BQ79600-Q1 Evaluation Module

The BQ79600-Q1 Evaluation Module user's guide describes the general features, theory of operation, hardware setup, and use of the BQ79600EVM. Throughout this user's guide, the abbreviations *EVM*, *BQ79600EVM*, and the term *evaluation module* are synonymous with the *BQ79600-Q1 Evaluation Module*, unless otherwise noted. This EVM is an evaluation board for the *BQ79600-Q1* device used as a bridge IC to interface between a microcontroller and the TI battery monitoring ICs, for example BQ7961x-Q1 family of devices. It translates between the daisy chain interface and SPI/UART interface.

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Trademarks

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1 General Description

TI's *BQ79600EVM Battery Management System* (BMS) is an evaluation board for the *BQ79600-Q1* device used as a bridge IC to interface between a microcontroller and the TI battery monitoring ICs, such as BQ7961x-Q1 devices. The BQ79600EVM can be powered through a 5-V source such as a PMIC device or directly through a 12-V battery. The device has an Auto Host Wake-up function that can be utilized with the BQ7961x-Q1 family to automatically wake up the host when an unmasked fault is detected in the battery monitoring ICs when using ring architecture. See the *BQ79600-Q1 data sheet* for more details.

The BQ79600EVM enables communication between a master controller and one or more battery modules to perform State of Charge (SOC) and State of Health (SOH) estimation. The EVM is equipped with an UART/SPI interface to enable a host device to communicate to the BQ79600-Q1 device and an isolated differential daisy chain interface to enable communication to a stack of battery monitoring ICs. The BQ79600EVM acts as a communication bridge between the host and the battery modules.

The BQ79600EVM is controlled using a PC-hosted GUI. Communication between the PC and the BQ79600EVMs is via an USB2ANY UART/SPI interface. Communication between the BQ79600EVM and all BQ79616EVMs in the stack is via the isolated, daisy-chain differential communication bus. The GUI allows configuration of the BQ79600EVMs to configure the communication interface to the host (UART/SPI) and to the stacked devices, as well as to enable/disable the automatic host wake-up function. The BQ79616EVMs can also be configured using the GUI to monitor cells and other analog data channels, control balancing, and monitor details of any faults.

1.1 Key Features

This EVM includes the following features:

- UART interface for communication to the host, configurable through jumpers
- SPI interface for communication to the host, configurable through jumpers
- Supports host communication through FTDI (UART only), USB2ANY, or TMS57012 microcontroller (direct connection to XL2-TMS57012 LAUNCHPAD boosterpack)
- Isolated differential daisy chain communications with optional ring architecture
- Jumpers to configure 5-V or 12-V options (use 5-V option when powering through a regulator/PMIC device and 12-V option when powering directly from 12-V battery and to use automatic host wake-up function)
- LEDs to indicate when the device is awake and when there is an unmasked fault

1.2 Key Electrical Parameters

The following table identifies the key electrical parameters:

Table 1. Key Electrical Parameters

Parameter	Value
Maximum operating voltage (BAT pin powered by battery)	24 V (J1 and J3 shunts placed in 1-2 position)
Minimum operating voltage (BAT pin powered by battery)	5.5 V (J1 and J3 shunts placed in 1-2 position)
Maximum operating voltage (BAT pin powered by 5-V regulator)	5.25 V (J1 and J3 shunts placed in 2-3 position)
Minimum operating voltage (BAT pin powered by 5-V regulator)	4.75 V (J1 and J3 shunts placed in 2-3 position)
Ambient temperature	–40ºC to 105ºC
SPI clock frequency	2 Mbps to 6 Mbps
UART baud rate	1 Mbps

2 Theory of Operation

Figure 1 shows the system stack diagram.

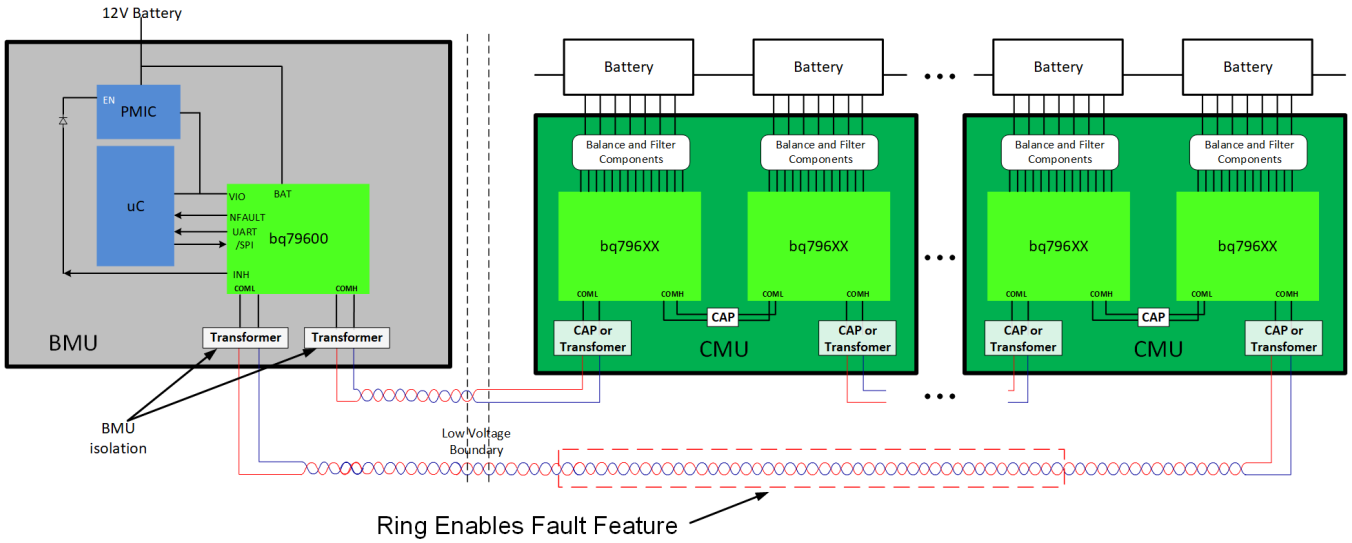

Figure 1. System Block Diagram

The typical BMS system consists of a Battery Management Unit (BMU) and one or more stacked Cell Monitoring Units (CMU). The BMU should be isolated from the CMU using transformers to keep the high voltage of the stacked battery modules isolated from the BQ79600-Q1 bridge device and the microcontroller.

The three components described below can be found on a typical BMU system, as shown in Figure 1.

- Host controller - in this case a TMS570 LaunchPad™
- Power management IC (PMIC)
- BQ79600-Q1 isolated communication bridge device - in this case a BQ79600EVM

The BQ79600 device can be powered from the 12-V battery directly or from a 5-V regulator/PMIC. When powered from the 12-V battery, the automatic host wake-up function on the BQ79600 can be used in a ring architecture to wake up the PMIC and the microcontroller when an unmasked fault is detected.

All commands and data between the host and the BQ79600 bridge device are communicated via either a UART or a SPI communication connection. The BQ79600EVM can support a host PC or a microcontroller (via the FTDI connection header, the USB2ANY connection header, or the LAUNCHXL2-TMS57012 LaunchPad™ boosterpack). The BQ79600 will remain idle until a command is received from the host. All commands and data between the BQ79600 and the cell monitoring devices, such as BQ79616, will be communicated via the daisy chain interface.

The typical flow is for the host to go through the following simplified sequence:

1. Wake up the BQ79600EVM board by sending a WAKE-UP pulse using the UART/SPI interface.
2. Send a "send wake up" command to the BQ79600EVM to wake up the stacked cell monitoring devices.
3. Autoaddress and initialize bridge and stacked devices.
4. Send a sample command to the BQ79616-Q1 to read the cell measurement results.
5. The host will use the cell measurement data to calculate an average and determine the highest or lowest cells and determine the cells that should be balanced.
6. If no stop command is sent, the BQ79616-Q1 has a built-in timeout (set by the user), after which time the discharge will be stopped automatically.
7. The host can then decide to repeat the process (back to step 4) or return later. When using the BQ79616-Q1 in a ring architecture, the host can enable the sniffer detector on the BQ79600-Q1 and the FAULT tones in the BQ97616-Q1, then send the stacked devices to SLEEP and the bridge and itself to shutdown. The AUTO reverse wake-up function will then wake up the host if an unmasked fault from the stacked devices is detected by the bridge.

2.1 Compatibility with Battery Monitoring Devices

The BQ79600-Q1 is fully compatible with the BQ7961x-Q1 family, supporting automatic host wake up through the INH pin when an unmask fault is detected in the high voltage battery pack.

3 Connectors

3.1 Primary Input and Output Connectors

3.1.1 Jumper Placements

The following table explains each of the jumpers available for user flexibility.

Table 2. Jumper Placements

Pinheader	Contacts	Jumper Connection	Populated by Default?
J1	1-2, 2-3	INH connection to 100-k pulldown for 12-V operation (1-2), or to BAT for 5-V operation (2-3)	Yes (2-3)
J3	1-2, 2-3	BAT connection to 12-V power supply (1-2), or to CVDD and 5-V power supply (2-3)	Yes (2-3)
J5	1-2	LED connection on DVDD to indicate the device is awake	Yes
J6	1-2, 2-3	VIO connection to 3.3-V supply from MCU (1-2). Leave jumper at position 1-2 when connecting to LAUNCHXL2-TMS57012 LaunchPad™ since it only supports 3.3-V. Position 2-3 not used	Yes (1-2). Leave jumper in this position when using LAUNCHXL2-TMS57012 LaunchPad™
J8	1-2	LED connection on nFAULT AVDD to indicate a fault on NFAULT pin (must have J13 shunt connected)	Yes

Table 2. Jumper Placements (continued)

Pinheader	Contacts	Jumper Connection	Populated by Default?
J10	1-2, 2-3	nUART_SPIRDY pullup to VIO for SPI (1-2), or pulldown to GND for UART (2-3)	Yes (2-3)
J11	1-2, 2-3	nCS pullup to VIO for SPI (1-2), or pulldown to GND for UART (2-3)	Yes (2-3)
J12	1-2, 2-3	SCLK pullup to VIO (1-2) or pulldown to GND for SPI/UART (2-3)	Yes (2-3)
J13	1-2	NFAULT pullup to VIO	Yes

3.1.2 Power Supply

The power supply connection is made from either the 5-V test point or 12-V test point. When powering the EVM directly through the 12-V battery, configure jumpers J1 and J3 in the "12V" configuration and connect the 12-V battery to the 12-V test point. If the EVM is powered up through a PMIC or 5-V regulator, configure jumpers J1 and J3 in the "5V" configuration and connect the PMIC/regulator 5-V output to the 5-V test point.

Figure 2. Keystone5010 (reference image only)

Table 3. Pin Description

Pin	Name	Comments
1	DVDD	1.8-V regulated output. DVDD supplies the internal digital circuits
2	NFAULT	Fault indication output
3	VIO	Power supply input for UART/SPI input/output pins
4	RX/MOSI	UART receiver input or SPI master out slave in
5	TX/MISO	UART transmitter output or SPI master in slave out
6	SCLK	SPI clock input
7	nCS	Active low chip select pin for SPI interface
8	nUART/SPI (SPI_RDY)	This pin is used as an input pin to select SPI or UART interface before device finishes wakeup/reset initialization. If SPI mode is selected, SPI_RDY is used to inform the host when read/write can be initiated or if wait time is needed
9	GND	Ground
10	COMLP	AC coupled bi-directional I/O pin for daisy chain (VIF) communication
11	COMLN	AC coupled bi-directional I/O pin for daisy chain (VIF) communication
12	COMHP	AC coupled bi-directional I/O pin for daisy chain (VIF) communication
13	COMHN	AC coupled bi-directional I/O pin for daisy chain (VIF) communication
14	CVDD	Dedicated 5-V supply used for the daisy chain communications
15	BAT	Battery supply Input
16	INH	Inhibit pin to control system voltage regulators

3.1.3 Host Interface

There are three different ways for the host to connect to the BQ79600EVM: using the USB2ANY interface adaptor, the UART FTDI cable (to communicate through UART only), or using the LAUNCHXL2-TMS57012 microcontroller BoosterPack connector.

The 10-pin J4 - serial connector is used to connect the BQ79600EVM to a PC running the GUI or to a host controller. Texas Instruments recommends using the USB2ANY interface adaptor which includes the proper 10-pin cable.

Figure 3. Samtec Inc. TSW-105-08-L-D-RA (reference image only)

Table 4. Connector Information

Designator	Manufacturer	Part Number	Mating Connector
J4	Samtec Inc.	Manufacturer: TSW-105-08-L-D-RA	10-pin ribbon connector packaged with USB2ANY

Table 5. Pin Description

Pin	Name
1	NC
2	nUART/SPI (SPI_RDY) signal from BQ79600-Q1
3	USB2ANY SCLK (SCLK of BQ79600-Q1)
4	nFAULT signal from BQ79600-Q1
5	GND
6	USB2ANY 3.3 V
7	USB2ANY TX (MOSI_RX of BQ79600-Q1)
8	USB2ANY RX (MISO_TX of BQ79600-Q1)
9	USB2ANY CS (nCS of BQ79600-Q1)
10	NC

The 6-pin J2 - serial connector is used to connect the BQ79600EVM to a PC running the GUI or to a host controller through a TTL-232R-5V FTTI cable. Only UART is supported.

Figure 4. Molex 0022124062 (reference image only)

Table 6. Connector Information

Designator	Manufacturer	Part Number	Mating Connector
J2	Molex	Manufacturer: 0022124062	6-pin connector in TTL-232R-5V FTTI cable

The 20-pin J7 - serial connector and the 20-pin J9-serial connector are used to connect the BQ79600EVM to a host controller. The BoosterPack in the LAUNCHXL2-TMS57012 LaunchPad™ can be directly plugged into the J7 and J9 connectors. Before making the connections between the EVM and the LaunchPad™, follow the steps described in Section 4.3 to ensure the boards are configured correctly.

Figure 5. Samtec SSQ-110-03-T-D (reference image only)

Table 7. Connector Information

Designator	Manufacturer	Part Number	Mating Connector
J7, J9	Samtec	Manufacturer: SSQ-110-03-T-D	20-pin connector 0.100" (2.54mm) in TMS570LS12x LaunchPad™

Table 8. Pin Description - J7

Pin	Name
1	MCU 3.3 V
2	TMS570LS12x LaunchPad™ 5 V
3	NC
4	GND
5	MCU RX (MISO_TX of BQ79600-Q1)
6	NC
7	MCU TX (MOSI_RX of BQ79600-Q1)
8	NC
9	NC
10	NC
11	NC
12	NC
13	MCU SCLK (SCLK of BQ79600-Q1)
14	NC
15	NC
16	NC
17	NC
18	NC
19	NC
20	NC

Table 9. Pin Description - J9

Pin	Name
1	NC
2	GND
3	NC
4	NC
5	NC
6	MCU CS (nCS of BQ79600-Q1)
7	NC
8	NC
9	NC
10	NC
11	NC
12	MCU SPI3SIMO (MOSI_RX of BQ79600-Q1)
13	NC
14	MCU SPI3SOMI (MISO_TX of BQ79600-Q1)
15	NC
16	NC
17	nUART/SPI (SPI_RDY) signal from BQ79600-Q1
18	NC

Table 9. Pin Description - J9 (continued)

Pin	Name
19	nFAULT signal from BQ79600-Q1
20	NC

3.1.4 High-Side and Low-Side Communications

There are two sets of 4-position molex connectors available on each board. These provide high-side (J15) and low-side (J14) communications between stacked EVM devices.

Table 10. Connector Information

Designator	Manufacturer	Part Number	Mating Connector
J14/J15	Molex	Manufacturer: 0705510038 Digi-Key: WM14059-ND	Manufacturer: 0050579404 Digi-Key: WM2902-ND

Table 11. Pin Description - J14

Pin	Name	Comments
1	COML_N	COM lowside negative
2	COML_P	COM lowside positive
3	N/A	Unused
4	N/A	Unused

Table 12. Pin Description - J15

Pin	Name	Comments
1	N/A	Unused
2	N/A	Unused
3	COMH_P	COM highside positive
4	COMH_N	COM highside negative

4 BQ79600EVM Quick Start Guide

This section includes hardware setup instructions, connection procedures, and software and GUI instructions.

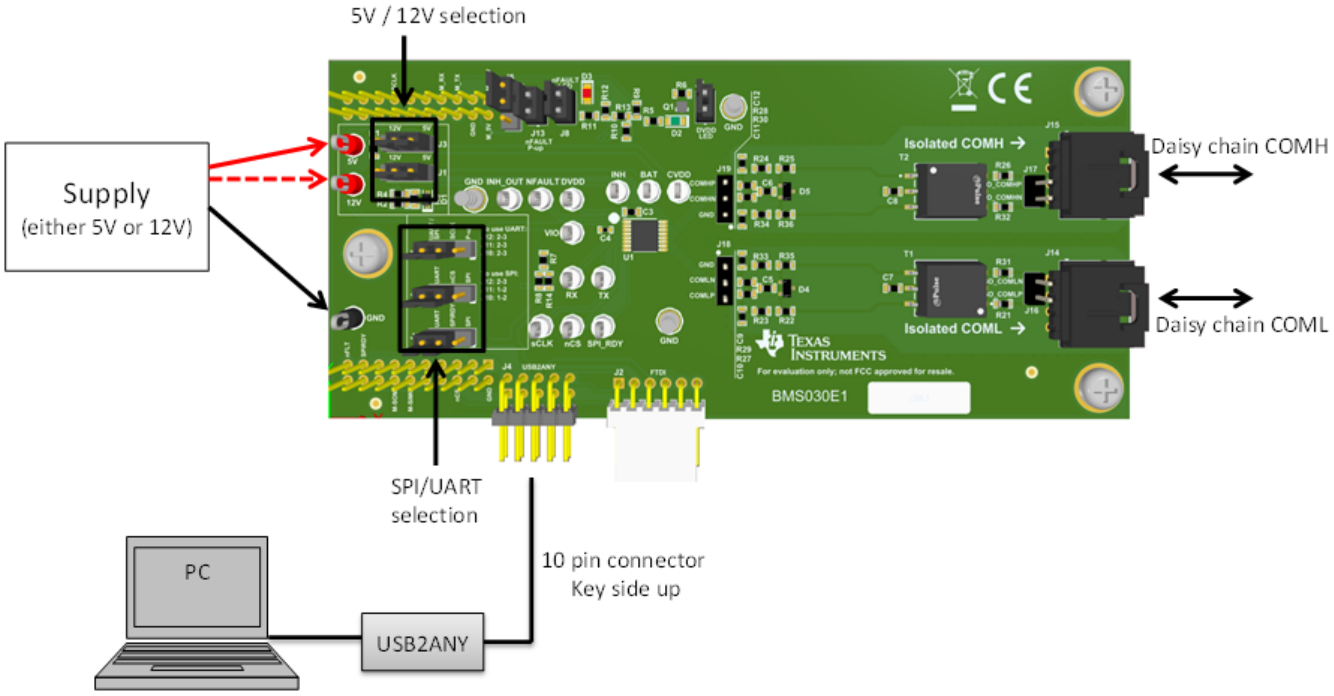

Figure 6. Basic EVM Setup

4.1 Required Devices for Using the Example Code

The system example code is implemented using the LAUNCHXL2-TMS57012 LaunchPad™ board (TMS570LS1224 MCU), the BQ79600EVM, and the BQ79616EVM via Code Composer Studio.

The part numbers of the evaluation modules are LAUNCHXL2-TMS57012, BQ79600EVM-030 and BQ79616EVM-021. These boards are available from the TI eStore (https://estore.ti.com/) or from your local TI sales representative. For more details and information related to the LaunchPad™modules, see the specific module user's guide.

4.2 Power Connections

The BQ79600EVM can be powered up either using a 5-V supply or a 12-V supply.

To use the 5-V option, ensure jumpers J1 and J3 are connected in the "5V" position as labeled in the board, and then connect the positive terminal of the 5-V supply to the "5V" testpoint provided on the board, and the power supply negative terminal to the "GND" testpoint provided on the board, or any "GND" standoff provided.

To use the 12-V option, ensure jumpers J1 and J3 are connected in the "12V" position as labeled in the board, and then connect the positive terminal of the 12-V supply to the "12V" testpoint provided on the board, and the power supply negative terminal to the "GND" testpoint provided on the board, or any "GND" standoff provided.

4.3 Connecting the BQ79600EVM to TMS570 LaunchPad

The following configuration needs to be set correctly on the EVM before connecting to LAUNCHXL2-TMS57012 LaunchPad™:

- Ensure that J6 jumper on BQ79600EVM is connected in position 1-2 (default) to connect 3.3-V supply from the LaunchPad to BQ79600-Q1 VIO pin. TMS5701224 microcontroller does not support 5-V option, therefore avoid powering VIO pin with 5 V when connecting to the LaunchPad.
- Remove plastic screw H1 on the left side of the board.
- If UART communication is used to communicate to the MCU, place R7 and R9 0-Ω resistors, and remove R8 and R10 resistors on BQ79600EVM. The EVMs are populated this way by default.
- If SPI communication will be used to communicate to host, place R8 and R10 0-Ω resistors, and remove R7 and R9 resistors on BQ79600EVM.

For correct functionality of the LAUNCHXL2-TMS57012 LaunchPad™, ensure JP2, JP3 and JP6 are placed, and JP1 is removed.

The EVM and the MCU are connected using the female connectors J7 and J9 on the bottom side of the BQ79600EVM and the male connectors J2, J3, J4, and J5 on the top side of the LAUNCHXL2-TMS57012 LaunchPad™. Connect the J7 20-pin female connector on the bottom side of the BQ79600EVM to the J2 and J3 10-pin male connectors on top side of the LAUNCHXL2-TMS57012 LaunchPad™, and J9 20-pin female connector on the bottom side of the BQ79600EVM to the J4 and J5 10-pin male connectors on the top side of the LAUNCHXL2-TMS57012 LaunchPad™, as shown in Figure 7. By default, the TMS570 LaunchPad is powered by the USB port on the host computer.

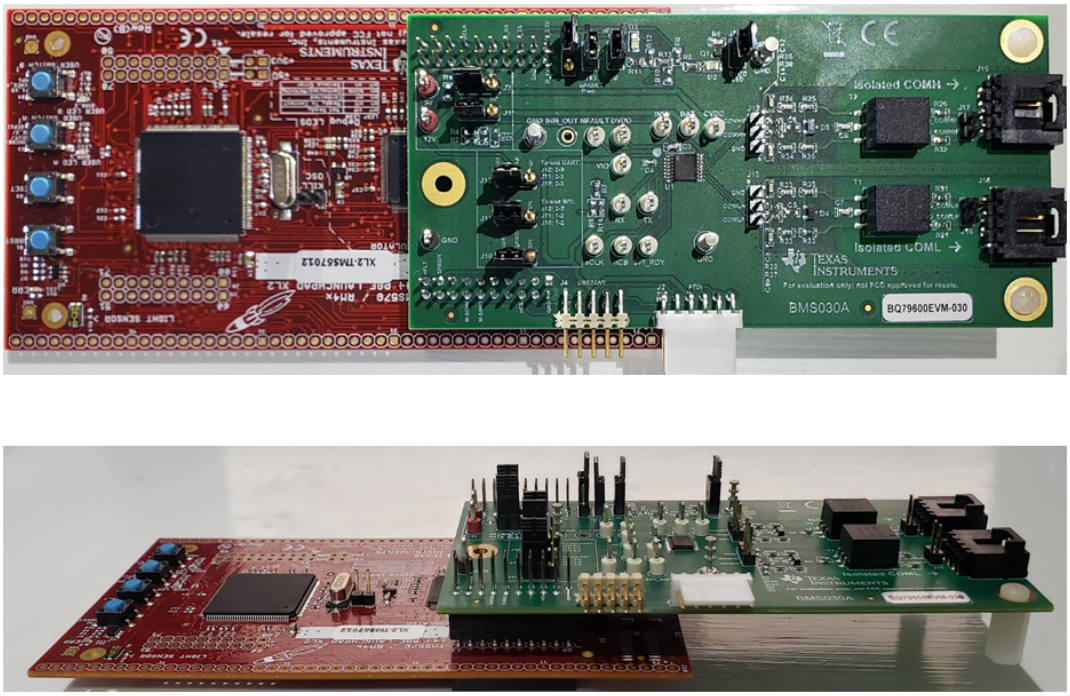

Figure 7. Connection Between BQ79600EVM and TMS570 LaunchPad

4.4 Connecting BQ79600EVM to BQ79616EVM

The EVMs are connected using 4-position Molex connectors. The BQ79600EVM has a high side (J15)and low side (J14) communication connector available on each board. To connect the BQ79600EVM to the BQ79616EVM using NORTH direction for communication, connect J15 on the BQ79600EVM to J10 on the BQ79616EVM. If several BQ79616EVMs are stacked, connect them as indicated in the EVM user's guide for the BQ79616-Q1 device. If using ring architecture, connect J11 of the top most BQ79616EVM to J14 on the BQ79600EVM.

Table 13. Connections Between BQ79600EVM High Side and BQ79616EVM Low Side

Connection Name	BQ79600EVM High Side	BQ79616EVM Low Side
COMH_N to COML_N	J15 pin 4	J10 pin 1
COMH_P to COML_P	J15 pin 3	J10 pin 2

Table 14. Connections Between BQ79616EVM High Side and BQ79600EVM Low Side (for ring architecture only)

Connection Name	BQ79600EVM Low Side	BQ79616EVM High Side
COML_N to COMH_N	J14 pin 1	J11 pin 4
COML_P to COMH_P	J14 pin 2	J11 pin 3

4.5 Software

The software provides a command API and drivers that are capable of implementing the examples provided in the *BQ79600-Q1 Software Design Reference* document.

The example code only provides a control interface to the BQ79600-Q1 and BQ79616-Q1 and does not provide any other communications interface to the outside world. The customer is expected to develop their own communication implementation. Two examples are available using TMS570 micocontroller:

- Example code using UART communication protocol between the microcontroller and BQ79600-Q1 device
- Example code using SPI communication protocol between the microcontroller and BQ79600-Q1 device

Importing a project into *Code Composer Studio* ™:

1. Launch the provided file: *BQ79600-Q1 UART Example Code 1.0 Installer.exe* or *BQ79600-Q1 SPI Example Code 1.0 Installer.exe* and extract files to the default path provided (C:\ti\bq79600-Q1 UART Example Code 1.0 or C:\ti\bq79600-Q1 SPI Example Code 1.0)
2. Launch *Code Composer Studio* (CCS):
   Start → Programs → Texas Instruments → Code Composer Studio v8 → Code Composer Studio v8
3. When it launches, CCS requests a workspace is selected, choose “C:\myWorkspace”. Once CCS loads, go to:
   Project → Import CSS Projects... → Select search-directory
4. In Select search-directory, browse to the folder:
   C:\ti\bq79600-Q1 UART Example Code 1.0 or C:\ti\bq79600-Q1 SPI Example Code 1.0
5. In *Discovered projects:*, check *BQ79600-Q1 UART example code* or *BQ79600-Q1 SPI example code*

4.6 GUI

For initial evaluation, it may be more beneficial to use the graphical user's interface (GUI), which provides a "point and click" interface to become familiar with the BQ79600. During the initial sampling phase, contact your local TI FAE to get the latest GUI version.

To get started with the GUI, please refer to the *BQAutoEval GUI User's Guide*.

4.6.1 GUI UART/SPI Connection

The physical setup for the GUI is the same as for the microcontroller, but will instead use an USB2ANY interface and 10-pin cable for the UART/SPI connections on J4. The USB2ANY has a USB Mini-B connector on the right side. Plug the provided USB cable (or any USB cable with a Mini-B connector) into the USB2ANY. Plug the other end of the cable (USB ‘A’) into the computer. Then connect the 10-pin connector cable to J4 of the USB2ANY (middle most connector) and the key side must be facing upwards when connecting to the EVM header J4. Refer to Figure 6 and this is explained in more detail in the *USB2ANY Interface Adapter User's Guide* and the *BQAutoEval GUI User's Guide*.

5 Physical Dimensions

5.1 Board Dimensions

Board dimensions: 2.300 in. × 5.130 in.

Board height:

- Top - Tallest component (shunts) is 0.35 in. (8.8 mm) above PCB.
- Bottom - Tallest component (transformers) is 0.41 in. (10.5 mm) above PCB.

5.2 Board Mounting

Figure 8 illustrates the EVM board dimensions.

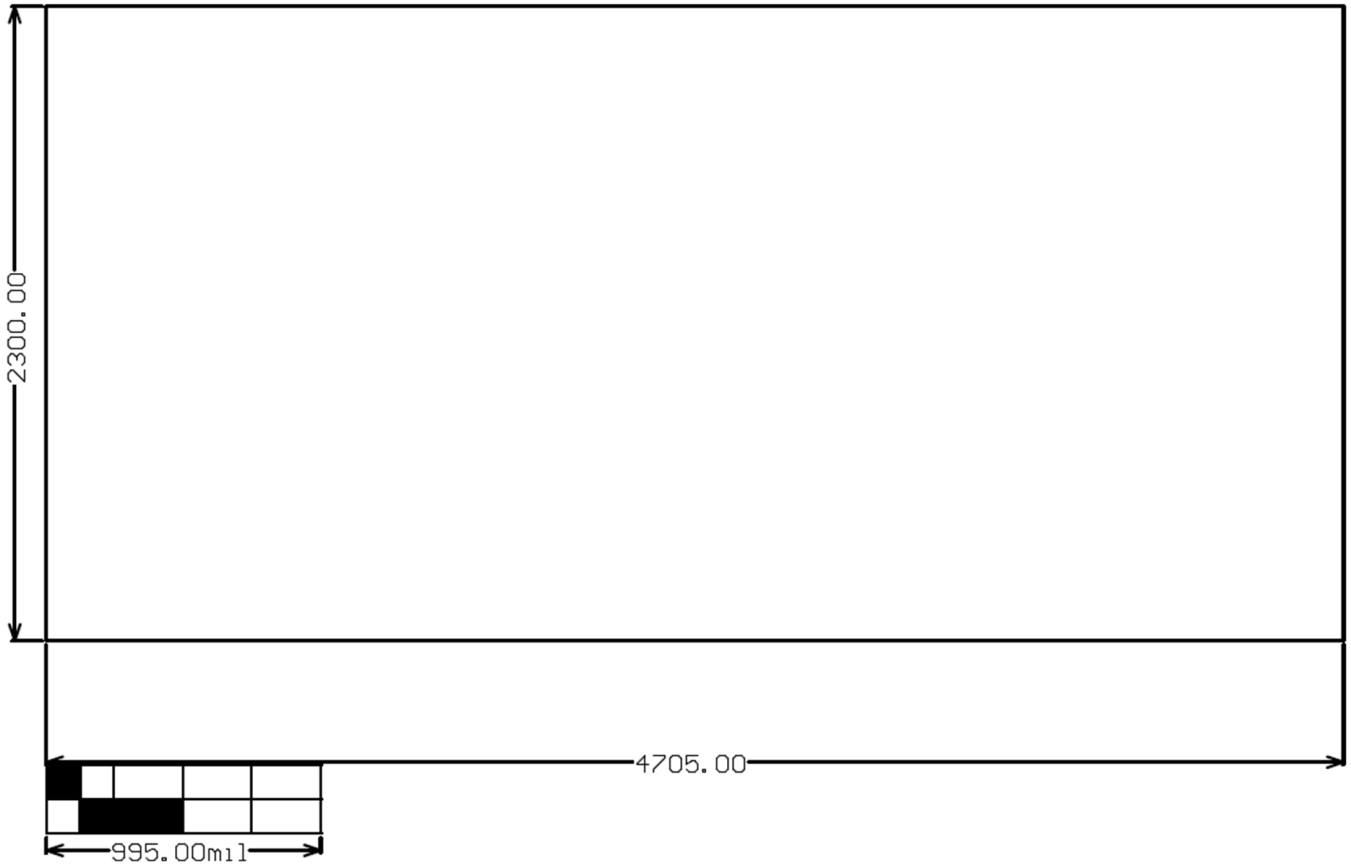

Figure 8. Board Dimensions

6 Schematics, Assembly, Layout, and Bill of Materials (BOM)

The BQ79600EVM schematics, assembly, layout, and BOM are provided in their respective sections.

6.1 Schematics

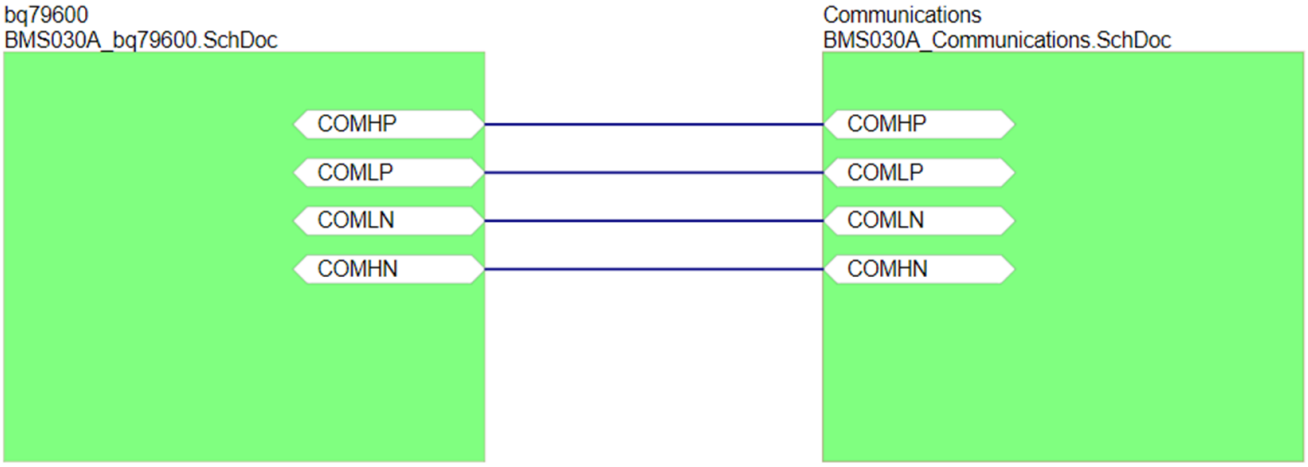

Figure 9. BQ79600EVM Schematic Part 1

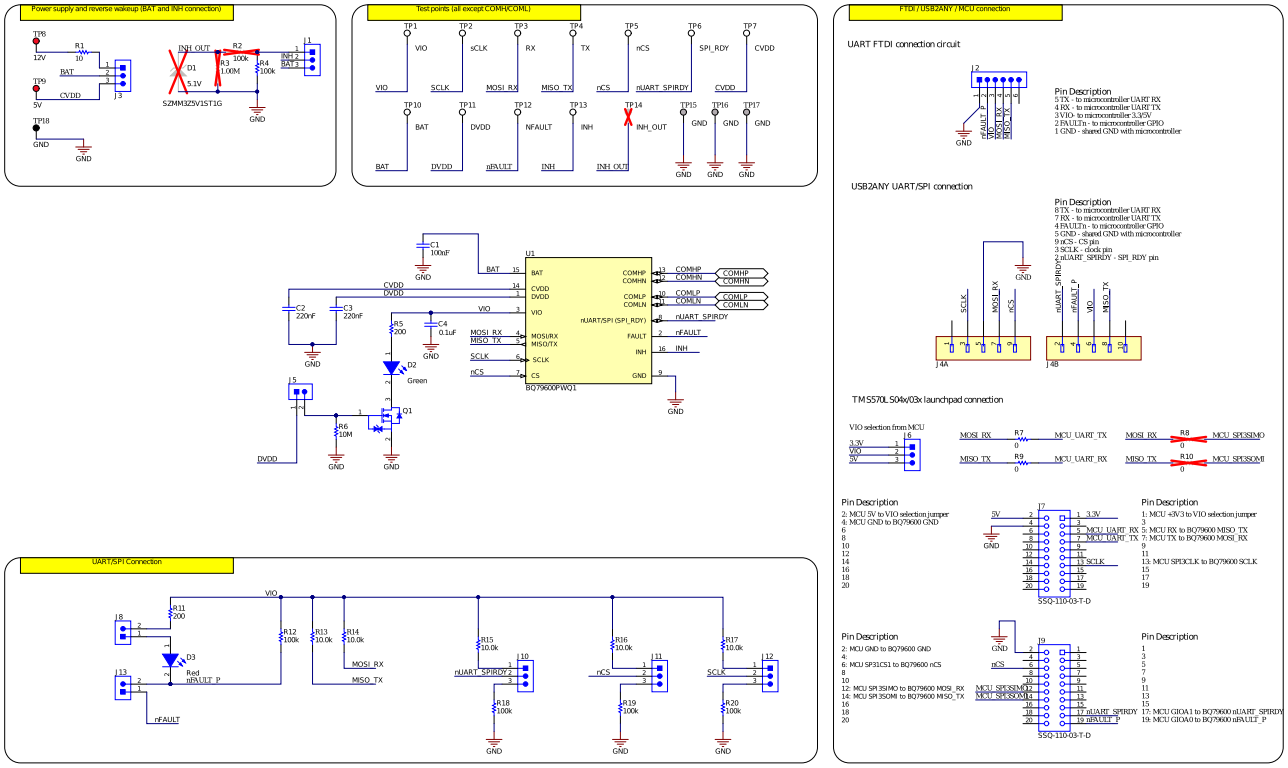

Figure 10. BQ79600EVM Schematic Part 2

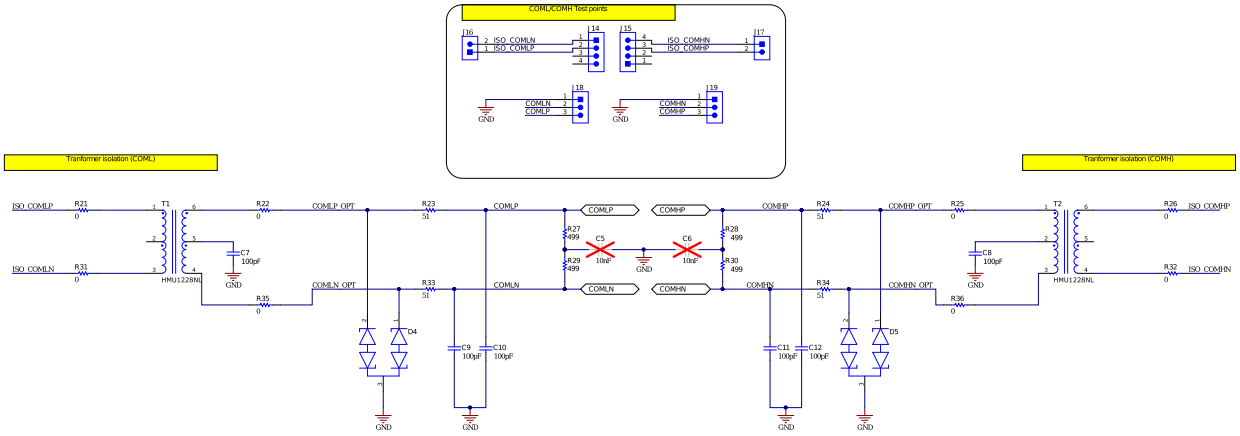

Figure 11. BQ79600EVM Schematic Part 3

6.2 Assembly

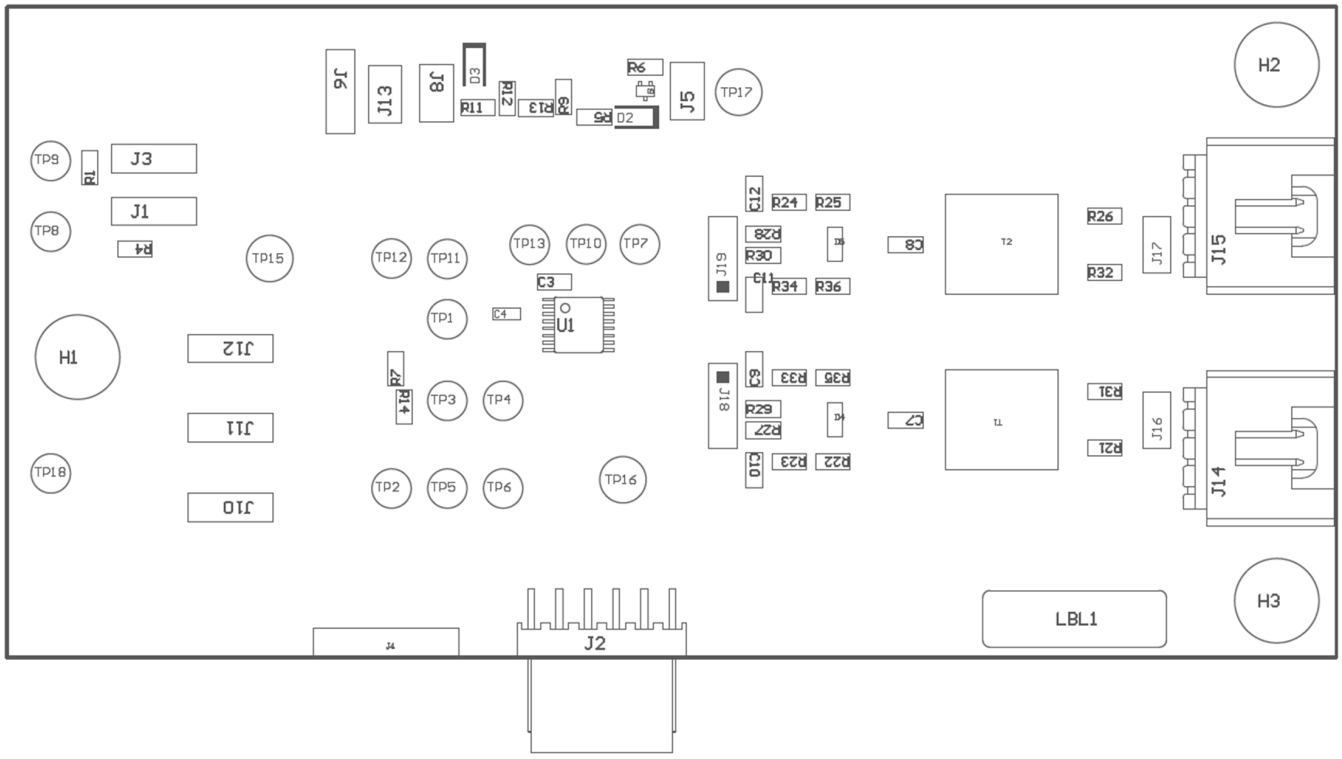

Figure 12. BQ79600EVM Assembly Top

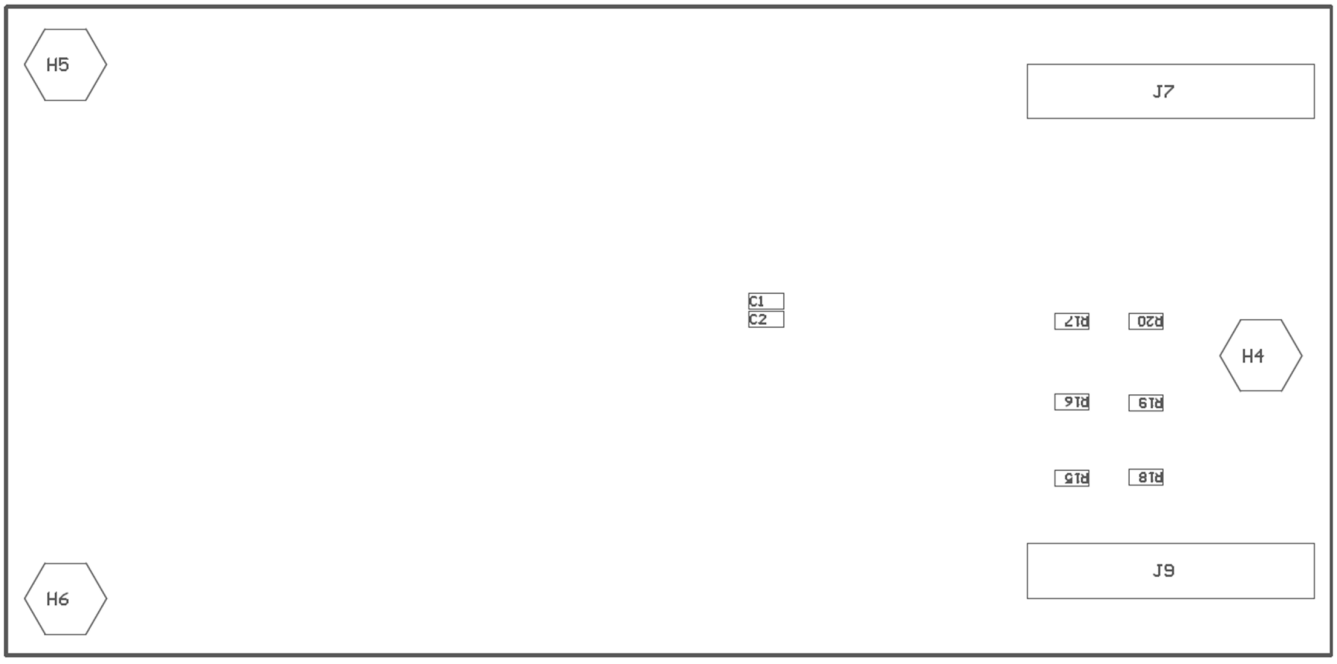

Figure 13. BQ79600EVM Assembly Bottom

6.3 Layout

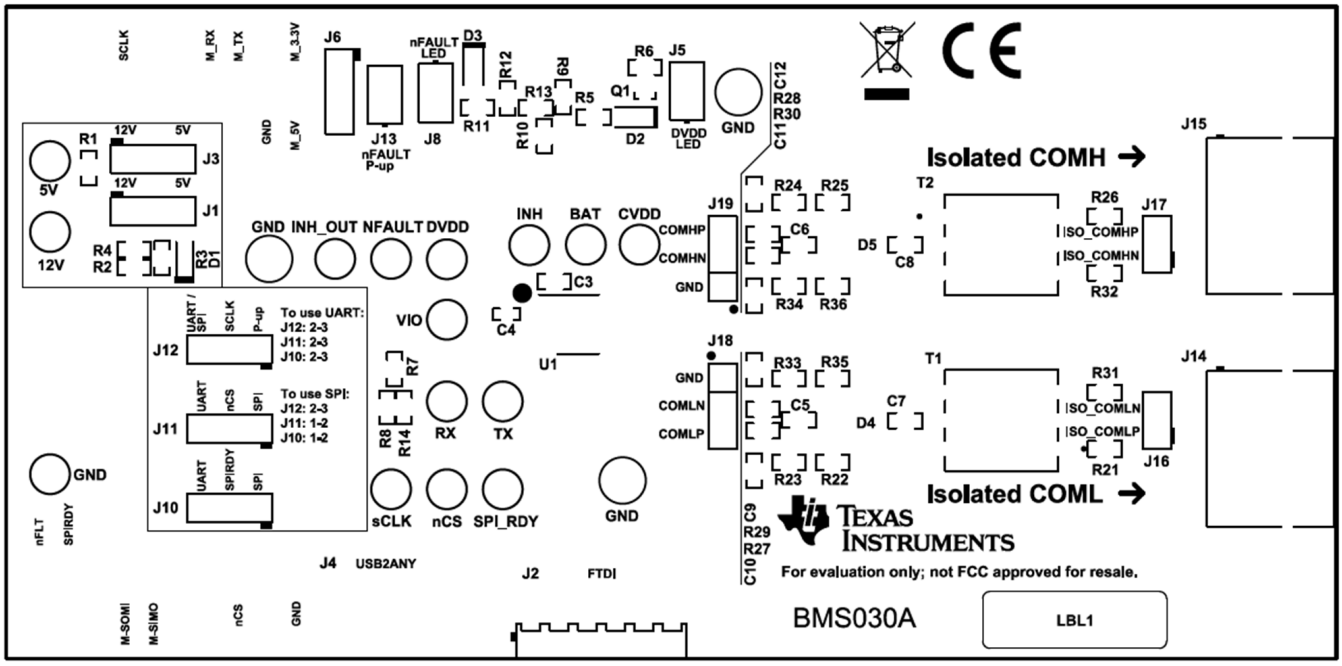

Figure 14. BQ79600EVM Top Overlay

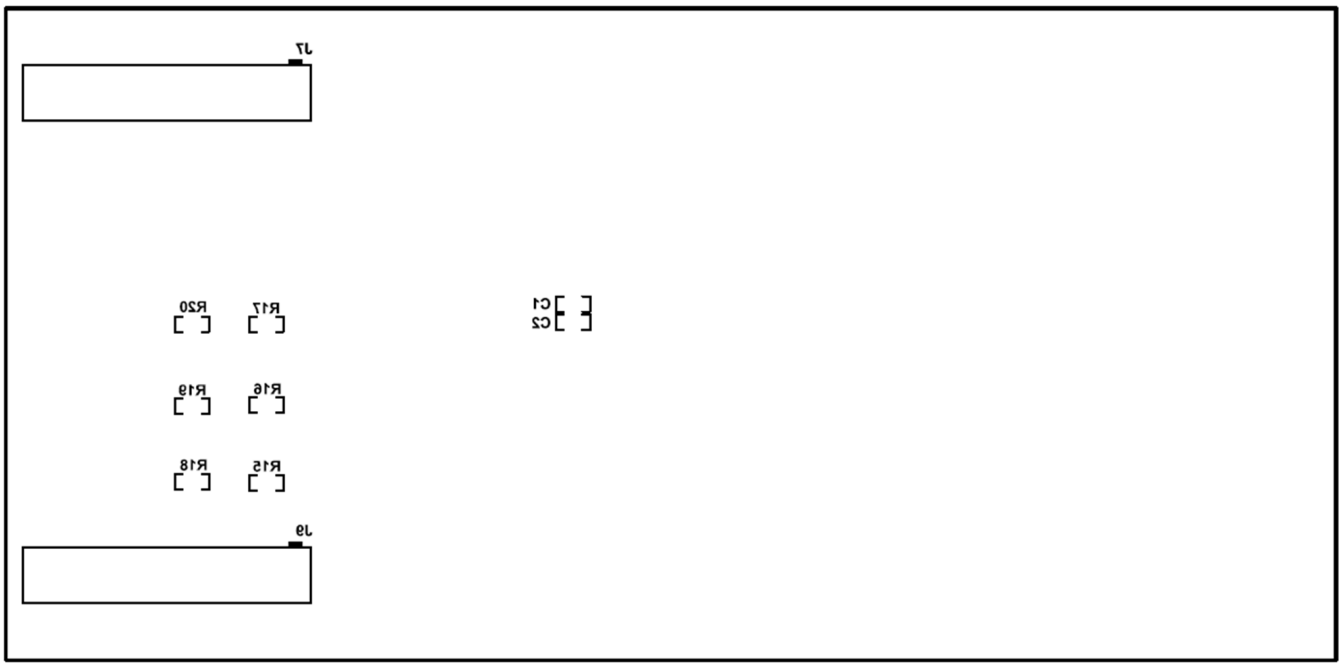

Figure 15. BQ79600EVM Bottom Overlay

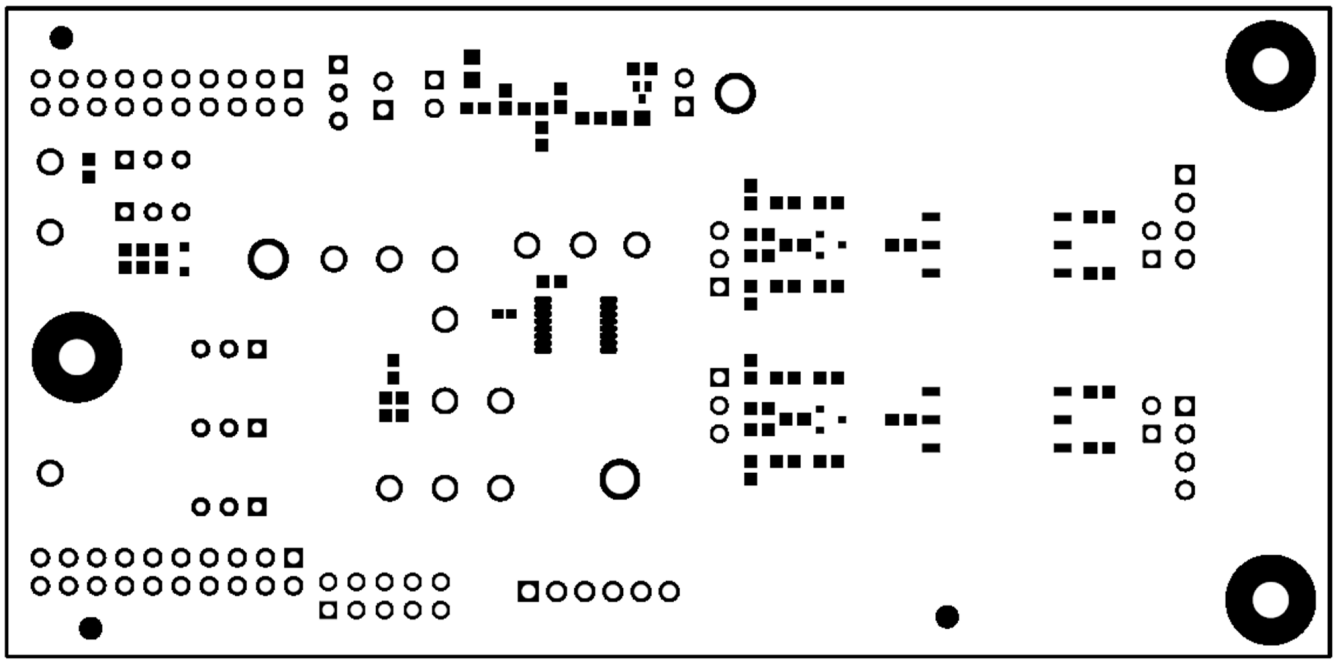

Figure 16. BQ79600EVM Top Solder

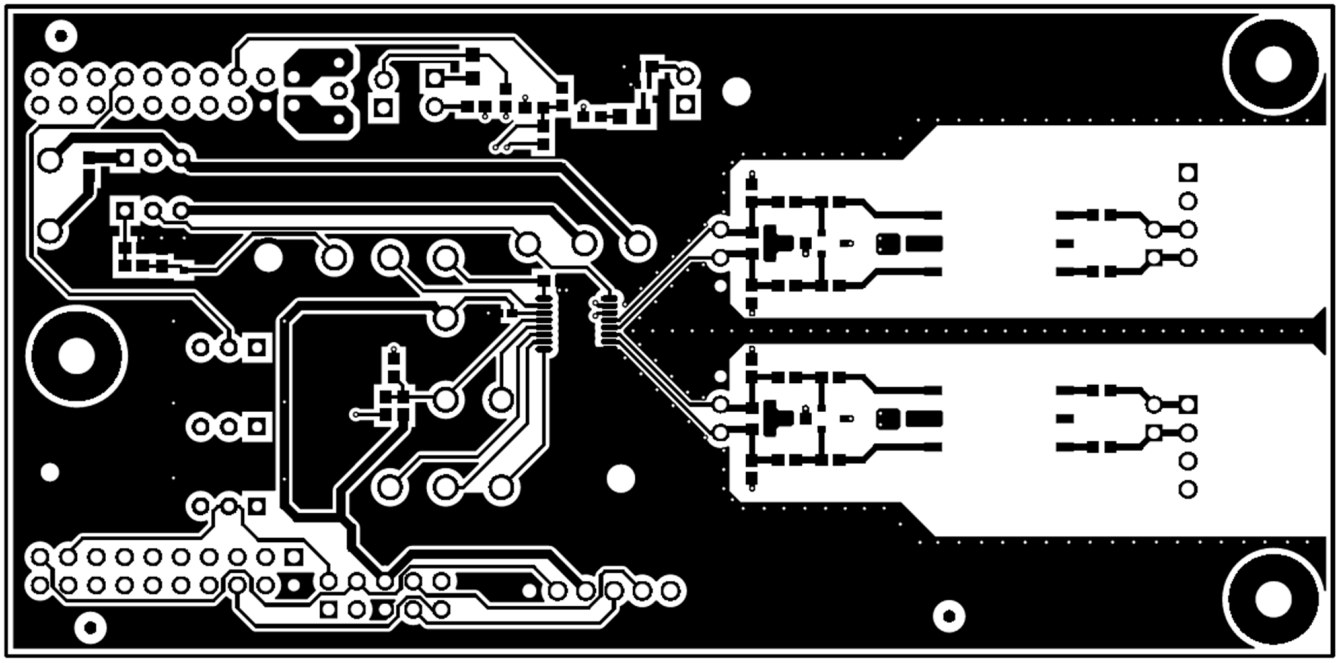

Figure 17. BQ79600EVM Top Layer

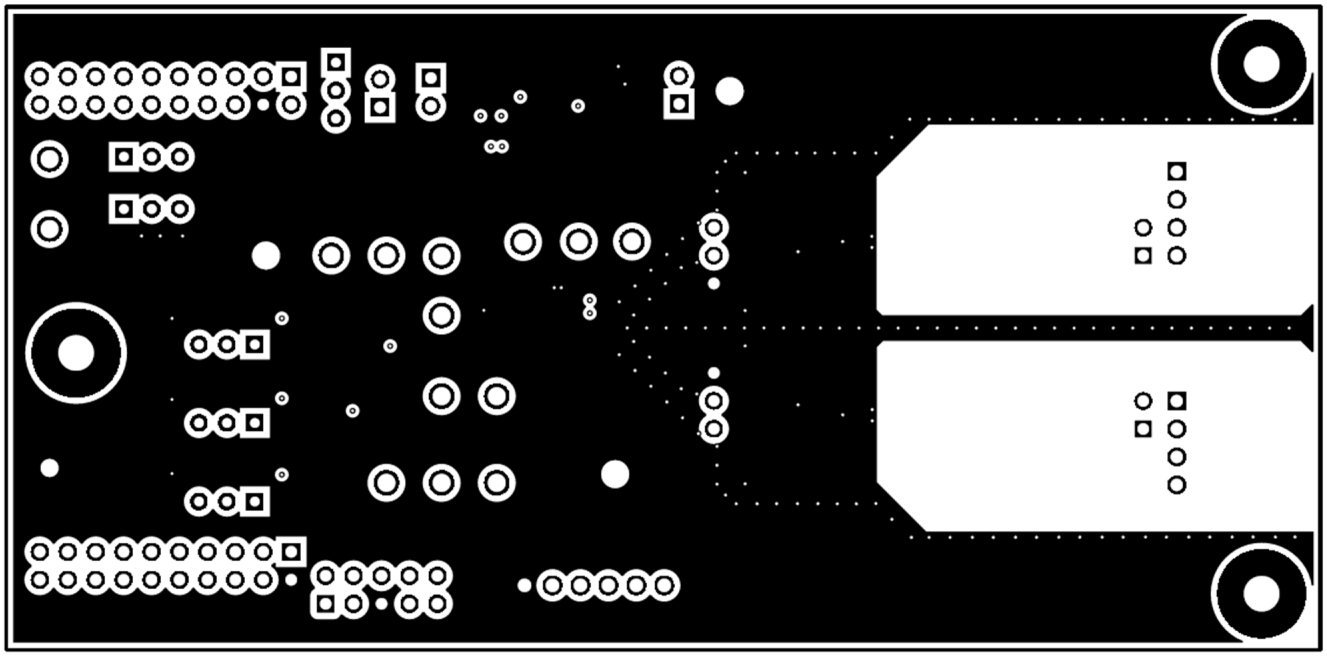

Figure 18. BQ79600EVM Internal Signal Layer 1 - GND Plane

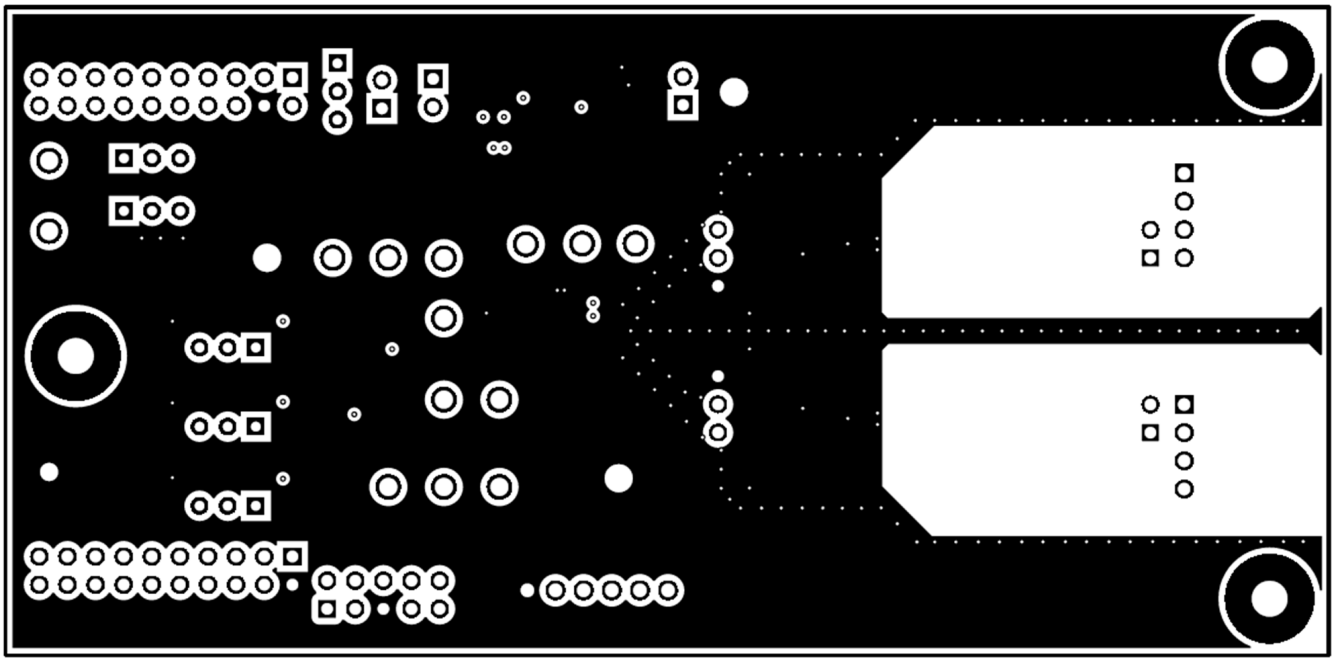

Figure 19. BQ79600EVM Internal Signal Layer 2 - GND Plane

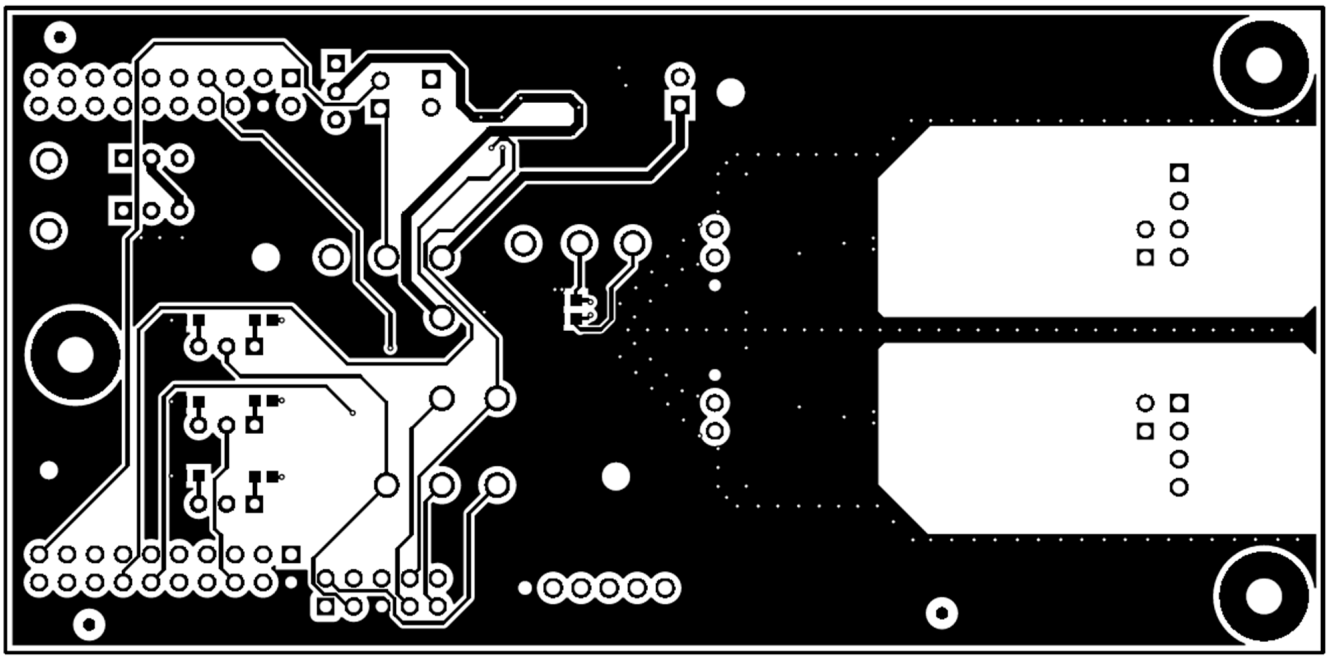

Figure 20. BQ79600EVM Bottom Layer

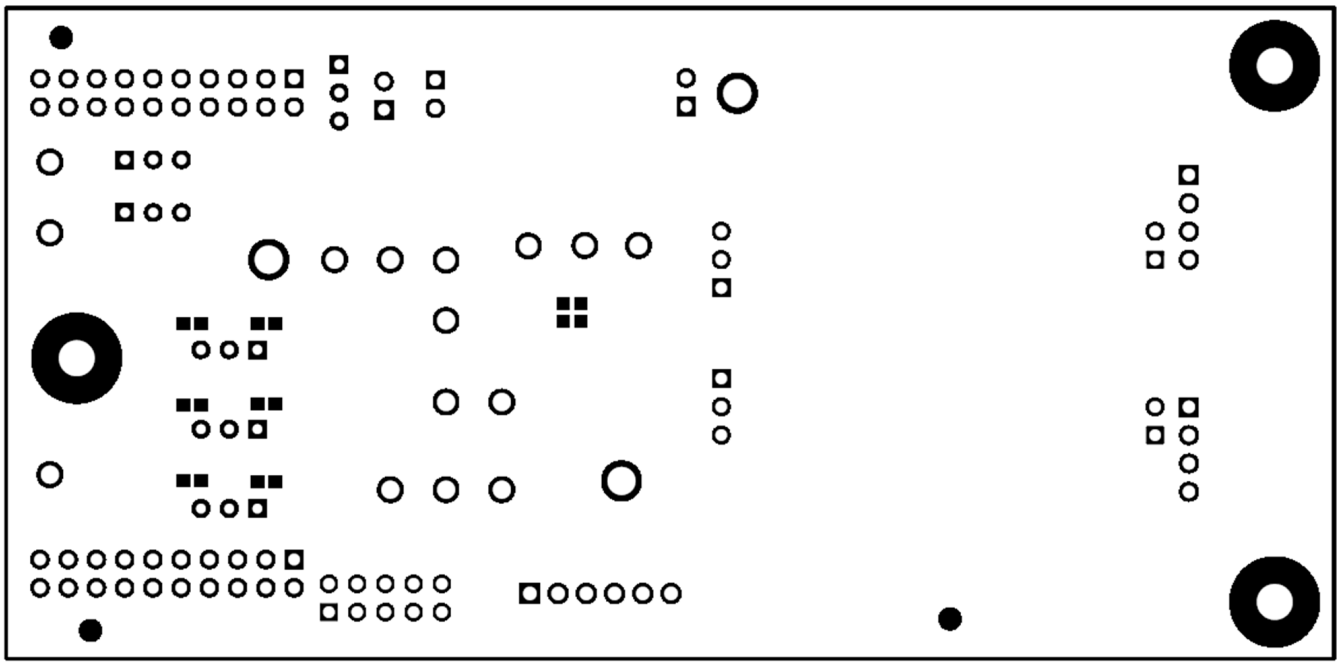

Figure 21. BQ79600EVM Bottom Solder

Symbol	Quantity	Finished Hole Size	Plated	Hole Type	Drill Layer Pair	Hole Tolerance
▽	4	133.86mil (3.400mm)	NPTH	Round	Top Layer - Bottom Layer	
▼	157	10.00mil (0.254mm)	PTH	Round	Top Layer - Bottom Layer	
⊠	18	33.47mil (0.850mm)	PTH	Round	Top Layer - Bottom Layer	
□	16	40.00mil (1.016mm)	PTH	Round	Top Layer - Bottom Layer	
■	50	40.16mil (1.020mm)	PTH	Round	Top Layer - Bottom Layer	
✡	8	42.91mil (1.090mm)	PTH	Round	Top Layer - Bottom Layer	
◉	6	46.85mil (1.190mm)	PTH	Round	Top Layer - Bottom Layer	
✪	15	63.00mil (1.600mm)	PTH	Round	Top Layer - Bottom Layer	
◇	3	98.43mil (2.500mm)	PTH	Round	Top Layer - Bottom Layer	
○	3	125.98mil (3.200mm)	PTH	Round	Top Layer - Bottom Layer	
	280 Total					

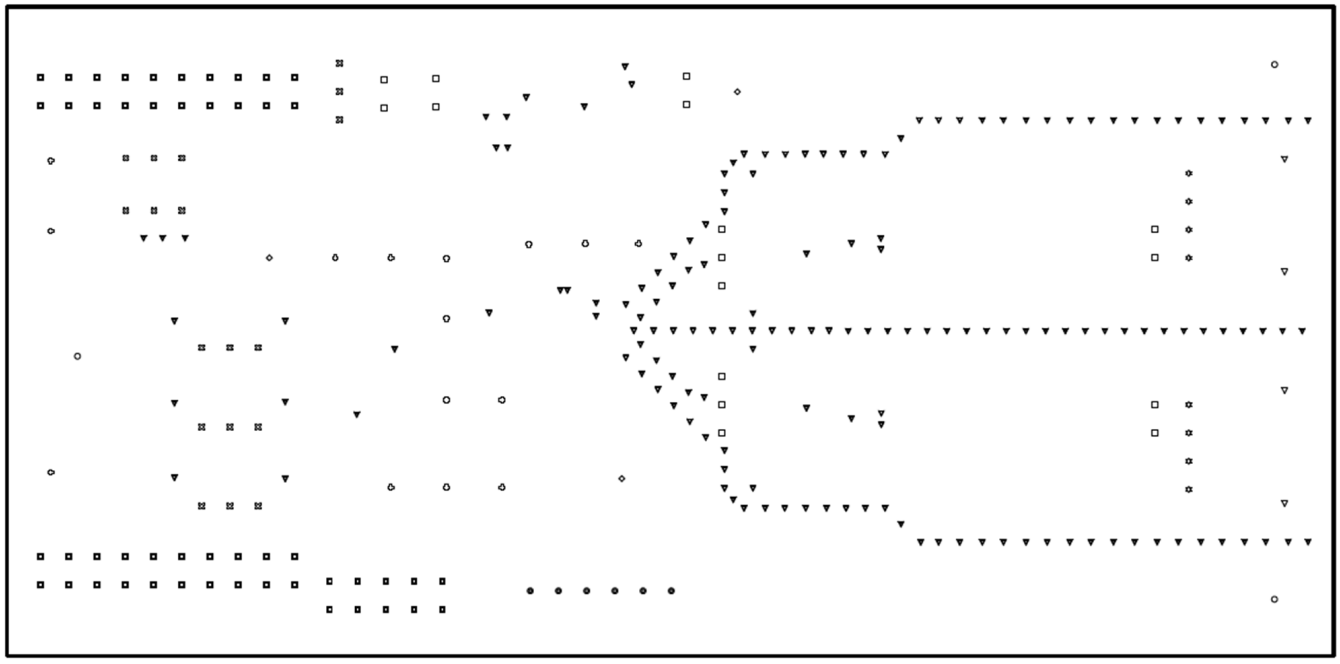

Figure 22. BQ79600EVM Drill Drawing

6.4 Bill of Materials (BOM)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
!PCB1	1		Printed Circuit Board		BMS030	Any
C1	1	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 5%, X7R, 0603	0603	C0603C104J5RACTU	Kemet
C2, C3	2	0.22uF	CAP, CERM, 0.22 uF, 10 V, +/- 10%, X7R, 0603	0603	C0603C224K8RACTU	Kemet
C4	1	0.1uF	CAP, CERM, 0.1 uF, 10 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	GCM155R71A104KA55D	MuRata
C7, C8, C9, C10, C11, C12	6	100pF	CAP, CERM, 100 pF, 50 V,+/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0603	0603	GCM1885C1H101JA16J	MuRata
D2	1	Green	LED, Green, SMD	LED_0805	LTST-C170KGKT	Lite-On
D3	1	Red	LED, Red, SMD	Red 0805 LED	LTST-C170KRKT	Lite-On
D4, D5	2		28V Clamp 13A (8/20µs) Ipp Tvs Diode Surface Mount TO-236AB	SOT23-3	PESD5V0L2BT,215	Nexperia
H1, H2, H3	3		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H4, H5, H6	3		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
H7, H8	2		Rectangular Housing Connector, 4 Pos, 2.54mm		50-57-9404	Molex
J1, J3, J6, J10, J11, J12	6		Header, 100mil, 3x1, TH	Header, 3x1, 100mil, TH	800-10-003-10-001000	Mill-Max
J2	1		Header, 0.5mm, 6x1, R/A, Gold, TH	Header, 0.5mm, 6x1, R/A, TH	22-12-4062	Molex
J4	1		CONN HEADER 10POS .100 DL R/A AU	HDR10	TSW-105-08-L-D-RA	Samtec
J5, J8, J13	3		Header, 2.54mm, 1x2, Tin, Black, TH	Header, 2.54mm, 2x1, TH	PEC01DAAN	Sullins Connector Solutions
J7, J9	2		Receptacle, 2.54mm, 10x2, Tin, TH	Receptacle, 2.54mm, 10x2, TH	SSQ-110-03-T-D	Samtec
J14, J15	2		Header(shrouded), 2.54mm, 4x1, R/A, Gold, TH	Header(shrouded), 2.54mm, 4x1, R/A, TH	70551-0038	Molex
J16, J17	2		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
J18, J19	2		Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
Q1	1	20V	MOSFET, N-CH, 20 V, 0.2 A, AEC-Q101, SC-89	SC-89	RE1C002UNTCL	Rohm
R1	1	10	RES, 10, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060310R0JNEA	Vishay-Dale

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
R4, R12, R18, R19, R20	5	100k	RES, 100 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603100KFKEA	Vishay-Dale
R5, R11	2	200	RES, 200, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603200RJNEA	Vishay-Dale
R6	1	10Meg	RES, 10 M, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060310M0JNEA	Vishay-Dale
R7, R9, R21, R22, R25, R26, R31, R32, R35, R36	10	0	RES, 0, 5%, 0.1 W, 0603	0603	RC0603JR-070RL	Yageo
R13, R14, R15, R16, R17	5	10.0k	RES, 10.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
R23, R24, R33, R34	4	51	RES, 51, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060351R0JNEA	Vishay-Dale
R27, R28, R29, R30	4	499	RES, 499, 1%, 0.1 W, 0603	0603	RC0603FR-07499RL	Yageo
SH1, SH2, SH3, SH4, SH5, SH6, SH7, SH8, SH9	9		Shunt, 100mil, Gold plated, Black	Shunt 2 pos. 100 mil	881545-2	TE Connectivity
T1, T2	2		BMS TRANSFORMER	SMT_TRANSFORMER_8MM89_10MM09	HMU1228NL	Pulse
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP10, TP11, TP12, TP13	11		Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	5012	Keystone
TP8, TP9	2		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone
TP15, TP16, TP17	3		Terminal, Turret, TH, Triple	Keystone1598-2	1598-2	Keystone
TP18	1		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone
U1	1		BQ79600PWQ1, PW0016A (TSSOP-16)	PW0016A	BQ79600PWQ1	Texas Instruments
C5, C6	0	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X7R, 0603	0603	CL10B103KB8NCNC	Samsung Electro-Mechanics
D1	0	5.1V	Diode, Zener, 5.1 V, 300 mW, AEC-Q101, SOD-323	SOD-323	SZMM3Z5V1ST1G	ON Semiconductor
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
R2	0	100k	RES, 100 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603100KFKEA	Vishay-Dale
R3	0	1.00Meg	RES, 1.00 M, 1%, 0.1 W, 0603	0603	RC0603FR-071ML	Yageo
R8, R10	0	0	RES, 0, 5%, 0.1 W, 0603	0603	RC0603JR-070RL	Yageo
TP14	0		Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	5012	Keystone

Revision History

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

Changes from Original (October 2019) to A Revision	Page
• Changed from Advance Information to Production Data release	2

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