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

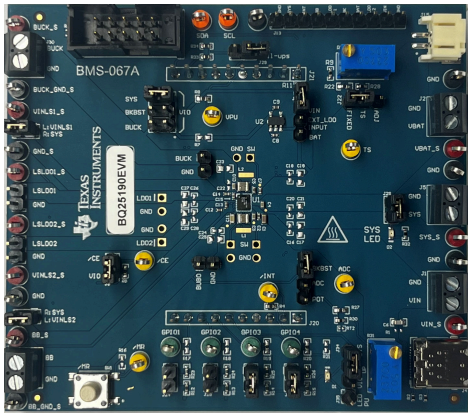
This EVM has the following features:

- 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

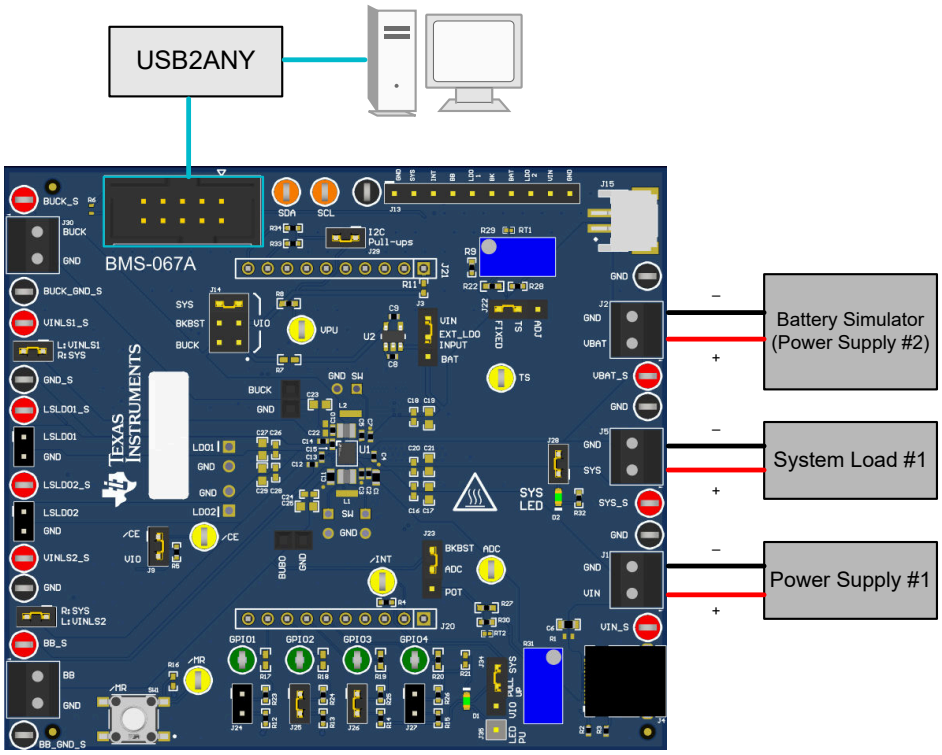


Table 3-2. Recommended Operating Conditions

		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} ≥ 3.0V, V_{BBOUT} = 3.3V)			600	mA
I_{OUT_LDO1} / I_{OUT_LDO2}	LDO1/LDO2 Output Current			200	mA
TA	Operating Ambient Temperature Range	-40		85	°C
TJ	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

1.85V. The device will begin to charge as long as the TS is left at default configuration and there are no other faults.

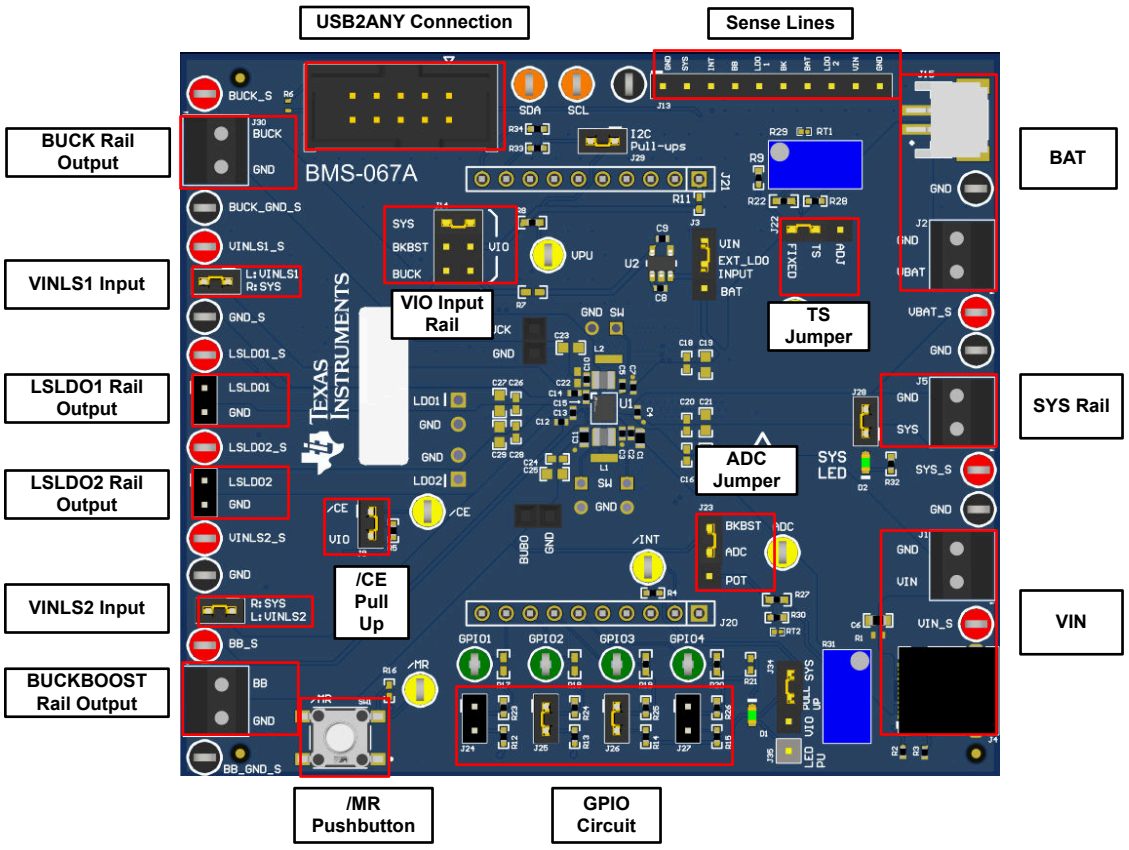


Figure 5-1. BQ25190 EVM Connections

To adjust the charge current or change other parameters, connect the USB2ANY to the EVM and then startup TI Charger GUI.

Note

If the supplies (VIN and VBAT) are turned off, you will need to restart the TI Charger GUI for correct I^2C transactions to be reflected in the TI Charger GUI

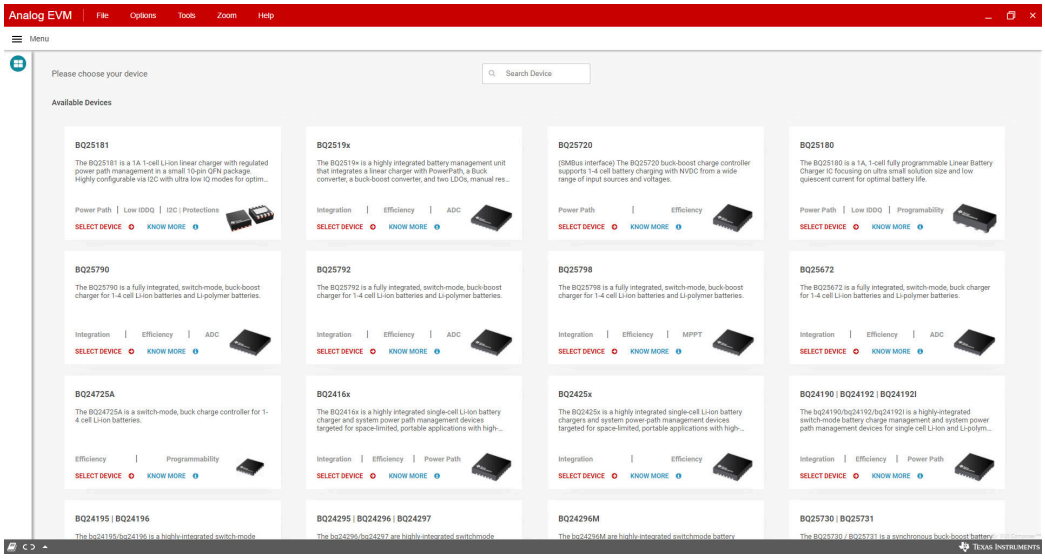


Figure 5-2. TI Charger GUI Device Selection

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

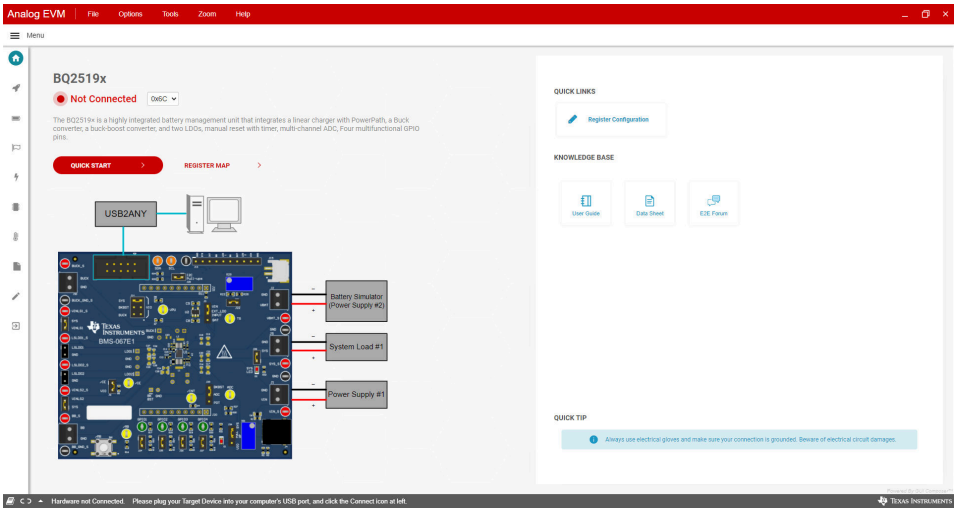


Figure 5-3. BQ25190EVM Connected

The Quick Start is shown in Figure 5-4

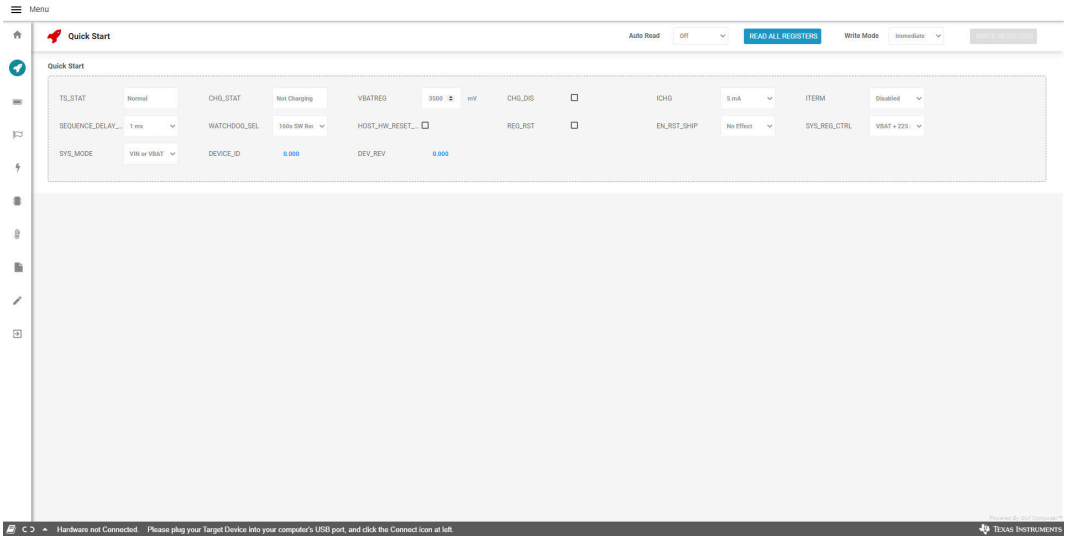


Figure 5-4. Quick Start

The register map is shown in Figure 5-5.

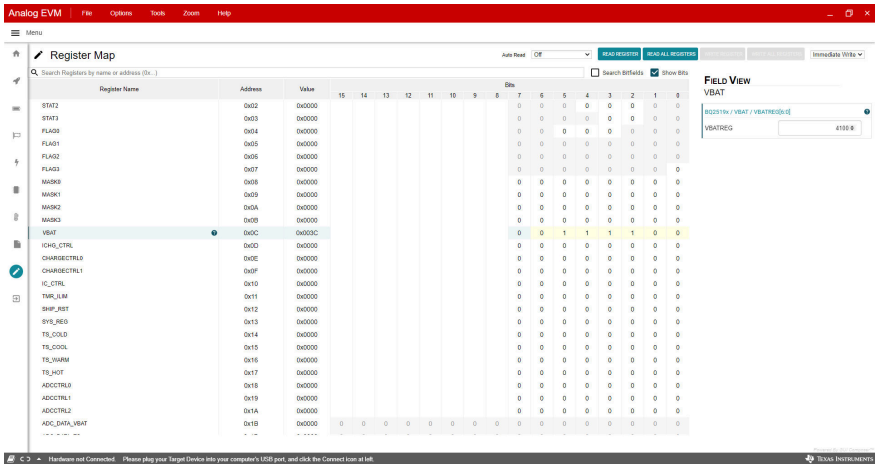


Figure 5-5. Register Map

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

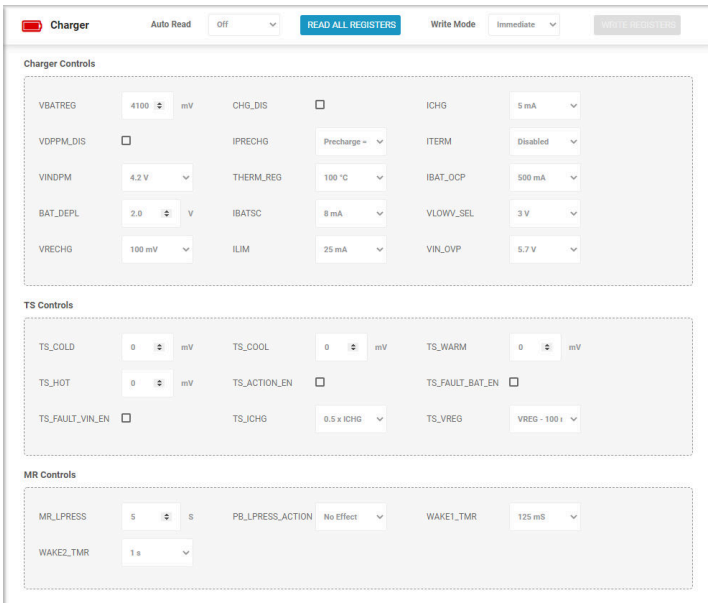


Figure 5-6. Charger Page

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

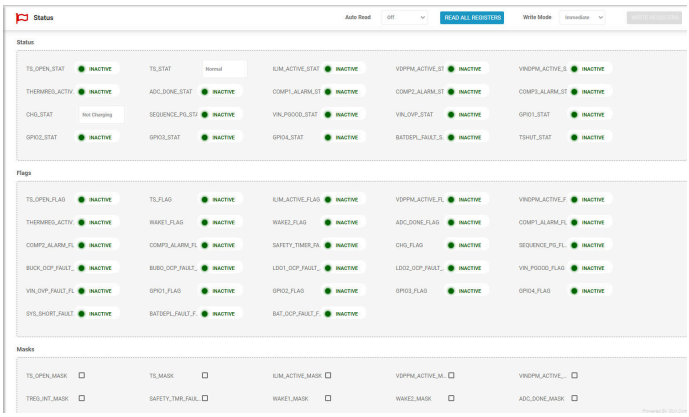


Figure 5-7. Status Page

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

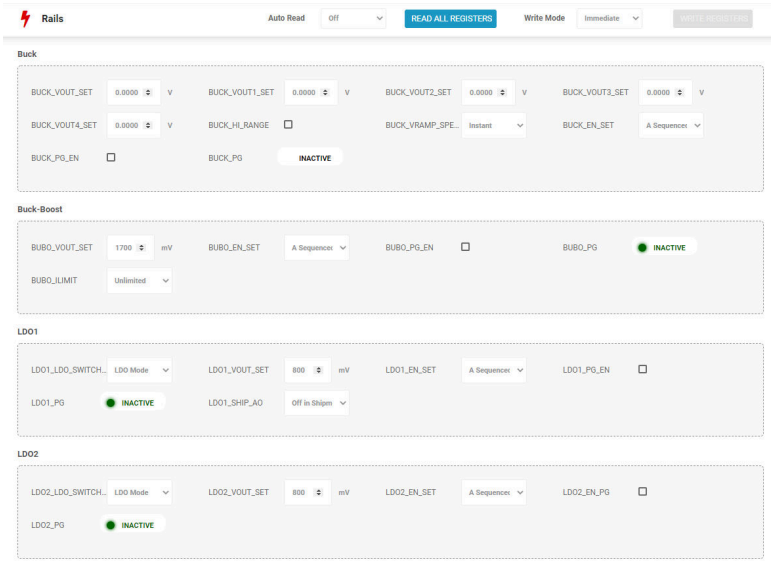


Figure 5-8. Power Rails Page

The Peripherals page provides configurations for timers and GPIO.

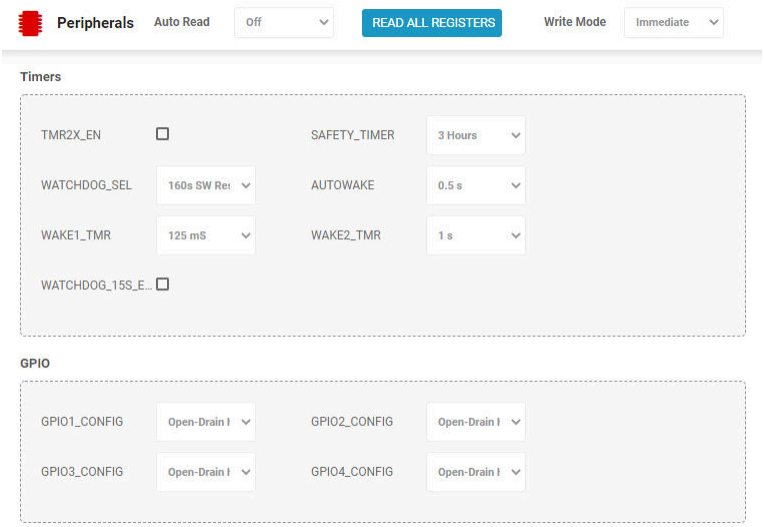


Figure 5-9. Peripherals Page

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

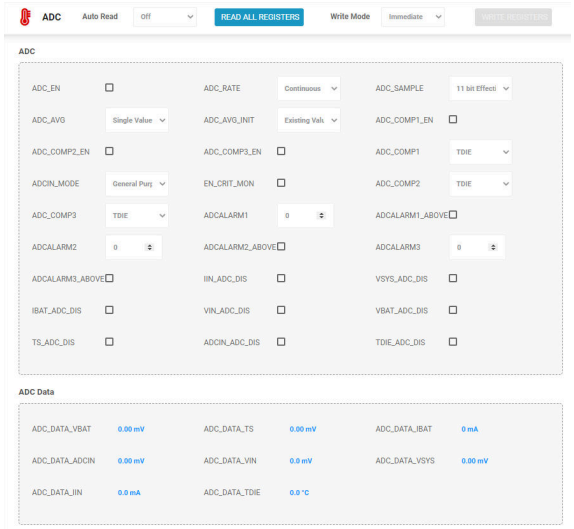


Figure 5-10. ADC Page

5.3 Ship Mode

To go to Ship Mode, enable ship mode through an I^2C 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.

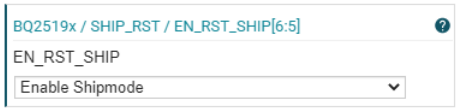


Figure 5-11. SHIP_RST Register

6 PCB Layouts

The images below show the EVM PCB layout.

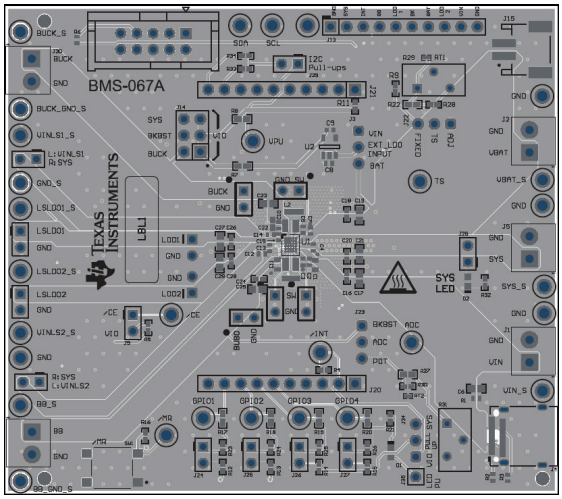


Figure 6-1. TopLayer

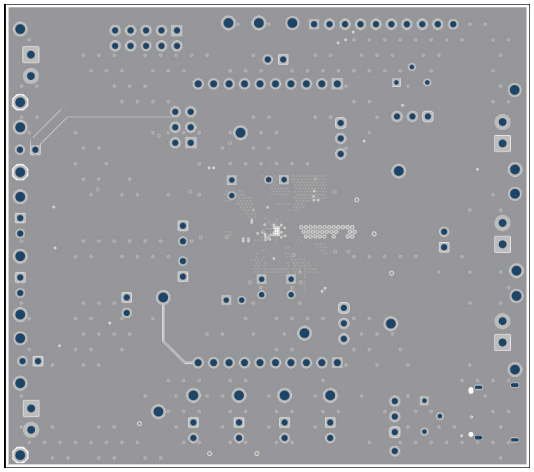


Figure 6-2. Second Layer

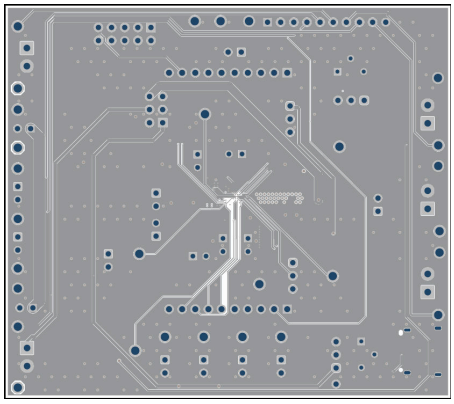


Figure 6-3. Third Layer

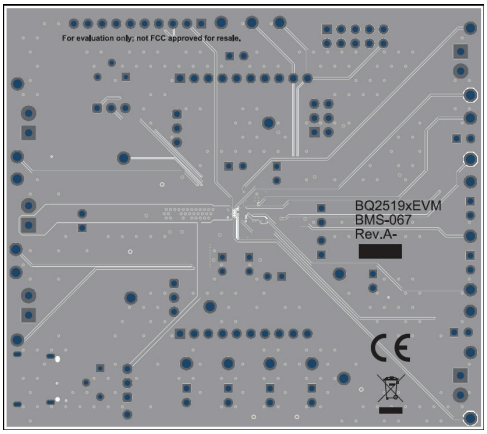


Figure 6-4. Bottom Layer

7 Schematic

Figure 7-1 illustrates the EVM schematic.

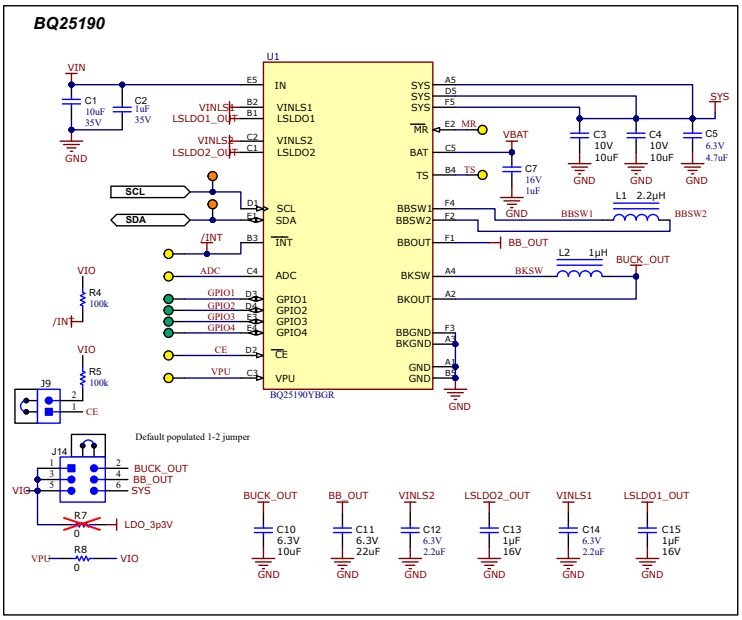


Figure 7-1. BQ25190EVM Schematic

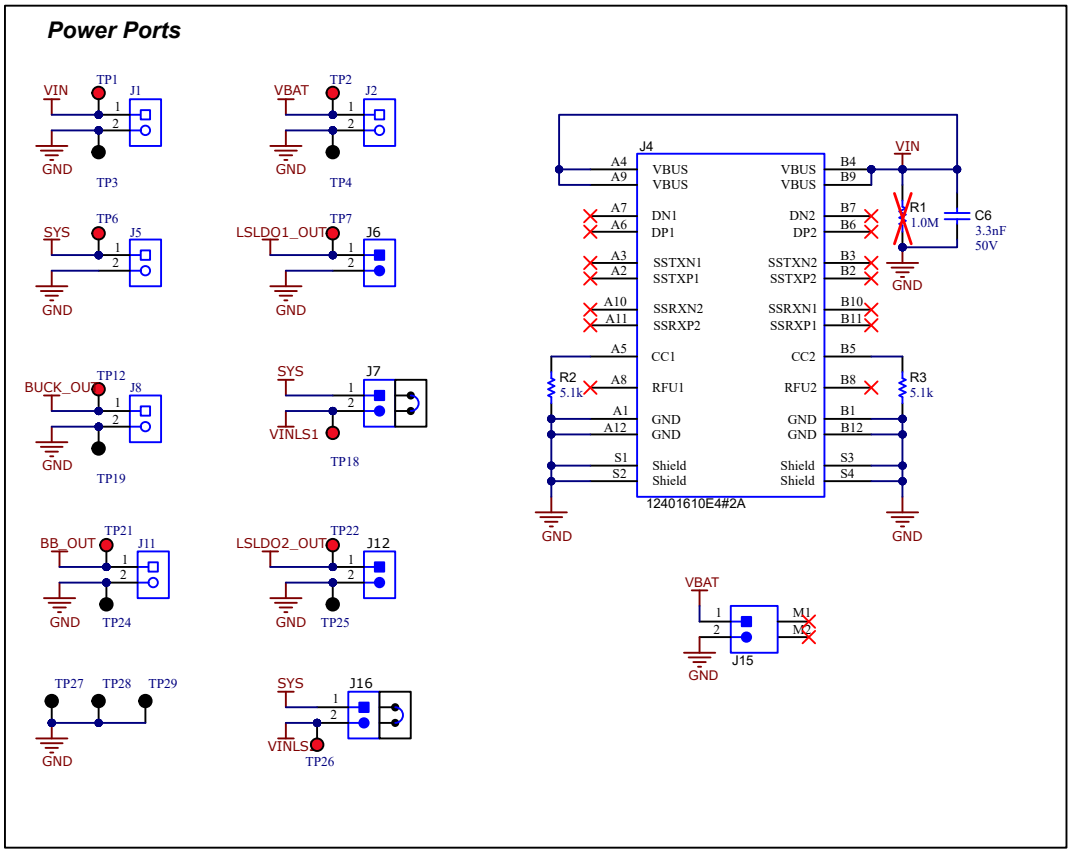


Figure 7-2. BQ25190EVM Power Ports

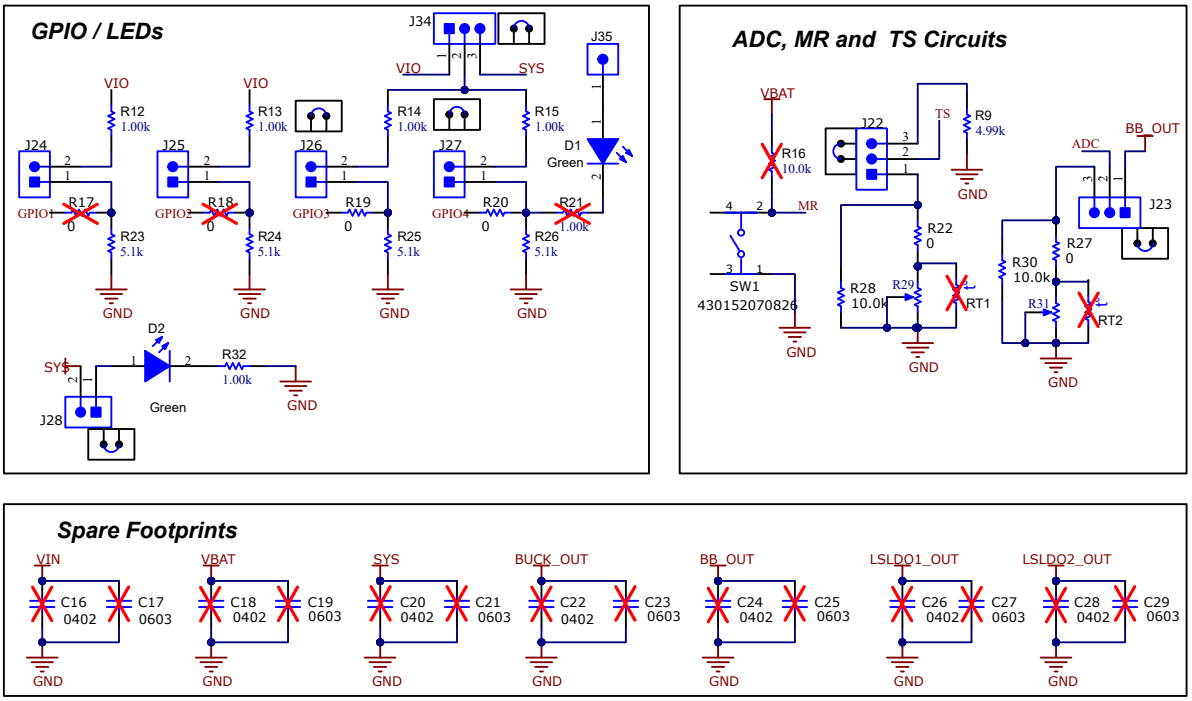


Figure 7-3. BQ25190EVM Peripheral Circuits

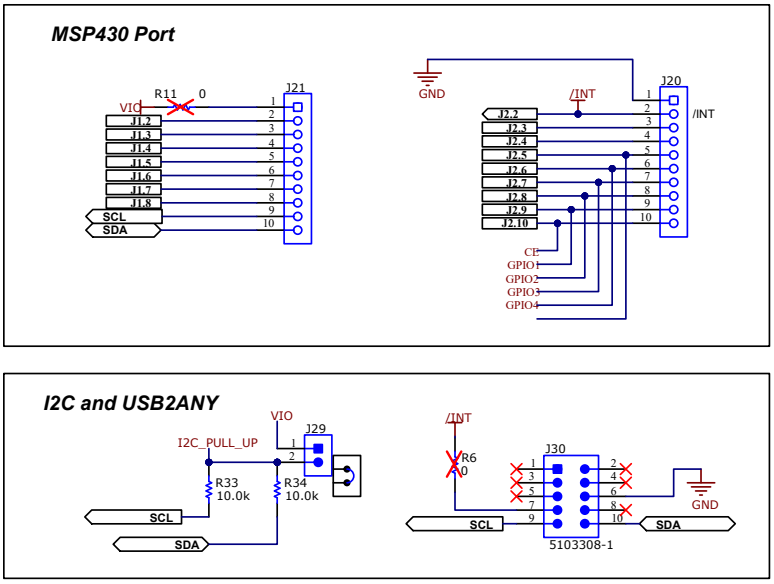


Figure 7-4. BQ25190EVM Digital Connections

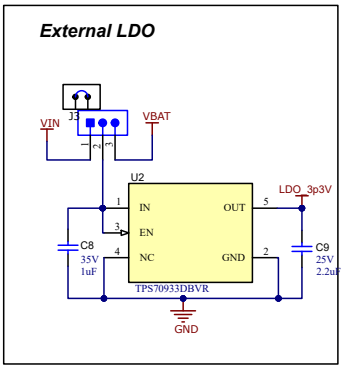


Figure 7-5. LDO for Other Peripherals

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	Wurth 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, 0.01µF, 10V, +/- 10%, X7R, 0402	0402ZC103KAT2A	AVX
C17, C19, C21, C23, C25, C27, C29	0	Capacitor, Ceramic, 10µF, 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, 0Ω, 5%, 0.1W, AEC-Q200 Grade 0, 0402	ERJ-2GE0R00X	Panasonic
R11	0	Resistor, 0Ω, 5%, 0.063W, 0402	RC0402JR-070RL	Yageo America
R16	0	Resistor, 10.0kΩ, 1%, 0.063W, AEC-Q200 Grade 0, 0402	AC0402FR-0710KL	Yageo America
R21	0	Resistor, 1.00kΩ, 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

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