TCAN1145EVM User's Guide

This user's guide details the TCAN1145EVM features and operation. The TCAN1145EVM is configurable to work with TCAN1144, TCAN1145, and TCAN1146 CAN transceivers. Different termination options, configurations for basic CAN evaluation, and connections for different interfaces for device configuration are all available on the evaluation module. All of the options and the overall operation of the EVM are explained in this user's guide.

Contents

List of Figures

List of Tables

Trademarks

1 Introduction

1.1 Features

This EVM supports the following 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
- DSUB9 connector with the CAN bus signals, VBAT, and GND for typical automotive cable harness connections
- All digital signals for configuration and control brought out to a header for easy access
- On-board processor with connections to device pins for control and monitoring through GUI using a controlling PC and commands through SPI and USB
- Pushbutton WAKE circuit for easy local wake
- Monitoring points for CAN bus common-mode

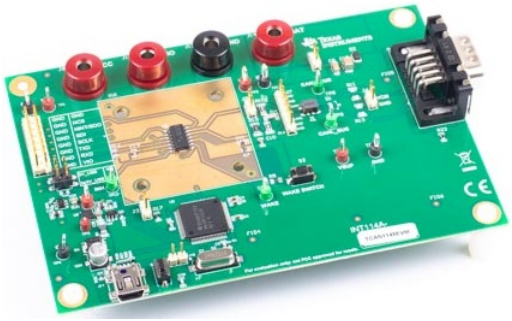

Figure 1. EVM Photo

1.2 Description

The TCAN1145EVM provides users with the ability to evaluate the TI TCAN114x-Q1 family of CAN transceivers. Table 1 shows the difference in features between the TCAN1144-Q1, TCAN1145-Q1, and TCAN1146-Q1.

Table 1. TCAN114x-Q1 Feature Differences

	TCAN1145-Q1	TCAN1146-Q1	TCAN1144-Q1
Selective Wake (Partial Networking)	Yes	Yes	No
Advanced Bus Fault Detection	No	Yes	Yes
Failsafe Mode	Yes	Yes	Yes
INH or LIMP	Programmable	Programmable	Programmable
RXD Pin Wake Function	Programmable (pulse)	Programmable (pulse)	Programmable (pulse)
SDO/nINT	Programmable	Programmable	Programmable
VIO	1.62 V - 5.5 V	1.62 V - 5.5 V	1.62 V - 5.5 V
VIO method	Pin	nCS pull up	nCS pull up
VCC supply pin	Yes	Yes	Yes
WD (Window)	No	Yes	Yes
GPO	No	• Programmable • WD output • Global interrupt • Bus fault • Wake request	• Programmable • WD output • Global interrupt • Bus fault • Wake request

The EVM allows for two termination schemes through a single jumper to select between just split termination configuration, or split with 120-Ω resistor as well.

All digital pin signals as well as VIO are available through the J1 header. This allows the user to connect in their own processor to configure and control the TCAN1145 device. The TCAN144X supports IO levels from 1.8 V to 5 V, allowing operation with a variety of processors with common IO voltage levels.

The TCAN114X supports 12-V automotive applications and is operated with three supply voltages:

- VSUP: 5 V to 28 V
- VIO: 1.71 V to 5.5 V
- VCC: 4.5 V to 5.5 V

The CAN bus also has extended fault protection range of ±58 V. Along with a wide bus fault protection range, there are also footprints for a common-mode choke, TVS diode for ESD protection, and capacitors for further EMC protection or signal conditioning if needed. A DSUB9 connector is included to allow the evaluation and use of the CAN bus in larger systems.

An onboard microprocessor is available to monitor and control the device through SPI ports. A GUI has been written and is available on the web to easily perform different tasks and guide the user through using the different features of the TCAN114X family. Visit the product page on TI.com to gain access to this GUI software.

2 EVM Setup and Features Explained

2.1 Evaluation Equipment

Use the following equipment to evaluate the performance of the TCAN114X device:

- Power supply capable of supplying the desired and/or necessary supply voltages
  - VIO can be supplied through the J13 banana jack, see Section 1.2 for the appropriate voltage range. If the on-board processor is to be used and the USB is plugged in to a PC, J2 can also be used to supply VIO through 3.3 V generated by the USB port and an on-board LDO
  - VCC can be supplied through the J8 banana jack, see Section 1.2 for the appropriate voltage range. If the on-board processor is to be used and the USB is plugged in to a PC, J2 can also be used to supply VCC through 5 V generated by the USB port.
  - VSUP can be supplied through the J14 banana jack, see Section 1.2 for the appropriate voltage range.
- An oscilloscope to observe any logic signal or CAN bus signal. Make sure to verify the voltage tolerance of the probes, as well as the impedance and capacitance. These can significantly affect what is seen on the oscilloscope screen.
- A function generator capable of 0 V to 5 V, square wave with a frequency up to 2.5 MHz.
- If the Texas Instruments provided GUI is used, a PC with Windows 7 or higher and a USB-to-miniUSB cable is needed.

2.2 Jumpers, and Test Points

Table 2 lists the jumper configurations and test points on the EVM.

Table 2. TCAN1145EVM Jumper and Test Point Description

Designator	Description	Function
J2	2x2 TH header	The J2 header can be used to probe the 5V USB2ANY generated voltage. Placing a shunt on positions 3 and 4 will supply VIO with the USB2ANY generated 3.3V.
J3	1x2 TH header	J3 allows the user to connect a high-resistance pull-down resistor to help discharge the INH once it is disabled in sleep mode. Populating the shunt will connect this pull-down resistor, leaving the jumper open will leave INH floating.
J5	1x2 TH header	J5 connects R15, a 121 ohm termination resistor between CANH and CANL. Along with the already populated 124 ohms (R10 and R16 in series), this will simulate the true CAN bus impedance of 60 ohms (two 120 ohm terminating resistors in parallel). Shunting J5 places R15 on the bus, not placing a shunt opens the bus and only leaves R10 and R16 for the termination.
J6	1x2 TH header	J6 gives the options of measuring the CAN bus common-mode signal without having to use an oscilloscope and differential probe. Pin 1 is the common-mode voltage and pin 2 is GND.
J9	1x2 TH header	J9 gives the user the option to bypass D2, the reverse-battery protection diode on VSUP. Shunting J9 bypasses the reverse-battery protection diode, and leaving J9 open will leave the reverse-battery protection diode in place.
TP1	Red multipurpose test point	TP1 allows the user to probe the VCC pin of the TCAN1145-Q1 device.
TP2	Red multipurpose test point	TP2 allows the user to probe the VIO pin of the TCAN1145-Q1 device.
TP3	Red multipurpose test point	If the user is using the TI GUI with the USB-to-miniUSB cable plugged in from a controlling PC, TP3 allows the monitoring of the 5V generated from the USB connection.
TP4, TP5, TP12, TP13	Black multipurpose test point(s)	TP4, TP5, TP12, and TP13 are all connected to GND.
TP6	Red multipurpose test point	If the user is using the TI GUI with the USB-to-miniUSB cable plugged in from a controlling PC, TP6 allows the monitoring of the 3.3V generated from the USB connection and power regulator on board.
TP7	Red multipurpose test point	TP7 allows the user to probe the VSUP pin of the TCAN1145-Q1 device.
TP8	Green multipurpose test point	TP8 allows the user to probe the CANH pin of the TCAN1145-Q1 device.
TP9	Green multipurpose test point	TP9 allows the user to probe the CANL pin of the TCAN1145-Q1 device.
TP10	Green multipurpose test point	TP10 allows the user to probe the INH pin of the TCAN1145-Q1 device.
TP11	Green multipurpose test point	TP11 allows the user to probe the WAKE pin of the TCAN1145-Q1 device.

2.3 Connectors

Table 3 lists the connectors available on the TCAN1145EVM.

Table 3. TCAN1145EVM Connector Description

Designator	Description	Function
J1	8x2 TH header	J1 gives access to all logic level signals on the TCAN1145-Q1 device. All even pins and pin 15 are connected to ground. The rest of the pin signals are listed below. • Pin 1: VIO • Pin 3: RXD • Pin 5: TXD • Pin 7: SCLK • Pin 9: SDI • Pin 11: nINT • Pin 13: nCS
J4	DSUB9 Connector	This connector has the CAN bus pins, VBAT, and GND connections. DSUB9 connectors are used in CAN applications, so this can be used to connect to other CAN networks.
J7	6x1 TH header	J7 is another way to access the CAN bus. Pin 1, 2, 5, and 6 are GND, pin 3 is CANH and pin 4 is CANL.

2.4 SPI Configuration and Control

The TCAN1145-Q1 device is configured and controlled through SPI, and there are two ways to access the SPI to the device. There is an on-board MSP430 flashed with firmware to work with the TCAN1145EVM GUI. In order to use the on-board MCU and GUI, a computer with at least Windows 7 must be connected to the EVM through the mini-USB connector. Switch S7 connects the logic signals of TCAN1145-Q1 to the MSP430, so switch positions 1-4 must be in the ON position to access the SPI pins (SDO, SDI, SCLK, and nCS). TXD and RXD are also routed to the MSP430 through switch positions 5 and 6 on S7.

If it is not desired to use the on-board processor, all the SPI pins can be accessed through pins 7, 9, 11, and 13 on the J1 connector. This connector gives easy access to many other logic signals, which can be referenced in Table 2.

2.5 WAKE Pushbutton Circuit

There is a WAKE pushbutton circuit to easily wake the TCAN1145-Q1 from sleep mode. The WAKE pin by default is biased to VSUP on startup. The WAKE pushbutton circuit works by pulling the WAKE pin to ground, causing a logic state change on the pin. To verify the function, place the device into sleep mode, then push down S2, and monitor the INH pin. The INH pin should be in a low logic state before the button is pushed, then pulled up to battery after the button is pushed.

2.6 TXD Input

The TXD input pin is how messages are transmitted to the bus through the TCAN1145-Q1 CAN transceiver. TXD can be accessed on pin 5 of the J1 jumper, and has a pull-up to VIO populated by default. This pull-up is not necessary for proper function, and can be removed by de-soldering R14.

2.7 RXD Output

The RXD output pin is how messages are received from the bus through the TCAN1145-Q1 CAN transceiver. RXD can be accessed on pin 7 of the J1 jumper, and has a pull-up to VIO populated by default. This pull-up is not necessary for proper function, and can be removed by de-soldering R12.

2.8 INH Pull-Down

The INH pin is typically used as a power supply enable for the system. Because INH is a logic high in standby and normal mode, and low in sleep mode, this is used to shut off the entire system into low-power mode via the transceiver sleep mode. When INH is disabled in sleep mode, the pin actually goes into a high-impedance state, not driven low. This can cause the INH high-voltage output to discharge slowly if the device it is connected to does not have a strong path to ground. Populating the shunt on J3 applies a stronger pull-down resistance to INH, forcing the voltage to discharge quickly when the function is disabled. The INH pin can be accessed via TP10, or J3.

3 Schematic and Bill of Materials

The EVM schematic and bill of materials can be referenced for circuit design or component questions.

3.1 Schematic

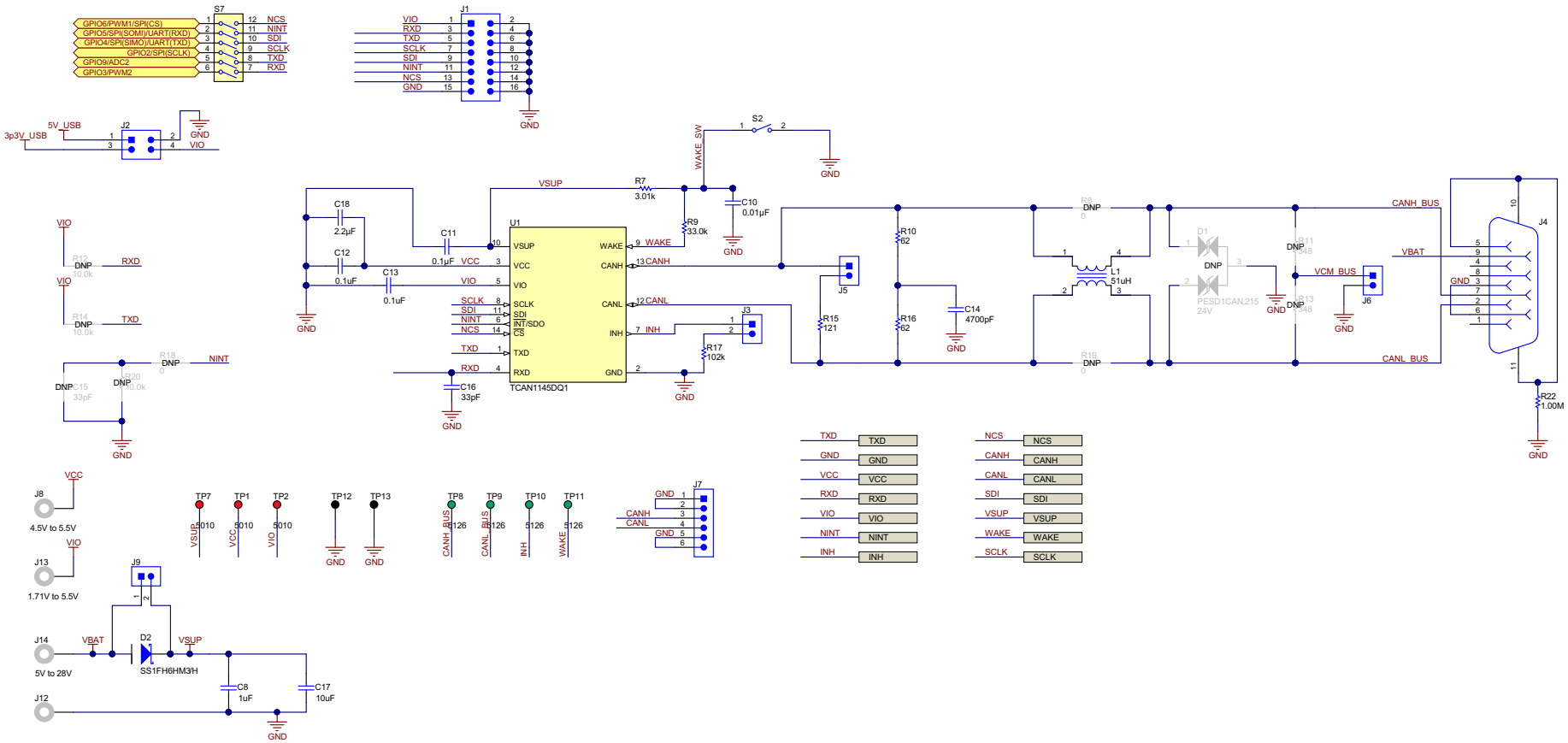

Figure 2. TCAN1145EVM CAN Schematic

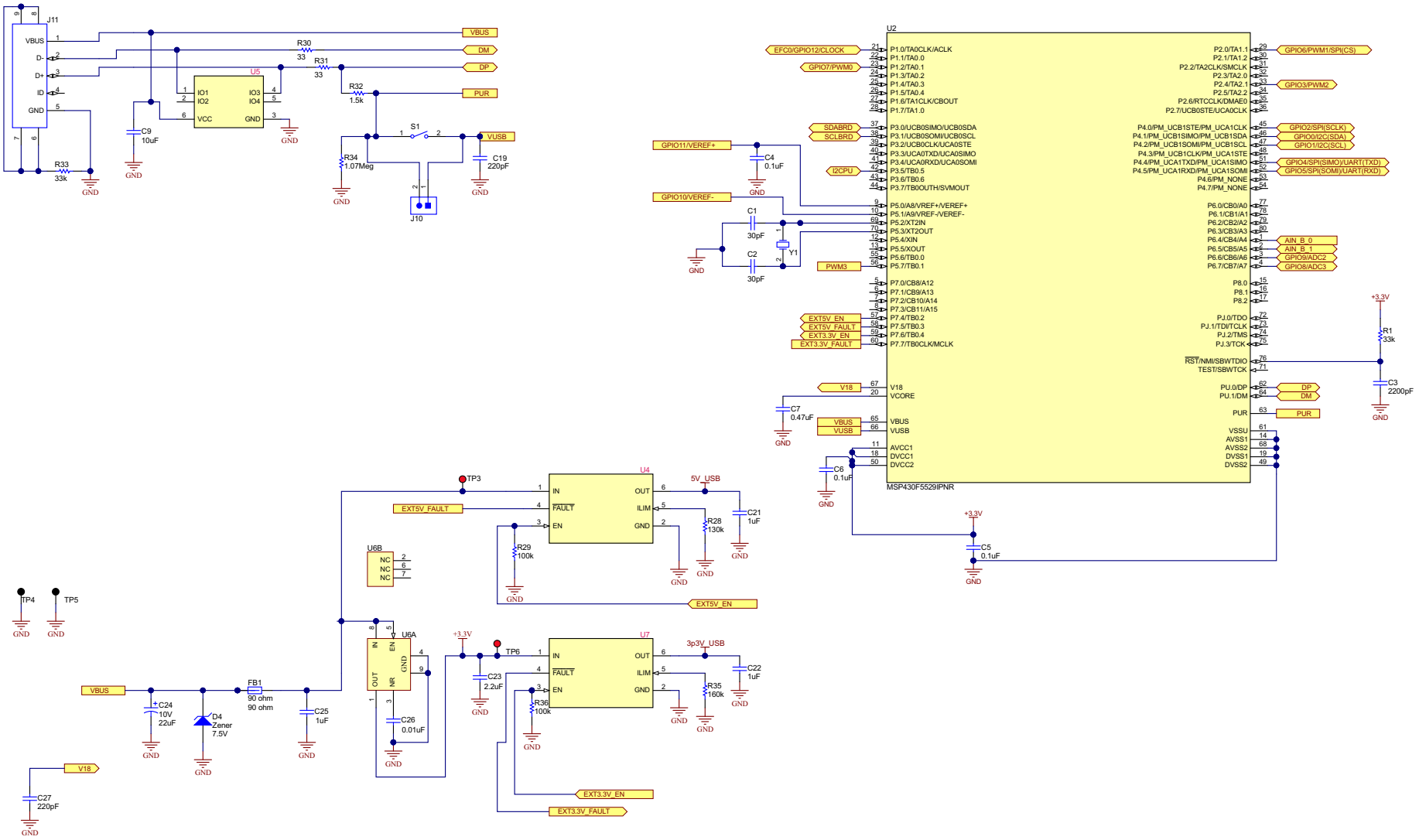

Figure 3. TCAN1145EVM USB2ANY Schematic

3.2 Bill of Materials

Table 4. Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C1, C2	2	30pF	CAP, CERM, 30 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	06035A300JAT2A	AVX
C3	1	2200pF	CAP, CERM, 2200 pF, 50 V, +/- 10%, X7R, 0603	0603	C0603X222K5RACTU	Kemet
C4, C5, C6	3	0.1uF	CAP, CERM, 0.1 uF, 16 V, +/- 5%, X7R, 0603	0603	0603YC104JAT2A	AVX
C7	1	0.47uF	CAP, CERM, 0.47 uF, 10 V, +/- 10%, X7R, 0603	0603	C0603C474K8RACTU	Kemet
C8	1	1uF	CAP, CERM, 1 uF, 50 V, +/- 10%, X8R, AEC-Q200 Grade 0, 1206	1206	CGA5L3X8R1H105K160AB	TDK
C9	1	10uF	CAP, CERM, 10 uF, 16 V, +/- 20%, X5R, 0805	0805	0805YD106MAT2A	AVX
C10	1	0.01uF	CAP, CERM, 0.01 µF, 100 V,+/- 10%, X8R, AEC-Q200 Grade 0, 0603	0603	CGA3E2X8R2A103K080AD	TDK
C11	1	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X8R, AEC-Q200 Grade 0, 0603	0603	CGA3E3X8R1H104K080AE	TDK
C12, C13	2	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X8R, AEC-Q200 Grade 0, 0603	0603	CGA3E2X8R1E104K080AA	TDK
C14	1	4700pF	CAP, CERM, 4700 pF, 100 V, +/- 5%, X7R, 1206	1206	12061C472JAT2A	AVX
C15	0	33pF	CAP, CERM, 33 pF, 50 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 0, 0603	0603	CGA3E2NP01H330J080AA	TDK
C16	1	33pF	CAP, CERM, 33 pF, 50 V, +/- 5%, C0G/NP0, AEC-Q200, Grade 0, 0603	0603	CGA3E2NP01H330J080AA	TDK
C17	1	10uF	CAP, CERM, 10 uF, 16 V, +/- 10%, X8R, AEC-Q200 Grade 0, 1210	1210	CGA6P3X8R1C106K250AB	TDK
C18	1	2.2uF	CAP, CERM, 2.2 uF, 16 V,+/- 10%, X7R, 0603	0603	EMK107BB7225MA-T	Taiyo Yuden
C19, C27	2	220pF	CAP, CERM, 220 pF, 50 V, +/- 1%, C0G/NP0, 0603	0603	06035A221FAT2A	AVX
C21, C22	2	1uF	CAP, CERM, 1 uF, 16 V, +/- 10%, X5R, 0805	0805	0805YD105KAT2A	AVX
C23	1	2.2uF	CAP, CERM, 2.2 uF, 16 V, +/- 10%, X5R, 0805	0805	0805YD225KAT2A	AVX
C24	1	22uF	CAP, AL, 22 uF, 10 V, +/- 20%, SMD	E55	EMVE100ADA220ME55G	Chemi-Con
C25	1	1uF	CAP, CERM, 1 uF, 16 V, +/- 10%, X7R, 0805	0805	C0805C105K4RACTU	Kemet
C26	1	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 5%, C0G/NP0, 0603	0603	SS1FH6HM3/H	Vishay-Semiconductor
D1	0	24V	Diode, TVS, Bi, 24 V, 70 Vc, AEC-Q101, SOT-23	SOT-23	PESD1CAN,215	NXP Semiconductor
D2	1	60V	Diode, Schottky, 60 V, 1 A, AEC-Q101, DO-219AB	DO-219AB	SS1FH6HM3/H	Vishay-Semiconductor
D4	1	7.5V	Diode, Zener, 7.5 V, 550 mW, SMB	SMB	1SMB5922BT3G	ON Semiconductor
FB1	1	90 ohm	Ferrite Bead, 90 ohm @ 100 MHz, 1.5 A, 1206	1206	MI1206K900R-10	Laird-Signal Integrity Products
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	1		Header, 100mil, 8x2, Gold, TH	PBC08DAAN	PBC08DAAN	Sullins Connector Solutions
J2	1		Header, 100mil, 2x2, Tin, SMT	2x2 100mil Tin Header	15-91-2040	Molex
J3, J9	2		Header, 100mil, 2x1, Gold, TH	Sullins 100mil, 1x2, 230 mil above insulator	PBC02SAAN	Sullins Connector Solutions

Table 4. Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
J4	1		D-Sub-9, 11Pos, Male, TH	D-Sub-9, 2rows, Male, TH	09 65 162 6810	Harting
J5, J6, J10	3		Header, 100mil, 2x1, Gold, TH	Header, 2x1, 100mil	5-146261-1	TE Connectivity
J7	1		Header, 100mil, 6x1, Tin, TH	TH, 6-Leads, Body 608x100mil, Pitch 100mil	PEC06SAAN	Sullins Connector Solutions
J8, J12, J13, J14	4		Standard Banana Jack, Uninsulated	Keystone_6095	6095	Keystone
J11	1		Connector, Receptacle, Mini-USB Type B, R/A, Top Mount SMT	USB Mini Type B	1734035-2	TE Connectivity
L1	1	51uH	Coupled inductor, 51 µH, 0.2 A, 1 ohm, AEC-Q200 Grade 0, SMD	SMD, 4-Leads, Body 4.7 x 3.7 mm	ACT45B-510-2P-TL003	TDK
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
R1, R33	2	33k	RES, 33 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040233K0JNED	Vishay-Dale
R7	1	3.01k	RES, 3.01 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06033K01FKEA	Vishay-Dale
R8, R18, R19	0	0	RES, 0, 0%, 0.25 W, AEC-Q200 Grade 0, 0603	0603	RCS06030000Z0EA	Vishay-Dale
R9	1	33.0k	RES, 33.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060333K0FKEA	Vishay-Dale
R10, R16	2	62	RES, 62, 5%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	CRCW120662R0JNEA	Vishay-Dale
R11, R13	0	348	RES, 348, 1%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	CRCW1206348RFKEA	Vishay-Dale
R12, R14, R20	0	10.0k	RES, 10.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	RMCF0603FT10K0	Stackpole Electronics Inc
R15	1	121	RES, 121, 1%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	CRCW1206121RFKEA	Vishay-Dale
R17	1	102k	RES, 102 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603102KFKEA	Vishay-Dale
R22	1	1.00Meg	RES, 1.00 M, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	RMCF0603FG1M00	Stackpole Electronics Inc
R28	1	130k	RES, 130 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402130KJNED	Vishay-Dale
R29, R36	2	100k	RES, 100 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402100KJNED	Vishay-Dale
R30, R31	2	33	RES, 33, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040233R0JNED	Vishay-Dale
R32	1	1.5k	RES, 1.5 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04021K50JNED	Vishay-Dale
R34	1	1.07Meg	RES, 1.07 M, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06031M07FKEA	Vishay-Dale
R35	1	160k	RES, 160 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402160KJNED	Vishay-Dale
S1, S2	2		Switch, Tactile, SPST-NO, 0.05A, 12V, TH	SW, SPST 3.5x5 mm	PTS635SL50LFS	C&K Components
S7	1		Switch, SPST, Slide, Off-On, 6 Pos, 0.1A, 20V, SMD	16.71x6.7mm	219-6MST	CTS Electrocomponents
TP1, TP2, TP6, TP7	4		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone
TP3	1		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone
TP4, TP5, TP12, TP13	4		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone
TP8, TP9, TP10, TP11	4		Test Point, Multipurpose, Green, TH	Green Multipurpose Testpoint	5126	Keystone
U1	1		CAN FD and High Speed CAN Transceiver with Selective Wake, D0014A (SOIC-14)	D0014A	TCAN1145DQ1	Texas Instruments
U2	1		25 MHz Mixed Signal Microcontroller with 128 KB Flash, 8192 B SRAM and 63 GPIOs, -40 to 85 degC, 80-pin QFP (PN), Green (RoHS & no Sb/Br)	PN0080A	MSP430F5529IPNR	Texas Instruments

Table 4. Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
U4, U7	2		Adjustable, Active High, Latch-off, Current-Limited Power-Distribution Switch, 0.075 to 1.7 A Current Limit, -40 to 85 degC, 6-pin SOT-23 (DBV), Green (RoHS & no Sb/Br)	DBV0006A	TPS2553DBVT-1	Texas Instruments
U5	1		4-Channel ESD Protection Array for High-Speed Data Interfaces, DRY0006A (USON-6)	DRY0006A	TPD4E004DRYR	Texas Instruments
U6	1		Single Output High PSRR LDO, 500 mA, Fixed 3.3 V Output, 2.7 to 6.5 V Input, with Low IQ, 8-pin SON (DRB), -40 to 125 degC, Green (RoHS & no Sb/Br)	DRB0008A	TPS73533DRBT	Texas Instruments
Y1	1		Crystal, 24.000 MHz, 20pF, SMD	Crystal, 11.4x4.3x3.8mm	ECS-240-20-5PX-TR	ECS Inc.

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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

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

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

【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。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

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