

EVM User's Guide: TMUX9616QFPEVM

TMUX9616QFPEVM User's Guide



ABSTRACT

This document is the EVM user's guide for the TMUX9616QFPEVM, which provides a quick way to evaluate TI's TMUX9616 and TMUX9616N multiplexer devices in the PT (QFP) package.

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1 Introduction

This user's guide describes the intended use of the TMUX9616QFPEVM evaluation module (EVM). This board allows for the quick prototyping and evaluation of TI's TMUX9616PT and TMUX9616NPT multiplexers. The TMUX9616 and TMUX9616N are 16-channel low resistance, low capacitance high-voltage analog switch integrated circuits (IC) with latch-up immunity. Each device has 16 independently selectable 1:1, single-pole, singlethrow (SPST) switch channels. The device works with dual supplies up to $\pm 110V$. The TMUX9616 includes bleed resistors on the output while the TMUX9616N does not.

TMUX9616 and TMUX9616N integrates cascadable 16-bit shift register with latches for controlling each of the 16 switches. The daisy chain capability allows for many TMUX9616 devices to be controlled without requiring a separate chip-select for every device. To reduce noise in the signal path due to potential clock feed-through, the active low latch enable can be held high while data is loaded into the shift registers.

Figure 1-1 and Figure 1-2 resemble the received EVM, and the TMUX9616QFPEVM kit contains the following items:

1. TMUX9616QFPEVM
2. 1 mini-USB cable

The TMUX9616N can be ordered separately and placed on the TMUX9616QFPEVM for evaluation.

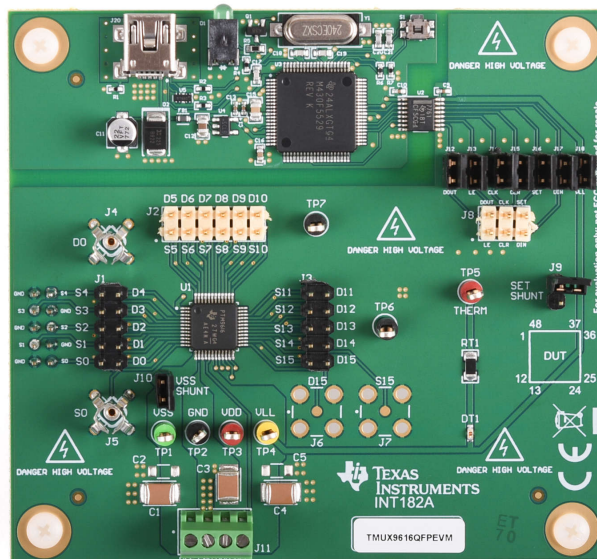


Figure 1-1. TMUX9616QFPEVM Top View

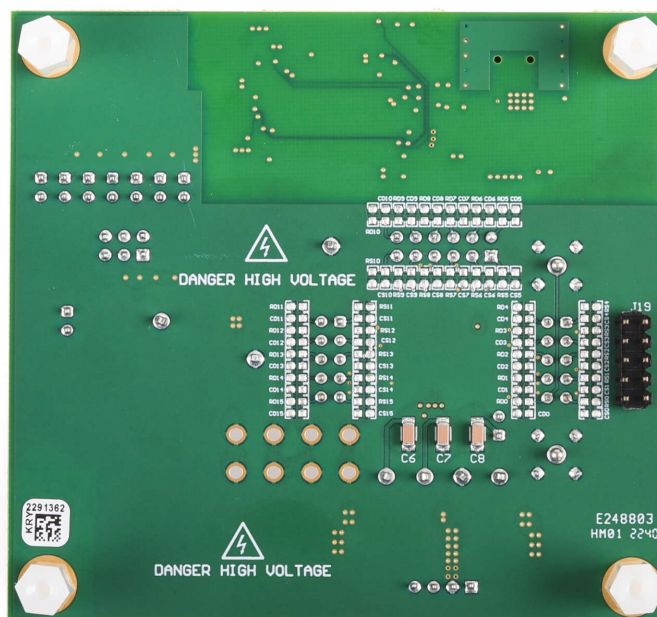


Figure 1-2. TMUX9616QFPEVM Bottom View

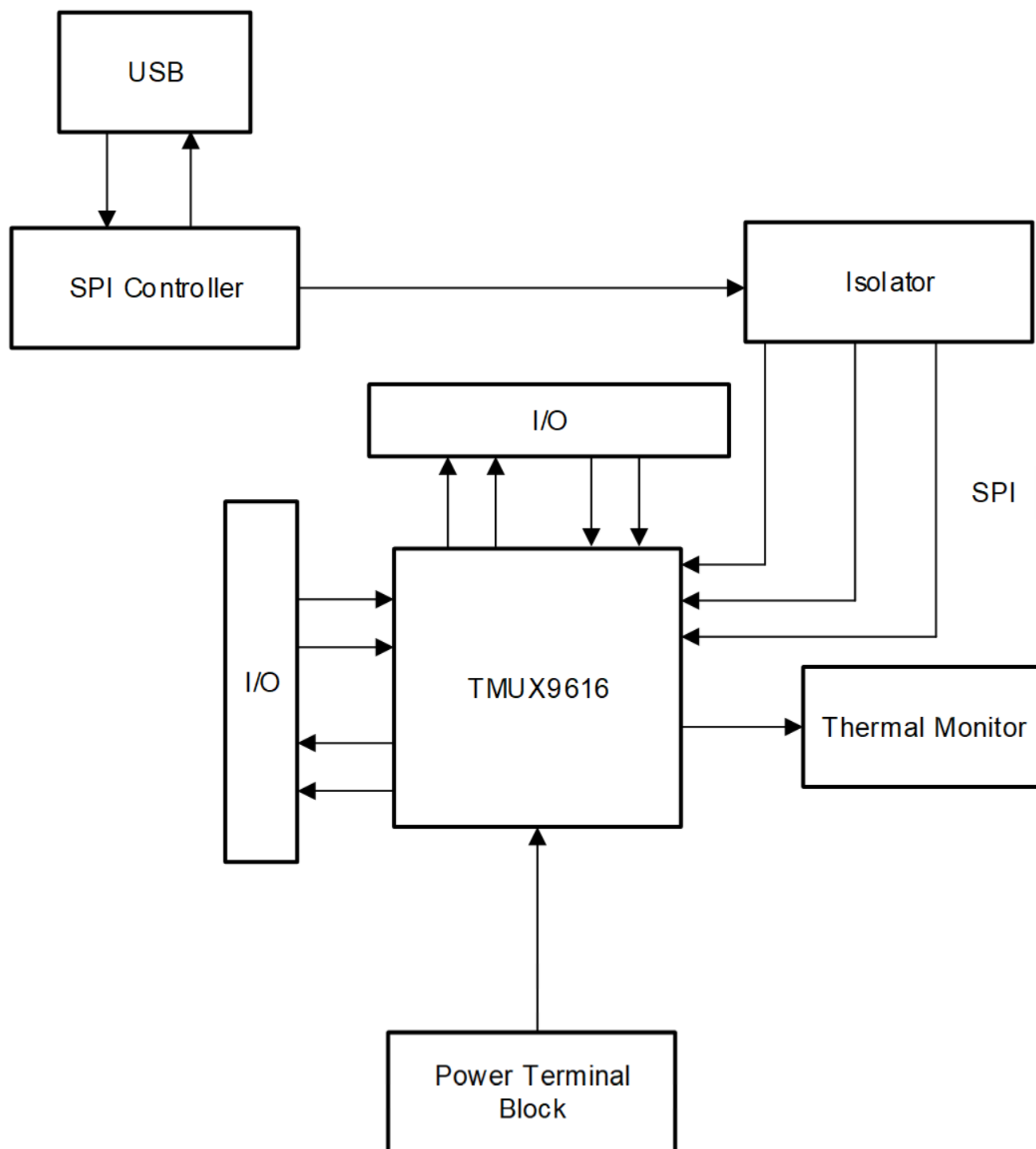


Figure 1-3. TMUX9616QFPEVM Functional Block Diagram

2 General Texas Instruments High Voltage Evaluation Module (TI HV EVM) User Safety Guidelines



Always follow TI's setup and application instructions, including use of all interface components within their recommended electrical rated voltage and power limits. Always use electrical safety precautions to help ensure your personal safety and those working around you. Contact TI's Product Information Center <http://support/ti.com> for further information.

Save all warnings and instructions for future reference.

WARNING

Failure to follow warnings and instructions may result in personal injury, property damage, or death due to electrical shock and burn hazards.

The term TI HV EVM refers to an electronic product typically provided as an open framed, unenclosed printed circuit board assembly. It is *intended strictly for use in development laboratory environments, solely for qualified professional users having training, expertise, and knowledge of electrical safety risks in development and application of high voltage electrical circuits. Any other use or application are strictly prohibited by Texas Instruments™*. Unqualified professionals should immediately stop using the HV EVM.

1. Work Area Safety

- a. Keep work area clean and orderly.
- b. One or more qualified observers must be present anytime circuits are energized.
- c. Effective barriers and signage indicating operation of accessible high voltages must be present in the area where the TI HV EVM and its interface electronics are energized for the purpose of protecting inadvertent access.
- d. All interface circuits, power supplies, evaluation modules, instruments, meters, scopes, and other related apparatus used in a development environment exceeding 50Vrms/75VDC must be electrically located within a protected Emergency Power Off EPO protected power strip.
- e. Use a stable and nonconductive work surface.
- f. Use adequately insulated clamps and wires to attach measurement probes and instruments. Do not test the EVM freehand whenever possible.

2. Electrical Safety

As a precautionary measure, it is always a good engineering practice to assume that the entire EVM may have fully accessible and active high voltages.

- a. De-energize the TI HV EVM and all its inputs, outputs, and electrical loads before performing any electrical or other diagnostic measurements. Revalidate that TI HV EVM power has been safely de-energized.
- b. With the EVM confirmed de-energized, proceed with the required electrical circuit configurations, wiring, measurement equipment connection, and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
- c. After the EVM is completely ready, energize the EVM as intended.

WARNING

While the EVM is energized, never touch the EVM or its electrical circuits, as they could be at high voltages capable of causing electrical shock hazard.

3. Personal Safety

- a. Wear personal protective equipment (for example, latex gloves or safety glasses with side shields) or protect the EVM in an adequate lucent plastic box with interlocks to protect it from being accidentally touched.

Limitation for safe use:

Do not use the EVMs as all or part of a production unit.

3 Information About Cautions and Warnings

The information in the warning statement is provided for personal protection and the information in the caution statement is provided to protect the equipment from damage. Read each caution and warning statement carefully.



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 the EVM with an antistatic wristband. Operate the EVM on an antistatic work surface. For more information on proper handling, see [Electrostatic Discharge \(ESD\)](#).

4 Features

The TMUX9616QFPEVM has the features that follow:

- Integrated SPI controller hardware and GUI for communications with TMUX9616(N)PT
- Direct docking headers for easy TX7516 pulser integration
- Power supply terminals for VDD, VLL, and GND with populated decoupling capacitors near input supply terminal and device
- Header pins for monitoring all source and drain pins and digital control pins
- Thermal shutdown monitoring circuit with LED signal
- Test points for VDD, VLL, and GND pins
- SMA footprints for option to install SMA connector on designated source and drain pins
- Probe tip holders for designated source and drain pins
- Resistor and capacitor loading footprints on the back of the board for customizable load conditions for every source and drain pin

5 TMUX9616QFPEVM GUI Software Installation

5.1 GUI Software Installation

1. Software Download – live software from dev.ti.com. The live software currently works on Chrome™, Firefox™, and Safari™ browsers. Internet Explorer is not supported. Users can access the live version through the link a Texas Instruments representative provides.
2. Click on the application icon within the gallery to launch the software. Click on the prompt to install the TI Cloud Agent Bridge browser plugin.
3. Offline Software – users can access the latest version of the offline software by navigating to the live version as noted previously. Look for the download icon and download both the application and runtime for the operating system as shown in the following figure:

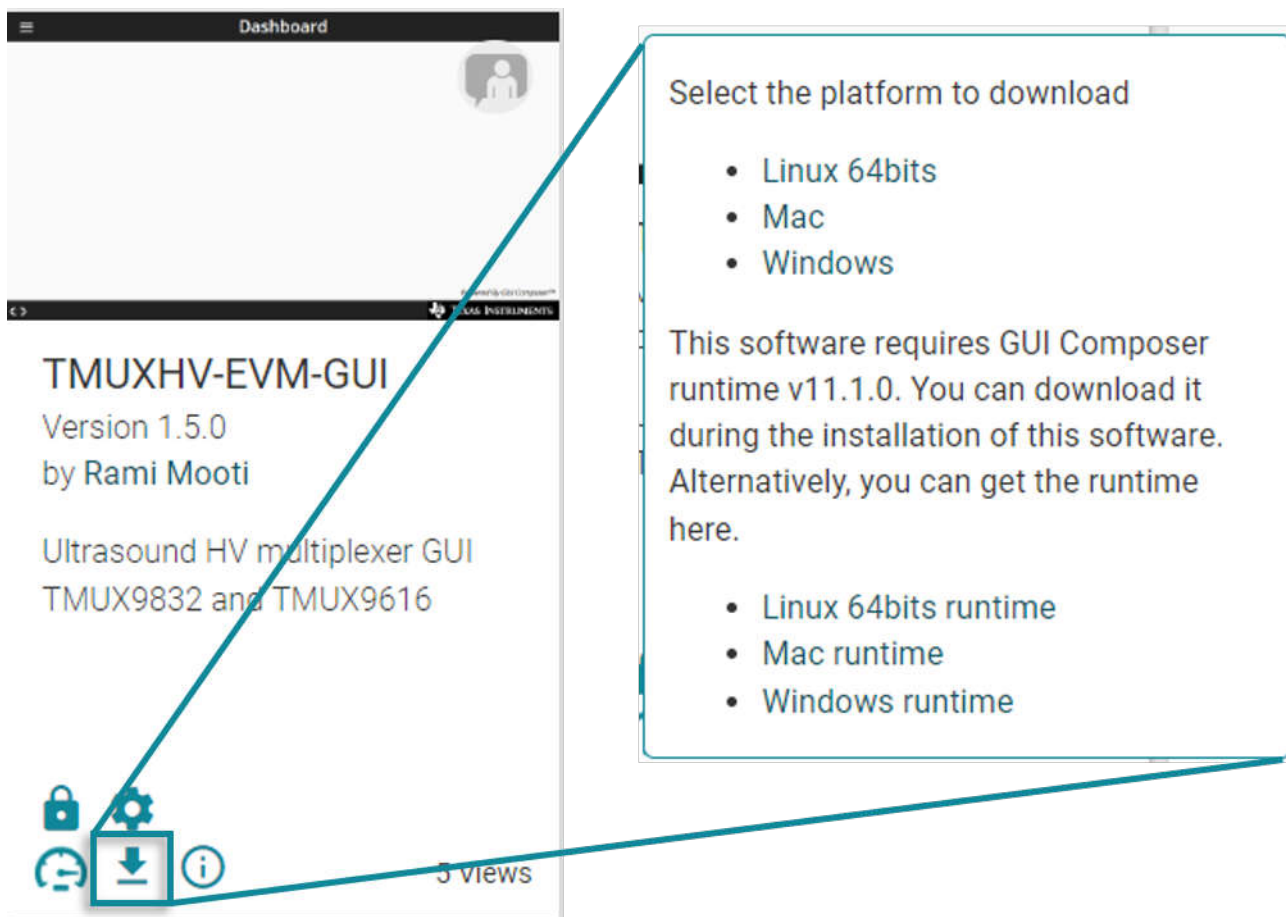


Figure 5-1. Download Icon for TMUXHV-EVM GUI

5.2 GUI Software Quick Start Guide

1. Home Tab

- The Home Tab will display when launching the hardware software. Select the appropriate EVM GUI from the drop-down list that appears here. Press 'connect' after selecting the desired device for proper functionality.
- The Home tab will also contain the shortcut icon to the GUI in the Quick Start page.

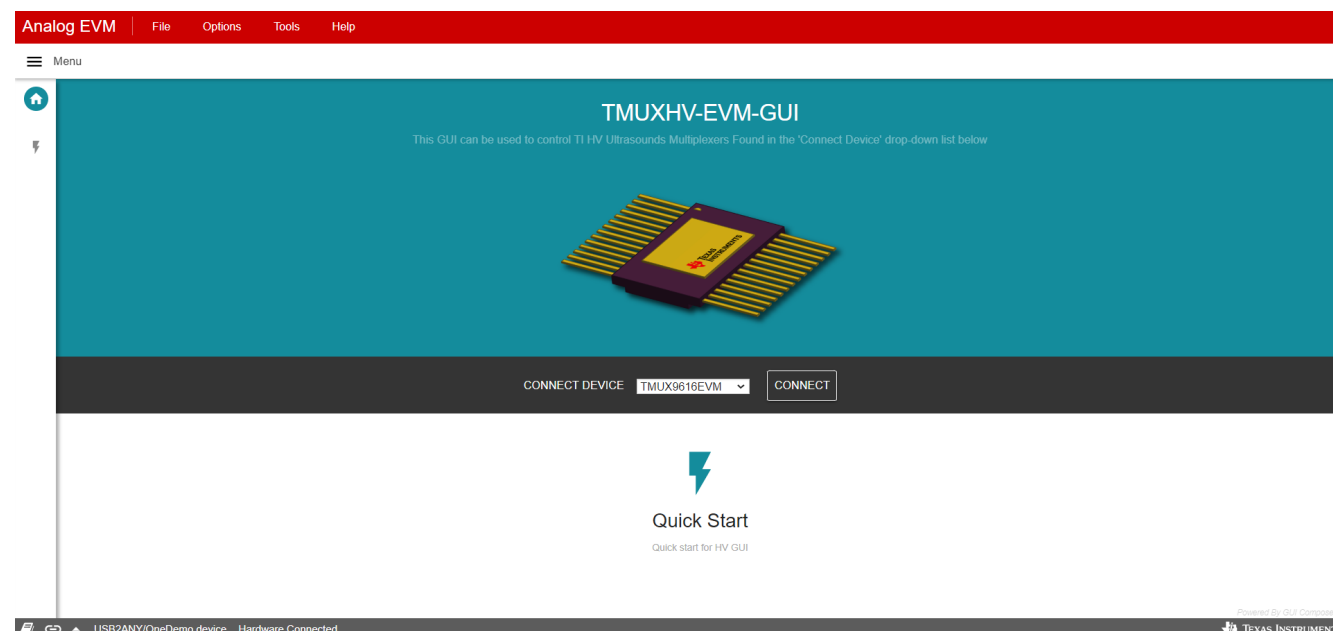


Figure 5-2. TMUXHV-EVM GUI Home Tab

1. GUI Control Panel

- a. The GUI will provide control over the following pins and functionality:
 - i. DIN – the 16 bits [D0:D15] are used to push data into the devices DIN pin. The 'WRITE' button will initialize the actual pushing of the bits starting with bit D15 as MSB.
 - ii. CLR – the CLR button will toggle the CLR GPIO input to the CLR pin on the device. The indicator light will be lit for a 'high' state and dimmed for 'low' state. The effects of this functionality can be found in the data sheet.

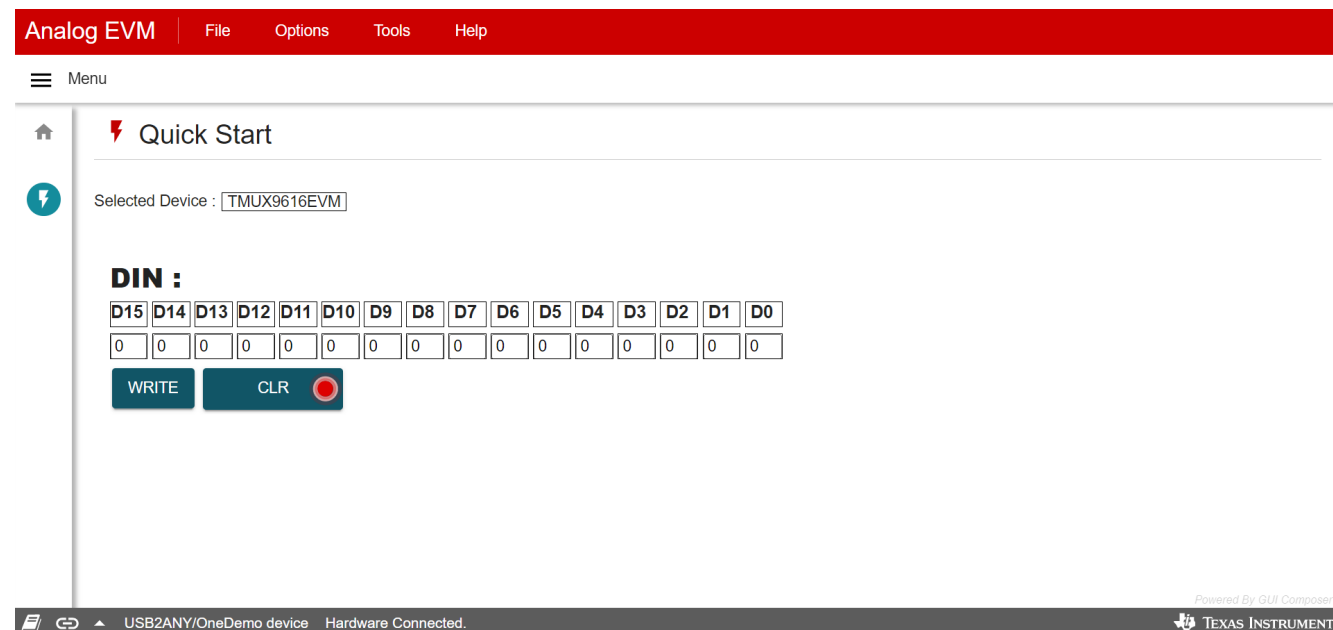


Figure 5-3. TMUXHV-EVM GUI

6 TMUX9616QFPEVM Setup Procedure

To properly operate the TMUX9616QFPEVM, complete the steps that follow:

1. Download and install the GUI software as described in the previous section.

2. Connect the following jumpers for the desired operation of the TMUX9616(N):
 - a. Install the VSS SHUNT jumper on J10.
 - b. Do *not* install (float) SET SHUNT jumper on J9.
 - c. If using the on-board SPI, then install jumpers on J12-J18 to enable this functionality. Otherwise, leave the jumpers uninstalled if providing communications externally.
 - d. Connect all necessary power supplies to the designated power terminal block (J11) inputs and power up the supplies according to the order in the table that follows:

Table 6-1. Power Supplies and Designated Power Terminal Block

Terminal	Rail	Voltage	Current Limit
J11-1	VSS	-10 V to -110 V	10 mA
J11-2	GND	0 V	—
J11-3	VDD	10 V to 110 V	10 mA
J11-4	VLL	5 V	50 mA

Note

- i. VLL has a higher current limit because it is used to power several other components on the EVM. Not indicative of typical VLL quiescent current for TMUX9616.
 - ii. Powering the TMUX9616QFPEVM up or down in an arbitrary sequence can cause damage to the device.
3. Connect the mini-USB between the PC and TMUX9616QFPEVM connector J20 to power up SPI communication block. Green LED (D1) next to J20 should illuminate indicating power is good.
 4. Open up the GUI weblink, select the proper device from the drop-down menu, press connect, and make sure there is a *Hardware Connected* prompt at the lower left side of the GUI to initialize the TMUXHV-EVM GUI. Then click the *Quick Start* icon to navigate into the GUI itself.
 5. Connect the desired inputs to the source and drain pins, and solder on the necessary resistors and capacitors for test loading (R/C footprints located on backside of the board for each I/O).
 6. Use the TMUXHV-EVM GUI to select and turn on or off the required channels and proceed with evaluating the TMUX9616PT and TMUX9616NPT.

7 TMUX9616QFPEVM Feature Descriptions

7.1 TX7516 Pulser Interface Headers

The TMUX9616QFPEVM allows for easy integration with TI's TX7516 pulser EVM. The J19 header pins are routed for and fit right into the TX7516 EVM output terminal block for a seamless integration. This helps eliminate extra parasitic elements that can often be introduced by external wiring and enable a clean and optimized interface between the two components.

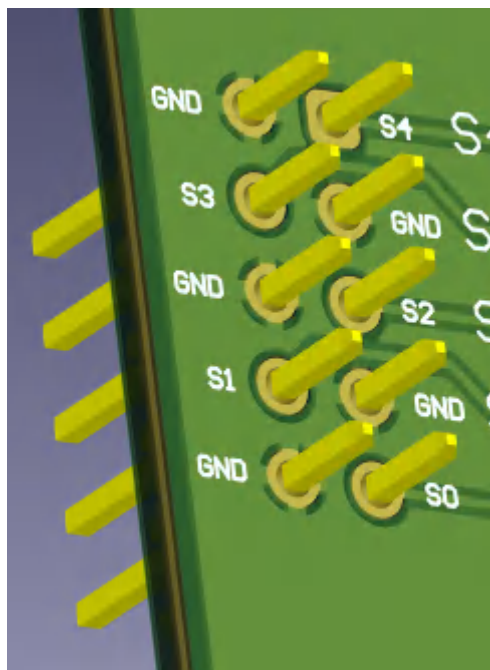


Figure 7-1. Pulsar Interface Headers

7.2 Thermal Shutdown

The TMUX9616PT and TMUX9616NPT offer a thermal shutdown safety feature to make sure the device does not continue to operate once internal temperatures exceed the thermal shutdown temperature defined in the data sheet. When the TMUX9616PT and TMUX9616NPT enter thermal shutdown, the /THERM pin will assert low and all switches will be disabled. The TMUX9616QFPEVM implements an easy to identify thermal shutdown indicator circuit in which an LED will illuminate if the device enters this condition. Once the device exits the thermal shutdown state, the LED will turn off, the switches will assume the appropriate state based on the current digital input conditions, and the /THERM pin will go into a high impedance state.



Figure 7-2. Thermal Shutdown Indicator

7.3 External SPI

The TMUX9616QFPEVM enables the user to configure the board for use with the integrated SPI controller and GUI, or to provide an external SPI communications setup. To provide an external communications setup, the user must leave the J12-J18 jumpers uninstalled to prevent unintended operation of the EVM. Next, the user can then connect their interface to the header pins provided by the J8 block that will communicate with the TMUX9616(N).

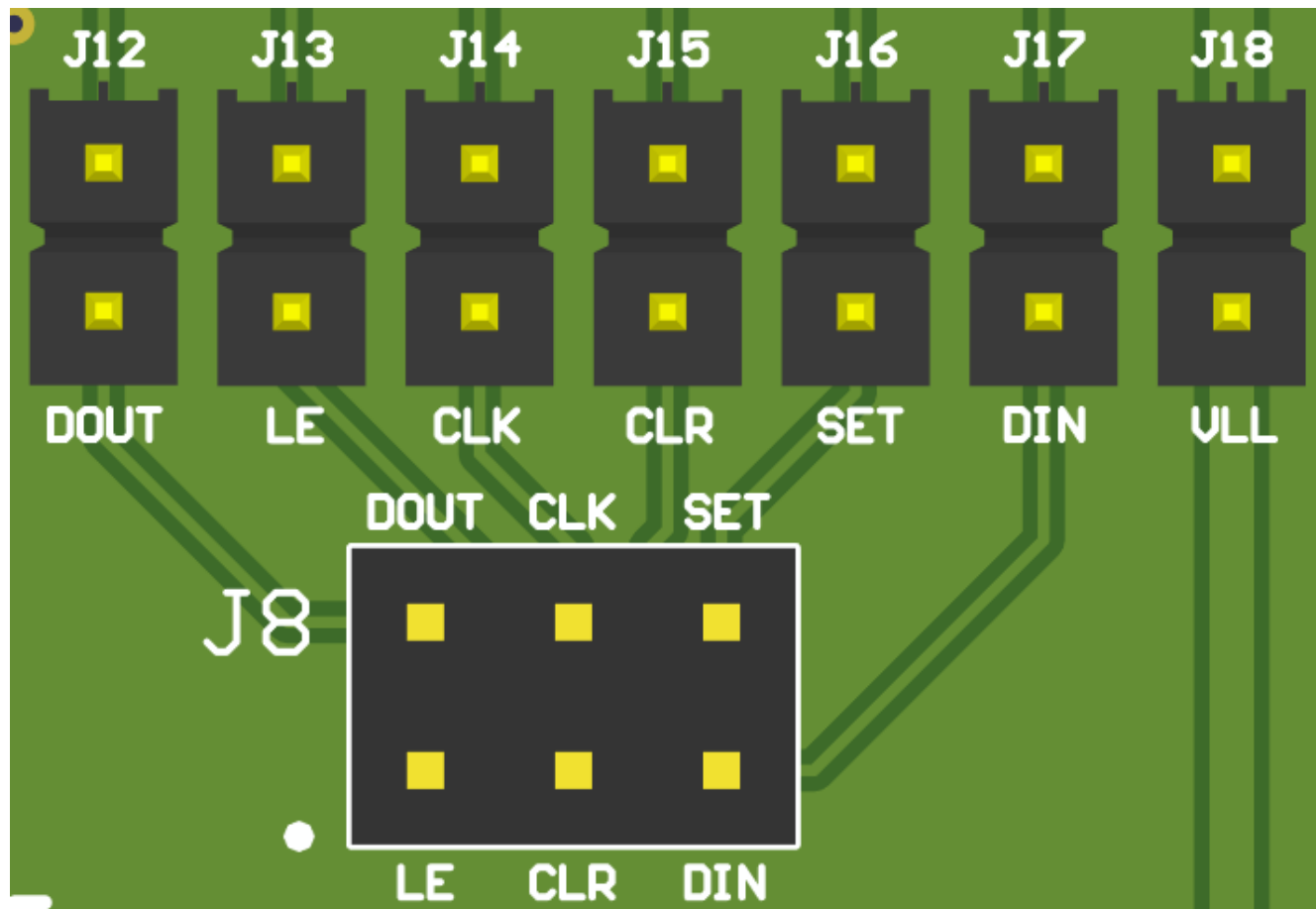


Figure 7-3. SPI Headers

7.4 Channel Loading Options

The TMUX9616QFPEVM features resistor and capacitor footprints (located on the backside of the board) to let the user install their own RC loads to evaluate the TMUX9616PT or TMUX9616NPT. Each input and output have a set of RC load footprints for maximum flexibility of the loading setup.

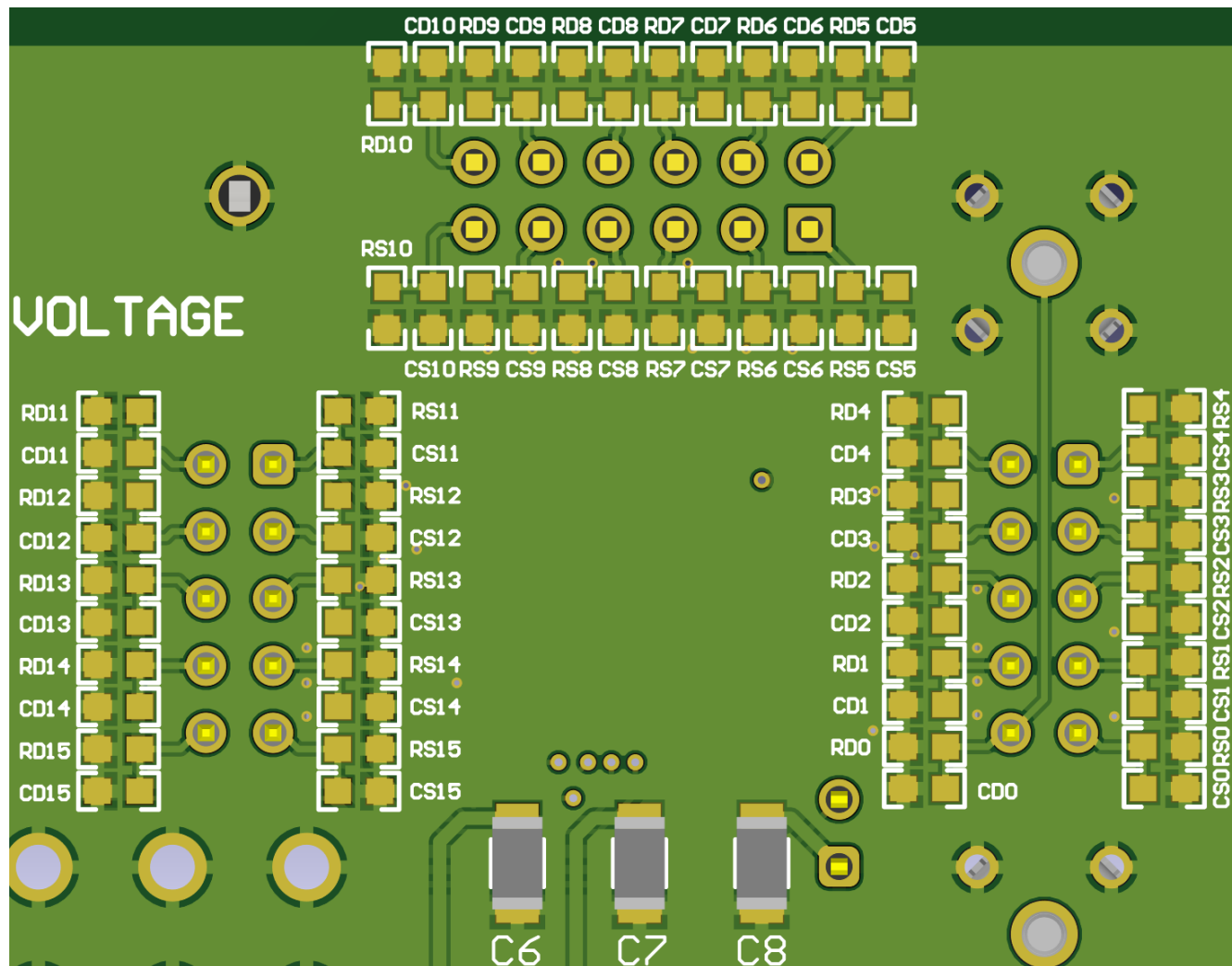


Figure 7-4. Resistor and Capacitor Loading Footprints

8 Connection Descriptions

Designator	Description
J1	Header pins for S0-S4 and D0-D4
J2	Header pins for S5-S10 and D5-D10
J3	Header pins for S11-S15 and D11-D15
J4	Probe tip holder for D0
J5	Probe tip holder for S0
J6	SMA connector for D15
J7	SMA connector for S15
J8	SPI header pins
J9	SET Shunt Select (unused for TMUX9616PT)
J10	VSS Shunt Select
J11	Power terminal block
J12	SPI Shunt – DOUT
J13	SPI Shunt – LE
J14	SPI Shunt – CLK
J15	SPI Shunt – CLR
J16	SPI Shunt – SET
J17	SPI Shunt – DIN
J18	SPI Shunt – VLL
J19	Direct dock TX7516 pulser headers
J20	USB-mini connector
TP1	VSS test point
TP2	GND test point
TP3	VDD test point
TP4	VLL test point
TP5	THERM test point
TP6-7	GND test points
C1-C8	Supply decoupling capacitors
D1	Communications power-good LED
DT1	Thermal shutdown indicator LED
RS0-RS31	Load resistor footprints (S-pins)
RD0-RD31	Load resistor footprints (D-pins)
CS0-CS31	Load capacitor footprints (S-pins)
CD0-CD31	Load capacitor footprints (D-pins)

9 Schematic

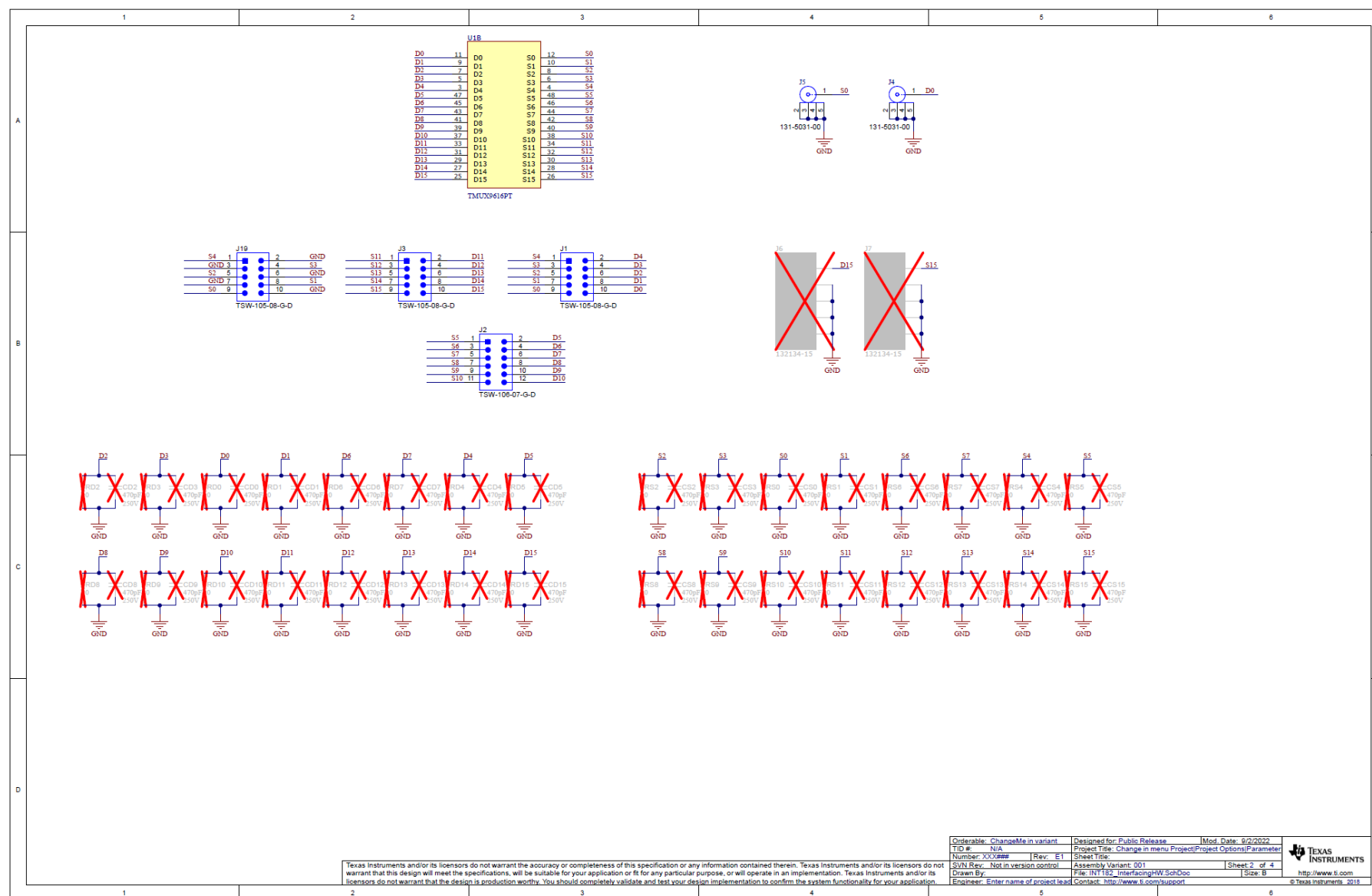


Figure 9-1. TMUX9616QFPEVM Schematic

Schematic

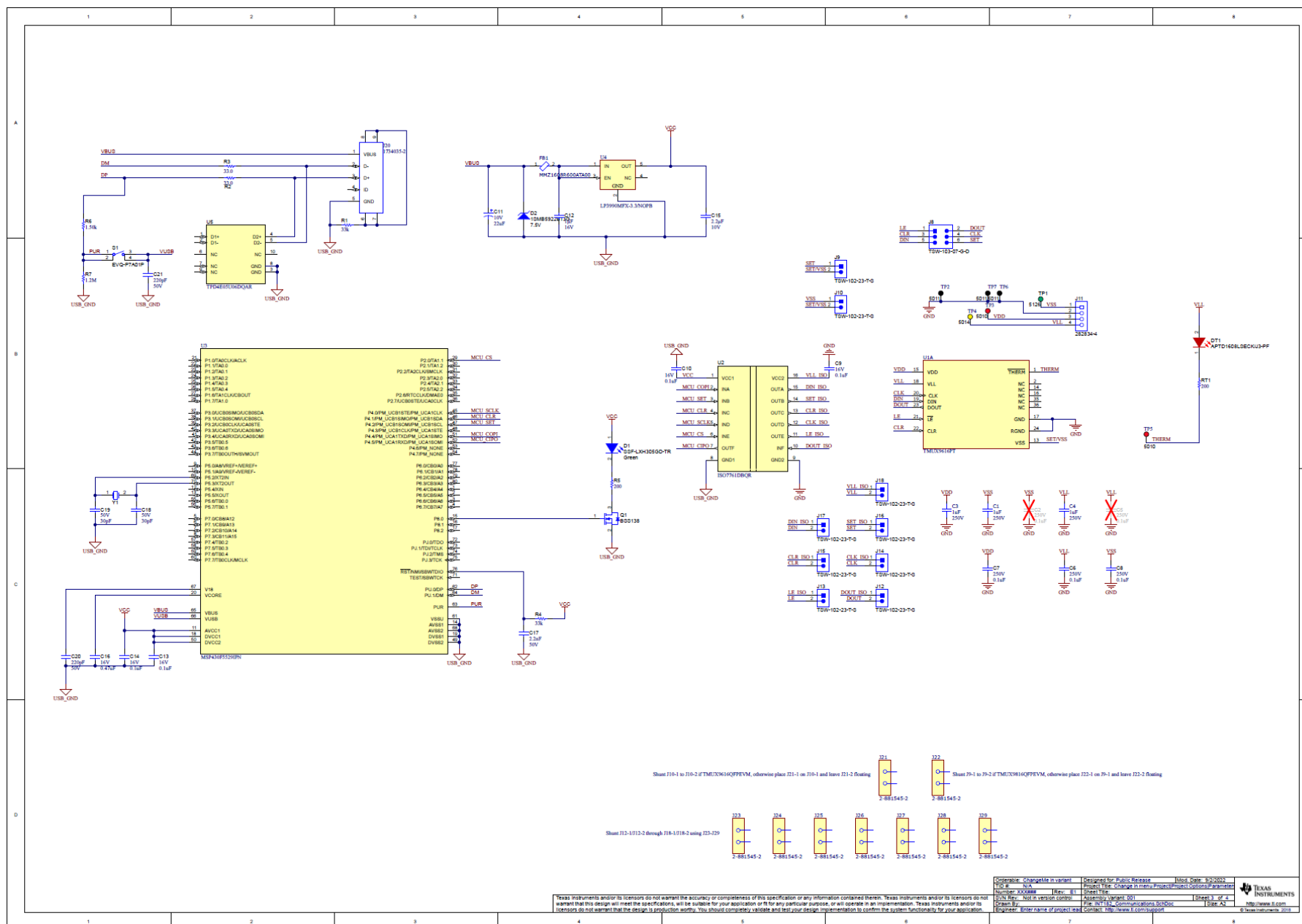


Figure 9-2. TMUX9616QFPEVM Schematic

10 Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		TMUX9616QFPEVM	Any
C1, C3, C4	3	1 μ F	Multilayer Ceramic Capacitors 1 μ F $\pm$ 10% 250 V X7T SMD 1812	1812	C4532X7T2E105K250KA	TDK
C6, C7, C8	3	0.1 μ F	CAP, CERM, 0.1 μ F, 250 V, $\pm$ 10%, X7R, 1206	1206	GRM31CR72E104KW03 L	MuRata
C9, C10, C13, C14	4	0.1 μ F	CAP, CERM, 0.1 μ F, 16 V, $\pm$ 10%, X7R, 0402	402	GRM155R71C104KA88D	MuRata
C11	1	22 μ F	CAP, AL, 22 μ F, 10 V, $\pm$ 20%, 1.35 ohm, AEC-Q200 Grade 2, SMD	SMT Radial B	EEE-FK1A220R	Panasonic
C12	1	1 μ F	CAP, CERM, 1 μ F, 16 V, $\pm$ 10%, X7R, 0805	805	C0805C105K4RACTU	Kemet
C15	1	2.2 μ F	CAP, CERM, 2.2 μ F, 10 V, $\pm$ 10%, X7R, 0805	805	LMK212B7225KG-T	Taiyo Yuden
C16	1	0.47 μ F	CAP, CERM, 0.47 μ F, 16 V, $\pm$ 10%, X5R, 0603	603	GRM188R61C474KA93D	MuRata
C17	1	2200 pF	CAP, CERM, 2200 pF, 50 V, $\pm$ 10%, X7R, 0603	603	C0603C222K5RACTU	Kemet
C18, C19	2	30 pF	CAP, CERM, 30 pF, 50 V, $\pm$ 5%, C0G/NP0, 0603	603	GRM1885C1H300JA01D	MuRata
C20, C21	2	220 pF	CAP, CERM, 220 pF, 50 V, $\pm$ 10%, X7R, 0603	603	C0603C221K5RACTU	Kemet
D1	1	Green	LED, Green, SMD	7 $\times$ 4 mm	SSF-LXH305GD-TR	Lumex
D2	1	7.5V	Diode, Zener, 7.5 V, 550 mW, SMB	SMB	1SMB5922BT3G	ON Semiconductor
DT1	1	Red	LED, Red, SMD	Body 1.6 $\times$ 0.8 mm	APTD1608LSECK/J3- pF	Kingbright
FB1	1		Signal Line Ferrite Bead 60 Ω at 100 MHz 800 mA DCR 100 m Ω SMD 0603	603	MMZ1608R600ATA00	TDK
FID1, FID2, FID3	3		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
H1, H3, H5, H7	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
H2, H4, H6, H8	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
J1, J3, J19	3		Header, 2.54 mm, 5 × 2, Gold, TH	Header, 2.54 mm, 5 × 2, TH	TSW-105-08-G-D	Samtec
J2	1		Header, 100 mil, 6 × 2, Gold, TH	6 × 2 Header	TSW-106-07-G-D	Samtec
J4, J5	2		Compact Probe Tip Circuit Board Test Points, TH, 25 per	TH Scope Probe	131-5031-00	Tektronix
J8	1		Header, 100 mil, 3 × 2, Gold, TH	3 × 2 Header	TSW-103-07-G-D	Samtec
J9, J10, J12, J13, J14, J15, J16, J17, J18	9		Header, 2.54 mm, 2 × 1, Tin, TH	Header, 2.54 mm, 2 × 1, TH	TSW-102-23-T-S	Samtec
J11	1		Terminal Block, 100 mil, 4X1 TH	10.62 × 10 × 6.5 mm	282834-4	TE Connectivity
J20	1		Connector, Receptacle, Mini-USB Type B, R/A, Top Mount SMT	USB Mini Type B	1734035-2	TE Connectivity
J21, J22, J23, J24, J25, J26, J27, J28, J29	9		2 (1 x 2) Position Shunt Connector Red Open Top, Grip 0.100" (2.54 mm) Gold	CONN_SHUNT-2POS	2-881545-2	TE
Q1	1	50 V	MOSFET, N-CH, 50 V, 0.22 A, SOT-23	SOT-23	BSS138	Fairchild Semiconductor
R1, R4	2	33k	RES, 33 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040233K0JNED	Vishay-Dale
R2, R3	2	33	RES, 33.0, 1%, 0.1 W, 0402	402	ERJ-2RKF33R0X	Panasonic
R5	1	200	RES, 200, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW0603200RJNEA	Vishay-Dale

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R6	1	1.50k	RES, 1.50 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04021K50FKED	Vishay-Dale
R7	1	1.2Meg	RES, 1.2 M, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04021M20JNED	Vishay-Dale
RT1	1	200	RES, 200, 1%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	CRCW1206200RFKEA	Vishay-Dale
S1	1		Switch, Tactile, SPST-NO, 0.05A, 12 V , SMD	3.5 × 3.55 mm	EVQ-P7A01P	Panasonic
TMUX9616QFPEVM	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 × 0.200 inch	THT-14-423-10	Brady
TP1	1		Test Point, Multipurpose, Green, TH	Green Multipurpose Testpoint	5126	Keystone
TP2, TP6, TP7	3		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone
TP3, TP5	2		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone
TP4	1		Test Point, Multipurpose, Yellow, TH	Yellow Multipurpose Testpoint	5014	Keystone
U1	1		220 V High Voltage 1:1, 16-Channel Switch with Latch-Up Immunity	LQFP48	TMUX9616PT	Texas Instruments
U2	1		High Speed, Robust EMC, Reinforced Six-Channel Digital Isolator, DBQ0016A (SSOP-16)	DBQ0016A	ISO7761DBQR	Texas Instruments
U3	1		25 MHz Mixed Signal Microcontroller with 128 KB Flash, 8192 B SRAM and 63 GPIOs, -40 to 85 °C, 80-pin QFP (PN), Green (RoHS & no Sb/Br)	PN0080A	MSP430F5529IPN	Texas Instruments

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
U4	1		150 mA Linear Voltage Regulator for Digital Applications, DBV0005A (SOT-23-5)	DBV0005A	LP3990MFX-3.3/NOPB	Texas Instruments
U5	1		4-Channel Ultra-Low-Capacitance IEC ESD Protection Diode, DQA0010A (USON-10)	DQA0010A	TPD4E05U06DQAR	Texas Instruments
Y1	1		Crystal, 24.000 MHz, 20 pF, SMD	Crystal, 11.4x4.3x3.8mm	ECS-240-20-5PX-TR	ECS Inc.
C2, C5	0	0.1 μ F	CAP, CERM, 0.1 μ F, 250 V, $\pm$ 10%, X7R, 1206	1206	GRM31CR72E104KW03 L	MuRata
CD0, CD1, CD2, CD3, CD4, CD5, CD6, CD7, CD8, CD9, CD10, CD11, CD12, CD13, CD14, CD15, CS0, CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15	0	470 pF	CAP, CERM, 470 pF, 250 V, $\pm$ 10%, X7R, 0603	603	GRM188R72E471KW07 D	MuRata
J6, J7	0		CONN SMA JACK STR 50 Ω SMD	CONN_SMA_JACK	132134-15	Amphenol Connex
RD0, RD1, RD2, RD3, RD4, RD5, RD6, RD7, RD8, RD9, RD10, RD11, RD12, RD13, RD14, RD15, RS0, RS1, RS2, RS3, RS4, RS5, RS6, RS7, RS8, RS9, RS10, RS11, RS12, RS13, RS14, RS15	0	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	ERJ-3GEY0R00V	Panasonic

11 Revision History

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

Changes from Revision A (November 2024) to Revision B (November 2024)	Page
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- | | |
|------------------------|---|
| • Added TMUX9616N..... | 1 |
|------------------------|---|

Changes from Revision * (February 2023) to Revision A (November 2024)	Page
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- | | |
|-----------------------------|---|
| • First public release..... | 1 |
|-----------------------------|---|

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/sds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

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

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないもの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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東京都新宿区西新宿 6 丁目 2 4 番 1 号
西新宿三井ビル

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