

EVM User's Guide: BQ25190EVM

BQ25190 Evaluation Module



Description

This user's guide provides detailed testing instructions for the BQ25190 evaluation module (EVM). Also included are descriptions of the necessary equipment, equipment setup, procedures, the printed-circuit board layouts, schematics, and the bill of materials (BOM).

Throughout this user's guide, the abbreviation *EVM*, *BQ25190EVM*, and the term evaluation module are synonymous with the BQ25190 evaluation module, unless otherwise noted.

Get Started

1. Order the [BQ25190EVM](#)
2. Order the [USB2ANY](#)
3. Follow this step-by-step guide.

1 Features

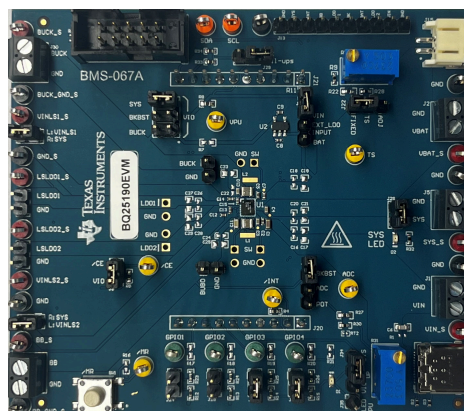
This EVM has the following features:

- 1-A Linear battery charger
- I2C Configurable Battery Regulation voltage with 0.5% Accuracy
- Configurable Termination Current down to 0.5 mA
- Programmable thermal charging profile with configurable Hot, Warm, Cool, and Cold thresholds
- Power Path Management for powering the system and charging the battery
- 15-nA shutdown mode for longest shelf life
- 12-bit, 7-Channel ADC
- Integrated Buck converter with DVS output
- Integrated Buck-Boost converter with DVS output
- Power Sequencing
- Two integrated I2C programmable LDOs
- One Button Wake-up and Reset Input with Adjustable Timers
- I2C Communication control
- Four GPIO lines with LED PWM driver

See the device datasheet for detailed features and operation of the integrated IC

Applications

- [Smartwatches](#) and [other wearable devices](#)
- [Portable Medical Equipment](#)
- [Smart Trackers](#)
- [Retail automation and payment](#)



BQ25190EVM Hardware Board



WARNING

Hot surface! Contact may cause burns. Do not touch!

Some components may reach high temperatures >55°C when the board is powered on. The user must not touch the board at any point during operation or immediately after operating, as high temperatures may be present.

2 Introduction

The BQ25190EVM is an evaluation kit for the BQ25190 integrated battery charge management IC. The BQ25190 is an integrated battery charge management IC that integrates the most common functions for wearable devices: linear charger, regulated output, manual reset with timer, and ship mode function.

3 EVM Setup

[Table 3-1](#) lists the jumper connections and the jumper description. [Table 3-2](#) lists the recommended operating conditions.

Table 3-1. Jumper Descriptions

Jumper Name	Description
J1	VIN and GND Connector. Input voltage from external power supply. Recommended voltage is 3V - 18V
J2	VBAT and GND connector.
J3	External LDO Power Selection. The source for this external LDO can be configured to VIN, VBAT, or connected directly to another source
J4	USB-C Connection. Configured for 5V and 1A Source.
J5	SYS Rail and GND Connection.
J6	LSLDO1 Rail and GND Connection
J7	VINLS1 connection. Populate to connect VINSL1 to SYS.
J8	BUCK Rail and GND Connection
J9	/CE Pull-up to VIO. Populate to pull /CE high, leave floating to pull /CE low.
J11	BUCK-BOOST Rail and GND Connection
J12	LSLDO2 Rail and GND Connection
J13	Sense Line headers for voltage reading.
J14	VIO / VPU Rail Selector. Select between BUCK, SYS, or BUCK-Boost Rails to power VIO or VPU. Short R7 to select the External LDO.
J15	Battery Pack Connector. Battery connection using JST header
J16	VINLS2 connection. Populate to connect VINLS2 to SYS
J22	TS Potentiometer Connection
J23	ADC Input Connection. Select between a potentiometer input or Buck-Boost Rail input
J24,J25,J26,J27	GPIO Pull up connections. Populate to pull up GPIO voltages, leave floating to pull GPIOs low
J28	SYS Indicator LED.
J29	I2C Pull up Rail. Populate to pull up the I2C lines to VIO
J30	USB2ANY Connector

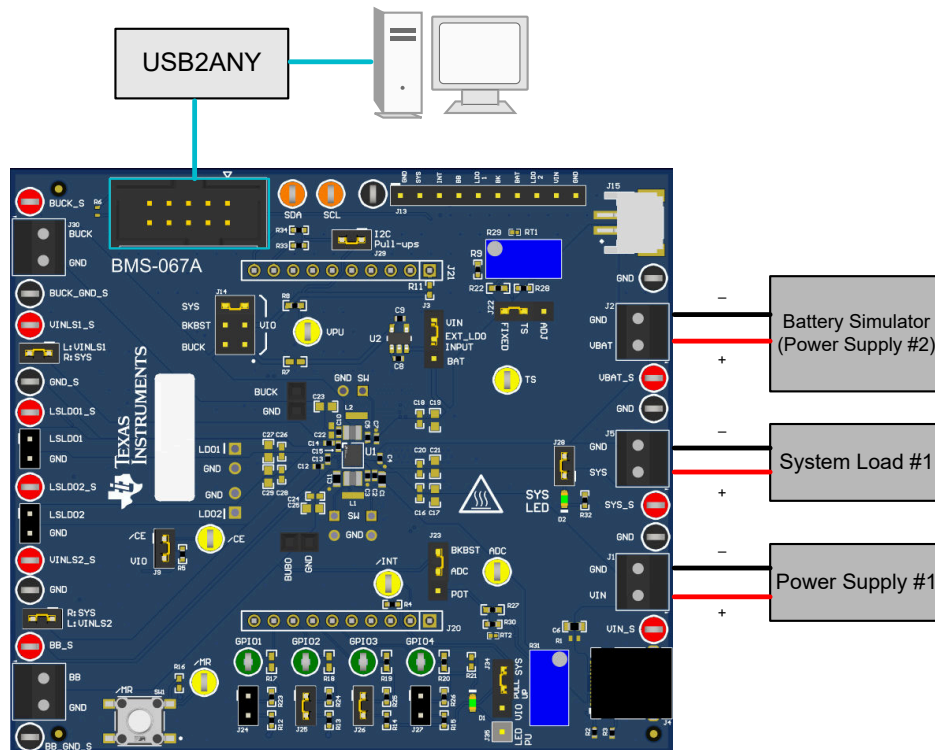


Table 3-2. Recommended Operating Conditions

		MIN	NOM	MAX	UNIT
V_{BAT}	Battery Voltage Range			4.65	V
I_{IN}	Input Current Range (IN to SYS)			1.05	A
I_{BAT}	Fast Charge Current			1	A
	RMS Discharge Current (continuously)			1.5	A
	Peak Discharge Current (Up to 50ms)			2.5	A
V_{INLS1}/V_{INLS2}	LDO1/LDO2 Input Voltage Range	1.5		6	V
I_{OUT_BUCK}	Buck Output Current			600	mA
I_{OUT_BUBO}	Buck-boost Output Current ($V_{SYS} \geq 3.0V$, $V_{BBOUT} = 3.3V$)			600	mA
$I_{OUT_LDO1} / I_{OUT_LDO2}$	LDO1/LDO2 Output Current			200	mA
T_A	Operating Ambient Temperature Range	-40		85	°C
T_J	Operating Junction Temperature Range	-40		125	°C

GPIO Resistor Configuration

The [GPIO Resistor configuration](#) is populated for default device configuration but designed for flexibility. All GPIO signals have a 0 Ohm 0402 resistors that connect the GPIO signal to a Jumper-configurable resistor network. GPIO3 and GPIO4 additionally can be pulled up to VIO or SYS through J34. GPIO4 additionally can be used to exhibit PWM functionality through D1 diode, where pull up voltage can be attached at J35 and requires a resistor placed at R21.

VIO Selection

VIO serves as the digital pull-up rail for the EVM. Various rails can be selected as the rail intended for as the supply for this rail. J14 allows simple changing between Buck, Buck-Boost, or the SYS rail. An external LDO can

be used by populating R7, though J14 should be disconnected at this point. This external LDO input rail can be selected via the J3 header.

4 EVM Connectors and Test Points

Table 4-1 shows the default configuration for connectors.

Table 4-1. Factory Jumper Settings

Jumper Name	Description	Setting
J1	VIN and GND	NA
J2	VBAT and GND	NA
J3	VIN, EXT LDO IN, and VBAT	NA
J4	USB-C Port	NA
J5	SYS and GND	NA
J6	LSLDO1 and GND	NA
J7	VINLS1 and SYS	Connected
J8	BUCK and GND	NA
J9	/CE and Pull-Up Res	Connected
J11	BUCK-BOOST and GND	NA
J12	LSLDO2 and GND	NA
J13	Sense Lines	NA
J14	VIO / VPU Selector	Connect to BBOUT
J15	Battery Pack	NA
J16	VINLS2 and SYS	Connected
J22	TS Potentiometer	Connected
J23	ADC Input	NA
J24,J25,J26,J27	GPIO Pull Up	NA
J28	SYS LED Indicator	NA
J29	I2C Pull-Up	NA
J30	USB2ANY	NA
J34	GPIO3 and GPIO 4 Pull up	Connected to VIO

Note

Connecting the SYS LED, I2C Pull-Up, External LDO, and other hardware will increment current consumption readings.

4.1 USB2ANY Debug

USB2ANY Debug

USB2ANY under some circumstances may not respond to the GUI. To resolve this you can proceed with resetting the USB2ANY device. This is done by first installing and opening the [USB2ANY Explorer Software](#). With the software open, press and hold the S1 switch and connect the USB2ANY via USB cable. The software should provide procedure to re-flash the device. More information about the [USB2ANY is available](#).

5 Testing Procedures

5.1 Equipment

This section includes a list of supplies required to perform tests on this EVM

1. *Two Power Supplies:* Keithley 2400 Powersupply or equivalent
 - a. Power Supply #1 (PS #1) will be used as input voltage
 - b. Power Supply #2 (PS #2) will be used as battery voltage
2. *4 Channel Oscilloscope:* To monitor voltages at VIN, VBAT, VSYS and BUCK
 - a. Channel 1 (SC #1) will be used to probe VIN
 - b. Channel 2 (SC #2) will be used to probe VBAT
 - c. Channel 3 (SC #3) will be used to probe VSYS
 - d. Channel 4 (SC #4) will be used to probe BUCK
3. *Computer:* A computer with at least one USB port and a USB cable
4. *PC communication interface:* [USB2ANY](#) with the latest firmware
5. *Software:* Download the [TI Charger GUI](#) from Texas Instruments.

5.2 Charge Mode

Connect the equipment as the following:

- Power Supply PS#1: VIN of the BQ25190 at 5V
- Power supply PS#2: VBAT of the BQ25190 at 3.7V
- Scope Channel SC#1: VIN
- Scope Channel SC#2: VSYS
- Scope Channel SC#3: VBAT
- Scope Channel SC#4: BUCK

Depopulate the /CE Pull-up jumper and ensure the TS jumper is placed for fixed TS resistor. Turn ON the supply PS#2, then turn ON the supply PS#1. The VSYS will rise to the level of 4.5V. BUCK should rise to the level of



Note

If the supplies (VIN and VBAT) are turned off, you will need to restart the TI Charger GUI for correct I²C transactions to be reflected in the TI Charger GUI

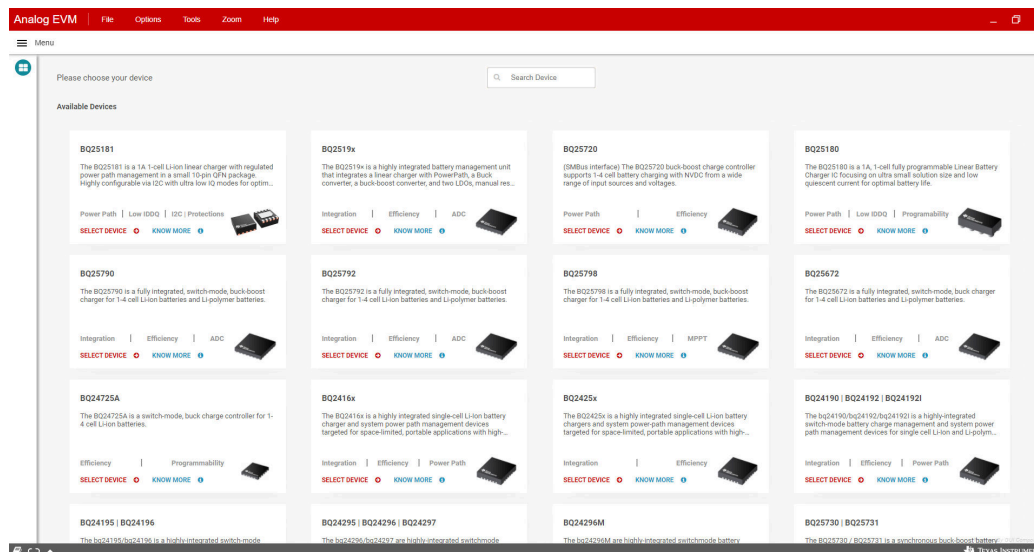


Figure 5-2. TI Charger GUI Device Selection

Select the BQ2518X from the charger selection. Click *Quick Start* or *Register Map*.

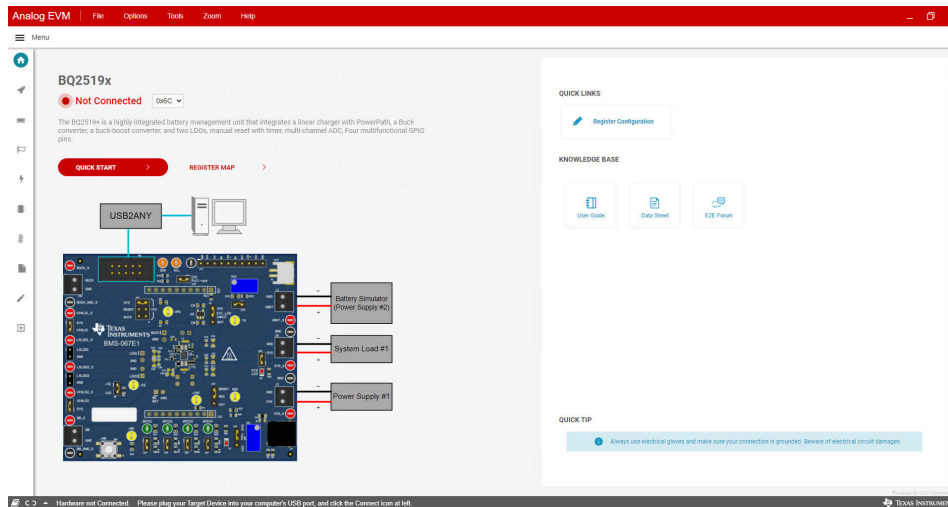


Figure 5-3. BQ25190EVM Connected

The Quick Start is shown in Figure 5-4

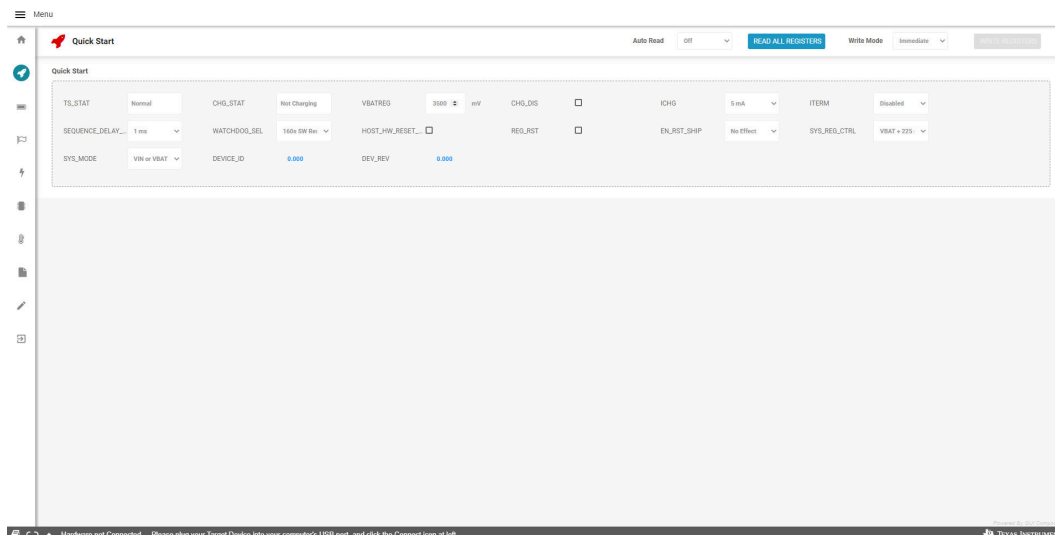


Figure 5-4. Quick Start

The register map is shown in [Figure 5-5](#).

The screenshot shows the 'Register Map' window in the Analog EVM software. It displays a table of registers with columns for Register Name, Address, Value, and Bits. The 'VBAT' register (0x0C) is highlighted, showing its bit fields: 7 (0), 6 (0), 5 (1), 4 (1), 3 (1), 2 (1), 1 (0), and 0 (0). The 'FIELD VIEW' on the right shows the VBAT register value as 0x00000000.

Register Name	Address	Value	Bits
STAT7	0x02	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
STAT3	0x03	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
FLAG0	0x04	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
FLAG1	0x05	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
FLAG2	0x06	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
FLAG3	0x07	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
MASK0	0x08	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
MASK1	0x09	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
MASK2	0x0A	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
MASK3	0x0B	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
VBAT	0x0C	0x0000	7 6 5 4 3 2 1 0
ICHG_CTRL	0x0D	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
CHARGE_CTRL0	0x0E	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
CHARGE_CTRL1	0x0F	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
IC_CTRL	0x10	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
TMR_ILM	0x11	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
SRP_RST	0x12	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
SVS_REG	0x13	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
TS_COLD	0x14	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
TS_COOL	0x15	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
TS_WARM	0x16	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
TS_HOT	0x17	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ADCCTRL0	0x18	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ADCCTRL1	0x19	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ADCCTRL2	0x1A	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ADC_DATA_VBAT	0x1B	0x0000	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

Figure 5-5. Register Map

The Charger page provides charging, TS, and MR related configurations.

The screenshot shows the 'Charger' page in the Analog EVM software. It contains three sections: 'Charger Controls', 'TS Controls', and 'MR Controls'. Each section has various configuration options with dropdown menus and checkboxes.

Charger Controls

- VBATREG: 4100 mV
- CHG_DIS: ☐
- ICHG: 5 mA
- VDFPM_DIS: ☐
- IPRECHG: Precharge =
- ITERM: Disabled
- VINDFPM: 4.2 V
- THERM_REG: 100 °C
- IBAT_OCP: 500 mA
- BAT_DEPL: 2.0 V
- IBATSC: 8 mA
- VLOWV_SEL: 3 V
- VRECHG: 100 mV
- ILIM: 25 mA
- VIN_OVP: 5.7 V

TS Controls

- TS_COLD: 0 mV
- TS_COOL: 0 mV
- TS_WARM: 0 mV
- TS_HOT: 0 mV
- TS_ACTION_EN: ☐
- TS_FAULT_BAT_EN: ☐
- TS_FAULT_VIN_EN: ☐
- TS_ICHG: 0.5 x ICHG
- TS_VREG: VREG - 100

MR Controls

- MRL_PRESS: 5 s
- PBL_PRESS_ACTION: No Effect
- WAKE1_TMR: 125 ms
- WAKE2_TMR: 1 s

Figure 5-6. Charger Page

The Status page provides the status bit indicators, flags, and masks.

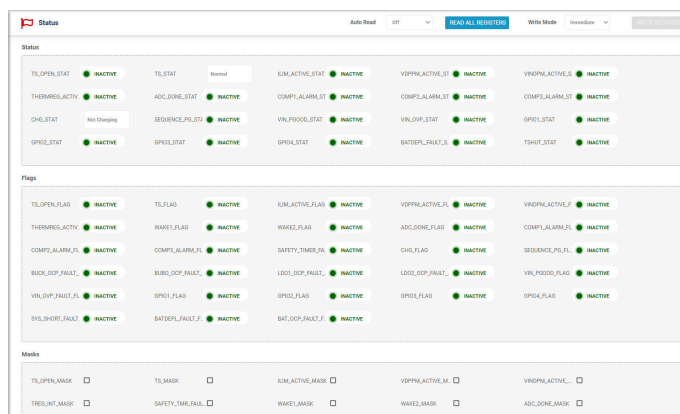


Figure 5-7. Status Page

The Power rails page provides configurations related to the Buck, Buck-boost, and LDO rails.

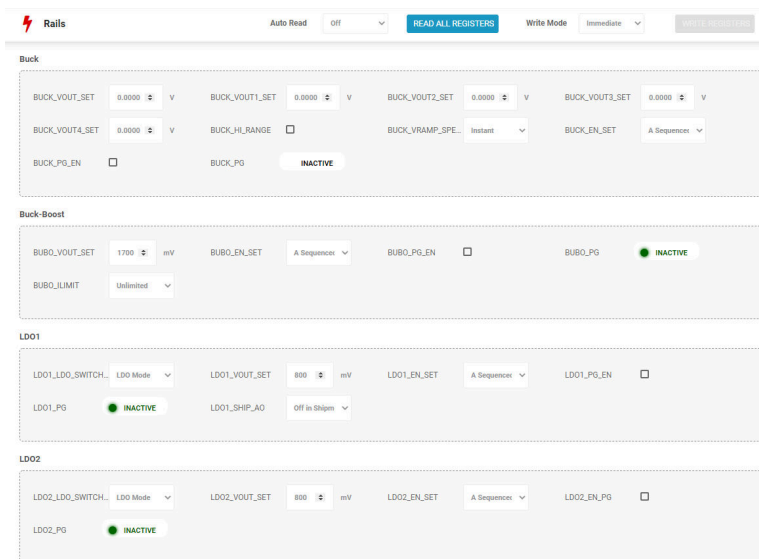



Figure 5-8. Power Rails Page

The Peripherals page provides configurations for timers and GPIO.


Peripherals
Auto Read: Off
 READ ALL REGISTERS
 Write Mode: Immediate

Timers


TMR2X_EN	<input type="checkbox"/>	SAFETY_TIMER	3 Hours
WATCHDOG_SEL	160s SW Res	AUTOWAKE	0.5 s
WAKE1_TMR	125 mS	WAKE2_TMR	1 s
WATCHDOG_15S_E...	<input type="checkbox"/>		

GPIO

GPIO1_CONFIG	Open-Drain I	GPIO2_CONFIG	Open-Drain I
GPIO3_CONFIG	Open-Drain I	GPIO4_CONFIG	Open-Drain I

Figure 5-9. Peripherals Page

The ADC page provides configurations and readings for the ADC and ADC Channels.


ADC
Auto Read: Off
 READ ALL REGISTERS
 Write Mode: Immediate

ADC

ADC_EN	<input type="checkbox"/>	ADC_RATE	Continuous	ADC_SAMPLE	11 bit Effect
ADC_AVG	Single Value	ADC_AVG_INIT	Existing Val	ADC_COMP1_EN	<input type="checkbox"/>
ADC_COMP2_EN	<input type="checkbox"/>	ADC_COMP3_EN	<input type="checkbox"/>	ADC_COMP1	TDR
ADCIN_MODE	General Purp	EN_CRIT_MON	<input type="checkbox"/>	ADC_COMP2	TDR
ADC_COMP3	TDR	ADCALARM1	0	ADCALARM1_ABOVE	<input type="checkbox"/>
ADCALARM2	0	ADCALARM2_ABOVE	<input type="checkbox"/>	ADCALARM3	0
ADCALARM3_ABOVE	<input type="checkbox"/>	IN_ADC_DIS	<input type="checkbox"/>	VSYS_ADC_DIS	<input type="checkbox"/>
IBAT_ADC_DIS	<input type="checkbox"/>	VIN_ADC_DIS	<input type="checkbox"/>	VBAT_ADC_DIS	<input type="checkbox"/>
TS_ADC_DIS	<input type="checkbox"/>	ADGIN_ADC_DIS	<input type="checkbox"/>	TDR_ADC_DIS	<input type="checkbox"/>

ADC Data

ADC_DATA_VBAT	0.00 mV	ADC_DATA_TS	0.00 mV	ADC_DATA_IBAT	0 mA
ADC_DATA_ADGIN	0.00 mV	ADC_DATA_VIN	0.0 mV	ADC_DATA_VSYS	0.00 mV
ADC_DATA_IIN	0.0 mA	ADC_DATA_TDR	0.0 °C		

Figure 5-10. ADC Page

5.3 Ship Mode

To go to Ship Mode, enable ship mode through an I²C transaction to set EN_SHIP_RST bits or the PB_LPRESS_ACTION bits as shown in [Figure 5-11](#):

- EN_RST_SHIP = 2b01 (Enable shipmode with wake on button press or adapter insert)
- PB_PRESS_ACTION = 2b10 (Enable shipmode)

Enter ship mode by removing VIN if setting EN_RST_SHIP to 2b01. If setting PB_LPRESS_ACTION to 2b10 to enable shipmode, hold the TS/MR button for the configured t_{LPRESS} then remove VIN.

You will know you are in Ship Mode as the voltage on the SYS (SC#2) will fall to 0 V.

BQ2519x / SHIP_RST / EN_RST_SHIP[6:5]

EN_RST_SHIP

Enable Shipmode

Figure 5-11. SHIP_RST Register

6 PCB Layouts

The images below show the EVM PCB layout.

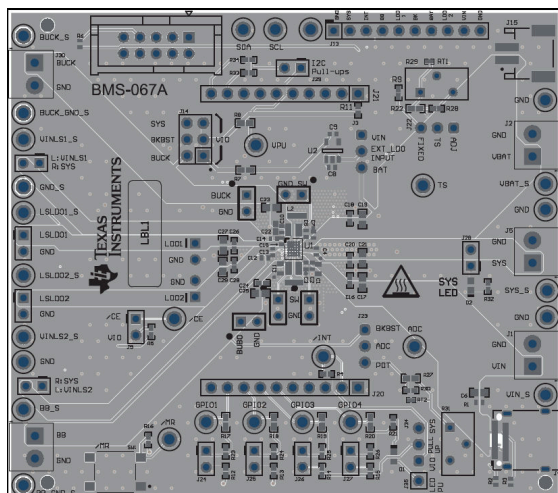


Figure 6-1. Top Layer

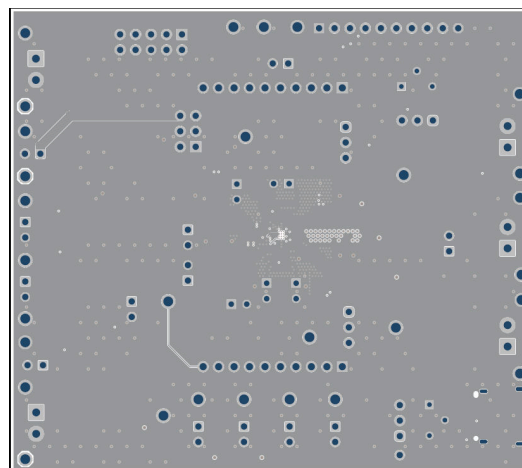


Figure 6-2. Second Layer

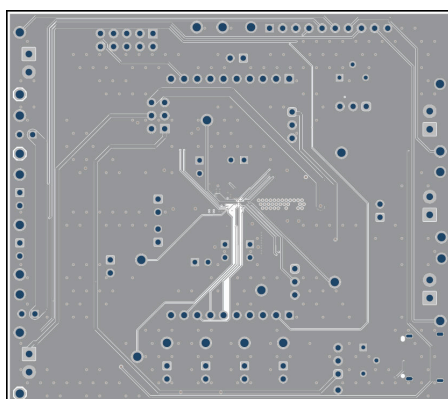


Figure 6-3. Third Layer

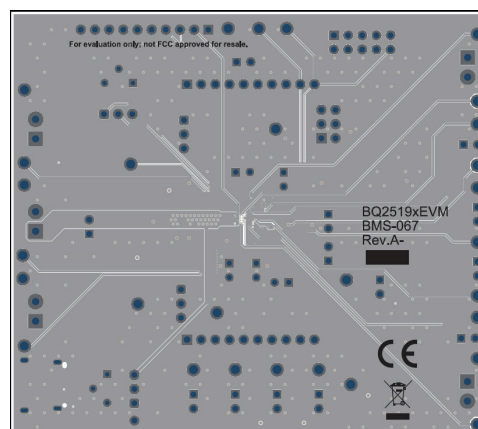


Figure 6-4. Bottom Layer

7 Schematic

Figure 7-1 illustrates the EVM schematic.

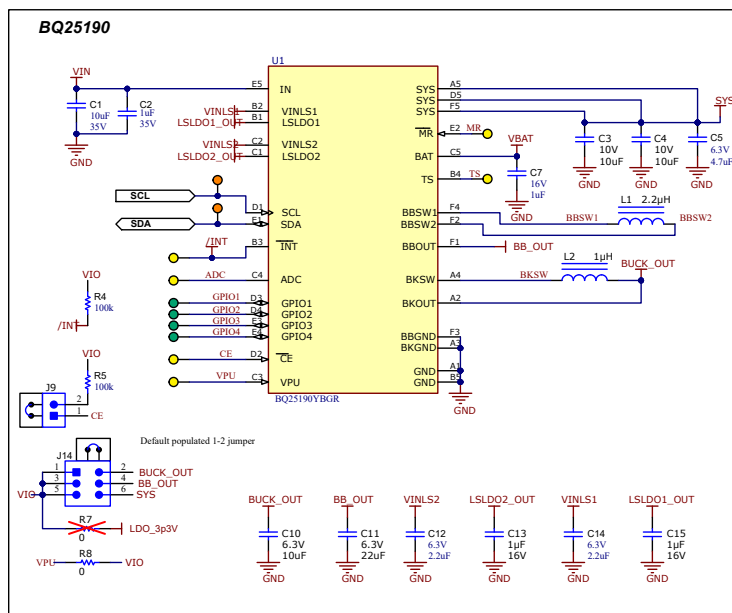


Figure 7-1. BQ25190EVM Schematic

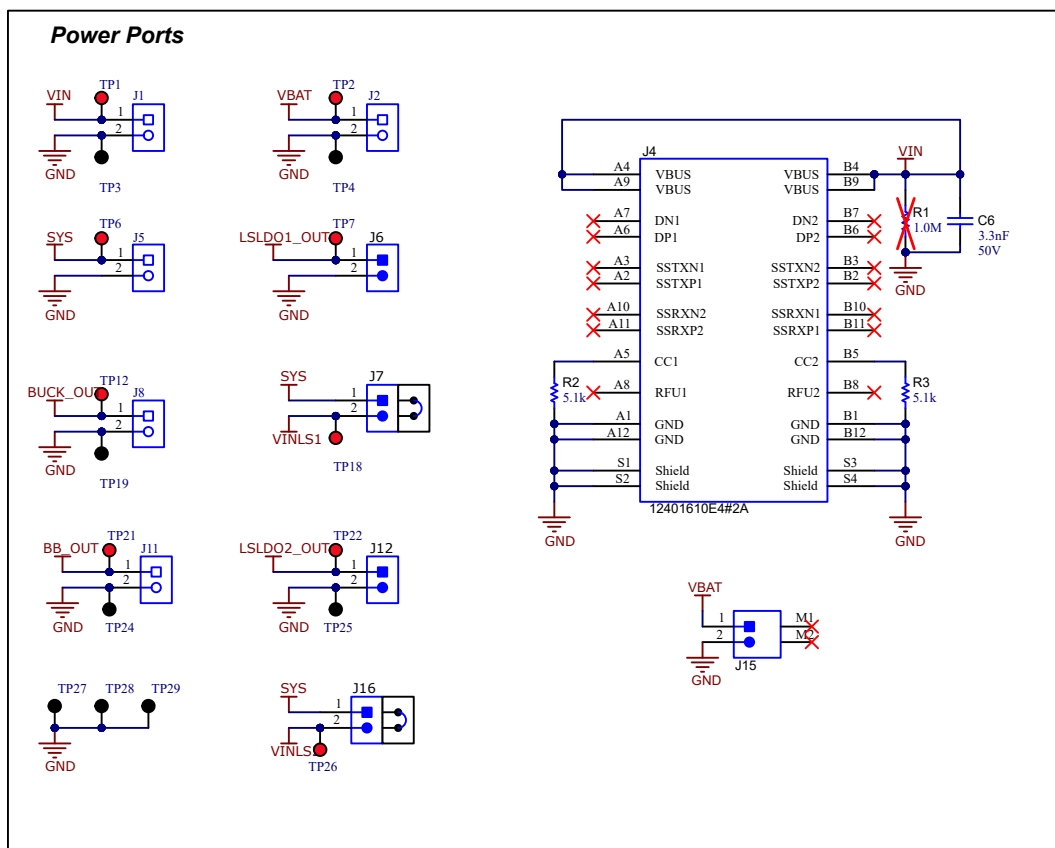


Figure 7-2. BQ25190EVM Power Ports

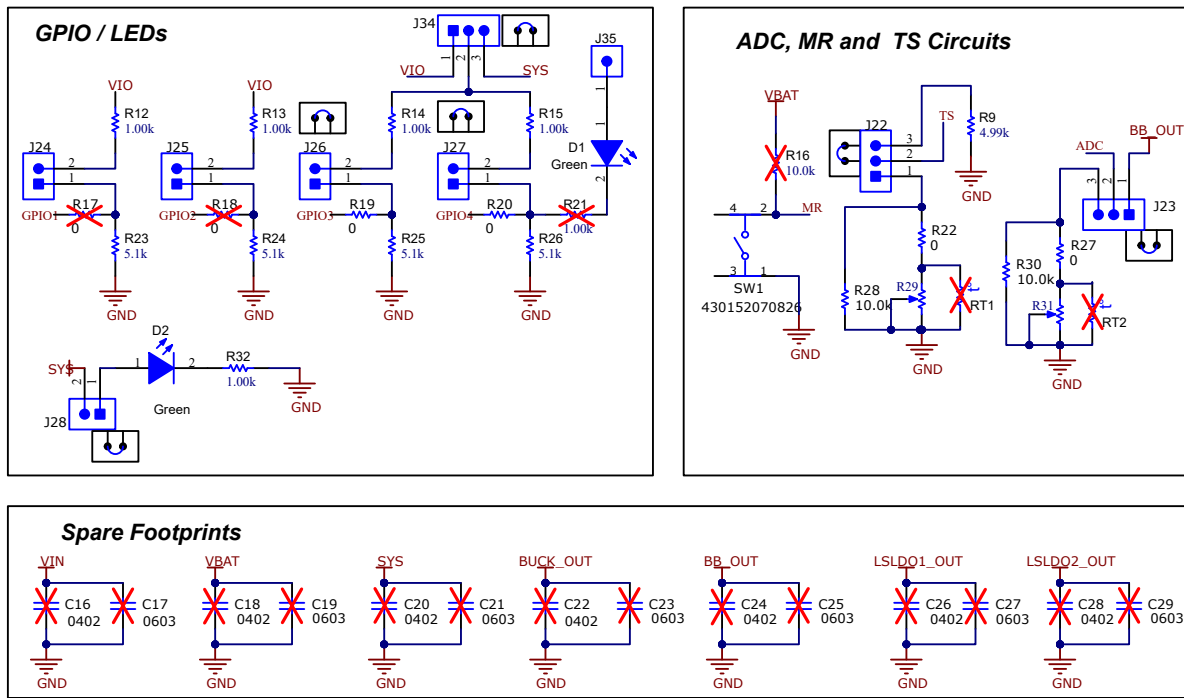


Figure 7-3. BQ25190EVM Peripheral Circuits

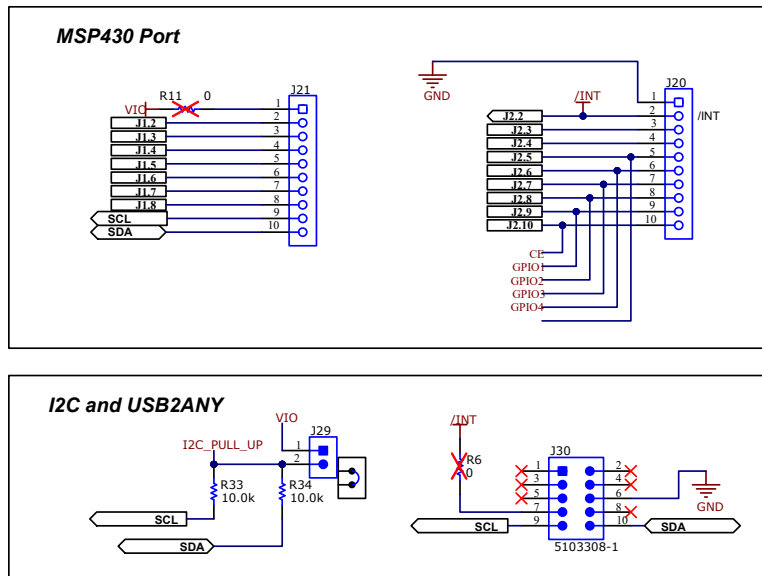


Figure 7-4. BQ25190EVM Digital Connections

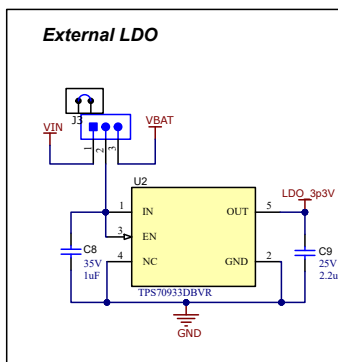


Figure 7-5. LDO for Other Peripherals

8 Bill of Materials

The table below lists the EVM bill of materials (BO

Table 8-1. Bill of Materials

Designator	Quantity	Description	PartNumber	Manufacturer
!PCB1	1	Printed Circuit Board	BMS-067	Any
C1	1	Capacitor, Ceramic, 10μF, 35V, +/- 20%, X5R, 0603	GRM188R6YA106MA73D	Murata
C2, C8	2	Capacitor, Ceramic, 1μF, 35V, +/- 10%, X5R, 0402	GRM155R6YA105KE11D	MuRata
C3, C4	2	Capacitor, Ceramic, 10μF, 10V, +/- 20%, X5R, 0402	GRM155R61A106ME11	MuRata
C5	1	Capacitor, Ceramic, 4.7μF, 6.3V, +/- 20%, X5R, 0402	GRM155R60J475ME47D	MuRata
C6	1	Capacitor, Ceramic, 3300pF, 50V, +/- 10%, X7R, 0603	C0603C332K5RACTU	Kemet
C7	1	Capacitor, Ceramic, 1μF, 16V, +/- 10%, X5R, 0402	EMK105BJ105KVHF	Taiyo Yuden
C9	1	Capacitor, Ceramic, 2.2μF, 25V, +/- 10%, X5R, 0402	GRM155R61E225KE11D	MuRata
C10	1	Capacitor, Ceramic, 10μF, 6.3V, +/- 20%, X5R, 0402	GRM155R60J106ME15D	MuRata
C11	1	Capacitor, Ceramic, 22μF, 6.3V, +/- 20%, X5R, 0603	GRM188R60J226MEA0D	MuRata
C12, C14	2	Capacitor, Ceramic, 2.2μF, 6.3V, +/- 20%, X5R, 0402	GRM155R60J225ME15D	MuRata
C13, C15	2	Capacitor, Ceramic, 1μF, 16V, +/- 20%, X5R, 0402	GRM155R61C105MA12D	MuRata
D1, D2	2	LED, Green, SMD	LTST-C190KGKT	Lite-On
J1, J2, J5, J8, J11	5	Terminal Block, 3.5mm Pitch, 2x1, TH	ED555/2DS	On-Shore Technology
J3, J22, J23, J34	4	Header, 100mil, 3x1, Gold, TH	TSW-103-07-G-S	Samtec
J4	1	Receptacle, 0.5mm, USB TYPE C, R/A, SMT	12401610E4#2A	Amphenol Canada
J6, J7, J9, J12, J16, J24, J25, J26, J27, J28, J29	11	Header, 100mil, 2x1, Tin, TH	PEC02SAAN	Sullins Connector Solutions
J10, J32	2	Connector, Receptacle, 100mil, 2x1, Gold plated, TH	5-534206-1	TE Connectivity
J13	1	Header, 100mil, 10x1, Gold, TH	TSW-110-07-G-S	Samtec
J14	1	Header, 100mil, 3x2, Gold, TH	TSW-103-07-G-D	Samtec
J15	1	Header (shrouded), 2mm, 2x1, R/A, SMT	S2B-PH-SM4-TB(LF)(SN)	JST Manufacturing
J20, J21	2	Connector, Receptacle, 100mil, 10x1, Gold plated, TH	SSW-110-23-F-S	Samtec
J30	1	Header (shrouded), 100mil, 5x2, Gold, TH	5103308-1	TE Connectivity
J35	1	Header, 2.54mm, 1x1, Gold, TH	HTSW-101-07-G-S	Samtec

Table 8-1. Bill of Materials (continued)

L1	1	Inductor, Shielded, Metal Composite, 2.2μH, 1.7A, 0.14Ω, SMD	DFE201610E-2R2M=P2	MuRata
L2	1	Inductor, Shielded, Metal Composite, 1 μH, 2.7A, 0.057Ω, SMD	DFE201610E-1R0M=P2	MuRata
LBL1	1	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	THT-14-423-10	Brady
R2, R3, R23, R24, R25, R26	6	Resistor, 5.1kΩ, 5%, 0.063W, AEC-Q200 Grade 0, 0402	CRCW04025K10JNED	Vishay-Dale
R4, R5	2	Resistor, 100kΩ, 1%, 0.0625 W, AEC-Q200 Grade 0, 0402	AC0402FR-07100KL	Yageo America
R8, R19, R20, R22, R27	5	Resistor, 0, 5%, 0.1W, AEC-Q200 Grade 0, 0402	ERJ-2GE0R00X	Panasonic
R9	1	Resistor, 4.99kΩ, 1%, 0.063W, AEC-Q200 Grade 0, 0402	CRCW04024K99FKED	Vishay-Dale
R12, R13, R14, R15	4	Resistor, 1.00kΩ, 0.1%, 0.063 W, 0402	ERA-2AEB102X	Panasonic
R28, R30, R33, R34	4	Resistor, 10.0kΩ, 1%, 0.063W, 0402	RC0402FR-0710KL	Yageo America
R29, R31	2	TRIMMER, 50kΩ, 0.5W, TH	3296Y-1-503LF	Bourns
R32	1	Resistor, 1.00kΩ, 1%, 0.063W, 0402	MCR01MZPF1001	Rohm
SH-JP1, SH-JP2, SH-JP4, SH-JP5, SH-JP6, SH-JP7, SH-JP8, SH-JP9, SH-JP11, SH-JP12, SH-JP13, SH-JP14	12	Shunt, 100mil, Gold plated, Black	SNT-100-BK-G	Samtec
SW1	1	Tactile Switch SPST-NO Top Actuated Surface Mount	4.30152E+11	Würth Electronics
TP1, TP2, TP6, TP7, TP12, TP18, TP21, TP22, TP26	9	Test Point, Multipurpose, Red, TH	5010	Keystone Electronics
TP3, TP4, TP19, TP24, TP25, TP27, TP28, TP29	8	Test Point, Multipurpose, Black, TH	5011	Keystone Electronics
TP5, TP9, TP11, TP13, TP20, TP23	6	Test Point, Multipurpose, Yellow, TH	5014	Keystone Electronics
TP8, TP10	2	Test Point, Multipurpose, Orange, TH	5013	Keystone Electronics
TP14, TP15, TP16, TP17	4	Test Point, Multipurpose, Green, TH	5126	Keystone Electronics

Table 8-1. Bill of Materials (continued)

U1	1	Ultra-low IQ BMU with 1A Linear Charger, Voltage Regulators, 12-bit ADC, and GPIOs	BQ25190YBGR	Texas Instruments
U2	1	150mA, 30V, Ultra-Low IQ, Wide Input Low-Dropout Regulator with Reverse Current Protection, DBV0005A (SOT-23-5)	TPS70933DBVR	Texas Instruments
C16, C18, C20, C22, C24, C26, C28	0	Capacitor, Ceramic, 0.01 μ F, 10V, +/- 10%, X7R, 0402	0402ZC103KAT2A	AVX
C17, C19, C21, C23, C25, C27, C29	0	Capacitor, Ceramic, 10 μ F, 10V, +/- 10%, X6S, 0603	C1608X6S1A106M080AC	TDK
FID1, FID2, FID3	0	Fiducial mark. There is nothing to buy or mount.	N/A	N/A
R1	0	Resistor, 1.0M, 5%, 0.063W, AEC-Q200 Grade 0, 0402	CRCW04021M00JNED	Vishay-Dale
R6, R7, R17, R18	0	Resistor, 0 Ω , 5%, 0.1W, AEC-Q200 Grade 0, 0402	ERJ-2GE0R00X	Panasonic
R11	0	Resistor, 0 Ω , 5%, 0.063W, 0402	RC0402JR-070RL	Yageo America
R16	0	Resistor, 10.0k Ω , 1%, 0.063W, AEC-Q200 Grade 0, 0402	AC0402FR-0710KL	Yageo America
R21	0	Resistor, 1.00k Ω , 1%, 0.063W, 0402	MCR01MZPF1001	Rohm
RT1, RT2		103AT Thermistor		

Trademarks

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9 Revision History

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

DATE	REVISION	NOTES
October 2024	*	Initial release

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
 - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

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

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

NOTE:

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

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

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

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

CAUTION

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

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

FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

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

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

3.2 Canada

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

Concerning EVMs Including Radio Transmitters:

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

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

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

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

Concernant les EVMs avec antennes détachables

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

3.3 Japan

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

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

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

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

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

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/sds/ti_ja/general/eStore/notice_02.page

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3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

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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.

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