

ABSTRACT

This user's guide describes the TPS2373-4 evaluation module (TPS2373-4EVM-758). The TPS2373-4EVM-758 contains evaluation and reference circuitry for the TPS2373-4. The TPS2373-4 device is an IEEE 802.3bt-compliant, powered-device (PD) controller optimized for isolated converter topologies. The TPS2373-4EVM-758 is designed for high-efficiency, 70-W, PD solutions.

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Trademarks

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1 Introduction

The TPS2373-4EVM-758 allows reference circuitry evaluation of the TPS2373-4, contains input and output power connectors and an array of on-board test points for circuit evaluation.

1.1 Features

The TPS2373-4EVM-758 features include:

- High-efficiency active clamp-forward converter
- Class 8, 5-V, 14-A, 70-W, DC output

1.2 Applications

The TPS2373-4EVM-758 can be used in the following applications:

- Voice over internet protocol – IP telephones
- Wireless LAN – wireless access points
- Security – wired IP cameras
- IoT applications

2 Electrical Specifications

Table 2-1 lists the EVM electrical specifications.

Table 2-1. TPS2373-4EVM-758 Electrical and Performance Specifications at 25°C

Parameter	Test Conditions	Min	Typ	Max	Unit
PD Power Interface					
Input Voltage	Applied to the power pins of connectors J2 or J4	0		57	V
Input UVLO, PoE input J2	Rising input voltage			36	V
	Falling input voltage	30			V
Detection Voltage	At device terminals	3		10	V
Classification Voltage	At device terminals	10		23	V
Classification Current	RclassA = 63.4 Ω	38		42	mA
	RclassB = 90.9 Ω	26.5		29.3	mA
Inrush Current-Limit		275		395	mA
Operating Current-Limit		1.9		2.5	A
DC/DC Converter (UCC2897A)					
Output Voltage	$V_{IN} = 48\text{ V}, I_{LOAD} \leq I_{LOAD}(\text{max})$	5.17		5.22	V
Output Current	$41.2 \leq V_{IN} \leq 57\text{ V}$			14	A
Output Ripple Voltage Peak-to-Peak	$V_{IN} = 48\text{ V}, I_{LOAD} = 14\text{ A}$		100		mV
Efficiency, End-to-End	$V_{IN} = 48\text{ V}, I_{LOAD} = 1\text{ A}$		73		%
	$V_{IN} = 48\text{ V}, I_{LOAD} = 6\text{ A}$		92		%
	$V_{IN} = 48\text{ V}, I_{LOAD} = 14\text{ A}$		91		%
Switching Frequency			200		kHz

3 Description

The TPS2373-4EVM-758 enables full evaluation of the TPS2373-4 device. Refer to the schematic shown in [Figure 4-1](#) and [Figure 4-2](#). Ethernet power is applied from J1 and is dropped to the FET bridge rectifier. At the output of the FET bridge is the EMI and EMC filter and transient protection for the TPS2373-4.

Input power can also be applied at J3 from a DC source when power at J1 is not present or when the DC/DC converter is being evaluated and not the PoE front end.

The TPS2373-4 (U1) PD controller is shown in [Figure 4-1](#). R30 provides the detection signature while J7 and J10 allow user selection of the classification signature and desired power level. To the right of U1 is the switched side of the PD controller. The TPS2373-4 RTN pin provides inrush, current limited turn on, and charge of the bulk capacitor C28 and C62.

The DC/DC converter is a high-efficiency, active clamp-forward converter. The primary (Q16) switching MOSFET is driven from the U2 OUT pin and the secondary (Q13/Q15) synch switching MOSFET is in a self-driven configuration.

Output voltage feedback is provided with U3 and associated error amplifier (U4) circuitry. R55 provides a means for error injection to measure the frequency response of the converter. This feedback circuit drives the U2 FB pin which provides a voltage proportional to the output load current. As the output load current decreases, the FB pin voltage decreases.

4 Schematic

Figure 4-1 and Figure 4-2 illustrate the EVM schematic.

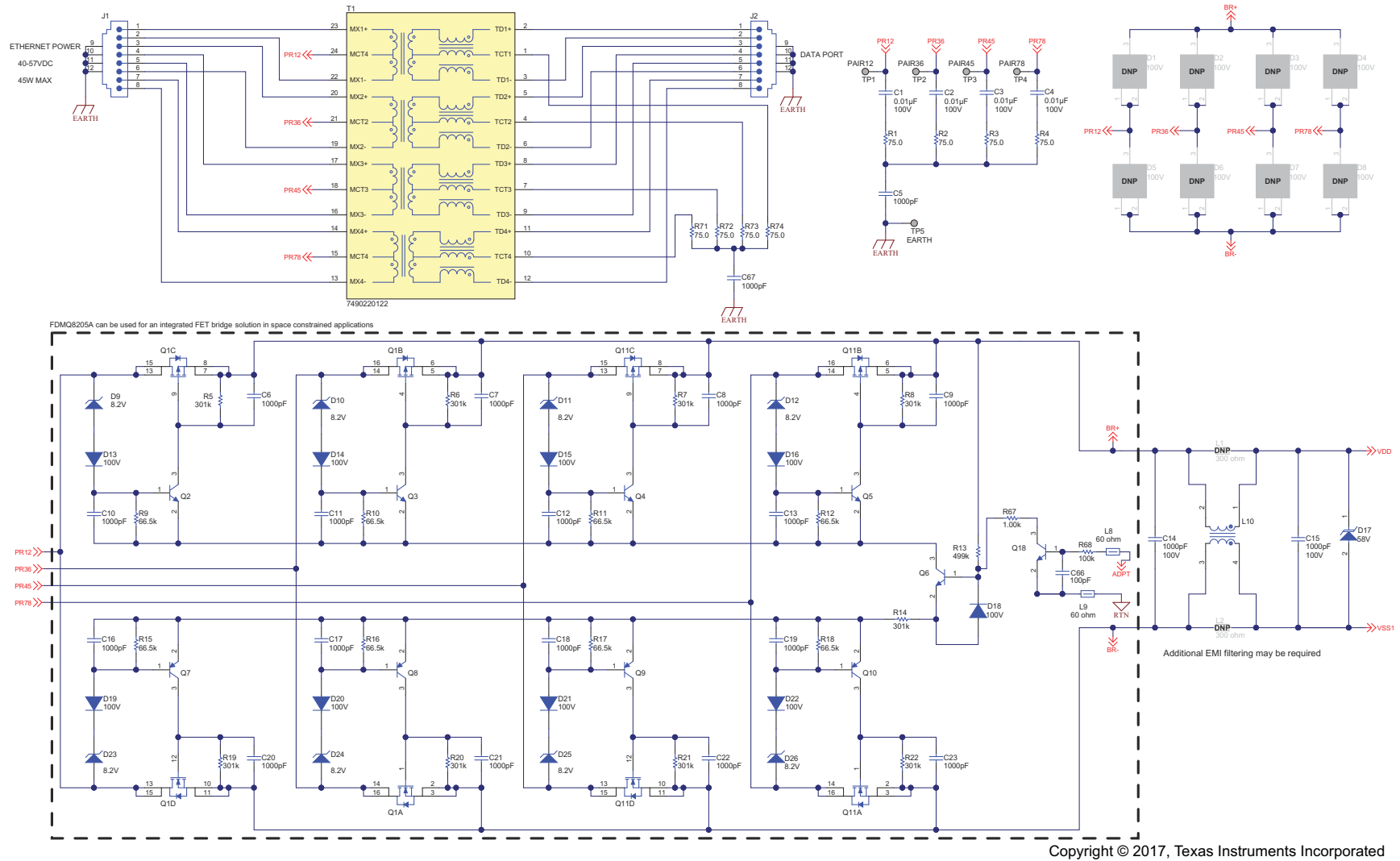
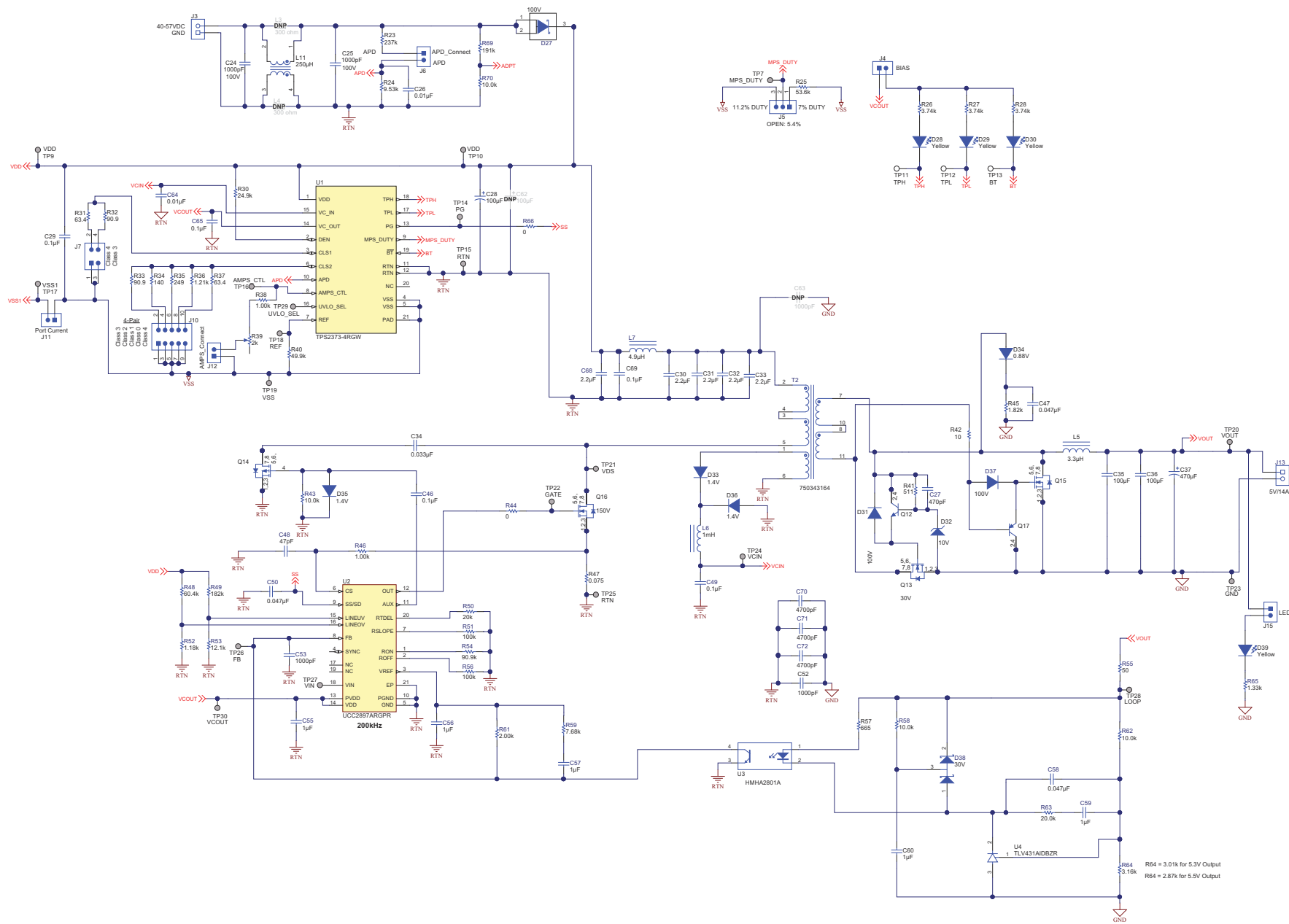


Figure 4-1. TPS2373-4EVM-758 PD Front-End Schematic



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Figure 4-2. TPS2373-4EVM-758 PD and DC/DC Converter Schematic

5 General Configuration and Description

5.1 Physical Access

Table 5-1 lists the EVM connector functionality and Table 5-2 describes the test point availability. Table 5-3 describes the jumper selections of the EVM.

Table 5-1. Connector Functionality

Connector	Label	Description
J1	ETHERNET POWER	PoE input. Connect to PSE power and data source.
J2	DATA	Ethernet data passthrough. Connect to downstream Ethernet device.
J13	Output	Output connector to load.
J3	DC/DC Input	DC/DC converter input bypassing the PoE front-end. Connect a DC power supply 40-57.

Table 5-2. Test Points

Test Point	Label	Description
TP1	PAIR 12	Data pair from Pins 1 and 2 of J1
TP2	PAIR 36	Data pair from Pins 3 and 6 of J1
TP3	PAIR 45	Data pair from Pins 4 and 5 of J1
TP4	PAIR 78	Data pair from Pins 7 and 8 of J1
TP5	EARTH	Connect to earth ground when available
TP7	MPS_DUTY	MPS_DUTY pin of the TPS2373-4
TP9, TP10	VDD	Input voltage of PD system
TP11	TPH	TPH output of the TPS2373-4
TP12	TPL	TPL output of the TPS2373-4
TP13	BT	BT output of the TPS2373-4
TP14	PG	Power Good output of the TPS2373-4
TP15, TP25	RTN	Load side return voltage
TP16	AMPS_CTL	AMPS_CTL output voltage
TP17	VSS1	EMI filter return side voltage
TP18	REF	Reference pin output voltage of the TPS2373-4
TP19	VSS	PD side return voltage
TP20	VOUT	Converter output voltage
TP21	VDS	Drain voltage of the primary FET of the converter
TP22	GATE	Gate voltage of the primary FET of the converter
TP23	GND	Secondary ground connection
TP24	VCIN	Bias winding circuit output voltage
TP26	FB	Feedback pin voltage of U2 PWM controller
TP27	VIN	Startup input voltage of U2 (open circuited)
TP28	LOOP	Feedback connection for frequency response measurements
TP29	UVLO_SEL	Select UVLO of U1 (open circuited)
TP30	VCOUT	Output voltage of advanced startup of U1

Table 5-3. Jumper Descriptions

Jumper	Description
J4	Jump to power TPH/TPL/BT through the bias winding. Or open to power through external circuit
J5	Automatic MPS duty cycle selection
J6	Jump for adapter priority
J7	CLSA selection
J10	CLSB selection
J11	Can be used to measure port current; otherwise, J11 must be shorted
J12	Jump to add auto MPS current
J15	Jump to power output LED

6 TPS237xEVM-758 Performance Data

6.1 Startup

Figure 6-1 illustrates the startup response of the TPS2373-4EVM-758.

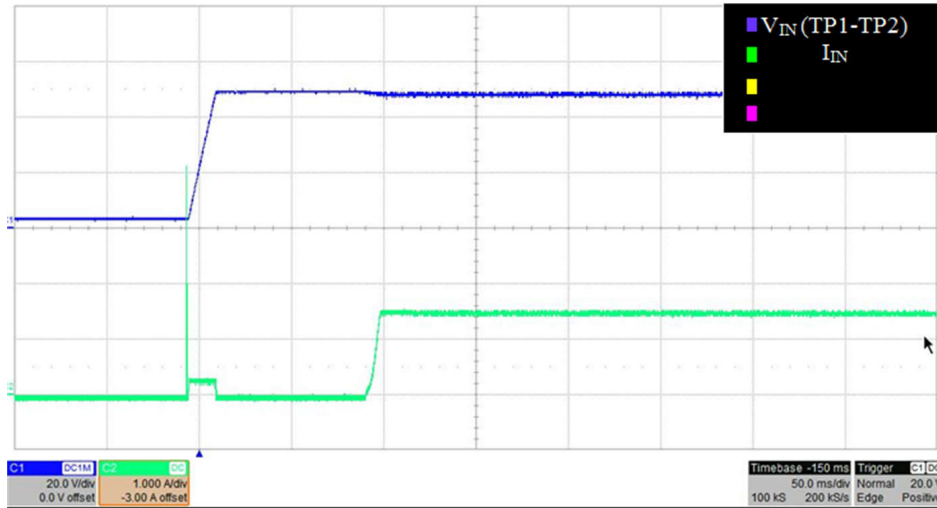


Figure 6-1. Startup Response to Full Load (14 A) for a 48-V Input

6.2 Transient Response

Figure 6-2 illustrates the transient response of the TPS2373-4EVM-758.

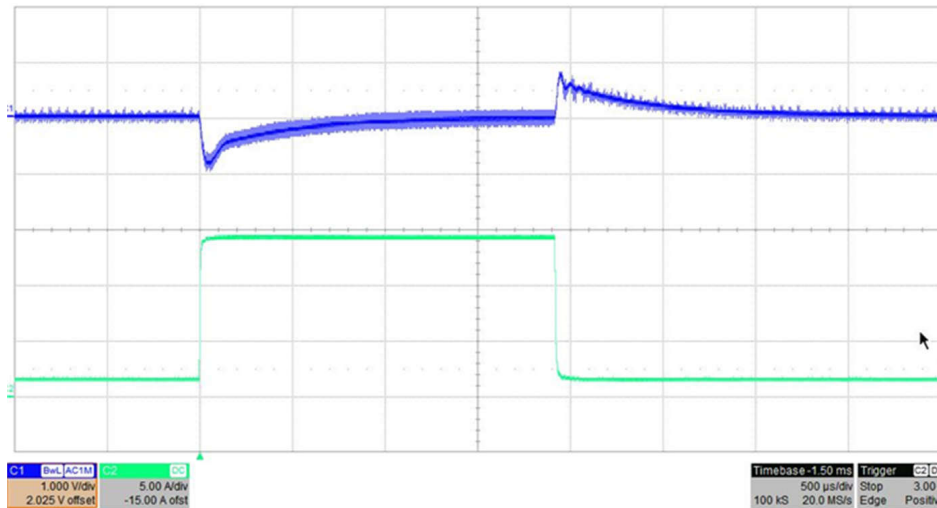


Figure 6-2. Transient Response from 7 A to 14 A for a 48-V Input

6.3 Efficiency

Figure 6-3 illustrates the efficiency of the TPS237xEVM-758.

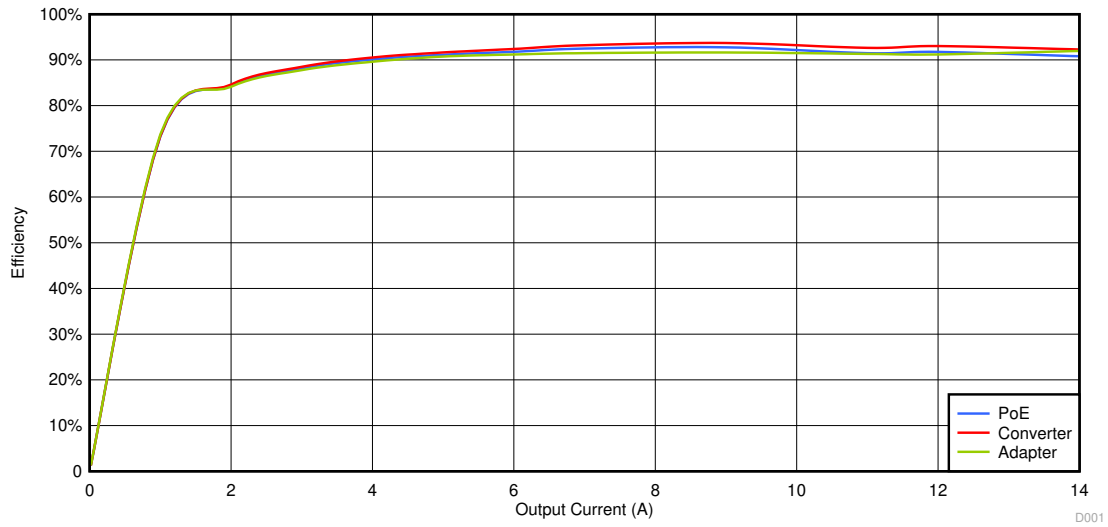


Figure 6-3. Efficiency of the TPS2373-4EVM-758, $V_{IN} = 48\text{ V}$

7 EVM Assembly Drawings and Layout Guidelines

This section contains the assembly drawings and layout guidelines.

7.1 PCB Drawings

Figure 7-1 through Figure 7-6 show component placement and layout of the TPS2373-4EVM-758.

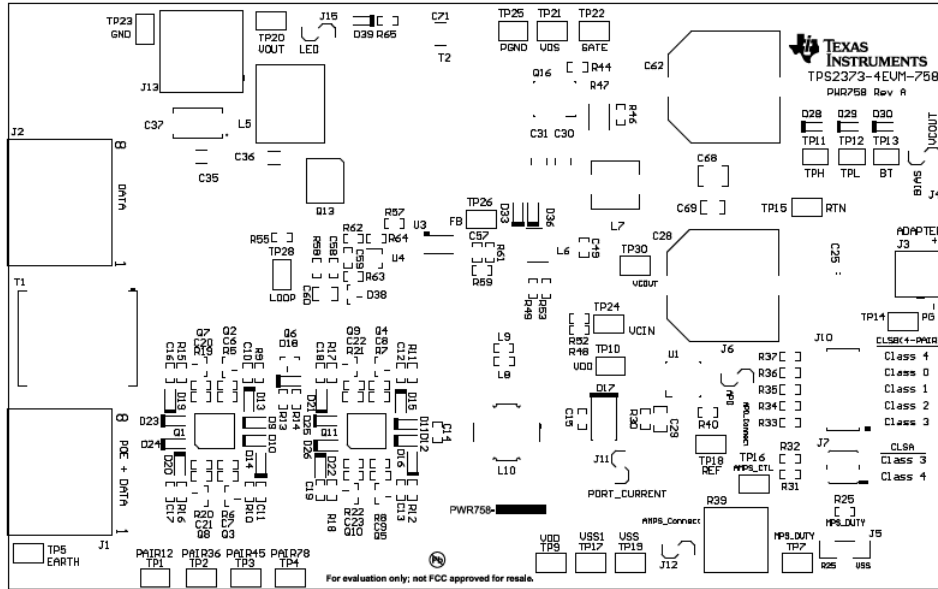


Figure 7-1. Top Side Component Placement

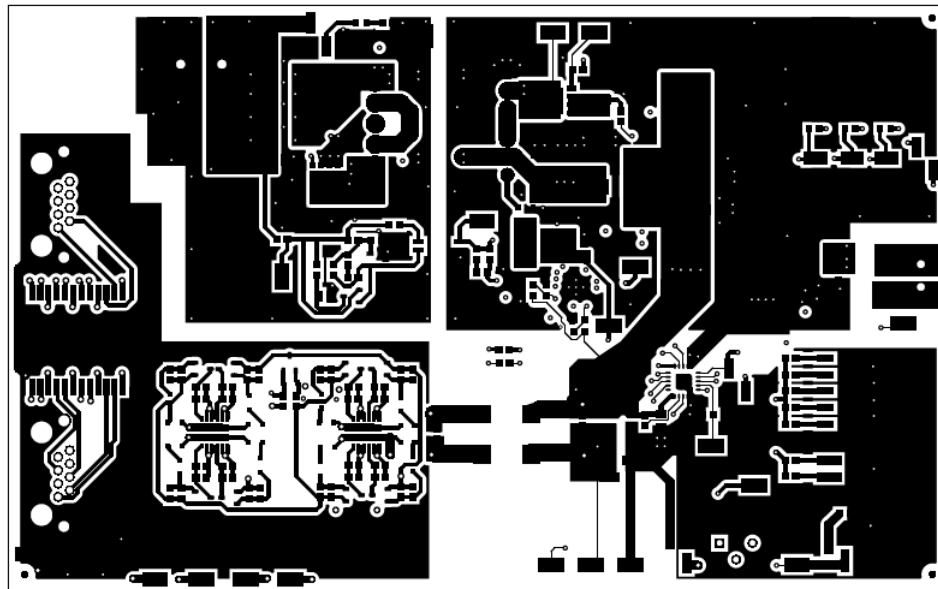


Figure 7-2. Top Side Routing

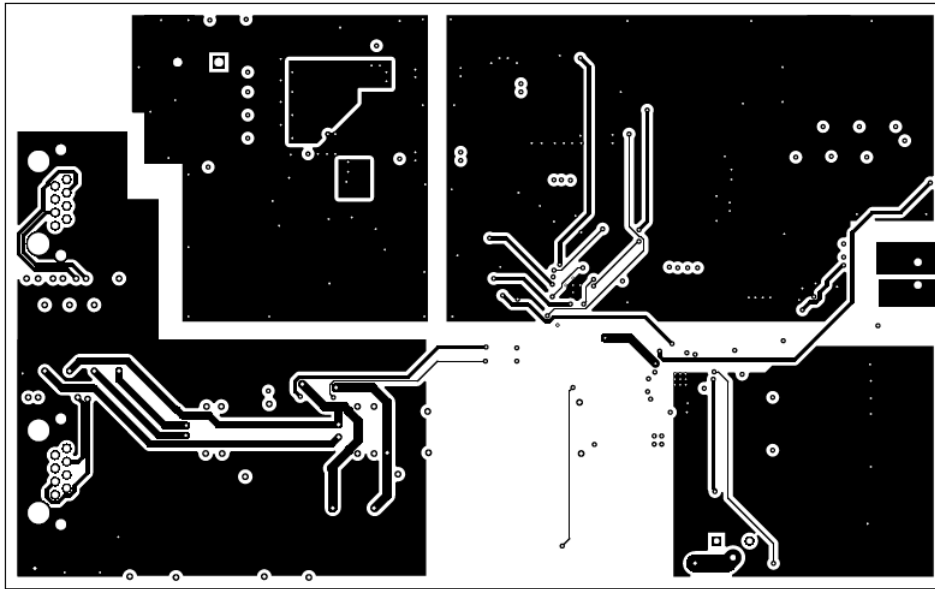


Figure 7-3. Layer 2 Routing

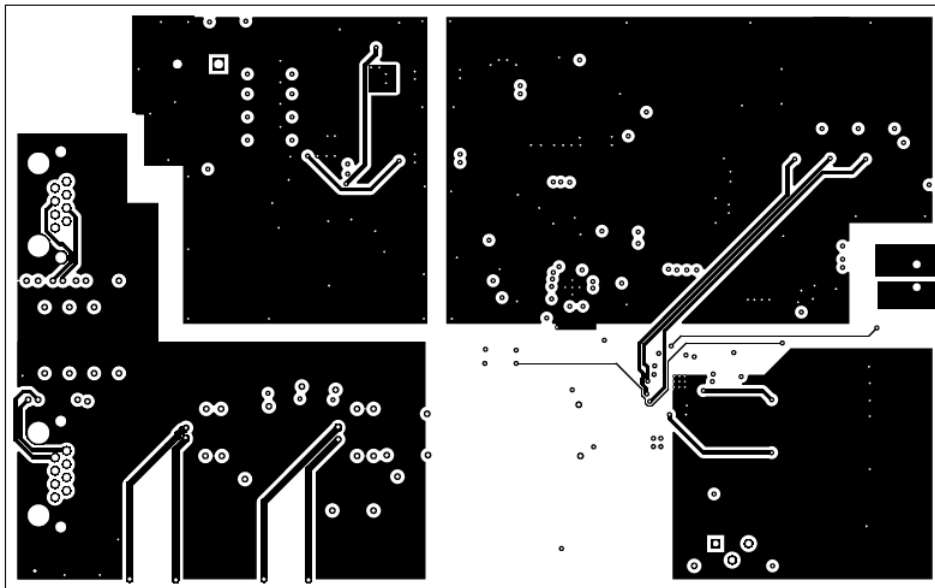


Figure 7-4. Layer 3 Routing

7.2 Layout Guidelines

The layout of the PoE front end must follow power and EMI and 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- μ F capacitor, and TPS237x converter input bulk capacitor.
- 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.
- Place the TPS237x over split, local ground planes referenced to VSS for the PoE input and to COM/RTN for the converter. Whereas the PoE side can operate without a ground plane, the converter side must have one. Do not place logic ground and power layers under the Ethernet input or the primary side of the converter.
- 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, Bob Smith EFT capacitor, and Bob Smith plane.
- Use Bob Smith plane as ground shield on the input side of the 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- 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 Materials

Table 8-1 lists the EVM BOM.

Table 8-1. TPS237xEVM-758 Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
!PCB1	1		Printed Circuit Board		PWR758	Any	-	-
C1, C2, C3, C4	4	0.01uF	CAP, CERM, 0.01uF, 100 V, +/-10%, X7R, 0603	0603	C1608X7R2A103K	TDK		
C5	1	1000 pF	CAP, CERM, 1000 pF, 2000 V, +/- 10%, X7R, 1808	1808	GR442QR73D102KW01L	Murata		
C6, C7, C8, C9, C10, C11, C12, C13, C16, C17, C18, C19, C20, C21, C22, C23	16	1000 pF	CAP, CERM, 1000 pF, 50 V, +/-10%, X7R, 0603	0603	C1608X7R1H102K	TDK		
C14, C15, C24, C25	4	1000 pF	CAP, CERM, 1000 pF, 100 V, +/-10%, X7R, 0603	0603	C1608X7R2A102K	TDK		
C26	1	0.01uF	CAP, CERM, 0.01uF, 50 V, +/-10%, X7R, 0603	0603	C1608X7R1H103K	TDK		
C27	1	470 pF	CAP, CERM, 470 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	06035A471JAT2A	AVX		
C28	1	100uF	CAP, AL, 100 uF, 100 V, +/- 20%, 0.17 ohm, SMD	SMT Radial J16	EEV-FK2A101M	Panasonic		
C29, C69	2	0.1uF	CAP, CERM, 0.1 uF, 100 V, +/- 10%, X7R, 0805	0805	C0805C104K1RACTU	Kemet		
C30, C31, C32, C33	4	2.2uF	CAP, CERM, 2.2uF, 100 V, +/-10%, X7R, 1210	1210	GRM32ER72A225KA35L	Murata		
C34	1	0.033uF	CAP, CERM, 0.033uF, 250 V, +/-10%, X7R, 1206	1206	GRM31CR72E333KW03L	Murata		
C35, C36	2	100uF	CAP, CERM, 100 uF, 10 V, +/- 20%, X5R, 1206_190	1206_190	C3216X5R1A107M160AC	TDK		
C37	1	470uF	CAP, TA, 470 uF, 6.3 V, +/- 10%, 0.1 ohm, SMD	7343-31	TPSD477K006R0100	AVX		
C46, C49	2	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X7R, 0603	0603	885012206071	Wurth Elektronik		
C47	1	0.047uF	CAP, CERM, 0.047 uF, 50 V, +/- 10%, X7R, 0603	0603	C1608X7R1H473K	TDK		
C48	1	47 pF	CAP, CERM, 47 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	06035A470JAT2A	AVX		
C50	1	0.047uF	CAP, CERM, 0.047 uF, 25 V, +/- 5%, X7R, 0603	0603	06033C473JAT2A	AVX		
C52	1	1000 pF	CAP, CERM, 1000 pF, 3kV, 1808	1808	STD	STD		
C53	1	1000 pF	CAP, CERM, 1000 pF, 50 V, +/- 10%, C0G/NP0, 0603	0603	06035A102KAT2A	AVX		
C55	1	1uF	CAP, CERM, 1 uF, 25 V, +/- 10%, X7R, 0805	0805	C2012X7R1E105K	TDK		
C56	1	1uF	CAP, CERM, 1 uF, 16 V, +/- 10%, X7R, 0603	0603	885012206052	Wurth Elektronik		
C57	1	1uF	CAP, CERM, 1 uF, 25 V, +/- 10%, X7R, 0603	0603	C0603C105K3RACTU	Kemet		
C58	1	0.047uF	CAP, CERM, 0.047 uF, 50 V, +/- 10%, X5R, 0603	0603	C1608X5R1H473K080AA	TDK		
C59	1	1uF	CAP, CERM, 1 uF, 35 V, +/- 10%, X7R, 0603	0603	C1608X7R1V105K080AC	TDK		
C60	1	1uF	CAP, CERM, 1 uF, 16 V, +/- 10%, X5R, 0805	0805	0805YD105KAT2A	AVX		
C64	1	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X5R, 0603	0603	GRM188R61H103KA01D	Murata		
C65	1	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X5R, 0603	0603	06033D104KAT2A	AVX		
C66	1	100 pF	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	885012006057	Wurth Elektronik		
C67	1	1000 pF	CAP, CERM, 1000 pF, 2000 V, +/- 10%, X7R, 1812	1812	1812GC102KA1	AVX		
C68	1	2.2uF	CAP, CERM, 2.2 uF, 100 V, +/- 10%, X7R, 1210	1210	GRM32ER72A225KA35L	Murata		
C70, C71, C72	3	4700 pF	CAP, CERM, 4700 pF, 2000 V, +/- 10%, X7R, 1812	1812	1812GC472KAT1A	AVX		
D9, D10, D11, D12, D23, D24, D25, D26	8	8.2V	Diode, Zener, 8.2V, 200mW, SOD-323	SOD-323	MMSZ5237BS-7-F	Diodes Inc.		
D13, D14, D15, D16, D18, D19, D20, D21, D22	9	100 V	Diode, Switching, 100 V, 0.2A, SOD-323	SOD-323	MMDL914-TP	Micro Commercial Components		
D17	1	58 V	Diode, TVS, Uni, 58 V, 600W, SMB	SMB	SMBJ58A-13-F	Diodes Inc.		

Table 8-1. TPS237xEVM-758 Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
D27	1	100 V	Diode, Schottky, 100 V, 5 A, PowerDI5	PowerDI5	PDS5100-13	Diodes Inc.		
D28, D29, D30, D39	4	Yellow	LED, Yellow, SMD	LED_0603	150060YS75000	Würth Elektronik		
D31	1	100 V	Diode, Switching, 100 V, 0.2A, SOD-123	SOD-123	MMSD4148T1G	ON Semiconductor		
D32	1	10 V	Diode, Zener, 10 V, 500 mW, SOD-123	SOD-123	MMSZ5240B-7-F	Diodes Inc.		
D33, D35, D36	3	1.4V	Diode, Ultrafast, 100 V, 0.25A, SOD-323	SOD-323	BAS316,115	NXP Semiconductor		
D34	1	0.88V	DIODE ULTRA FAST 100 V 2 A SMA	SMA	MURA110	ON Semi		
D37	1	100 V	Diode, Switching, 100 V, 0.2 A, SOD-123	SOD-123	MMSD914T1G	ON Semiconductor		
D38	1	30 V	Diode, Schottky, 30 V, 0.2 A, SOT-23	SOT-23	BAT54S-7-F	Diodes Inc.		
H1, H2, H3, H4	4		Bumpon, Hemisphere, 0.375 X 0.235, Black	Black Bumpon	SJ61A2	3M		
J1, J2	2		RJ-45, No LED, tab up, R/A, TH	16.26x14.54x15.75	1-406541-1	TE Connectivity		
J3	1		Terminal Block, 3.5 mm, 2x1, Tin, TH	Terminal Block, 3.5 mm, 2x1, TH	39357-0002	Molex		
J4, J6, J11, J12, J15	5		Header, 2.54 mm, 2x1, Gold, R/A, SMT	Header, 2.54 mm, 2x1, R/A, SMT	87898-0204	Molex		
J5	1		Header, 100mil, 3x1, Gold, SMT	Samtec_TSM-103-01-X-SV	TSM-103-01-L-SV	Samtec		
J7	1		Header, 100mil, 2x2, Tin, SMT	2x2 100mil Tin Header	15-91-2040	Molex		
J10	1		Header, 100mil, 5x2, Tin, SMT	500x180x290mil	TSM-105-01-T-DV-P	Samtec		
J13	1		Terminal Block, 2x1, 6.35mm, Green, TH	Terminal Block, 2x1, 6.35mm, Green, TH	1714955	Phoenix Contact		
L5	1	3.3uH	Inductor, Shielded, Composite, 3.3uH, 25 A, 0.0037 ohm, SMD	Inductor, 11.3x10x10mm	XAL1010-332MEB	Coilcraft		
L6	1	1mH	Inductor, Wirewound, 1 mH, 0.2 A, 6 ohm, SMD	5.0x5.0x4.0mm	74404054102	Würth Elektronik		
L7	1	4.9uH	Inductor, Shielded Drum Core, Superflux, 4.9 uH, 6.5 A, 0.0155 ohm, SMD	6.9x4.8x6.9mm	744314490	Würth Elektronik		
L8, L9	2	60 ohm	Ferrite Bead, 60 ohm @ 100 MHz, 0.5 A, 0603	0603	74279267	Würth Elektronik		
L10, L11	2	250uH	Coupled inductor, 250 uH, A, 0.035 ohm, SMD	8.7x10mm	744272251	Würth Elektronik		
Q1, Q11	2	100 V	MOSFET, N-CH, 100 V, 3.4 A, 4.5x5x0.8mm	4.5x5x0.8mm	FDMQ8203	Fairchild Semiconductor		None
Q2, Q3, Q4, Q5	4	0.2V	Transistor, NPN, 40 V, 0.2A, SOT-23	SOT-23	MMBT3904-7-F	Diodes Inc.	None	None
Q6, Q18	2	300 V	Transistor, NPN, 300 V, 0.1 A, SOT-23	SOT-23	MMBTA42	NXP Semiconductor		
Q7, Q8, Q9, Q10	4	0.25V	Transistor, PNP, 40 V, 0.2A, SOT-23	SOT-23	MMBT3906-7-F	Diodes Inc.	None	None
Q12	1	100 V	Transistor, NPN, 100 V, 1 A, SOT-89	SOT-89	FCX493TA	Diodes Inc.		
Q13	1	30 V	MOSFET, N-CH, 30 V, 100 A, SON 5x6mm	SON 5x6mm	CSD17501Q5A	Texas Instruments		None
Q14	1	-150V	MOSFET, P-CH, -150 V, -3 A, QFN-8	QFN-8	FDMC2523P	Fairchild Semiconductor		None
Q15	1	40 V	MOSFET, N-CH, 40 V, 100 A, SON 5x6mm	SON 5x6mm	CSD18502Q5B	Texas Instruments		None
Q16	1	150 V	MOSFET, N-CH, 150 V, 35 A, PQFN08A	PQFN08A	FDMS86200	Fairchild Semiconductor		None
Q17	1	80 V	Transistor, PNP, 80 V, 1 A, SOT-89	SOT-89	2SB1260T100R	Rohm		
R1, R2, R3, R4, R71, R72, R73, R74	8	75.0	RES, 75.0 ohm, 1%, 0.1W, 0603	0603	CRCW060375R0FKEA	Vishay-Dale		

Table 8-1. TPS237xEVM-758 Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
R5, R6, R7, R8, R14, R19, R20, R21, R22	9	301k	RES, 301k ohm, 1%, 0.1W, 0603	0603	CRCW0603301KFKEA	Vishay-Dale		
R9, R10, R11, R12, R15, R16, R17, R18	8	66.5k	RES, 66.5k ohm, 1%, 0.1W, 0603	0603	CRCW060366K5FKEA	Vishay-Dale		
R13	1	499k	RES, 499k ohm, 1%, 0.1W, 0603	0603	CRCW0603499KFKEA	Vishay-Dale		
R23	1	237k	RES, 237k ohm, 1%, 0.1W, 0603	0603	CRCW0603237KFKEA	Vishay-Dale		
R24	1	9.53k	RES, 9.53 k, 1%, 0.1 W, 0603	0603	CRCW06039K53FKEA	Vishay-Dale		
R25	1	53.6k	RES, 53.6 k, 1%, 0.1 W, 0603	0603	CRCW060353K6FKEA	Vishay-Dale		
R26, R27, R28	3	3.74k	RES, 3.74 k, 1%, 0.1 W, 0603	0603	CRCW06033K74FKEA	Vishay-Dale		
R30	1	24.9k	RES, 24.9 k, 1%, 0.1 W, 0603	0603	CRCW060324K9FKEA	Vishay-Dale		
R31, R37	2	63.4	RES, 63.4 ohm, 1%, 0.1W, 0603	0603	CRCW060363R4FKEA	Vishay-Dale		
R32, R33	2	90.9	RES, 90.9, 1%, 0.1 W, 0603	0603	CRCW060390R9FKEA	Vishay-Dale		
R34	1	140	RES, 140, 1%, 0.1 W, 0603	0603	CRCW0603140RFKEA	Vishay-Dale		
R35	1	249	RES, 249, 1%, 0.1 W, 0603	0603	CRCW0603249RFKEA	Vishay-Dale		
R36	1	1.21k	RES, 1.21 k, 1%, 0.1 W, 0603	0603	CRCW06031K21FKEA	Vishay-Dale		
R38	1	1.00k	RES, 1.00 k, 1%, 0.75 W, 2010	2010	CRCW20101K00FKEF	Vishay-Dale		
R39	1	2k	TRIMMER, 2k ohm, 0.5W, TH	375x190x375mil	3386P-1-202LF	Bourns		
R40	1	49.9k	RES, 49.9 k, 1%, 0.1 W, 0603	0603	CRCW060349K9FKEA	Vishay-Dale		
R41	1	511	RES, 511, 1%, 0.125 W, 0805	0805	CRCW0805511RFKEA	Vishay-Dale		
R42	1	10	RES, 10, 5%, 0.1 W, 0603	0603	CRCW060310R0JNEA	Vishay-Dale		
R43, R58, R62	3	10.0k	RES, 10.0 k, 1%, 0.1 W, 0603	0603	CRCW060310K0FKEA	Vishay-Dale		
R44, R66	2	0	RES, 0, 5%, 0.1 W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale		
R45	1	1.82k	RES, 1.82 k, 1%, 1 W, 2512	2512	CRCW25121K82FKEG	Vishay-Dale		
R46, R67	2	1.00k	RES, 1.00 k, 1%, 0.1 W, 0603	0603	CRCW06031K00FKEA	Vishay-Dale		
R47	1	0.075	RES, 0.075, 1%, 2 W, 2512	2512	CSRN2512FK75L0	Stackpole Electronics Inc		
R48	1	60.4k	RES, 60.4 k, 1%, 0.1 W, 0603	0603	CRCW060360K4FKEA	Vishay-Dale		
R49	1	182k	RES, 182 k, 1%, 0.1 W, 0603	0603	CRCW0603182KFKEA	Vishay-Dale		
R50	1	20k	RES, 20 k, 5%, 0.1 W, 0603	0603	CRCW060320K0JNEA	Vishay-Dale		
R51, R56	2	100k	RES, 100 k, 5%, 0.1 W, 0603	0603	CRCW0603100KJNEA	Vishay-Dale		
R52	1	1.18k	RES, 1.18 k, 1%, 0.1 W, 0603	0603	CRCW06031K18FKEA	Vishay-Dale		
R53	1	12.1k	RES, 12.1 k, 1%, 0.1 W, 0603	0603	CRCW060312K1FKEA	Vishay-Dale		
R54	1	90.9k	RES, 90.9 k, 1%, 0.1 W, 0603	0603	CRCW060390K9FKEA	Vishay-Dale		
R55	1	50	RES, 50, 1%, 0.1 W, 0603	0603	CRCW060350R0FKEA	Vishay-Dale		
R57	1	665	RES, 665, 1%, 0.1 W, 0603	0603	CRCW0603665RFKEA	Vishay-Dale		
R59	1	7.68k	RES, 7.68 k, 1%, 0.1 W, 0603	0603	RC0603FR-077K68L	Yageo America		
R61	1	2.00k	RES, 2.00 k, 1%, 0.1 W, 0603	0603	CRCW06032K00FKEA	Vishay-Dale		
R63	1	20.0k	RES, 20.0 k, 1%, 0.1 W, 0603	0603	CRCW060320K0FKEA	Vishay-Dale		
R64	1	3.16k	RES, 3.16 k, 1%, 0.1 W, 0603	0603	CRCW06033K16FKEA	Vishay-Dale		
R65	1	1.33k	RES, 1.33 k, 1%, 0.1 W, 0603	0603	CRCW06031K33FKEA	Vishay-Dale		
R68	1	100k	RES, 100 k, 1%, 0.1 W, 0603	0603	CRCW0603100KFKEA	Vishay-Dale		
R69	1	191k	RES, 191 k, 1%, 0.1 W, 0603	0603	CRCW0603191KFKEA	Vishay-Dale		

Table 8-1. TPS237xEVM-758 Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
R70	1	10.0k	RES, 10.0 k, 1%, 0.1 W, 0603	0603	RCG060310K0FKEA	Vishay Draloric		
SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9	8	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		
T2	1	153uH	Transformer, High Frequency Flat Coil Planar, SMT	920x910x850mil	750343164	Würth Electronik	ZD2247-AE	Coilcraft
TP1, TP2, TP3, TP4, TP5, TP7, TP9, TP10, TP14, TP15, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP23, TP24, TP25, TP26, TP27, TP28, TP29, TP30	25		Test Point, Miniature, SMT	Test Point, Miniature, SMT	5019	Keystone		
TP11, TP12, TP13	3	SMT	Test Point, Miniature, SMT	Testpoint_Keystone_Minature	5015	Keystone		
U1	1		Mid Power "bt" PoE PD Interface with "Automatic" Maintain Power Signature, Advanced Startup and Ultra-Low Standby Power, TPS2372RGW	TPS2372RGW	TPS2373-4RGW	Texas Instruments		Texas Instruments
U2	1		Advanced Active Clamp PWM Controller with Current Control, -40 to +125 degC, 20-pin QFN (RGP), Green (RoHS & no Sb/Br)	RGP0020D	UCC2897ARGPR	Texas Instruments	Equivalent	None
U3	1		Optocoupler, 3.75 kV, 80-160% CTR, SMT	Mini Flat Package	HMHA2801A	Fairchild Semiconductor		
U4	1		LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATOR, DBZ0003A	DBZ0003A	TLV431AIDBZR	Texas Instruments		Texas Instruments
C62	0	100uF	CAP, AL, 100 µF, 100 V, +/- 20%, 0.17 ohm, SMD	SMT Radial J16	EEV-FK2A101M	Panasonic		
C63	0	1000 pF	CAP, CERM, 1000 pF, 3kV, 1808	1808	STD	STD		
D1, D2, D3, D4, D5, D6, D7, D8	0	100 V	Diode, Schottky, 100 V, 5 A, PowerDI5	PowerDI5	PDS5100-13	Diodes Inc.		
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A		
L1, L2, L3, L4	0	300 ohm	Ferrite Bead, 300 ohm @ 100 MHz, 2 A, 0603	0603	742792641	Würth Elektronik		
Notes:			Unless otherwise noted in the Alternate Part Number and/or Alternate Manufacturer columns, all parts can be substituted with equivalents.					

9 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision A (June 2017) to Revision B (July 2023)	Page
• Added ZD2247-AE Coilcraft as an alternate part to component T2.....	16
Changes from Revision * (February 2017) to Revision A (June 2017)	Page
• Changed <i>TPS2373-4EVM-758 PD front-end schematic</i> and <i>TPS2373-4EVM-758 pd and DC/DC converter schematic</i>	5

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 semiconductors 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.

WARNING

Evaluation Kits 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 shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

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。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないものご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
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。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。日本テキサス・イ

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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

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。 <https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html>

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.

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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.
 - 6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.
 7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.
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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.

8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

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