User's Guide

TPS7H5001-SP Evaluation Module

ABSTRACT

This user's guide describes the characteristics, operation, and use of the TPS7H5001-SP Evaluation Module (EVM). Setup to ensure proper operation of the device as well as a complete schematic diagram, printed-circuit board layouts, and bill of materials are included in this document. Basic waveforms of operation are also shown.

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Trademarks

1 Introduction

This board enables the TPS7H5001-SP to be connected to other components needed to quickly prototype and evaluate a complete power converter design. The TPS7H5001-SP is placed on an open test board similar to the board used in the *TPS7H5001-SP Lookahead Total Ionizing Dose (TID) Radiation Report*. Adding test points and voltage terminals is the only major change to the design that was needed to facilitate probing the TPS7H5001-SP without additional hardware. Minor changes were made to the BOM for manufacturability purposes.

1.1 Features

This EVM has the following features:

- Synchronous rectification outputs with adjustable dead time
- 0.613-V ±1% Voltage reference overtemperature, radiation, and line and load
- Adjustable slope compensation and soft start
- Configurable duty cycle limit

1.2 Applications

- Space satellite isolated power supplies
- Radiation hardened applications
- Space satellite payloads

2 EVM Setup and Quick Start Guide

Default EVM Configuration lists the default configuration.

Table 2-1. Default EVM Configuration

Parameter	Specification
Input Power Supply	4 V to 14V
Operating Temperature	25°C
Switching Frequency	500 kHz

The TPS7H5001-SP can be quickly turned on and run using the connections shown in TPS7H5001-SP Connections.

Table 2-2. TPS7H5001-SP Connections

Terminal or Test Point	Voltage Source
J11 (VIN)	4 to 14 V input at 10 mA, See Positive and Negative Terminal for J11 for connections
TP9 (COMP)	1 V at < 10 mA (Input range can be –0.3 V to 3.3 V based on the *TPS7H5001-SP Radiation-Hardness-Assured Si and GaN Dual Output Controller* data sheet)

Positive and Negative Terminal for J11 shows which terminal is the positive and negative on J11. Connect the positive input voltage to the positive terminal and GND to negative terminal.

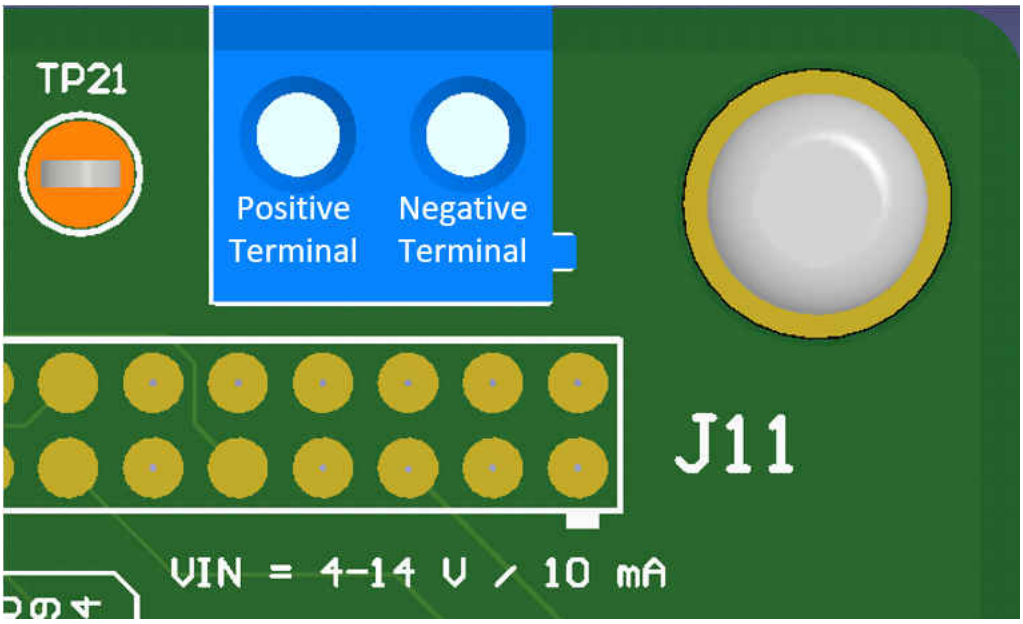

Figure 2-1. Positive and Negative Terminal for J11

The device should then turn on and operate in open loop mode as shown in TPS7H5001-SP Output. TPS7H50011-SP Output shows the output of TPS7H5001-SP measured on J1–J4 with the quick start method.

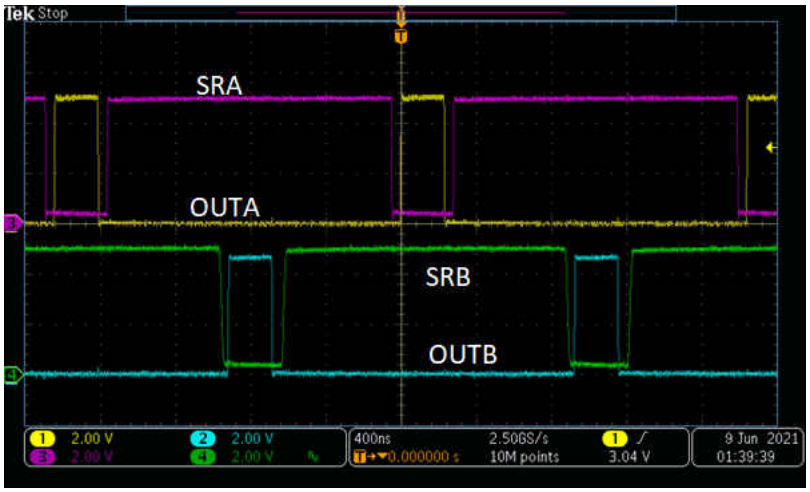

Figure 2-2. TPS7H5001-SP Output

The operation of this mode is such that forcing the voltage on COMP will create an output on the TPS7H5001-SP. The duty cycle varies based on the input voltage on COMP as well as the triangle waveform created by the CS_LIM circuit, or any other waveform that the user decides to add to the CS_LIM pin. See Duty Cycle Generation for signal generation waveforms.

Duty Cycle Generation shows waveforms for input and output signal generations for the TPS7H5001-SP based on COMP voltage and CS_LIM pin voltage.

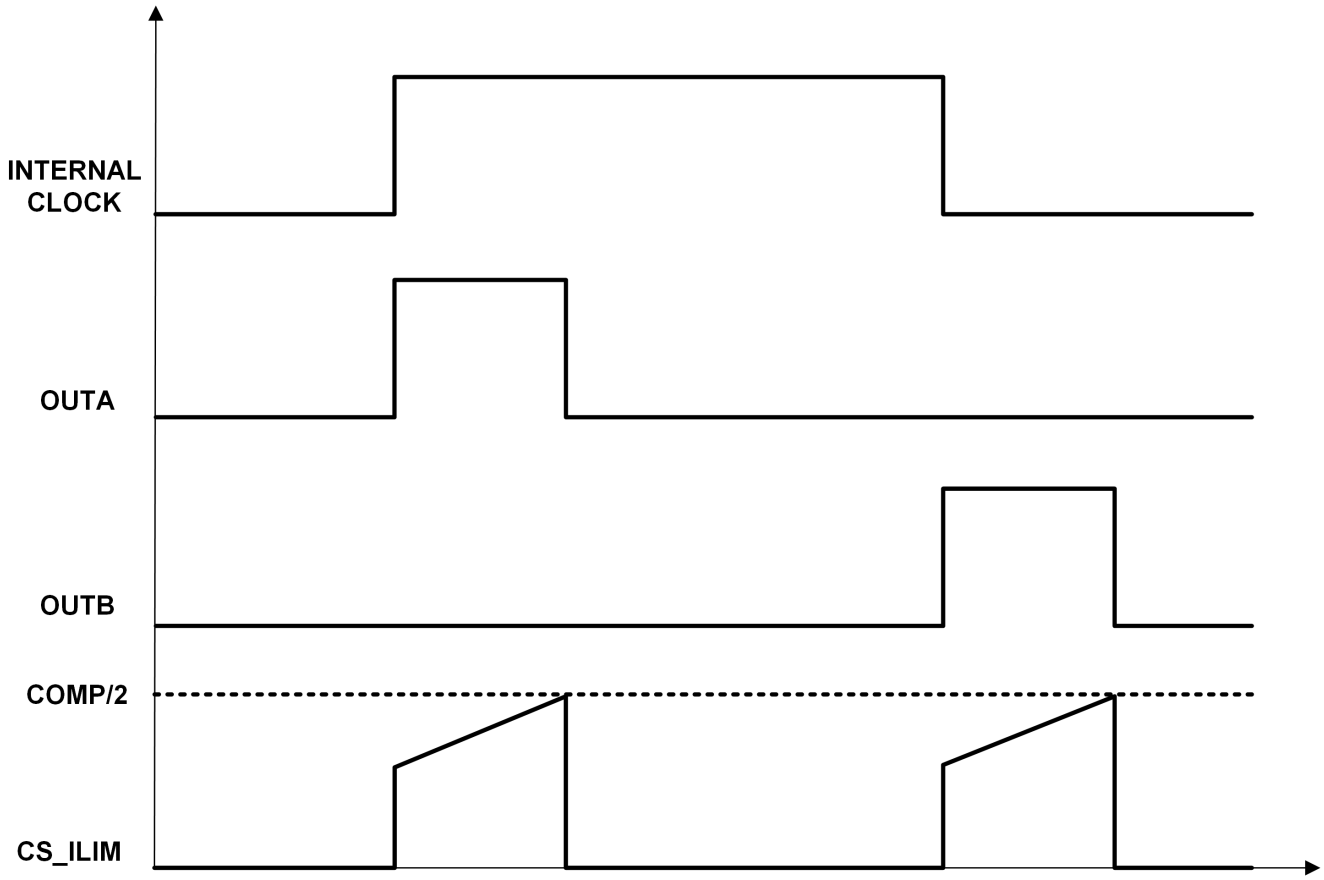

Figure 2-3. Duty Cycle Generation

3 EVM Connectors and Test Points

Table 3-1 is a list of major connections on the board. For further information see the relevant section in the *TPS7H5001-SP Radiation-Hardness-Assured Si and GaN Dual Output Controller* data sheet.

Table 3-1. EVM Board Connections

Test Point	Connection	Description
TP1, J1	OUTA	Connected to the gate driver in the design. Components R5, C5 can be used to test different R/C loads.
TP2, J2	OUTB	Connected to the gate driver in the design. Components R6, C6 can be used to test different R/C loads.
TP3, J3	SRA	Connected to the gate driver in the design. Components R7, C7 can be used to test different R/C loads.
TP4, J4	SRB	Connected to the gate driver in the design. Components R8, C8 can be used to test different R/C loads.
TP5, TP6	CS_LIM	Input for current sense in the design. The CS_LIM circuit provides small triangle waveform from OUTA, OUTB. Note that this can load OUTA, OUTB causing a slow in the slew rate. If R9 and R10 are unpopulated, CS_LIM can be force from TP5.
TP7	VIN	Voltage input for the TPS7H5001-SP device
TP8	EN	Enable pin for the TPS7H5001-SP device, currently pulled high to VLDO
TP9	COMP	Error amplifier output for the TPS7H5001-SP, forcing this voltage runs the TPS7H5001-SP in open loop.
TP10	REFCAP	Internal reference for TPS7H5001-SP
TP11, TP12	SS	In a closed loop design, this slowly increases converter output voltage during start-up
TP13, TP15	SYNC	Inputting a clock on this pin synchronizes the TPS7H5001-SP to a frequency half of the input frequency
TP14	VLDO	Internal voltage rail for device logic
TP20	VSENSE	Voltage sense for the TPS7H5001-SP. Connected to converter output voltage in the full design.
TP21	RSC	Slope compensation selection resistor. Sets slope compensation slew rate internal to the device.
TP22	HICC	Configurability for the hiccup time of the converter. While grounded through a resistor on the EVM, in a full design it is generally a capacitor.
TP23	FAULT	A signal high on this node turns the TPS7H5001-SP off for any fault condition needed
TP24	SP	Configurability for the delay between the synchronous rectifiers and main output
TP25	RT	Frequency select for the TPS7H5001-SP. Change this to vary the frequency of the converter.
TP26	PS	Configurability for the delay between the main output and synchronous rectifiers
TP27	LEB	Configurability for the leading edge blanking time of the converter

Table 3-2 describes and lists the connections and configuration for J6. Use J6 to switch between different DCL connections to test different duty cycle limits. Pin 1 is noted by the dot next to the pin.

Table 3-2. J6 Connections and Configuration

Pin Connection	Duty Cycle Limit Configuration	Description
Pin 1 and Pin 2	100%	DCL is connected high to VLDO
Pin 2 and Pin 3	50%	DCL is connected low to AVSS
Floating	75%	DCL is left floating

4 PCB Layouts

Top Overlay through Board Dimensions show the EVM PCB layout images.

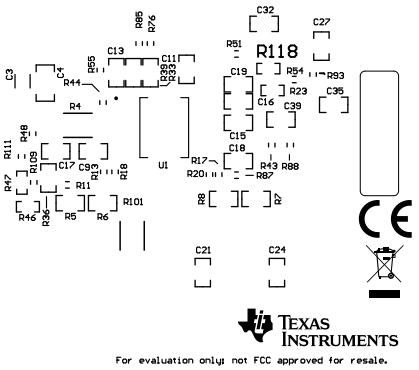

Figure 4-1. Top Overlay

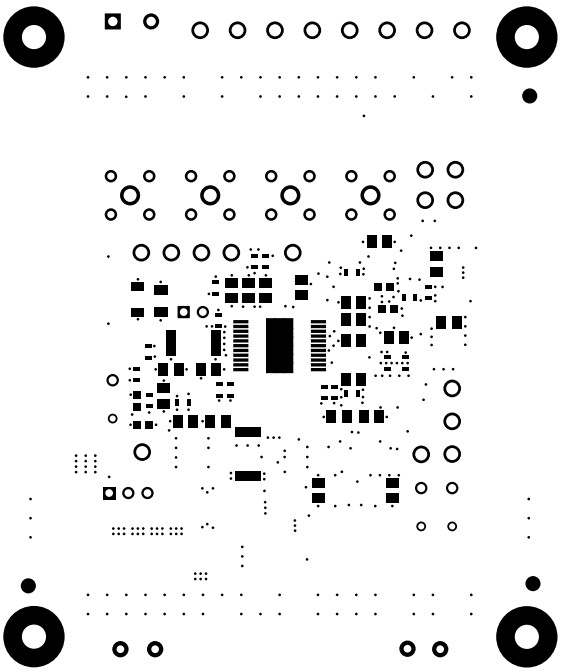

Figure 4-2. Top Solder

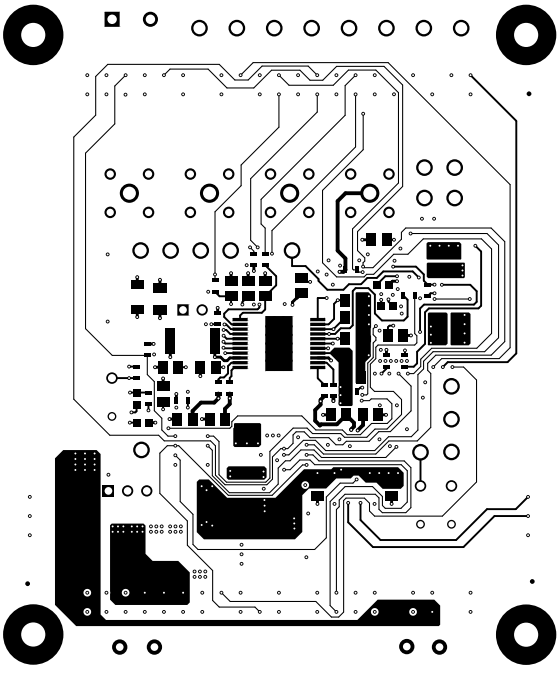

Figure 4-3. Top Layer

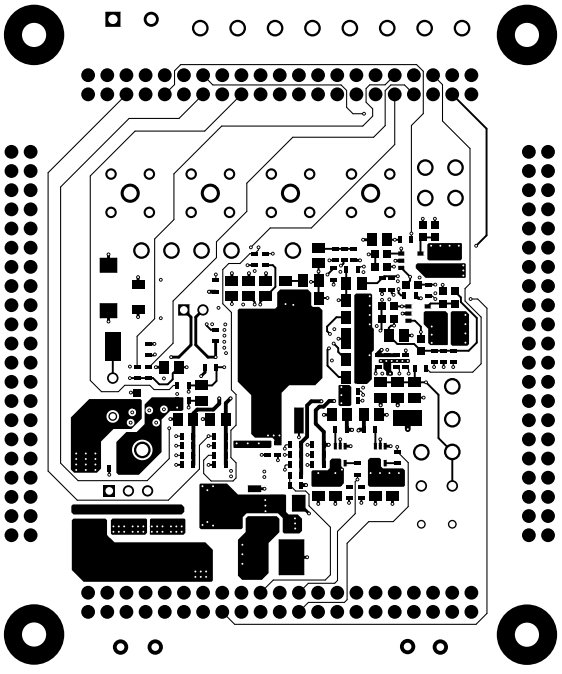

Figure 4-4. Bottom Layer

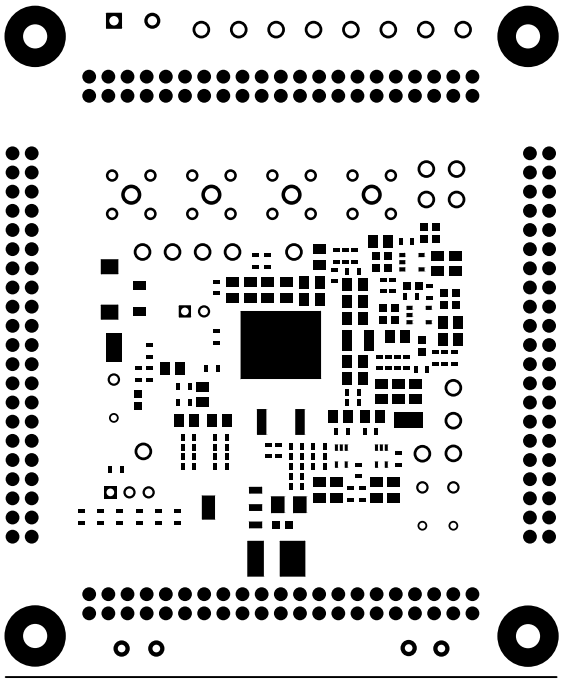

Figure 4-5. Bottom Solder

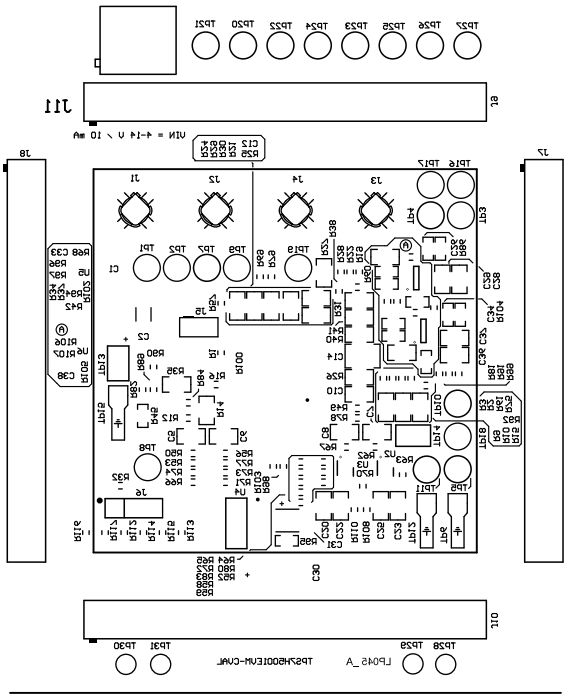

Figure 4-6. Bottom Overlay

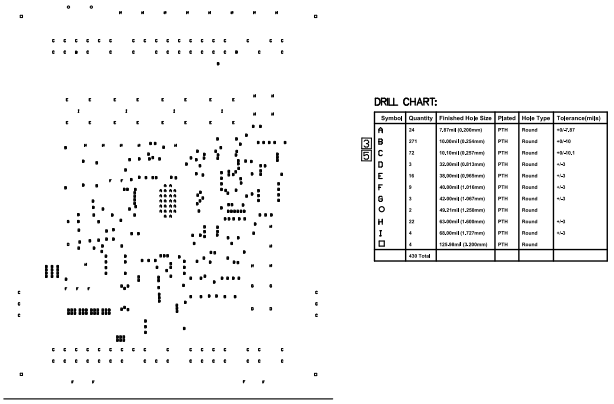

Figure 4-7. Drill Drawing

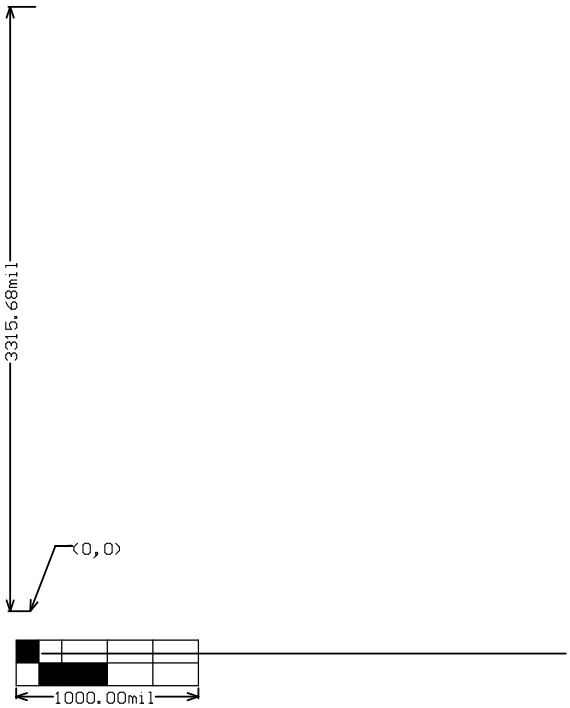

Figure 4-8. Board Dimensions

5 Schematics

Figure 5-1 through Figure 5-3 show the EVM schematics.

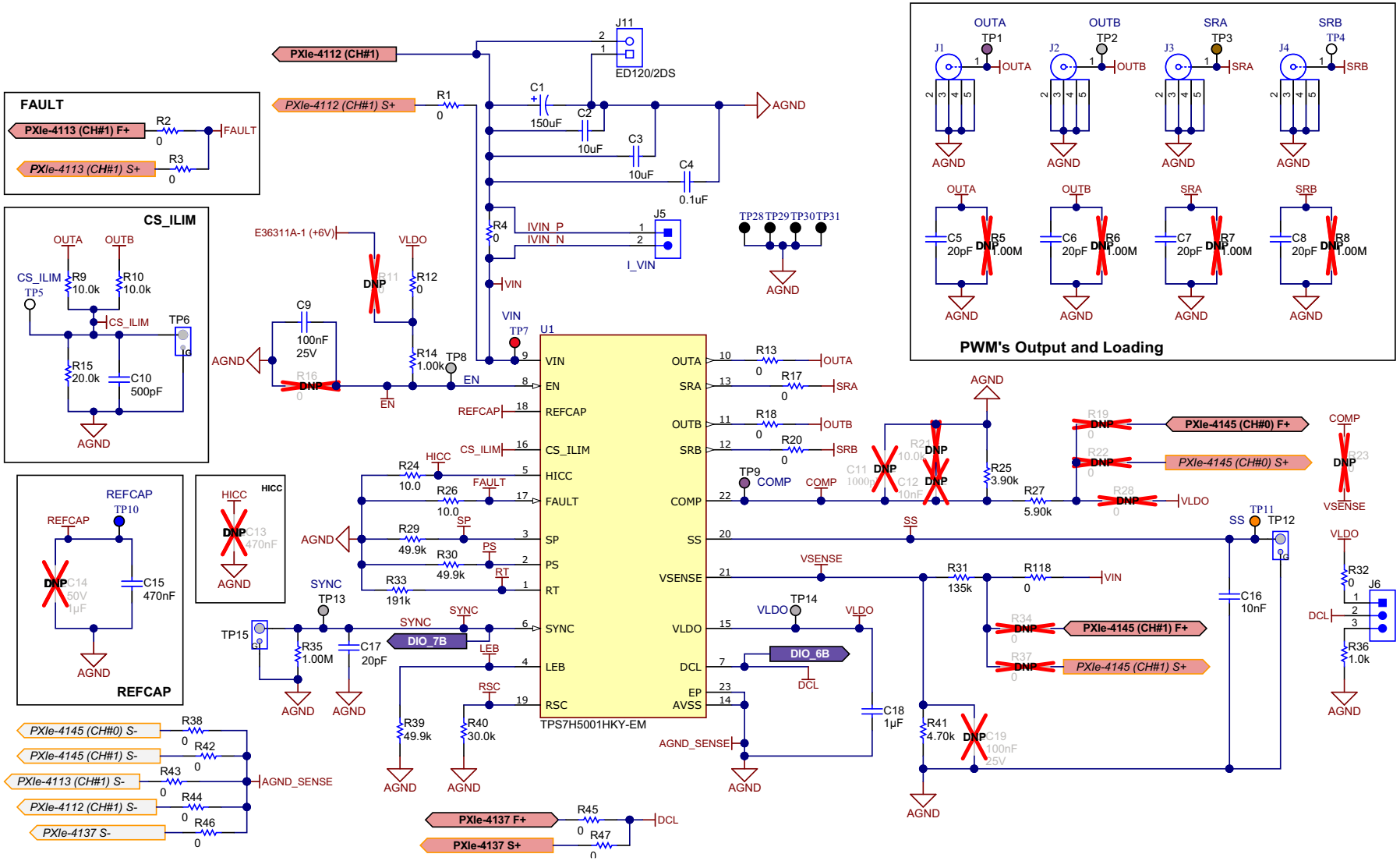

Figure 5-1. TPS7H5001-SP Schematic (Page 1)

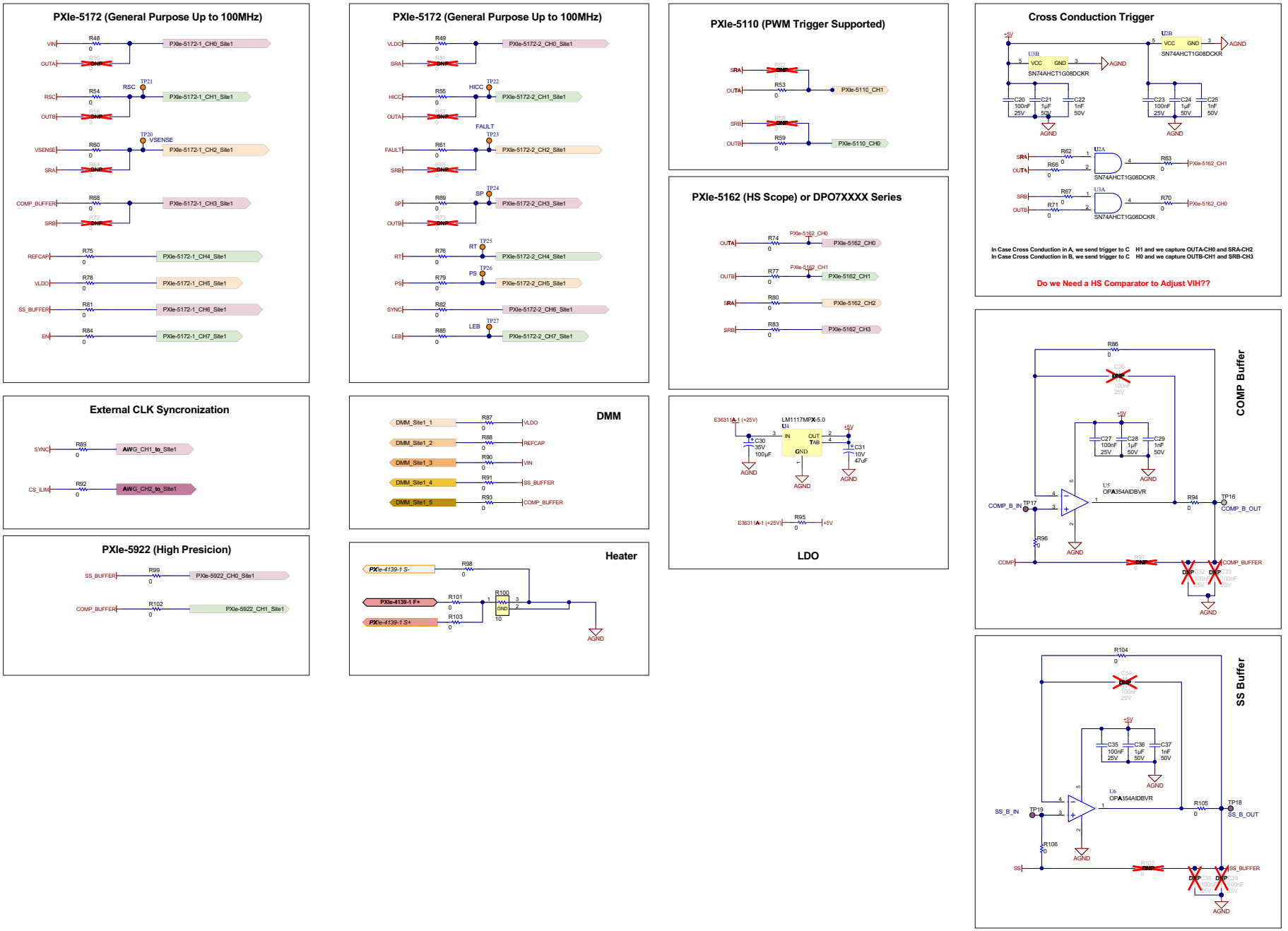

Figure 5-2. TPS7H5001-SP Schematic (Page 2)

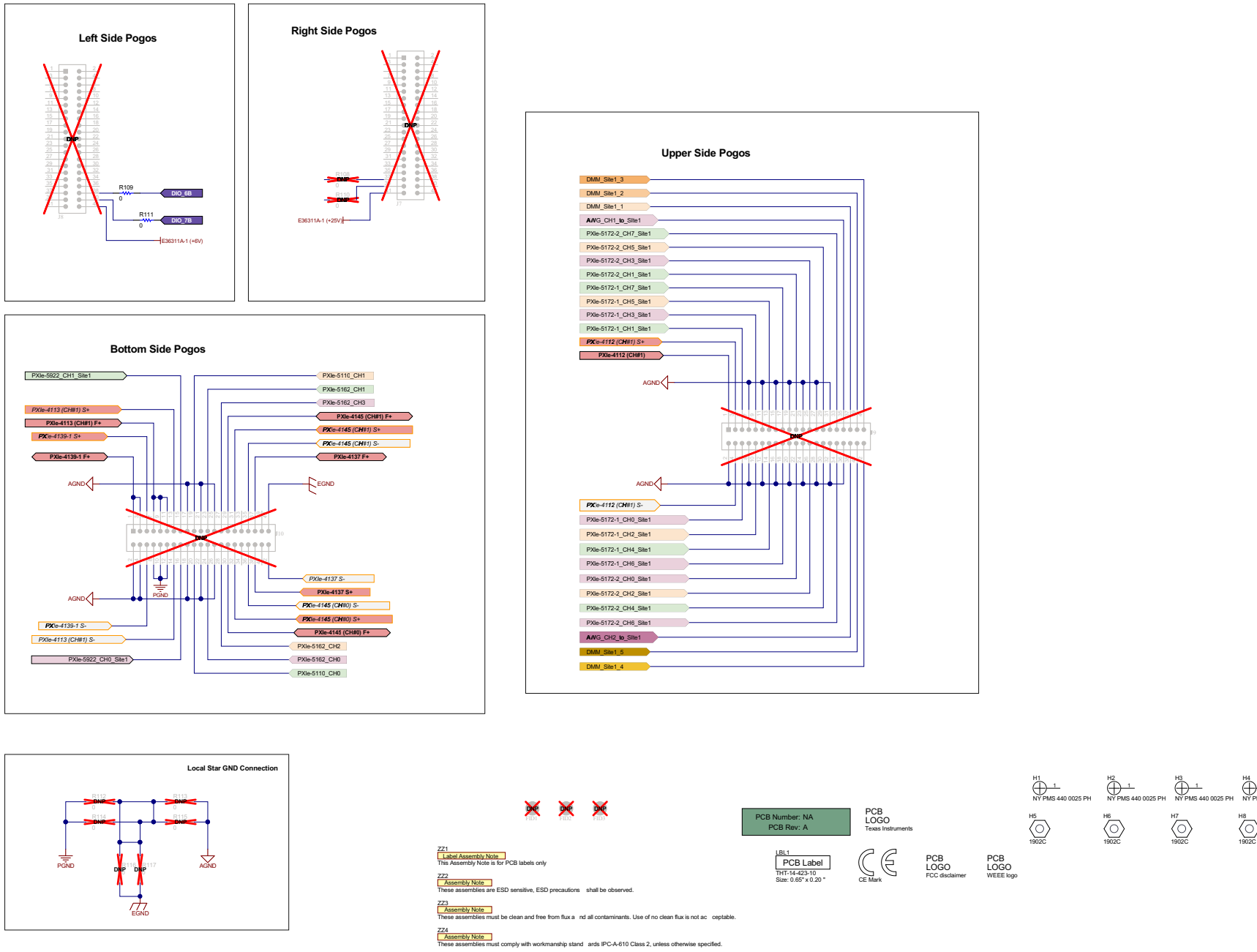

Figure 5-3. TPS7H5001-SP Schematic (Page 3)

6 Bill of Materials

TPS7H5001-SP Bill of Materials lists the EVM bill of materials (BOM).

Table 6-1. TPS7H5001-SP Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		NA	Any
C1	1		150µF Molded Tantalum Polymer Capacitor 20V 2917 (7343 Metric) 50mOhm @ 100kHz	2917	T521D157M020ATE050	Kemet
C2, C3	2	10uF	CAP, CERM, 10 uF, 50 V, ±10%, X5R, 1206	1206	GRM31CR61H106KA12L	MuRata
C4	1	0.1uF	CAP, CERM, 0.1 uF, 50 V, ±5%, X7R, 1206	1206	12065C104JAT2A	AVX
C5, C6, C7, C8, C17	5	20pF	CAP, CERM, 20 pF, 100 V, ±5%, C0G/NP0, 0805	0805	08051A200JAT2A	AVX
C9, C20, C23, C27, C35	5	0.1uF	CAP, CERM, 0.1 uF, 25 V, ±10%, X7R, 0805	0805	C0805C104K3RACTU	Kemet
C10	1	500pF	CAP, CERM, 500 pF, 50 V,±2%, C0G/NP0, 0805	0805	08055A501GAT2A	AVX
C15	1	0.47uF	CAP, CERM, 0.47 uF, 50 V, ±10%, X7R, AEC-Q200 Grade 1, 0805	0805	GCM21BR71H474KA55L	MuRata
C16	1	0.01uF	CAP, CERM, 0.01 uF, 50 V, ±5%, X7R, 0805	0805	08055C103JAT2A	AVX
C18	1	1uF	CAP, CERM, 1 uF, 50 V, ±10%, X7R, 0805	0805	08055C105KAT2A	AVX
C21, C24, C28, C36	4	1uF	CAP, CERM, 1 uF, 50 V, ±10%, X7R, 0805	0805	885012207103	Wurth Elektronik
C22, C25, C29, C37	4	1000pF	CAP, CERM, 1000 pF, 50 V, ±10%, X7R, 0805	0805	C0805C102K5RACTU	Kemet
C30	1	100uF	CAP, Tantalum Polymer, 100 µF, 35 V,±20%, 0.1 ohm, 7.3x6.1mm SMD	7.3x6.1mm	TCN4107M035R0100	AVX
C31	1	47uF	CAP, TA, 47 uF, 10 V, ±10%, 0.5 ohm, SMD	3528-21	TPSB476K010R0500	AVX
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1, J2, J3, J4	4		Compact Probe Tip Circuit Board Test Points, TH, 25 per	TH Scope Probe	131-5031-00	Tektronix
J5	1		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
J6	1		Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions
J11	1		Terminal Block, 5.08 mm, 2x1, Brass, TH	2x1 5.08 mm Terminal Block	ED120/2DS	On-Shore Technology
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady

Table 6-1. TPS7H5001-SP Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R1, R2, R3, R12, R13, R17, R18, R20, R32, R38, R42, R43, R44, R48, R49, R53, R54, R55, R59, R60, R61, R62, R63, R66, R67, R68, R69, R70, R71, R74, R75, R76, R77, R78, R79, R80, R81, R82, R83, R84, R85, R87, R88, R89, R90, R91, R92, R93, R98, R99, R102, R103, R109, R111	54	0	RES, 0, 5%, 0.125 W, 0603	0603	MCT06030Z0000ZP500	Vishay/Beyschlag
R4, R101	2	0	RES, 0, 5%, 1 W, AEC-Q200 Grade 0, 2512	2512	CRCW25120000Z0EG	Vishay-Dale
R9, R10	2	10.0k	RES, 10.0 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW080510K0FKEA	Vishay-Dale
R14	1	1.00k	RES, 1.00 k, 0.1%, 0.125 W, 0805	0805	RG2012P-102-B-T5	Susumu Co Ltd
R15	1	20.0k	RES, 20.0 k, 0.1%, 0.125 W, 0805	0805	RG2012P-203-B-T5	Susumu Co Ltd
R24, R26	2	10.0	RES, 10.0, 0.1%, 0.1 W, 0805	0805	CRT0805-BY-10R0ELF	Bourns
R25	1	3.90k	RES, 3.90 k, 0.5%, 0.1 W, 0805	0805	RR1220P-392-D	Susumu Co Ltd
R27	1	5.90k	RES, 5.90 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW08055K90FKEA	Vishay-Dale
R29, R30, R39	3	49.9k	RES, 49.9 k, 0.1%, 0.125 W, 0805	0805	RG2012P-4992-B-T5	Susumu Co Ltd
R31	1	135k	RES, 135 k, 0.1%, 0.125 W, 0805	0805	RT0805BRD07135KL	Yageo America
R33	1	191k	RES, 191 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW0805191KFKEA	Vishay-Dale
R35	1	1.00Meg	RES, 1.00 M, 0.5%, 0.1 W, 0805	0805	RR1220P-105-D	Susumu Co Ltd
R36	1	1.0k	RES, 1.0 k, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW08051K00JNEA	Vishay-Dale
R40	1	30.0k	RES, 30.0 k, 0.5%, 0.1 W, 0805	0805	RR1220P-303-D	Susumu Co Ltd
R41	1	4.70k	RES, 4.70 k, 1%, 0.5 W, AEC-Q200 Grade 0, 0805	0805	ERJ-P06F4701V	Panasonic
R45, R46, R47, R86, R94, R95, R96, R104, R105, R106, R118	11	0	RES, 0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	RMCF0603ZT0R00	Stackpole Electronics Inc
R100	1	10	RES, 10, 5%, 35 W, DDPAK	DDPAK	TDH35P10R0JE	Ohmite
TP1, TP9, TP17, TP18, TP19	5		Test Point, Multipurpose, Purple, TH	Purple Multipurpose Testpoint	5129	Keystone
TP2, TP8, TP16	3		Test Point, Multipurpose, Grey, TH	Grey Multipurpose Testpoint	5128	Keystone
TP3	1		Test Point, Multipurpose, Brown, TH	Brown Multipurpose Testpoint	5125	Keystone
TP4, TP5	2		Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	5012	Keystone
TP7	1		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone

Table 6-1. TPS7H5001-SP Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
TP10	1		Test Point, Multipurpose, Blue, TH	Blue Multipurpose Testpoint	5127	Keystone
TP11, TP20, TP21, TP22, TP23, TP24, TP25, TP26, TP27	9		Test Point, Multipurpose, Orange, TH	Orange Multipurpose Testpoint	5013	Keystone
TP13, TP14	2		Test Point, Miniature, SMT	Test Point, Miniature, SMT	5019	Keystone
TP28, TP29, TP30, TP31	4		Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone
U1	1		Radiation-Hardness-Assured Si and GaN Dual Output Controller	CFP22	TPS7H5001HKY-EM	Texas Instruments
U2, U3	2		Single 2-Input Positive-AND Gate, DCK0005A, LARGE T&R	DCK0005A	SN74AHCT1G08DCKR	Texas Instruments
U4	1		800mA Low-Dropout Linear Regulator, 4-pin SOT-223	DCY0004A	TLV1117-50DCY	Texas Instruments
U5, U6	2		250 MHz, Rail-to-Rail I/O, CMOS Single Operational Amplifier, 2.5 to 5.5 V, -40 to 125 degC, 5-pin SOT23 (DBV5), Green (RoHS & no Sb/Br)	DBV0005A	OPA354AIDBVR	Texas Instruments
C11	0	1000pF	CAP, CERM, 1000 pF, 50 V, ±10%, C0G/NP0, 0805	0805	08055A102KAT2A	AVX
C12	0	0.01uF	CAP, CERM, 0.01 uF, 50 V, ±20%, X7R, 0805	0805	C0805C103M5RACTU	Kemet
C13	0	0.47uF	CAP, CERM, 0.47 uF, 50 V, ±10%, X7R, AEC-Q200 Grade 1, 0805	0805	GCM21BR71H474KA55L	MuRata
C14	0	1uF	CAP, CERM, 1 µF, 50 V,±5%, X7R, AEC-Q200 Grade 1, 1210	1210	C1210C105J5RACTU	Kemet
C19, C32, C33, C38, C39	0	0.1uF	CAP, CERM, 0.1 uF, 25 V, ±10%, X7R, 0805	0805	C0805C104K3RACTU	Kemet
C26, C34	0	0.1uF	CAP, CERM, 0.1 uF, 25 V, ±10%, X7R, 0603	0603	C0603X104K3RACTU	Kemet
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
J7, J8, J9, J10	0		Header Mate, 2.54mm, 21x2	Pads to Mate with Mill-Max_820-22-042-30-001101	820-22-042-30-001101_MATE	Mill-Max
R5, R6, R7, R8	0	1.00Meg	RES, 1.00 M, 0.5%, 0.1 W, 0805	0805	RR1220P-105-D	Susumu Co Ltd
R11, R16, R19, R22, R28, R34, R37, R50, R51, R52, R56, R57, R58, R64, R65, R72, R73, R108, R110, R112, R113, R114, R115, R116, R117	0	0	RES, 0, 5%, 0.125 W, 0603	0603	MCT06030Z0000ZP500	Vishay/Beyschlag
R21	0	10.0k	RES, 10.0 k, 1%, 0.2 W, 0805	0805	MCU08050C1002FP500	Vishay/Beyschlag
R23, R97, R107	0	0	RES, 0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	RMCF0603ZT0R00	Stackpole Electronics Inc

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 DEGREDATION 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/lsds/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/lsds/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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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。

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東京都新宿区西新宿 6 丁目 2 4 番 1 号
西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/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.

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.

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, INDEMITY 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.

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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