User's Guide
SLUU495A–October 2011–Revised September 2012

bq24140, Fully Integrated, Dual-Input, Switch-Mode, One-Cell, Li-Ion Charger With Full USB Compliance and USB-OTG Support EVM

The bq24140 evaluation module is a complete charger module for evaluating compact, flexible, high-efficiency, USB-friendly, switch-mode charge management and USB-OTG solution for single-cell Li-ion and Li-polymer batteries used in a wide range of portable applications.

Contents

List of Figures

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1 Introduction

1.1 EVM Features

- High-efficiency, fully integrated, NMOS-NMOS, synchronous buck charger with 3-MHz frequency
- Integrated power FETs for up to 1.55-A charge rate from either VIN or VBUS inputs
- Programmable battery voltage, charge current, and input current via I^{2}C™ interface
- VIN operating range 4 V – 9 V and VBUS operating range 4 V – 6 V
- Boost-mode operation for USB OTG from VBUS input while charging through VBAT
- LED indication for status signals
- Test points for key signals available for testing purposes. Easy probe hook-up
- Jumpers available. Easy-to-change connections.

1.2 General Description

The bq24140 evaluation module (EVM) is a complete charger module for evaluating compact, flexible, high-efficiency, USB-friendly, switch-mode charge management and USB-OTG solution for single-cell Li-ion and Li-polymer batteries used in a wide range of portable applications.

The bq24140, bq24145 integrates a synchronous PWM controller, power MOSFETs, input current sensing, high-accuracy current and voltage regulation, and charge termination into a small WCSP package. The charge parameters can be programmed through an I^{2}C interface.

For details, see the bq24140 data sheet. (SLUSAO5).

1.3 I/O Description

Header/Terminal Block	Description
J1–VIN	AC adapter positive input terminal
J1–GND	AC adapter negative input terminal
J2	USB-TO-GPIO box connector
J3-VBUS	USB positive input terminal
J3-GND	USB negative input terminal
J4-VIN	AC adapter positive input header
J5–GND	AC adapter negative input header
J6-VBUS	USB positive input header
J7-VBAT	Battery positive output terminal
J7-GND	Battery negative output terminal
J8-VREG	Internal regulator positive output terminal
J8-GND	Internal regulator negative output terminal
J9-GND	USB negative input header
J10-VBAT	Battery positive output header
J11-GND	Battery negative output header
J12-VREG	Internal regulator positive output header
J13-GND	Internal regulator negative output header

1.4 Test Point Descriptions

Test Point	Description
TP1	VIN
TP2	VBUS
TP3	PMID2

Test Point	Description
TP4	PMID1
TP5	SW2
TP6	SW1
TP7	CSIN
TP8	VREF
TP9	VREG
TP10	VBAT
TP11	GND - closest to VBAT
TP12	GND - closest to VIN
TP13	GND - closest to VBUS
TP14	SCL
TP15	SDA

1.5 Control and Key Parameters Setting

Jack	Description	Factory Setting
JP1	LED 1-2: Connect STAT pin to LED on EVM EXT - shunt removed to allow STAT to be connected to external output using pin 2 or pin 3	Shunt on LED (1-2)
JP2	High 1-2: OTG pin high (VREF or battery voltage) Low 2-3: OTG pin low (ground) See data sheet explanation of OTG pin functionality.	Shunt on High (1-2)
JP3	High 1-2: SLRST pin high (VREF or battery voltage) - The host can program the Safety Limit register until the first WRITE action to any other register. Low 2-3: SLRST pin low (ground) - All Safety Llimit values are reset to default values regardless of WRITE actions to the Safety Limit register.	Shunt on High (1-2)
JP4	High 1-2: DIS pin high (VREF or battery voltage) - Charge disable control pin is high, therefore charge is disabled. Low 2-3: DIS pin low (ground) - Charge disable control pin is low, therefore charge is enabled.	Shunt on Low (2-3)
JP5	INT 1-2: Connect LED pin to LED on EVM EXT - shunt removed to allow LED to be connected to external output using pin 2 or pin 3	Shunt on INT (1-2)

1.6 Recommended Operating Conditions

		Min	Typ	Max	Unit
Supply voltage, VIN	Input voltage from ac adapter input	4	5	9	V
USB voltage, VBUS	Input voltage from USB input	4	5	6	V
Battery voltage, V_{BAT}	Regulated voltage at VBAT terminals/headers	3.5		4.44	V
Supply current, I_{AC}	Maximum input current from ac adapter input			1.8	A
Supply current, I_{VBUS}	Maximum input current from USB input			1.7	A
Fast-charge current, I_{chrg}	Battery fast-charge current	0.55		1.55	A
Operating junction temperature range, T_J		0		125	°C

2 Test Summary

This procedure details how to configure the HPA697 evaluation board for bench evaluation. An electronic load is used to simulate a battery.

2.1 Definitions

This procedure details how to configure the PWR003 evaluation board. The following naming conventions apply. See the PWR003 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 jack terminal Jxx
V(TP(XXX)):	Voltage at test point XXX. For example, V(ACDET) means the voltage at the test point that is marked as ACDET.
V(XXX, YYY):	Voltage across point XXX and YYY.
I(JXX(YYY)):	Current going out from the YYY terminal of jack XX.
Jxx(BBB):	Terminal or pin BBB of jack xx
Jxx ON :	Internal jumper Jxx terminals are shorted.
Jxx OFF:	Internal jumper Jxx terminals are open.
Jxx (-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): a power supply capable of supplying 5 V at 2 A is required.

2.2.2 Load #1

A 10-V (or above), 2-A (or above) electronic load that can operate in constant-current or resistance mode.

2.2.3 Load #2

A 10-V (or above), 2-A (or above) electronic load that can operate in constant-voltage mode or a source meter to simulate a battery.

2.2.4 Meters

Two equivalent voltage meters and two equivalent current meters. The current meters must be able to measure a 2-A current.

2.2.5 Computer

A computer with at least one USB port and a USB cable. The bq2414x evaluation software must be properly installed.

2.2.6 HPA172 Communication Kit (USB TO GPIO)

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

2.2.7 Software

Download BQ2414xSW.zip from the charger's product folder, unzip the file, and double-click on the SETUP.EXE file. Follow the installation steps.

2.3 Recommended Test Equipment Setup

1. Set Power Supply #1 for 5 V ± 100 mVdc, 2-A ± 0.1-A current limit, and then turn off supply.
2. Connect the output of Power Supply #1 in series with a current meter (multimeter) to J1 (VIN, GND).
3. Connect a voltage meter across J4 and J5 (VIN, GND).
4. Connect the Load #2 in series with a current meter (multimeter) to J7 (BAT, GND). Ensure that a voltage meter is connected across J10 or TP10 and J11 or TP11 (BAT, GND).
5. Turn on the Load #2. Use the constant voltage mode. Set the output voltage to 2.5 V.
6. Turn off Load #2.
7. Connect the HPA172 USB-TO-GPIO to J2 using 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 1.

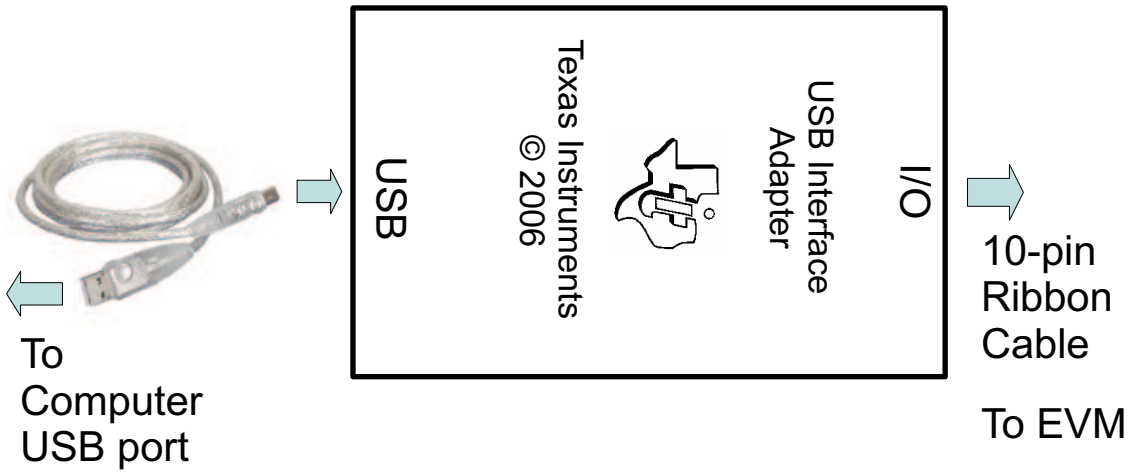


Figure 1. Connections of HPA172 Kit

8. Install jumpers per Section 1.5
9. After the preceding steps have been performed, the test setup for charging from VIN is shown in Figure 2

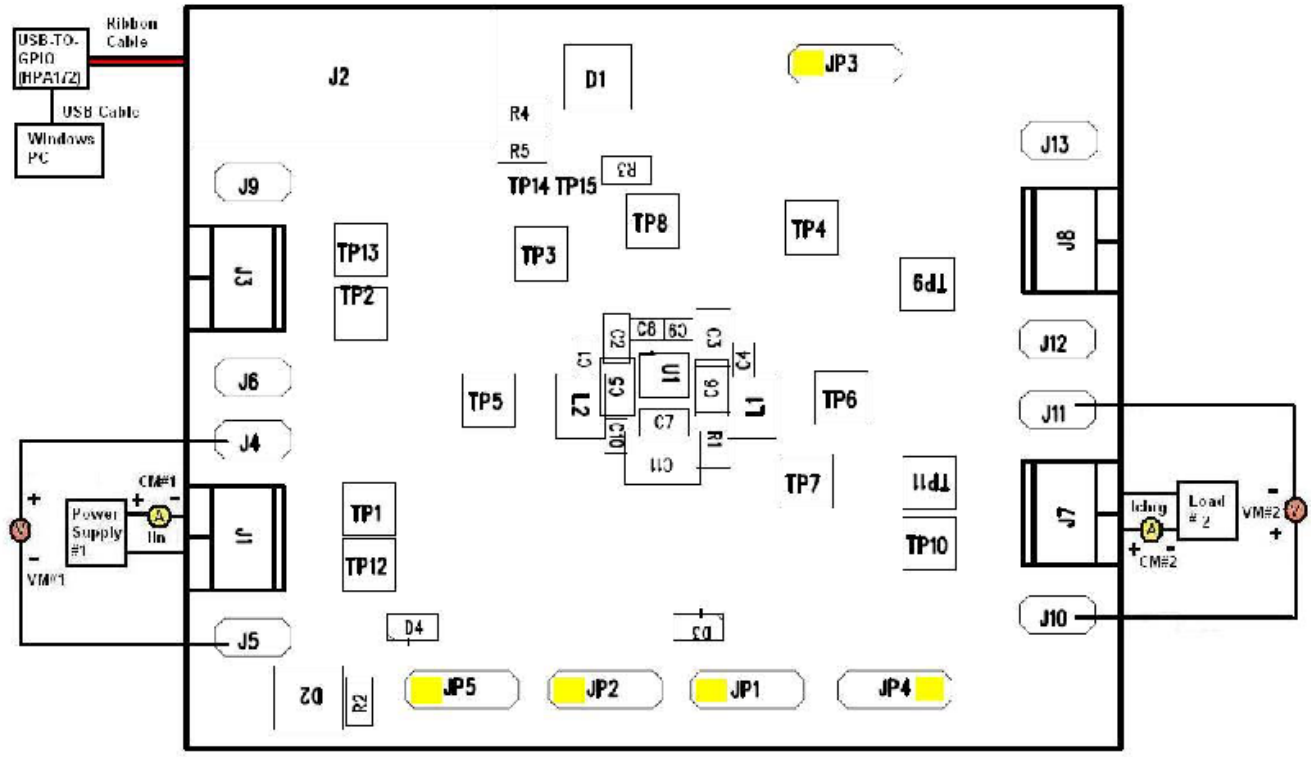


Figure 2. Test Setup for Charging From VIN

10. Turn on the computer, and open the bq2414x evaluation software. The main window of the software is shown in Figure 3.

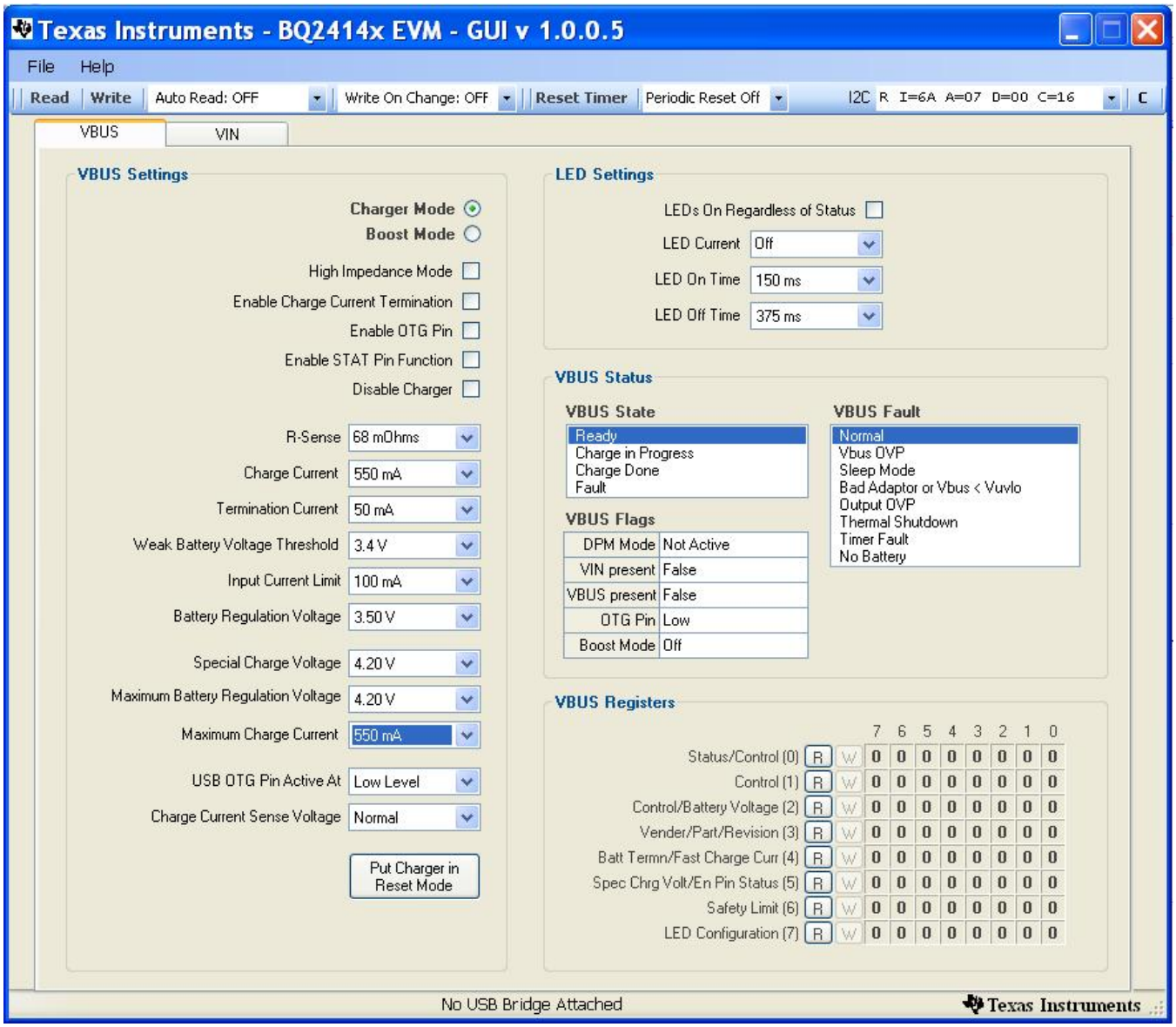


Figure 3. Main Window of bq2414x Evaluation Software

2.4 Recommended Test Procedure

The following test procedure may be 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 #2).

2.4.1 Maximum Charge Current and Maximum Battery Regulation Voltage in the Safety Limit Register

The Maximum Charge Current and Maximum Battery Regulation Voltage values for each input are stored in the Safety Limit Register. If the default values (950mA maximum charge current and 4.20V maximum charge voltage) are acceptable for your application, this step is unnecessary. If not, the Safety Limit Register bits are reset to default values and can be changed immediately after V(VBAT) transitions from below V_{SHORT} (2.05V typ) to above V_{SHORT} if the SLRST pin is logic high. In addition, the Safety Limit Register bits are reset to default values and can be changed immediately after the SLRST pin transitions from logic low to logic high if V(VBAT) is above V_{SHORT} (2.05V typ). Once a change (WRITE command) to any other register is made, the safety limit registers are locked until one of the previously explained transitions occur. The following steps are recommended to modify any of the Safety Limit Register bits.

1. Ensure that Section 2.3 steps are followed.
2. Turn on PS#1. Turn on Load#2 but set its constant voltage to below 2.05V and move the SLRST jumper shunt to LO.
3. With the software running, disable the **Immediate Updates**, **Periodic Resets**, and **Periodic Reads** features.
4. Increase Load#2 constant voltage to 2.5V and move the SLRST jumper shunt to HI.
5. Use the appropriate drop-down box (Maximum Battery Regulation Voltage or Maximum Charge Current) to select the desired maximum value.
6. Click the now active **W**rite button(S) in VBUS registers section in the lower right corner of the GUI.
7. Re-enable the **Immediate Updates**, **Periodic Resets**, and optionally **Periodic Reads**

The Maximum Charge Current and Maximum Battery Regulation Voltages drop down boxes now display the updated values and the charger is now ready for evaluation.

2.4.2 Charge Voltage and Current Regulation from VIN

1. Ensure that the Section 2.3 steps are followed. Turn on PS #1.
2. Software setup on VIN tab:
   - Ensure that **Immediate Updates** is enabled.
   - Check **Periodic Resets**, and set Rate to 5 seconds.
   - Ensure that **Operation Mode** is Charger mode.
   - Uncheck **Charge Current Termination**.
   - Check **STAT** pin.
   - Ensure that the **Input Current Limit** is 500 mA.
   - Ensure that the **Charge Current** is 550 mA.
   - Set **Charge Current Sense Voltage** to Normal.
   - Set **Battery Regulation Voltage** to 4.2 V.

   Measure on VM #2 → V(J10/TP10, J11,TP11(VBAT, GND)) = 4.2 ± 100 mV

   Observe → D3 is on and D4 is blinking.
3. Enable Load #2. Adjust PS #1 so that VM #1 still measures 5 V ± 100 mV

   Measure on CM #2→ Ichrg = 550 mA ± 50 mA

   Measure on CM #1→ Iin = 300 mA ± 50 mA
4. Software setup: Check **Disable Charger**.
5. Turn off PS #1, turn off Load #2, and disconnect.

2.4.3 Charge Voltage and Current Regulation from VBUS

1. Connect the output of Power Supply #1 in series with a current meter (multimeter) to J3 (VBUS, GND).
2. Connect a voltage meter across J6 and J9 (VBUS, GND).
3. Repeat steps in Section 2.4.2 except on the VBUS tab.

2.4.4 Boost Function

1. Adjust PS #1 output to 3.7 V, and disable the output.
2. Connect the PS #1 in series with a current meter (multimeter) to J7 (BAT, GND). Ensure that a voltage meter is connected across J10/TP10 and J11/TP11 (BAT, GND).
3. Set the Load #1 so that either constant current or equivalent resistance yields a 200 mA ± 20 mA dc load, then disable the output. Connect the output of the Load #1 in series with a current meter (multimeter) to J3 (VBUS, GND). Ensure that a voltage meter is connected across J6/TP2 and J9/TP13 (VBUS, GND). The setup is now configured as is shown in Figure 4 for PWR003.

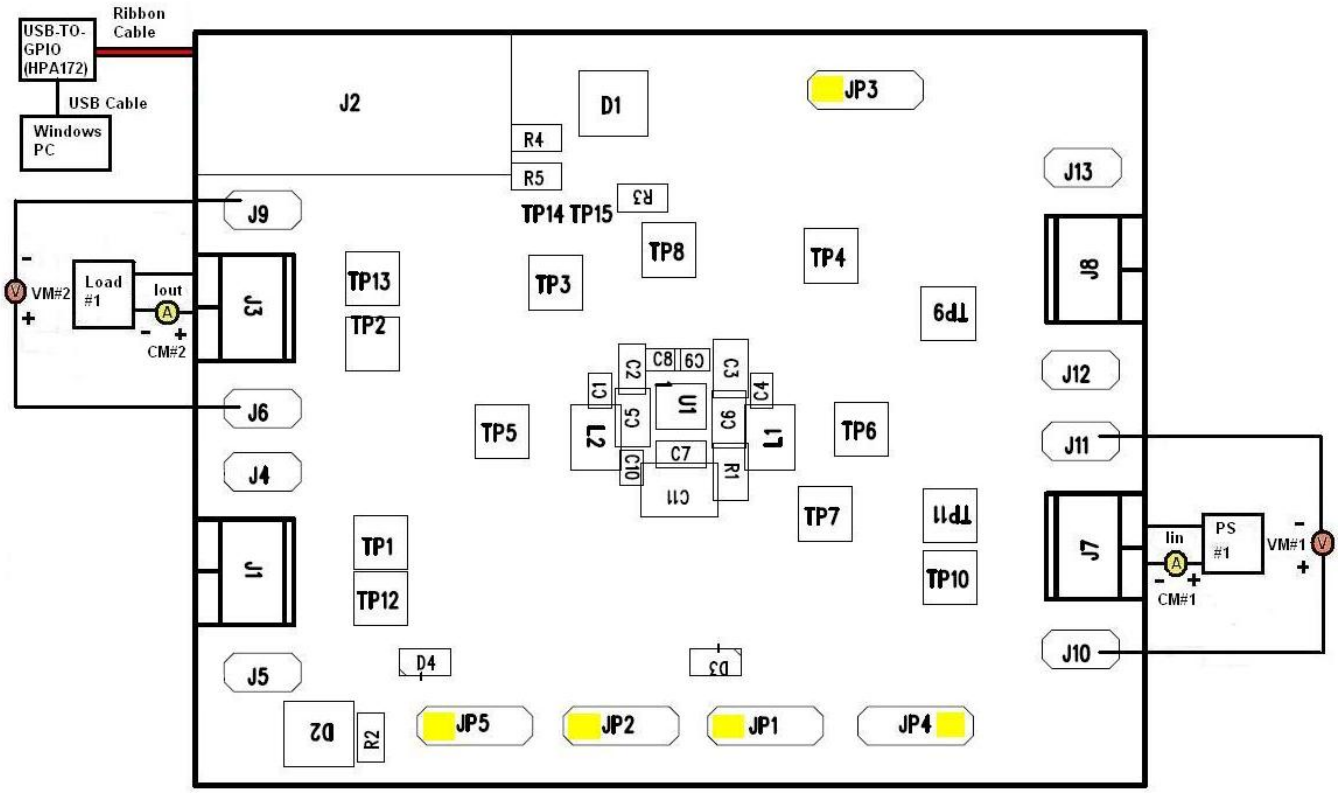


Figure 4. Test Setup for USB OTG Boost Mode

4. Turn on PS #1 output.
5. Software setup: Change **Operation Mode** to Boost mode.

   Measure on VM #2→ V(J6/TP2, J9/TP13(VBUS, GND)) = 5 V ± 0.2 V
6. Enable Load #1.

   Measure on VM #2 → V(J6/TP2, J9/TP13(VBUS, GND)) = 5 V ± 0.2 V

   Measure on CM #1→ Iin = 330 mA ± 40 mA

   Measure on CM #2→ Io = 200 mA ± 20 mA
7. Turn off PS #1, turn off Load #1, and disconnect.

3 Printed-Circuit Board Layout Guideline

1. To obtain optimal performance, the power input capacitors, connected from input to PGND, must be placed as close as possible to the integrated circuit (IC).
2. The output inductor must be placed close to the IC and the output capacitor connected between the inductor 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. To prevent high-frequency oscillation problems, proper layout to minimize high-frequency current path loop is critical.
3. The sense resistor must be adjacent to the junction of the inductor and output capacitor. Route the sense leads connected across the RSNS back to the IC, close to each other (minimize loop area) or on top of each other on adjacent layers (do not route the sense leads through a high-current path).
4. Place all decoupling capacitors close to their respective IC pin and as close as 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 PCB must have a ground plane (return) connected directly to the return of all components through vias (two vias per capacitor for power-stage capacitors, two vias for the IC PGND, one via per capacitor for small-signal components). 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. No ground-bounce issue occurs with this small layout and a single ground plane. Having the components segregated minimizes coupling between signals.

6. The high-current charge paths into VBUS, PMID, 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.

4 Bill of Materials, Board Layout, and Schematics

4.1 Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
1	C2	1.0uF	Capacitor, Ceramic, 25V, X5R, 10%	0603	STD	STD
1	C8	1.0uF	Capacitor, Ceramic, 6.3V, X5R, 10%	0402	STD	STD
4	C1, C4, C9, C10	0.1uF	Capacitor, Ceramic, 25V, X5R, 10%	0402	STD	STD
3	C3, C5, C6	4.7uF	Capacitor, Ceramic, 25V, X5R, 10%	0805	STD	STD
1	C7	10uF	Capacitor, Ceramic, 10V, X5R, 20%	0603	STD	STD
1	C11	47uF	Capacitor, Ceramic, 10V, X5R, 10%	1210	STD	STD
2	D1, D2	BAT54C	Diode, Dual Schottky, 200-mA, 30-V	SOT23	BAT54C	Vishay-Liteon
1	D3	LTST-C190GKT	Diode, LED, Green, 2.1V, 10-mA, 6-mcd	0603	LTST-C190GKT	Lite On
1	D4	LTST-C193KRKT	Diode, LED, Red, 2V, 5-mA, 26-mcd	0603	LTST-C193KRKT	Lite On
1	J2	N2510-6002RB	Connector, Male Straight 2x5 pin, 100mil spacing, 4 Wall	0.338 x 0.788 inch	N2510-6002RB	3M
4	J1, J3, J7, J8	ED555/2DS	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25 inch	ED555/2DS	OST
8	J4-6, J9, J10-13	PEC02SAAN	Header, Male 2-pin, 100mil spacing,	0.100 inch x 2	PEC02SAAN	Sullins
5	JP1 - JP5	PEC03SAAN	Header, Male 3-pin, 100mil spacing,	0.100 inch x 3	PEC03SAAN	Sullins
2	L1-2	1.0uH	Inductor, SMT ±30%	2x2.5 mm	1239AS-H-1R0N	Toko
1	R1	0.068	Resistor, Chip, 1/10W, 1%	0805	STD	STD
1	R2	1.50k	Resistor, Chip, 1/16W, 1%	0603	STD	STD
1	R3	0	Resistor, Chip, 1/16W, 1%	0603	STD	STD
2	R4, R5	200	Resistor, Chip, 1/16W, 1%	0603	STD	STD
10	TP1-TP10	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
3	TP11-TP13	5001	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone
0	TP14-TP15	STD	Test Point, 0.020 Hole		STD	STD
1	U1	BQ24140YFF	IC, Switch-Mode One-Cell Li-Ion Charger	WCSP	BQ24140YFF	TI
5	–		Shunt, 100-mil, Black	0.100	929950-00	3M
1	–		PCB, 1.97" x 2.48" x 0.031"		PWR003	Any

4.2 Board Layout

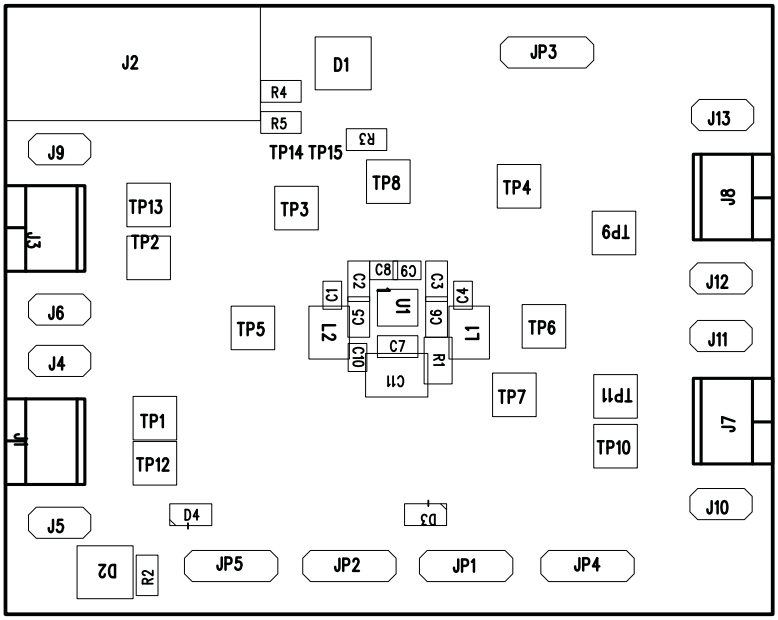


Figure 5. Assembly Top Layer

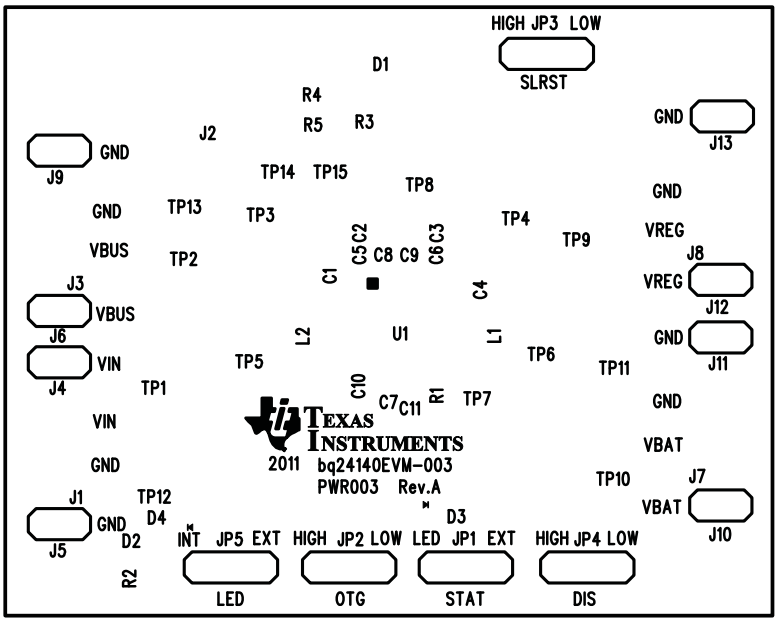


Figure 6. Top Silk Layer

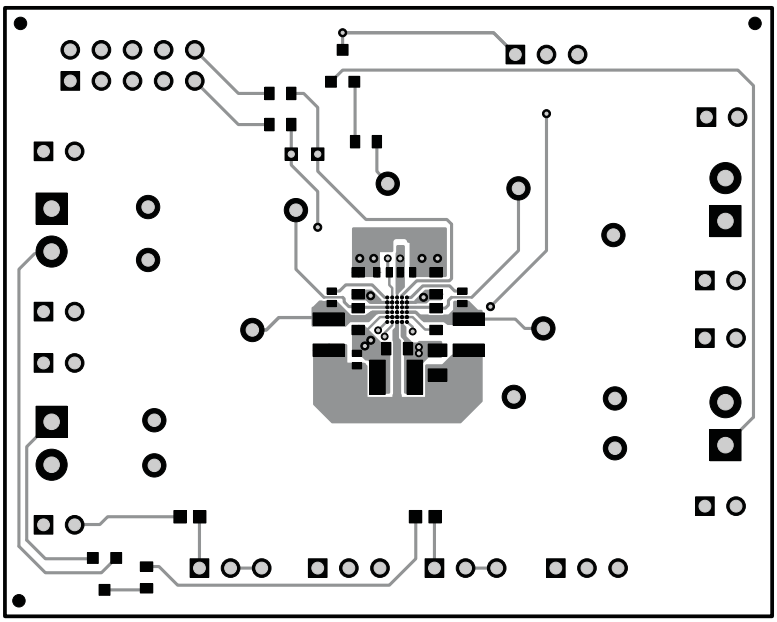


Figure 7. Top Layer

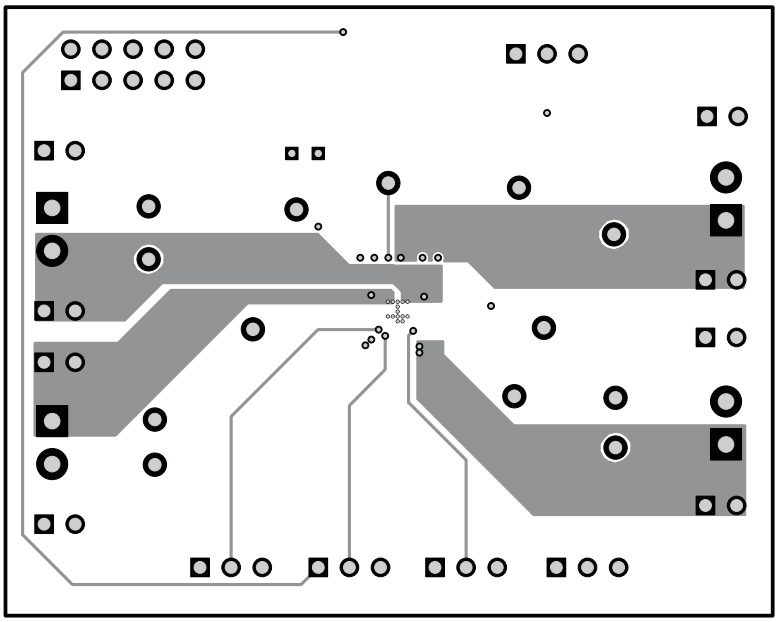


Figure 8. Internal 1

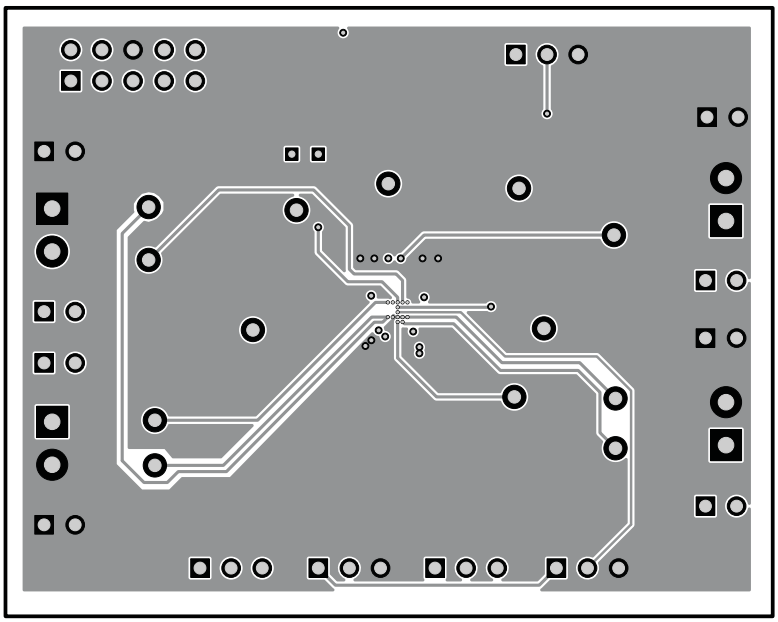


Figure 9. Layer 3

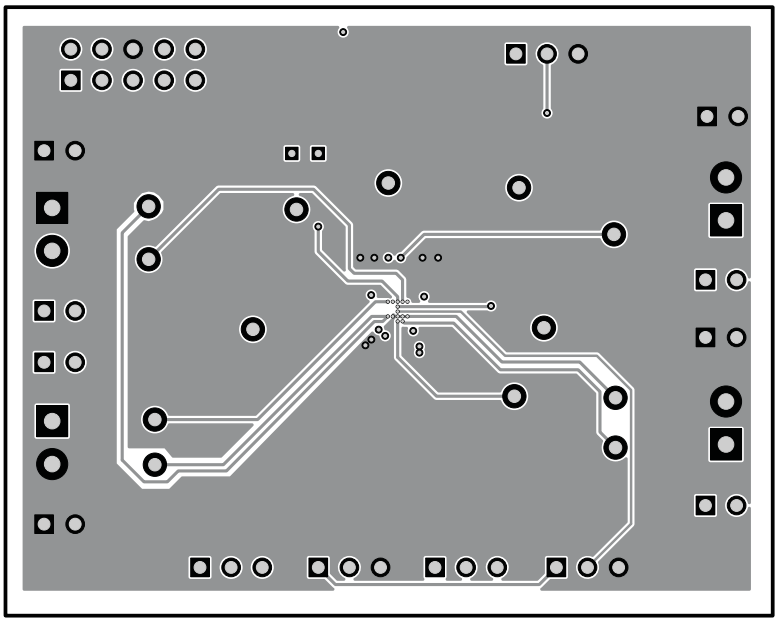
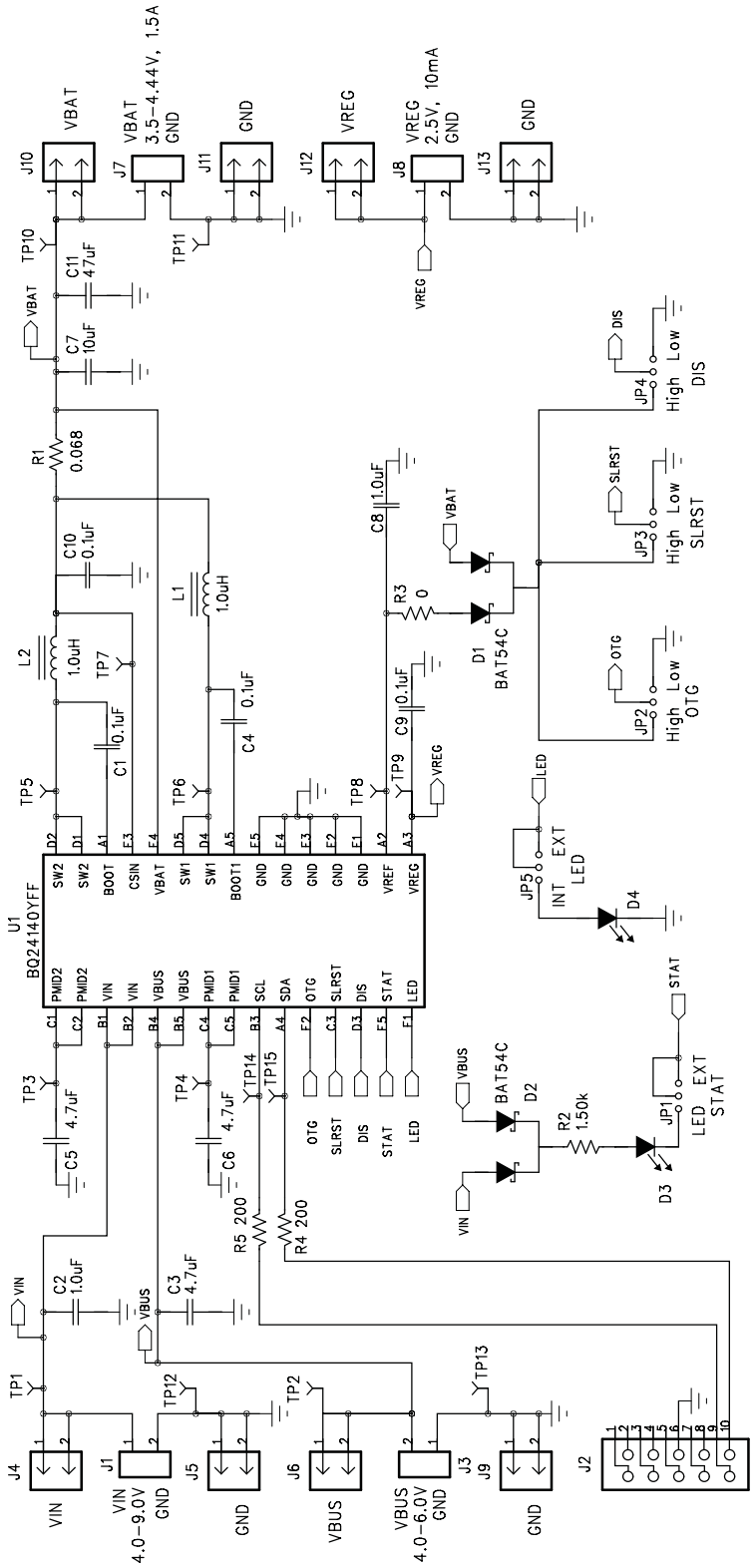


Figure 10. Bottom Layer

4.3 Schematic



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.

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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.

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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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