

TPS2372-3EVM-757 Evaluation Module

This user's guide describes the TPS2372-3 evaluation module (TPS2372-3EVM-757). The TPS2372-3EVM-757 contains evaluation and reference circuitry for the TPS2372-3. The TPS2372-3 device is an IEEE 802.3bt (draft) compliant, powered-device (PD) controller optimized for non-isolated converter topologies and converter modules. The TPS2372-3EVM-757 is designed for 60-W PoE lighting solutions.

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1 Introduction

The TPS2372-3EVM-757 allows reference circuitry evaluation of the TPS2372-3. It contains input and output power connectors and an array of onboard test points for circuit evaluation.

1.1 Features

The TPS2372-3EVM-757 features include:

- IEEE802.3bt-ready PoE PD
- Class 6, 51-W DC output
- LM3409HV Buck LED driver
- Autoclass capable

1.2 Applications

The TPS2372-3EVM-757 can be used in the following applications:

- Power-over-Ethernet (PoE) lighting
- Internet of Things (IoT)

2 Electrical Specifications

Table 1 lists the EVM electrical specifications.

Table 1. TPS2372-3EVM-757 Electrical and Performance Specifications at 25°C

Parameter	Test Conditions	Min	Typ	Max	Unit
Power Interface					
Input Voltage	Applied to the power pins of connectors J13 or J14	0		57	V
Input UVLO, POE input J14	Rising input voltage			36	V
	Falling input voltage	30			V
Detection Voltage	At device terminals	1.4		10.1	V
Classification Voltage	At device terminals	11.9		23	V
Classification Current	RclassA = 63.4 Ω	38		42	mA
	RclassB = 249 Ω	9.9		11.2	mA
Inrush Current-Limit		165		237	mA
Operating Current-Limit		1.55		2.05	A
DC/DC Converter (LM3409HV)					
Output LED Voltage				44	V
Output Current	$42.5 \leq V_{IN} \leq 57$ V			1.15	A
Switching Frequency			525		kHz
Efficiency	J14 = 48 V, J11 = 40 V/1 A		94		%

3 Description

The TPS2372-3EVM-757 enables full evaluation of the TPS2372-3 device, see the schematic in [Figure 1](#). Ethernet power is applied from J14 and is dropped to the Half-FET bridge rectifier. At the output of the Half-FET bridge is the EMI and EMC filter and transient protection for the TPS2372-3.

Input power can also be applied at J13 from a DC source when power at J14 is not present or when the DC/DC converter is being evaluated and not the PoE front end.

The TPS2372-3 (U2) PD controller is shown in [Figure 2](#). R11 provides the detection signature. To the right of U2 is the switched side of the PD controller. The TPS2372-3 RTN pin provides inrush limited turn on and the charge of the bulk capacitor C11. The detection resistor R11 is chosen to be 27.4k when using the FET-diode bridge at the PD front end.

The DC/DC converter is a buck LED driver-converter using the LM3409HV. The Q1 switching MOSFET is driven from the U1 PGATE pin.

4 Schematic

Figure 1 and Figure 2 illustrate the TPS2372-3EVM-757 schematics.

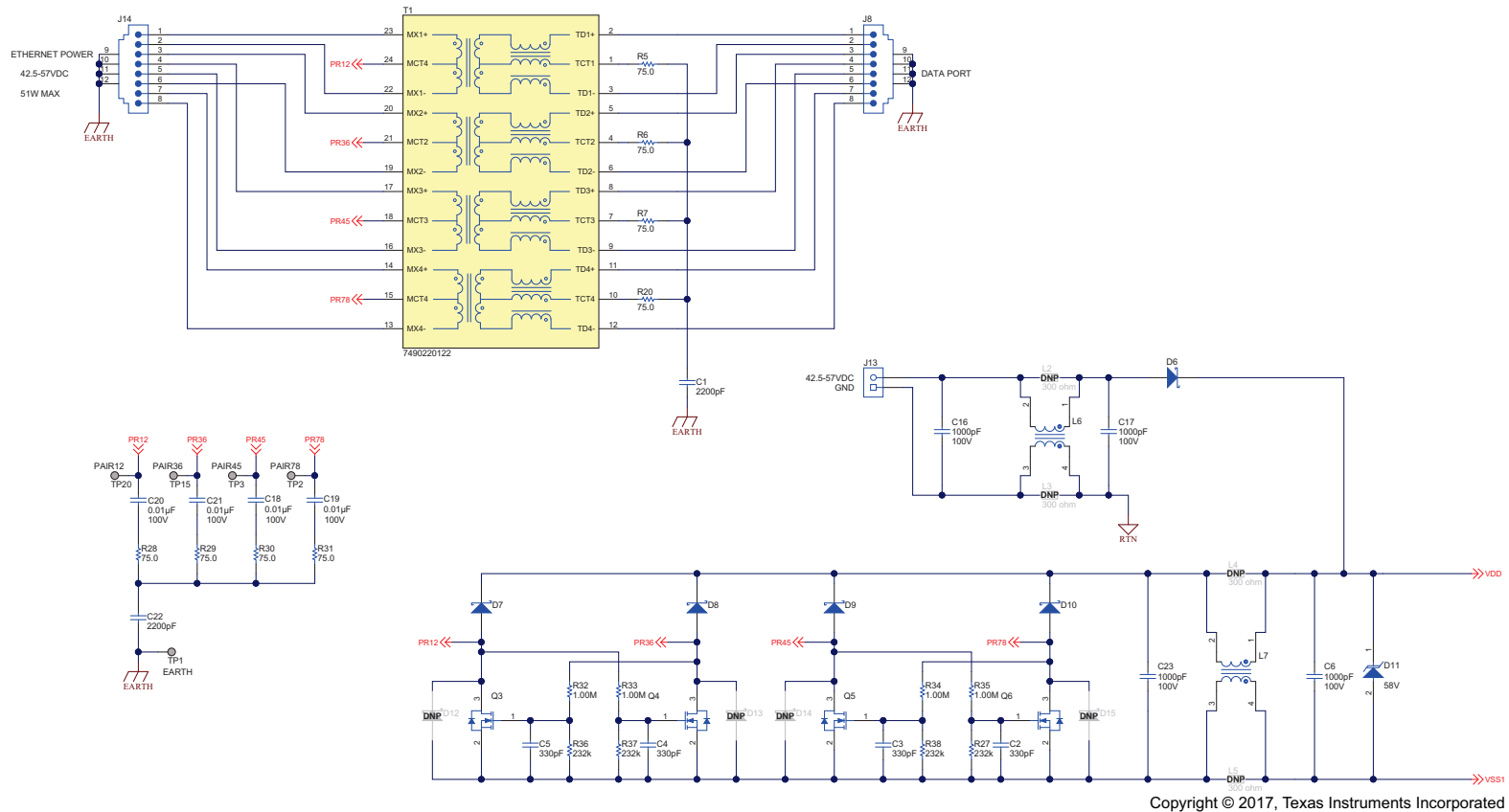
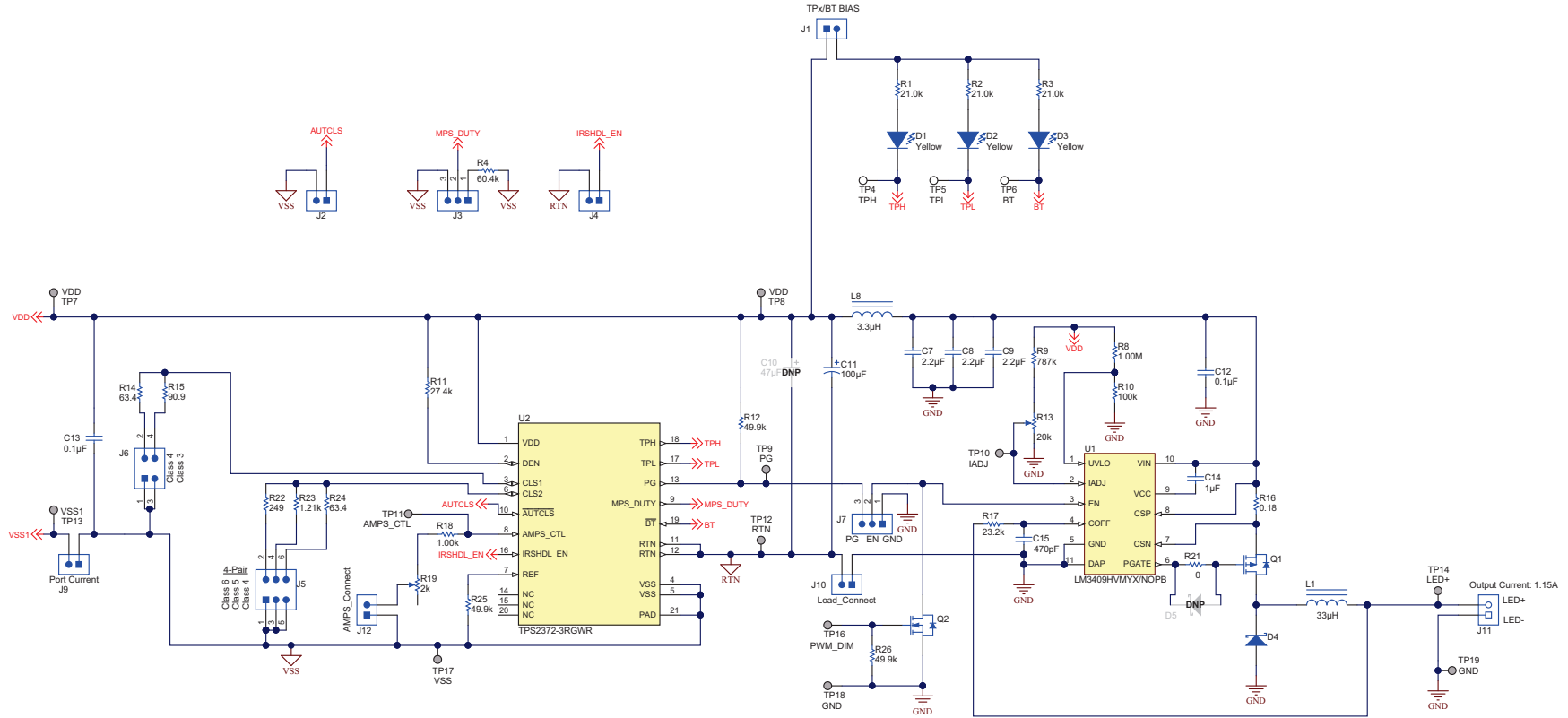


Figure 1. TPS2372-3EVM-757 PoE PD Front End Schematic



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Figure 2. TPS2372-3EVM-757 PD Controller and Converter Schematic

5 General Configuration and Description

5.1 Physical Access

Table 2 lists the EVM connector functionality and Table 3 describes the test point availability.

Table 2. Connector Functionality

Label	Description
TPx/BT BIAS	Bias voltage for the THx/BT indicators
AUTCLS	Jump J2 to enable Autoclass
MPS_DUTY	Automatic MPS duty cycle selection
IRSHDL_EN	Jump to disable inrush delay
CLSB	Jump to select class current level
CLSA	Jump to select class current level
EN	Jump to enable the converter with PG or disable.
DATA	Ethernet data passthrough, connect to downstream Ethernet device
Port Current	Jump to connect PD front end and PD controller circuits
Load_Connect	Jump to connect PD to converter, remove jumper if evaluating the PD only
Output	Output connector to LED load
AMPS_Connect	Jump to add auto MPS current
DC Input	DC/DC converter input bypassing the PoE front end, connect a DC power supply 42–57
ETHERNET POWER	PoE input, connect to PSE power and data source

Table 3. Test Points

Test Point	Label	Description
TP1	EARTH	Bob Smith Earth or Shield connection
TP2	PAIR78	Voltage taken directly at PAIR78
TP3	PAIR45	Voltage taken directly at PAIR45
TP4	TPH	TPH output of the TPS2372-3
TP5	TPL	TPL output of the TPS2372-3
TP6	BT	BT output of the TPS2372-3
TP7, TP8	VDD	Input voltage of PD system
TP9	PG	Power Good output fo the TPS2372-3
TP10	IADJ	Input bias to vary the output current of the LED driver
TP11	AMPS_CTL	AMPS_CTL output voltage
TP12	RTN	Load side return voltage
TP13	VSS1	EMI filter return side voltage
TP14	LED+	LED output voltage
TP15	PAIR36	Voltage taken directly at PAIR36
TP16	PWM_DIM	Input for external PWM dimming of the LED driver
TP17	VSS	PD side return voltage
TP18, TP19	GND	LED ground reference
TP20	PAIR 12	Voltage taken directly at the load.

6 TPS2372-3EVM-757 Performance Data

Figure 3 through Figure 5 illustrate EVM performance waveforms

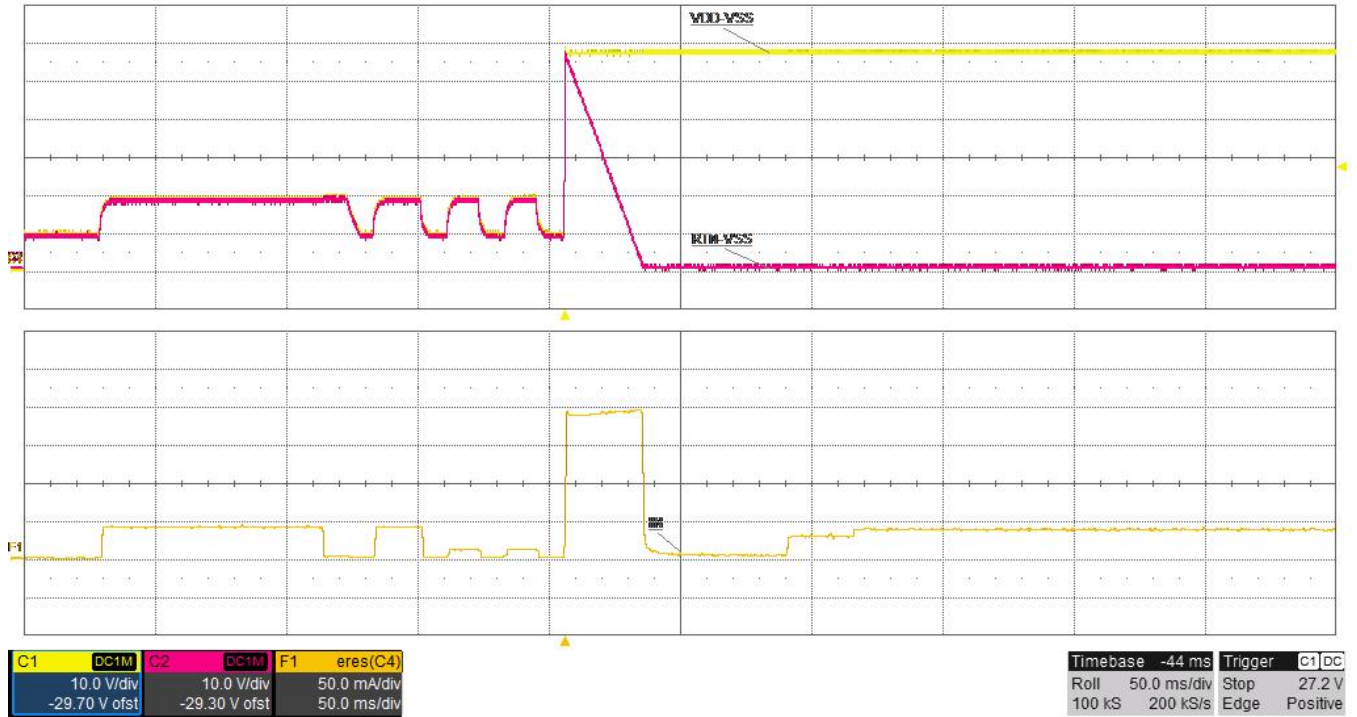


Figure 3. Startup Using .bt-ready PSE and Autoclass Enabled

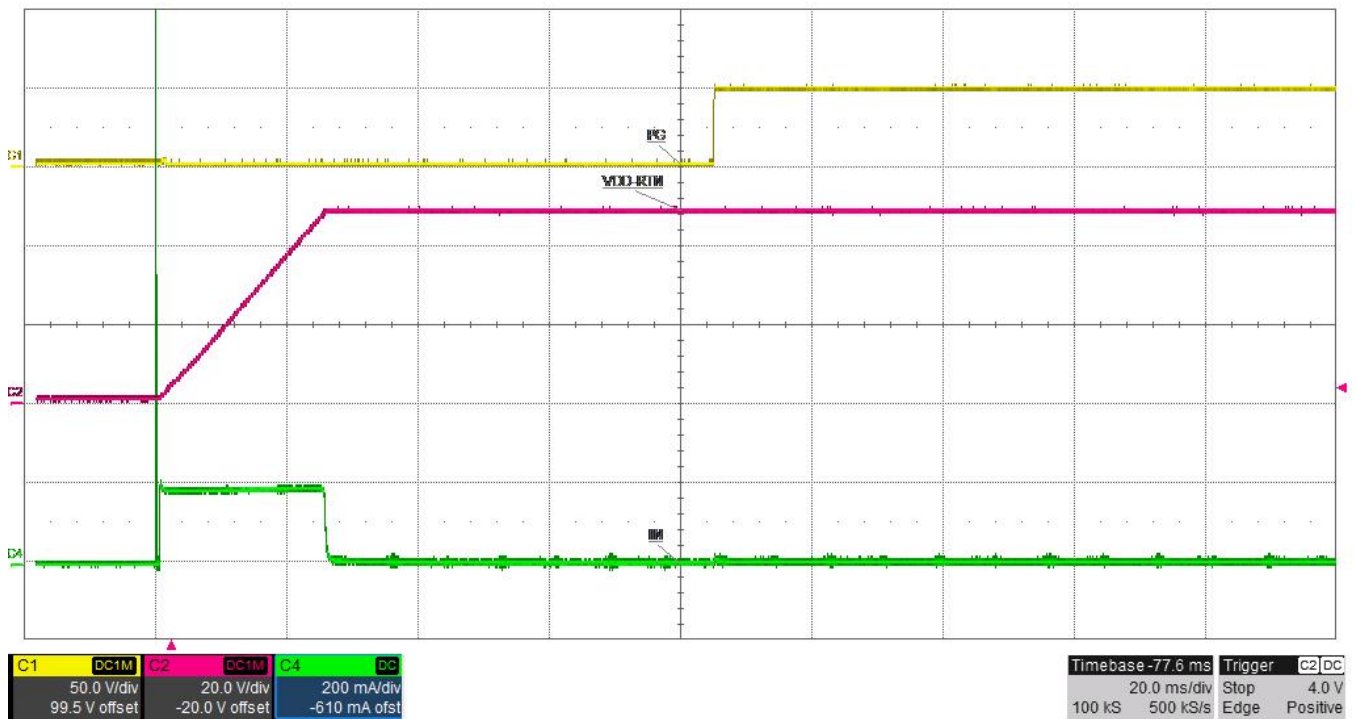


Figure 4. PD Startup With PG Delay

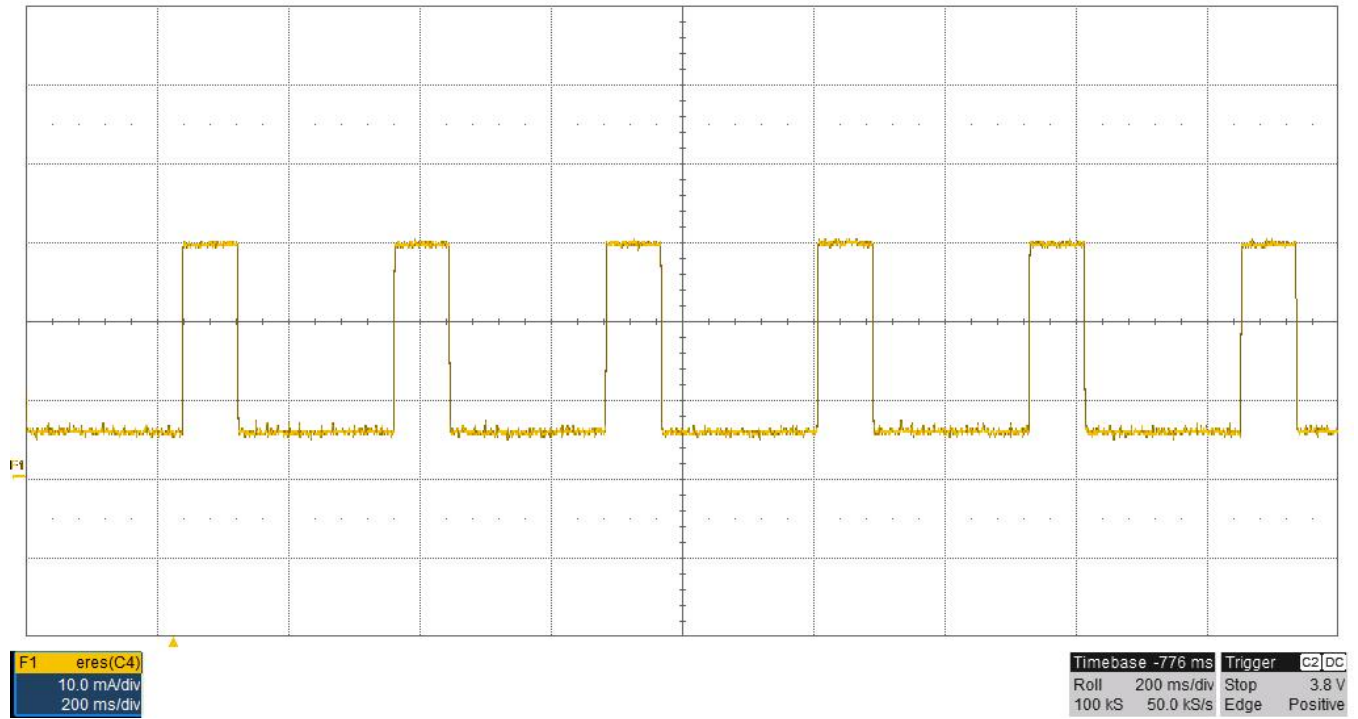


Figure 5. Auto MPS Adjustable From 8 mA to 30 mA Through R19

7 EVM Assembly Drawing and Layout Guidelines

7.1 PCB Drawings

Figure 6 through Figure 11 show component placement and layout of the TPS2372-3EVM-757.

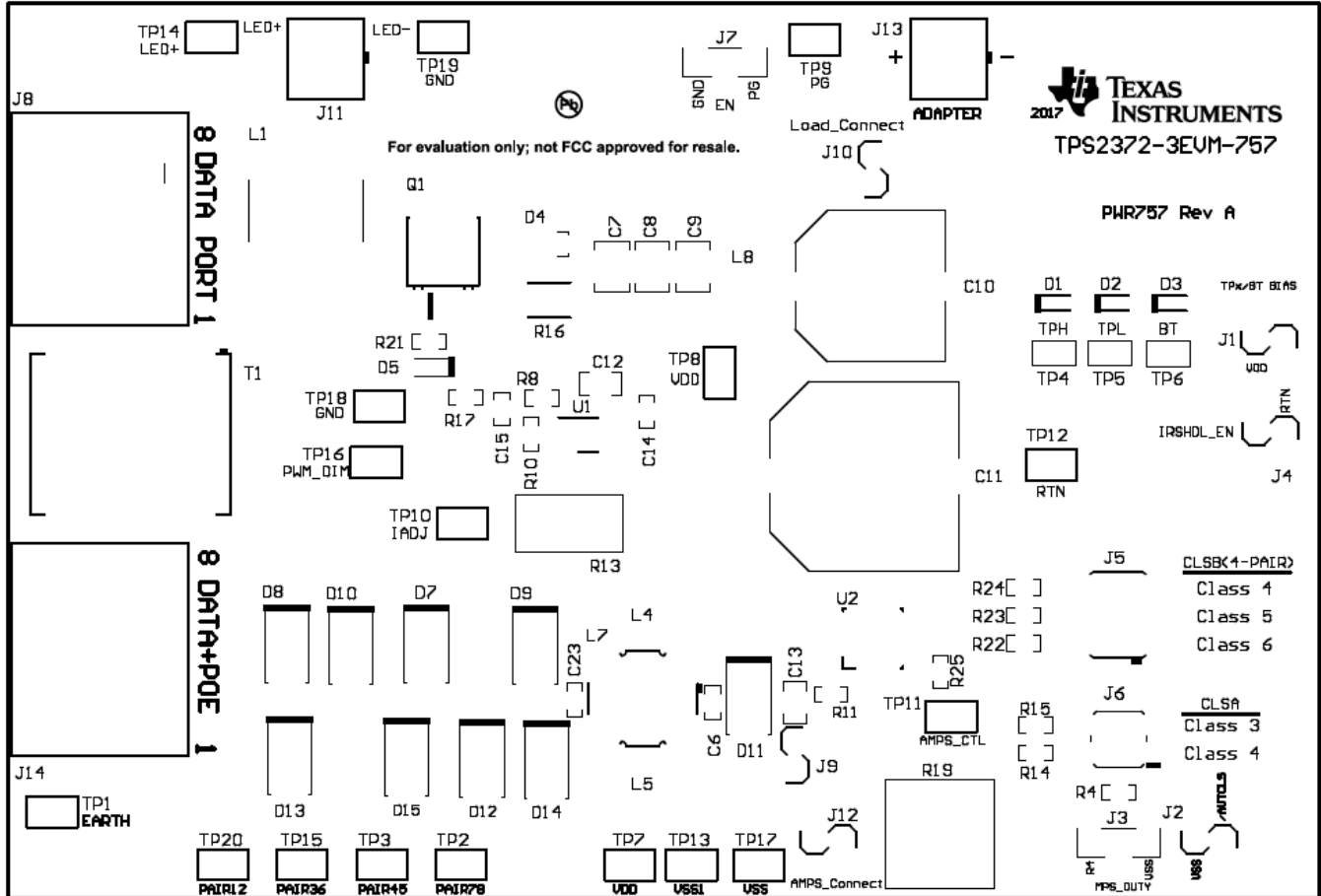


Figure 6. Top Side Component Placement

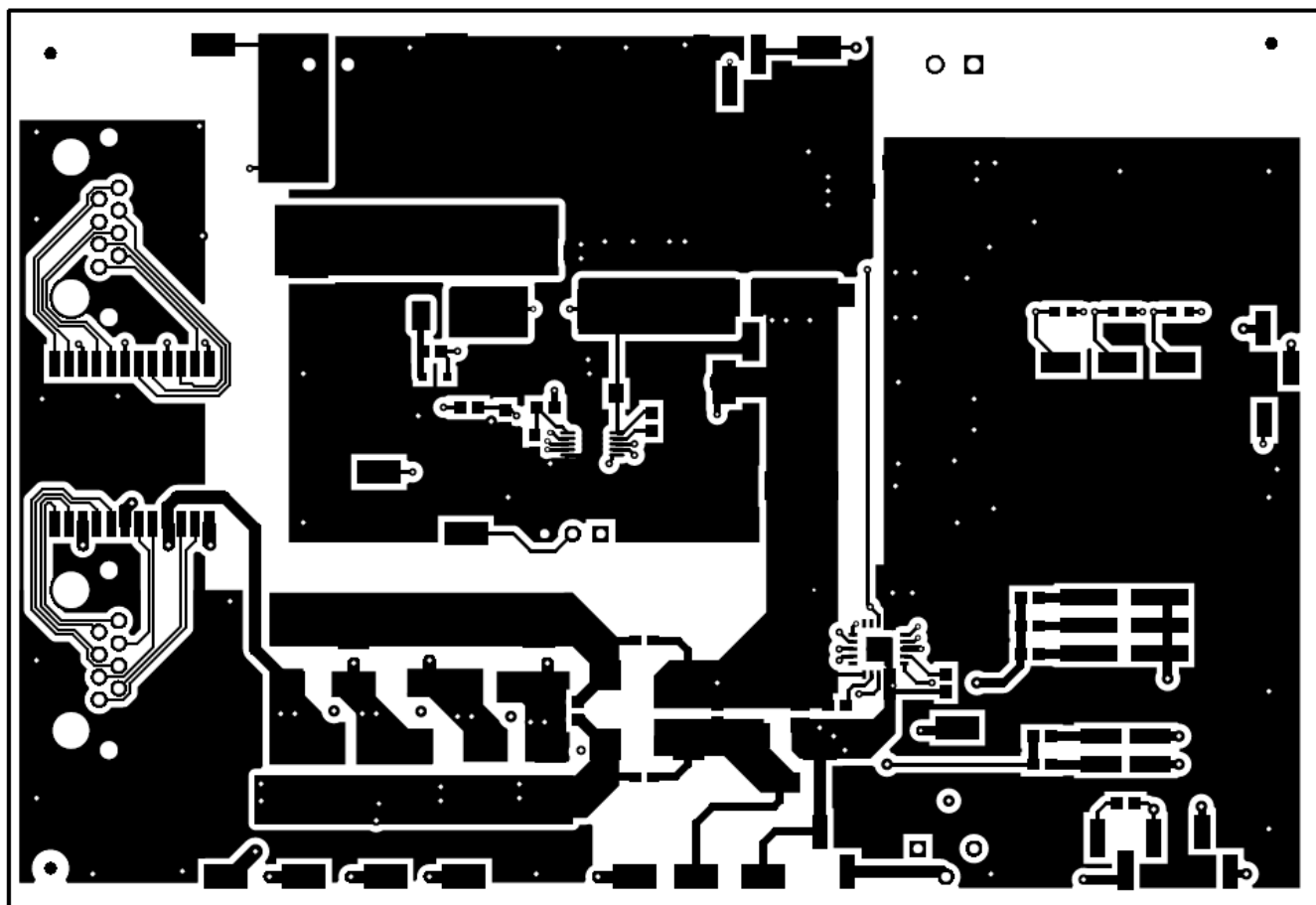


Figure 7. Top Side Routing

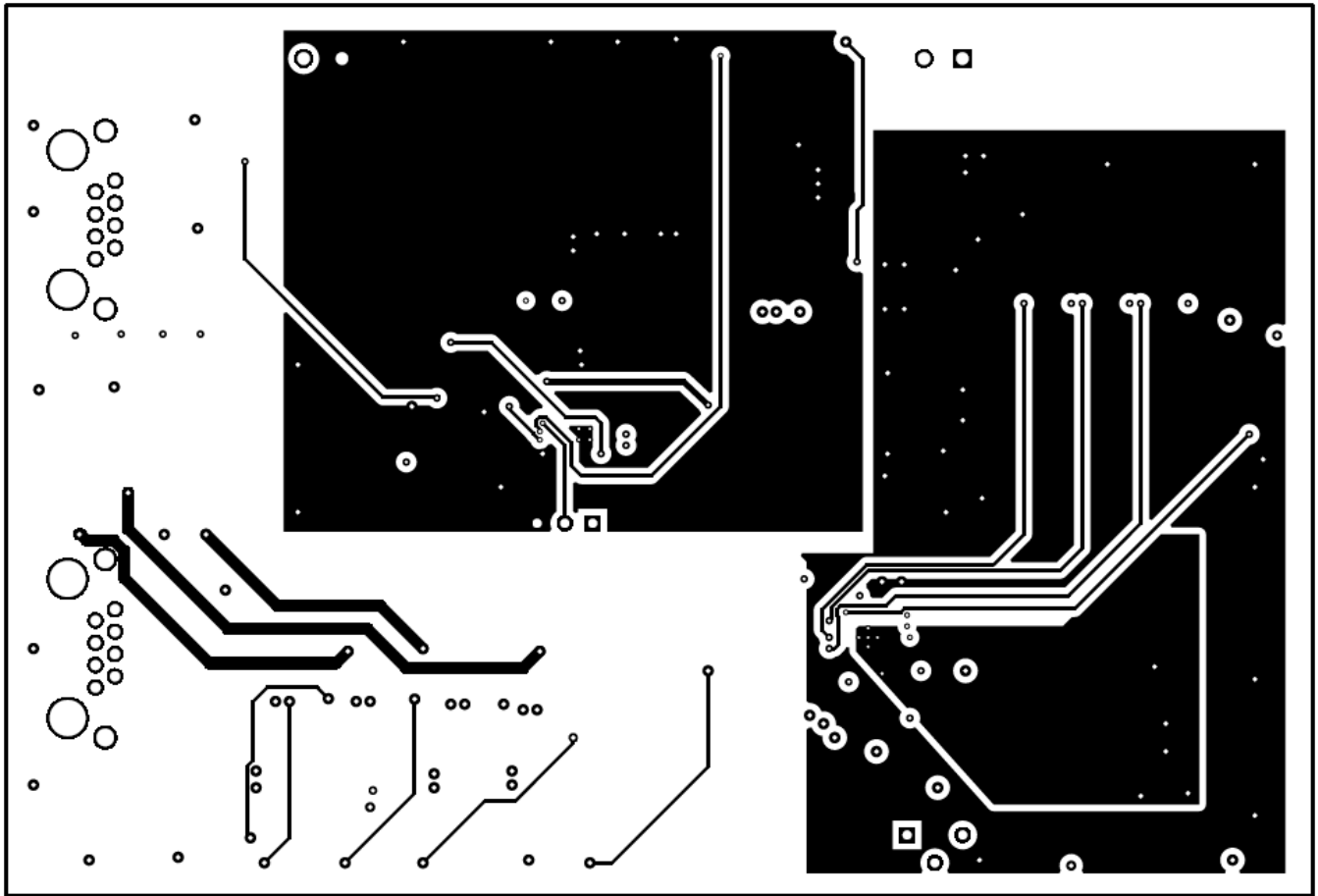


Figure 8. Layer 2 Routing

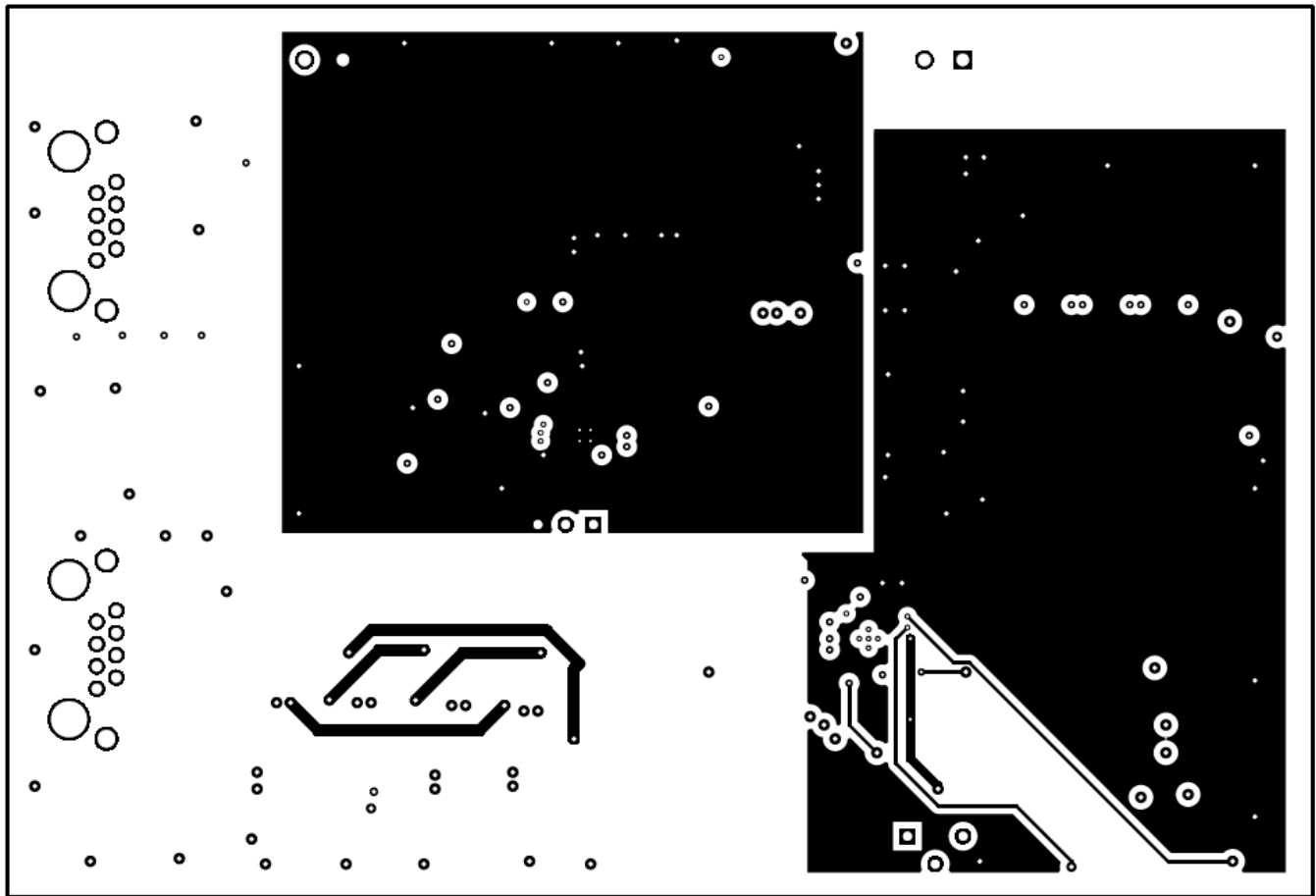


Figure 9. Layer 3 Routing

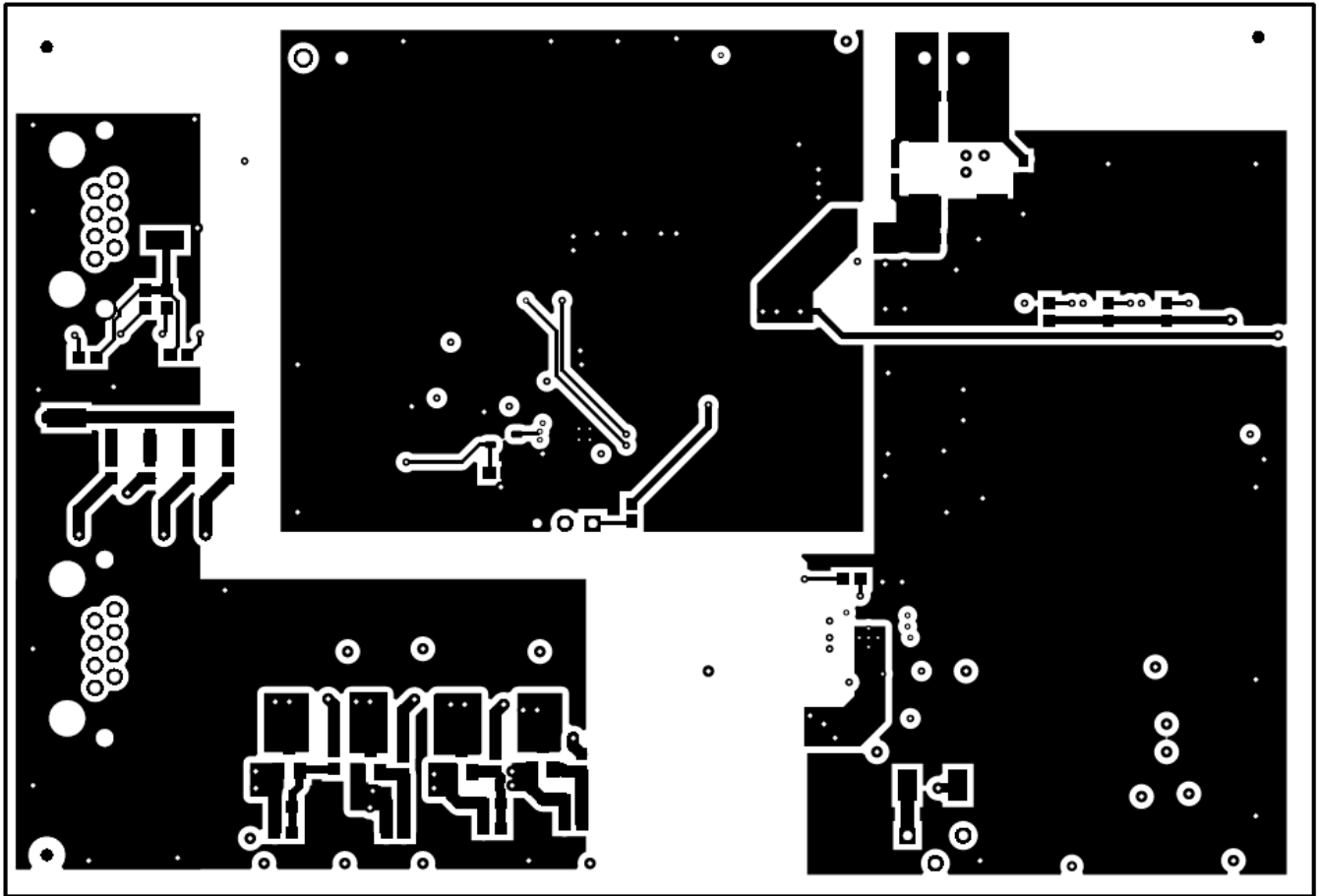


Figure 10. Bottom Side Routing

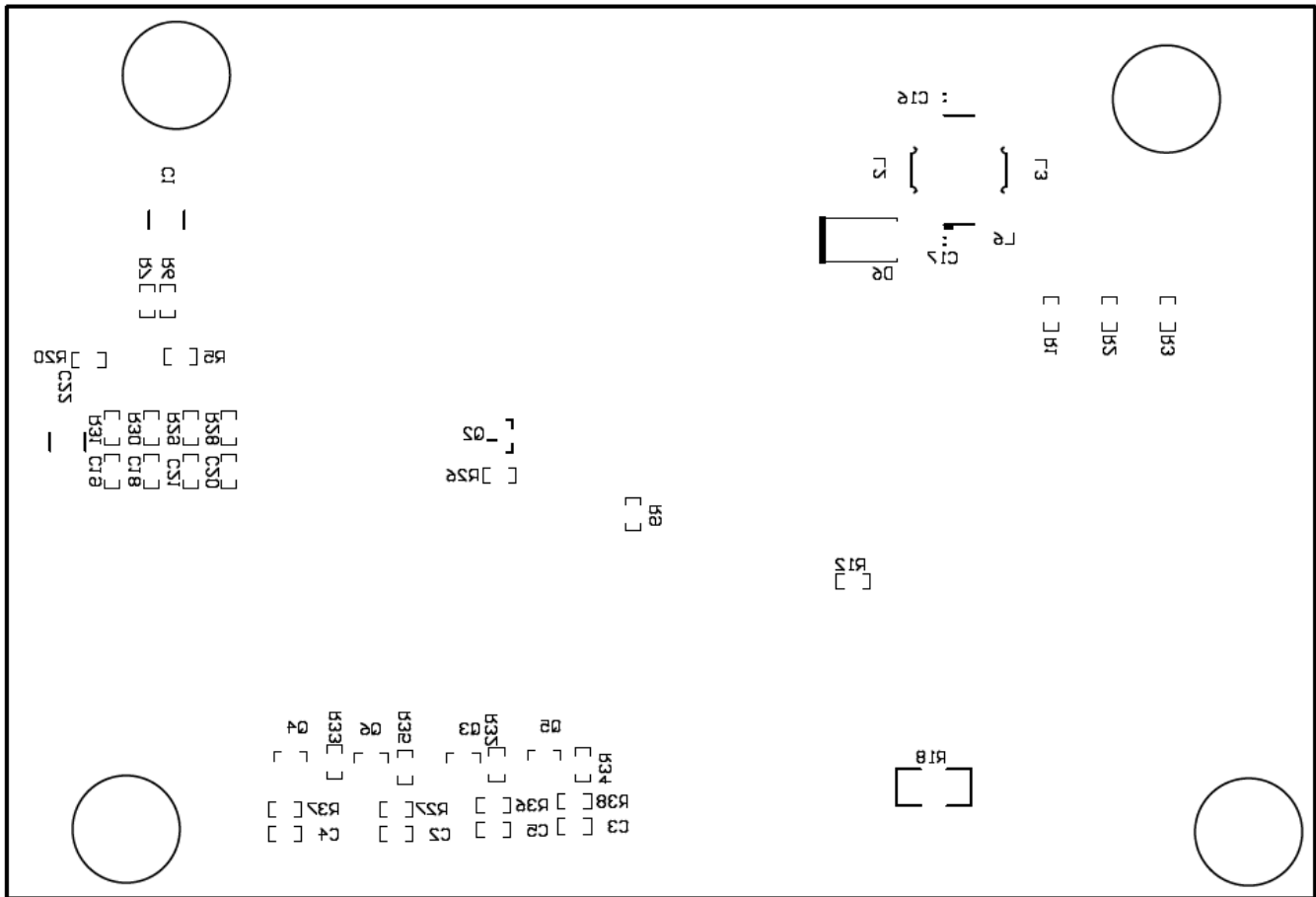


Figure 11. Bottom Component Placement

7.2 Layout Guidelines

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

- Make all leads as short as possible with wide power traces and paired signal and return.
- No crossovers of signals from one part of the flow to another are allowed.
- 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.
- Use large copper fills and traces on SMT power-dissipating devices, and use wide traces or overlay copper fills in the power path.

The DC/DC converter layout benefits 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.
- Use proper spacing around the high-voltage sections of the converter.

7.3 EMI Containment

The following guidelines are provided for 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 a 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, a Bob Smith EFT capacitor, and Bob Smith plane.
- Use a Bob Smith plane as ground shield on the input side of the PCB (creating a phantom or literal earth ground).
- Use an LC filter at the 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- Ω resistors)
- Maintain physical separation between input-related circuitry and power circuitry (use ferrite beads as boundary line).
- Balance efficiency versus 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 Material

Table 4 lists the EVM BOM.

Table 4. TPS237xEVM-757 BOM⁽¹⁾

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
!PCB1	1		Printed Circuit Board		PWR757	Any		
C1, C22	2	2200pF	CAP, CERM, 2200 pF, 2000 V, ±10%, X7R, 1812	1812	C4532X7R3D222K130KA	TDK		
C2, C3, C4, C5	4	330pF	CAP, CERM, 330 pF, 50 V, ±5%, C0G/NP0, 0603	0603	885012006060	Würth Elektronik		
C6, C16, C17, C23	4	1000pF	CAP, CERM, 1000pF, 100V, ±10%, X7R, 0603	0603	C1608X7R2A102K	TDK		
C7, C8, C9	3	2.2uF	CAP, CERM, 2.2 µF, 100 V, ±10%, X7R, 1210	1210	GRM32ER72A225KA35L	Murata		
C11	1	100uF	CAP, AL, 100 µF, 100 V, ±20%, 0.17 ohm, SMD	SMT Radial J16	EEV-FK2A101M	Panasonic		
C12, C13	2	0.1uF	CAP, CERM, 0.1 µF, 100 V, ±10%, X7R, 0805	0805	C0805C104K1RACTU	Kemet		
C14	1	1uF	CAP, CERM, 1 µF, 16 V, ±10%, X7R, 0603	0603	885012206052	Würth Elektronik		
C15	1	470pF	CAP, CERM, 470 pF, 50 V, ±5%, C0G/NP0, 0603	0603	06035A471JAT2A	AVX		
C18, C19, C20, C21	4	0.01uF	CAP, CERM, 0.01uF, 100V, ±10%, X7R, 0603	0603	C1608X7R2A103K	TDK		
D1, D2, D3	3	Yellow	LED, Yellow, SMD	LED_0603	150060YS75000	Würth Elektronik		
D4	1	100V	Diode, Schottky, 100 V, 2 A, DO-220AA	DO-220AA	SS2PH10-M3	Vishay-Semiconductor		
D6, D7, D8, D9, D10	5	100V	Diode, Schottky, 100 V, 2 A, SMB	SMB	B2100-13-F	Diodes Inc.		
D11	1	58V	Diode, TVS, Uni, 58V, 600W, SMB	SMB	SMBJ58A-13-F	Diodes Inc.		
H1, H2, H3, H4	4		Bumpon, Hemisphere, 0.375 X 0.235, Black	Black Bumpon	SJ61A2	3M		
J1, J2, J4, J9, J10, J12	6		Header, 2.54 mm, 2x1, Gold, R/A, SMT	Header, 2.54 mm, 2x1, R/A, SMT	87898-0204	Molex		
J3, J7	2		Header, 100mil, 3x1, Gold, SMT	Samtec_TSM-103-01-X-SV	TSM-103-01-L-SV	Samtec		
J5	1		Header, 2.54mm, 3x2, Gold, Black, SMT	Header, 2.54mm, 3x2, SMT	GBC03DABN-M30	Sullins Connector Solutions		
J6	1		Header, 100mil, 2x2, Tin, SMT	2x2 100mil Tin Header	15-91-2040	Molex		
J8, J14	2		RJ-45, No LED, tab up, R/A, TH	16.26x14.54x15.75	1-406541-1	TE Connectivity		
J11, J13	2		Terminal Block, 3.5 mm, 2x1, Tin, TH	Terminal Block, 3.5 mm, 2x1, TH	39357-0002	Molex		
L1	1	33uH	Inductor, Shielded Drum Core, Ferrite, 33 µH, 2.5 A, 0.066 ohm, SMD	10x5x10mm	7447714330	Würth Elektronik		
L6, L7	2	250uH	Coupled inductor, 250 µH, A, 0.035 ohm, SMD	8.7x10mm	744272251	Würth Elektronik		
L8	1	3.3uH	Inductor, Shielded Drum Core, Ferrite, 3.3 µH, 1.5 A, 0.085 ohm, SMD	Inductor, 2.8x2.8x2.8mm	744025003	Würth Elektronik		
Q1	1	-100V	MOSFET, P-CH, -100 V, 3 A, DPAK	DPAK	ZXMP10A16KTC	Diodes Inc.	SUD09P10-195-GE3	None
Q2	1	100V	MOSFET, N-CH, 100 V, 0.17 A, SOT-23	SOT-23	BSS123	Fairchild Semiconductor		
Q3, Q4, Q5, Q6	4	100V	MOSFET, N-CH, 100V, 2.7A, SSOT-3	SSOT-3	FDN8601	Fairchild Semiconductor		
R1, R2, R3	3	21.0k	RES, 21.0 k, 1%, 0.1 W, 0603	0603	CRCW060321K0FKEA	Vishay-Dale		
R4	1	60.4k	RES, 60.4 k, 1%, 0.1 W, 0603	0603	RC0603FR-0760K4L	Yageo America		
R5, R6, R7, R20, R28, R29, R30, R31	8	75.0	RES, 75.0 ohm, 1%, 0.1W, 0603	0603	CRCW060375R0FKEA	Vishay-Dale		
R8	1	1.00Meg	RES, 1.00 M, 1%, 0.1 W, 0603	0603	RC0603FR-071ML	Yageo America		

⁽¹⁾ Unless otherwise noted in the *Alternate Part Number* or *Alternate Manufacturer* columns, all parts may be substituted with equivalents.

Table 4. TPS237xEVM-757 BOM⁽¹⁾ (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
R9	1	787k	RES, 787 k, 1%, 0.1 W, 0603	0603	CRCW0603787KFKEA	Vishay-Dale		
R10	1	100k	RES, 100 k, 1%, 0.1 W, 0603	0603	RC0603FR-07100KL	Yageo America		
R11	1	27.4k	RES, 27.4 k, 1%, 0.1 W, 0603	0603	CRCW060327K4FKEA	Vishay-Dale		
R12, R25, R26	3	49.9k	RES, 49.9 k, 1%, 0.1 W, 0603	0603	CRCW060349K9FKEA	Vishay-Dale		
R13	1	20k	Trimmer, 20k ohm, 0.5W, TH	Trimmer, 9.7x9.8x4.6mm	T93YA203KT20	Vishay Sfernice		
R14, R24	2	63.4	RES, 63.4 ohm, 1%, 0.1W, 0603	0603	CRCW060363R4FKEA	Vishay-Dale		
R15	1	90.9	RES, 90.9, 1%, 0.1 W, 0603	0603	CRCW060390R9FKEA	Vishay-Dale		
R16	1	0.18	RES, 0.18, 1%, 2 W, 2512	2512	RLP73K3AR18FTDF	TE Connectivity		
R17	1	23.2k	RES, 23.2 k, 1%, 0.1 W, 0603	0603	CRCW060323K2FKEA	Vishay-Dale		
R18	1	1.00k	RES, 1.00 k, 1%, 0.75 W, 2010	2010	CRCW20101K00FKEF	Vishay-Dale		
R19	1	2k	TRIMMER, 2k ohm, 0.5W, TH	375x190x375mil	3386P-1-202LF	Bourns		
R21	1	0	RES, 0, 5%, 0.1 W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale		
R22	1	249	RES, 249, 1%, 0.1 W, 0603	0603	CRCW0603249RFKEA	Vishay-Dale		
R23	1	1.21k	RES, 1.21 k, 1%, 0.1 W, 0603	0603	CRCW06031K21FKEA	Vishay-Dale		
R27, R36, R37, R38	4	232k	RES, 232 k, 1%, 0.1 W, 0603	0603	CRCW0603232KFKEA	Vishay-Dale		
R32, R33, R34, R35	4	1.00Meg	RES, 1.00 M, 1%, 0.1 W, 0603	0603	CRCW06031M00FKEA	Vishay-Dale		
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10	10	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec
T1	1	350 uH	Transformer, 350 uH, SMT	14.7x18.29mm	7490220122	Würth Elektronik	B78476A9726A003	TDK-EPCOS
TP1, TP2, TP3, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20	17		Test Point, Miniature, SMT	Test Point, Miniature, SMT	5019	Keystone		
TP4, TP5, TP6	3	SMT	Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone		
U1	1		PFET Buck Controller for High Power LED Drives, 10-pin eMSOP, Pb-Free	MUC10A	LM3409HVMYX/NOPB	Texas Instruments		
U2	1		Mid Power "bt" PoE PD Interface with "Automatic" Maintain Power Signature, Advanced Startup and Ultra-Low Standby Power, RGW0020B (VQFN-20)	RGW0020B	TPS2372-3RGWR	Texas Instruments	TPS2372-3RGWT	Texas Instruments
C10	0	47uF	CAP, AL, 47 µF, 100 V, ±20%, 0.32 ohm, SMD	SMT Radial H13	EEV-FK2A470Q	Panasonic		
D5	0	30V	Diode, Schottky, 30 V, 0.1 A, SOD-323	SOD-323	SD107WS-7-F	Diodes Inc.		
D12, D13, D14, D15	0	100V	Diode, Schottky, 100 V, 2 A, SMB	SMB	B2100-13-F	Diodes Inc.		
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A		
L2, L3, L4, L5	0	300 ohm	Ferrite Bead, 300 ohm @ 100 MHz, 2 A, 0603	0603	742792641	Würth Elektronik		

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
 - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductor products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.
3. *Regulatory Notices:*
 - 3.1 *United States*
 - 3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.
 - 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.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- 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.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. 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.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

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.

3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
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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2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

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西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page
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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user 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, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

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8. *Limitations on Damages and Liability:*

8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS, REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

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9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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