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 ±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 sepeate 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 seperately and placed on the TMUX9616QFPEVM for evalution.

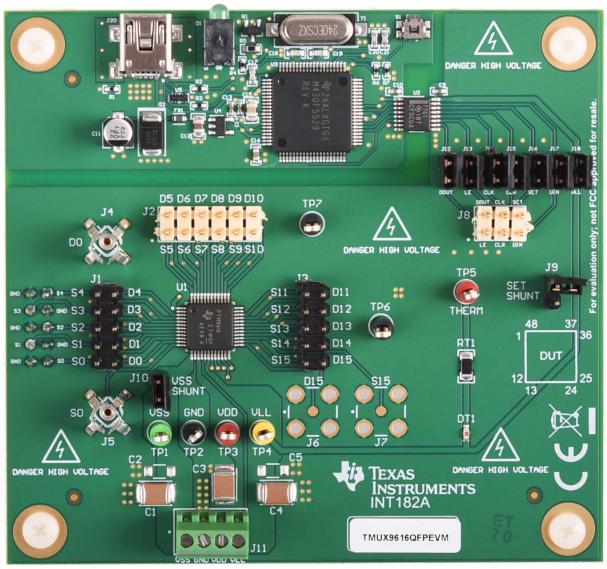

Figure 1-1. TMUX9616QFPEVM Top View

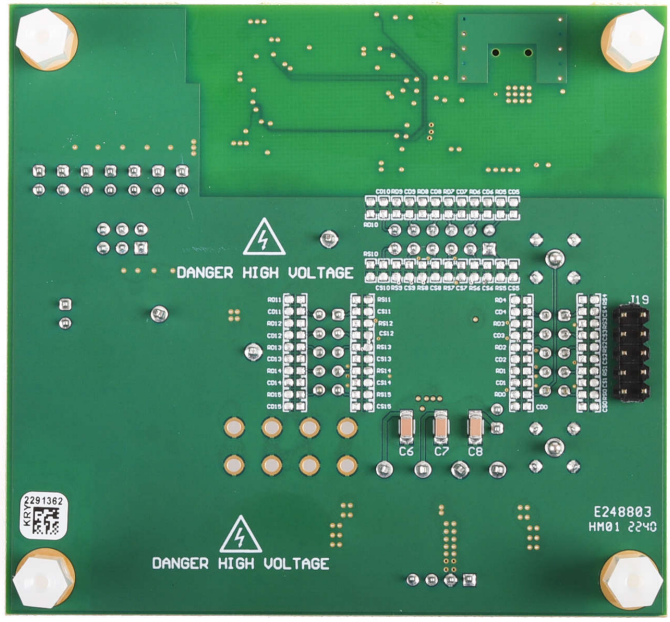

Figure 1-2. TMUX9616QFPEVM Bottom View

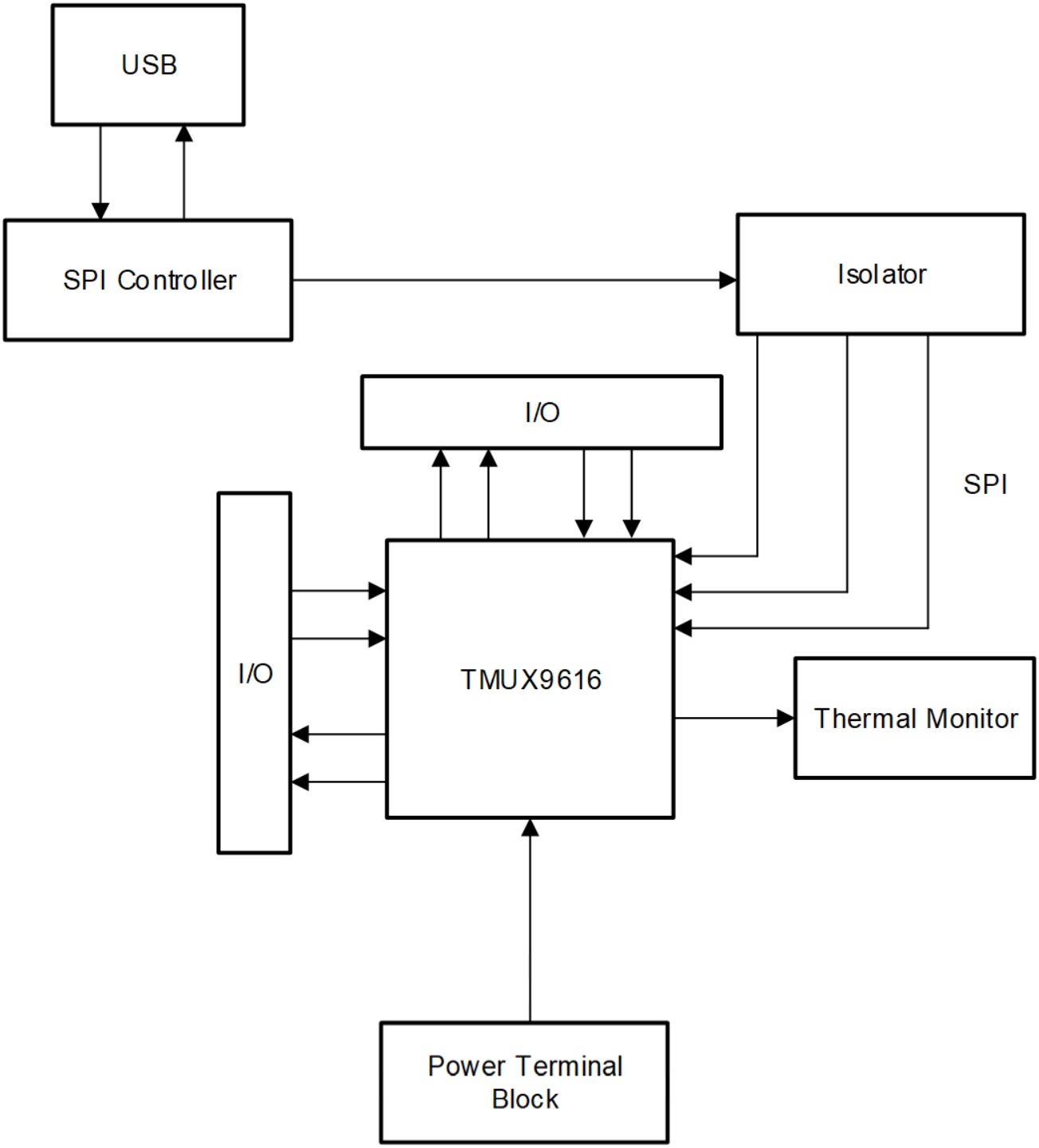

Figure 1-3. TMUX9616QFPEVM Functional Block Diagram

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:

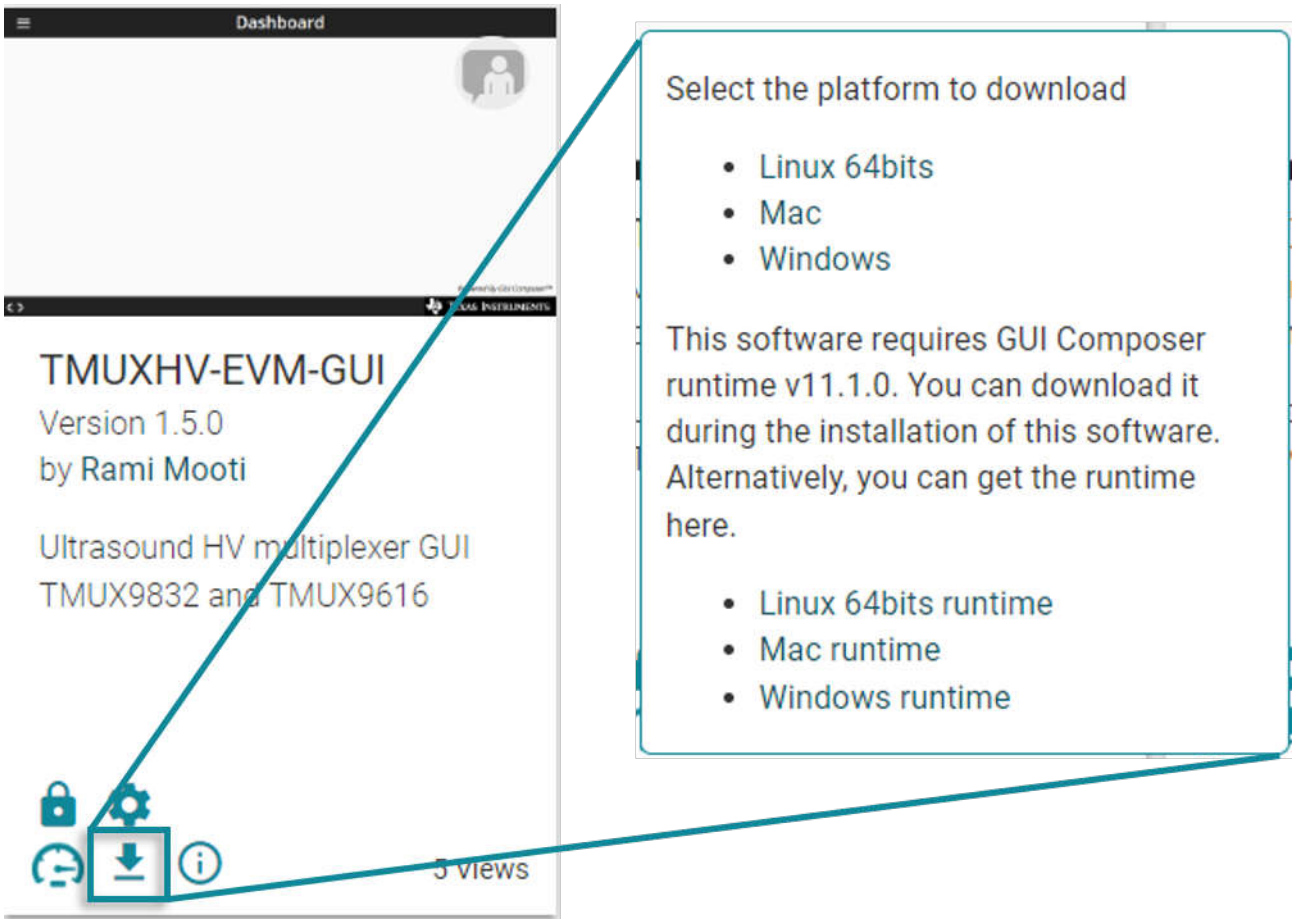

Figure 5-1. Download Icon for TMUXHV-EVM GUI

5.2 GUI Software Quick Start Guide

1. Home Tab
   a. 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.
   b. The Home tab will also contain the shortcut icon to the GUI in the Quick Start page.

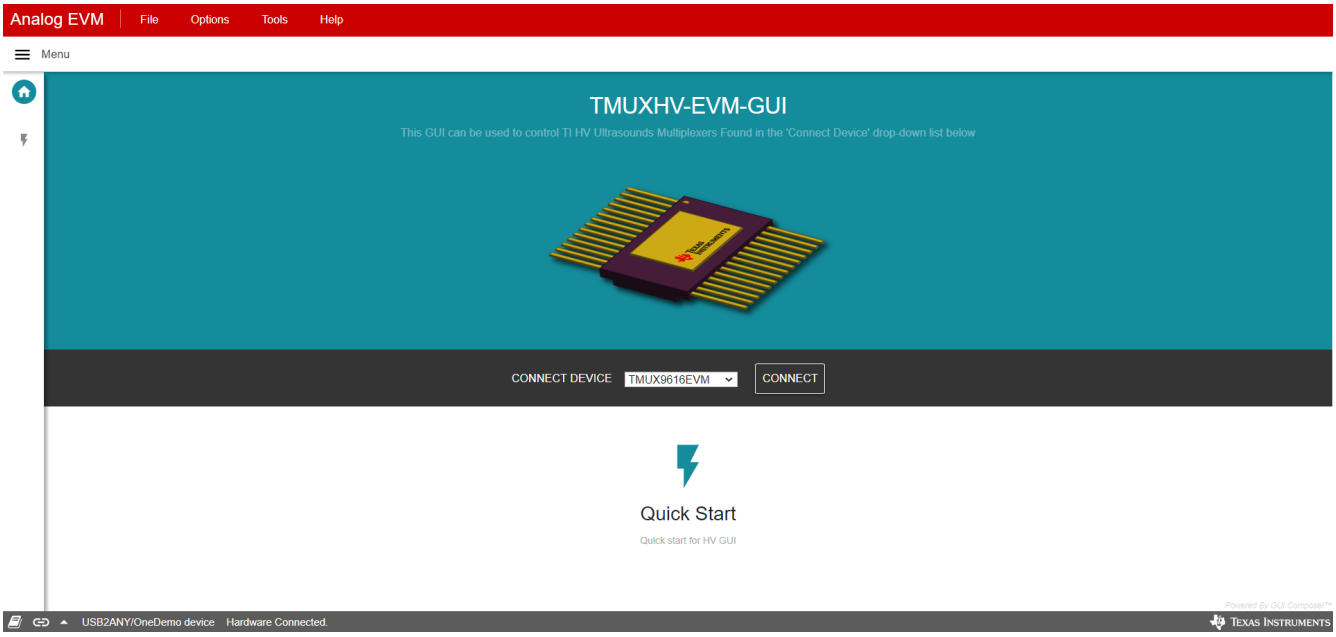

Figure 5-2. TMUXHV-EVM GUI Home Tab

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.

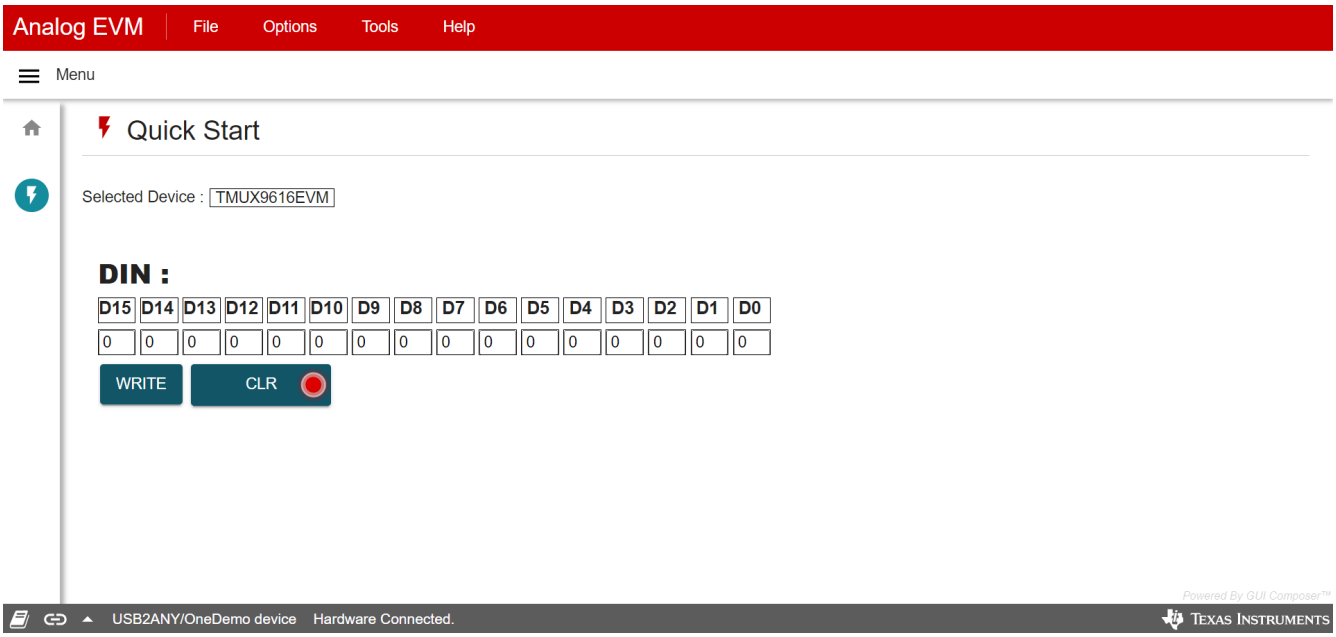

Figure 5-3. TMUXHV-EVM GUI

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.

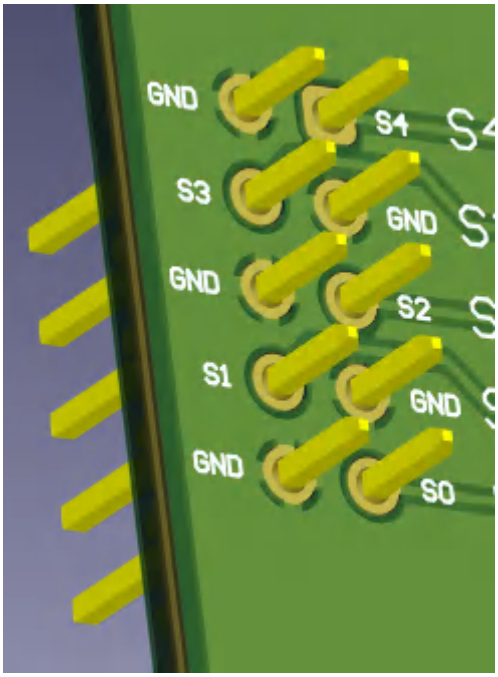

Figure 7-1. Pulser Interface Headers

7.2 Thermal Shutdown

The TMUX9616PT and TMUX9616NPToffer 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.

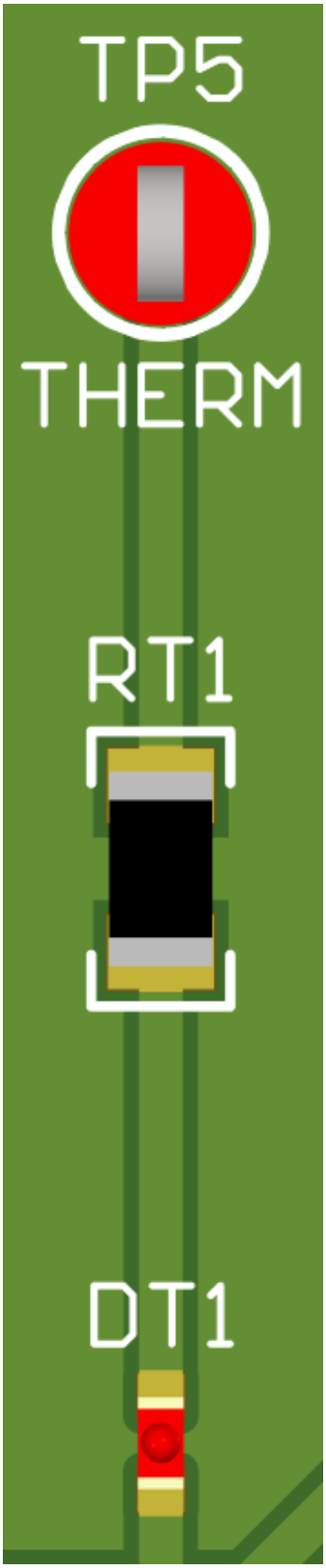

Figure 7-2. Thermal Shutdown Indicator

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).

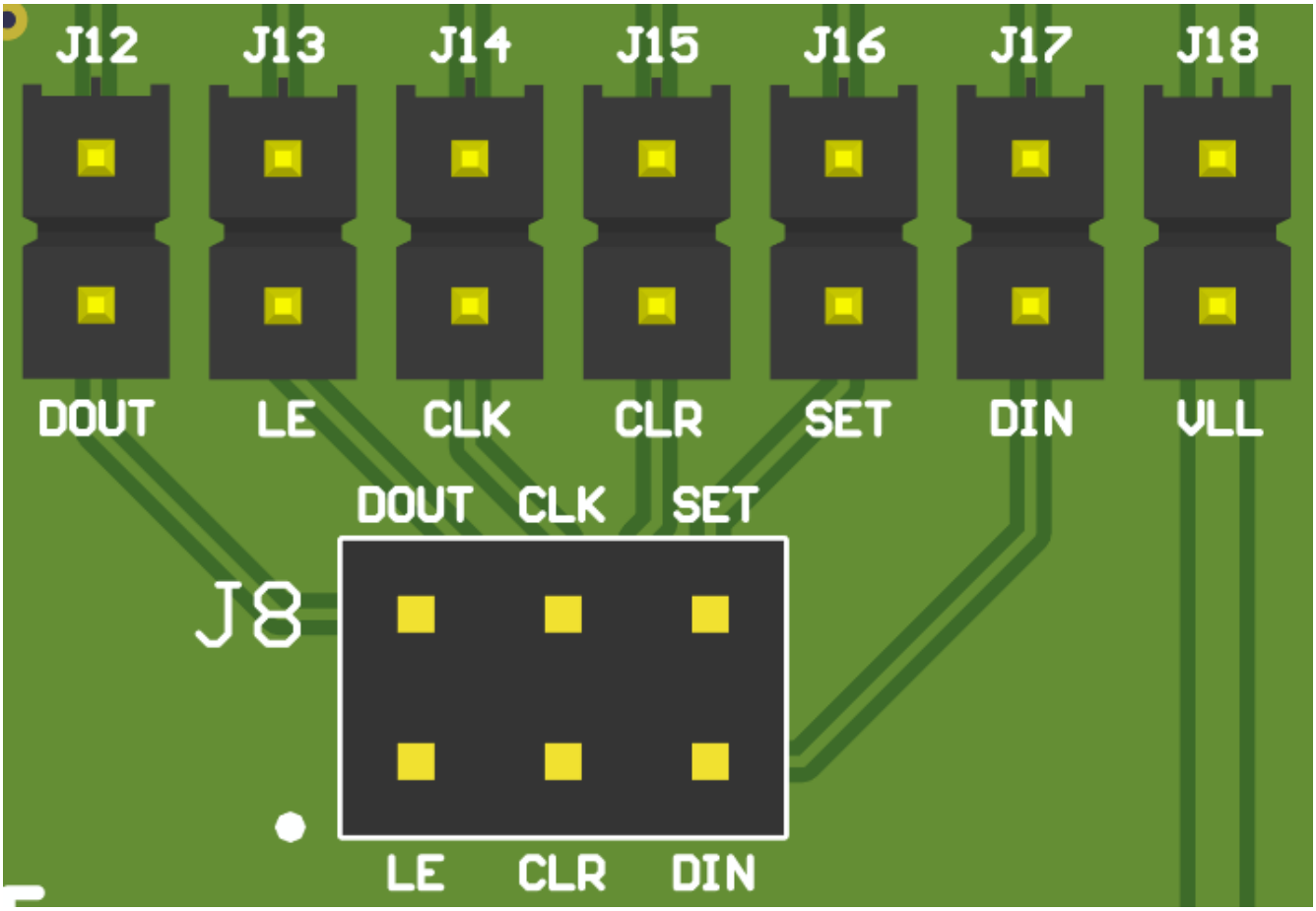

Figure 7-3. SPI Headers

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.

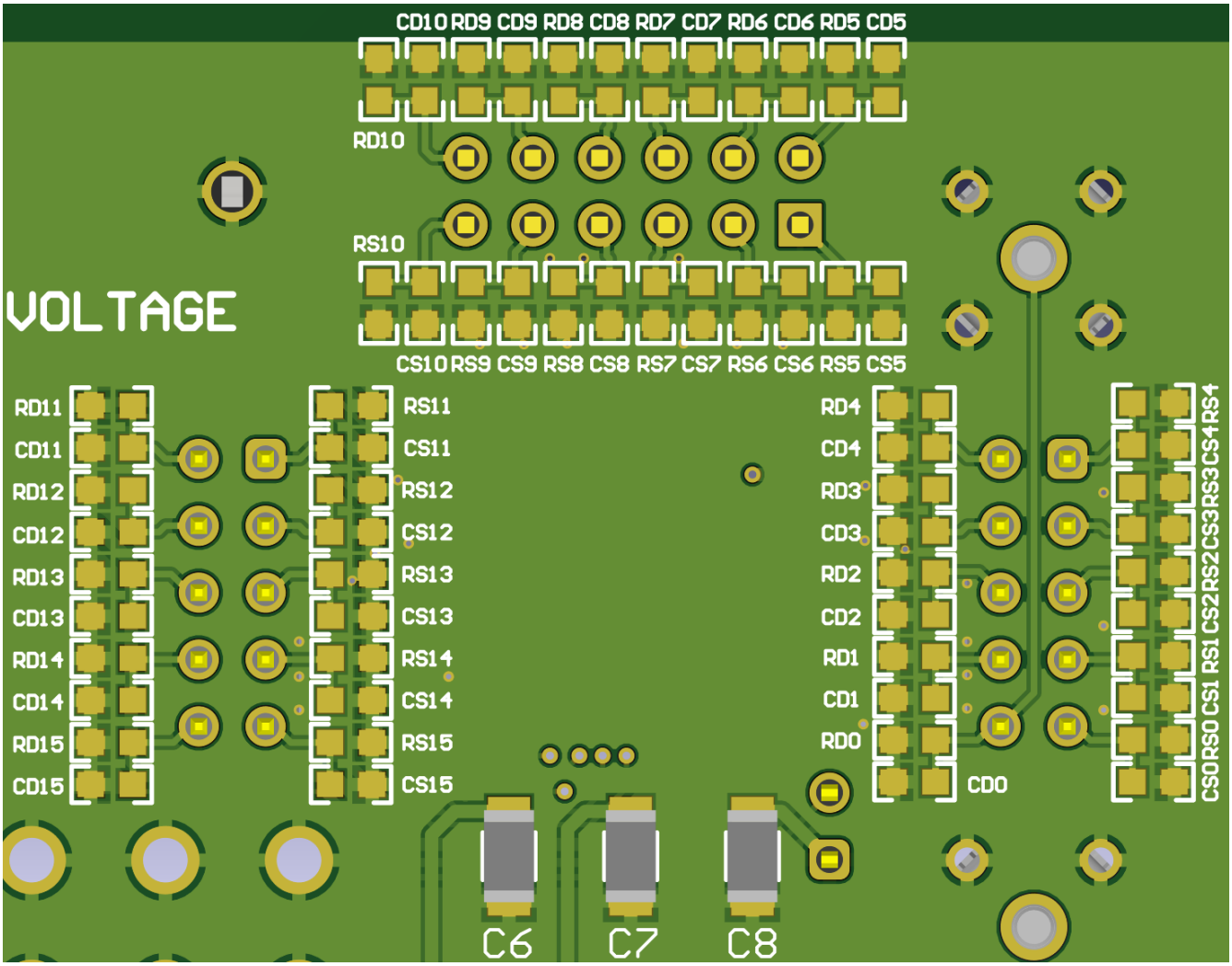

Figure 7-4. Resistor and Capacitor Loading Footprints

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

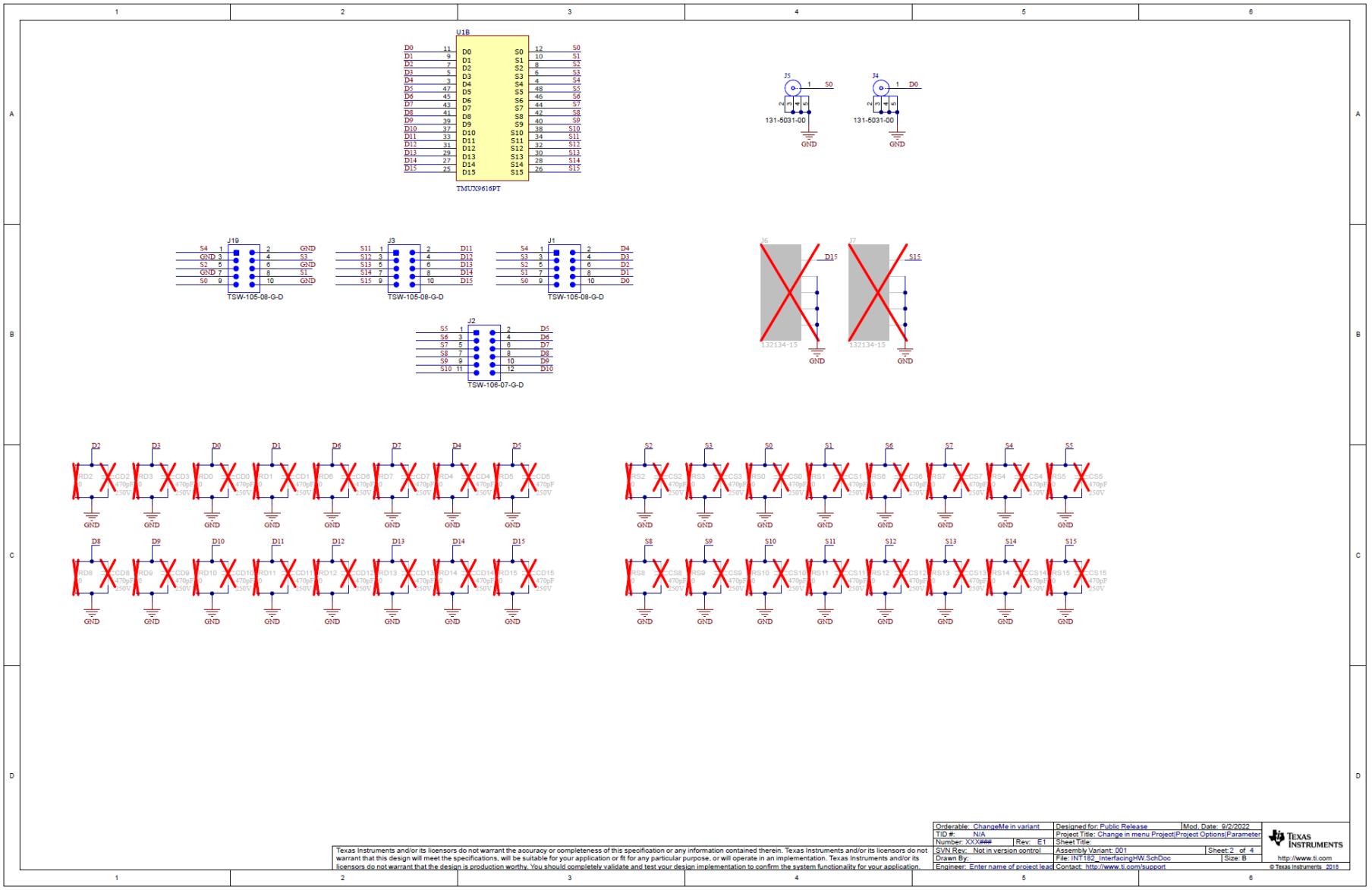

Figure 9-1. TMUX9616QFPEVM Schematic

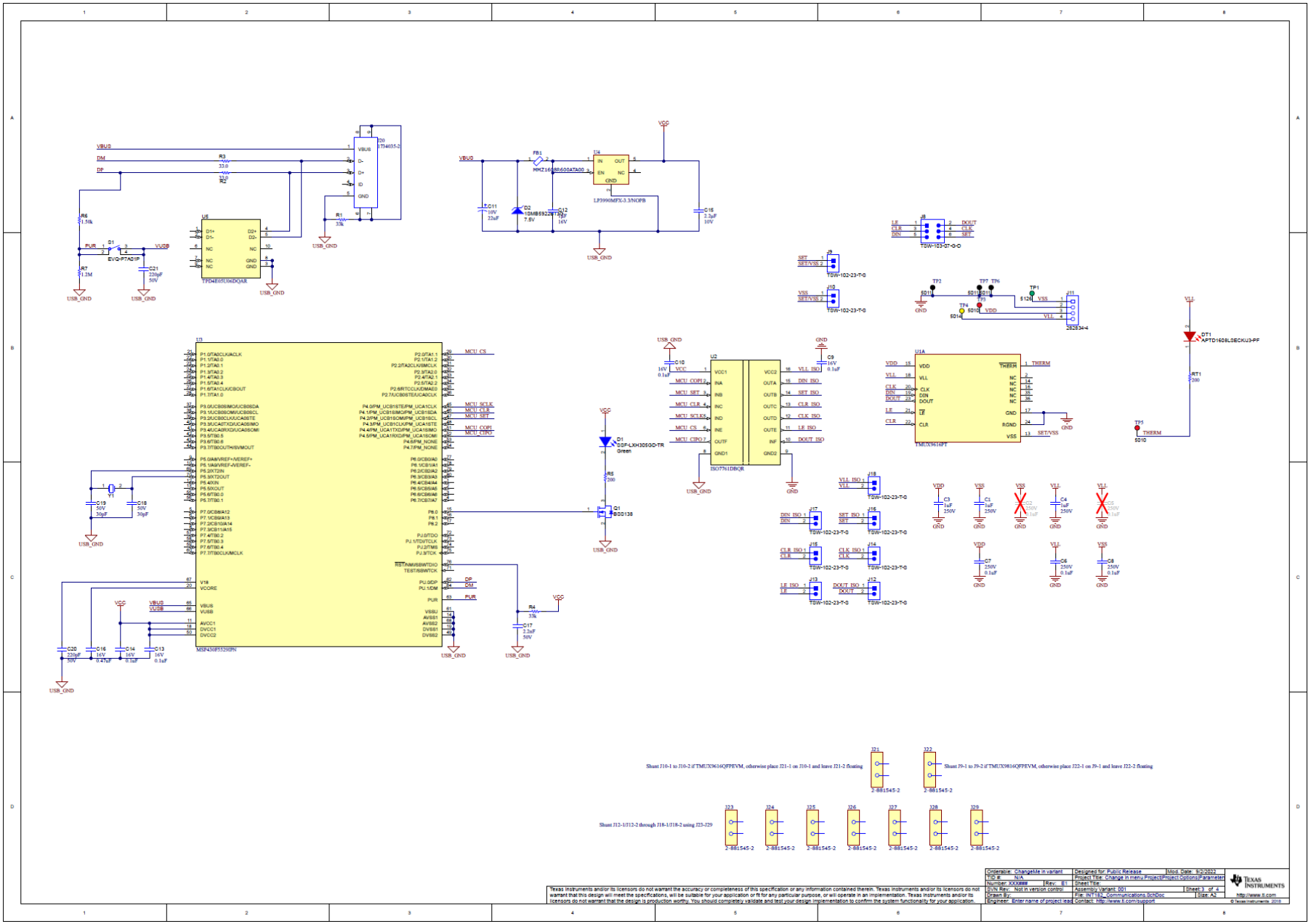

Figure 9-2. TMUX9616QFPEVM Schematic

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 µF	Multilayer Ceramic Capacitors 1 µF ±10% 250 V X7T SMD 1812	1812	C4532X7T2E105K250KA	TDK
C6, C7, C8	3	0.1 µF	CAP, CERM, 0.1 µF, 250 V, ± 10%, X7R, 1206	1206	GRM31CR72E104KW03L	MuRata
C9, C10, C13, C14	4	0.1 µF	CAP, CERM, 0.1 µF, 16 V, ± 10%, X7R, 0402	402	GRM155R71C104KA88D	MuRata
C11	1	22 µF	CAP, AL, 22 µF, 10 V, ± 20%, 1.35 ohm, AEC-Q200 Grade 2, SMD	SMT Radial B	EEE-FK1A220R	Panasonic
C12	1	1 µF	CAP, CERM, 1 µF, 16 V, ± 10%, X7R, 0805	805	C0805C105K4RACTU	Kemet
C15	1	2.2 µF	CAP, CERM, 2.2 µF, 10 V, ± 10%, X7R, 0805	805	LMK212B7225KG-T	Taiyo Yuden
C16	1	0.47 µF	CAP, CERM, 0.47 µF, 16 V, ± 10%, X5R, 0603	603	GRM188R61C474KA93D	MuRata
C17	1	2200 pF	CAP, CERM, 2200 pF, 50 V, ± 10%, X7R, 0603	603	C0603C222K5RACTU	Kemet
C18, C19	2	30 pF	CAP, CERM, 30 pF, 50 V, ± 5%, C0G/NP0, 0603	603	GRM1885C1H300JA01D	MuRata
C20, C21	2	220 pF	CAP, CERM, 220 pF, 50 V, ± 10%, X7R, 0603	603	C0603C221K5RACTU	Kemet
D1	1	Green	LED, Green, SMD	7 × 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 × 0.8 mm	APTD1608LSECK/J3- pF	Kingbright
FB1	1		Signal Line Ferrite Bead 60 Ω at 100 MHz 800 mA DCR 100 mΩ 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 µF	CAP, CERM, 0.1 µF, 250 V, ± 10%, X7R, 1206	1206	GRM31CR72E104KW03L	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, ± 10%, X7R, 0603	603	GRM188R72E471KW07D	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
• Added TMUX9616N	1

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

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