bq76200 High Voltage Battery Pack Front-End Charge/Discharge High-Side NFET Driver Evaluation Module

This evaluation module (EVM) is a complete evaluation system for the bq76200 High Voltage Battery Pack Front-End Charge/Discharge High-Side NFET Driver. The EVM includes one bq76200 and FETs to control current in a configuration typical for switching current in a lithium-ion battery pack. The circuit module includes one bq76200 integrated circuit (IC), two CSD19351Q5A FETs, and all other onboard components necessary to switch charge, discharge, and precharge current and to monitor the output pack voltage. The circuit module connects between a "battery" source and a "pack" load. With the on-board jumpers or external control, the user can switch the FETs to evaluate the overall functionality of the solution under different charge and discharge conditions.

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General Texas Instruments High Voltage Evaluation (TI HV EVM) User Safety Guidelines



WARNING

Always follow TI's set-up and application instructions, including use of all interface components within their recommended electrical rated voltage and power limits. Always use electrical safety precautions to help ensure your personal safety and the safety of those working around you. Contact TI's Product Information Center http://support/ti./com for further information.

Save all warnings and instructions for future reference.

Failure to follow warnings and instructions may result in personal injury, property damage, or death due to electrical shock and/or burn hazards.

The term TI HV EVM refers to an electronic device typically provided as an open framed, unenclosed printed circuit board assembly. It is intended strictly for use in development laboratory environments, solely for qualified professional users having training, expertise, and knowledge of electrical safety risks in development and application of high-voltage electrical circuits. Any other use and/or application are strictly prohibited by Texas Instruments. If you are not suitably qualified, you should immediately stop from further use of the HV EVM.

1. **Work Area Safety:**
   (a) Keep work area clean and orderly.
   (b) Qualified observer(s) must be present anytime circuits are energized.
   (c) Effective barriers and signage must be present in the area where the TI HV EVM and its interface electronics are energized, indicating operation of accessible high voltages may be present, for the purpose of protecting inadvertent access.
   (d) All interface circuits, power supplies, evaluation modules, instruments, meters, scopes and other related apparatus used in a development environment exceeding 50 V_{RMS}/75 VDC must be electrically located within a protected Emergency Power Off (EPO) protected power strip.
   (e) Use a stable and non-conductive work surface.
   (f) Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.
2. **Electrical Safety:**As a precautionary measure, it is always a good engineering practice to assume that the entire EVM may have fully accessible and active high voltages.
   (a) De-energize the TI HV EVM and all its inputs, outputs, and electrical loads before performing any electrical or other diagnostic measurements. Revalidate that TI HV EVM power has been safely de-energized.
   (b) With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment hook-ups and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
   (c) Once EVM readiness is complete, energize the EVM as intended.

   WARNING: while the EVM is energized, never touch the EVM or its electrical circuits as they could be at high voltages capable of causing electrical shock hazard.
3. **Personal Safety:**
   (a) Wear personal protective equipment, for example, latex gloves and/or safety glasses with side shields or protect EVM in an adequate lucent plastic box with interlocks from accidental touch.
4. **Limitation for Safe Use:**
   (a) EVMs are not to be used as all or part of a production unit.

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1 Features

- Complete evaluation system for the bq76200 High Voltage Battery Pack Front-End Charge/Discharge High-Side NFET Driver IC
- Populated circuit module for quick setup

1.1 Kit Contents

- bq76200 circuit module

1.2 Ordering Information

The EVM orderable part number is bq76200EVM-606. For complete ordering information, see the product page at www.ti.com.

1.3 Documentation

See the device data sheet for bq76200 (SLUSC16) on www.ti.com for information on device hardware.

1.4 bq76200 Circuit Module Performance Specification Summary

This section summarizes the performance specifications of the bq76200EVM.

Table 1. Performance Specification Summary

Specification	Minimum	Typical	Maximum	Unit
Input voltage BATT+ to BATSR–	10	n/a	70	V
Output voltage PACK+ to PACK-	0	n/a	70	V
Charge and discharge current	0	2	15	A
Operating temperature	20	25	30	°C

2 bq76200EVM Quick Start Guide

This section provides the step-by-step procedures required to use a new EVM and configure it for operation in a laboratory environment.

2.1 Before You Begin

The following warnings and cautions are noted for the safety of anyone using or working close to the bq76200 EVM. Observe all safety precautions.



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



Caution Do not leave EVM powered when unattended.



Danger High Voltage The bq76200 EVM does not have an isolation boundary. If you apply high voltage to this board, all terminals should be considered high voltage.

Electric shock is possible when connecting the board to live wire. The board should be handled with care by a professional.

For safety, use of isolated test equipment with overvoltage and overcurrent protection is highly recommended.

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CAUTION

The circuit module has signal traces and component leads on the bottom of the board. This may result in exposed voltages, hot surfaces, or sharp edges. Do not reach under the board during operation.

CAUTION

The circuit module may be damaged by overtemperature. To avoid damage, monitor the temperature during evaluation and provide cooling, as needed, for your system environment.

CAUTION

Some power supplies can be damaged by application of external voltages. If using more than one power supply, check your equipment requirements and use blocking diodes or other isolation techniques, as needed, to prevent damage to your equipment.

CAUTION

The circuit module is not a finished product or electrical appliance. The module does not contain current or voltage thresholds for circuit protection. It must be used by qualified personnel with additional equipment for evaluation only.

2.2 Items Needed for EVM Quick Start Evaluation

- bq76200 circuit module
- A DC power supply that can provide 10 V and 1 A minimum (a voltage range, bipolar operation, and constant current – constant voltage capability is desirable)
- A load such as a 100-kΩ 1/4-W or other suitable resistor
- A DC meter or measurement instrument
- Suitable cables for connection

2.3 EVM Connections

This section covers the hardware connections for the EVM (see Figure 1).

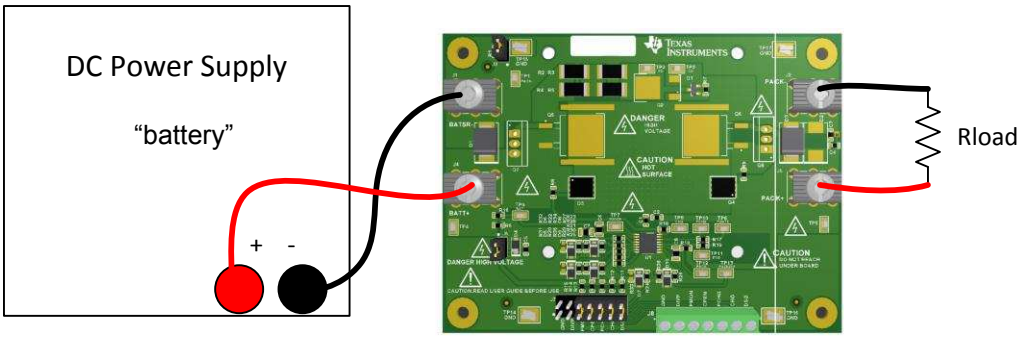


Figure 1. bq76200 Circuit Module Connection for Simple Demonstration

- Supply terminals (BATT+, BATSR–)

  These are the supply terminals for the board. BATT+ is the positive terminal of the battery or supply,

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BATSR– is the negative terminal of the power supply or after the sense resistor. When using a power supply for evaluation, be sure the power supply can accept or is protected from any reverse current such as with a blocking diode if another supply is used in the system.

- Pack terminals (PACK+ and PACK–)

  Attach the load or charger to the pack terminals. If using a power supply to simulate a charger, be sure it can accept or is protected from any reverse current.

- Ground shunt (J3)

  This shunt connects the IC VSS to the high-current return path. When the shunt is removed, the two signals are connected with a 1-kΩ resistor.

- Control voltage shunt (J6)

  This shunt connects BATT+ to a zener regulator to provide an on-board control voltage for simple evaluation.

- Control input header (J7)

  J7 allows enabling the bq76200 control signals from the on-board zener regulator voltage using shunts. See the bq76200 data sheet for the description of the control signals. The divided pack voltage can also be accessed here as the PDIV signal. When the shunts are not used, the header may be used for connection to other equipment.

- Control input terminal block (J8)

  The J8 terminal block provides an alternate connection point for control inputs and PDIV signal.

2.4 Quick Start Sequence

These steps describe a simple demonstration or check of the operation of the bq76200EVM.

1. Connect a 100-kΩ resistor to the PACK terminals.
2. Confirm shunts are in place on J3, J6, and J7 at the PMON, CPEN, PCHG, CHG, and DSG positions.
3. Connect a 10-V power supply across the BATT+ and BATSR– terminals.
4. Enable the supply.
5. Measure the voltage on the pack terminals. Observe this is approximately 10 V.
6. Remove the shunt at the J7 CHG position. Observe that the pack voltage drops approximately 300 mV below the supply. When using a smaller load resistor the voltage drop will be greater
7. Remove the shunt at the J7 PCHG position also. Observe that the pack voltage drops to approximately 500 mV below the supply. When using a smaller load resistor, this additional drop may not be observed.
8. Re-install the CHG and PCHG shunts.
9. Remove the shunt at the J7 DSG position. Observe that the pack voltage drops to approximately 0 V.
10. Measure the voltage on the PDIV pin J7 pin 3 or J8 pin 2. Observe that this voltage is approximately 0 V.
11. Re-install the shunt at the J7 DSG position. Observe that the PDIV voltage is approximately 0.36 V.
12. Remove the shunt at the J7 PMON position. Observer that the PDIV voltage drops to approximately 0 V.
13. Re-install the PMON shunt.
14. Disable the power supply and disconnect, if complete.

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3 Additional Evaluation Setups

CAUTION

The bq76200 EVM does not contain capacitors on the input or output current paths to dampen transients. Be sure to use appropriate capacitance (Csys and Cload in the following diagrams) to avoid damage to the board from cable or equipment transient responses during evaluation.

3.1 Operation With Charge and Discharge Currents

If bipolar power supplies are available, current control can be demonstrated through the board in both directions, see Figure 2. A battery voltage in range must be applied to the BAT side of the EVM for operation. The instrument on the PACK side can be used as a load if it is set to a lower voltage than the battery side or as a charger if set to a higher voltage.

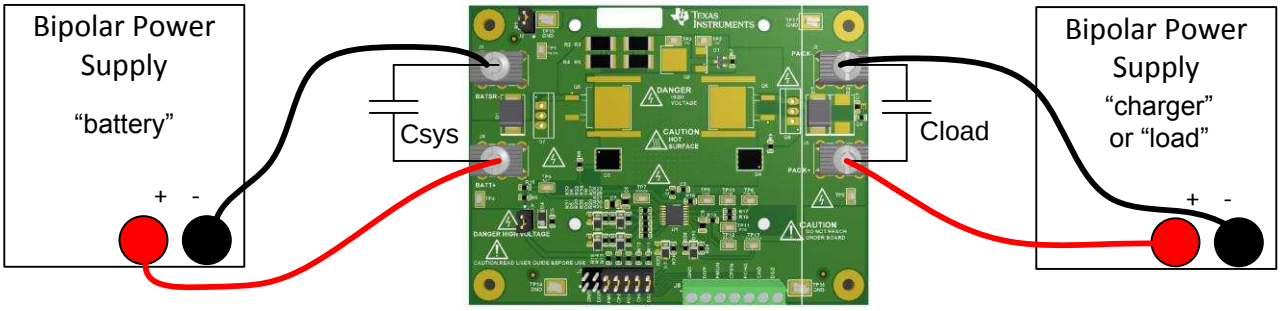


Figure 2. Bipolar Operation

3.2 Connecting to a BMS System

The bq76200 EVM may be connected to a BMS board so that the BMS device can provide the control signals for the bq76200, a concept is shown in Figure 3. The J7 header or J8 terminal block may be useful to connect signals to the bq76200 EVM, refer to the documentation for the BMS board to determine where to connect and how to interface the signals. Ensure that the BMS settings are correctly changed to match the pack and application for the solution being evaluated and the bq76200 EVM limits. The J6 shunt should be removed since the BMS board will provide control signal levels. The pull-down resistor patterns on the bq76200 EVM inputs may be populated, if needed, for the evaluation.

When connecting to the BMS board, the J3 shunt should be removed. The R1 resistor will be in parallel with the sense resistor through the path of the signal ground connected at J7 or J8. Generally, this should be OK since the current error would be ≈ 1 ppm with a 1-mΩ sense resistor or ≈ 10 ppm with a 10-mΩ sense resistor. However, connect the board grounds as appropriate for the evaluation.

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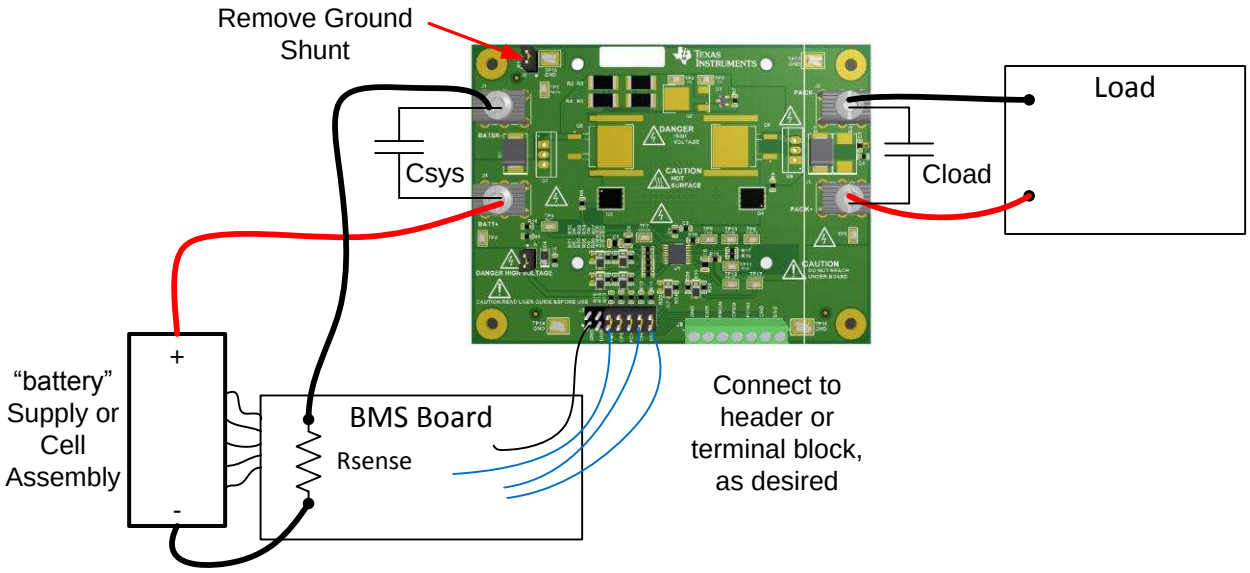


Figure 3. Operation with a BMS

3.3 Connecting to a MCU

It may be desired to evaluate the board with control from an MCU, see Figure 4. The J7 header or J8 terminal block may be useful to connect signals depending on the MCU board and cabling used. The J6 shunt should be removed since the MCU board should provide the control signals. Generally, it is expected that the J3 shunt would be installed, but provide an appropriate ground for the system.

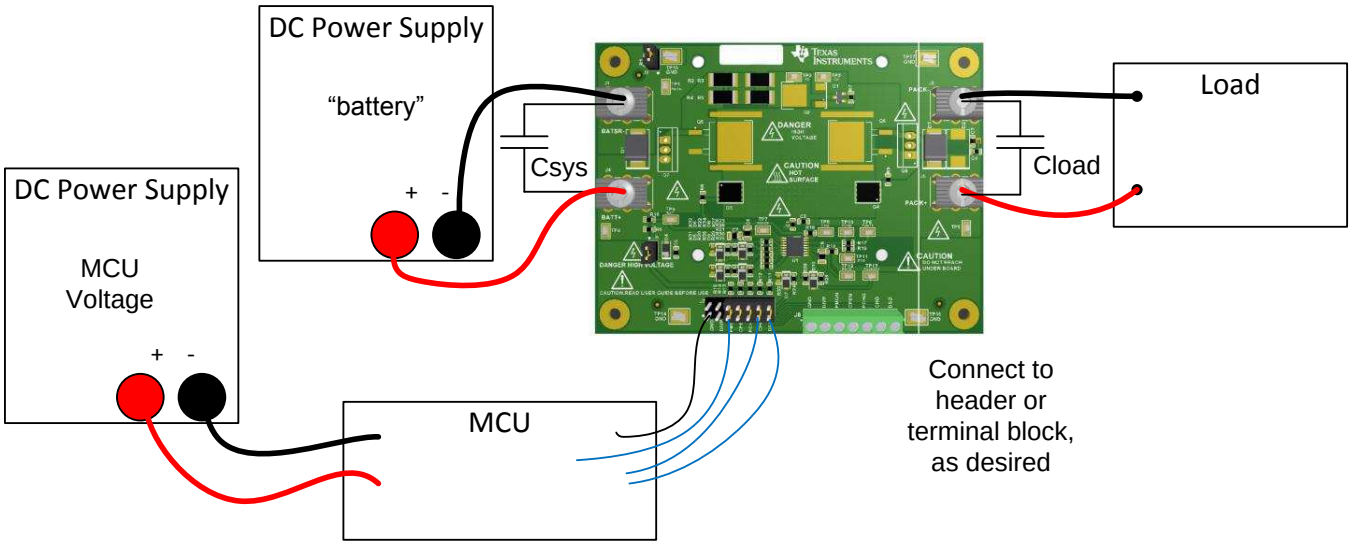


Figure 4. Operation With a MCU

3.4 Troubleshooting

If the bq76200 does not appear to be operating, check the BATT+ and enable voltages. BATT+ must be in the range of the board and the BAT test point in the range of the IC as shown in the data sheet. Check that the board ground is appropriately connected to the system supply ground. With the CP_EN voltage applied in the 3 to 12 V or other range indicated in the data sheet, measure the voltage of the VDDCP (TP7) with respect to BAT (TP9) and confirm it is within the range shown in the data sheet. The Quick Start Sequence section is a good procedure to check the operation of the board.

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4 bq76200EVM Circuit Module Schematic

This section contains information on other EVM features.

4.1 Alternate FETs

The EVM has D2PAK and TO-220 footprints for power FETs as options for evaluation. A DPAK footprint option is available as a precharge FET option.

4.2 Heatsink Patterns

The EVM is designed with copper plane areas to distribute heat on the board. The board has a hole pattern for an optional bolt on heatsink H9 shown in the bill of materials. The board also has patterns on the top layer for D2PAK heatsinks HS10 and HS11 shown in the bill of materials. The flat areas of the back of the board may be used for adhesive mount heatsinks, if appropriate.

4.3 PACK Transient Pattern

D2 is a pattern for a TVS on the pack, if desired.

4.4 Input Limit Circuit

The bq76200 EVM contains zener diodes and resistors on the inputs. These may limit the voltage to the control input pins if multiple pins on the IC are shorted together and the ground connection is maintained, but do not provide a safety isolation boundary. The zeners are not intended for protection of the inputs to the IC.

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5 Circuit Module Physical Layouts

This section contains the printed-circuit board (PCB) layout, assembly drawings, and schematic for the bq76200 circuit module.

5.1 Board Layout

This section shows the PCB layers and assembly drawing for the bq76200 module (see Figure 5 through Figure 12).

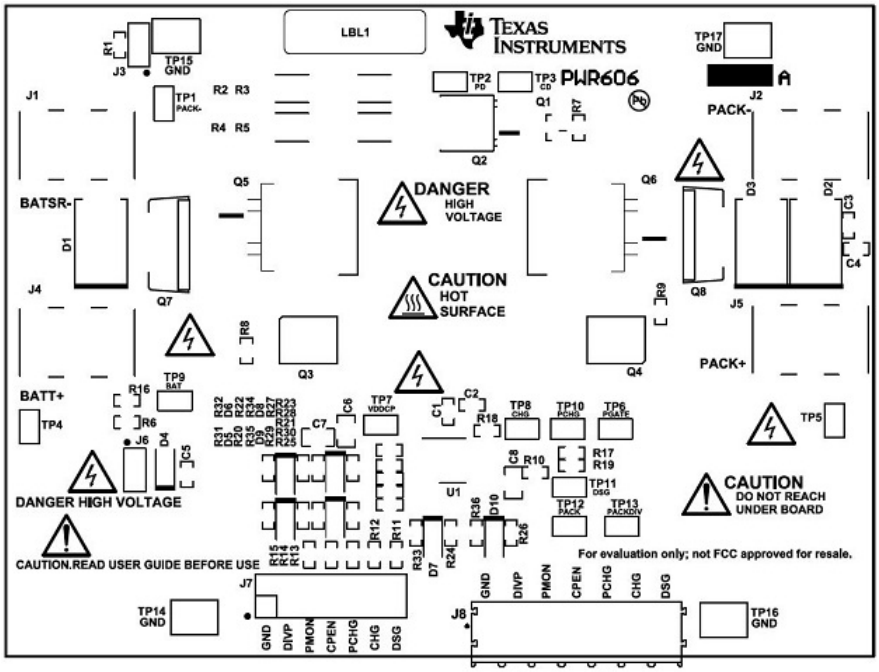


Figure 5. Top Silk Screen

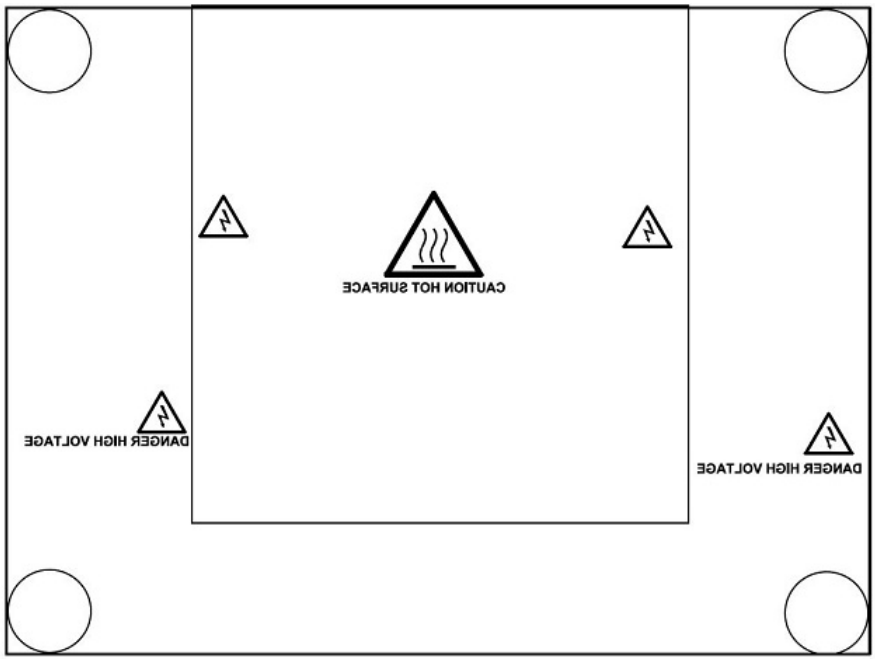


Figure 6. Bottom Silk Screen

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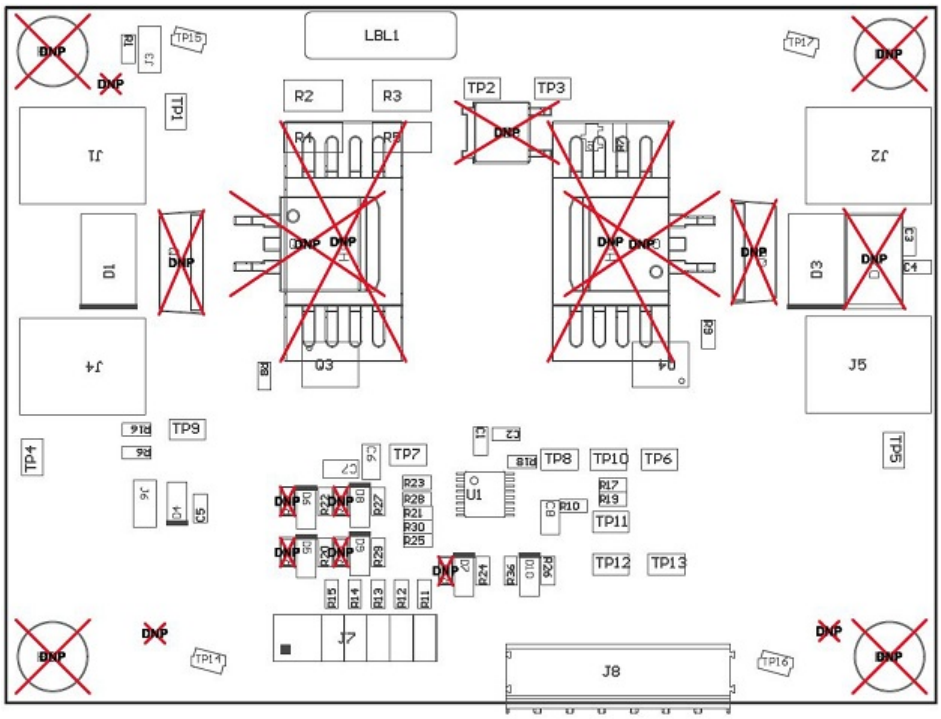


Figure 7. Top Assembly

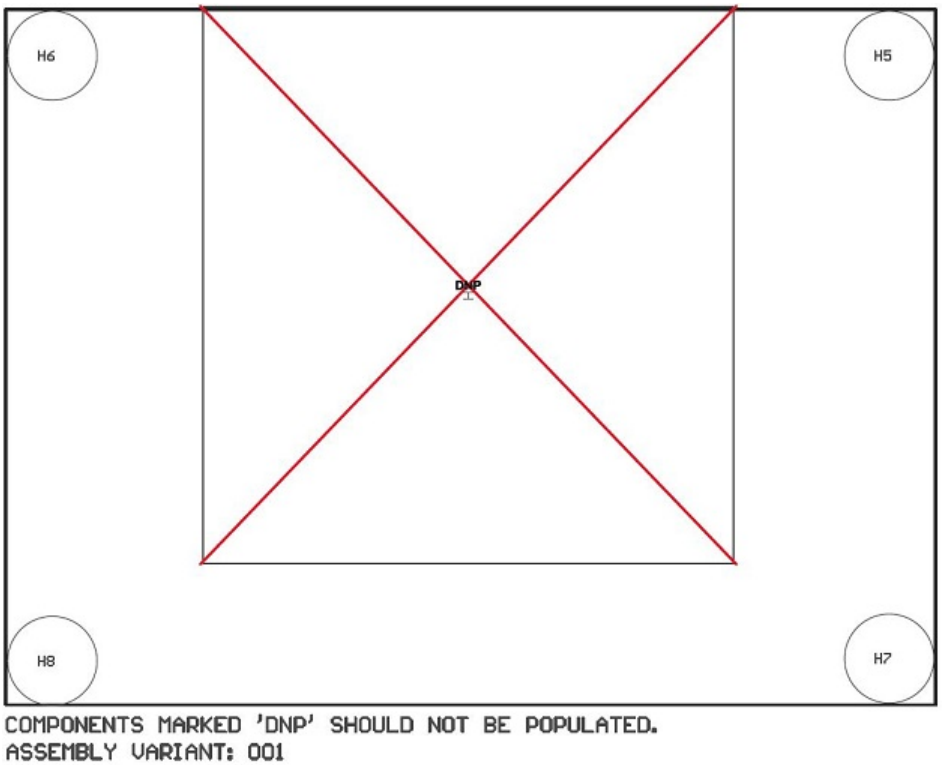


Figure 8. Bottom Assembly

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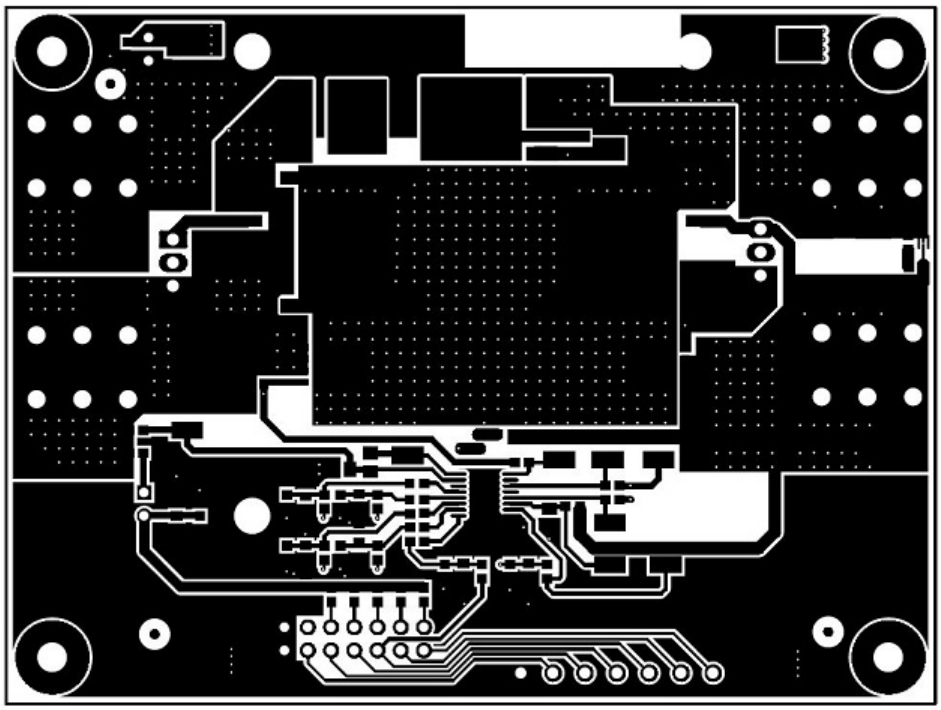


Figure 9. Top Layer

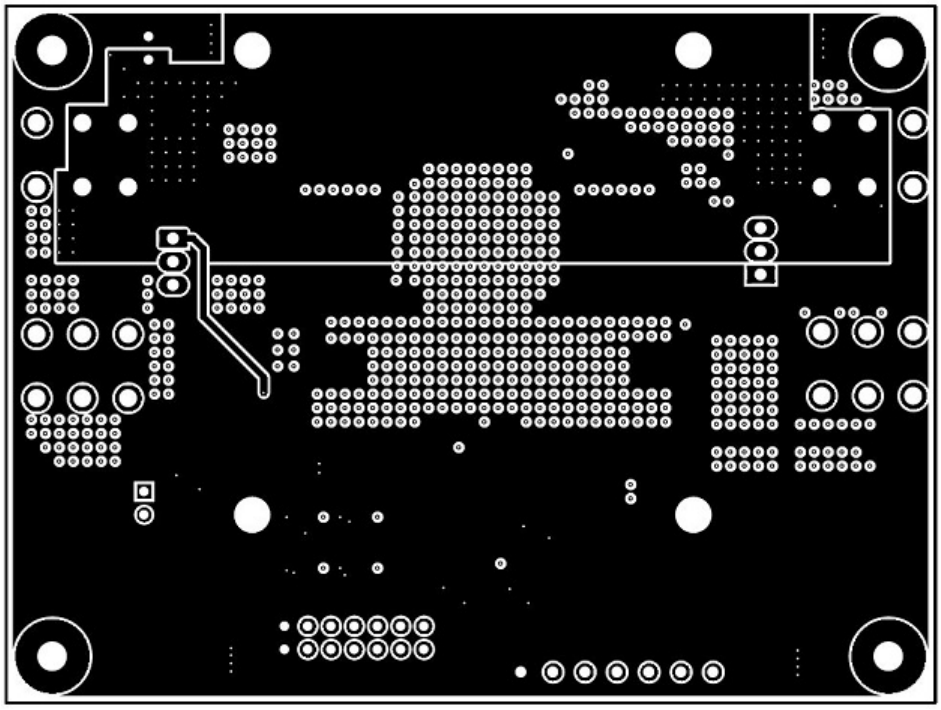


Figure 10. Internal Layer 1

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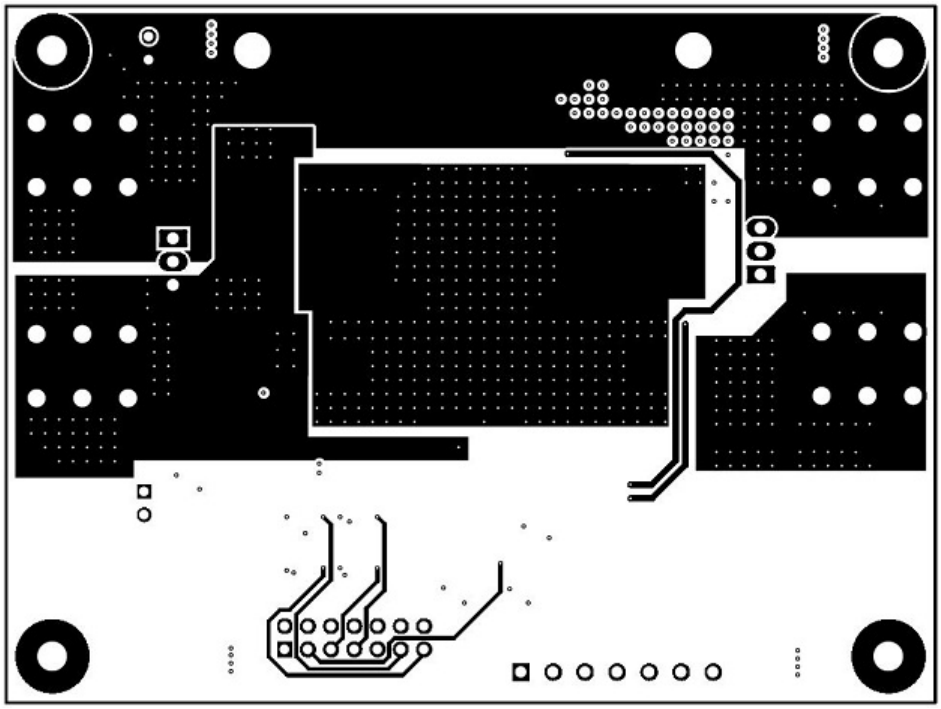


Figure 11. Internal Layer 2

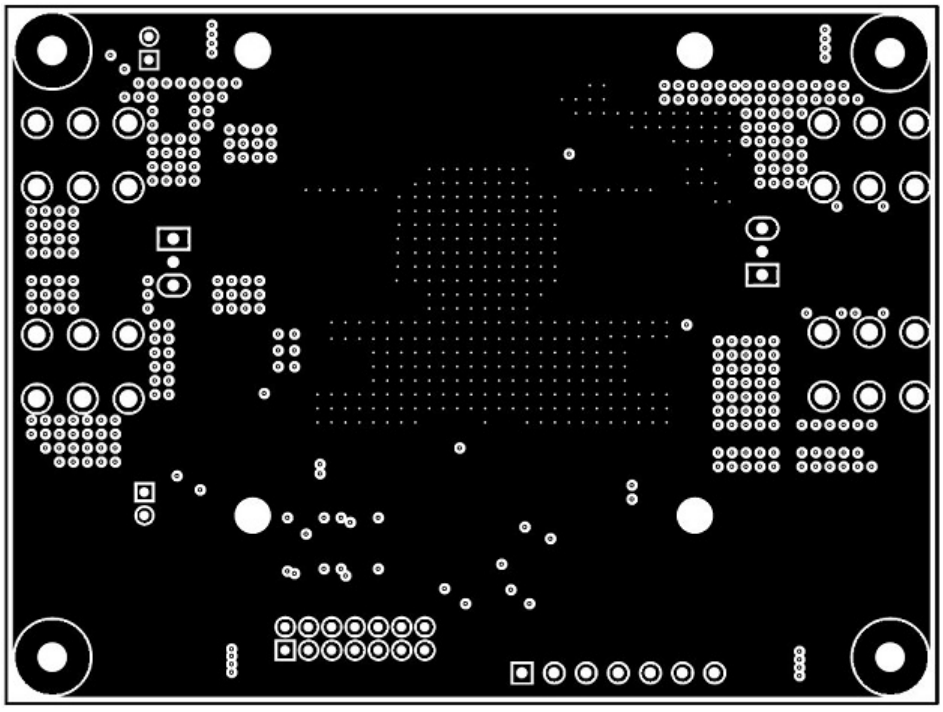


Figure 12. Bottom Layer

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5.2 Schematic

Figure 13 shows the bq76200EVM schematic.

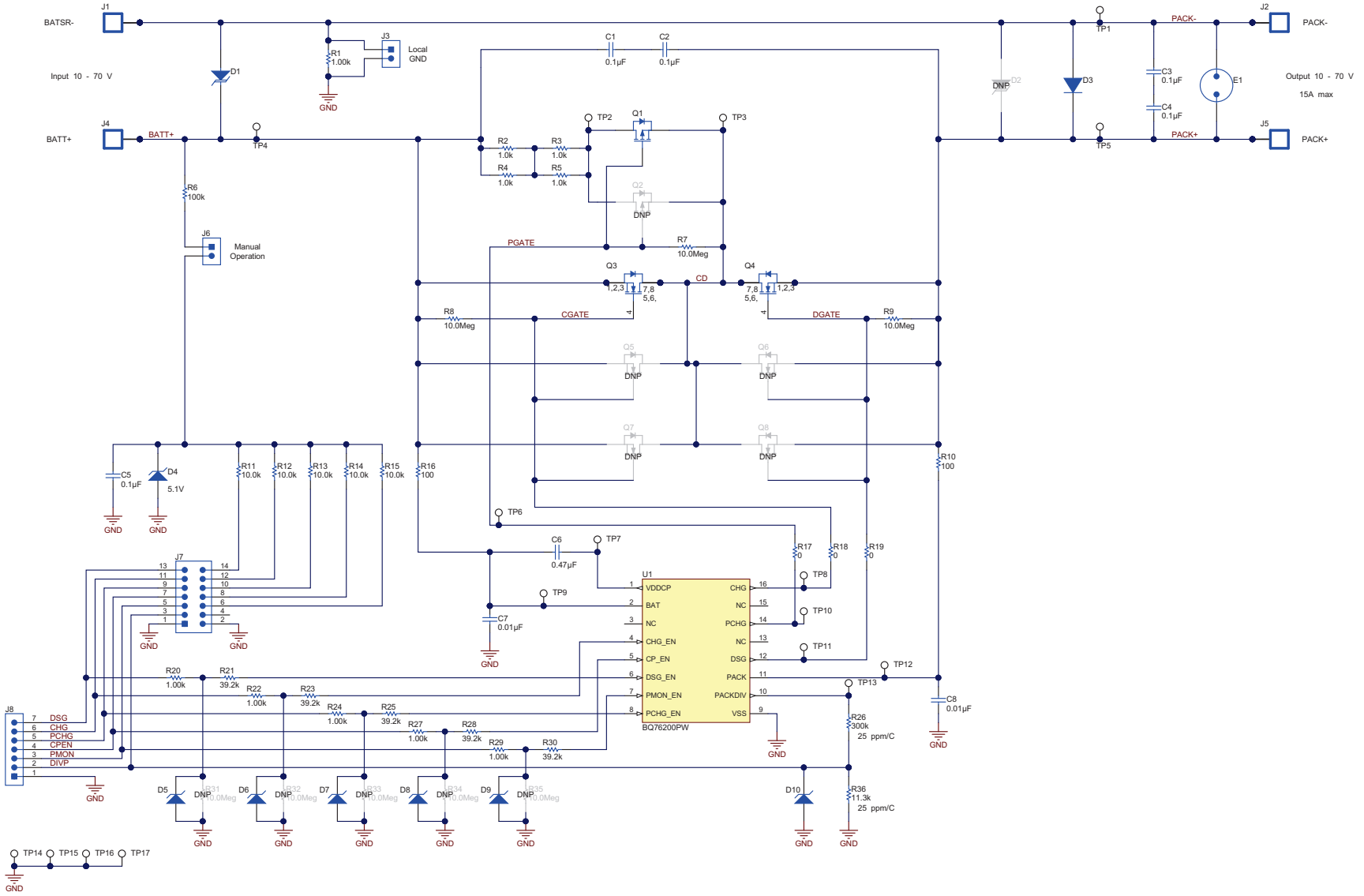


Figure 13. bq76200EVM Schematic

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6 Bill of Materials

Table 2 lists the bq76200EVM BOM.

Table 2. bq76200EVM Bill of Materials[(1)]

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
!PCB	1		Printed Circuit Board		PWR606	Any	-	-
C1, C2, C3, C4, C5	5	0.1uF	CAP, CERM, 0.1uF, 100V, +/-10%, X7R, 0603	0603	GRM188R72A104KA35D	MuRata		
C6	1	0.47uF	CAP, CERM, 0.47uF, 25V, +/-10%, X7R, 0805	0805	C2012X7R1E474K	TDK		
C7, C8	2	0.01uF	CAP, CERM, 0.01uF, 100V, +/-10%, X7R, 0805	0805	08051C103KAT2A	AVX		
D1	1	75V	Diode, TVS, Uni, 75V, 1500W, SMC	SMC	SMCJ75A	Fairchild Semiconductor		
D3	1	200V	Diode, Ultrafast, 200V, 3A, SMC	SMC	ES3D-E3/57T	Vishay-Semiconductor		
D4	1	5.1V	Diode, Zener, 5.1V, 500mW, SOD-123	SOD-123	MMSZ5231B-7-F	Diodes Inc.		
D5, D6, D7, D8, D9, D10	6	14V	Diode, Zener, 14 V, 500 mW, SOD-123	SOD-123	MMSZ4701T1G	ON Semiconductor		
H5, H6, H7, H8	4		Bumpon, Hemisphere, 0.375 X 0.235, Black	Black Bumpon	SJ61A2	3M		
J1, J2, J4, J5	4		TERMINAL SCREW PC 30AMP, TH	12.9x6.3x7.9 mm	8199	Keystone		
J3, J6	2		Header, 100mil, 2x1, Tin plated, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
J7	1		Header, 100mil, 7x2, Tin plated, TH	Header, 7x2, 100mil, Tin	PEC07DAAN	Sullins Connector Solutions		
J8	1		TERM BLOCK, 7POS, 3.5MM, TH	24.5x9.2x7.6mm	1984662	Phoenix Contact		
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650"H x 0.200"W	THT-14-423-10	Brady	-	-
Q1	1	-100V	MOSFET, P-CH, -100V, -0.6A, SOT-23	SOT-23	ZXMP10A13FTA	Diodes Inc.		None
Q3, Q4	2	100V	MOSFET, N-CH, 100V, 16A, SON 5x6mm	SON 5x6mm	CSD19531Q5A	Texas Instruments		None
R1, R20, R22, R24, R27, R29	6	1.00k	RES, 1.00k ohm, 1%, 0.1W, 0603	0603	CRCW06031K00FKEA	Vishay-Dale		
R2, R3, R4, R5	4	1.0k	RES, 1.0k ohm, 5%, 1W, 2512	2512	ERJ-1TYJ102U	Panasonic		
R6	1	100k	RES, 100k ohm, 1%, 0.1W, 0603	0603	CRCW0603100KFKEA	Vishay-Dale		
R7, R8, R9	3	10.0Meg	RES, 10.0Meg ohm, 1%, 0.1W, 0603	0603	CRCW060310M0FKEA	Vishay-Dale		
R10, R16	2	100	RES, 100 ohm, 1%, 0.1W, 0603	0603	CRCW0603100RFKEA	Vishay-Dale		
R11, R12, R13, R14, R15	5	10.0k	RES, 10.0k ohm, 1%, 0.1W, 0603	0603	CRCW060310K0FKEA	Vishay-Dale		
R17, R18, R19	3	0	RES, 0 ohm, 5%, 0.1W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale		
R21, R23, R25, R28, R30	5	39.2k	RES, 39.2k ohm, 1%, 0.1W, 0603	0603	CRCW060339K2FKEA	Vishay-Dale		
R26	1	300k	RES, 300k ohm, 0.1%, 0.1W, 0603	0603	RG1608P-304-B-T5	Susumu Co Ltd		
R36	1	11.3k	RES, 11.3k ohm, 0.1%, 0.1W, 0603	0603	RG1608P-1132-B-T5	Susumu Co Ltd		
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7	7	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec

(1) Unless otherwise noted in the Alternate Part Number and/or Alternate Manufacturer columns, all parts may be substituted with equivalents.

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Table 2. bq76200EVM Bill of Materials[(1)] (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13	13	SMT	Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone		
TP14, TP15, TP16, TP17	4	SMT	Test Point, Compact, SMT	Testpoint_Keystone_Compact	5016	Keystone		
U1	1		bq76200: Low-Power, High-Side N-channel FET Driver with Pack Voltage Monitor, PW0016A	PW0016A	BQ76200PW	Texas Instruments		None
D2	0	75V	Diode, TVS, Uni, 75V, 1500W, SMC	SMC	SMCJ75A	Fairchild Semiconductor		
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A		
H1, H2, H3, H4	0		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply	-	-
H9	0		HEATSINK DC/DC HALF BRICK VERT	DC/DC Half Brick Vertical Heat Sink	518-95AB	Wakefield Solutions		
H10, H11	0		Heatsink, DDPAK/TO-263, SMT	Heatsink, DDPAk	573300D00010G	Aavid		
Q2	0	-60V	MOSFET, P-CH, -60V, -19A, DPAK	DPAK	SUD19P06-60L	Vishay-Siliconix		None
Q5, Q6	0	100V	MOSFET, N-CH, 100V, 18A, DDPAK	DDPAK	AOB290L	AOS		None
Q7, Q8	0	100V	MOSFET, N-CH, 100V, 97A, TO-220AB	TO-220AB	IRFB4410ZPBF	International Rectifier		None
R31, R32, R33, R34, R35	0	10.0Meg	RES, 10.0Meg ohm, 1%, 0.1W, 0603	0603	CRCW060310M0FKEA	Vishay-Dale		

7 Related Documentation from Texas Instruments

- bq76200, *High Voltage Battery Pack Front-End Charge/Discharge High-Side NFET Driver* data sheet, SLUSC16

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STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

   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 and conditions 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 and conditions 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 any defects that are 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. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.

   2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, 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.

3 *Regulatory Notices:*

   3.1 *United States*

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

      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*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

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

Concernant les EVMs avec antennes détachables

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

3.3 *Japan*

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

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

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

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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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。
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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 WRITTEN DESIGN MATERIALS PROVIDED WITH THE EVM (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 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 AND CONDITIONS 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 MADE, CONCEIVED OR ACQUIRED PRIOR TO OR AFTER DELIVERY OF THE EVM.

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 AND CONDITIONS. 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 ANDCONDITIONS OR THE USE OF THE EVMS PROVIDED HEREUNDER, 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 ONE YEAR AFTER THE RELATED CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY WARRANTY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS AND CONDITIONS, OR ANY USE OF ANY TI EVM PROVIDED HEREUNDER, EXCEED THE TOTAL AMOUNT PAID TO TI FOR THE PARTICULAR UNITS SOLD UNDER THESE TERMS AND CONDITIONS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM AGAINST THE PARTICULAR UNITS SOLD TO USER UNDER THESE TERMS AND CONDITIONS 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.

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No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

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