QFN-Packaged bq24160/161/162A/63EVM Evaluation Modules

The bq24160/161/162A/63EVM evaluation module is a complete charger module for evaluating compact, flexible, high-efficiency, USB-friendly, switch-mode, charge-management solutions for single-cell, Li-ion and Li-polymer batteries used in a wide range of portable applications.

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1 Introduction

1.1 bq2416x IC Features

The bq24160/161/163/168 integrates a synchronous PWM controller, power MOSFETs, input-current sensing, high-accuracy current and voltage regulation, charge termination and power path management into a QFN package. The charge parameters can be programmed through an I^2C interface. Key integrated circuit (IC) features include:

- High-efficiency, fully integrated, NMOS-NMOS, synchronous buck charger with 1.5-MHz frequency
- Integrated power FETs for up to 2.5-A charge rate
- Power path management between battery and system voltages

For details, see the bq24160/161/163/168 data sheet (SLUSAO0).

1.2 bq24160/161/163/168EVM Features

The bq24160/161/163/168EVM evaluation module (EVM) is a complete charger module for evaluating compact, flexible, high-efficiency, USB-friendly, switch-mode battery charge and power path management solutions for single-cell, Li-ion and Li-polymer battery-powered systems used in a wide range of portable applications. Key EVM features include:

- Input power connectors for both USB input and ac adapter
- Programmable battery voltage, charge current, input current, and status via I^2C™ interface
- IN operating range of 4.2 V – 10 V (bq24160/161/163EVM) or 4.2 V – 6 V (bq24168)
- USB operating range of 4.2 V – 6 V
- LED indication for status signals
- Test points for key signals available for testing purposes. Easy probe hook-up

1.3 Schematic

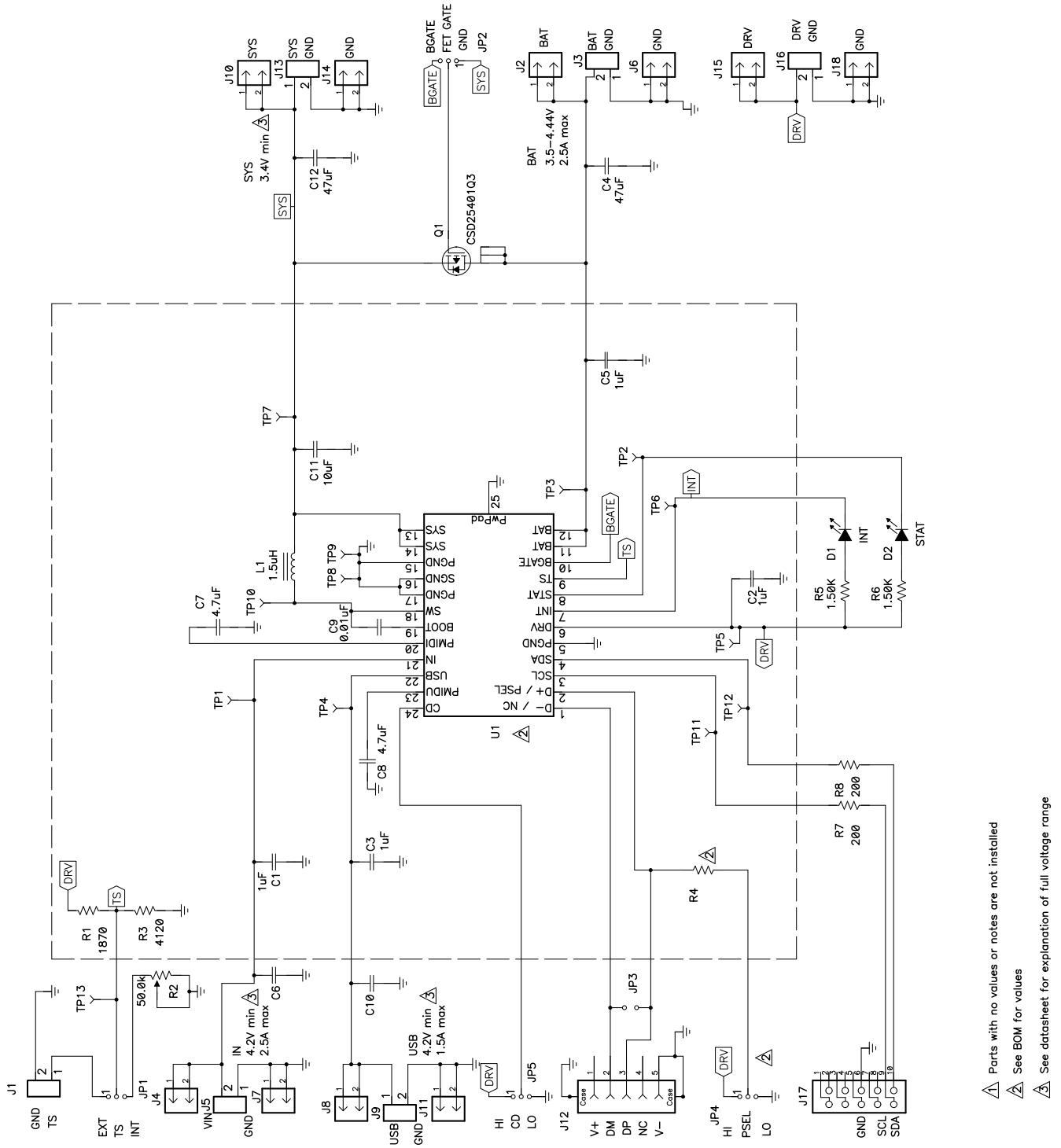

Figure 1. HPA742A Schematic

1.4 I/O Description

Header/Terminal Block	Description
J1–TS	External thermistor positive terminal
J1–GND	Ground terminal for external thermistor
J2–BAT	Battery positive header
J3-BAT	Battery positive terminal
J3-GND	Battery negative terminal
J4-IN	Adapter positive header
J5-IN	Adapter positive terminal
J5-GND	Adapter negative terminal
J6-GND	Battery negative terminal
J7-GND	Adapter negative terminal
J8-USB	USB positive header
J9-USB	USB positive terminal
J9-GND	USB negative terminal
J10-SYS	System output positive header
J11-GND	USB negative header
J12	USB miniconnector
J13-SYS	System output positive terminal
J13-GND	System output negative terminal
J14-GND	System output negative header
J15-DRV	DRV reference voltage positive header
J16-DRV	DRV reference voltage positive terminal
J16-GND	DRV reference voltage negative terminal
J17	USB-TO-GPIO box connector

1.5 Test Points

Test Point	Description
TP1	Kelvin to VIN
TP2	STAT
TP3	Kelvin to BAT
TP4	Kelvin to USB
TP5	DRV
TP6	INT
TP7	Kelvin to SYS
TP8	GND
TP9	GND
TP10	SW
TP11	SCL
TP12	SDA
TP13	TS

1.6 Control and Key Parameters Setting

Jumper	Description	Default Factory Setting
JP1	1-2 (TS = INT): Connects a potentiometer to the TS so that the potentiometer can emulate a thermistor. The potentiometer has been preset to approximately 3.4 kΩ so that the TS voltage is 0.5 x V (DRV). 2-3 (TS = EXT): Connects the TS pin to an external thermistor. The resistor divider formed by R1 and R3 has been sized to accommodate a 10-kΩ thermistor. If a different thermistor is used, R1 and R3 must be resized.	1-2 (TS = INT)
JP2	1-2 (FET GATE = SYS): External PFET's gate tied to SYS and therefore disabled. 2-3 (FET GATE = BGATE): External PFET's gate tied to BGATE pin and therefore controlled by IC.	2-3 (FET GATE = BGATE)
JP3	Shorting jumper for USB data lines DM (D-) and DP (D+). When shorted, USB input current limit defaults to 1.5 A. Otherwise, USB100 mode is selected.	Shorted
JP4	bq24161 and bq24168 only 1-2 (PSEL = LO): Indicates that an ac adapter is connected to the USB input and sets the USB input current limit to 1.5 A. 2-3 (PSEL = HI): Indicates that a USB source is connected to the USB input and sets the input current limit to 500 mA.	2-3 (PSEL = HI)
JP5	1-2 (CD = LO): Charge disable low for normal operation 2-3 (CD = HI): Charge disable high to disable charge and enter Hi-Z mode	1-2 (CD = LO)

1.7 Recommended Operating Conditions

		Min	Typ	Max	Unit
Supply voltage, V_{IN}	Input voltage from ac adapter (bq24160/161/163)	4.2		10	V
Supply voltage, V_{IN}	Input voltage from ac adapter (bq24168)	4.2		6	V
USB voltage, V_{USB}	Input voltage from USB or equivalent supply	4.2		6	V
Battery voltage, V_{BAT}	Voltage applied at VBAT terminal of J8	0	3-4.2	4.44	V
Supply current, $I_{IN(MAX)}$	Maximum input current from ac adapter input	1.5		2.5	A
Supply current, $I_{USB(MAX)}$	Maximum input current from USB input	0.1	0.5	1.5	A
Charge current, I_{chrg}	Battery charge current		1	2.5	A
Operating junction temperature range, T_J		0		125	°C

2 Test Summary

This procedure describes one test configuration of the HPA742 evaluation board for bench evaluation.

2.1 Definitions

This procedure details how to configure the HPA742 evaluation board. The following naming conventions are followed. See the bq24160/161/163/168 QFN EVM schematic for details.

VXXX :	External voltage supply name (VADP, VBT, VSBT)
LOADW:	External load name (LOADR, LOADI)
V(TPyyy):	Voltage at internal test point TPyyy. For example, V(TP12) means the voltage at TP12.
V(Jxx):	Voltage at header Jxx
V(TP(XXX)):	Voltage at test point XXX. For example, V(ACDET) means the voltage at the test point which is marked as ACDET.
V(XXX, YYY):	Voltage across point XXX and YYY
I(JXX(YYY)):	Current going out from the YYY terminal of header XX
Jxx(BBB):	Terminal or pin BBB of header xx
JPx ON :	Internal jumper Jxx terminals are shorted.
JPx OFF:	Internal jumper Jxx terminals are open.
JPx (-YY-)	ON: Internal jumper Jxx adjacent terminals marked as YY are shorted
Measure: → A,B	Check specified parameters A, B. If measured values are not within specified limits, the unit under test has failed.
Observe → A,B	Observe if A, B occur. If they do not occur, the unit under test has failed.

Assembly drawings have location for jumpers, test points, and individual components.

2.2 Recommended Test Equipment

2.2.1 Power Supplies

Power Supply #1 (PS#1) capable of supplying 6 V at 3 A is required.

If not using a battery as the load, then power supply #2 (PS#2) capable of supplying 5 V at 5-A is required to power the circuit shown in Figure 2.

2.2.2 Load #1 Between BAT and GND

Testing with an actual battery as the load is the best way to verify operation in the system. If a batttery is not available, then a circuit similar to the one shown in Figure 2 can simulate a battery when connected to a power supply.

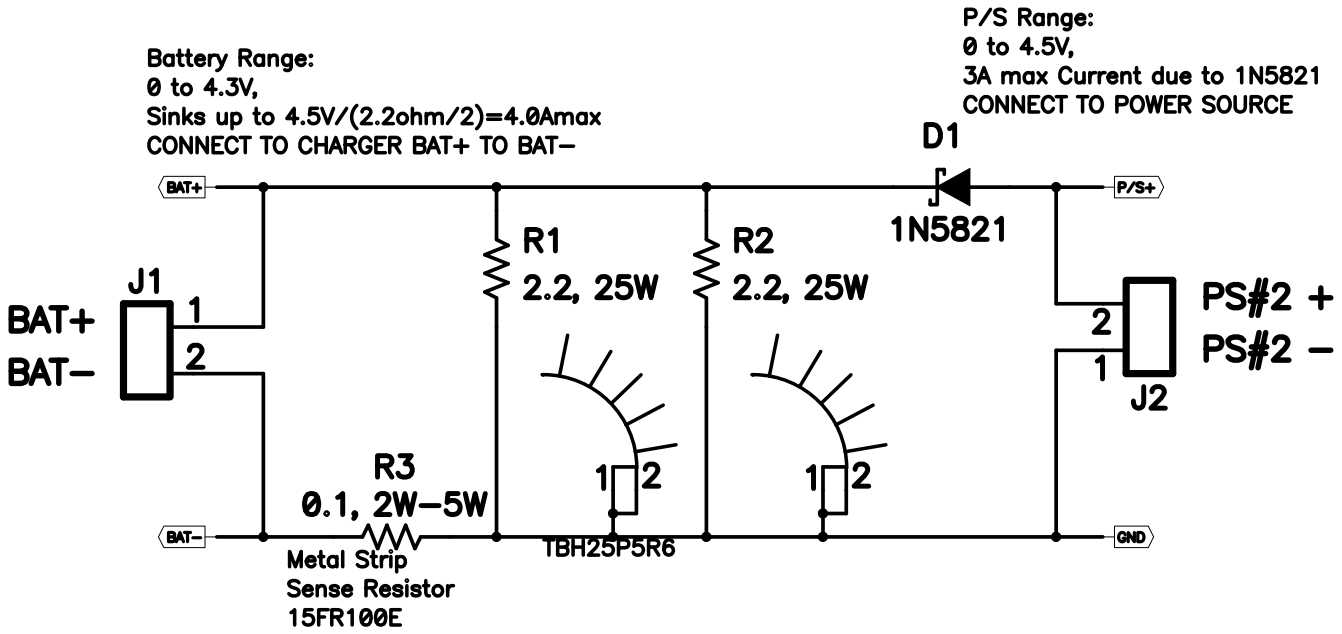

Figure 2. BAT_Load (PR1010) Schematic

2.2.3 Load #2 Between SYS and GND

Although not required, a resistive load capable of sinking up to 3 A can be used.

2.2.4 Meters

Four equivalent voltage meters (VM#) and two equivalent current meters (CM#). The current meters must be configured to measure 3-A current.

2.2.5 Computer

A computer with at least one USB port and a USB cable. The bq2416x evaluation software must be properly installed.

2.2.6 HPA172 Communication Kit (USB to GPIO)

A HPA172 USB-to-I^2C communication kit.

2.2.7 Software

Download the BQ2416xSW.zip file from the charger's product folder, unzip the file, and double-click on the SETUP.EXE file. Follow the installation steps.

Because the bq24160, bq24161, and bq24163 have the watchdog timers enabled, it is recommended that you set the software's **Reset Watchdog Timer** to reset every 5 seconds. Otherwise, after 30 seconds of operation, the integrated circuit (IC) enters Default mode. Note that the 27-minute safety timer is not reset by this function and eventually times out if charging does not complete, unless the **Safety Timer Time Limit** is expanded or disabled via the GUI. One way to reset the safety timer is to allow the 30-second watchdog timer to expire. See Figure 3 in the data sheet for more information about the timers.

Also, it is generally helpful to set the **AutoRead** and **Write On Change** functions, in the upper left of the GUI window, to ON. The AutoRead function periodically updates the GUI with the IC status. The Write On Change function writes any changes to the GUI check boxes, drop-down boxes, and registers to the IC. Otherwise, the user is responsible for periodically pressing the **READ** button to find the IC instantaneous status and **WRITE** button to write changes to the IC.

2.3 Recommended Test Equipment Setup

1. For all power connections, use short, twisted-pair wires of appropriate gauge wire for the maximum current amount.
2. Set Power Supply #1 (PS#1) for 6-V ± 100 mVdc, 3-A ± 100-mA current limit, and then turn off supply.
3. If BAT_Load is the circuit shown in Figure 3, connect Power Supply #2 (PS#2) set to approximately 3.6 V to the input side of BAT_Load, and then turn off PS#2.
4. Connect the output side (or battery terminals) of BAT_Load in series with current meter (multimeter) #2 (CM#2) to J2 and J6 or J3 (BAT, GND). Ensure that a voltage meter is connected across J2 or TP3 and J6 or TP9 (BAT, GND).
5. Connect VM#3 across J10 or TP7 and J14 or TP9 (SYS, GND).
6. Connect VM#4 across J15 or TP5 and J14 or TP9 (DRV, GND).
7. Connect J17 to HPA172 kit by the 10-pin ribbon cable. Connect the USB port of the HPA172 kit to the USB port of the computer. The connections are shown in Figure 3.

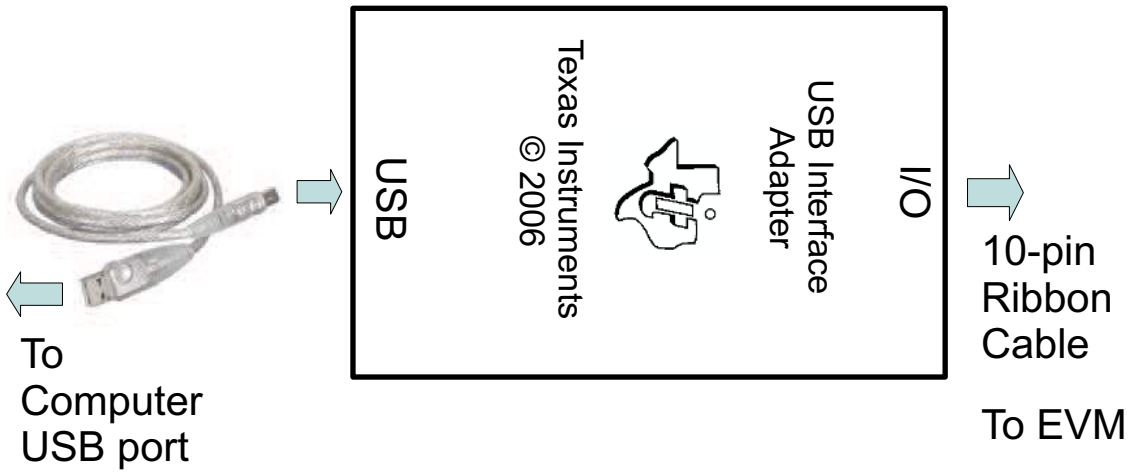

Figure 3. Connections of HPA172 Kit

8. Ensure jumpers are at the default factory settings per Section 1.6
9. After the preceding steps have been performed, the test setup for HPA742 is configured as is shown in Figure 4

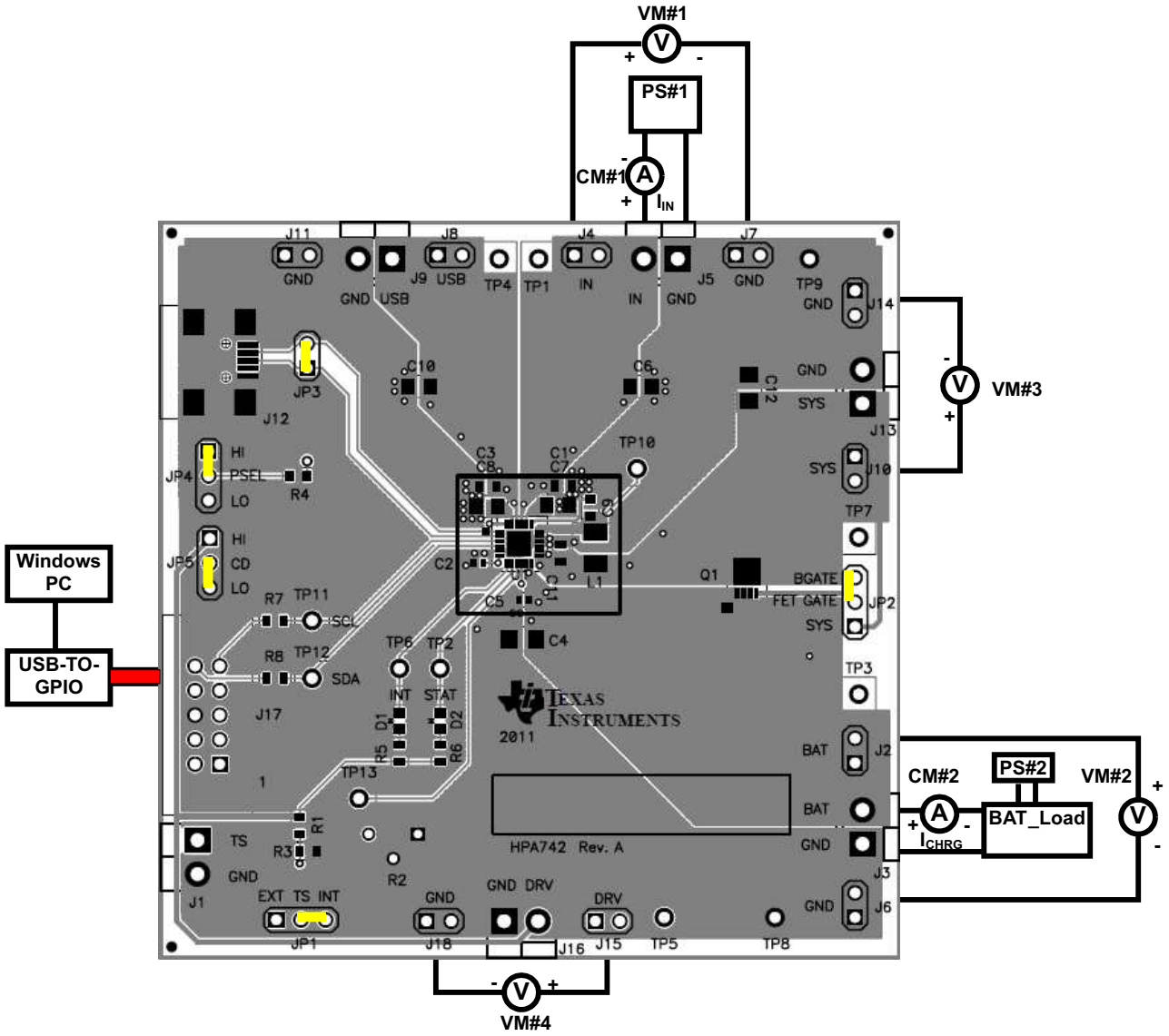

Figure 4. Original Test Setup for bq24160/161/163/168EVM (HPA742)

10. Turn on the computer.
    - Open the bq2416x evaluation software. The main window of the software is shown in Figure 5.

Figure 5. Main Window of bq2416xSW Evaluation Software

2.4 Recommended Test Procedure

The following test procedure is useful for evaluating the charger IC outside of a real system, especially when no battery is available to connect to the output (i.e., Load #1).

2.4.1 Charge Voltage and Current Regulation of IN

1. Ensure that the Section 2.3 steps are followed.
2. Connect the output of Power Supply #1 (PS #1) in series with current meter (multimeter) #1 (CM #1) to J4 and J7 or J5 (IN, GND).
3. Connect voltage meter 1 (VM #1) across J4 or TP1 and J7 or TP8 (IN, GND).
4. Move JP5 to HI.
5. Turn on PS #1 and PS #2 if used.
6. Return JP5 to LO.
7. Software setup:
   - Press the **READ** button to obtain the current settings.
   - Set **Write On Change** to ON if not already set.

- Set **Reset Watchdog Timer** to update every 5 seconds.
- Set **Supply Precedence** to IN if not already set.
- Uncheck **Disable Charging** if checked.
- Check **Enable STAT/INT Outputs**.
- Set **Battery Regulation Voltage** to 4.20 V.
- Set **IN Input Current Limit** to 2.5 A.
- Set **Charge Current** to 1000 mA.
- Click the **READ** button at the top of the window and confirm that the previous settings remain.

8. Enable PS #2 and adjust PS #2 so that the voltage measured by VM #2, across BAT and GND, measures 3.3 V ± 50 mV.
9. Adjust the power supply so that VM #1 still reads 6 V ± 100 mV, if necessary, then
   Measure on CM#2 → I_{CHRG} = 1000 mA ± 100 mA
   Measure on CM#1 → I_{IN} = 700 mA ± 70 mA
10. Turn off PS #1 and PS #2.

2.4.2 Charge Voltage and Current Regulation of USB

1. Be sure to follow Section 2.3 steps .
2. Connect the output of Power Supply #1 (PS #1) in series with current meter (multimeter) #1 (CM #1) to J8 and J11 or J9 (USB, GND).
3. Connect a voltage meter 1 (VM #1) across J8 or TP4 and J11 or TP8 (USB, GND).
4. Move JP5 to HI.
5. Turn on PS #1 and PS #2 if used.
6. Return JP5 to LO.
7. Software setup:
   - Press the **READ** button to obtain the current settings.
   - Set **Write On Change** to ON if not already set.
   - Set **Reset Watchdog Timer** to update every 5 seconds.
   - Set **Supply Precedence** to USB if not already set.
   - Uncheck **Disable Charging** if checked.
   - Check **Enable STAT/INT Outputs**.
   - Set **Battery Regulation Voltage** to 4.20 V.
   - Set **USB Input Current Limit** to 1500 mA.
   - Set **Charge Current** to 1000 mA.
   - Click the **READ** button at the top of the window, and confirm that the previous settings remain.
8. Enable PS #2 and adjust PS #2 so that the voltage measured by VM #2, across BAT and GND, measures 3.3 V ± 50 mV.
9. Adjust the power supply so that VM #1 still reads 6 V ± 100 mV if necessary then
   Measure on CM#2 → I_{CHRG} = 1000 mA ± 100 mA
   Measure on CM#1 → I_{IN} = 700 mA ± 70 mA
10. Turn off PS #1 and PS #2.

2.4.3 Helpful hints

1. To observe the taper current as the battery voltage approaches the set regulation voltage, allow the battery to charge or, if using BAT_Load (PR1010), slowly increase the PS #2 voltage powering BAT_Load (PR1010). Use VM #2 across BAT and GND to measure the battery voltage seen by the IC.
2. To observe the V_{INDPM} function, lower the current limit on PS #1.
3. To observe battery supplement mode, apply a resistive load across SYS and GND that is higher than

the maximum charge current.

3 Printed-Circuit Board Layout Guideline

1. To obtain optimal performance, the power input capacitors, connected from the PMID input to PGND, must be placed as close as possible to the bq2416x.
2. Place a 4.7-µF input capacitor as close to PMID pin and PGND pin as possible to make the high-frequency, current-loop area as small as possible. Place 1-µF input capacitor GNDs as close to the respective PMID capacitor GND and PGND pins as possible to minimize the ground difference between the input and PMID_.
3. The local bypass capacitor from SYS to GND must be connected between the SYS pin and PGND of the IC. The intent is to minimize the current path loop area from the SW pin through the LC filter and back to the PGND pin.
4. Place all decoupling capacitors close to their respective IC pins and as close as possible to PGND (do not place components such that routing interrupts power stage currents). All small control signals must be routed away from the high-current paths.
5. The printed-circuit board must have a ground plane (return) connected directly to the return of all components through vias (two vias per capacitor for power-stage capacitors, one via per capacitor for small-signal components). It is also recommended to put vias inside the PGND pads for the IC, if possible. A star ground design approach is typically used to keep circuit block currents isolated (high-power/low-power small-signal) which reduces noise-coupling and ground-bounce issues. A single ground plane for this design gives good results. This small layout and a single ground plane eliminates ground-bounce issues, and having the components segregated minimizes coupling between signals.
6. The high-current charge paths into IN, USB, BAT, SYS, and from the SW pins must be sized appropriately for the maximum charge current in order to avoid voltage drops in these traces. The PGND pins must be connected to the ground plane to return current through the internal low-side FET.
7. For high-current applications, the balls for the power paths must be connected to as much copper in the board as possible. This allows better thermal performance because the board conducts heat away from the IC.

4 Bill of Materials and Board Layout

4.1 Bill of Materials

Table 1. Bill of Materials - HPA742

Count				RefDes	Value	Description	Size	Part Number	MFR
160	161	168	163						
2	2	2	2	C1, C3	1 µF	Capacitor, Ceramic, 25V, X5R, 10%	603	Std	Std
2	2	2	2	C2, C5	1 µF	Capacitor, Ceramic, 6.3V, X5R, 10%	402	Std	Std
2	2	2	2	C4, C12	47uF	Capacitor, Ceramic, 6.3V, X5R, 20%	1206	Std	Std
0	0	0	0	C6, C10	Open	Capacitor, Ceramic	1206	Std	Std
2	2	2	2	C7, C8	4.7 µF	Capacitor, Ceramic, 25V, X5R, 10%	805	Std	Std
1	1	1	1	C9	0.01 µF	Capacitor, Ceramic, 16V, X7R, 10%	603	Std	Std
1	1	1	1	C11	10 µF	Capacitor, Ceramic, 10V, X5R, 10%	603	Std	Std
2	2	2	2	D1, D2	Green	Diode, LED, Green, 2.1-V, 20-mA, 6-mcd	603	LTST-C190GKT	Liteon
6	6	6	6	J1, J3, J5, J9, J13, J16	ED555/2DS	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25	ED555/2DS	OST
0	0	0	0	J12	UX60-MB-5ST	Connector, Recpt, USB-B, Mini, 5-pins, SMT	0.354 X 0.303 Inches	UX60-MB-5ST	Hiroise Electrical Co
1	1	1	1	J17	N2510-6002-RB	Connector, Male Straight 2x5 pin, 100mil spacing, 4 Wall	0.338 x 0.788 inch	N2510-6002-RB	3M
10	10	10	10	J2, J4, J6, J7, J8, J10, J11, J14, J15, J18	PEC02SAAN	Header, Male 2-pin, 100mil spacing	0.100 inch x 2	PEC02SAAN	Sullins
3	3	3	3	JP1, JP2, JP5	PEC03SAAN	Header, Male 3-pin, 100mil spacing,	0.100 inch x 3	PEC03SAAN	Sullins
1	1	1	1	JP3	PEC02SAAN	Header, Male 2-pin, 100mil spacing,	0.100 inch x 2	PEC02SAAN	Sullins
0	1	1	0	JP4	PEC03SAAN	Header, Male 3-pin, 100mil spacing,	0.100 inch x 3	PEC03SAAN	Sullins
1	1	1	1	L1	1.5µH	Inductor, SMT, 3.5A, 70 mW	4.1x4.4 mm	SPM4012T-1R5M Alternate: FDSD0415-H-1R5M	TD Alternate: Toko
1	1	1	1	Q1	CSD25401Q3	MOSFET, PChan, -20V, 60A, 8.7 mΩ	QFN3.3X3.3mm	CSD25401Q3	TI
1	1	1	1	R1	1870	Resistor, Chip, 1/16W, 1%	603	Std	Std
1	1	1	1	R2	50.0k	Potentiometer, 3/8 Cermet, 12-Turn	0.25x0.17 inch	3266W-1-503LF	Bourns
1	1	1	1	R3	4120	Resistor, Chip, 1/16W, 1%	603	Std	Std
0	1	1	0	R4	0	Resistor, Chip, 1/16W, 1%	603	Std	Std
2	2	2	2	R5, R6	1.50K	Resistor, Chip, 1/16W, 1%	603	Std	Std
2	2	2	2	R7, R8	200	Resistor, Chip, 1/16W, 1%	603	Std	Std
7	7	7	7	TP1, TP2, TP3, TP4, TP6, TP7, TP10	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
2	2	2	2	TP8, TP9	5001	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone
4	4	4	4	TP5, TP11, TP12, TP13	5002	Test Point, White, Thru Hole Color Keyed	0.100 x 0.100 inch	5002	Keystone
1	0	0	0	U1	BQ24160RGE	IC, 2.5A, Dual-Input, Single Cell Switch-mode Li-Ion BATTERY CHARGER with	QFN3.3X3.3mm	BQ24160RGE	TI

Table 1. Bill of Materials - HPA742 (continued)

Count				RefDes	Value	Description	Size	Part Number	MFR
160	161	168	163						
0	1	0	0	U1	BQ24161RGE	IC, 2.5A, Dual-Input, Single Cell Switch-mode Li-Ion BATTERY CHARGER with	QFN3.3X3.3mm	BQ24161RGE	TI
0	0	1	0	U1	BQ24168RGE	IC, 2.5A, Dual-Input, Single Cell Switch-mode Li-Ion BATTERY CHARGER with	QFN3.3X3.3mm	BQ24168RGE	TI
0	0	0	1	U1	BQ24163RGE	IC, 2.5A, Dual-Input, Single Cell Switch-mode Li-Ion BATTERY CHARGER with	QFN3.3X3.3mm	BQ24163RGE	TI
4	5	5	4	—		Shunt, 100-mil, Black	0.100	929950-00	3M

4.2 Board Layout

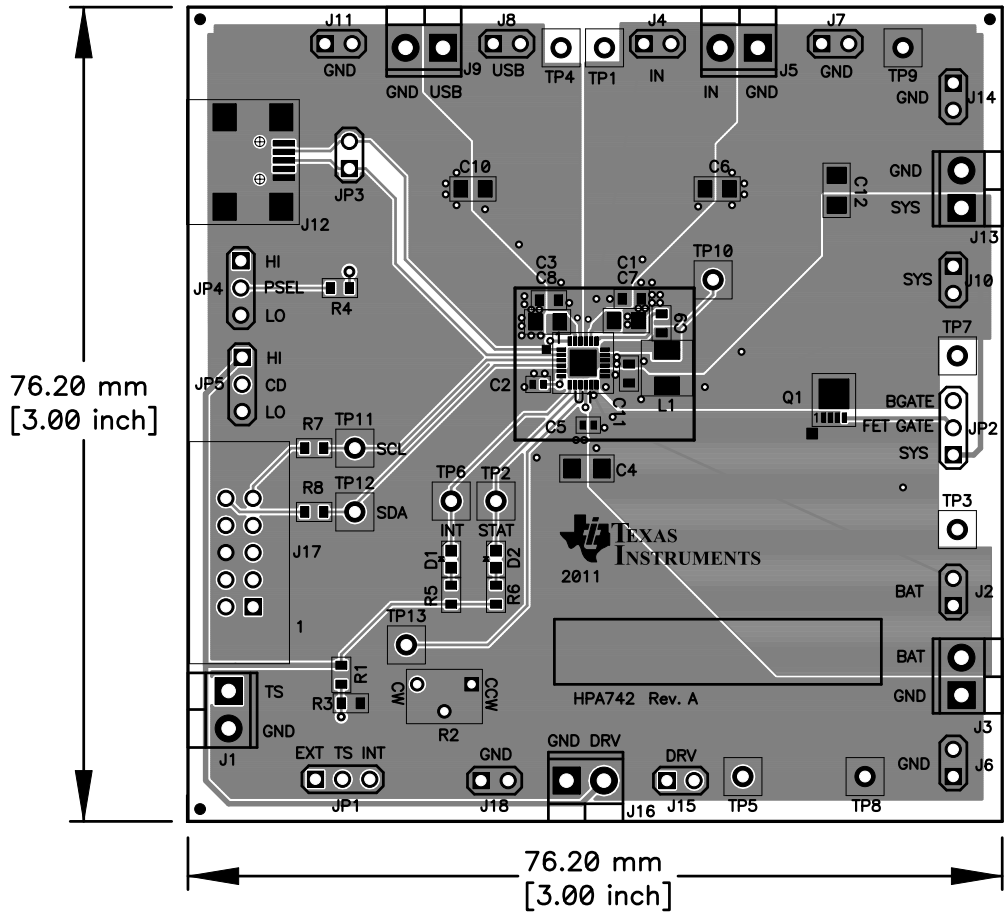

Figure 6. Top Assembly Layer

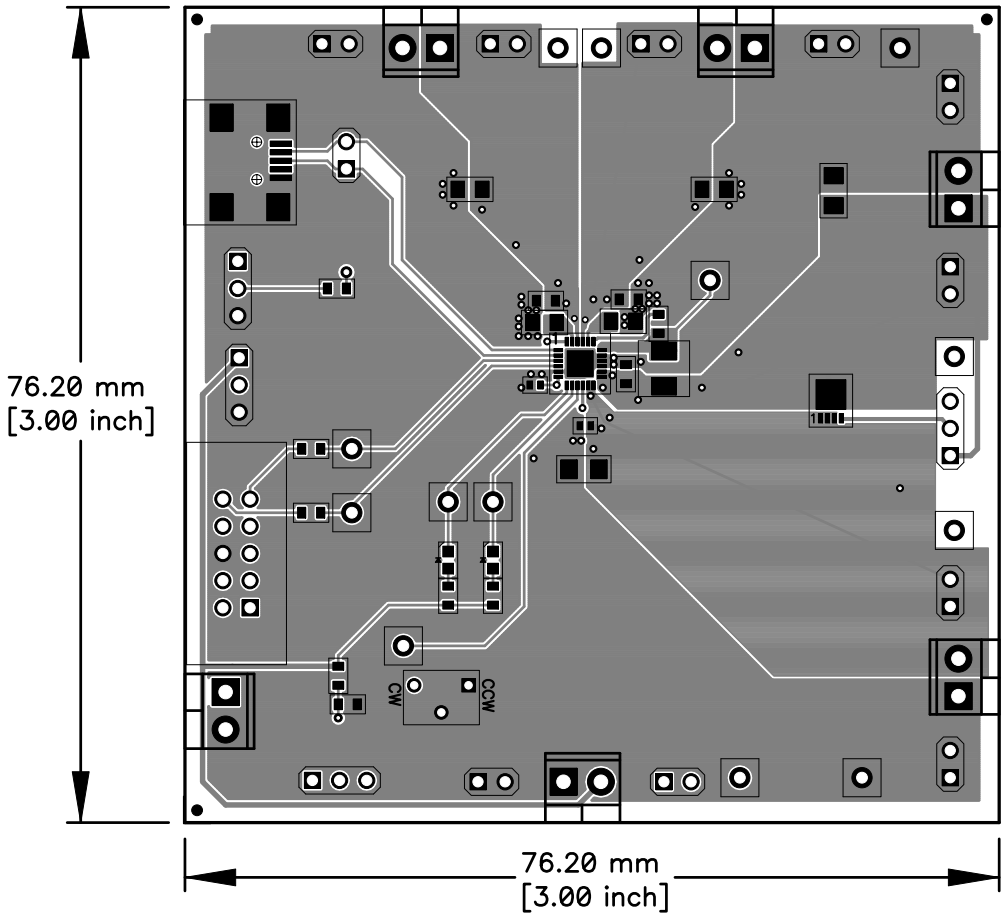

Figure 7. Top Layer

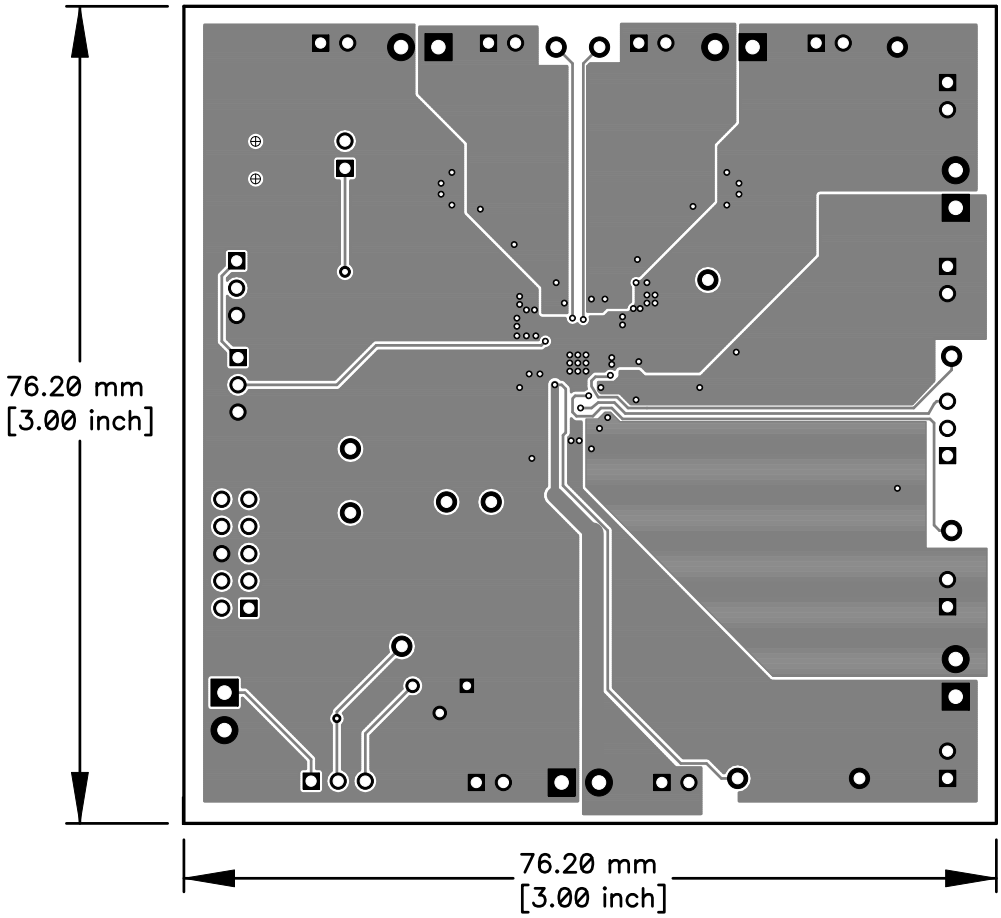

Figure 8. First Internal Layer

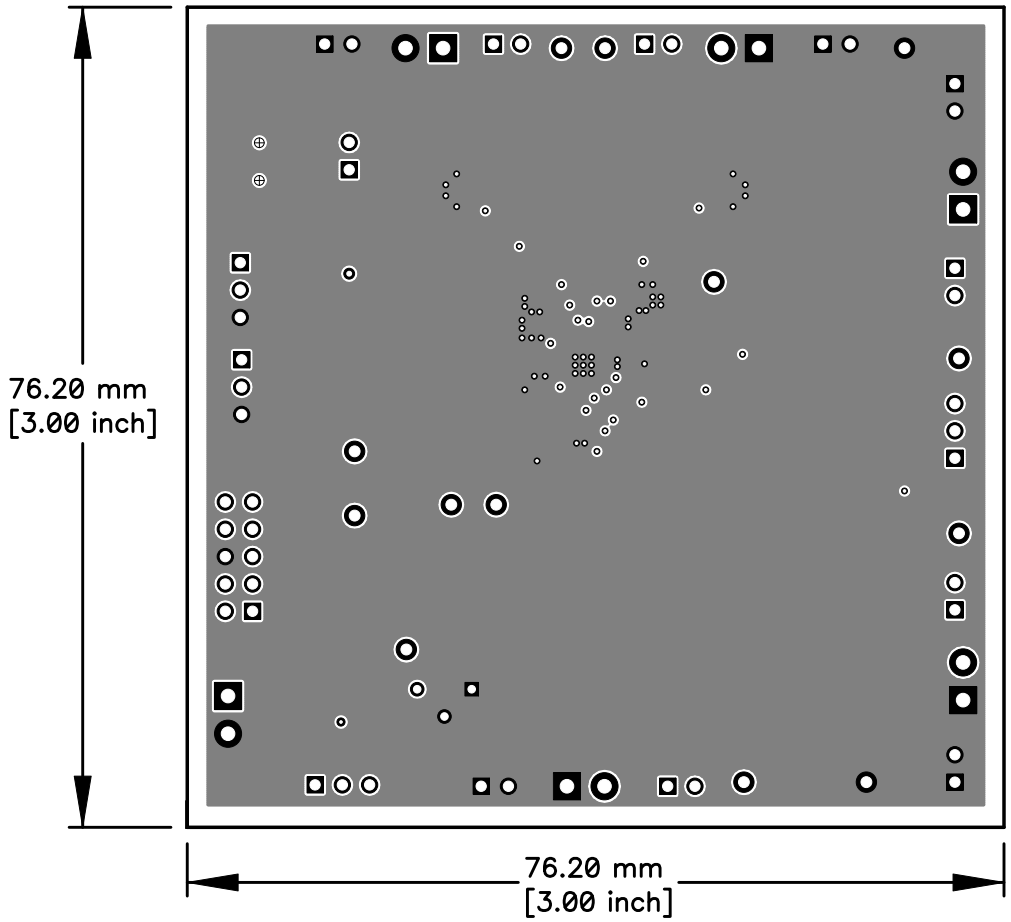

Figure 9. Second Internal Layer

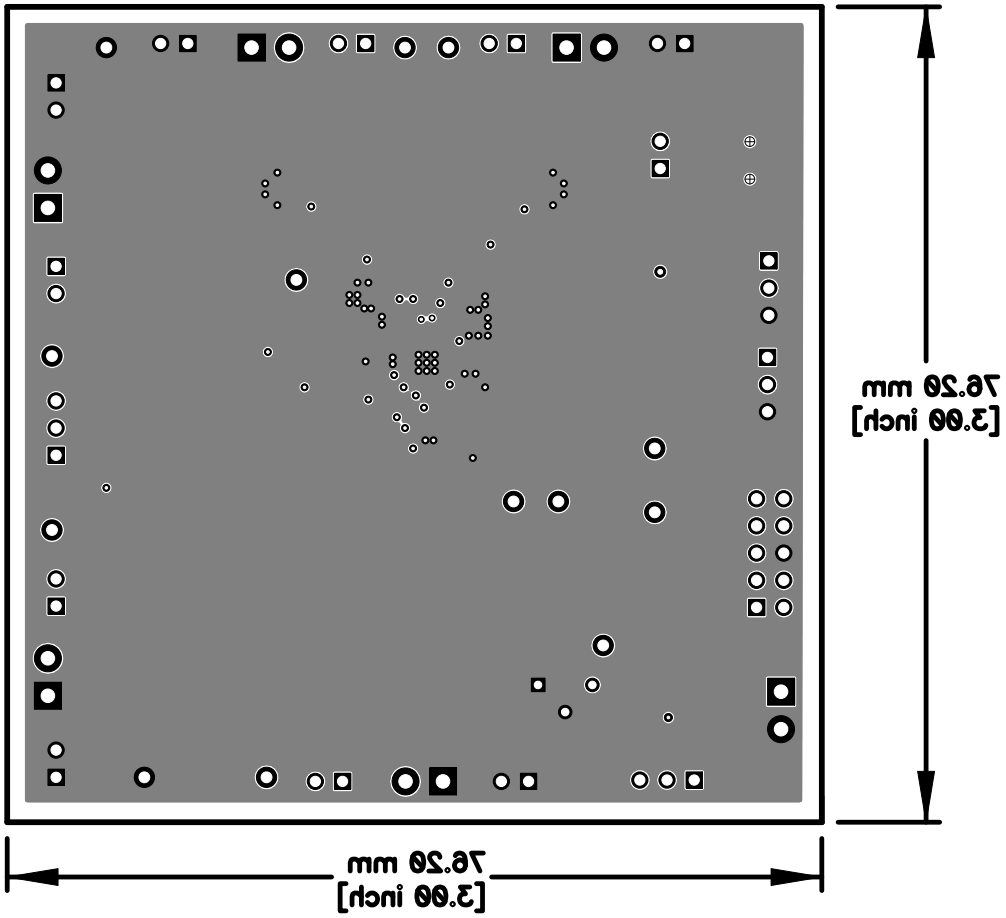

Figure 10. Bottom Layer

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This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 4 V to 6 V and the output voltage range of 0 V to 4.44 V .

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 65°C. The EVM is designed to operate properly with certain components above 125°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

Texas Instruments (TI) provides the enclosed Evaluation Board/Kit/Module (EVM) under the following conditions:

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please visit www.ti.com/esh or contact TI.

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REGULATORY COMPLIANCE INFORMATION

As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

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

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

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.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

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

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-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.

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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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.

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.

【Important Notice for Users of this Product in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

Texas Instruments Japan Limited
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http://www.tij.co.jp

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http://www.tij.co.jp

EVALUATION BOARD/KIT/MODULE (EVM)
WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

Certain Instructions. It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

Agreement to Defend, Indemnify and Hold Harmless. You agree to 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 use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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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 which meet ISO/TS16949 requirements, mainly for automotive use. Components which have not been so designated are neither designed nor intended for automotive use; and TI will not be responsible for any failure of such components to meet such requirements.

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