The TPS23754 should be located over split, local ground planes referenced to VSS for the PoE input and to COM/RTN for the converter. Whereas the PoE side may operate without a ground plane, the converter side must have one. Logic ground and power layers should not be present under the Ethernet input or the converter primary side.
- Large copper fills and traces should be used on SMT power-dissipating devices, and wide traces or overlay copper fills should be used in the power path.

The DC/DC Converter layout can benefit from basic rules such as:

- Pair signals to reduce emissions and noise, especially the paths that carry high-current pulses which include the power semiconductors and magnetics.
- Minimize trace length of high current, power semiconductors, and magnetic components.
- Where possible, use vertical pairing.
- Use the ground plane for the switching currents carefully.
- Keep the high-current and high-voltage switching away from low-level sensing circuits including those outside the power supply.
- Proper spacing around the high-voltage sections of the converter.

## 7.3 EMI Containment

- Use compact loops for dv/dt and di/dt circuit paths (power loops and gate drives)
- Use minimal, yet thermally adequate, copper areas for heat sinking of components tied to switching nodes (minimize exposed radiating surface).
- Use copper ground planes (possible stitching) and top layer copper floods (surround circuitry with ground floods)
- Use 4 layer PCB if economically feasible (for better grounding)
- Minimize the amount of copper area associated with input traces (to minimize radiated pickup)
- Hide copper associated with switching nodes under shielded magnetics where possible
- Heat sink the “quiet side” of components instead of the “switching side” where possible (like the output side of inductor)
- Use Bob Smith terminations, Bob Smith EFT capacitor, and Bob Smith plane
- Use Bob Smith plane as ground shield on input side of PCB (creating a phantom or literal earth ground)
- Use LC filter at DC/DC input
- Dampen high frequency ringing on all switching nodes if present (allow for possible snubbers)
- Control rise times with gate drive resistors and possibly snubbers
- Switching frequency considerations
- Use of EMI bridge capacitor across isolation boundary (isolated topologies)
- Observe the polarity dot on inductors (embed noisy end)
- Use of ferrite beads on input (allow for possible use of beads or 0 ohm resistors)
- Maintain physical separation between input-related circuitry and power circuitry (use ferrite beads as boundary line)
- Balance efficiency vs. Acceptable noise margin
- Possible use of common-mode inductors
- Possible use of integrated RJ-45 jacks (shielded with internal transformer and Bob Smith terminations)

- End-product enclosure considerations (shielding)

## 8 Bill of Materials

**Table 4. TPS23754EVM-420 Bill of Materials**

| Count | RefDes | Value | Description | Size | Part Number | MFR |
|---|---|---|---|---|---|---|
| 1 | C1 | 1 nF | Capacitor, Ceramic, 100V, X7R, 10% | 0805 | Std | Std |
| 2 | C10, C11 | 1 µF | Capacitor, Ceramic, 1 µF, 100V, X7R, 15% | 1210 | Std | Std |
| 1 | C14 | 10 nF | Capacitor, Ceramic, 100V, X7R, 10% | 0603 | Std | Std |
| 3 | C15–C17 | 47 µF | Capacitor, Ceramic, 10V, X5R, 15% | 1210 | Std | Std |
| 2 | C18, C19 | 330 µF | Capacitor, Aluminum, 6.3V, 20% inch | 0.260 × 0.276 | EEVFK0J331XP | Panasonic |
| 1 | C2 | 0.1 µF | Capacitor, Ceramic, 100V, X7R, 10% | 0805 | Std | Std |
| 1 | C20 | 1 µF | Capacitor, Ceramic, 16V, X7R, 15% | 0603 | Std | Std |
| 2 | C21, C32 | 1.0 µF | Capacitor, Ceramic, 16V, X7R, 10% | 0603 | Std | Std |
| 1 | C22 | 1200 pF | Capacitor, Ceramic, 50V, X7R, 15% | 0603 | Std | Std |
| 1 | C23 | 1000 pF | Capacitor, Ceramic, 100V, X7R, 15% | 0603 | Std | Std |
| 1 | C24 | 2200 pF | Capacitor, Ceramic, 2KV, X7R, 15% | 1812 | Std | Std |
| 1 | C25 | 1.0 µF | Capacitor, Ceramic, 25V, X7R, 10% | 0805 | Std | Std |
| 1 | C26 | 22 µF | Capacitor, Aluminum, 25V, 20% | 5 × 5,8mm | EEVFK1E220R | Panasonic |
| 2 | C27, C28 | 0.47 µF | Capacitor, Ceramic, 16V, X7R, 15% | 0603 | Std | Std |
| 1 | C29 | 3300 pF | Capacitor, Ceramic, 50V, X7R, 15% | 0603 | Std | Std |
| 4 | C3–C6 | 0.01 µF | Capacitor, Ceramic, 100V, X7R, 15% | 0603 | Std | Std |
| 1 | C30 | 27 nF | Capacitor, Ceramic, 50V, X7R, 15% | 0603 | Std | Std |
| 1 | C31 | 10 nF | Capacitor, Ceramic, 50V, X7R, 15% | 0603 | Std | Std |
| 1 | C7 | 1000 pF | Capacitor, Ceramic, 2kV, X7R, 15% | 1210 | Std | Std |
| 3 | C8, C12, C13 | 0.1 µF | Capacitor, Ceramic, 100V, X7R, 15% | 0805 | Std | Std |
| 1 | C9 | 47 µF | Capacitor, Aluminum, 63V, ±20% | 0.328 0 × 0.390 inch | EEVFK1J470P | Panasonic |
| 1 | CL1 | NA | Current Loop, 0.025 holes | 0.120 0 × 0.075 inch | NA | NA |
| 1 | D1 | B2100 | Diode, Schottky, 2-A, 100-V | SMB | B2100-13 | Diodes Inc |
| 2 | D14, D18 | SMAJ58A | Diode, TVS, 58-V, 1W | SMA | SMAJ58A | Diodes Inc. |
| 2 | D15, D16 | BAV20WS | Diode, Small Signal, 250mA, 150V | SOD-323 | BAV20WS | Micro Commercial Components |
| 2 | D17, D19 | BAV99 | Diode, Dual Ultra Fast, Series, 200-mA, 70-V | SOT23 | BAV99 | Fairchild |
| 2 | D2, D3 | LN1371G | Diode, LED, Green, 10-mA, 2.6-mcd | 0.114 0 × 0.049 inch | LN1371G | Panasonic |
| 1 | D4 | LN1271RAL | Diode, LED, Ultra Bright Red, 10-mA, 5-mcd | 0.114 0 × 0.049 inch | LN1271RAL | Panasonic |
| 9 | D5– D13 | B1100 | Diode, Schottky, 1A, 100V | SMA | B1100 | Diodes, Inc |
| 4 | FB1–FB4 | 500 | Bead, Ferrite, 2000mA, 60mΩ | 1206 | MI1206L501R-10 | Steward |
| 2 | J1, J2 | 5520252-4 | Connector, Jack, Modular, Rt. Angle,8 POS | 0.705 0 × 0.820 inch | 5520252-4 | AMP |
| 2 | J3, J11 | ED1514 | Terminal Block, 2-pin, 6-A, 3,5mm | 0.27 0 × 0.25 | ED1514 | |
| 2 | J4, J10 | PTC36SAAN | Header, Male 3-pin, 100mil spacing, (36-pin strip) | 0.100 inch 0 × 3 | PTC36SAAN | Sullins |
| 5 | J5–J9 | PTC36SAAN | Header, Male 2-pin, 100mil spacing, (36-pin strip) | 0.100 inch 0 × 2 | PTC36SAAN | Sullins |
| 1 | L1 | 3.3uH | Inductor, SMT, 2.0A, 80-mΩ | 4.450 × 6.6mm | DO1608C-332 | Coilcraft |
| 1 | L2 | 0.33uH | Inductor, SMT, 6.26A, 7.4-mΩ | 0.300 sq" | DR74-R33 | Cooper |
| 1 | Q1 | SiR464DP | MOSFET, NChannel, 30V, 29A, 3mΩ | PWRPAK S0-8 | SiR464DP | Vishay |
| 1 | Q2 | Si7898DP | MOSFET, NChannel, 150V, 4.8A, 85-mΩ | PWRPAK S0-8 | Si7898DP | Vishay |
| 1 | Q3 | MMBT3906 | Bipolar, PNP, 40V, 200mA, 225mW | SOT23 | MMBT3906LT1 | On Semi |
| 1 | R1 | 100K | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R12 | 39K | Resistor, Chip, 1/10W, 1% | 0805 | Std | Std |
| 1 | R13 | 24.9k | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 2 | R14, R15 | 69.8K | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R16 | 10 | Resistor, Chip, 1/10W, 1% | 0805 | Std | Std |
| 1 | R17 | 38.3k | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R18 | 10 | Resistor, Chip, 1/16W, 5% | 0603 | Std | Std |

**Table 4. TPS23754EVM-420 Bill of Materials (continued)**

| Count | RefDes | Value | Description | Size | Part Number | MFR |
|---|---|---|---|---|---|---|
| 1 | R19 | 63.4 | Resistor, Chip, 1/10W, 1% | 0805 | Std | Std |
| 1 | R2 | 15K | Resistor, Chip, 1/4W, 1% | 1210 | Std | Std |
| 1 | R20 | 10 | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 3 | R21 | 1k | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R22 | 0.18 | Resistor, Chip, 1/2W, 1% | 2010 | Std | Std |
| 2 | R23, R28 | 10K | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R24 | 499 | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R25 | 2K | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R26 | 49.9 | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R27 | 604 | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R29 | 41.2K | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 2 | R3, R4 | 1K | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R30 | 13.7K | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R5 | 6.49K | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R6 | 4.02K | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R7 | 8.87K | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 4 | R8–R11 | 75 | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | T1 | ETH1-230LD | XFMR, Mid-Power PoE Magnetics | S0 14 Wide | ETH1-230LD | Coilcraft |
| 1 | T2 | POE300F-50L | Transformer, SMT For PoE/PD, 25W, 2.8A | 0.810 0 × 1.181 inch | POE300F-50L | Coilcraft |
| 1 | T3 | PA0184 | XFMR, SMT Gate Drive | 0.355 0 × 0.340 inch | PA0184 | Pulse |
| 5 | TP1, TP6, TP7, TP9, TP17 | 5010 | Test Point, Red, Thru Hole | 0.125 0 × 0.125 inch | 5010 | Keystone |
| 3 | TP10, TP13, TP18 | 5013 | Test Point, Orange, Thru Hole | 0.125 0 × 0.125 inch | 5013 | Keystone |
| 7 | TP2–TP5, TP11, TP16, TP19 | 5012 | Test Point, White, Thru Hole | 0.125 0 × 0.125 inch | 5012 | Keystone |
| 4 | TP8, TP12, TP14, TP15 | 5011 | Test Point, Black, Thru Hole | 0.125 0 × 0.125 inch | 5011 | Keystone |
| 1 | U1 | FOD817D | IC, Optocoupler, 70-V, 300 - 600% CTR | SMT-4PDIP | FOD817DS | Fairchild |
| 1 | U2 | TPS23754PWP | IC, IEEE 802.3at PoE Interface and Isolated Converter Controller | PWP20 | TPS23754PWP | TI |
| 1 | U3 | TCMT1107 | IC, Photocoupler, 3750VRMS, 80-160% CTR | MF4 | TCMT1107 | Vishay |
| 1 | U4 | TLV431A | IC, Shunt Regulator, 6V, 10mA, 1% | SOT23-5 | TLV431ACDBVR | TI |
| 6 | — | | Shunt, Black | 100-mil | 929950-00 | 3M |
| 4 | | 2566 | Rubber Bumbers | | 2566 | |
| 1 | — | | PCB, 5.90 In × 2.03 In × 0.062 In | | HPA420 | Any |

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## EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 0 V to 57 V and the output voltage range of 4 V to 6 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 80°C. The EVM is designed to operate properly with certain components above 80°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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