

TPS212x Evaluation Module

This user's guide describes the characteristics, operation, and use of the TPS212xEVM (EVM). This document contains the EVM schematics, board layout, bill of materials (BOM), and necessary instructions on how to properly operate the EVM.

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1 Introduction

The TPS212x EVM is an evaluation module for TI's TPS212x family of two-input, one-output power multiplexers. This device automatically detects, selects, and seamlessly transitions between two power supplies, each operating from 2.7 V to 22 V. The TPS2121 device, the VSON hot-rod package, can deliver up to 4 A while the TPS2120, WCSP package, can handle up to 3 A. This user's guide contains the EVM schematics, board layout, list of materials, and necessary instructions on how to properly operate the EVM.

The EVM has test points for convenient access to all critical voltages and pins, and jumpers to configure the different modes of operation. There are also jumpers to configure input and output capacitance, output load resistance, current limit, and the adjustable soft-start time.

1.1 Features

The TPS212x EVM offers many features including:

- Uninterrupted system power with seamless switchover
- Overvoltage protection
- Low R_{ON} resistance at both inputs: 50 m Ω typical
- Multiple configurations for different modes of operation

1.2 Applications

The TPS212x power multiplexer can be used in many applications, including:

- Add-on cards (PCIE, RAID, Network)
- ePos
- Video surveillance
- ORing controllers

1.3 Description

The TPS212x EVM power MUX evaluation board enables evaluation of the TPS212x family of Power MUX devices. Although both variants (TPS2121EVM-042 or TPS2120EVM-023) contain different jumpers and connectors, they will function almost identically. Both EVMs allow operation at different input voltages, although the resistors and jumpers are configured for operation at 3.3 V, 5 V, and 12 V. See the TPS212x data sheet for more information regarding these settings.

The TPS212x EVMs also allow multiple modes of operation. By configuring the jumpers, the EVMs automatically detect, select, and seamlessly transition between available inputs. The different modes of operation are explained in [Table 1](#).

Table 1. TPS212x EVM Comparison Table

EVM	Modes of Operation:	V_{OUT} Range	I_{OUT} MAX	Package
TPS2121EVM	<ul style="list-style-type: none"> • VCOMP • VREF • XCOMP • XREF 	2.7 V–22 V	4 A	VSON, 2.0 mm × 2.5 mm
TPS2120EVM	<ul style="list-style-type: none"> • VCOMP • VREF 	2.7 V–22 V	3 A	WCSP, 1.5 mm × 2.0 mm

2 General Configurations

2.1 TPS2121 Configurations

This section provides an overview of the TPS212x evaluation board input and output jumpers. [Table 2](#) describes the input and output connectors on the EVM. [Table 3](#) describes the different test points and functionality, while [Table 4](#) describes the jumper functionality and configurations.

Table 2. TPS2121 Input and Output Connector Functionality

Input	Connector	Label	Description
VIN1	J21	VIN1 + , GND -	Input block header for VIN1
	TP8	VIN1	Input test point for VIN1
	TP6	VIN1_SNS	Input sense connector for VIN1
VIN2	J14	VIN2 + , GND -	Input block header for VIN2
	TP11	VIN2	Input test point for VIN2
	TP6	VIN2_SNS	Input sense connector for VIN2
VOUT	J15	VOUT + , GND -	Output block header for VOUT
	TP9	VOUT	Output test point for VOUT
	TP7	VOUT_SNS	Output sense connector for VOUT
GND	TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19	GND	Test point for GND

Table 3. TPS2121 Test Points Description

Input	Connector	Label	Description
VIN1	TP1	OV1	Overvoltage test point for VIN1
	TP4	PR1	Priority test point for VIN1
VIN2	TP2	OV2	Overvoltage test point for VIN2
	TP3	CP2	Comparator test point for VIN2
VOUT	TP5	ST	Status test point

Table 4. TPS2121 Jumper Description

Input	Connector	Label	Description
VIN1	J1, J2, J3	PR1 Resistors (3.3 V, 5 V, 12 V)	Sets priority operation based on voltage J1 sets 3.3 V J2 sets 5 V J3 sets 12 V
	J4, J5, J6	OV1 Resistors (3.3 V, 5 V, 12 V)	Sets overvoltage protection for VIN1 J4 sets 3.3 V J5, sets 5 V J6 sets 12 V
	JP1	PR1	Priority operation control Position 1-2 sets VCOMP (GND) Position 2-3 sets VREF, XCOMP, XREF
VIN2	J7, J8, J9	CP2 Resistors (3.3 V, 5 V, 12 V)	Sets XCOMP operation based on voltage J7 sets 3.3 V J8 sets 5 V J9 sets 12 V
	J10, J11, J12	OV2 Resistors (3.3 V, 5 V, 12 V)	Sets overvoltage protection for VIN2 channel J10 sets 3.3 V J11, sets 5 V J12 sets 12 V
	J13	CP2	CP2 enable, disable

Table 4. TPS2121 Jumper Description (continued)

Input	Connector	Label	Description
VOUT	J17, J18	100 μ F	100- μ F output capacitor
	J19	100 μ F	100- μ F output capacitor
	J19	220 μ F	220- μ F output capacitor
	J16	-	Female header for custom output resistance, capacitance
	J20	10 Ω	10- Ω external resistor
	JP2	ST	Sets adjustable hysteresis Position 1-2 sets ST, 2-3 disables (GND)
	J22, J23	SS	Soft-start control
	JP3	ILIM	Current limit control Position 1-2 position sets 4.5 A maximum Position 2-3 sets 2 A maximum No jumper sets 1.5 A maximum

2.2 TPS2120 Configurations

This section provides an overview of the TPS212x evaluation board input and output jumpers. [Table 2](#) describes the input and output connectors on the EVM. [Table 3](#) describes the different test points and functionality, while [Table 4](#) describes the jumper functionality and configurations.

Table 5. TPS2120 Input and Output Connector Functionality

Input	Connector	Label	Description
VIN1	J10	VIN1 + , GND -	Input block header for VIN1
	TP7	VIN1	Input test point for VIN1
	TP5	VIN1_SNS	Input sense connector for VIN1
VIN2	J17	VIN2 + , GND -	Input block header for VIN2
	TP11	VIN2	Input test point for VIN2
	TP10	VIN2_SNS	Input sense connector for VIN2
VOUT	J11	VOUT + , GND -	Output block header for VOUT
	TP8	VOUT	Output test point for VOUT
	TP6	VOUT_SNS	Output sense connector for VOUT
GND	TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19	GND	Test point for GND

Table 6. TPS2120 Test Points Description

Input	Connector	Label	Description
VIN1	TP1	OV1	Overvoltage test point for VIN1
	TP3	PR1	Priority test point for VIN1
VIN2	TP2	OV2	Overvoltage test point for VIN2
	TP9	SEL	Select test point
VOUT	TP4	ST	Status test point

Table 7. TPS2120 Jumper Description

Input	Connector	Label	Description
VIN1	J1, J2, J3	PR1 Resistors (3.3 V, 5 V, 12 V)	Sets priority operation based on voltage J1 sets 3.3 V J2 sets 5 V J3 sets 12 V
	J4, J5, J6	OV1 Resistors (3.3 V, 5 V, 12 V)	Sets overvoltage protection for VIN1 channel J4 sets 3.3 V J5, sets 5 V J6 sets 12 V
	JP2	PR1	Priority operation control Position 1-2 sets VCOMP (GND) Position 2-3 sets VREF
VIN2	J7, J8, J9	OV2 Resistors (3.3 V, 5 V, 12 V)	Sets overvoltage protection for VIN2 channel J10 sets 3.3 V J11, sets 5 V J12 sets 12 V
	JP1	SEL	Selects between priority control or GND Position 1-2 disables priority Position 2-3 enables priority
VOUT	J12	100 μ F	100- μ F output capacitor
	J13	100 μ F	100- μ F output capacitor
	J14	220 μ F	220- μ F output capacitor
	J15	10 Ω	10- Ω external resistor
	J16	-	Female header for custom output resistance, capacitance
	JP3	ST	Sets adjustable hysteresis Position 1-2 sets ST Position 2-3 disables (GND)
	J18, J19	SS	Soft-start control
	JP4	ILIM	Current Limit Control Position 1-2 sets 4.5 A maximum Position 2-3 sets 2 A No jumper sets 1.5 A

3 Test Setup and Results

This chapter describes the proper setup for the TPS212x power MUX EVM. This section explains the different configuration modes present on each EVM, and the required jumper positions to enable each configuration.

3.1 TPS212x EVM Test Equipment

Read the TPS212x data sheet before using the EVM.

The following test equipment is recommended:

- Storage oscilloscope
- Current problem
- Two adjustable power supplies, 0 V–22 V at 4 A maximum
- A passive or active load

3.2 Setting up the TPS2121 EVM

Make sure the TPS2121 evaluation board has the default jumper settings as [Table 8](#) shows.

Table 8. Default Jumper Settings for TPS2121 Evaluation Board

Input	Connector	Label	Position
VIN1	J1	PR1 (3.3 V)	Install
	J4	OV1 (3.3 V)	Install
VIN2	J12	OV2 (12 V)	Install
	J13	CP2	Install
VOUT	J17, J18	100 μ F	Install
	J20	10 Ω	Install
	J22	SS (10 nF)	Install
	JP1	PR1	Jump pins 2 and 3
	JP2	ST	Jump pins 2 and 3
	JP3	ILIM (4.5 A maximum)	Jump pins 1 and 2

The default jumper configuration sets the Internal Voltage Reference (VREF) configuration. Since the voltage on the priority pin is set for 3.3-V operation and CP2 is grounded, priority will be given to VIN1. Therefore, VIN1 can be set to 3.3 V, and the device will prioritize VIN1 even if VIN2 is at a higher voltage. See the data sheet for more information regarding the configuration settings.

3.3 Setting up the TPS2120 EVM

Make sure the TPS2120 evaluation board has default jumper settings as [Table 9](#) shows.

Table 9. Default Jumper Settings for TPS2120 Evaluation Board

Input	Connector	Label	Position
	J1	PR1 (3.3 V)	Install
	J4	OV1 (3.3 V)	Install
	J9	J9 (12 V)	Install
	J12, J13	100 μ F	Install
	J15	10 Ω	Install
	J18	SS (10 nF)	Install
	JP1	SEL	Jump pins 1 and 2
	JP2	PR1	Jump pins 2 and 3
	JP3	ST	Jump pins 2 and 3
	JP4	ILIM (4.5 A maximum)	Jump pins 2 and 3

The default jumper configuration sets the Internal Voltage Reference (VREF) configuration. Since the voltage on the priority pin is set for 3.3-V operation and SEL is grounded, the priority is given to VIN1. Therefore, VIN1 can be set to 3.3 V, and the device will prioritize VIN1 even if VIN2 is at a higher voltage. See the data sheet for more information regarding the configuration settings.

4 Board Layout

Figure 1 and Figure 2 show the test equipment setup for the TPS2121 and TPS2120, respectively.

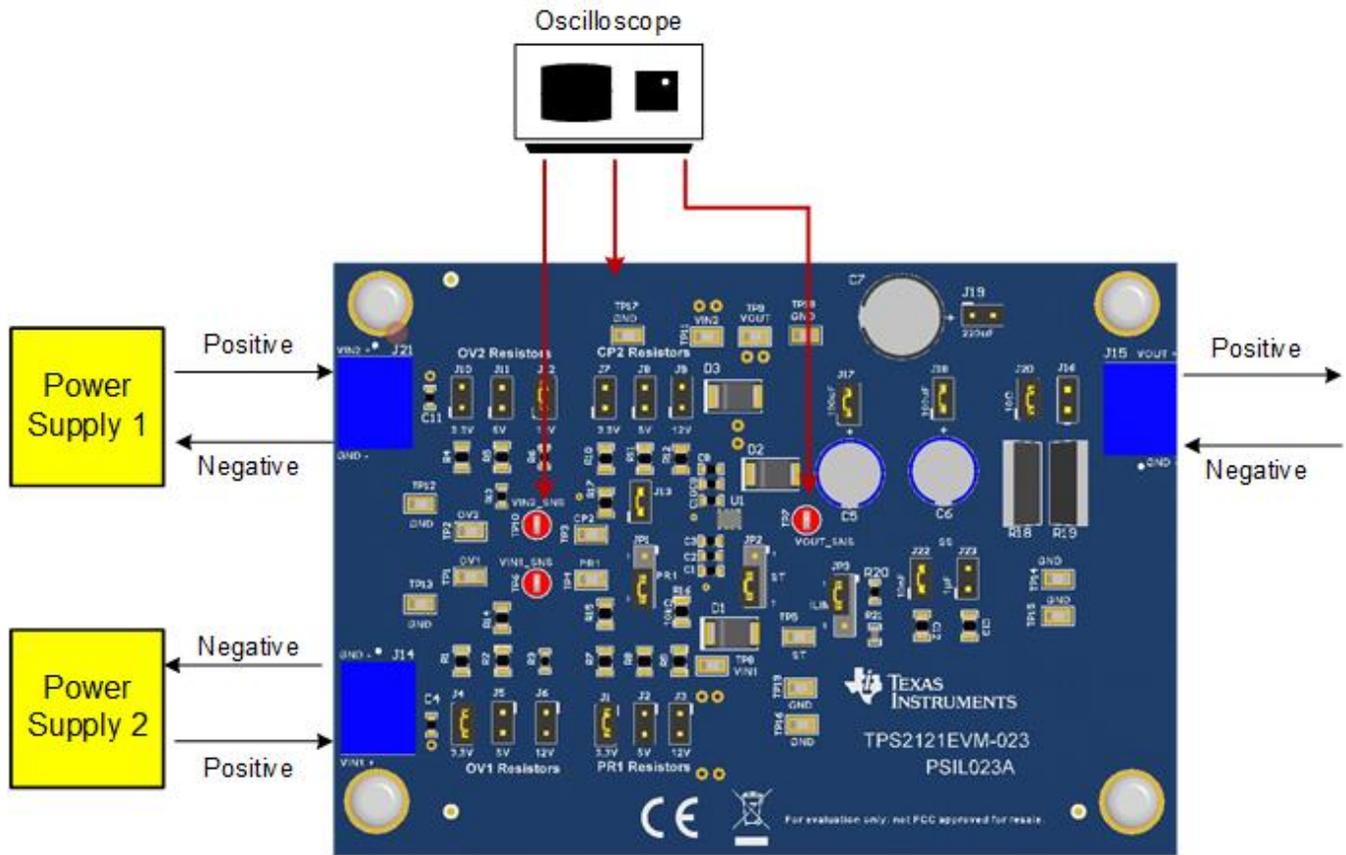


Figure 1. TPS2121 Setup With Test Equipment

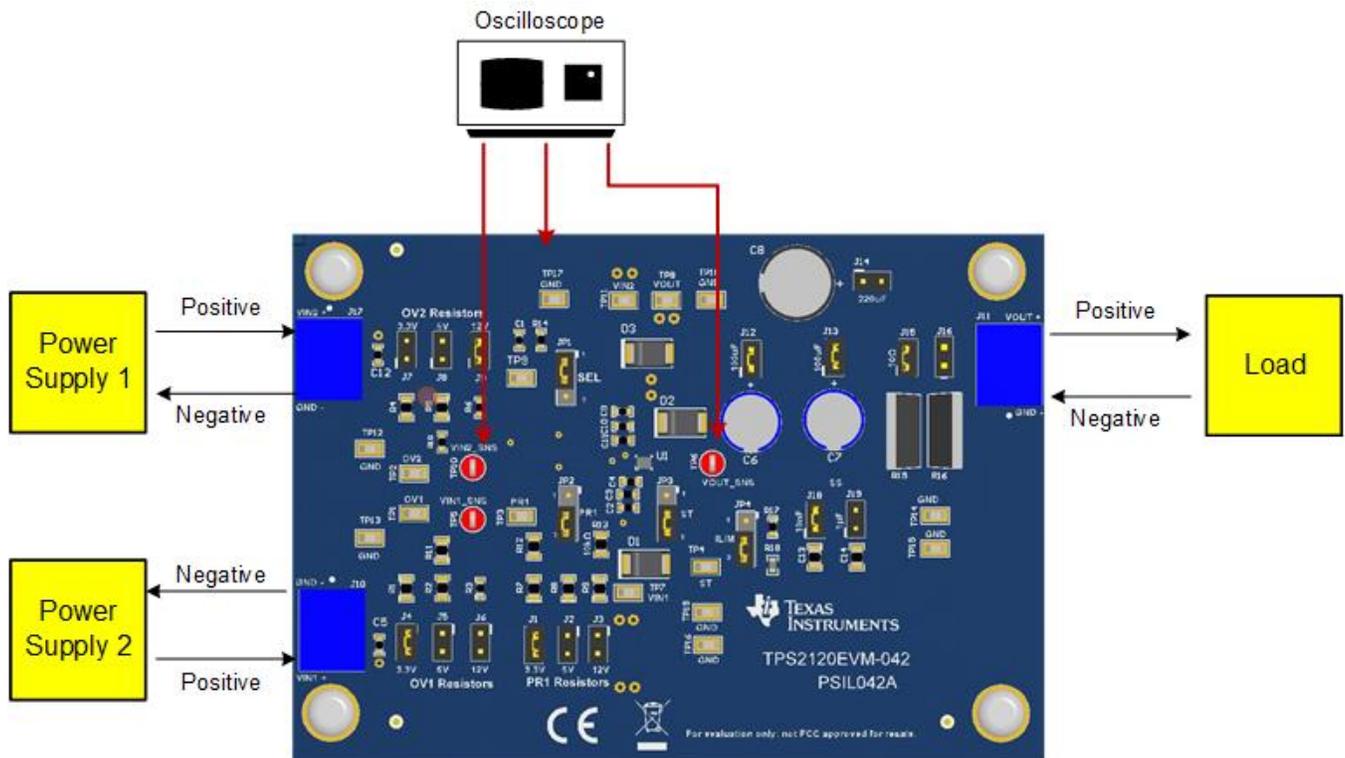


Figure 2. TPS2120 Setup With Test Equipment

5 Schematic

Figure 3 illustrates the TPS2121 schematic and Figure 4 illustrates the TPS2120 schematic.

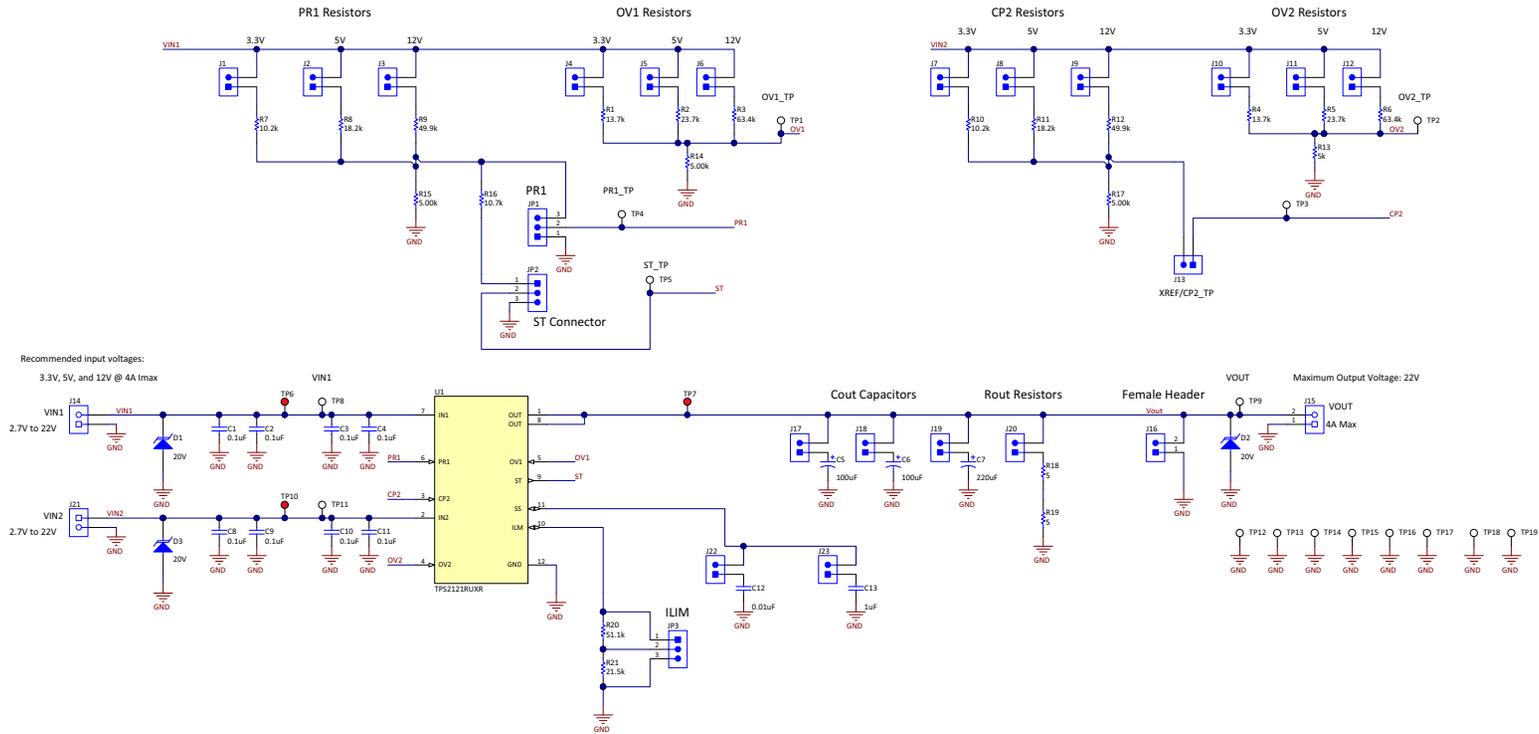


Figure 3. TPS2121 Schematic

6 Bill of Materials

Table 10 lists the TPS2121EVM-023 BOM and Table 11 lists the TPS2120EVM-042 BOM.

Table 10. TPS2121EVM-023 Bill of Materials⁽¹⁾

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer	Alternate PartNumber	Alternate Manufacturer
!PCB1	1		Printed Circuit Board		PSIL023	Any		
C1, C2, C3, C4, C8, C9, C10, C11	8	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X7R, 0603	0603	06033C104KAT2A	AVX		
C5,C6	2	100uF	CAP, AL, 100 uF, 50 V, +/- 20%, 0.17 ohm, TH	8.0x10.5mm	UHE1H101MPD	Nichicon		
C7	1	220uF	CAP, AL, 220 uF, 35 V, +/- 20%, TH	D10xL12.5mm	UHE1V221MPD6	Nichicon		
C12	1	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X7R, 0805	0805	885012207092	Würth Elektronik		
C13	1	1uF	CAP, CERM, 1 uF, 50 V, +/- 10%, X7R, 0805	0805	C0805C105K5RAC TU	Kemet		
D1, D2, D3	3	20V	Diode, TVS, Uni, 20 V, 32.4 Vc, SMB	SMB	SMBJ20A-13-F	Diodes Inc.		
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Phillips 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, J5, J6, J7, J8, J9, J10, J11, J12, J13, J17, J18, J19, J20, J22, J23	19		Header, 100mil, 2x1, Gold, TH	2x1 Header	TSW-102-07-G-S	Samtec		
J14, J15, J21	3		Terminal Block, 2x1, 5.08mm, TH	2x1 Terminal Block	OSTTA024163	On-Shore Technology		
J16	1		Receptacle, 2x1, 2.54mm, Tin, TH	Receptacle, 2x1, 2.54mm, TH	SSW-102-01-T-S	Samtec		
JP1, JP2, JP3	3		Header, 100mil, 3x1, TH	Header, 3x1, 100mil, TH	800-10-003-10-001000	Mill-Max		

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

Table 10. TPS2121EVM-023 Bill of Materials⁽¹⁾ (continued)

R1, R4	2	13.7k	RES, 13.7 k, 1%, 0.125 W, 0805	0805	ERJ-6ENF1372V	Panasonic		
R2, R5	2	23.7k	RES, 23.7 k, 0.1%, 0.125 W, 0805	0805	RT0805BRD0723K 7L	Yageo America		
R3, R6	2	63.4k	RES, 63.4 k, 0.1%, 0.1 W, 0603	0603	RT0603BRD0763K 4L	Yageo America		
R7, R10	2	10.2k	RES, 10.2 k, 0.5%, 0.1 W, 0805	0805	RR1220P-1022-D- M	Susumu Co Ltd		
R8, R11	2	18.2k	RES, 18.2 k, 0.1%, 0.125 W, 0805	0805	RT0805BRD0718K 2L	Yageo America		
R9, R12	2	49.9k	RES, 49.9 k, 0.5%, 0.1 W, 0805	0805	RR1220P-4992-D- M	Susumu Co Ltd		
R13	1	5.00k	RES, 5.00 k, 0.1%, 0.05 W, 0402	0402	PNM0402E5001BS T1	Vishay-Dale		
R14, R15, R17	3	5.00k	RES, 5.00 k, 0.1%, 0.2 W, 0805	0805	PNM0805E5001BS T5	Vishay Thin Film		
R16	1	10.7k	RES, 10.7 k, 1%, 0.125 W, AEC- Q200 Grade 0, 0805	0805	CRCW080510K7F KEA	Vishay-Dale		
R18, R19	2	5	RES, 5, 1%, 50 W, TO-220-2	TO-220-2	PF2205-5RF1	RIDEON		
R20	1	51.1k	RES, 51.1 k, 0.5%, 0.1 W, 0603	0603	RT0603DRE0751K 1L	Yageo America		
R21	1	21.5k	RES, 21.5 k, .5%, .0625 W, 0603	0603	RR0816P-2152-D- 33C	Susumu Co Ltd		
SH-J1, SH-J2, SH- J3, SH-J4, SH-J5, SH-J6, SH-J7, SH- J8, SH-J9, SH-J10, SH-J11	11	1x2	Shunt, 100mil, Flash Gold, Black	Closed Top 100mil Shunt	SPC02SYAN	Sullins Connector Solutions		
TP1, TP2, TP3, TP4, TP5, TP8, TP9, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19	16		Test Point, Miniature, SMT	Testpoint_Keyston e_Miniature	5015	Keystone		
TP6, TP7, TP10	3		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone		

Table 10. TPS2121EVM-023 Bill of Materials⁽¹⁾ (continued)

U1	1		2.7V-22V, 4A, 50mohm Priority Power MUX, RUX0012A (VQFN-HR-12)	RUX0012A	TPS2121RUXR	Texas Instruments	TPS2121RUXT	Texas Instruments
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		

Table 11. TPS2120EVM-042 Bill of Materials⁽¹⁾

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer	Alternate PartNumber	Alternate Manufacturer
!PCB1	1		Printed Circuit Board		PSIL042	Any		
C1, C2, C3, C4, C5, C9, C10, C11, C12	9	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X7R, 0603	0603	06033C104KAT2A	AVX		
C6, C7	2	100uF	CAP, AL, 100 uF, 50 V, +/- 20%, 0.17 ohm, TH	8.0x10.5mm	UHE1H101MPD	Nichicon		
C8	1	220uF	CAP, AL, 220 uF, 35 V, +/- 20%, TH	D10xL12.5mm	UHE1V221MPD6	Nichicon		
C13	1	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X7R, 0805	0805	885012207092	Wurth Elektronik		
C14	1	1uF	CAP, CERM, 1 uF, 50 V, +/- 10%, X7R, 0805	0805	C0805C105K5RAC TU	Kemet		
D1, D2, D3	3	20V	Diode, TVS, Uni, 20 V, 32.4 Vc, SMB	SMB	SMBJ20A-13-F	Diodes Inc.		
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, J5, J6, J7, J8, J9, J12, J13, J14, J15, J18, J19	15		Header, 100mil, 2x1, Gold, TH	2x1 Header	TSW-102-07-G-S	Samtec		

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

Table 11. TPS2120EVM-042 Bill of Materials⁽¹⁾ (continued)

J10, J11, J17	3		Terminal Block, 2x1, 5.08mm, TH	2x1 Terminal Block	OSTTA024163	On-Shore Technology		
J16	1		Receptacle, 2x1, 2.54mm, Tin, TH	Receptacle, 2x1, 2.54mm, TH	SSW-102-01-T-S	Samtec		
JP1, JP2, JP3, JP4	4		Header, 100mil, 3x1, TH	Header, 3x1, 100mil, TH	800-10-003-10- 001000	Mill-Max		
R1, R4	2	13.7k	RES, 13.7 k, 1%, 0.125 W, 0805	0805	ERJ-6ENF1372V	Panasonic		
R2, R5	2	23.7k	RES, 23.7 k, 0.1%, 0.125 W, 0805	0805	RT0805BRD0723K 7L	Yageo America		
R3, R6	2	63.4k	RES, 63.4 k, 0.1%, 0.1 W, 0603	0603	RT0603BRD0763K 4L	Yageo America		
R7	1	10.2k	RES, 10.2 k, 0.5%, 0.1 W, 0805	0805	RR1220P-1022-D- M	Susumu Co Ltd		
R8	1	18.2k	RES, 18.2 k, 0.1%, 0.125 W, 0805	0805	RT0805BRD0718K 2L	Yageo America		
R9	1	49.9k	RES, 49.9 k, 0.5%, 0.1 W, 0805	0805	RR1220P-4992-D- M	Susumu Co Ltd		
R10	1	5.00k	RES, 5.00 k, 0.1%, 0.05 W, 0402	0402	PNM0402E5001BS T1	Vishay-Dale		
R11, R12	2	5.00k	RES, 5.00 k, 0.1%, 0.2 W, 0805	0805	PNM0805E5001BS T5	Vishay Thin Film		
R13	1	10.7k	RES, 10.7 k, 1%, 0.125 W, AEC- Q200 Grade 0, 0805	0805	CRCW080510K7F KEA	Vishay-Dale		
R14	1	10.0k	RES, 10.0 k, 0.5%, 0.1 W, 0603	0603	RT0603DRE0710K L	Yageo America		
R15, R16	2	5	RES, 5, 1%, 50 W, TO-220-2	TO-220-2	PF2205-5RF1	RIDEON		
R17	1	51.1k	RES, 51.1 k, 0.5%, 0.1 W, 0603	0603	RT0603DRE0751K 1L	Yageo America		
R18	1	21.5k	RES, 21.5 k, .5%, .0625 W, 0603	0603	RR0816P-2152-D- 33C	Susumu Co Ltd		
SH-J1, SH-J2, SH- J3, SH-J4, SH-J5, SH-J6, SH-J7, SH- J8, SH-J9, SH-J10	10	1x2	Shunt, 100mil, Flash Gold, Black	Closed Top 100mil Shunt	SPC02SYAN	Sullins Connector Solutions		

Table 11. TPS2120EVM-042 Bill of Materials⁽¹⁾ (continued)

TP1, TP2, TP3, TP4, TP7, TP8, TP9, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19	16		Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone		
TP5, TP6, TP10	3		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone		
U1	1		TPS2120YFPR, YFP0020AAAA (DSBGA-20)	YFP0020AAAA	TPS2120YFPR	Texas Instruments	TPS2120YFPT	Texas Instruments
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		

Revision History

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

Changes from Original (September 2018) to A Revision	Page
• Changes made in Table 4	3
• Changes made in the <i>Bill of Materials</i> table.....	11

STANDARD TERMS FOR EVALUATION MODULES

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 - 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.

【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。

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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
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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, 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.

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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