TPS65982BBEVM Evaluation Module

User's Guide

![Texas Instruments logo]

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TPS65982BBEVM Evaluation Module

This document is the user's guide for the TPS65982BB Evaluation Module (TPS65982BBEVM). The TPS65982BBEVM allows for the evaluation of the TPS65982BB IC, which is used in Type-C and PD applications that require USB Billboard functionality. The TPS65982BBEVM demonstrates the integrated USB mux, allowing billboard functionality for two USB Type-C ports. It also includes a Downstream Face Port (DFP) USB Type-A receptacle to pass through USB2 signals and VBUS to a device when billboard functionality is not required. The TPS65982BBEVM is supported with the *TPS65982BB Application Configuration* software tool to enable the billboard feature over I2C communication.
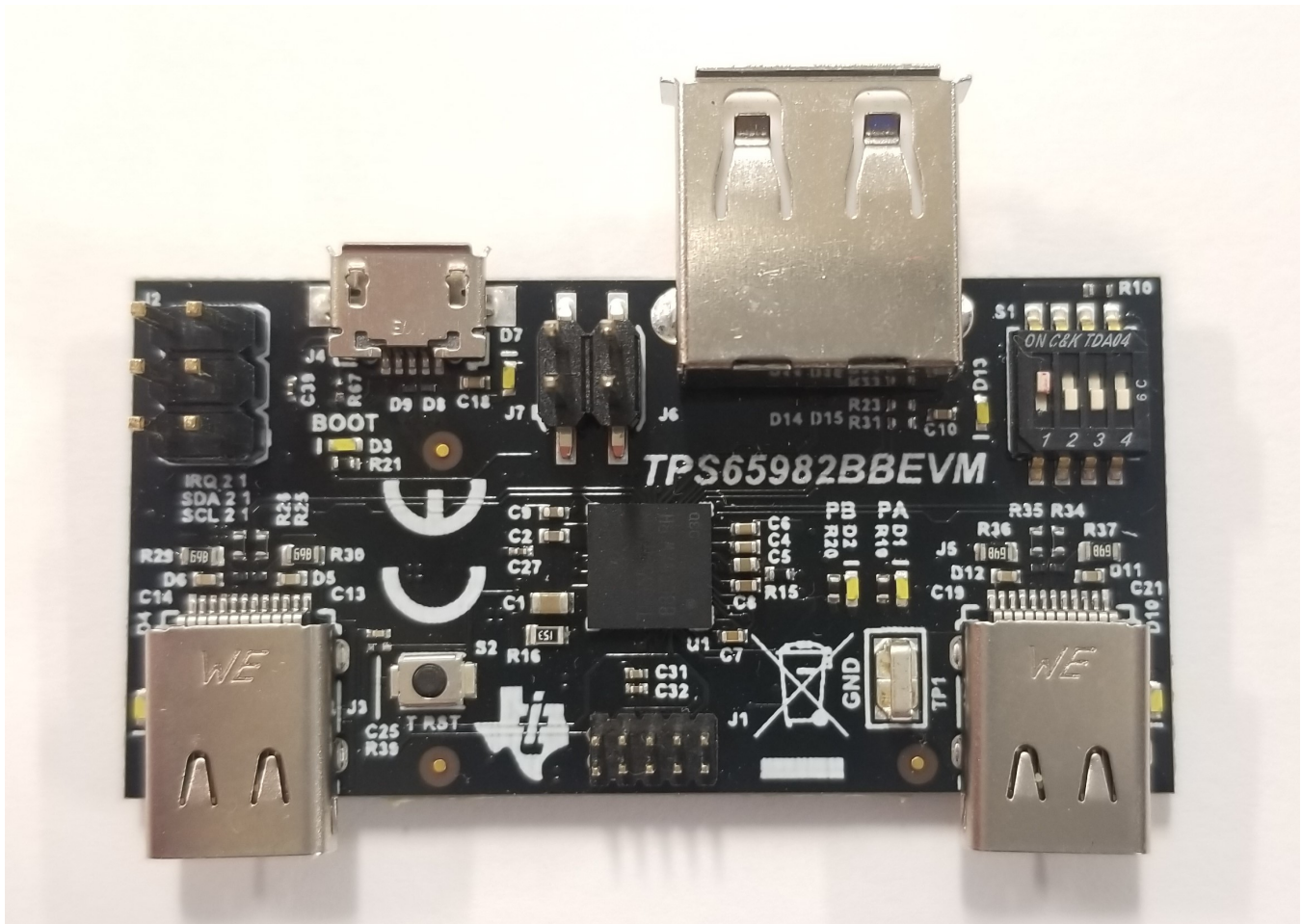
1   Trademarks

All trademarks are the property of their respective owners.

2   Introduction

The TPS65982BBEVM helps designers evaluate the functions for the TPS65982BB billboard device. The TPS65982BB can work in single-port and dual-port applications where billboard is required. The two Type-C ports represent a dual-port application where the USB signals can be passed through to the DFP USB Type-A port or provide the billboard function to the USB Type-C port connected to a USB host. The DFP USB Type-A port provides 5 V through the TPS65982BB integrated power switch. The onboard I2C communication tool aids in developing the I2C control from an Embedded Controller or Power Delivery Controller in the system. The TPS65982BBEVM can be powered either from the USB Type-C port or the USB micro B port that interfaces with the *TPS65982BB Application Configuration* software tool. The onboard I2C communication is controlled by the TIVA microcontroller, which also has the ability to update the TPS65982BB configurations.

2.1   Information About Cautions and Warnings

ATTENTION
STATIC SENSITIVE DEVICES

HANDLE ONLY AT
STATIC SAFE WORK STATIONS
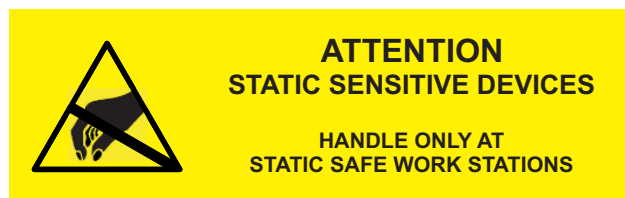
CAUTION

This EVM contains components that can potentially be damaged by electrostatic discharge. Always transport and store the EVM in the supplied ESD bag when not in use. Handle while using an antistatic wristband. Operate on an antistatic work surface. For more information on proper handling, see Electrostatic Discharge (ESD).

2.2   Related Documents

- Universal Serial Bus Specification, Revision 2.0, April 27, 2000 plus ECN and Errata.
- Billboard Device Class Spec Revision 1.21, September 08, 2016.
- USB Power Delivery Specification Revision 3.0, Version 1.0a
- USB Type-C Cable and Connector Specification Revision 1.2, March 25, 2016.
- Proposed DisplayPort Alt Mode on USB Type-C Standard, Version 1, Draft 5, September 6, 2014

3   Setup

3.1   Items Required for Operation

The following items are required for full evaluation of the EVM:

- TPS65982BB Data Sheet
- TPS65982BB Host Interface Technical Reference Manual
- TPS65982BBEVM

- TPS65982BB Application Customization Tool
- USB Type-A to USB Micro-B Cable (Interface with I2C Master)
- USB Type-C to Type-C cable or USB Type-A to USB Type-C
- USB Device (flash drive, mouse, and so forth)

3.2 USB Ports Functionality

Table 1. USB Ports Functionality

DESIGNATOR	DESCRIPTION
J5	Port A USB Type-C Upstream Facing Port
J3	Port B USB Type-C Upstream Facing Port
J4	USB micro B port used to interface with the *TPS65982BB Application Configuration* software tool
J6	RP USB Type-A Downstream Facing Port, USB2 signals muxed from either Port A/B USB Type-C Ports

3.3 Header Functionality

Table 2. Header Functionality

DESIGNATOR	DESCRIPTION
J1	TPS65982BB SPI pins and GPIO control signals, used to probe and measure signals
J2	TPS65982BB I2C1/2 pins, used to probe I2C communication or control the TPS65982BB through an external I2C master
J7	TIVA I2C master JTAG pins, used only for internal debugging

3.4 S1 Switch Bank Functionality

Table 3. S1 Switch Back Functionality

SWITCH (S1)	DESCRIPTION
1	PP_5V0_EN Control: Enables/disables the 5 V supply to the RP USB Type-A Port.
2	BB_ENABLE: Automatically enables billboard functions on the Port A USB Type-C, used when I2C control is not available
3	SPI_MISO: TPS65982BB SPI_MISO pin, used for debugging purposes only
4	BB_RST: TPS65982BB hardware reset control

3.5 S2 TIVA Reset Switch

S2 is used to reset the TIVA I2C master to recover from a communication error to the TPS65982BB or to the *TPS65982BB Application Configuration* software tool. This switch is not intended to be used outside of error recovery for the TIVA microcontroller.

3.6 LED Indicators

Table 4. LED Indicators

DESIGNATOR	DESCRIPTION
D1	BB_PLUG_PA LED Indicator
D2	BB_PLUG_PB LED Indicator

Table 4. LED Indicators (continued)

DESIGNATOR	DESCRIPTION
D3	BB_BOOT_OK LED Indicator
D4	Port B USB Type-C VBUS LED Indicator
D10	Port A USB Type-C VBUS LED Indicator
D7	TIVA USB micro B VBUS LED Indicator
D13	RP USB Type-A VBUS LED Indicator

4   Using the TPS65982BBEVM

4.1   Powering the TPS65982BBEVM

The board is powered from either Port A/B USB Type-C or the USB micro B connectors. The VBUS are all connected to the system rail, which provides 5 V to the RP USB Type-A connector through the TPS65982BB. Each path is RCP-protected and the highest VBUS voltage is passed through to the system.

4.2   Port A and B to RP USB2 Mux and Billboard Function

When a connection is made on one of the Type-C ports, the USB signals are connected to the RP USB path. The BB_PLUG_PA/B controls are first come first serve, which means the first port to get connected maintains the USB path. A USB device can be connected to the USB Type-A receptacle and must enumerate to the connected USB host. The USB path is disabled when the billboard function is enabled through I2C or through the BB_ENABLE control signal. When BB_ENABLE is used, it forces the billboard function on the Port A USB Type-C only. With I2C control, the billboard functions can be connected to either Port A/B.

4.3   RP USB 5V VBUS

The 5 V for the RP USB Type-A port can be controlled from the S1 switch bank. In order to supply power to a USB device connected to the Type-A receptacle, this control signal must be enabled.

4.4   Port A/B USB Type-C Ports

These ports are both UFP ports and always present Rd pulldowns on the CC lines. The EVM is only intended to operate with 5 V on VBUS. **Verify the connected USB Type-C DFP is not applying greater than 5 V, as this will permanently damage the EVM.**

4.5   TPS65982BB GPIO Summary

The TPS65982BBEVM exposes all of the GPIO required to operate the TPS65982BB. The BB_PLUG_PA/B GPIO are generated by logic at each Type-C connector. PP_5V0_EN is controlled through the S1 switch bank.

Table 5. TPS65982BB GPIO Summary

TPS65982BB GPIO		
GPIO EVENT	INPUT/OUTPUT	COMMENT
BB_ENABLE	Input	Enables the billboard function with iAdditionalInfoURL on PA_USB_P/N only.
PP_5V0_EN	Input	PP_5V0_EN = 0: Disables the 5 V. VBUS Switch PP_5V0_EN = 1: Enables the 5 V VBUS Switch

Table 5. TPS65982BB GPIO Summary (continued)

TPS65982BB GPIO		
GPIO EVENT	**INPUT/OUTPUT**	**COMMENT**
BB_PLUG_PA	Input	BB_PLUG_PA = 0: Disconnect PA_USB_P/N (Port A Type-C USB) to USB_RP_P/N. BB_PLUG_PA = 1: Connect PA_USB_P/N (Port A Type-C USB) to USB_RP_P/N.
BB_PLUG_PB	Input	BB_PLUG_PB = 0: Disconnect PB_USB_P/N (Port A Type-C USB) to USB_RP_P/N. BB_PLUG_PB = 1: Connect PB_USB_P/N (Port A Type-C USB) to USB_RP_P/N.
HRESET	Input	BB_RESET = 0: Normal Operation BB_RESET = 1: Hardware Reset (Firmware Reload)
BB_SRST	Input	BB_SRESET = 1: Soft Reset (No Firmware Reload) BB_SRESET = 0: Normal Operation
BB_BOOT_OK	Output	BB_Boot = 0: Not Booted BB_Boot = 1: Successful Boot

4.6   TPS65982BB I2C Control

The TPS65982BBEVM uses a TIVA microcontroller to execute the I2C writes required to control the TPS65982BB. The configuration of the TPS65928BB is set by writing to the Data1 register and then executing a 4CC command by writing BDCc to the CMD1 register. For additional details, refer to the TPS65982BB Host Interface.

Table 6 shows the configuration options programmable through I2C.

Table 6. TPS65982BB Configuration - Data1 Register I2C Write

INPUT TO DATA REGISTER		
BIT	**DEFINITION**	**COMMENT**
0	Enable Billboard = 1 Disable Billboard = 0	Overrides USB_RP connection when enabled
1	PA_USB_P/N Connected = 1 PB_USB_P/N Connected = 0	PA_USB_P/N Connection PB_USB_P/N Connection
2	Enable RP = 1 Disable RP = 0	Connects USB2 to USB RP
3	Enable iAdditionalinfoURL2 = 1 Disable iAdditionalinfoURL2 = 0	Uses iAdditionalinfoURL2
4:5	00: TBT Mode Entry Error 01: DP Mode Entry Error 10: CIO Mode Entry Error 11: No Mode Entry Error	Shows descriptor pertaining to which alternate mode failed
6:7	00: TBT Mode Entry Successful 01:DP Mode Entry Successful 10:CIO Mode Entry Successful 11: No Mode Entry Successful	Shows descriptor pertaining to which alternate mode entered. Use when no USB Hub or USB System present.
8	0: Mode Entry Error (Capabilities Mismatch) 1: Mode Entry Failure due to no PD comm	Sets the reason why the preferred Alt Mode was not entered.
9:11	000: TBT String 001: DP String 010: CIO String 011: Reserved (Future Use) 100-111: Use Default Billboard String	Option to force a specific Billboard String when request is received
12:15	Reserved	Write all zeros.

4.7   I2C Control Example - Enable Billboard on Port A

1. I2C Master Write to device TPS65982BB address (0x38)
   a. Data1 Register address (0x09)
   b. 2 Byte Write
   c. 0x3EF0
2. I2C Master Write to device TPS65982BB address (0x38)
   a. CMD1 Register address (0x08)
   b. 4 Byte Write
   c. 0x42444363 (BDCc)

4.8   Debugging the EVM

Use the following when the EVM is not working as expected.

- Every USB input has a VBUS LED indicator. Verify that the host connected is providing 5 V on VBUS.
- D3 (BOOT) LED indicates that the TPS65982BB has loaded its firmware successfully. When this LED is off and VBUS LED is present, the firmware for the TPS65982BB may have to be programmed to the SPI flash. Refer to the TPS65982BB Application Customization Tool for the recovery firmware.

5   Board Layout

Top Layer

GND1

High Speed

GND2

Power 1

Power 3
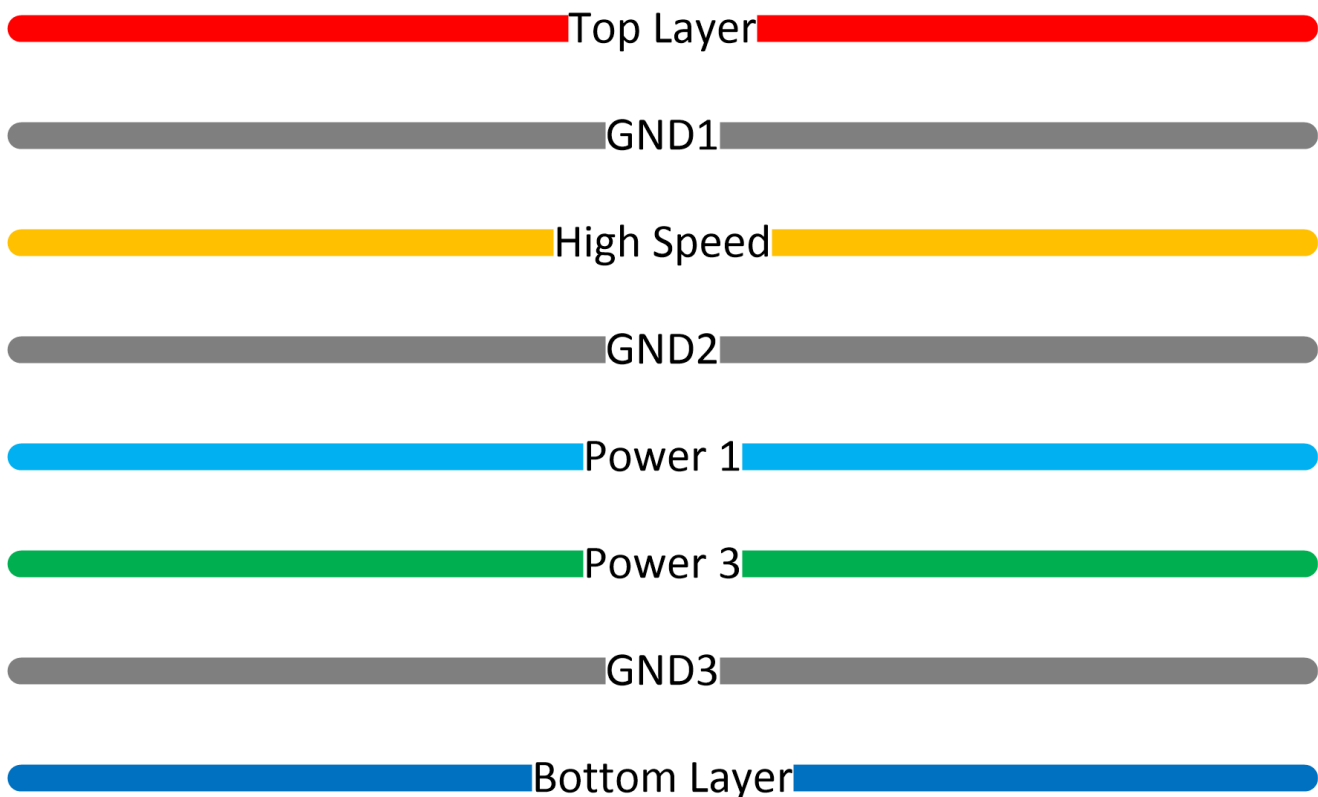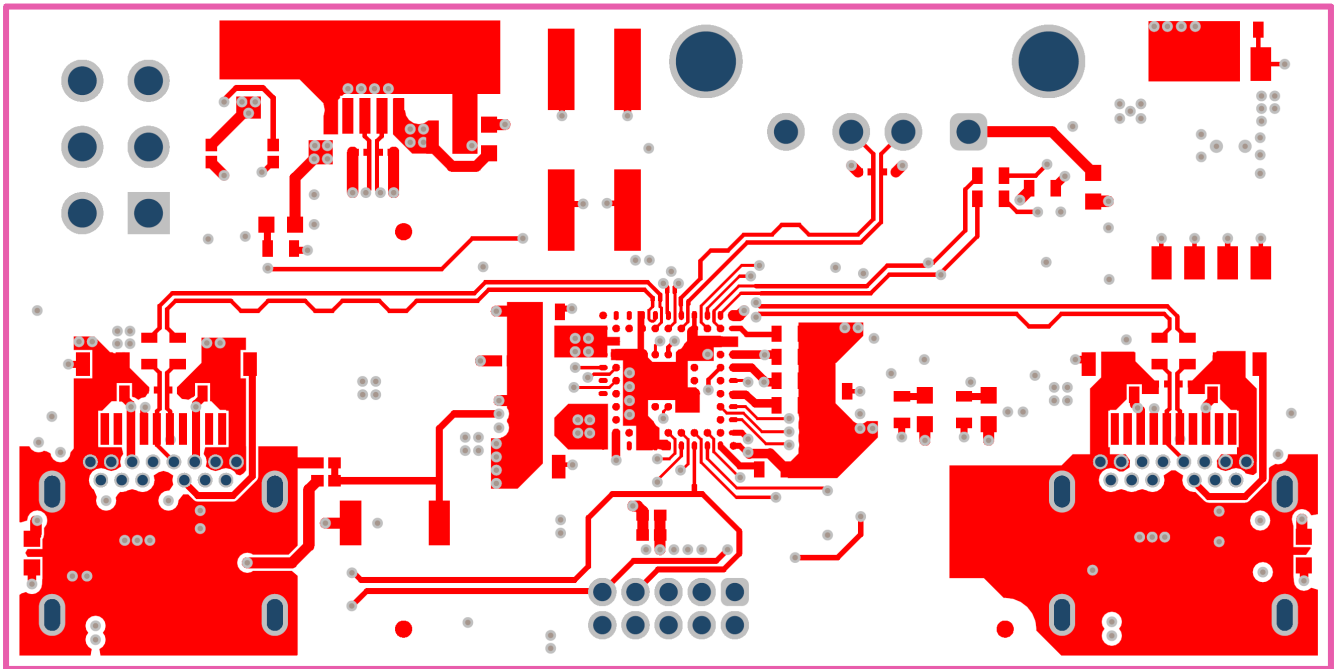
GND3

Bottom Layer

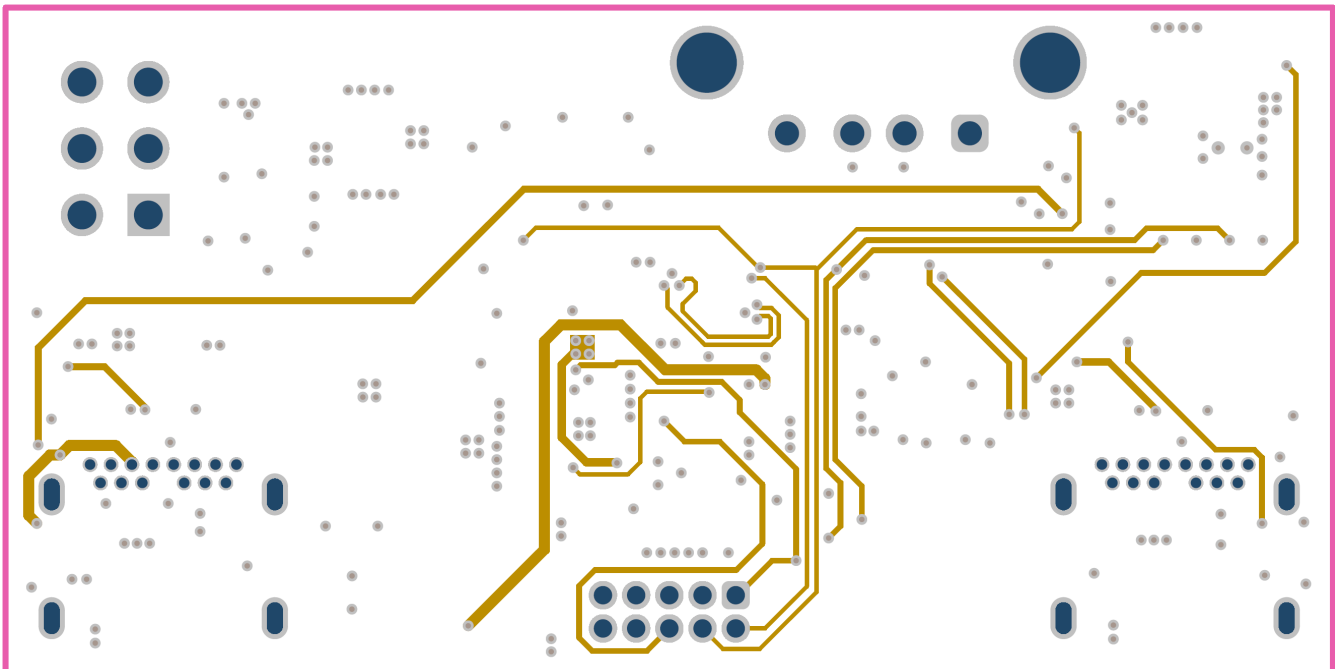**Figure 1. Board Stack-Up**

Figure 2. Top Layer
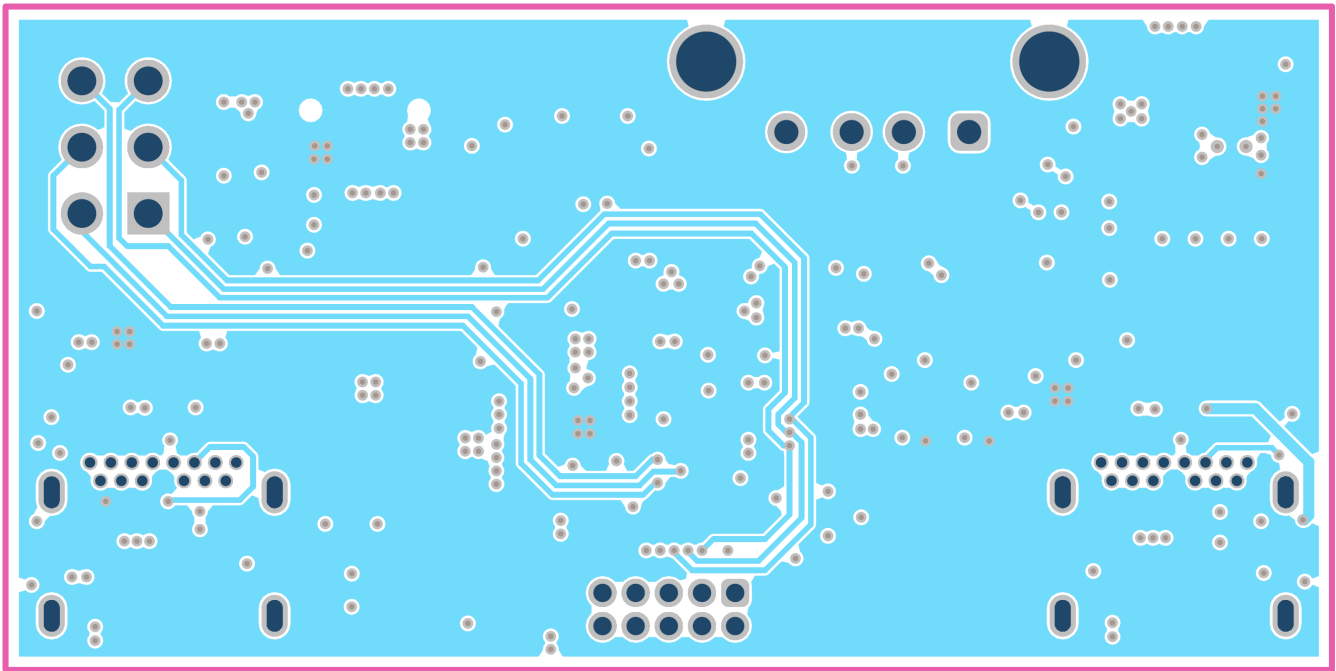

Figure 3. High-Speed Layer

Figure 4. Power 1 Layer
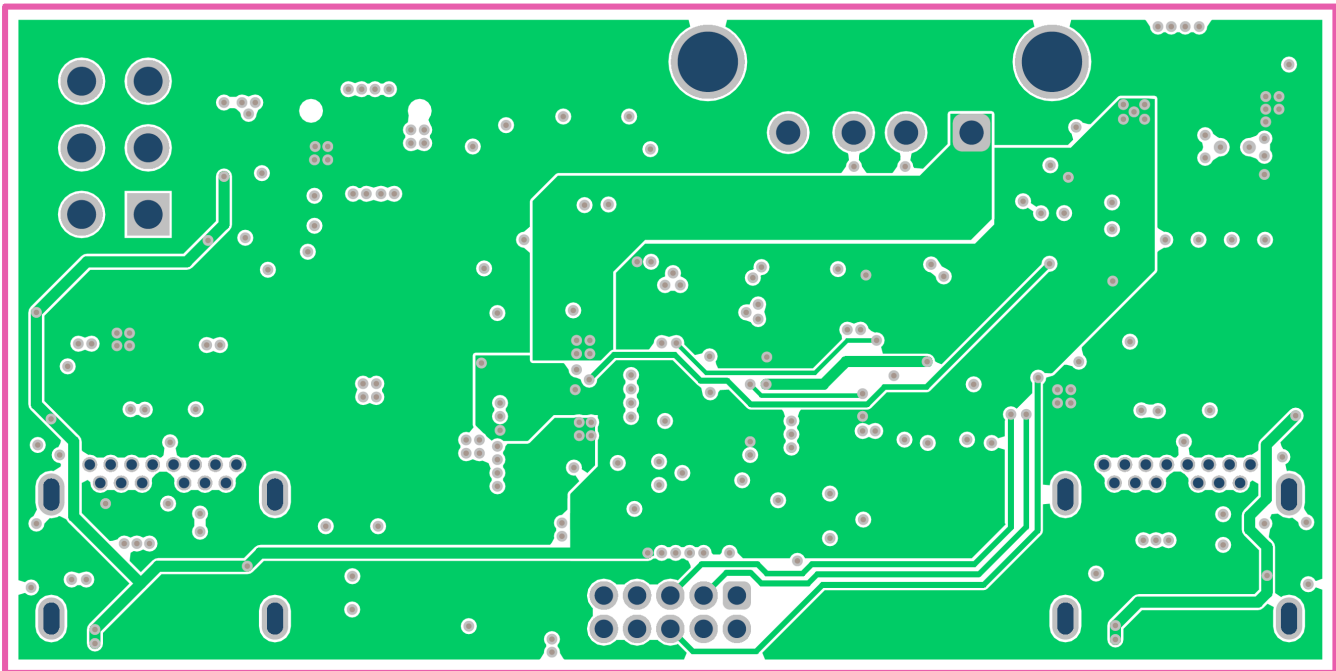
Figure 5. Power 2 Layer
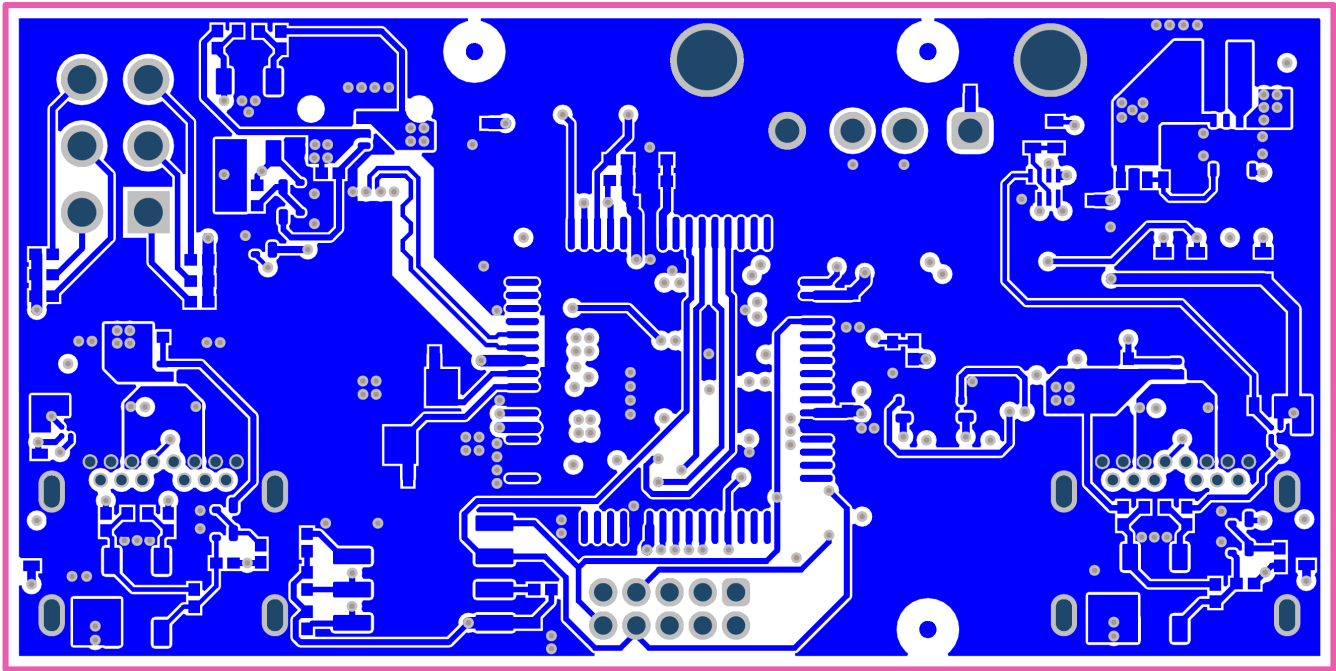
Figure 6. Bottom Layer

6   Schematic and Bill of Materials

6.1   Schematic
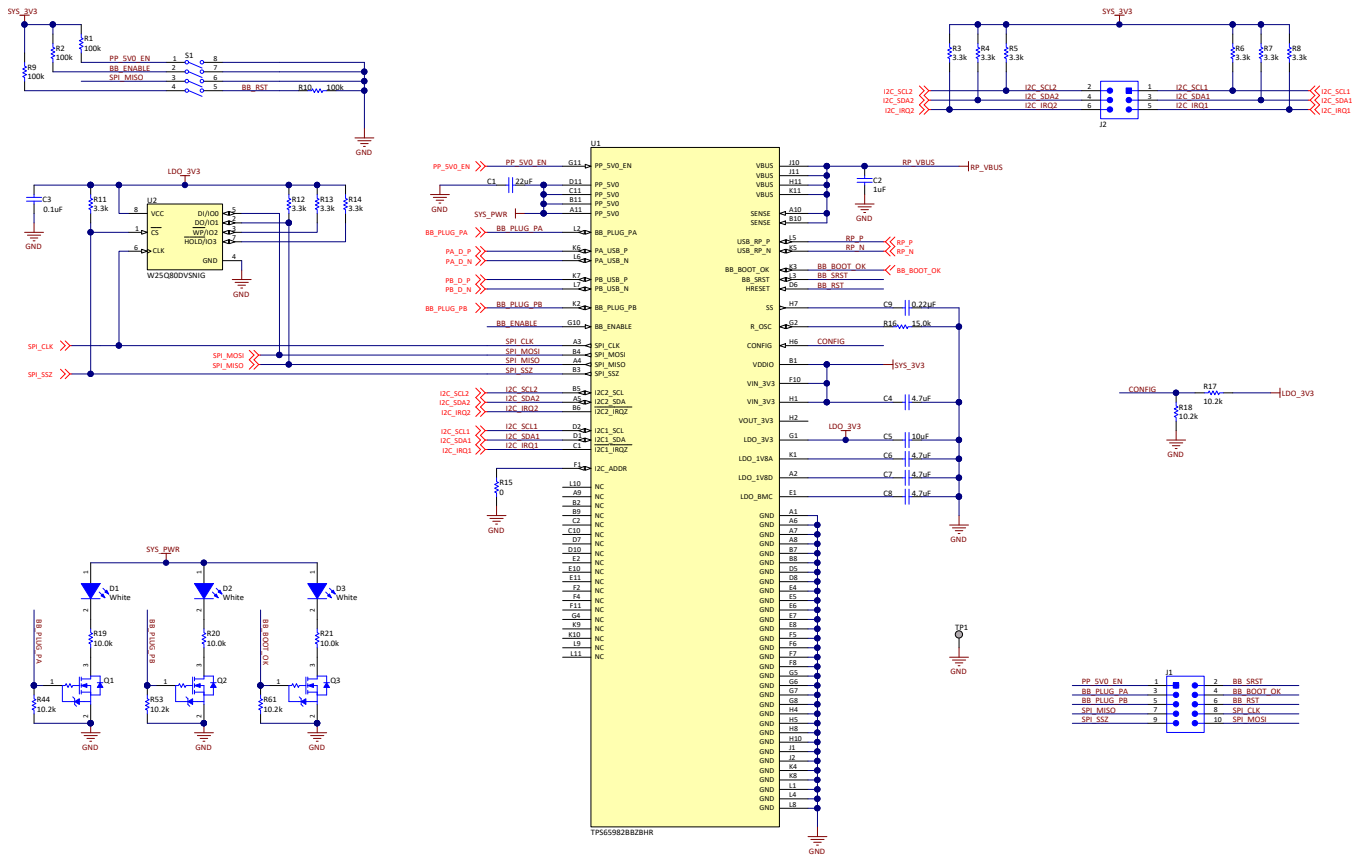
Figure 7. TPS65982BB Schematic
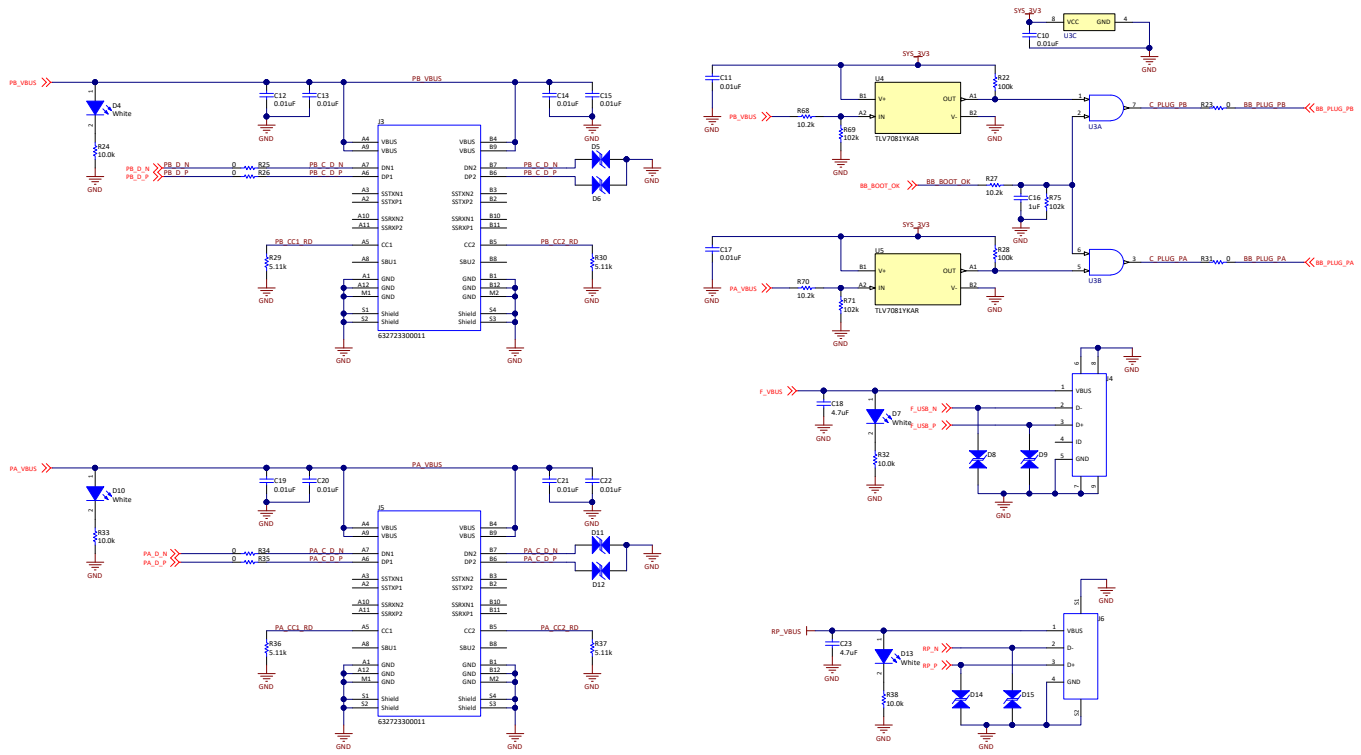
Figure 8. USB Connectors

Figure 9. TIVA

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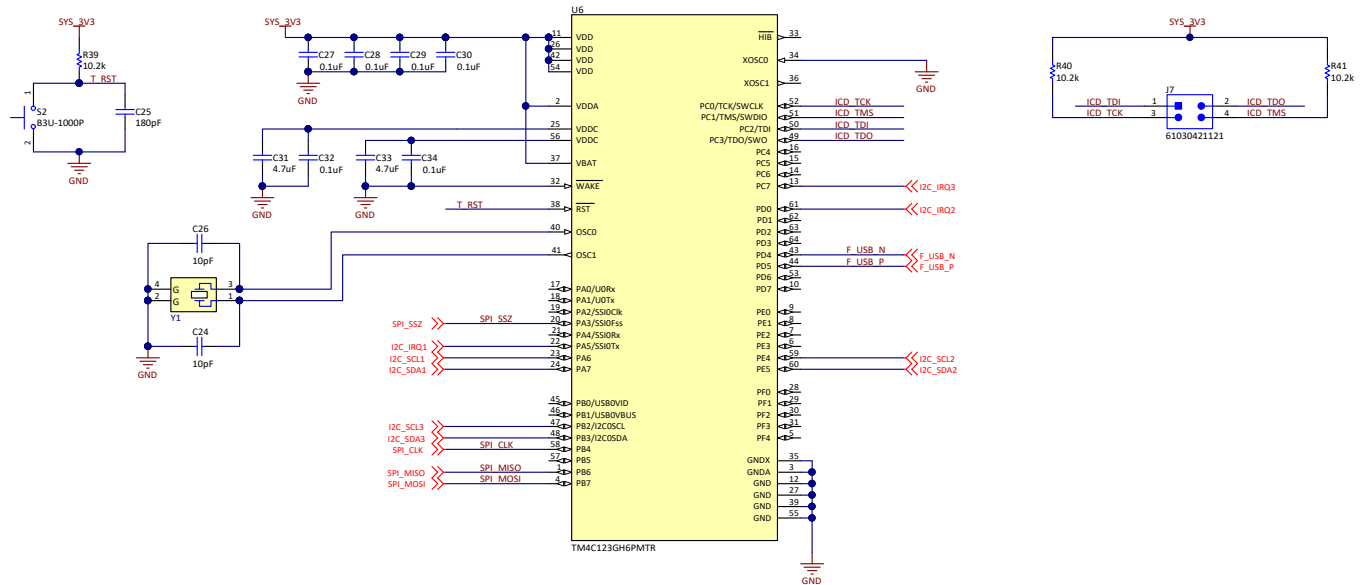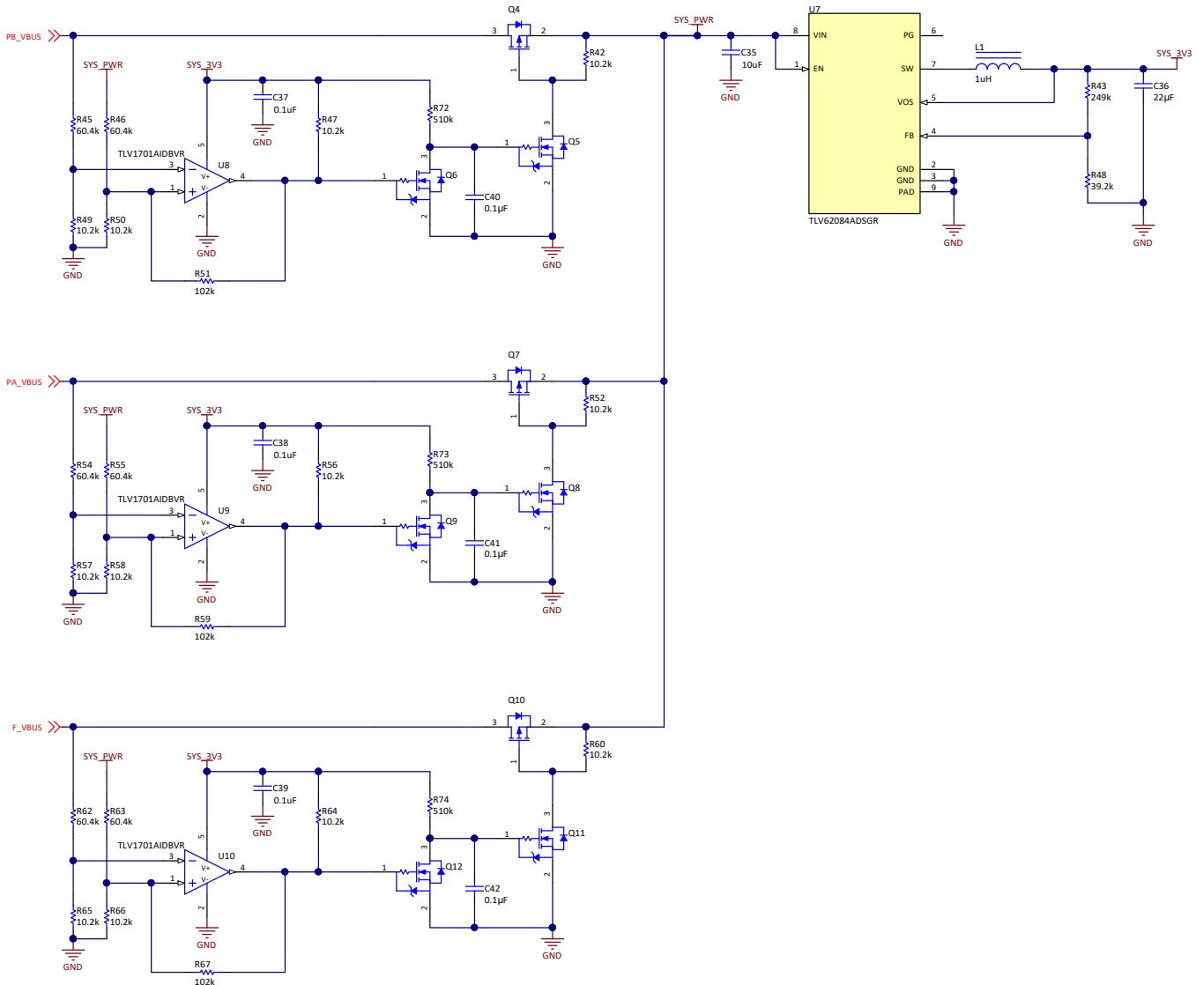
Figure 10. Power Supplies

6.2 Bill of Materials

Table 7. Bill of Materials

DESIGNATOR	QUANTITY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
C1	1	22 µF	CAP, CERM, 22 µF, 10 V, +/- 20%, X5R, 0603	0603	C1608X5R1A226M080AC	TDK
C2, C16	2	1 µF	CAP, CERM, 1 µF, 10 V, +/- 20%, X5R, 0402	0402	885012105012	Wurth Elektronik
C3, C27, C28, C29, C30, C32, C34, C37, C38, C39	10	0.1 µF	CAP, CERM, 0.1 µF, 10 V, +/- 10%, X5R, 0201	0201	CL03A104KP3NNNC	Samsung Electro-Mechanics
C4, C6, C7, C8, C18, C23	6	4.7 µF	CAP, CERM, 4.7 µF, 6.3 V, +/- 20%, X5R, 0402	0402	885012105008	Wurth Elektronik

Table 7. Bill of Materials (continued)

DESIGNATOR	QUANTITY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
C5, C35	2	10 µF	CAP, CERM, 10 µF, 10 V, +/- 20%, X5R, 0402	0402	CL05A106MP5NU NC	Samsung Electro-Mechanics
C9	1	0.22 µF	CAP, CERM, 0.22 µF, 10 V,+/- 20%, X5R, 0402	0402	885012105011	Wurth Elektronik
C10, C11, C12, C13, C14, C15, C17, C19, C20, C21, C22	11	0.01 µF	CAP, CERM, 0.01 µF, 16 V, +/- 10%, X7R, 0402	0402S	885012205031	Wurth Elektronik
C24, C26	2	10 pF	CAP, CERM, 10 pF, 16 V, +/- 10%, C0G, 0402	0402	C0402C100K4GAC TU	Kemet
C25	1	180 pF	CAP, CERM, 180 pF, 25 V, +/- 10%, X7R, 0201	0201	GRM033R71E181 KA01D	MuRata
C31, C33	2	4.7 µF	CAP, CERM, 4.7 µF, 6.3 V, +/- 20%, X5R, 0201	0201	GRM035R60J475 ME15D	MuRata
C36	1	22 µF	CAP, CERM, 22 µF, 10 V, +/- 20%, X5R, 0805	0805	885012107011	Wurth Elektronik
C40, C41, C42	3	0.1 µF	CAP, CERM, 0.1 µF, 16 V,+/- 10%, X5R, 0201	0201	GRM033R61C104 KE14D	MuRata
D1, D2, D3, D4, D7, D10, D13	7	White	LED, White, SMD	0402, White	LW QH8G-Q2S2-3K5L-1	OSRAM
D5, D6, D8, D9, D11, D12, D14, D15	8		1-Channel ESD Protection Diode for USB Type-C and Antenna Protection, DPL0002A (X2SON-2)	DPL0002A	TPD1E0B04DPLR	Texas Instruments
J2	1		Header, 2.54 mm, 3x2, Gold, TH	Header, 2.54 mm, 3×2, TH	61300621121	Wurth Elektronik
J3, J5	2		Connector, Receptacle, USB Type-C, R/A	Connector, Receptacle, USB Type-C, R/A, THT/SMT	632723300011	Wurth Elektronik
J4	1		USB 2.0 TYPE B, R/A, SMT	USB 2.0 TYPE B, R/A, SMT	629105136821	Wurth Elektronik
J6	1		USB 2.0 Type A, 4 Pos, Gold, R/A, TH	USB Type A R/A	61400416021	Wurth Elektronik
J7	1		Header, 2.54 mm, 2x2, Gold, SMT	Header, 2.54 mm, 2×2, Gold, TH	61030421121	Wurth Elektronik
L1	1	1 µH	Inductor, Shielded, Powdered Iron, 1 µH, 2.8 A, 0.06 Ω, SMD	SMD, 2.5×2 mm	74438324010	Wurth Elektronik
Q1, Q2, Q3, Q5, Q6, Q8, Q9, Q11, Q12	9	30 V	MOSFET, N-CH, 30 V, 3 A, YJJ0003A (PICOSTAR-3)	YJJ0003A	CSD17484F4T	Texas Instruments
Q4, Q7, Q10	3	-20 V	MOSFET, P-CH, -20 V, -5.3 A, YJK0003A (PICOSTAR-3)	YJK0003A	CSD25485F5	Texas Instruments
R1, R2, R9, R10, R22, R28	6	100 k	RES, 100 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402100KJ NED	Vishay-Dale
R3, R4, R5, R6, R7, R8, R11, R12, R13, R14	10	3.3 k	RES, 3.3 k, 5%, 0.05 W, 0201	0201	RC0201JR-7D3K3L	Yageo America

Table 7. Bill of Materials (continued)

DESIGNATOR	QUANTITY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
R15, R23, R31	3	0	RES, 0, 5%, 0.063 W, 0402	0402	RC0402JR-070RL	Yageo America
R16	1	15.0 k	RES, 15.0 k, 0.1%, 0.1 W, 0603	0603	RG1608P-153-B-T5	Susumu Co Ltd
R19, R20, R21	3	10.0 k	RES, 10.0 k, 1%, 0.063 W, 0402	0402	RC0402FR-0710KL	Yageo America
R24, R32, R33, R38	4	10.0 k	RES, 10.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K0FKED	Vishay-Dale
R25, R26, R34, R35	4	0	RES, 0, 5%, 0.063 W, 0402	0402S	RC0402JR-070RL	Yageo America
R27, R39, R40, R41, R42, R44, R47, R49, R50, R52, R53, R56, R57, R58, R60, R61, R64, R65, R66, R68, R70	21	10.2 k	RES, 10.2 k, 1%, 0.05 W, 0201	0201	RC0201FR-0710K2L	Yageo America
R29, R30, R36, R37	4	5.11 k	RES, 5.11 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603S	CRCW06035K11FKEA	Vishay-Dale
R43	1	249 k	RES, 249 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402249KFKED	Vishay-Dale
R45, R46, R54, R55, R62, R63	6	60.4 k	RES, 60.4 k, 1%, 0.05 W, 0201	0201	RC0201FR-7D60K4L	Yageo America
R48	1	39.2 k	RES, 39.2 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040239K2FKED	Vishay-Dale
R51, R59, R67, R69, R71, R75	6	102 k	RES, 102 k, 1%, 0.05 W, 0201	0201	ERJ-1GEF1023C	Panasonic
R72, R73, R74	3	510 k	RES, 510 k, 5%, 0.05 W, 0201	0201	RC0201JR-07510KL	Yageo America
S1	1		DIP Switch, SPST 4Pos, Slide, SMT	6.2×2.0×6.2 mm	TDA04H0SB1	C&K Components
S2	1		SWITCH TACTILE SPST-NO 0.05 A 12 V	3×1.6×2.5 mm	B3U-1000P	Omron Electronic Components
TP1	1		Test Point, Miniature, SMT	Test Point, Miniature, SMT	5019	Keystone
U1	1		Dual USB Billboard for USB-PD Devices with Integrated 5 V Load Switch, ZBH0096A (NFBGA-96)	ZBH0096A	TPS65982BBZBHR	Texas Instruments
U2	1		3 V, 8Mbit, Serial Flash Memory with Dual and Qual SPI, SOIC-8	SOIC-8	W25Q80DVSNIG	Winbond
U3	1		Low-Power Dual 2-Input Positive-AND Gate, DQE0008A, LARGE T&R	DQE0008A		Texas Instruments
U4, U5	2		NanoPower, MicroPackage Low-Voltage Comparator, YKA0004ACAC (DSBGA-4)	YKA0004ACAC	TLV7081YKAR	Texas Instruments

Table 7. Bill of Materials (continued)

DESIGNATOR	QUANTITY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
U6	1		Tiva C Series Microcontroller, 256 KB Flash, 32 KB SRAM, 12 Bit, 12 Channels, -40 to 105°C, 64-Pin LQFP (PM), Green (RoHS and no Sb/Br), Tape and Reel	PM0064A	TM4C123GH6PMTR	Texas Instruments
U7	1		2 A High Efficient Step Down Converter in 2×2 mm SON Package, DSG0008A (WSON-8)	DSG0008A	TLV62084ADSGR	Texas Instruments
U8, U9, U10	3		2.2-V to 36-V, microPower Comparator, DBV0005A (SOT-23-5)	DBV0005A	TLV1701AIDBVR	Texas Instruments
Y1	1		Crystal, 16 MHz, 8 pF, SMD	3.2×0.75×2.5 mm	NX3225GA-16.000M-STD-CRG-1	NDK
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
J1	0		Header, 50 mil, 5x2, Gold, TH	Header, 5×2, 50 mil	GRPB052VWVN-RC	Sullins Connector Solutions
R17, R18	0	10.2k	RES, 10.2 k, 1%, 0.05 W, 0201	0201	RC0201FR-0710K2L	Yageo America

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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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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3.4 *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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