EVM User's Guide: DRV8000-Q1EVM, DRV8001-Q1EVM, DRV8002-Q1EVM

DRV8000-Q1 Evaluation Module

Description

The DRV8000-Q1 evaluation module (EVM) allows for easy evaluation of the DRV8000-Q1 device. The EVM has been programmed and configured to work out of the box and begin driving loads right away. The EVMs showcase an integrated driver with a H-bridge gate driver, six integrated half-bridges, six integrated high-side drivers, one external high-side gate driver for heater, one external high-side gate driver for electrochromic charge and one integrated low-side driver for electrochromic load discharge. The device features protection features such as under and over voltage monitors, offline open load and short circuit diagnostics, and zone-based thermal monitoring and shutdown protection. The device also has a muxable sense output (IPROPI) and integrate current regulation (ITRIP). The EVM is accompanied by a GUI application for easy control of the motor driver.

Get Started

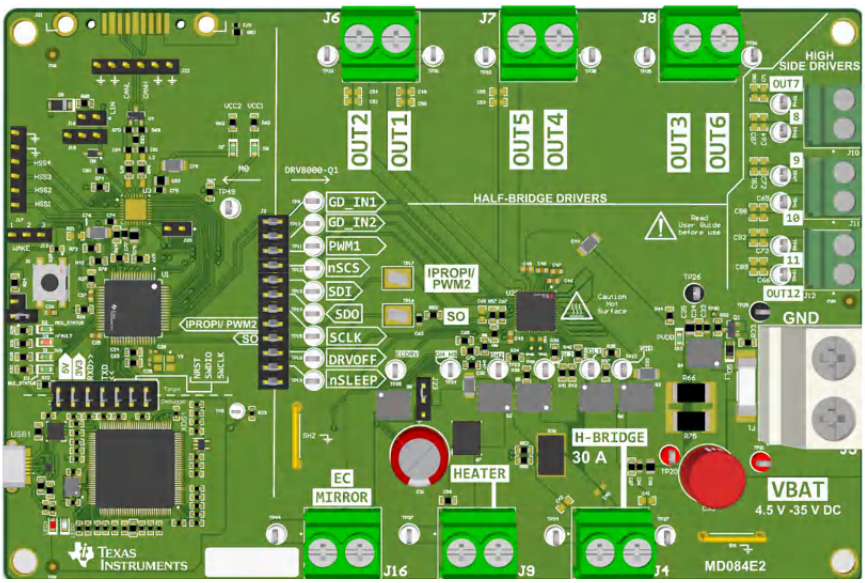
1. Order the EVM from tools page on ti.com (DRV8000EVM
2. Use the web-based GUI: https://dev.ti.com/gallery/view/MotorDriversBSM/DRV800x-Q1/
3. Connect USB and external power supply
4. Launch DRV800x-EVM-GUI and select the EVM variant on the home page

Features

- XDS110 USB-based on-board emulator for ease of programming and debugging MSPM0 microcontroller
- Main signal header with removable shunts to disconnect main signals going to the motor driver IC from the MCU
- GUI software to control EVM and DRV IC

Applications

- Door module
- Body control modules
- Zonal module



DRV8000-Q1EVM

1 Evaluation Module Overview

1.1 Introduction

The DRV8000-Q1 devices integrate multiple types of drivers intended for multiple functions: driving and diagnosing motor (inductive), resistive and capacitive loads. This document is provided with the DRV8000-Q1 evaluation modules (EVM) as a supplement to the DRV8000-Q1 data sheets. This user's guide covers EVM hardware setup instructions, GUI installation, and usage instructions.

1.2 Kit Contents

Table 1-1 lists the contents of the EVM kit. Contact the nearest Texas Instruments Product Information Center if any component is missing.

Table 1-1. Kit Contents

ITEM	QUANTITY
DRV8000-Q1EVM	1
3ft White USB-A to Micro-USB Cable	1

1.3 Specification

The DRV8000-Q1 EVM connects to a local computer USB port through a USB-A to Micro-USB cable. An onboard XDS110 USB emulator allows for programming and debugging the main MSPM0 microcontroller without the need for an external debugger. A 3.3V LDO generates a 3.3V rail from the USB 5V supply. This 3.3V is used to power the XDS110 MCU, main MSPM0, and motor driver DVDD pin. J2 signal header uses removable shunts to pass the signals from the MCU to the motor driver. Remove any of these shunts to easily jump in the control signals to the driver. Provide an external motor power supply to the J5 screw terminal within the operating range of the device. DRV8000-Q1 support supply voltage range 4.5V to 35V.

1.4 Device Information

The DRV8000-Q1 devices integrate multiple types of drivers intended for multiple functions: driving and diagnosing motor (inductive), resistive and capacitive loads. The device features two half-bridge gate drivers, 6 integrated half-bridges, 6 integrated highside drivers, one external high-side gate driver for heater, one external high-side gate driver for electrochromic charge and one integrated low-side driver for electrochromic load discharge.

The documents in Table 1-2 provide information regarding Texas Instruments integrated circuits used in the assembly of the EVM. This user's guide is available from the TI web site under literature number SLVUCZ2. Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. Newer revisions are available from the TI web site at www.ti.com, or call the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center at (972) 644-5580. When ordering, identify the document by both title and literature number

Table 1-2. Related Device Documentation

Description	Data Sheet
XDS110 MCU	MSP432E401Y
Main MSPM0 MCU	MSPM0G3507
Motor Driver	DRV8000-Q1

2 Hardware

2.1 Headers and Test Points Information

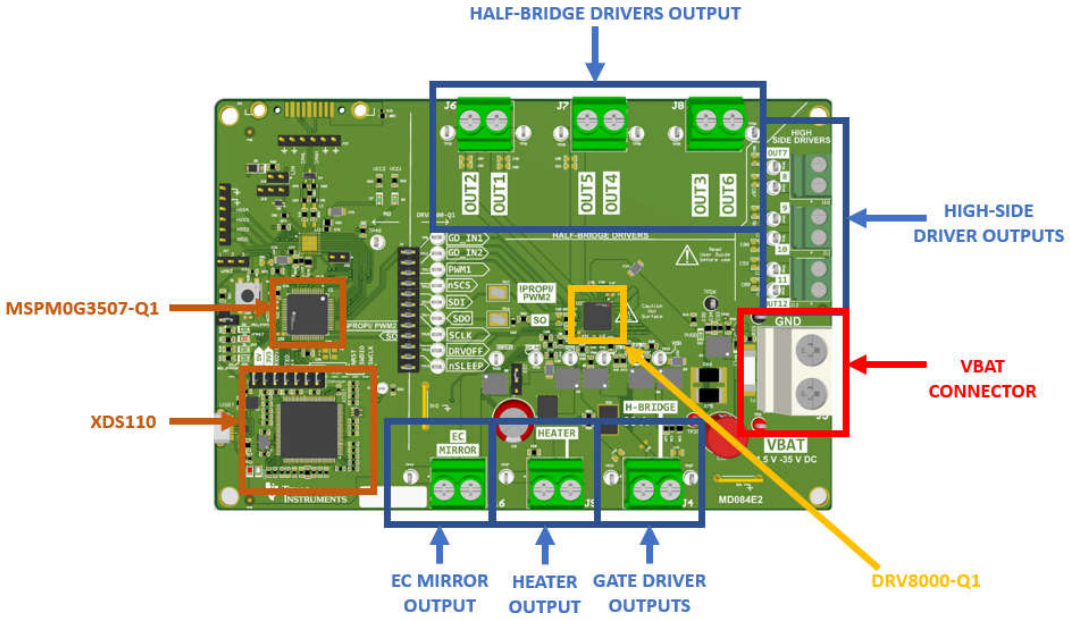


Figure 2-1. DRV8000-Q1EVM (MD084-001) (Top View)

CAUTION

Hot surface temperature. The EVM can have high surface temperatures marked by the FIRE triangular symbol on the EVM. Avoid touching the marked hot surface area when driving high currents to prevent potential burn damage.

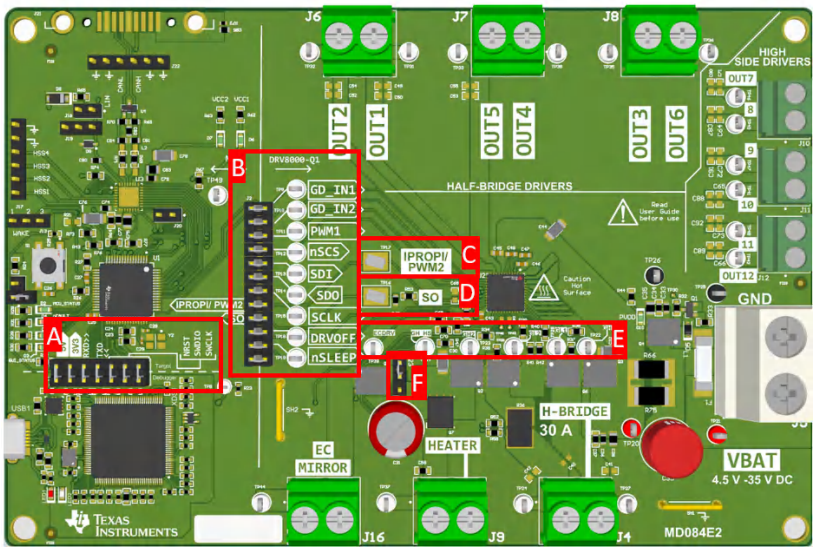


Figure 2-2. DRV8000-Q1EVM Header and Test Point Information

Table 2-1. Header and Test Point Description - DRV8000-Q1EVM

Component label	Description
Aee	XDS110 header between MSP432E401Y and MSPM0G3507.
B	Main signal header: • **GD_IN1**: Half-bridge and H-bridge control input 1. • **GD_IN2**: Half-bridge and H-bridge control input 2. • **PWM1**: PWM input 1 for regulation of all drivers except electrochrome. • **nSCS**: Serial chip select. A logic low on this pin enables serial interface communication. Internal pullup resistor. • **SDI**: Serial data input. Data is captured on the falling edge of the SCLK pin. Internal pulldown resistor. • **SDO**: Serial data output. Data is shifted out on the rising edge of the SCLK pin. Push-pull output. • **SCLK**: Serial clock input. Serial data is shifted out and captured on the corresponding rising and falling edge on this pin. • **DRVOFF**: Gate driver shutdown pin. Logic high to pull down both high-side and low-side gate driver outputs. Internal pull-down Resistor. • **nSLEEP**: Device enable pin. Logic low to shutdown the device and enter sleep mode. Internal pulldown resistor.
C	**IPROPI/ PWM2 -** Sense output is multiplexed from any of driver load current feedback, PVDD voltage feedback, or thermal cluster temperature feedback. Can also be configured as second PWM pin input for half-bridge drivers.
D	**SO -** Shunt amplifier output.
E	Gate Driver, EC Driver, Heater Test points (Left to Right): • **ECDRV** - For EC control, pin controls the gate of external MOSFET for EC voltage regulation • **GH_HS -** Gate driver output for heater MOSFET. Connected to gate of high-side MOSFET • **GH2** - High-side gate driver output. Connected to the gate of the high-side MOSFET. • **GL2** - Low-side gate driver output. Connected to the gate of the low-side MOSFET • **GL1**- Low-side gate driver output. Connected to the gate of the low-side MOSFET • **GH1** - High-side gate driver output. Connect to the gate of the high-side MOSFET
F	Drain of external EC voltage regulation FET (Top to Bottom): • **OUT11 -** If jumper is set between OUT11 and EC FET Drain then OUT11 is the drain of the EC FET • **EC FET Drain** • P**VDD -** If jumper is set between PVDD and EC FET Drain, then PVDD is the drain of the EC FET

2.2 Connector Information

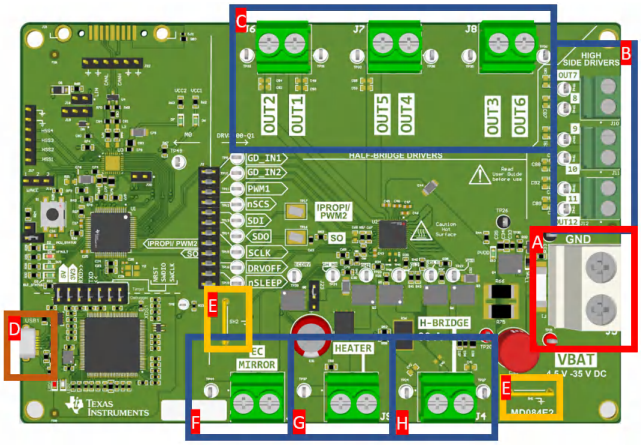


Figure 2-3. Connectors

Table 2-2. Connectors Description

Component Label	Description
A	Input power supply connector. Power cables can be directly connected to the screw terminals or clipped to the test points on either side of the connector.
B	High-side driver output connectors
C	Half-bridge output connectors
D	USB connector
E	Ground strap can be used as ground for probes and other connectors.
F	EC mirror output and ground. Ground located on the right side of terminal block.
G	Heater output and ground. Ground located on the right side of terminal block.
H	H-Bridge outputs. SH1 and SH2 are right side and left side of the terminal blocks respectively.

2.3 Indicator LEDs

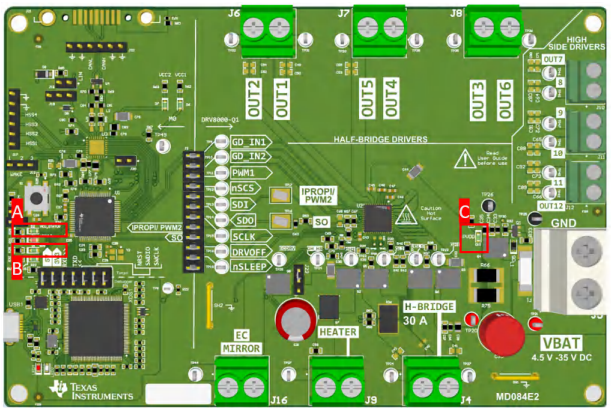


Figure 2-4. LED Indicators

LED	Function
A/D2	**MCU_STATUS**: LED toggles at a rate of around 1s when MCU is active. Unplug and reconnect the EVM to the computer if this stops flashing.
B/ D1	**3V3**: **OFF** when 3.3V is not active. **ON** when 3.3V is active
C/ D10	**PVDD**: **OFF** when PVDD is not provided. **ON** when PVDD is provided

2.4 Hardware Setup

The EVM hardware is designed and kitted to simplify setup and begin spinning motors. The EVM comes with the jumpers placed at the appropriate location in the headers. The location of the jumpers, also called shunts, are shown in Figure 2-1.

Note

Before using the EVM, check that the shunt location matches the location shown in Figure 2-1.

Before connecting the EVM to the GUI software, follow these steps:

1. Make sure all the jumpers are populated on J1 and J2 if using the GUI with the EVM controller. If users are not using the GUI and TI firmware, then users can remove all the jumpers from J2 except the bottom most jumper DVDD. Users can remove the DVDD jumper if the DVDD voltage is supplied externally and not from the onboard MCU.
2. If using the EC driver, then make sure J23 is set to the desired position.
3. Connect the micro-USB cable to micro-USB receptacle in the **XDS110 section**. LED2 illuminates.
4. Provide VBAT voltage through VBAT connector.
5. Set up is now complete. See Figure 2-5 for setup image.

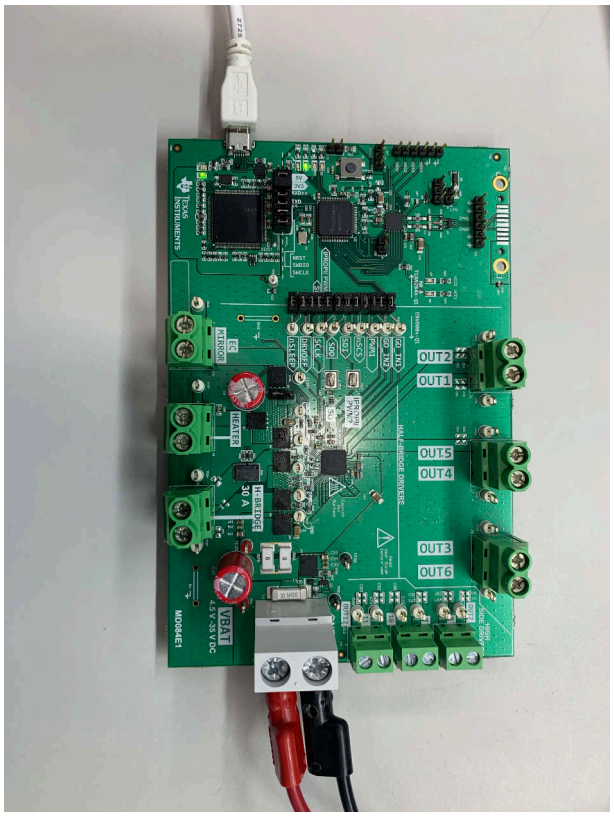


Figure 2-5. Hardware Setup

3 Software

3.1 Web GUI Access or Local GUI Installation

The EVM is controlled via a GUI application and can be used via a chrome-based browser or installed locally to a PC. Download the latest GUI installer here or use web-based GUI here.

To use the Web GUI (recommended), follow these steps:

1. Open the latest version of the GUI at this link: https://dev.ti.com/gallery/view/MotorDriversBSM/DRV800x-Q1/
   a. Alternatively, log into https://dev.ti.com/gallery/ and search for *DRV800x* sorting by *Recently updated*.
   b. Click on the title or blank space of the first search result to open the Web-Based GUI.

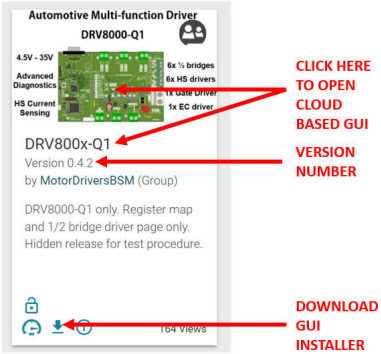


Figure 3-1. TI GUI Composer Gallery Results for Launching or Downloading Local Installer

To install the GUI locally follow these steps:

1. Log in to https://dev.ti.com/gallery/ using myTI log in credentials. Note that the GUI composer log in searches for a very specific username match including case input at the time of sign up.
2. Open the latest version of the GUI at this link: https://dev.ti.com/gallery/view/MotorDriversBSM/DRV800x-Q1/
   a. Alternatively, search for *DRV800x* sorting by *Recently updated*.
3. Hover the mouse over the *Download* icon and select the installer for the relevant operating system from the top list. Refer back to the previous section for a visual depiction of the gallery page.
4. Extract the ZIP folder with the installer and run the installer. The installer contents is self-explanatory and look slightly different for each OS.
5. Click *Next* and then agree to the terms and conditions on the following page.
6. Keep the application and runtime directory to the default locations. Click *Next* to install GUI.
7. Select *Download from Web* to download the GUI Composer Runtime if prompted, then click *Next*.
   a. If a network firewall prevents Runtime download from the web, then the Runtime installer can be downloaded here.
8. Check the box to create a desktop shortcut and click *Finish* to complete installation.
9. GUI is now installed.

3.2 Connecting EVM to GUI

Now that the EVM hardware setup and GUI installation is complete, the EVM can now be connected to the GUI. The following steps outline how to connect the EVM to GUI:

1. With the EVM connected to the PC, open the GUI. The home page is shown in Figure 3-2.

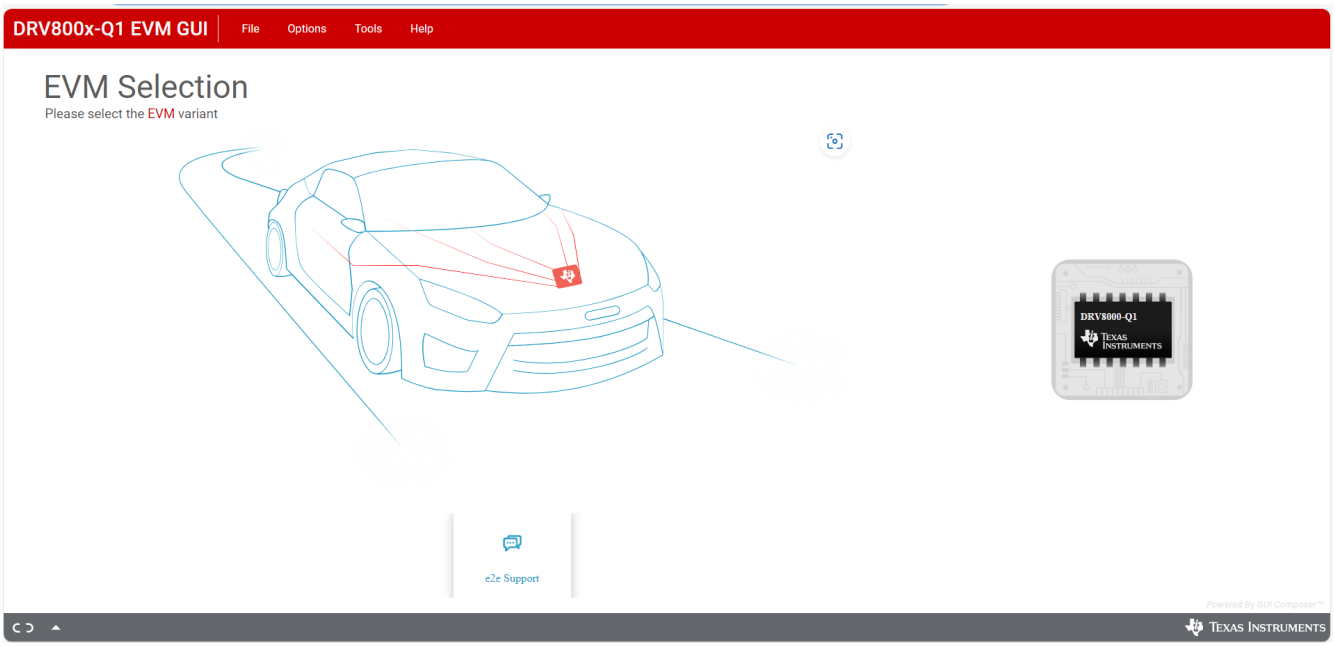


Figure 3-2. GUI Landing Page

2. Program EVM with latest software by clicking on *File -> Program Device*. (See Figure 3-3).

   This needs to be done the first time the user sets up the EVM, as a software update can have been released since the EVM was initially programmed.

   a.

Figure 3-3. Program Device

3. Select the appropriate GUI variant from the five options for the EVM (Figure 3-3).

   a.

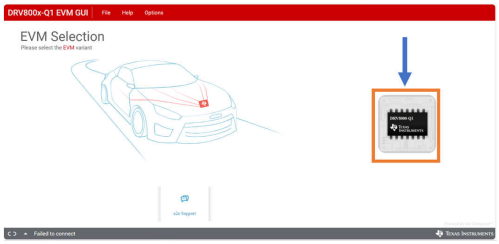


Figure 3-4. Select EVM Variant

4. The GUI attempts to connect with EVM. The GUI displays the following once successfully connected. If there is no successful connection, then double check hardware setup is correct following steps in Section 2.4.

   a.

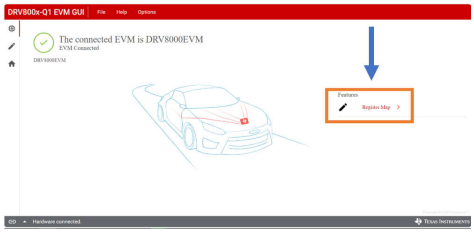


Figure 3-5. Successful GUI connection

5. The GUI setup is now complete. The following section provides an overview of the GUI and how to use the GUI to control EVM.

3.3 GUI Overview

These following sections provides an overview for DRV8000-Q1EVM GUI.

3.4 DRV8000-Q1EVM

The DRV8000-Q1EVM GUIs has five main pages: *Half Bridge Controls*, *High Side Driver Controls*, *EC and Heater Controls, Gate Driver Controls* and *Register Map*. Each controls page gives the important register settings and hardware control to configure the respective peripheral. Each page does not offer all the controls for the peripheral; for full control, the *Register Map* page is recommended after setting basic configurations in the controls page. There is also a *IPROPI & Diagnostics* panel that can be expanded from any GUI screen.

Access the IPROPI & Diagnostics pane at any time by clicking the blue control on the right side of the screen. Figure 3-6 below shows the pane opened.

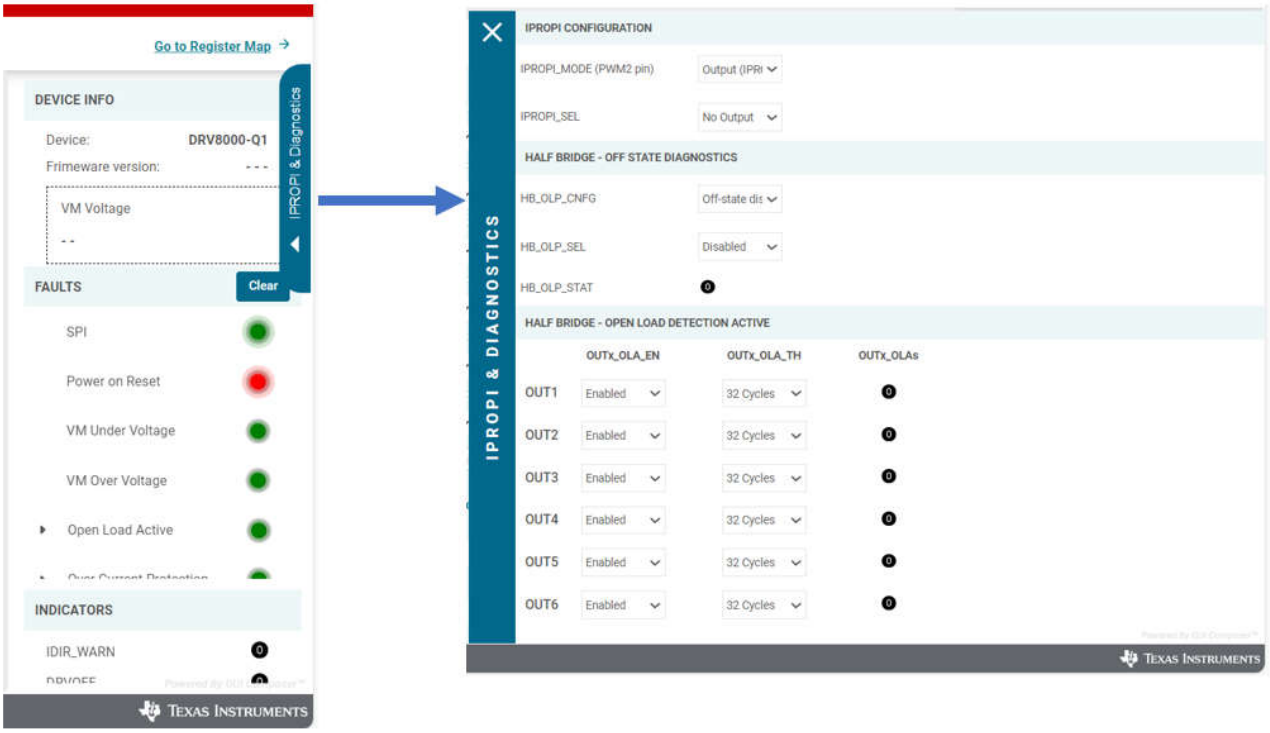


Figure 3-6. Driver Control Panel

3.4.1 Register Map

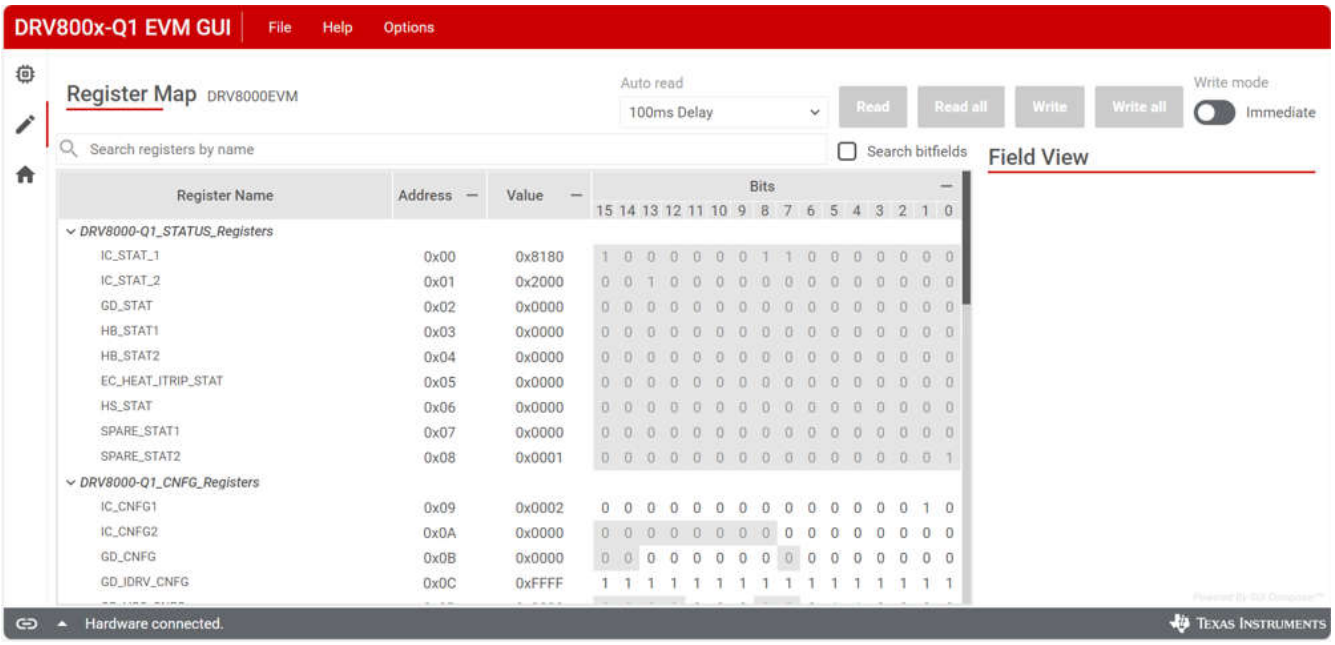


Figure 3-7. Register Map Page

The register map page is shown in Figure 3-7. The register names, address, and values are on the left hand side. The right hand side is the Field View, which provides more information regarding the bit fields of each register. The Auto Read widget sets how often the GUI reads back the register from the motor driver. The fastest option *Fast* is 500ms and the delay can be increase up to 1 minute. Setting Auto Read *Off* allows manual reading of either all registers at once or individually.

Saving and Loading Register Configurations

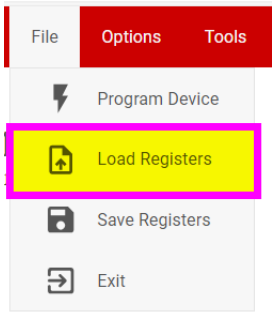


Figure 3-8. Load and Save Registers

The GUI has a built-in feature to save the current register configurations as a .json file which loads to the GUI. The following steps outline the procedure for saving and loading register configurations.

1. After writing the desired register values or using the GUI to configure the device, click on the *File* tab and click *Save Registers*. A save file pop-up window appears so the user can name and save the .json file.
2. To recall the register configurations, click on the *File* tab and then the click *Load Registers*. Select the saved .json file to load the register values.

4 Hardware Design Files

4.1 Schematics

Figure 4-1 shows the schematics for DRV8000-Q1EVM.

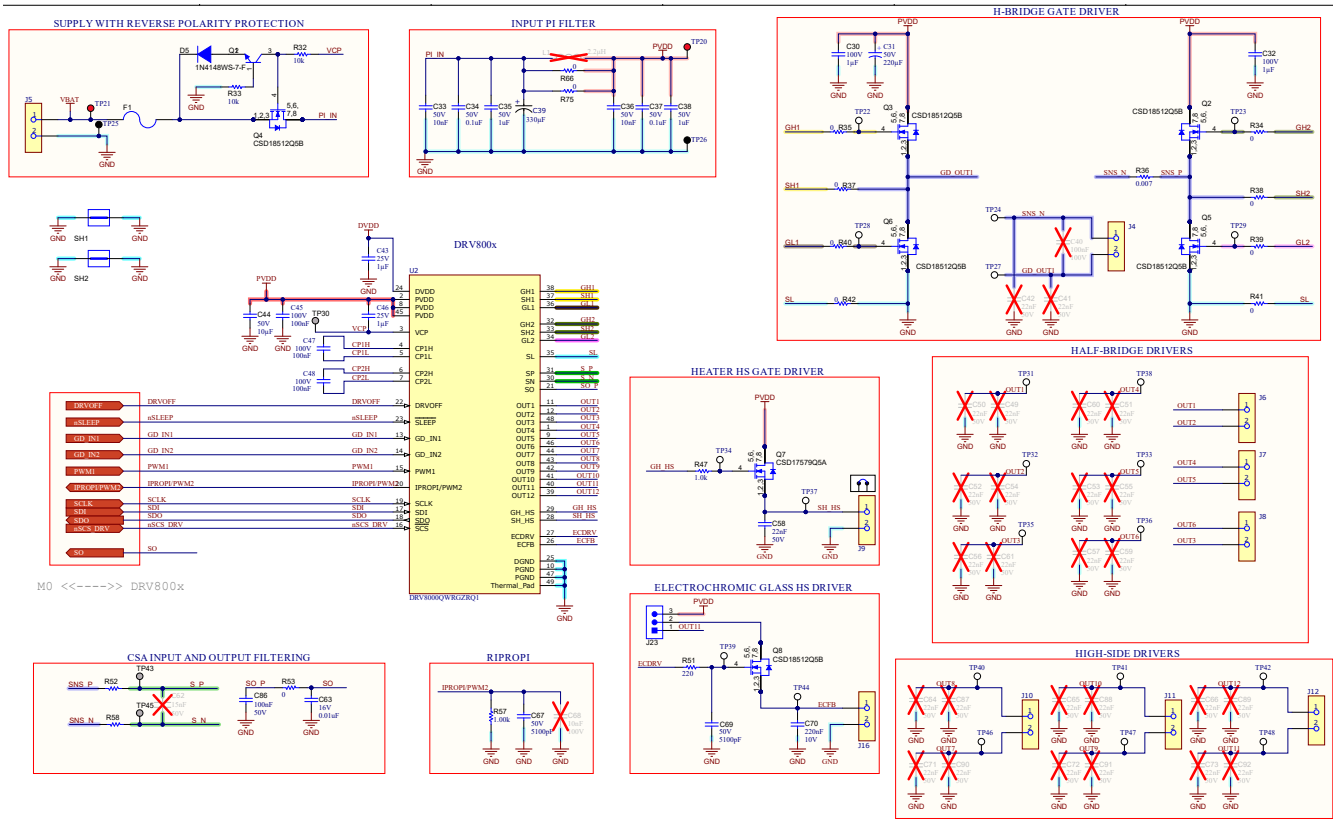


Figure 4-1. Motor Driver DRV8000-Q1

Figure 4-2 shows the schematics for the MSPM0 sections of the EVM.

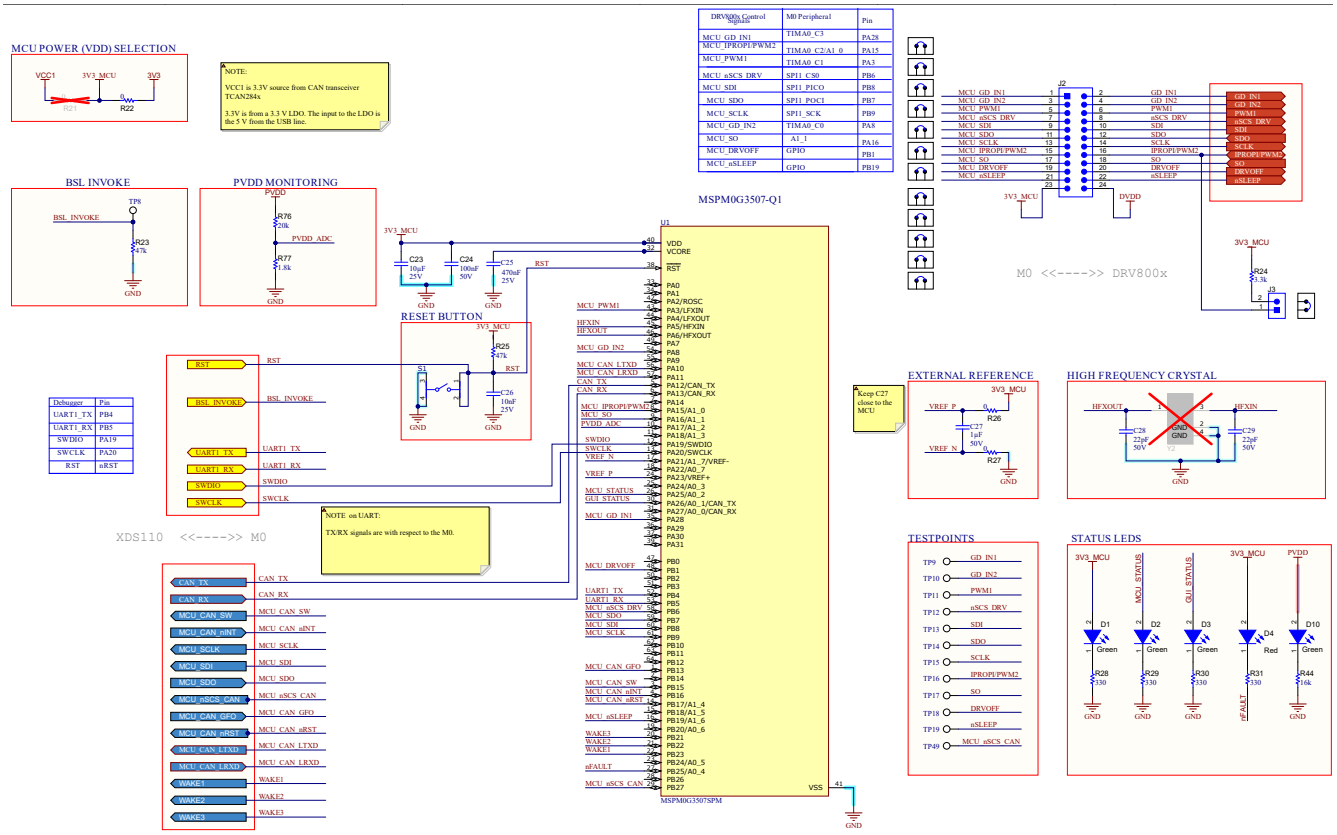


Figure 4-2. MCU MSPM0G3507-Q1

4.2 PCB Layout

Figure 4-3 through Figure 4-6 show the PCB layers of the EVM. The Altium source files can be downloaded in the aforementioned *Hardware Design Files* for a given EVM.

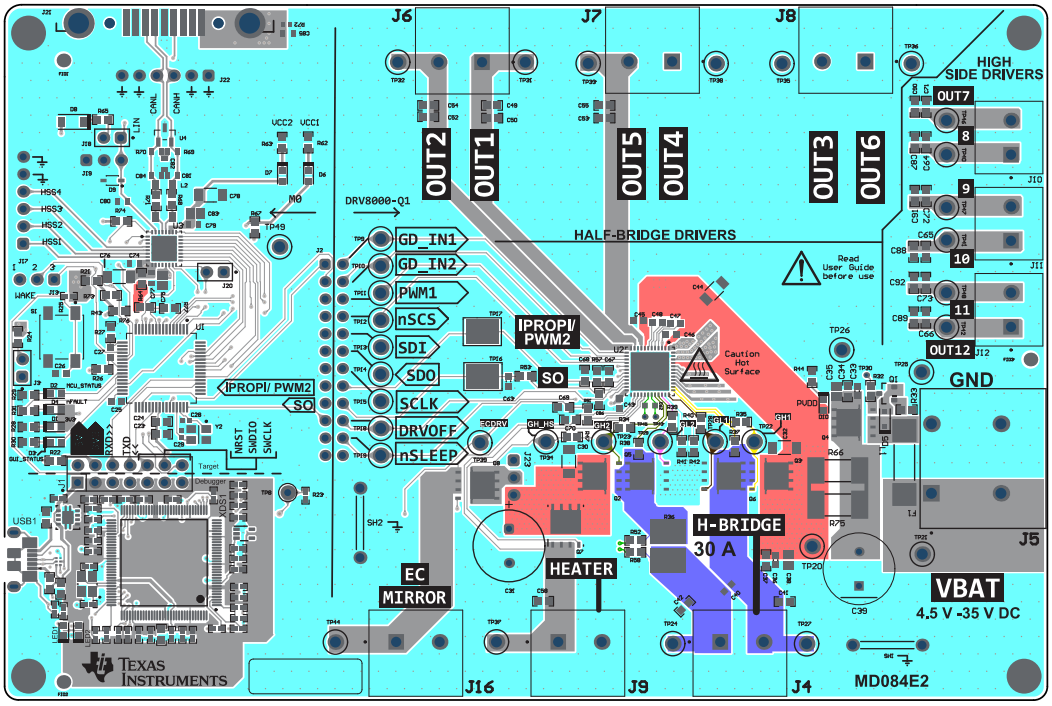


Figure 4-3. Top View

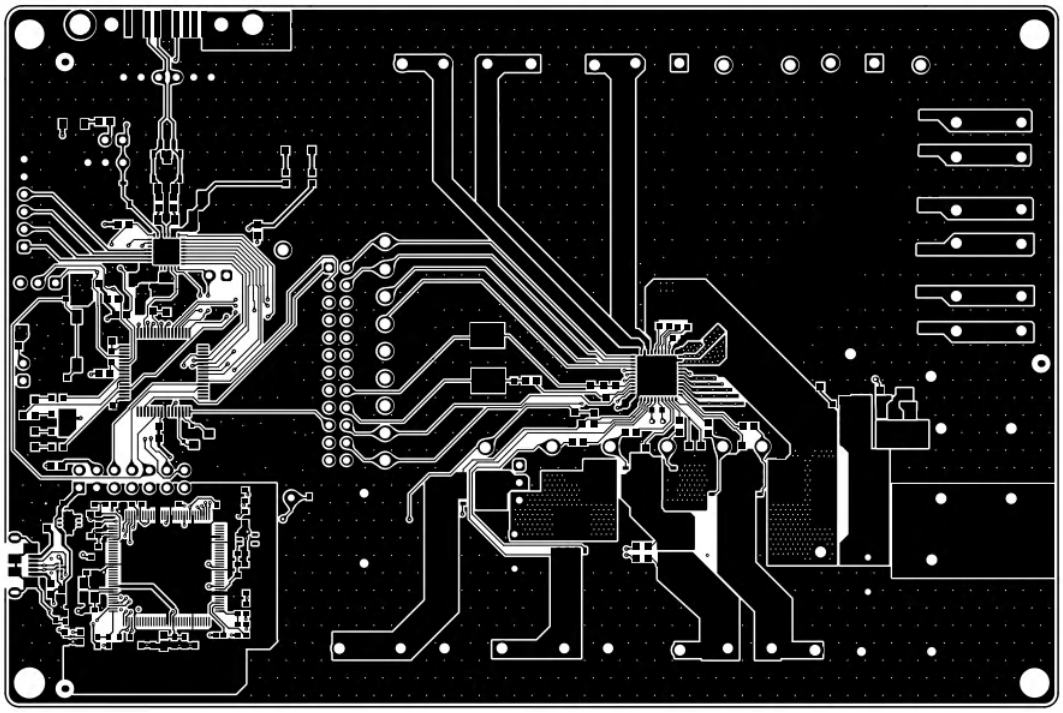


Figure 4-4. Top Layer

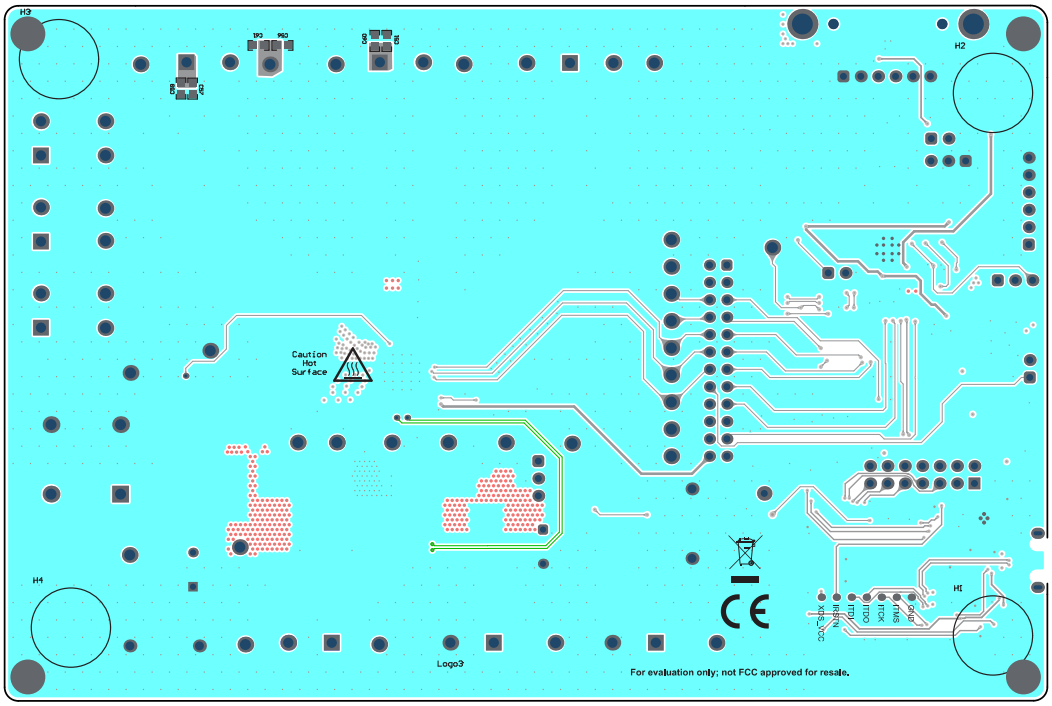


Figure 4-5. Bottom View

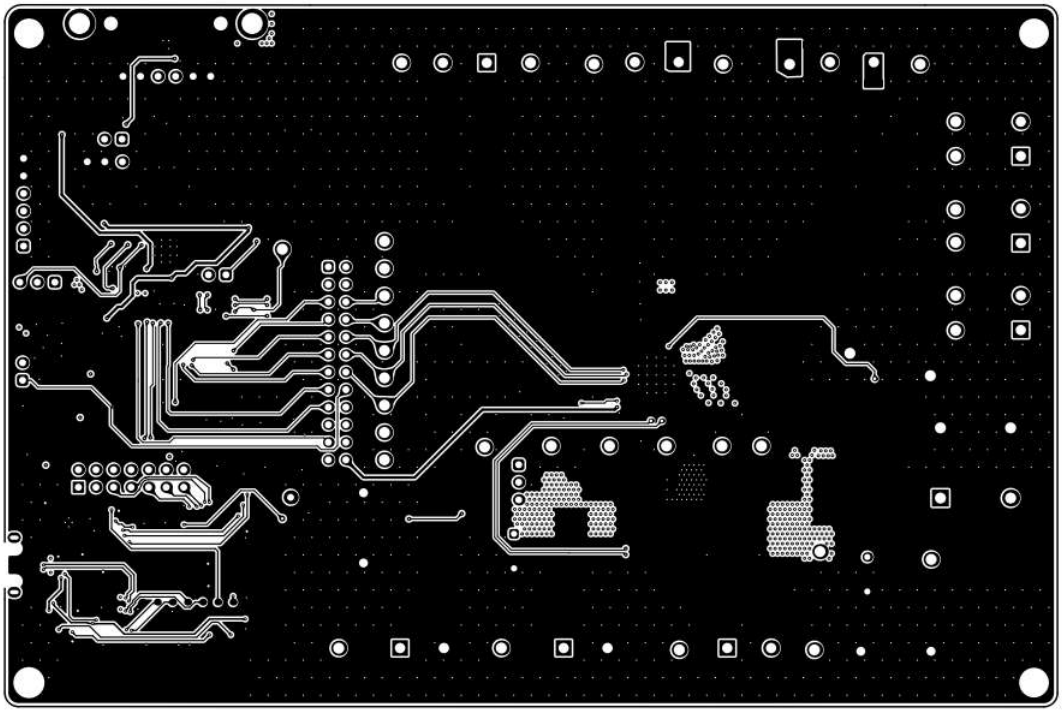


Figure 4-6. Bottom Layers

4.3 Bill of Materials (BOM)

Table 4-1 provides the parts list for DRV8000-Q1EVM.

Table 4-1. Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		MD084	Any
C1, C15	2	2.2uF	CAP, CERM, 2.2uF, 10V, +/- 10%, X5R, 0603	0603	C0603C225K8PACTU	Kemet
C2	1	3300pF	CAP, CERM, 3300pF, 50V, +/- 10%, X7R, 0402	0402	GRM155R71H332KA01D	MuRata
C3, C10, C13, C17	4	1uF	CAP, CERM, 1uF, 25V, +/- 10%, X5R, 0402	0402	C1005X5R1E105K050BC	TDK
C4	1	2.2uF	CAP, CERM, 2.2uF, 6.3V, +/- 10%, X5R, 0402	0402	CL05A225KQ5NNNC	Samsung
C5, C6, C7, C14, C20	5	0.01uF	CAP, CERM, 0.01uF, 25V, +/- 10%, X7R, 0402	0402	GRM155R71E103KA01D	MuRata
C8, C9, C11, C12, C16, C21, C22	7	0.1uF	CAP, CERM, 0.1uF, 6.3V, +/- 10%, X7R, 0402	0402	GRM155R70J104KA01D	MuRata
C18, C19	2	12pF	CAP, CERM, 12pF, 50V, +/- 5%, C0G/NP0, 0402	0402	GRM1555C1H120JA01D	MuRata
C23	1	10uF	CAP, CERM, 10µF, 25V,+/- 10%, X5R, 0603	0603	GRM188R61E106KA73D	MuRata
C24, C34, C37, C86	4	0.1uF	CAP, CERM, 0.1uF, 50V, +/- 10%, X7R, 0603	0603	8.85012E+11	Wurth Elektronik
C25	1	470nF	WCAP-CSGP Multilayer Ceramic Chip Capacitor, General Purpose, size 0603, X7R Class II, 470nF, 25VDC	0603	885012206075R	Wurth Elektronik
C26	1	10nF	WCAP-CSGP Multilayer Ceramic Chip Capacitor, General Purpose, size 0603, X7R, 10nF, 25VDC	0603	8.85012E+11	Wurth Elektronik
C27	1	1µF	WCAP-CSGP Multilayer Ceramic Chip Capacitor, General Purpose, size 0603, X7R, 1µF, 50VDC	0603	8.85012E+11	Wurth Elektronik
C28, C29	2	22pF	WCAP-CSGP Multilayer Ceramic Chip Capacitor, General Purpose, size 0402, NP0, 22pF, 50VDC	0402	8.85012E+11	Wurth Elektronik
C30, C32	2	1uF	CAP, CERM, 1µF, 100V,+/- 10%, X7R, 1206	1206	CC1206KKX7R0BB105	Yageo America
C31	1	220µF	WCAP-ATG5 Aluminum Electrolytic Capacitor, Radial, THT, D10 x H12.5mm, 220µF, 50V		8.60021E+11	Wurth Elektronik
C33, C36	2	0.01uF	CAP, CERM, 0.01µF, 50V,+/- 10%, X7R, 0603	0603	8.85012E+11	Wurth Elektronik

Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C35, C38	2	1uF	CAP, CERM, 1uF, 50V, +/- 10%, X7R, 0805	0805	8.85012E+11	Wurth Elektronik
C39	1		Electrolytic Capacitor, 330uF, 50V, WCAP-ATG5 Series, 20%, Radial Leaded, 10mm	RADIAL	8.60021E+11	Wurth Electronics
C43, C46	2	1µF	WCAP-CSGP Multilayer Ceramic Chip Capacitor, General Purpose, size 0603, X7R, 1µF, 25VDC	0603	8.85012E+11	Wurth Elektronik
C44	1	10uF	CAP, CERM, 10µF, 50V,+/- 20%, X5R, 1206	1206	8.85012E+11	Wurth Elektronik
C45, C47, C48	3	100nF	WCAP-CSGP Multilayer Ceramic Chip Capacitor, General Purpose, size 0603, X7R, 100nF, 100VDC	0603	8.85012E+11	Wurth Elektronik
C58	1	0.022uF	CAP, CERM, 0.022uF, 50V, +/- 10%, X7R, 0603	0603	8.85012E+11	Wurth Elektronik
C63	1	0.01uF	CAP, CERM, 0.01uF, 16V, +/- 10%, X7R, 0603	0603	8.85012E+11	Wurth Elektronik
C67, C69	2	5100pF	CAP, CERM, 5100pF, 50V,+/- 5%, C0G/NP0, 0603	0603	C0603C512J5GAC7867	Kemet
C70	1	0.22uF	CAP, CERM, 0.22µF, 10V,+/- 10%, X7R, 0603	0603	8.85012E+11	Wurth Elektronik
C74, C77, C79	3	0.1uF	CAP, CERM, 0.1uF, 50V, +/- 10%, X7R, 0603	0603	C1608X7R1H104K080AA	TDK
C75, C83	2	4.7uF	CAP, CERM, 4.7µF, 16V,+/- 10%, X7R, AEC-Q200 Grade 1, 0805	0805	CGA4J3X7R1C475K125AE	TDK
C76, C78	2	10uF	CAP, CERM, 10uF, 50V, +/- 10%, X7R, 1206	1206	CL31B106KBHNNNE	Samsung
C80	1	220pF	CAP, CERM, 220pF, 50V, +/- 1%, C0G/NP0, 0603	0603	06035A221FAT2A	AVX
C81, C84	2	20pF	CAP, CERM, 20pF, 100V, +/- 5%, C0G/NP0, 0603	0603	GRM1885C2A200JA01D	MuRata
C82	1	4700pF	CAP, CERM, 4700pF, 100V, +/- 10%, X7R, 0603	0603	06031C472KAT2A	AVX
C85	1	0.01uF	CAP, CERM, 0.01uF, 100V, +/- 10%, X7R, 0603	0603	C0603X103K1RACTU	Kemet
D1, D2, D3, D6, D7, D10	6	Green	LED, Green, SMD	LED_0603	150060VS75000	Wurth Elektronik
D4	1	Red	LED, Red, SMD	LED_0603	150060RS75000	Wurth Elektronik

Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
D5	1	75V	Diode, Switching, 75V, 0.15A, AEC-Q101, SOD-323	SOD-323	1N4148WS-7-F	Diodes Inc.
D8	1	100V	Diode, Switching, 100V, 0.15A, SOD-123	SOD-123	1N4148W-TP	Micro Commercial Components
D9	1		24V, 1-Channel ESD Protection Diode	SOD323	ESD1LIN24DYFR	Texas Instruments
F1	1		Fuse, 30A, 250 VAC, 100 VDC, SMD	10.1x3.12mm	0463030.ER	Littelfuse
FID1, FID2, FID3	3		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
H1, H2, H3, H4	4		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M
IC1	1		4-Channel ESD Protection Array for High-Speed Data Interfaces, DRY0006A (USON-6)	DRY0006A	TPD4E004DRYR	Texas Instruments
IC2	1		500mA, Adjustable, Low Quiescent Current, Low-Noise, High-PSRR, Single-Output LDO Regulator, DRB0008A (VSON-8)	DRB0008A	TPS73533DRBT	Texas Instruments
IC3	1		Precision Micropower Shunt Voltage Reference, 0.5% accuracy, 2.5V, 15ppm / ℃, 15mA, -40℃ to 85℃, 5-pin SC70 (DCK), Green (RoHS & no Sb/Br)	DCK0005A	LM4040C25IDCKR	Texas Instruments
J1	1		Header, 100mil, 7x2, Gold, TH	7x2 Header	TSW-107-07-G-D	Samtec
J2	1		Header, 2.54mm, 12x2, Gold, TH	Header, 2.54mm, 12x2, TH	TSW-112-08-G-D	Samtec
J3, J18, J20	3		Header, 100mil, 2x1, Gold, TH	2x1 Header	TSW-102-07-G-S	Samtec
J4, J6, J7, J8, J9, J16	6		2 Position Wire to Board Terminal Block Horizontal with Board 0.250" (6.35mm) Through Hole	CONN_TERM_BLOCK2	6.91251E+11	Wurth Electronics
J5	1		2 Position Wire to Board Terminal Block Horizontal with Board 0.400" (10.16mm) Through Hole	HDR2	6.91257E+11	Wurth
J10, J11, J12	3		2 Position Wire to Board Terminal Block Horizontal with Board 0.197" (5.00mm) Through Hole	HDR2	6.91217E+11	Wurth Electronics
J13, J19, J23	3		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
J17, J22	2		Header, 100mil, 6x1, Gold, TH	6x1 Header	TSW-106-07-G-S	Samtec

Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
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
LED1	1	Red	LED, Red, SMD	Red LED, 1.6x0.8x0.8mm	LTST-C190KRKT	Lite-On
LED2	1	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On
Q1	1	65V	Transistor, NPN, 65V, 0.1A, SOT-23	SOT-23	BC846BLT1G	ON Semiconductor
Q2, Q3, Q4, Q5, Q6, Q8	6	40V	MOSFET, N-CH, 40V, 100A, DNK0008A (VSON-CLIP-8)	DNK0008A	CSD18512Q5B	Texas Instruments
Q7	1	30V	MOSFET, N-CH, 30V, 25A, DQJ0008A (VSONP-8)	DQJ0008A	CSD17579Q5A	Texas Instruments
R1	1	330k	RES, 330 k, 1%, 0.0625 W, 0402	0402	RC0402FR-07330KL	Yageo America
R2, R5, R22, R26, R27, R34, R35, R37, R38, R39, R40, R41, R42, R52, R53, R58, R64, R68, R71	19	0	RES, 0, 5%, 0.1 W, 0603	0603	RC0603JR-070RL	Yageo
R3	1	220k	RES, 220 k, 1%, 0.0625 W, 0402	0402	RC0402FR-07220KL	Yageo America
R4	1	3.30k	RES, 3.30 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2RKF3301X	Panasonic
R6	1	1.00Meg	RES, 1.00M, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04021M00FKED	Vishay-Dale
R7, R8, R14	3	10k	RES, 10 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K0JNED	Vishay-Dale
R9, R10, R11, R12, R17	5	1.0k	RES, 1.0 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04021K00JNED	Vishay-Dale
R13, R16	2	100	RES, 100, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402100RJNED	Vishay-Dale
R15	1	4.87k	RES, 4.87 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04024K87FKED	Vishay-Dale
R18	1	51	RES, 51, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040251R0JNED	Vishay-Dale
R19, R20	2	470	RES, 470, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402470RJNED	Vishay-Dale

Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R23, R25	2	47k	RES, 47 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040247K0JNED	Vishay-Dale
R24, R43, R73, R74	4	3.3k	RES, 3.3 k, 5%, 0.1 W, 0603	0603	RC0603JR-073K3L	Yageo
R28, R29, R30, R31, R63	5	330	RES, 330, 5%, 0.1 W, 0603	0603	RC0603JR-07330RL	Yageo
R32, R33, R67	3	10k	RES, 10 k, 5%, 0.1 W, 0603	0603	RC0603JR-0710KL	Yageo
R36	1	0.007	RES, 0.007, 1%, 7 W, AEC-Q200 Grade 0, 7.1x4.6mm	7.1x4.6mm	WSHM28187L000FEA	Vishay-Dale
R44	1	16k	RES, 16 k, 5%, 0.1 W, 0603	0603	RC0603JR-0716KL	Yageo
R47, R65	2	1.0k	RES, 1.0 k, 5%, 0.1 W, 0603	0603	RC0603JR-071KL	Yageo
R51	1	220	RES, 220, 1%, 0.1 W, 0603	0603	RC0603FR-07220RL	Yageo
R57	1	1.00k	RES, 1.00 k, 1%, 0.1 W, 0603	0603	RC0603FR-071KL	Yageo
R62	1	560	RES, 560, 5%, 0.1 W, 0603	0603	RC0603JR-07560RL	Yageo
R66, R75	2	0	RES, 0, 0.05%, 2 W, AEC-Q200 Grade 0, 2512	2512	HCJ2512ZT0R00	Stackpole Electronics Inc
R69, R70	2	60.4	RES, 60.4, 1%, 0.1 W, 0603	0603	RC0603FR-0760R4L	Yageo
R72	1	1.00Meg	RES, 1.00M, 1%, 0.1 W, 0402	0402	ERJ-2RKF1004X	Panasonic
R76	1	20k	RES, 20 k, 5%, 0.1 W, 0603	0603	RC0603JR-0720KL	Yageo
R77	1	1.8k	RES, 1.8 k, 5%, 0.1 W, 0603	0603	RC0603JR-071K8L	Yageo
S1	1		Tactile Switch SPST-NO Top Actuated Surface Mount	SMT_SW_6MM2_6MM2	4.30481E+11	Wurth Electronics
SH1, SH2	2		1mm Uninsulated Shorting Plug, 10.16mm spacing, TH	Shorting Plug, 10.16mm spacing, TH	D3082-05	Harwin
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10, SH-J11, SH-J12, SH-J13, SH-J14, SH-J15, SH-J16, SH-J17, SH-J18, SH-J19, SH-J20, SH-J21	21		Shunt, 2.54mm, Gold, Black	Shunt, 2.54mm, Black	60900213421	Wurth Elektronik

Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
TP8	1		Test Point, Miniature, White, TH	White Miniature Test point	5002	Keystone Electronics
TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP18, TP19, TP22, TP23, TP24, TP27, TP28, TP29, TP31, TP32, TP33, TP34, TP35, TP36, TP37, TP38, TP39, TP40, TP41, TP42, TP44, TP46, TP47, TP48, TP49	32		Test Point, Multipurpose, White, TH	White Multipurpose Test point	5012	Keystone Electronics
TP16, TP17	2		Test Point, Compact, SMT	Test point_Keystone_Compact	5016	Keystone Electronics
TP20, TP21	2		Test Point, Multipurpose, Red, TH	Red Multipurpose Test point	5010	Keystone Electronics
TP25, TP26	2		Test Point, Multipurpose, Black, TH	Black Multipurpose Test point	5011	Keystone Electronics
U1	1		Mixed-Signal Microcontrollers With CAN-FD Interface LQFP64	LQFP64	MSPM0G3507SPM	Texas Instruments
U2	1		Automotive Multi-function Driver with Integrated Half-bridges &HighSide and Current Sensing & Advanced Diagnostics	VQFN48	DRV8000QWRGZRQ1	Texas Instruments
U4	1		24V, 2-Channel ESD Protection Diode for In-Vehicle Networks	SOT-23-3	ESD2CAN24DBZR	Texas Instruments
USB1	1		Receptacle, USB 2.0, Micro B, 5 Position, R/A, SMT	Receptacle, USB 2.0, Micro B, 5 Pos, 0.65mm Pitch, R/A, SMT	1051640001	Molex
XDS1	1		MSP432E401YTPDT, PDT0128A (TQFP-128)	PDT0128A	MSP432E401YTPDTR	Texas Instruments
Y1	1		Crystal, 16MHz, 8pF, SMD	3.2x0.75x2.5mm	NX3225GA-16.000M-STD-CRG-1	NDK
C40	0		WCAP-CSGP Multilayer Ceramic Chip Capacitor, General Purpose, size 0603, X7R, 100nF, 100VDC			Wurth Elektronik

Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C41, C42, C49, C50, C51, C52, C53, C54, C55, C56, C57, C59, C60, C61, C64, C65, C66, C71, C72, C73, C87, C88, C89, C90, C91, C92	0	0.022uF	CAP, CERM, 0.022uF, 50V, +/- 10%, X7R, 0603	0603	8.85012E+11	Wurth Elektronik
C62	0		CAP CER 0.015UF 50V X7R 0603	0603	8.85012E+11	Wurth Electronics
C68	0	0.01uF	CAP, CERM, 0.01µF, 100V,+/- 10%, X7R, 0603	0603	8.85012E+11	Wurth Elektronik
J21	0		Receptacle, D-Sub, 9 Position, R/A, SMT	30.81x10.28x10.10 mm	190-009-263R001	NorComp
L1	0		FIXED IND 2.2UH 16A 2.2 MOHM	IND_SMT_11MM6_10MM5	74439369022	Wurth Electronics
L2	0	100uH	Inductor, Ferrite, 100 uH, 0.15A, 2 ohm, SMD	SMD, 4-Leads, Body 4.7 x 3.7mm	ACT45B-101-2P-TL003	TDK
R21	0	0	RES, 0, 5%, 0.1 W, 0603	0603	RC0603JR-070RL	Yageo
Y2	0		Crystal 40MHz ±10ppm (Tol) ±20ppm (Stability) 12pF FUND 40Ohm 4-Pin Mini-CSMD T/R	TSX-3225	X1E0000210179	Seiko Epson

5 Additional Information

5.1 Trademarks

All trademarks are the property of their respective owners.

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。

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

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), 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, regulatory 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 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.

TI objects to and rejects any additional or different terms you may have proposed.

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