

USB Type-C™ PD TKT Evaluation Module

This user's guide describes the TPS65987DDJ evaluation module (USB-C-PD-TKT-EVM). The USB-C-PD-TKT-EVM allows for the evaluation of the TPS65987DDJ Power Delivery (PD). In addition, the EVM contains a Type-A to USB Type-C converter, a plug-to-receptacle converter, and a passing through board for debugging purposes. The USB-C-PD-TKT-EVM uses default configurations to allow for sourcing 45 W or 60 W by simply using a switch. This document contains an introduction, setup conditions, the EVM schematics, top- and bottom-board layouts and component views, layout, and a bill of materials (BOM).

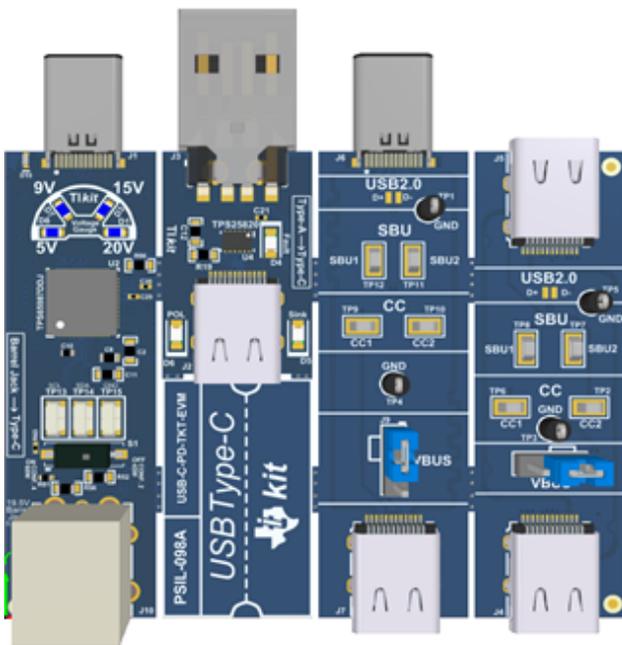


Figure 1. Front Layout

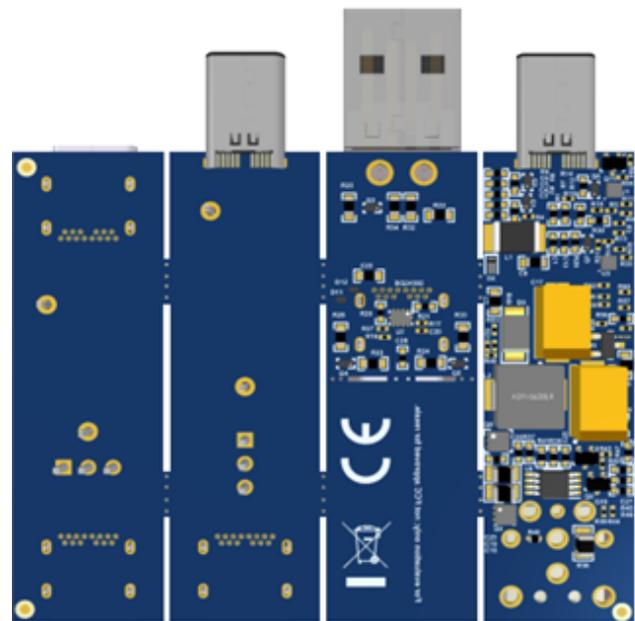


Figure 2. Back Layout

Trademarks

USB Type-C is a trademark of USB Implementers Forum.
 All other trademarks are the property of their respective owners.

1 Introduction

The USB-C-PD-TKT-EVM allows the TPS65987DDJ device to enter default configuration 2 which supports a 45-W source and default configuration 4 which supports a 60-W source. The USB-C-PD-TKT-EVM contains a Type-A to USB Type-C converter, a plug-to-receptacle converter, and a passing through board for debugging purposes.

2 Setup and Switches, Test Points, and LED Descriptions

2.1 LEDs (D1), (D3), (D7), and (D8)

These LEDs highlight if the source board is outputting a 5-V, 9-V, 15-V, or 20-V PD contract respectively.

2.2 LED (D10)

This LED highlights if a valid USB Type-C connection is detected.

2.3 LED (D4)

This LED highlights if a fault condition is detected.

2.4 LED (D5)

This LED highlights if a USB Type-C sink is detected on the CC lines.

2.5 LED (D6)

This LED highlights if the CC2 pin is connected to the cable CC line.

2.6 TP1 (GND), TP3 (GND), TP4 (GND), and TP5 (GND)

These are test points connected to the ground nets for debugging or testing purposes.

2.7 Jumpers (J8) and (J9)

These jumpers connect the VBUS nets from receptacle-to-receptacle and plug-to-receptacle, respectively.

2.8 Switch (S1)

This switch allows the user to select which default configuration to enter.

On – Configuration 4. 60-W Source

OFF - Configuration 2. 45-W Source

2.9 J1 and J6 USB Type-C™ Plugs

These USB Type-C plugs can be connected to any USB Type-C receptacle for a valid connection.

2.10 J3 USB Type-A Plug

This plug is located in the board to allow data transfer from USB Type-C to Type-A.

2.11 J2, J4, J5, J7 USB Type-C™ Receptacles

These are type receptacles that required a USB Type-C plug to establish a valid connection.

2.12 J10 Barrel Jack Connector

This connector requires a minimum 20-V_{OUT}, 3-A I_{OUT} power supply for the board to function as specified.

2.13 TP2 (CC2), TP6 (CC1), TP9 (CC1), and TP10 (CC2)

Use test points TP6 and TP9 to test the data transferred and data communication through CC1 lines on the receptacle-to-receptacle and plug-to-receptacle board, respectively. Use test points TP2 and TP10 to test the data transferred and data communication through CC2 lines on the receptacle-to-receptacle and plug-to-receptacle board respectively.

2.14 TP13 (SCL), TP14 (SDA), and TP15 (GND)

Use this set of tests points for I2C communication in case of user-defined configurations from an SPI flash. TP13, TP14, and TP15 connect to the I2C1_SCL, I2C1_SDA, and the ground nets, respectively.

3 Using the USB-C-PD-TKT-EVM

To get started with the USB-C-PD-TKT-EVM, connect a barrel jack power supply of 20-V_{OUT}, 3-A I_{OUT} minimum into J10. Next, connect the J1 USB Type-C plug into a USB Type-C receptacle that is PD compliant. After the connection, depending on the sinking characteristics the LEDs D1, D3, D7, and D8 will highlight the current PD contract.

4 USB-C-PD-TKT-EVM Schematics

Figure 3 through Figure 9 illustrate the USB-C-PD-TKT-EVM schematics.

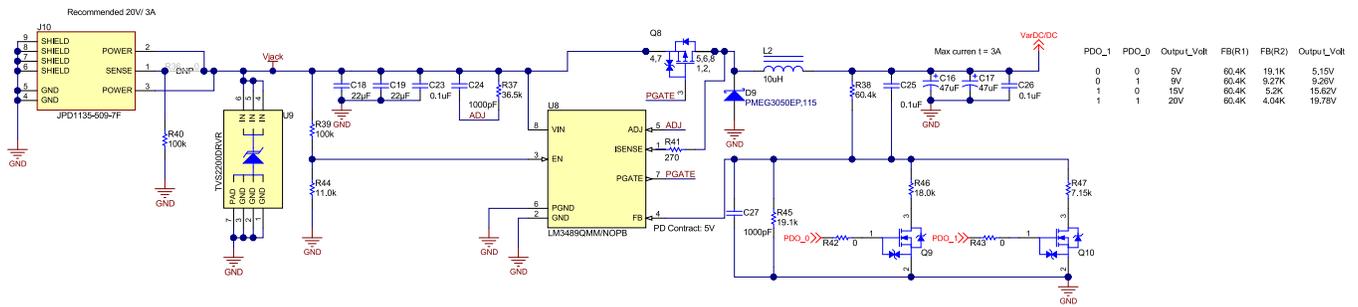


Figure 3. DC/DC Buck Converter

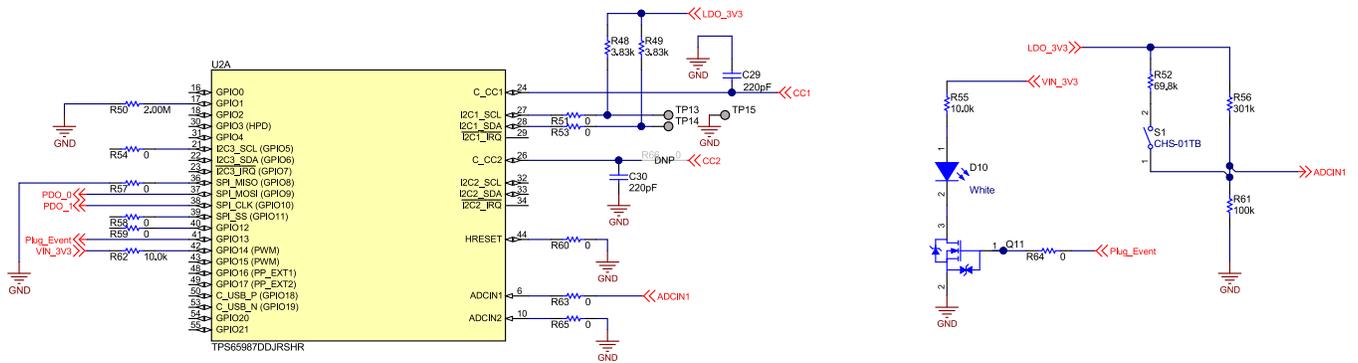


Figure 4. PD Controller

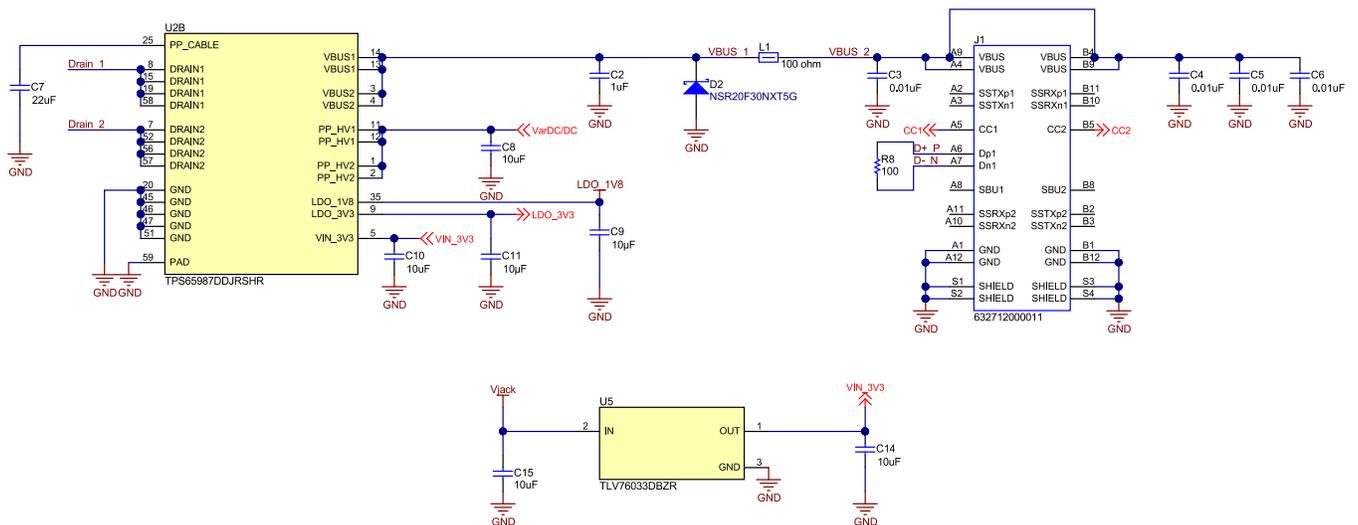


Figure 5. Power Path

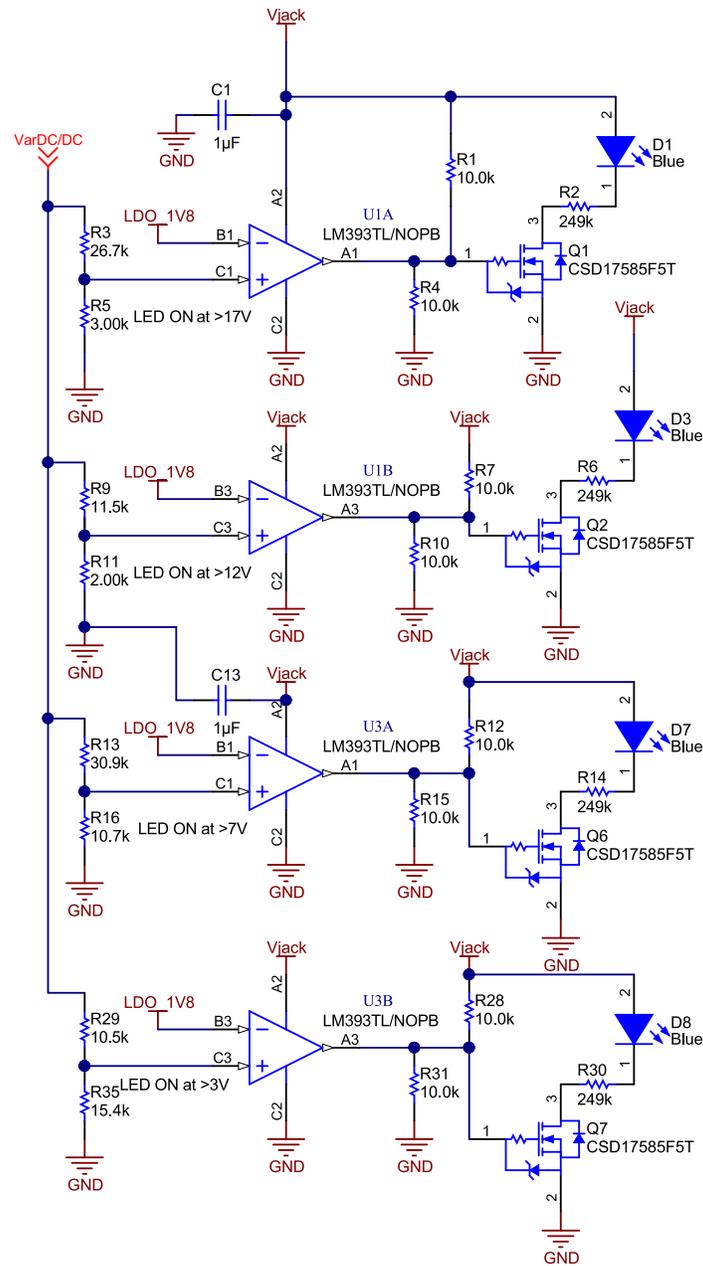


Figure 6. LED Control

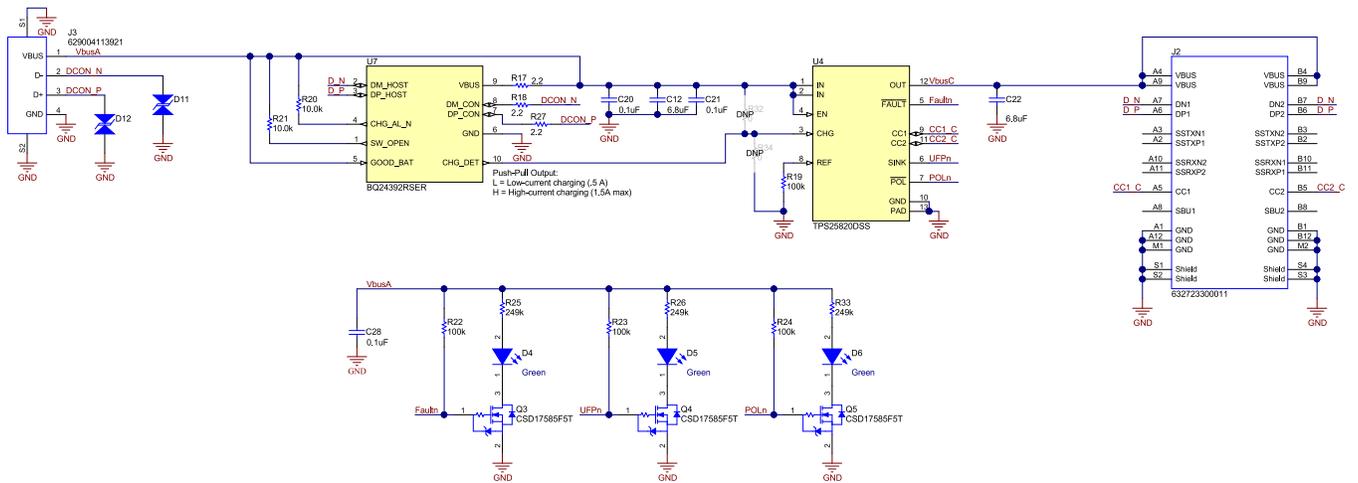


Figure 7. Type-A to USB Type-C™ Converter

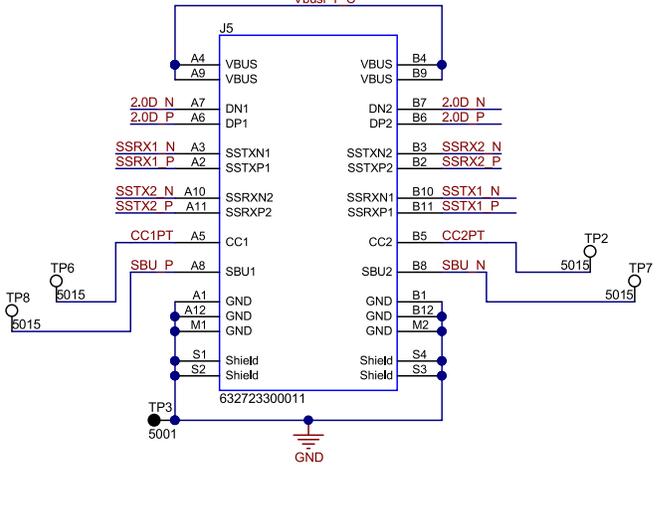
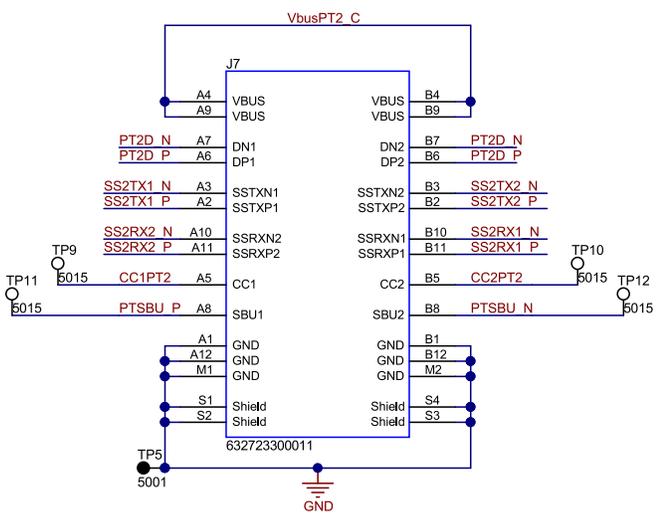
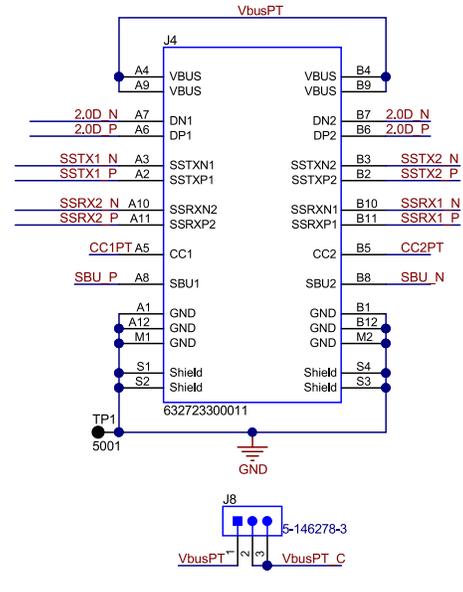
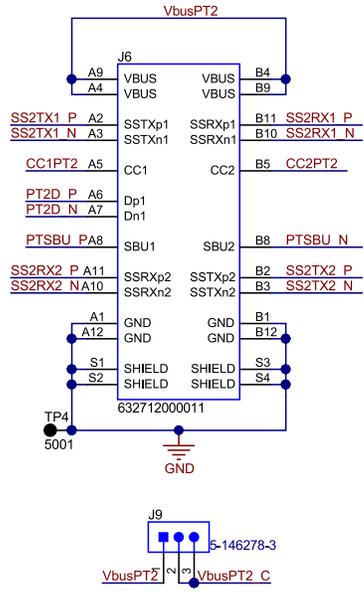


Figure 8. Plug to Receptacle

Figure 9. Receptacle to Receptacle

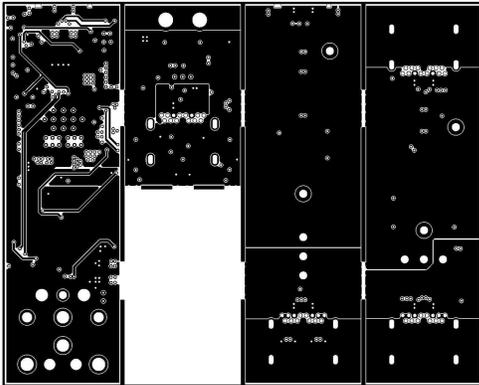


Figure 16. USB-C-PD-TKT-EVM Power 1

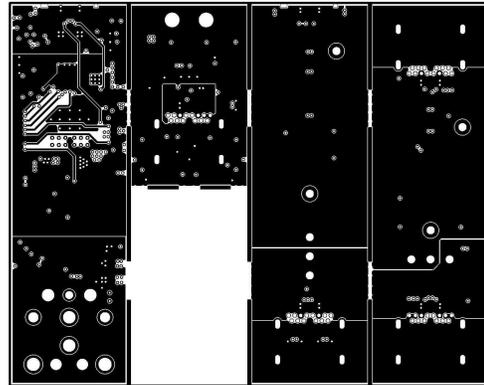


Figure 17. USB-C-PD-TKT-EVM Power 2

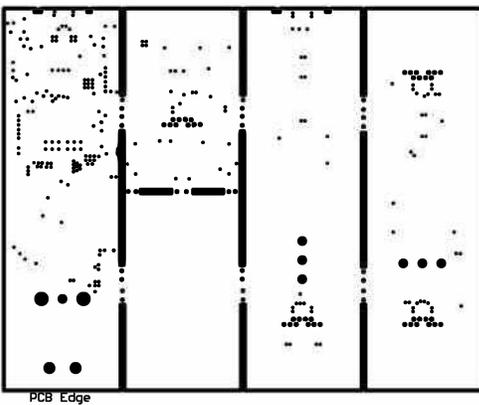


Figure 18. USB-C-PD-TKT-EVM Plane 3

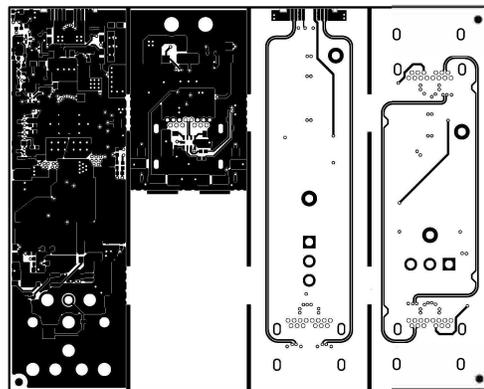


Figure 19. USB-C-PD-TKT-EVM Bottom Layer

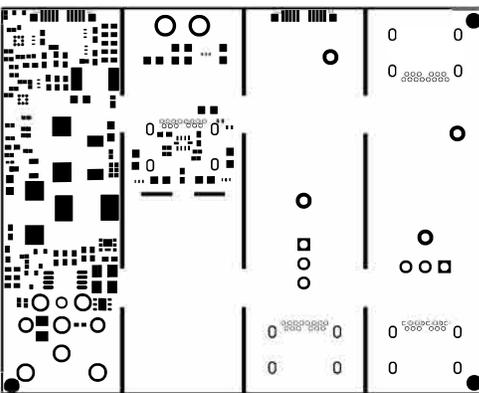


Figure 20. USB-C-PD-TKT-EVM Bottom Solder

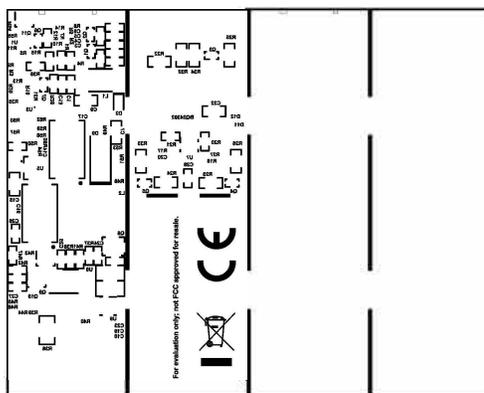


Figure 21. USB-C-PD-TKT-EVM Bottom Overlay

6 USB-C-PD-TKT-EVM Bill of Materials

Table 1 shows the USB-C-PD-TKT-EVM BOM.

Table 1. USB-C-PD-TKT-EVM BOM⁽¹⁾

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
!PCB1	1		Printed Circuit Board		PSIL098	Any		
C1, C13	2	1 uF	CAP, CERM, 1 uF, 35 V, ±10%, X5R, AEC-Q200 Grade 3, 0402	0402	GRT155R6YA105KE13D	MuRata		
C2	1	1 uF	CAP, CERM, 1 uF, 50 V, ±10%, X7R, 0603	0603	UMK107AB7105KA-T	Taiyo Yuden		
C3, C4, C5, C6	4	0.01 uF	CAP, CERM, 0.01 uF, 50 V, ±10%, X7R, AEC-Q200 Grade 1, 0402	0402	CGA2B3X7R1H103K050BB	TDK		
C7	1	22 uF	CAP, CERM, 22 uF, 10 V, ±20%, X5R, 0603	0603	C1608X5R1A226M080AC	TDK		
C8	1	10 uF	CAP, CERM, 10 uF, 25 V, ±20%, X5R, 0603	0603	GRM188R61E106MA73D	MuRata		
C9, C11	2	10 uF	CAP, CERM, 10 uF, 6.3 V, ±20%, X7R, 0603	0603	CL10B106MQ8NRNC	Samsung Electro-Mechanics		
C10, C14	2	10 uF	CAP, CERM, 10 uF, 10 V, ±20%, X5R, 0402	0402	CL05A106MP5NUNC	Samsung Electro-Mechanics		
C12, C22	2	6.8 uF	CAP, CERM, 6.8 uF, 25 V, ±10%, X5R, 0603	0603	C1608X5R1E685K080AC	TDK		
C15	1	10 uF	CAP, CERM, 10 uF, 35 V, ±20%, X5R, 0603	0603	GRM188R6YA106MA73D	MuRata		
C16, C17	2	47 uF	CAP, TA, 47 uF, 35 V, ±10%, 0.3 Ω, SMD	7343-43	T495X476K035ATE300	Kemet		
C18, C19	2	22 uF	CAP, CERM, 22 uF, 35 V, ±20%, X5R, 0805	0805	NMC0805X5R226M35TRPL PF	NIC Components		
C20, C21	2	0.1 uF	CAP, CERM, 0.1 uF, 16 V, ±10%, X5R, 0201	0201	GRM033C71C104KE14D	MuRata		
C23, C25, C26	3	0.1 uF	CAP, CERM, 0.1 uF, 50 V, ±10%, X7R, 0402	0402	C1005X7R1H104K050BE	TDK		
C24, C27	2	1000 pF	CAP, CERM, 1000 pF, 50 V, ±1%, C0G/NP0, 0402	0402	GRM1555C1H102FA01D	MuRata		
C28	1	0.1 uF	CAP, CERM, 0.1 uF, 10 V, ±10%, X5R, 0402	0402	LMK105BJ104KV-F	Taiyo Yuden		
C29, C30	2	220 pF	CAP, CERM, 220 pF, 25 V, ±10%, X7R, 0201	0201	GRM033R71E221KA01D	MuRata		
D1, D3, D7, D8	4	Blue	LED, Blue, SMD	LED_0603	150060BS75000	Würth Elektronik		
D2	1	30 V	Diode, Schottky, 30 V, 2 A, 2-XFDFN	2-XFDFN	NSR20F30NXT5G	ON Semiconductor		
D4, D5, D6	3	Green	LED, Green, SMD	LED_0805	150080GS75000	Würth Elektronik		
D9	1	30 V	Diode, Schottky, 30 V, 5 A, SOD-128	SOD-128	PMEG3050EP,115	Nexperia		
D10	1	White	LED, White, SMD	0402, White	LW QH8G-Q2S2-3K5L-1	OSRAM	LW QH8G-Q2OO-3K5L-1	
D11, D12	2		1-Channel ESD Protection Diode With Low Dynamic Resistance and Low Clamping Voltage, DPY0002A (X1SON-2)	DPY0002A	TPD1E1B04DPYR	Texas Instruments	TPD1E1B04DPYT	Texas Instruments
J1, J6	2		Plug, USB3.1 TypeC, 22 Position, R/A, SMT	Plug, USB3.1 TypeC, 22 Position, R/A, SMT	632 712 000 011	Würth Elektronik		

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

Table 1. USB-C-PD-TKT-EVM BOM⁽¹⁾ (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
J2, J4, J5, J7	4		Connector, Receptacle, USB Type C, R/A	Connector, Receptacle, USB Type C, R/A, THT/SMT	632 723 300 011	Würth Elektronik		
J3	1		Plug, USB 2.0 Type A, Gold, R/A, SMT	Plug, USB 2.0 Type A, R/A, SMT	629004113921	Würth Elektronik		
J8, J9	2		Header, 100 mil, 3 x 1, Tin, TH	Header, 3 x 1, 100 mil, TH	5-146278-3	TE Connectivity		
J10	1		Connector, DC Power Jack, R/A, 3 Pos, TH	Power connector	JPD1135-509-7F	Foxconn		
L1	1	100 Ω	Ferrite Bead, 100 Ω at 100 MHz, 8 A, 1812	1812	74279226101	Würth Elektronik		
L2	1	10 μ H	Inductor, Shielded, 10 μ H, 4 A, 0.068 Ω , SMD	7.2 x 6.65 mm	ASPI-0630LR-100M-T15	Abracon Corporation		
Q1, Q2, Q3, Q4, Q5, Q6, Q7	7	30 V	MOSFET, N-CH, 30 V, 5.9 A, YJK0003A (PICOSTAR-3)	YJK0003A	CSD17585F5T	Texas Instruments		None
Q8	1	-30 V	MOSFET, P-CH, -30 V, -10 A, UDFN6B	UDFN6B	SSM6J507NU,LF	Toshiba		None
Q9, Q10, Q11	3	30 V	MOSFET, N-CH, 30 V, 0.35 A, AEC-Q101, SOT-323	SOT-323	NX3008NBKW,115	Nexperia		None
R1, R7, R12, R28	4	10.0 k Ω	RES, 10.0 k Ω , 0.1%, 0.063 W, 0402	0402	MCR01MRTF1002	Rohm		
R2, R6, R14, R30	4	249 k Ω	RES, 249 k Ω , 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402249FKED	Vishay-Dale		
R3	1	26.7 k Ω	RES, 26.7 k Ω , 1%, 0.05 W, 0201	0201	RC0201FR-0726K7L	Yageo America		
R4, R10, R15, R31, R55, R62	6	10.0 k Ω	RES, 10.0 k Ω , 1%, 0.05 W, 0201	0201	RC0201FR-0710K7L	Yageo America		
R5	1	3.00 k Ω	RES, 3.00 k Ω , 1%, 0.05 W, 0201	0201	RC0201FR-073K7L	Yageo America		
R8	1	100	RES, 100, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402100RJNED	Vishay-Dale		
R9	1	11.5 k Ω	RES, 11.5 k Ω , 1%, 0.05 W, 0201	0201	RC0201FR-0711K5L	Yageo America		
R11	1	2.00 k Ω	RES, 2.00 k Ω , 1%, 0.05 W, 0201	0201	RC0201FR-072K7L	Yageo America		
R13	1	30.9 k Ω	RES, 30.9 k Ω , 1%, 0.05 W, 0201	0201	RC0201FR-0730K9L	Yageo America		
R16	1	10.7 k Ω	RES, 10.7 k Ω , 1%, 0.05 W, 0201	0201	RC0201FR-0710K7L	Yageo America		
R17, R18, R27	3	2.2	RES, 2.2, 5%, 0.05 W, 0201	0201	RC0201JR-072R2L	Yageo America		
R19	1	100 k Ω	RES, 100 k Ω , 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603100KFKEA	Vishay-Dale		
R20, R21	2	10.0 k Ω	RES, 10.0 k Ω , 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	RMCF0402FT10K0	Stackpole Electronics Inc		
R22, R23, R24	3	100 k Ω	RES, 100 k Ω , 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603100KJNEA	Vishay-Dale		
R25, R26, R33	3	249 k Ω	RES, 249 k Ω , 1%, 0.1 W, 0603	0603	RC0603FR-07249KL	Yageo		
R29	1	10.5 k Ω	RES, 10.5 k Ω , 1%, 0.05 W, 0201	0201	RC0201FR-0710K5L	Yageo America		
R35	1	15.4 k Ω	RES, 15.4 k Ω , 1%, 0.05 W, 0201	0201	RC0201FR-0715K4L	Yageo America		
R37	1	36.5 k Ω	RES, 36.5 k Ω , 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040236K5FKED	Vishay-Dale		
R38	1	60.4 k Ω	RES, 60.4 k Ω , 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040260K4FKED	Vishay-Dale		

Table 1. USB-C-PD-TKT-EVM BOM⁽¹⁾ (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
R39	1	100 kΩ	RES, 100 kΩ, 1%, 0.05 W, 0201	0201	CRCW0201100KFKED	Vishay-Dale		
R40, R61	2	100 kΩ	RES, 100 kΩ, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402100KFKED	Vishay-Dale		
R41	1	270	RES, 270, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402270RJNED	Vishay-Dale		
R42, R43, R51, R53, R54, R57, R58, R59, R60, R63, R64, R65	12	0	RES, 0, 5%, 0.05 W, 0201	0201	CRCW02010000Z0ED	Vishay-Dale		
R44	1	11.0 kΩ	RES, 11.0 kΩ, 1%, 0.05 W, 0201	0201	CRCW020111K0FKED	Vishay-Dale		
R45	1	19.1 kΩ	RES, 19.1 kΩ, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040219K1FKED	Vishay-Dale		
R46	1	18.0 kΩ	RES, 18.0 kΩ, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040218K0FKED	Vishay-Dale		
R47	1	7.15 kΩ	RES, 7.15 kΩ, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04027K15FKED	Vishay-Dale		
R48, R49	2	3.83 kΩ	RES, 3.83 kΩ, 1%, 0.05 W, 0201	0201	CRCW02013K83FKED	Vishay-Dale		
R50	1	2.00 Meg	RES, 2.00 M, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04022M00FKED	Vishay-Dale		
R52	1	69.8 kΩ	RES, 69.8 kΩ, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060369K8FKEA	Vishay-Dale		
R56	1	301 kΩ	RES, 301 kΩ, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603301KFKFA	Vishay-Dale		
S1	1		Switch, Slide, SPST, Top Slide, SMT	Switch, Single Top Slide, 2.5 × 8 × 2.5 mm	CHS-01TB	Copal Electronics		
SH-J1, SH-J2	2		Shunt, 2.54 mm, Gold, Blue	Shunt, 2.54 mm, Blue	60900213621	Würth Elektronik		
TP1, TP3, TP4, TP5	4		Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone		
TP2, TP6, TP7, TP8, TP9, TP10, TP11, TP12	8		Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone		
TP13, TP14, TP15	3		Test Point, Miniature, SMT	Test Point, Miniature, SMT	5019	Keystone		
U1, U3	2		Low Power Low Offset Voltage Dual Comparator, 8-pin Micro SMD, Pb-Free	YZR0008ADAD	LM393TL/NOPB	Texas Instruments		
U2	1		USB Type-C and USB PD Controller with Integrated Power Switches, RSH0056E (VQFN-56)	RSH0056E	TPS65987DDJRSHR	Texas Instruments		Texas Instruments
U4	1		USB Type-C 1.5 A DFP Controller and Power Switch, DSS0012B (WSON-12)	DSS0012B	TPS25820DSS	Texas Instruments		Texas Instruments
U5	1		100-mA, 30-V, Fixed-Output, Linear-Voltage Regulator, DBZ0003A (SOT-23-3)	DBZ0003A	TLV76033DBZR	Texas Instruments	TLV76033DBZT	Texas Instruments
U7	1		SPST USB 2.0 High-Speed Switch With Battery Charging Detection, RSE0010A (UQFN-10)	RSE0010A	BQ24392RSEER	Texas Instruments		Texas Instruments

Table 1. USB-C-PD-TKT-EVM BOM⁽¹⁾ (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
U8	1		Automotive Grade 4.5-35V, Hysteretic Non-Synchronous PFET Buck Controller with Enable Pin, DGK0008A (VSSOP-8)	DGK0008A	LM3489QMM/NOPB	Texas Instruments		Texas Instruments
U9	1		22-V Precision Surge Protection Clamp, DRV0006A (WSON-6)	DRV0006A	TVS2200DRVR	Texas Instruments		Texas Instruments
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		
R32, R34, R66	0	0	RES, 0, 5%, 0.1 W, 0603	0603	RC0603JR-070RL	Yageo		
R36	0	0	RES, 0, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	ERJ-6GEY0R00V	Panasonic		

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。
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。

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2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

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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.

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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.
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8. *Limitations on Damages and Liability:*

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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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