TPS23753EVM-004: Evaluation Module for TPS23753

This user's guide describes the TPS23753EVM (TPS23753EVM-004). The TPS23753EVM-004 contains evaluation and reference circuitry for the TPS23753. The TPS23753 is an IEEE 802.3-2005 compliant powered-device controller and power supply controller optimized for isolated converter topologies. The TPS23753EVM-004 is targeted at general, efficient, synchronous rectifier, 10-W flyback converter applications.

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1 Description

TPS23753EVM-004 allows users to evaluate the reference circuitry of the TPS23753. It contains input and output power connectors and an array of onboard test points for circuit evaluation. TPS23753EVM-003 (5-V output) and TPS23753EVM-005 (12-V output) can be configured with simple bill of materials (BOM) changes.

1.1 Features

- Efficient, general market design
  - Simple gate drive, synchronous rectified secondary
  - 10-W output power from power over Ethernet (PoE), 48-V or 24-V adapter and 6-W output power from a 12-V adapter
  - 5-V or 12-V output voltage with simple BOM changes

1.2 Applications

- Voice over Internet protocol – IP telephones
- Wireless LAN – Wireless access points
- Security – Wired IP cameras

2 Electrical Specifications

Table 1. TPS23753EVM-003, -004, and -005 Electrical and Performance Specifications at T = 25°C

PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT
POWER INTERFACE						
Input Voltage	Applied to the power pins of connectors J2, J4, or J6		0		57	V
Operating Voltage	After start up		30		57	V
Input UVLO	Rising input voltage				36	V
	Falling input voltage		30			
Detection voltage	At device terminals		3		10	mA
Classification voltage	At device terminals		10		23	mA
Classification current	Rclass = 1270 Ω		1.8		2.4	mA
Inrush current-limit			90		190	mA
Operating current-limit			405		495	mA
DC/DC CONVERTER						
Output voltage	20 V ≤ Vin ≤ 57 V, ILOAD ≤ ILOAD (max) 10.8 V ≤ Vin ≤ 13.2 V, ILOAD ≤ ILOAD (max)	3.3-V output (-004)	3.13	3.3	3.47	V
		5-V output (-003)	4.75	5.0	5.25	
		12-V output (-005)	11.4	12.0	12.6	
Output current	20 V ≤ Vin ≤ 57 V	3.3-V output			3	A
		5-V output			2	
		12-V output			0.9	
	10.8 V ≤ Vin ≤ 13.2 V	3.3-V output			1.8	A
		5-V output			1.2	
		12-V output			0.5	
Output ripple voltage, peak-to-peak	Vin = 44 V, ILOAD = 3 A	3.3-V output		30		mV
	Vin = 44 V, ILOAD = 2 A	5-V output		40		
	Vin = 44 V, ILOAD = 0.9 A	12-V output		100		
Efficiency, end-to-end	Vin = 44 V, ILOAD = 2 A	3.3-V output		83		%
	Vin = 44 V, ILOAD = 1.4 A	5-V output		82		%
	Vin = 44 V, ILOAD = 0.9 A	12-V output		83		%
Switching frequency			112		138	kHz

3 Schematic

The TPS23753EVM-004 schematic follows.

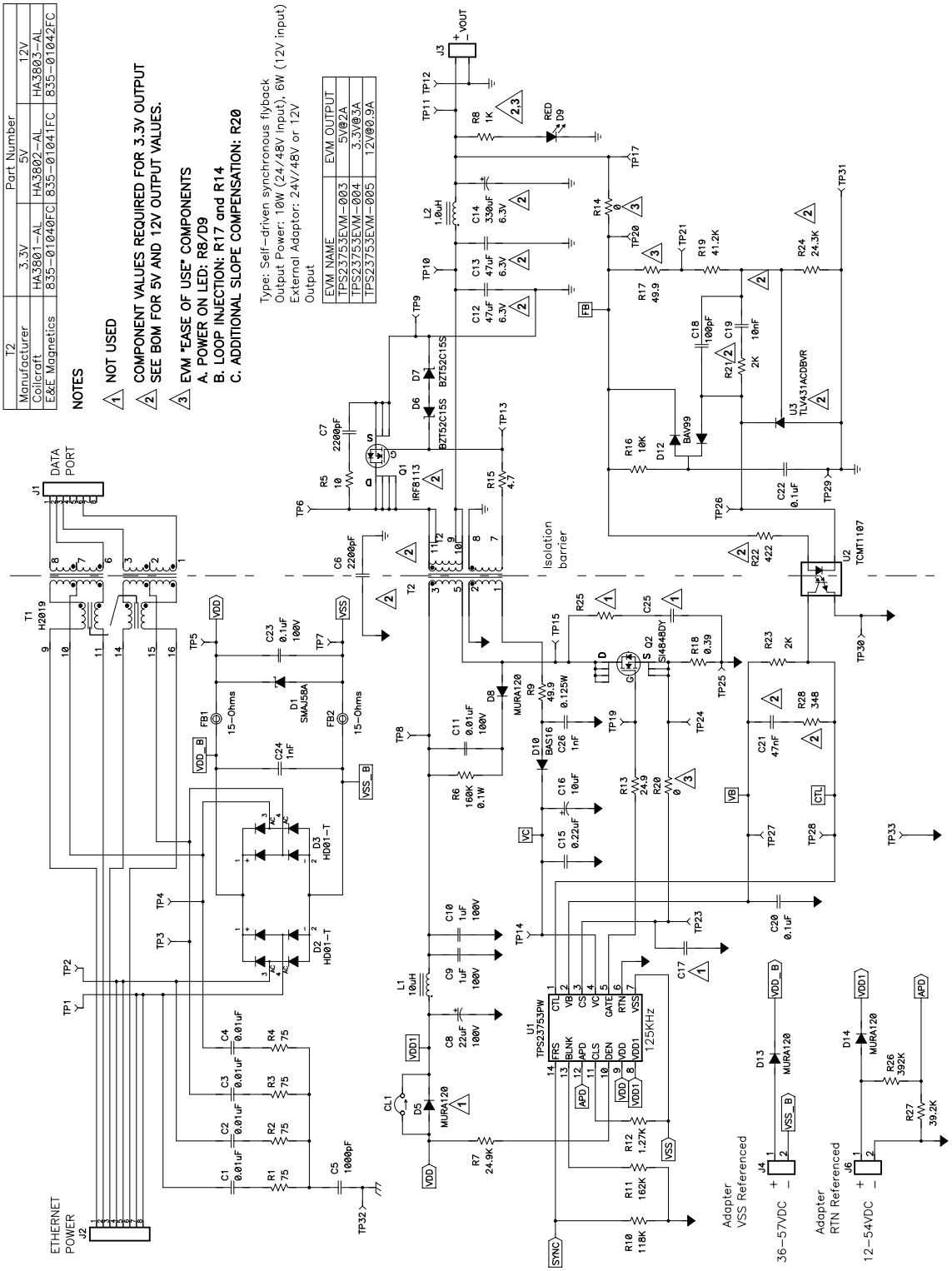


Figure 1. TPS23753EVM-004 Schematic

4 General Configuration and Description

4.1 Physical Access

Table 2 lists the TPS23753EVM-004 connector functionality and Table 3 describes the test point availability.

Table 2. Connector Functionality

Connector	Label	Description
J1	DATA PORT	Ethernet data port connector
J2	ETHERNET POWER	Ethernet power input connector. Contains Ethernet transformer and cable terminations
J3	VOUT	Output voltage connector
J4	ADP-VSS	VSS referenced external adapter input connector. J4-1/J4-1 are used with a powered-device adapter input (VSS)
J6	AP-RTN	RTN referenced external adapter input connector. J6-1/J6-2 are used with DC/DC converter adapter input (RTN) and

Table 3. Test Points

Test Point	Color	Label	Description
TP9, TP12, TP29, TP31	BLK	GND	Secondary-side (output) grounds (GND)
TP14	RED	VC	DC/DC converter bias supply
TP15	ORG	DR-P	Drain terminal of the primary-side switching MOSFET
TP7	BLK	VSS	POE input, low side
TP25, TP30, TP33	BLK	RTN	DC/DC converter return
TP20.	ORG	LOOP	Can be used with TP17 for overall feedback loop measurements.
TP21	WHT	I-LOOP	Can be used with TP17 for outer feedback loop measurements.
TP11, TP17	RED	VOUT	DC/DC converter output voltage.
TP10	RED	VOUT1	DC/DC converter output voltage (before LC filter).
TP13	WHT	GTS	Gate drive for the secondary-side synchronous rectifier MOSFET
TP6	WHT	DR-S	Drain terminal of the secondary-side synchronous rectifier MOSFET
TP28	WHT	CTL	Control loop input to the pulse width modulator
TP24	WHT	RCS	DC/DC converter primary-side switching MOSFET current sense (resistor side)
TP23	WHT	CS	DC/DC converter primary-side switching MOSFET current sense input (chip side)
TP27	RED	VB	Bias voltage regulator
TP19	WHT	GATE	Gate drive for the primary-side switching MOSFET
TP8	RED	VPRI	Transformer primary high side.
TP26	WHT	VKAT	Error amplifier (secondary-side) output drive for opto-isolator
TP1	RED	PR78	Pair 7,8
TP4	RED	PR12	Pair 1,2
TP2	ORG	PR45	Pair 4,5
TP3	ORG	PR36	Pair 3,6
D9	RED	POWER ON	Output power indicator

5 Test Setup

Figure 2 shows a typical test setup for TPS23753EVM-004. Input voltage can be applied as described in Table 2.

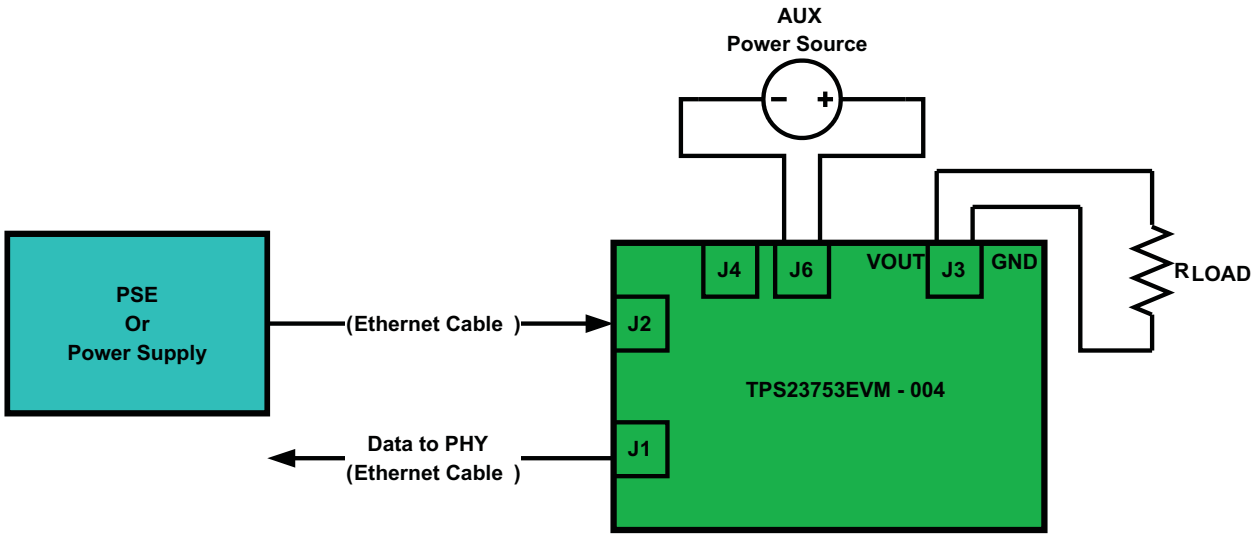


Figure 2. Typical TPS23753EVM-004 Test Setup

6 TPS23753EVM-004 Typical Performance Data

6.1 3.3-V Efficiency

Figure 3 illustrates the efficiency at three different input voltage levels: 1) PoE 48V from J2, 2) 48V RTN-based adapter, and 3) 24V RTN-based adapter.

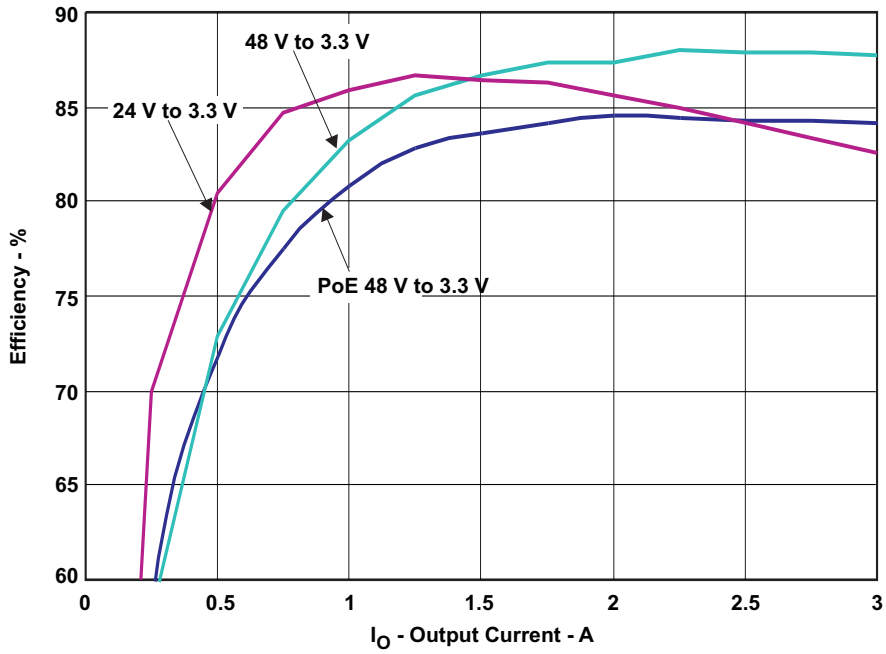


Figure 3. TPS23753EVM-004 Efficiency With 3.3-V Output

6.2 5-V DC/DC Efficiency

Figure 4 illustrates the efficiency at three different input voltage levels: 1) PoE 48V from J2, 2) 48V RTN-based adapter, and 3) 24V RTN- based adapter.

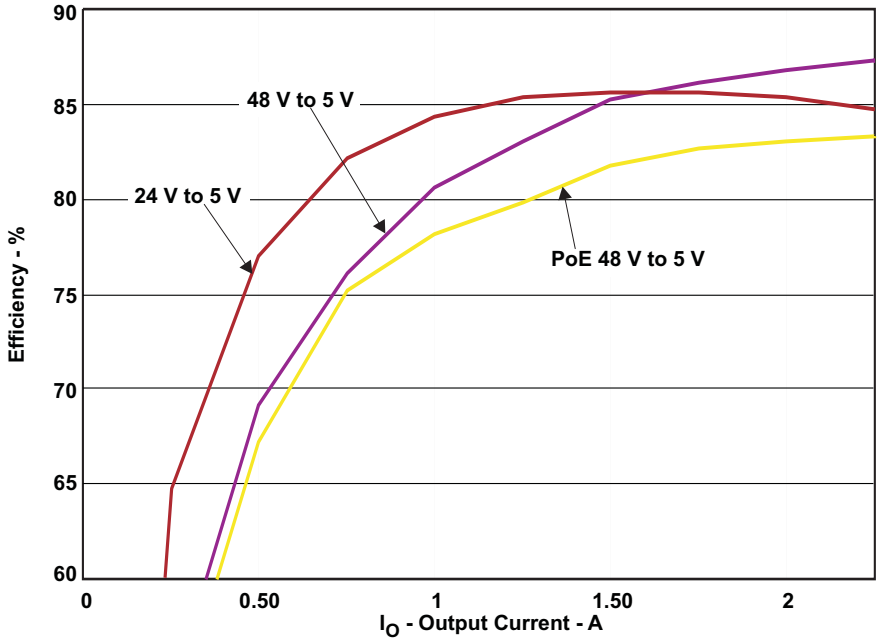


Figure 4. TPS23753EVM-003 Efficiency With 5-V Output

6.3 12-V DC/DC Efficiency

Figure 5 illustrates the efficiency at three different input voltage levels: 1) PoE 48V from J2, 2) 48V RTN-based adapter, and 3) 24V RTN-based adapter.

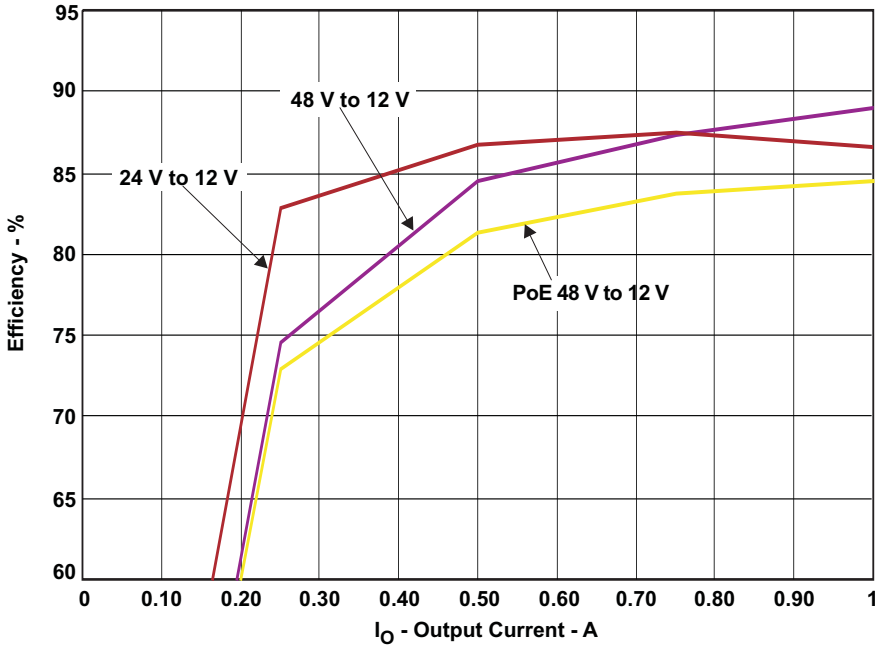


Figure 5. TPS23753EVM-005 Efficiency With 12-V Output

7 EVM Assembly Drawings and Layout Guidelines

7.1 PCB Drawings

Figure 6 shows the component placement and layout.

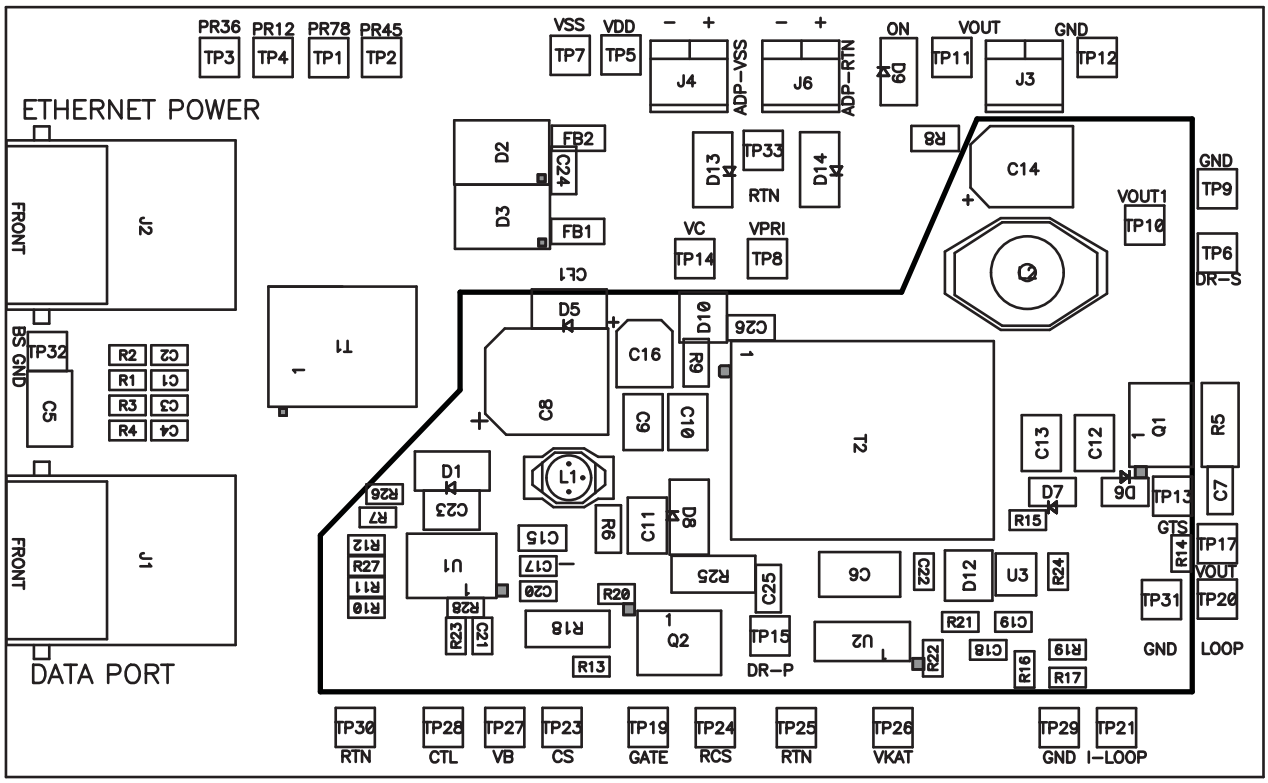


Figure 6. Top Side Placement

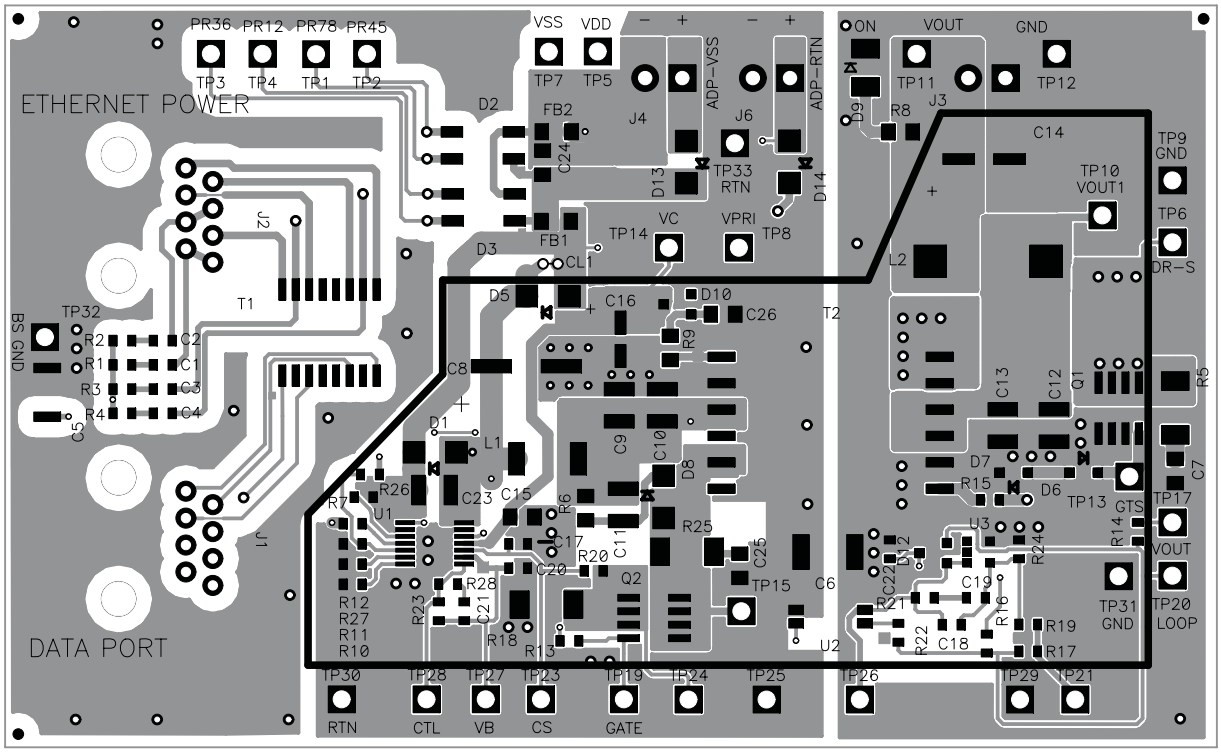


Figure 7. Top-Side Routing

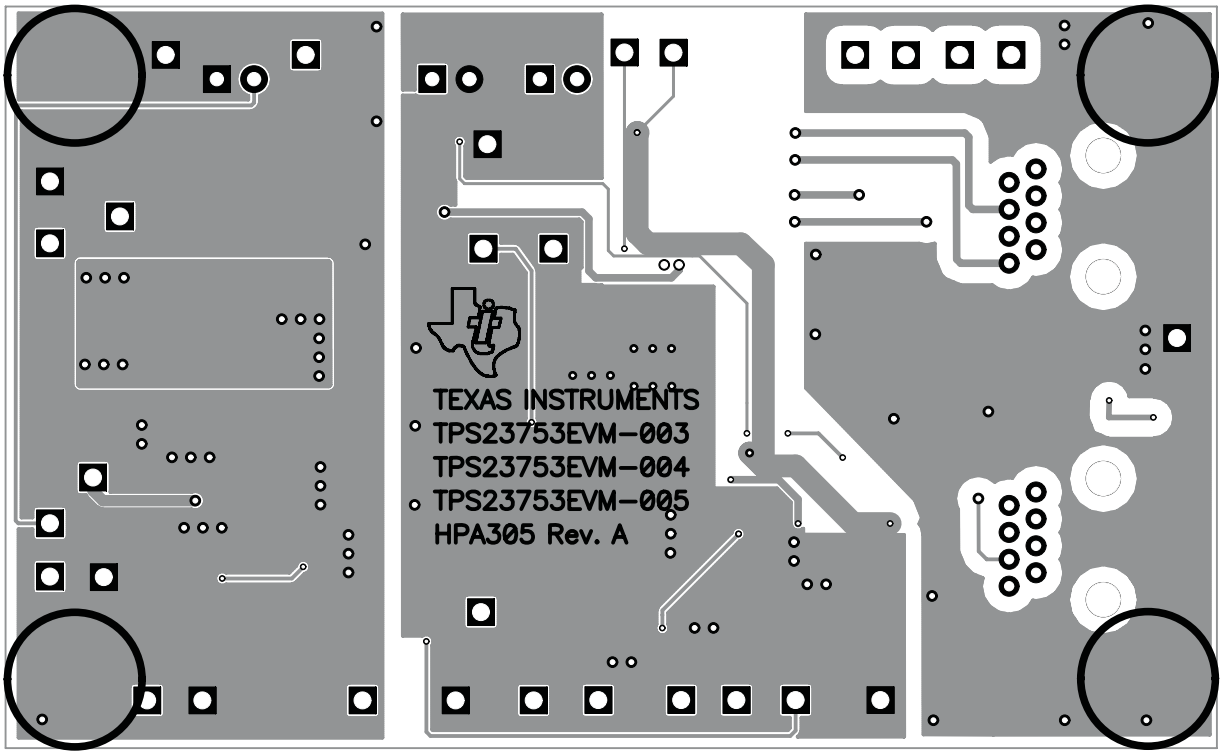


Figure 8. Bottom-Side Routing

8 Bill of Materials

Table 4. TPS23753EVM-003, -004, and -005 Bill of Materials

TPS23753EVM-X			Refdes	Value	Description	Size	Part Number	MFR
Outputs (V)								
12	3.3	5						
Count								
X=005	X=004	X=003						
4	4	4	C1–C4	0.01µF	Capacitor, Ceramic, 100V, X7R, 10%	0603	Std	Std
1	1	1	C11	0.01µF	Capacitor, Ceramic, 100V, X7R, 10%	1210	Std	Std
0	2	2	C12, C13	47µF	Capacitor, Ceramic, 6.3-V, X5R, 20%	1210	C3225X5R0J476M	TD
2	0	0	C12, C13	10µF	Capacitor, Ceramic, 16-V, X5R, 20%	1210	C3225X5R1C106M	TD
0	1	1	C14	330µF	Capacitor, Aluminum, 6.3V, 20%	0.260 × 0.276 in	EEVFK0J331XP	Panasonic
1	0	0	C14	68µF	Capacitor, Aluminum, 16V, 20%	0.217 × 0.169	EEVFK1C680P	Panasonic
1	1	1	C15	0.22µF	Capacitor, Ceramic, 25V, X7R, 10%	0805	Std	Std
1	1	1	C16	10µF	Capacitor, Aluminum, 25V, = 20%	0.200 × 0.210 in	EEVFK1E100R	Panasonic
0	0	0	C17	220pF	Capacitor, Ceramic, 16V, X7R, 10%	0603	Std	Std
0	1	1	C18	100pF	Capacitor, Ceramic, 16V, X7R, 10%	0603	Std	Std
1	0	0	C18	10pF	Capacitor, Ceramic, 16V, X7R, 10%	0603	Std	Std
0	0	1	C19	8.2nF	Capacitor, Ceramic, 16V, X7R, 10%	0603	Std	Std
0	1	0	C19	10nF	Capacitor, Ceramic, 16V, X7R, 10%	0603	Std	Std
1	0	0	C19	6.8nF	Capacitor, Ceramic, 16V, X7R, 10%	0603	Std	Std
2	2	2	C20, C22	0.1µF	Capacitor, Ceramic, 16V, X7R, 10%	0603	Std	Std
0	0	1	C21	22nF	Capacitor, Ceramic, 16V, X7R, 10%	0603	Std	Std
0	1	0	C21	47nF	Capacitor, Ceramic, 16V, X7R, 10%	0603	Std	Std
1	0	0	C21	10nF	Capacitor, Ceramic, 16V, X7R, 10%	0603	Std	Std
1	1	1	C23	0.1µF	Capacitor, Ceramic, 100V, X7R, 10%	1210	Std	Std
2	2	2	C24, C26	1nF	Capacitor, Ceramic, 100V, X7R, 10%	0805	Std	Std
0	0	0	C25	330pF	Capacitor, Ceramic, 200V, X7R, 10%	0805	Std	Std
1	1	1	C5	1000pF	Capacitor, Ceramic, 2kV, X7R 10%	1808	C4520X7R3D102K	TD
1	1	1	C6	2200pF	Capacitor, Ceramic, 2KV, X7R, 20%	1812	C4532X7R3D222K	TD
1	1	1	C7	2200pF	Capacitor, Ceramic, 100V, X7R, 10%	0805	Std	Std
1	1	1	C8	22µF	Capacitor, Aluminum, 100V, 20%	8 × 10.2 mm	EEVFK2A220P	Panasonic
2	2	2	C9, C10	1µF	Capacitor, Ceramic, 100V, X7R, 10%	1210	Std	Std
1	1	1	CL1	NA	Current Loop, 0.025 holes	0.120 × 0.075 in	NA	NA
1	1	1	D1	SMAJ58A	Diode, TVS, 58-V, 1W	SMA	SMAJ58A	Diodes Inc.
1	1	1	D10	BAS16	Diode, Switching, 200mA, 75V, 225mW	SOT-23	BAS16LT1	On Semi
1	1	1	D12	BAV99	Diode, Dual Ultra Fast, Series, 200-mA, 70-V	SOT23	BAV99	Fairchild
2	2	2	D2, D3	HD01-T	Bridge Rectifier, 100V, 0.8A, Glass Passivated, SMD	MINI DIP4	HD01-T	Diodes, Inc
3	3	3	D8, D13, D14	MURA120	Diode, Rectifier, 1A, 200V	SMA	MURA120	On Semi
0	0	0	D5	MURA120	Diode, Rectifier, 1A, 200V	SMA	MURA120	On Semi
2	2	2	D6, D7	BZT52C15S	Diode, Zener, 200mW, 15V	SOD-323	BZT52C15S	Diodes, Inc
2	2	2	FB1, FB2	15-Ω	Bead, Ferrite, SMT, 15-Ω, 1500mA	0805	MMZ2012R150A	TDK
2	2	2	J1, J2	5520252-4	Connector, Jack, Modular, 8 POS	0.705 × 0.820	5520252-4	AMP
3	3	3	J3, J4, J6	ED1514	Terminal Block, 2-pin, 6-A, 3,5mm	0.27 × 0.25	ED1514	OST
1	1	1	L1	10uH	Inductor, SMT, 1.1A, 160mΩ	4.45x6.6mm	DO1608C-103ML_	Coilcraft
1	1	1	L2	1.0uH	Inductor, SMT, 1.0-uH, 6.8-A, 9-mΩ	0.51x0.37	DO3316P-102HCB	Coilcraft
0	1	1	Q1	IRF8113	MOSFET, N-ch, 30-V, 17.2-A, 5.6-mΩ	SO8	IRF8113	IR
1	0	0	Q1	IRF7855	MOSFET, N-ch, 60-V, 12-A, 9.4-mΩ	SO8	IRF7855	IR
1	1	1	Q2	SI4848DY	MOSFET, N-ch, 150-V, 3.7-A, 85-mΩ	SO8	SI4848DY	Vishay
4	4	4	R1–R4	75	Resistor, Chip, 1/16W, 5%	0603	Std	Std
1	1	1	R10	118K	Resistor, Chip, 1/16W,1%	0603	Std	Std
1	1	1	R11	162K	Resistor, Chip, 1/16W,1%	0603	Std	Std
1	1	1	R12	1.27K	Resistor, Chip, 1/16W,1%	0603	Std	Std
1	1	1	R13	24.9	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	R16	10K	Resistor, Chip, 1/16W,1%	0603	Std	Std

Table 4. TPS23753EVM-003, -004, and -005 Bill of Materials (continued)

TPS23753EVM-X			Refdes	Value	Description	Size	Part Number	MFR
Outputs (V)								
12	3.3	5						
Count								
X=005	X=004	X=003						
1	1	1	R17	49.9	Resistor, Chip, 1/16W,1%	0603	Std	Std
1	1	1	R18	0.39	Resistor, Chip, 1/2W, 1%	2010	Std	Std
1	1	1	R19	41.2K	Resistor, Chip, 1/16W,1%	0603	Std	Std
2	2	2	R14, R20	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	1	R21	21K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	1	0	R21	2K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	0	0	R21	142K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	1	R22	1K	Resistor, Chip, 1/16W,1%	0603	Std	Std
0	1	0	R22	422	Resistor, Chip, 1/16W,1%	0603	Std	Std
1	0	0	R22	4.02K	Resistor, Chip, 1/16W,1%	0603	Std	Std
1	1	1	R23	2K	Resistor, Chip, 1/16W,1%	0603	Std	Std
0	0	1	R24	13.3K	Resistor, Chip, 1/16W,1%	0603	Std	Std
0	1	0	R24	24.3K	Resistor, Chip, 1/16W,1%	0603	Std	Std
1	0	0	R24	10.7K	Resistor, Chip, 1/16W,1%	0603	Std	Std
1	1	1	R26	392K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	R27	39.2K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	1	R28	249	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	1	0	R28	348	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	0	0	R28	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	R15	4.7	Resistor, Chip, 1/16W, 5%	0603	Std	Std
0	0	0	R25	79	Resistor, Chip, 1/2W, 5%	2010	Std	Std
1	1	1	R5	10	Resistor, Chip, 1/2W, 5%	2010	Std	Std
1	1	1	R6	160K	Resistor, Chip, 1/10W, 5%	0805	Std	Std
1	1	1	R7	24.9K	Resistor, Chip, 1/16W,1%	0603	Std	Std
1	1	1	R9	49.9	Resistor, Chip, 1/8-W, 1%	0805	Std	Std
1	1	1	T1	H2019	XFMR, Center-tapped, Voice Over IP	0.500 × 0.370	H2019	Pulse
0	0	1	T2	HA3802-AL or 835-01041FC	Transformer, PoE 13W, Triple Secondary, 150uH, 5V, 2A	0.875 × 0.675	HA3802-AL or 835-01041FC	Coilcraft or E&E Magnetic Products
0	1	0	T2	HA3801-AL or 835-01040FC	Transformer, PoE 13W, Triple Secondary, 165uH, 3.3V, 3A	0.875 × 0.675	HA3801-AL or 835-01040FC	Coilcraft or E&E Magnetic Products
1	0	0	T2	HA3803-AL or 835-01042FC	Transformer, PoE 13W, Triple Secondary, 150uH, 12V, 1A	0.875 × 0.675	HA3803-AL or 835-01042FC	Coilcraft or E&E Magnetic Products
1	1	1	U1	TPS23753PW	IC, IEEE 802.3-2005 Integrated Primary Side Controller	TSSOP14	TPS23753PW	TI
1	1	1	U2	TCMT1107	IC, Photocoupler, 3750VRMS, 80-160% CTR	MF4	TCMT1107	Vishay
0	1	1	U3	TLV431ACDBVR	IC, Shunt Regulator, 1.24-V ref, 6-V, 10-mA, 1%	SOT23-5	TLV431ACDBVR	TI
1	0	0	U3	TL431ACDBVR	IC, Shunt Regulator, 2.49-V ref, 36-V, 10-mA, 1%	SOT23-5	TL431ACDBVR	TI
1	1	1	—	—	PCB, 2.76 In x 4.50 In x 0.062 In	—	HPA305	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 3 V to 15 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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