EVM User's Guide: TCAN-SOIC14-EVM

Universal 14-pin CAN Evaluation Module

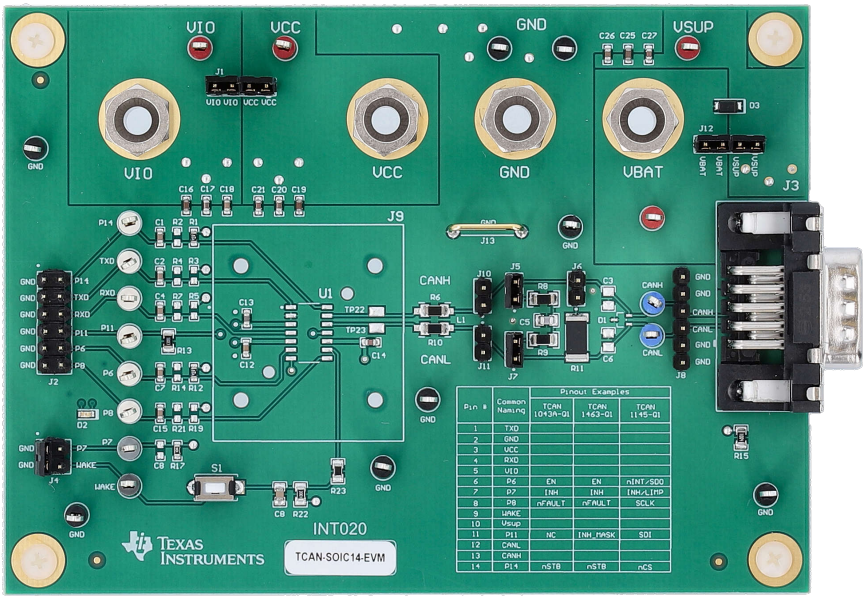
Description

The universal 14-pin CAN EVM provides users with the ability to evaluate all the TI 14-pin CAN transceiver families. The universal 14-pin CAN EVM is configurable for use with all the TI 14-pin CAN transceiver families by populating the transceiver and setting jumpers on the EVM.

This EVM also has the footprints for a SIC network, which can be connected to the CAN bus lines via user-installed J10 and J11. Connecting the SIC network to CANH and CANL simulates a noisy CAN bus by adding more reflections and ringing to the signals. This can be used to test the reliability of the transceiver in a very noisy environment.

Features

- Standard and split termination on the CAN bus
- Footprints for filter capacitors, common-mode choke, and TVS diode for CAN bus protection from RF noise and transient pulses
- Footprints for common 14-pin SOIC socket, and CAN FD SIC loading
- DSUB9 connector with the CAN bus signals and GND for typical automotive cable harness connections
- All digital signals for configuration and control brought out to a header for easy access
- Multifunctional jumpers for different functional use of generic pins



TCAN-SOIC14-EVM

1 Evaluation Module Overview

1.1 Introduction

This user's guide details the universal 14-pin CAN (Controller Area Network) EVM operation. All of the options and the overall operation of the EVM are explained in this user's guide. This user's guide explains the EVM configurations for basic CAN evaluation, various load and termination settings.

1.2 Kit Contents

1. Universal 14-pin CAN EVM

1.3 Specification

TI offers a broad portfolio of high speed (HS) CAN, CAN FD, and CAN SIC transceivers. These transceivers can range from single suppies 5V V_{CC} only, 3.3V V_{CC} only, and 5V V_{CC} with I/O level shifting CAN transceivers. These CAN transceiver families include product mixes with varying features such as low-power standby modes with and without wake up, silent modes, loop back, and diagnostic modes.

The TI CAN EVM helps designers evaluate the operation and performance of various TI CAN transceivers in normal and SIC networks. The CAN EVM also provides bus termination, bus filtering, and protection concepts. The CAN EVM is easily configured by the user for the TI 14-pin CAN transceiver families as needed by jumper settings, simple soldering tasks, and replacement of standard components.

1.4 Device Information

The CAN EVM has simple connections to all necessary pins of the CAN transceiver device, and jumpers, where necessary, to provide flexibility for device pin and CAN bus configuration. There are test points (loops) for all main points where probing is necessary for evaluation such as GND, V_{CC}, TXD, RXD, CANH, CANL, and other logic pins. The EVM supports many options for CAN bus configuration. The CAN EVM allows for two termination schemes through the use of jumpers to select between the split termination configuration or a single 120Ω resistor. If needed, there are footprints for a common-mode choke, TVS diode for ESD protection, and capacitors for further EMC protection or signal conditioning. A DSUB9 connector is included to allow the evaluation and use of the CAN bus in larger systems.

2 Hardware

Jumper Information

Table 2-1 lists the jumper connections for the EVM.

Table 2-1. Jumper Connections

Connection	Type	Description
J1	4-pin header	Shunt the middle pins for a shared V_{IO} and V_{CC} supply.
J2	12-pin header	Access to all critical digital I/O and GND for driving the CAN transceiver externally with test equipment or interfaced to a processor EVM.
J3	DSUB9 connector	Provides an alternative way to connect CANH, CANL, and GND all through a standard DB9 CAN pinout rather than through a regular header.
J4	4-pin header	Access to pin 7, WAKE, and GND
J5	2-pin jumper	Implements 120Ω split termination. Must be used in combination with J7.
J6	2-pin jumper	Implements 120Ω termination resistor. Along with the split termination (J5 and J7), this simulates the true CAN bus impedance of 60Ω (two 120Ω terminations in parallel).
J7	2-pin jumper	Implements 120Ω split termination. Must be used in combination with J5.
J8	6-pin header	CAN bus connection (CANH, CANL) and GND
J9	Socket	Provides optional placement for a socket.
J10	2-pin jumper	Connect SIC network to CANH. Must be used in combination with J11.
J11	2-pin jumper	Connect SIC network to CANH. Must be used in combination with J10.
J12	4-pin header	Shunt the middle pins to connect V_{BAT} and V_{VSUP}. This bypasses diode D3.
J13	Ground clip	Provides extra connection to GND.
Test point	Red	Voltage supplies
	Black	GND
	White	Logic I/O
	Grey	Logic I/O
	Blue	CANH and CANL

2.1 EVM Setup and Operation

This section describes the setup and operation of the EVM for parameter performance evaluation.

2.1.1 Overview and Basic Operation Settings

2.1.1.1 Power Supply Inputs V_{BAT}, V_{CC} and V_{IO}

14-pin CAN devices require V_{SUP}, V_{CC}, and V_{IO}. Each supply pin can be connected with a banana jack, test point, or header. V_{CC} and V_{IO} can share a voltage supply by shunting the J1 header. Diode D3 can be biased by shunting V_{BAT} and V_{SUP} on the J12 header.

2.1.1.2 I/O Headers (J2, J4)

All key I/O and supply GND functions are brought to headers J2 and J4. These headers can be used on either interface to test equipment or a short cable can be made to connect to an existing customer-application board with a CAN controller.

These headers are arranged to provide a separate ground for each signal pair (TXD/GND and RXD/GND). If the EVM is being used with lab equipment, connect separate cables to these main points via simple 2-pin header connectors. If connecting the board to a processor-based system, connect cables to all necessary signals to these headers.

Table 2-2. J2 Pin Definitions

Row	Connection	Description
1	P14	Pin 14 of transceiver: nSTB or nCS
2	TXD	CAN transmit data input
3	RXD	CAN receive data output
4	P11	Pin 11of transceiver: No Connect (NC), nSTB or nCS
5	P6	Pin 6 of transceiver: EN or nINT/SDO
6	P8	Pin 8 of transceiver: nFAULT or SCLK

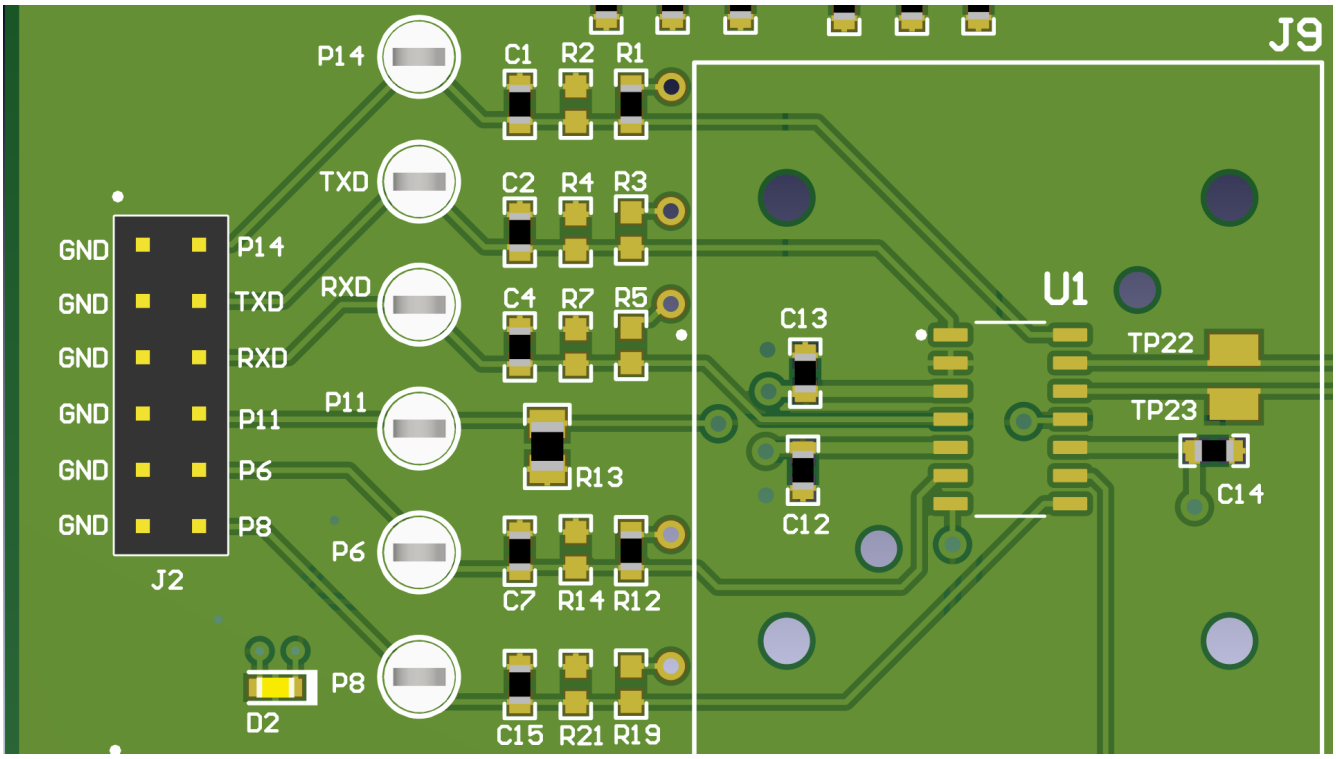


Figure 2-1. J2 Board Layout

Table 2-3. J4 Pin Definitions

Row	Connection	Description
1	P7	Pin 7 of transceiver: INH or INH/LIMP
2	WAKE	Wake input terminal. Switch S1 can be used to toggle pin high or low.

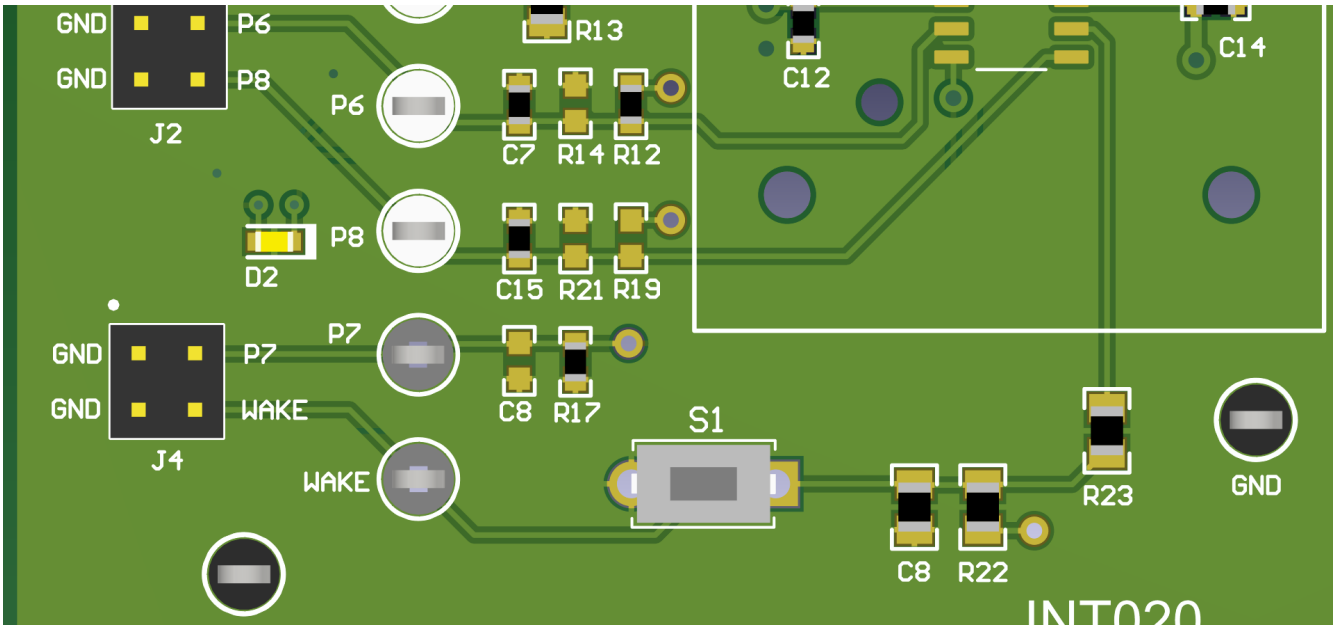


Figure 2-2. J4 Board Layout

Pin #	Common Naming	Pinout Examples		
		TCAN 1043A-Q1	TCAN 1463-Q1	TCAN 1145-Q1
1	TXD			
2	GND			
3	VCC			
4	RXD			
5	VIO			
6	P6	EN	EN	nINT/SDO
7	P7	INH	INH	INH/LIMP
8	P8	nFAULT	nFAULT	SCLK
9	WAKE			
10	Vsup			
11	P11	NC	INH_MASK	SDI
12	CANL			
13	CANH			
14	P14	nSTB	nSTB	nCS

Figure 2-3. Pinout Guide

2.1.1.3 Pin 14

Pin 14 of the transceiver is normally for mode selection (nSTB) or for the SPI chip select (nCS). The signal path to the J2 header is pre-installed with a 100nF filtering capacitor, C1, and with a pullup resistor to VIO installed, R1. An optional pulldown resistor to GND can be installed on R2.

2.1.1.4 TXD Input

The TXD (pin 1) of the transceiver, transmit data, is routed to J2. The signal path to the J2 header is pre-installed with a 100nF filtering capacitor, C2. An optional pullup resistor to VIO can be installed on R3, and an optional pulldown resistor to GND can be installed on R4.

2.1.1.5 RXD Output

The RXD (pin 4) of the transceiver, receive data, is routed to J2. The signal path to the J2 header is pre-installed with a 100nF filtering capacitor, C4. An optional pullup resistor to VIO can be installed on R5, and an optional pulldown resistor to GND can be installed on R7.

2.1.1.6 Pin 11

Pin 11 of the transceiver is normally a No Connection pin (NC), an enable pin for Inhibit function (INH_MASK) or the SPI serial data input pin (SDI). The signal path to the J2 header is pre-installed with a 100kΩ pulldown resistor to GND, R13.

2.1.1.7 Pin 6

Pin 6 of the transceiver is normally for mode selection (EN), or the combined interrupt output/SPI serial data output pin (nINT/SD0). The signal path to the J2 header is pre-installed with a 100nF filtering capacitor, C7, and a 4.7kΩ pullup resistor to VIO, R12. An optional pulldown resistor to GND can be installed on R14.

2.1.1.8 Pin 8

Pin 8 of the transceiver is normally a status indicator flag (nFAULT) or a SPI clock pin (SCLK). The signal path to the J2 header is pre-installed with a 100 nF filtering capacitor, C15. An optional pulldown resistor to GND can be installed on R21, and an optional pullup resistor to VIO can be installed on R19. Additionally, diode D2 signifies whether pin 8 is high or low. Note that the diode is inverted.

2.1.1.9 Pin 7

Pin 7 of the transceiver is normally a high voltage output to control external regulators (INH) or a split ouput for external regulators combined with LIMP home mode (INH/LIMP). The signal path to the J4 header is pre-installed with a 100 kΩ pulldown resistor, R17. An optional filtering capacitor can be installed on C8.

2.1.1.10 WAKE Pin

The WAKE pin of the transceiver (pin 9) is routed to J4. The signal path to the J2 header is pre-installed the with a 22nF filtering capacitor, C8, a 3.3kΩ pullup resistor to VSUP, R22, and a 33.2kΩ series resistor, R23. The switch S1 can be used to generate a rising or falling edge to wake up the device in addition to the J4 header.

2.1.1.11 SIC Network Configuration (J10 and J11)

The SIC network can be enabled connecting shunts to J10 and J11. This connects the network of inductors, capacitors, and resistors to the CANH and CANL lines and create a much noisier CAN bus. Note that both J4 and J5 need to be shunted for this to work. All SIC network components are left open and need user installation.

2.1.2 Using CAN Bus Load, Termination, and Protection Configurations

The generic 14-pin CAN EVM is populated with one 120Ω resistor selectable via jumper, between CANH and CANL, and the 120Ω split termination (two 60Ω resistors in series) including the split capacitor. When using only split termination, the EVM is used as a terminated end of a bus. For electrical measurements to represent the total loading of the bus, use both the split termination and the 120Ω resistor in parallel to give the standard 60Ω load for parametric measurement. Table 2-4 summarizes how to use these termination options.

Table 2-4. Bus Termination Configuration

Termination Configuration	Termination Jumpers			Split Termination Resistors		Split Termination Capacitor
Jumper	**J5**	**J6**	**J7**	**R8**	**R9**	**C5**
No termination	Open	Open	Open	Not available	Not available	Not available
120Ω standard termination	Open	Shorted	Open			
60Ω load	Shorted	Shorted	Shorted			
Split termination (common mode stabilization)	Shorted	Open	Shorted	60Ω	60Ω	4.7nF

The EVM also has footprints for various protection schemes to enhance robustness for extreme system-level EMC requirements. Table 2-5 summarizes these options.

Table 2-5. Protection and Filtering Configuration

Configuration	Footprint Reference	Use Case	Population and Description
Series resistors or common mode choke	R6/R10 or L1 (common footprint)	Direct CAN transceiver to bus connection	R6 and R10 populated with 0Ω (default population)
		Series resistance protection, CAN transceiver to bus connection	R6 and R10 populated with MELF resistor as necessary for harsh EMC environment
		CM choke (bus filter)	L1 populated with CM choke to filter noise as necessary for harsh EMC environment
Bus filtering caps transient protection	C3/C6	Bus filter	Filter noise as necessary for harsh EMC environment. Use filter caps in combination with L1 CM choke
	D1	Transient and ESD protection	To add extra protection for system level transients and ESD protection, D1 populated with ESD2CAN24-Q1

2.1.3 Using Customer Installable I/O Options for Current Limiting, Pullup and Pulldown, Noise Filtering

The generic 14-pin CAN EVM has footprints on the PCB for the installation of various filtering and protection options to adapt the EVM to match CAN network topology requirements if the EVM is being used as a CAN node.

Each digital input or output pin has footprints allowing for series current-limiting resistors (default populated with 0Ω), pullup or down resistors (depending on pin use), and a capacitor to GND which allows for RC filters when configured with a series resistor. Table 2-6 lists these features for each of the digital input and output pins of the EVM. Replace or populate the RC components as necessary for the application.

Table 2-6. RC Filter and Protection Lists

Device Pin			Pullup and Pulldown	C to GND	Description
No.	Description	Type			
1	TXD	Input	R3 PU/ R4 PD	C2	
4	RXD	Output	R5 PU/ R7 PD	C4	
6	EN	Input	R12 PU/ R14 PD	C7	
	nINT/SDO	Output			
7	INH	Output	R17 PD	C8	
	INH/LIMP	Output			
8	nFAULT	Output	R19 PU/ R21 PD	C15	
	SCLK	Input			
9	WAKE	Input	R22 PD	C8	Series resistor R23 also included.
11	NC	No Connect	R13 PD	N/A	
	INH_MASK	Input			
	SDI	Input			
14	nSTB	Input	R1 PU/ R2 PD	C1	
	nCS	Input			

3 Hardware Design Files

3.1 Schematics

Figure 3-1 shows the EVM schematic.

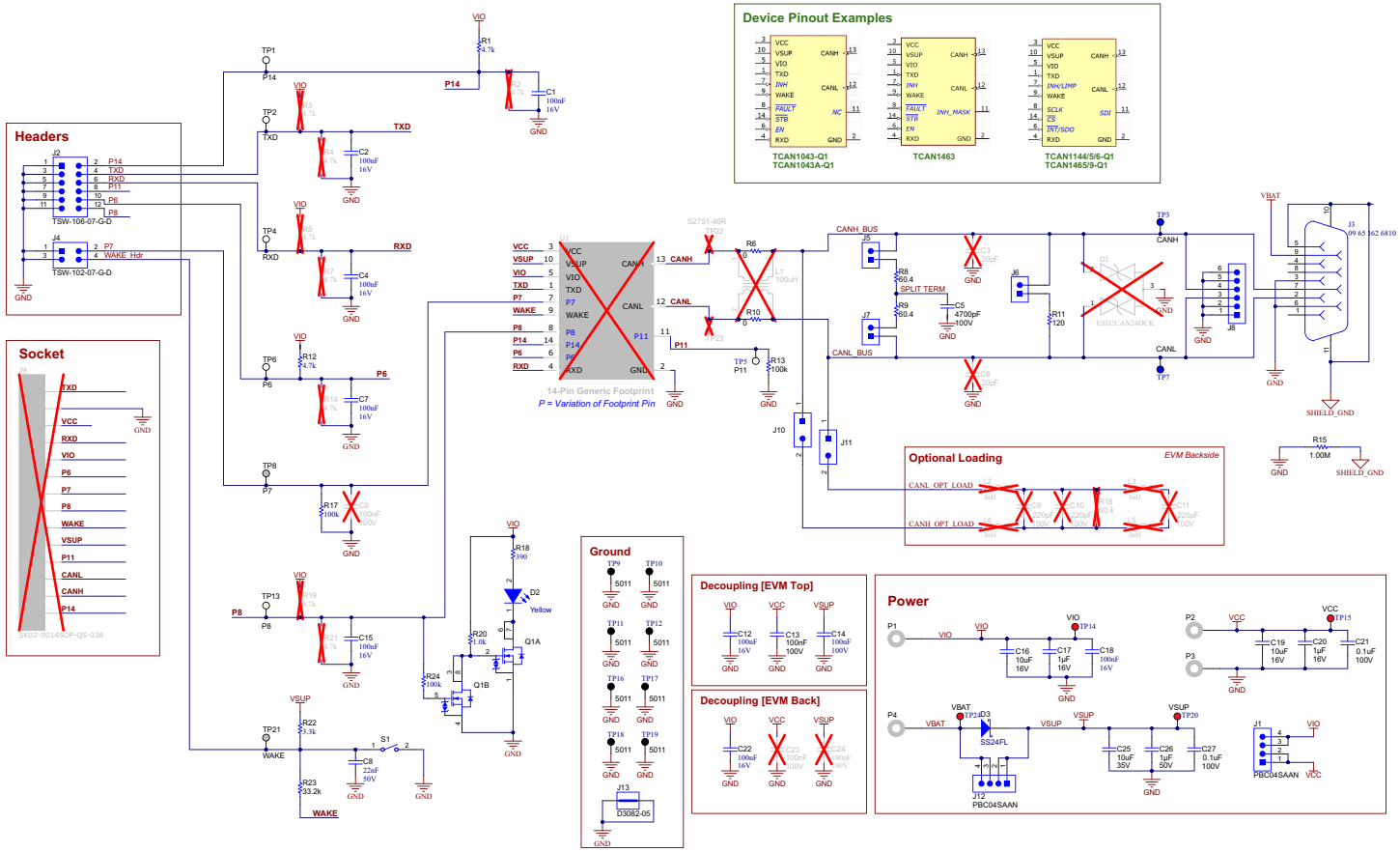


Figure 3-1. EVM Schematic

3.2 PCB Layouts

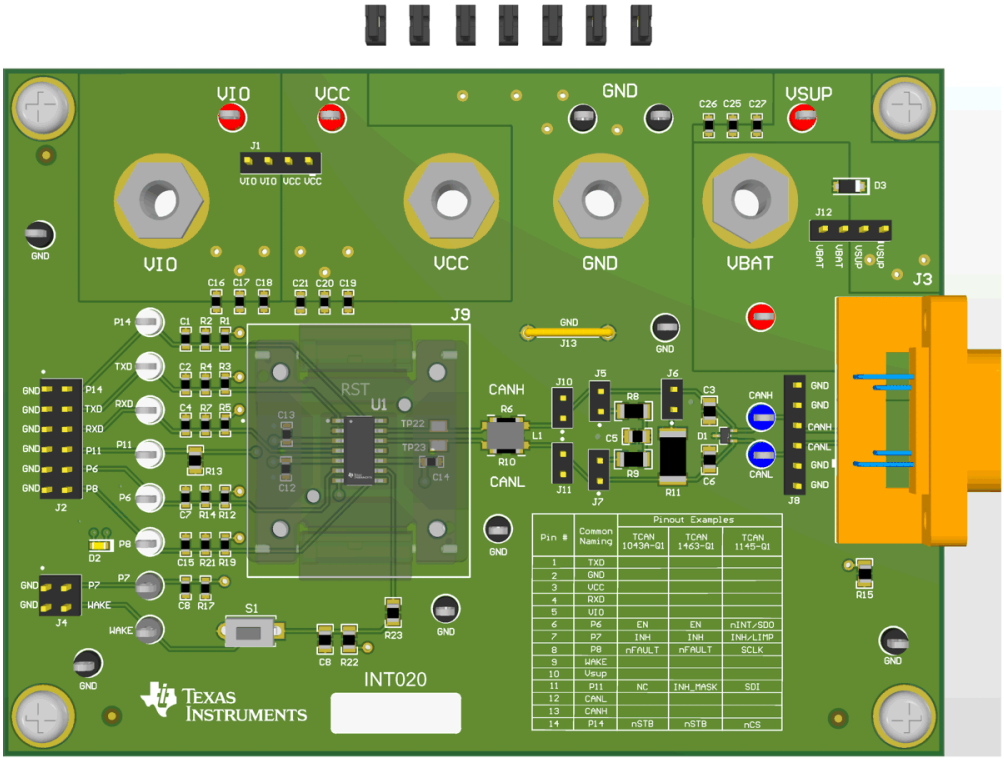


Figure 3-2. EVM Layout (Top View)

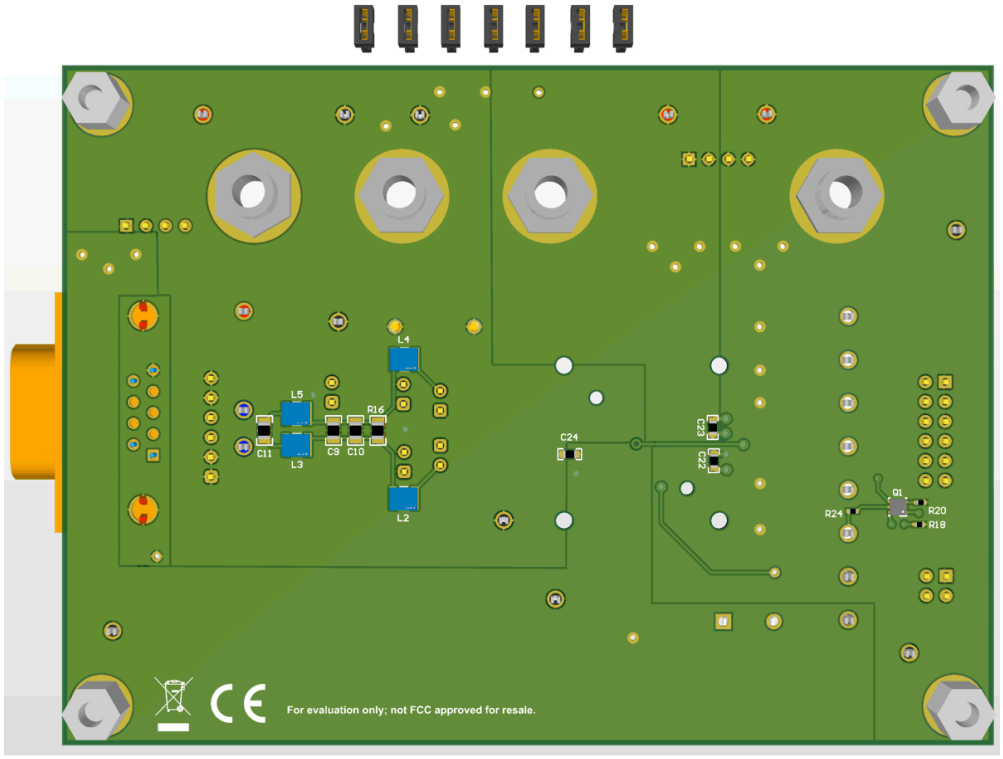


Figure 3-3. EVM Layout (Bottom View)

3.3 Bill of Materials (BOM)

Table 3-1. Bill of Materials

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
C1, C2, C4, C7, C12, C15, C18, C22	8	0.1uF	CAP, CERM, 0.1 uF, 16 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	603	GCM188R71C104KA37J	MuRata
C5	1	4700pF	CAP, CERM, 4700 pF, 100 V, +/- 10%, X7R, 0805	805	GRM219R72A472KA01D	MuRata
C8	1	0.022uF	CAP, CERM, 0.022 uF, 50 V, +/- 10%, X7R, 0805	805	CC0805KRX7R9BB223	Yageo America
C13	1	0.1uF	CAP, CERM, 0.1 µF, 100 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	603	HMK107B7104KAHT	Taiyo Yuden
C14	1	0.1uF	CAP, CERM, 0.1 uF, 100 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	603	GCJ188R72A104KA01D	MuRata
C16, C19	2	10uF	CAP, CERM, 10 uF, 16 V, +/- 20%, X5R, 0603	603	GRM188R61C106MAALD	MuRata
C17, C20	2	1uF	CAP, CERM, 1 uF, 16 V, +/- 10%, X7R, 0603	603	C1608X7R1C105K080AC	TDK
C21, C27	2	0.1uF	CAP, CERM, 0.1 uF, 100 V, +/- 10%, X7S, AEC-Q200 Grade 1, 0603	603	CGA3E3X7S2A104K080AB	TDK
C25	1	10uF	CAP, CERM, 10 uF, 35 V, +/- 20%, X5R, 0603	603	GRM188R6YA106MA73D	Murata
C26	1	1uF	CAP, CERM, 1 uF, 50 V, +/- 10%, X7R, 0603	603	UMK107AB7105KA-T	Taiyo Yuden
D2	1	Yellow	LED, Yellow, SMD	LED_0603	150060YS75000	Wurth Elektronik
D3	1	40V	Diode, Schottky, 40 V, 2 A, AEC-Q101, SOD-123F	SOD-123F	SS24FL	Fairchild Semiconductor
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1, J12	2		Header, 2.54 mm, 4x1, Gold, TH	Header, 2.54 mm, 4x1, TH	PBC04SAAN	Sullins Connector Solutions
J2	1		Header, 100mil, 6x2, Gold, TH	6x2 Header	TSW-106-07-G-D	Samtec
J3	1		D-Sub-9, 11Pos, Male, TH	D-Sub-9, 2rows, Male, TH	09 65 162 6810	Harting
J4	1		Header, 100mil, 2x2, Gold, TH	2x2 Header	TSW-102-07-G-D	Samtec

Table 3-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
J5, J6, J7, J10, J11	5		Header, 100mil, 2x1, Gold, TH	2x1 Header	TSW-102-07-G-S	Samtec
J8	1		Header, 100mil, 6x1, Gold, TH	6x1 Header	TSW-106-07-G-S	Samtec
J13	1		1mm Uninsulated Shorting Plug, 10.16mm spacing, TH	Shorting Plug, 10.16mm spacing, TH	D3082-05	Harwin
J15, J16, J17, J18, J19, J20, J21	7		2 (1 x 2) Position Shunt Connector Open Top, Grip 0.100" (2.54mm) Gold	CONN_JUMPER	NPC02SXON-RC	Sullins Connector Solutions
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
P1, P2, P3, P4	4		Standard Banana Jack, Uninsulated, 15A	Banana Jack	108-0740-001	Cinch Connectivity
Q1	1	20V	MOSFET, 2-CH, N-CH, 20 V, 6.7 A, DQK0006B (WSON-6)	DQK0006B	CSD85301Q2	Texas Instruments
R1, R12	2	4.7k	RES, 4.7 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06034K70JNEA	Vishay-Dale
R6, R10	2	0	RES, 0, 5%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	CRCW12060000Z0EA	Vishay-Dale
R8, R9	2	60.4	RES, 60.4, 1%, 0.25 W, 1206	1206	RC1206FR-0760R4L	Yageo America
R11	1	120	RES, 120, 1%, 1 W, AEC-Q200 Grade 0, 2512	2512	CRCW2512120RFKEG	Vishay-Dale
R13	1	100k	RES, 100 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	805	CRCW0805100KFKEA	Vishay-Dale
R15	1	1.00Meg	RES, 1.00 M, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	805	ERJ-6ENF1004V	Panasonic
R17	1	100k	RES, 100 k, 0.1%, 0.1 W, 0603	603	RG1608P-104-B-T5	Susumu Co Ltd
R18	1	390	RES, 390, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW0402390RJNED	Vishay-Dale
R20	1	1.0k	RES, 1.0 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04021K00JNED	Vishay-Dale
R22	1	3.3k	RES, 3.3 k, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	805	CRCW08053K30JNEA	Vishay-Dale
R23	1	33.2k	RES, 33.2 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	805	CRCW080533K2FKEA	Vishay-Dale

Table 3-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
R24	1	100k	RES, 100 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW0402100KJNED	Vishay-Dale
S1	1		Switch, Tactile, SPST-NO, 0.05A, 12V, TH	SW, SPST 3.5x5 mm	PTS635SL50LFS	C&K Components
TP1, TP2, TP4, TP5, TP6, TP13	6		Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	5012	Keystone Electronics
TP3, TP7	2		Test Point, Multipurpose, Blue, TH	Blue Multipurpose Testpoint	5127	Keystone Electronics
TP8, TP21	2		Test Point, Multipurpose, Grey, TH	Grey Multipurpose Testpoint	5128	Keystone Electronics
TP9, TP10, TP11, TP12, TP16, TP17, TP18, TP19	8		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone Electronics
TP14, TP15, TP20, TP24	4		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone Electronics
C3, C6	0	20pF	CAP, CERM, 20 pF, 100 V, +/- 5%, C0G/NP0, 0805	805	08051A200JAT2A	AVX
C8, C23	0	0.1uF	CAP, CERM, 0.1 µF, 100 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	603	HMK107B7104KAHT	Taiyo Yuden
C9, C10, C11	0	220pF	CAP, CERM, 220 pF, 100 V, +/- 5%, C0G/NP0, 0805	805	C0805C221J1GACTU	Kemet
C24	0	0.1uF	CAP, CERM, 0.1 uF, 100 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	603	GCJ188R72A104KA01D	MuRata
D1	0		24-V, 2-Channel ESD Protection Diode for In-Vehicle Networks, SC70-3	SC70-3	ESD2CAN24DCK	Texas Instruments
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
J9	0		Custom Surface Mount Socket for 3.9 X 8.65 X 1.75mm D(R-PDSO-G14) 14LD SOP Device, 1.27mm Pitch	SOCKET_SOIC8		RS Tech
L1	0	100uH	Inductor, Ferrite, 100 uH, 0.15 A, 2 ohm, SMD	SMD, 4-Leads, Body 4.7 x 3.7 mm	ACT45B-101-2P-TL003	TDK
L2, L3, L4, L5	0	3uH	Ind Chip Wirewound 3uH 5% 7.9MHz 20Q-Factor Ceramic 300mA 1210 T/R	1210	AISC-1210-3R0J-T	Abracon
R2, R3, R4, R5, R7, R14, R19, R21	0	4.7k	RES, 4.7 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06034K70JNEA	Vishay-Dale

Table 3-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
R16	0	60.4	RES, 60.4, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	805	CRCW080560R4FKEA	Vishay-Dale
TP22, TP23	0		Test Point, SMT	Test Point, SMT	S2751-46R	Harwin

4 Additional Information

All TI's SOIC 14-pin CAN transceivers supported by this EVM are listed on ti.com: CAN transceivers.

4.1 Trademarks

All trademarks are the property of their respective owners.

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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。

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。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

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/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

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.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

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