

bq2406x Evaluation Module

1 Introduction

This user's guide describes the bq2406x evaluation module (EVM). The EVM provides a convenient method for evaluating the performance of a charge management solution for portable applications using the bq2406x product family. A complete designed and tested charger is presented. The charger is designed to deliver up to 1 A of continuous charge current for single-cell Li-Ion or Li-polymer applications using a DC power supply.

1.1 Background

The bq2406x series are highly integrated Li-Ion and Li-polymer linear chargers, targeted at space-limited portable applications. The bq2406x series offers a variety of safety features and functional options, while still implementing a complete charging system in a small package. The battery is charged in three phases: conditioning, constant or thermally regulated current, and constant voltage. Charge is terminated based on minimum current. An internal programmable charge timer provides a backup safety feature for charge termination and is dynamically adjusted during the thermal regulation phase. The bq2406x automatically re-starts the charge if the battery voltage falls below an internal threshold; sleep mode is set when the external input supply is removed. Multiple versions of this device family enable easy design of the bq2406x in cradle chargers or in the end equipment, while using low-cost or high-end AC adapters.

1.2 Performance Specification Summary

This section summarizes the performance specifications of the EVM. [Table 1](#) gives the EVM performance specifications.

Table 1. Performance Specification Summary

SPECIFICATION	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input DC Voltage, $V_{I(DC)}$		$V_{REG} + 0.5$	5	12 ⁽¹⁾	Volts
Battery Charge Current, $I_{O(CHG)}$				1 ⁽¹⁾	Amperes
Power Dissipation	$(V_{(DC+)} - V_{(BAT+)}) \times I_{(CHG)}$			1.5	Watts

- ⁽¹⁾ This maximum recommended input of the IC is 16.5 V. The IC has an OVP (overvoltage protection) input circuit that disables the charging circuit if the threshold is exceeded. Most IC selections are set for 6.5 V, but some are set as high as 12 V (see data sheet specification). The EVM can handle an input voltage up to the recommended maximum of 16.5 V, but the IC will be shut down due to the internal voltage protection. It is recommended that in normal operation the IC be designed and run below the thermal regulation junction temperature of 125°C. The thermal loop can run continuously without any issues, but the suggested thermal loop operational use is for more harsh environments where the ambient temperature is high (e.g., in an automobile during the summer) or with an incorrect adaptor with a higher input voltage. For typical input and ambient conditions with the PowerPAD™ tied to a copper plane, one can expect 1.5 W of heat dissipation prior to the thermal loop reducing the current. $P_{dissIC} = I_{CHG} \times (V_{DC+} - V_{BAT+})$. For the worst-case, steady-state thermal condition, $V_{BAT+} = 3.4$ VDC (the battery when transitioning from precharge to fast charge reaches a steady-state value after approximately 2 minutes). If the thermal regulation limit of 125°C is reached, then the charging current is adjusted lower.

2 Test Summary

This section shows the test setups used and the tests performed in evaluating the EVM.

Setup: The bq2406xEVM board requires a 5-VDC, 1-A power source to provide input power and a single-cell Li-ion or Li-polymer battery pack. The test setup connections and jumper setting selections are configured for a stand-alone evaluation but can be changed to interface with external hardware such as a microcontroller.

Table 2. I/O and Jumper Connections

Jack	Connect To:
J1-DC+	Power supply positive, preset to 5 VDC, 1-A current limit.
J1-DC-	Power supply ground
J2-BAT+	Positive battery pack terminal
J2-BAT-	Negative battery pack terminal
J2-TS	NC
J2-BAT-	NC
J3-STAT1	External hardware if J4-EXT is jumpered (Not jumpered from factory)
J3-STAT2	External hardware if J5-EXT is jumpered (Not jumpered from factory)
J3-DC-	Return for J3 signals
J3-PG	External hardware if J6-EXT if jumpered (Not jumpered from factory)
J4 (Jumper)	STAT1 indication location – LED⁽¹⁾ (EVM) EXT
J5 (Jumper)	STAT2 indication location – LED⁽¹⁾ (EVM) EXT
J6 (Jumper)	PG indication location – LED⁽¹⁾ (EVM) EXT
J7 (Jumper)	TMR enable - Installed⁽¹⁾

⁽¹⁾ Factory jumper selections are shown in **BOLD**.

2.1 Test Procedure

Set up the evaluation board as previously described by making the necessary I/O connections and jumper selections. Prior to test and evaluation, it is important to verify that the maximum power dissipation on the IC is not exceeded, $P_{(MAX)} = 1.5 \text{ W}$.

1. Turn on the power supply, which was preset to 5 VDC, and 1 A for the current-limit setting.
2. The bq2406x enters preconditioning mode if the battery is below the $V_{(LOWV)}$ threshold. In this mode, the bq2406x precharges the battery with a low current (typically $IO(CHG) / 10 = 0.7A / 10 = 70 \text{ mA}$) until the battery voltage reaches the $V_{(LOWV)}$ threshold or until the precharge timer expires. If the timer expires, then the charge current is terminated and the bq2406x enters fault mode. Both LEDs turn off when in fault mode. Toggling input power or battery replacement resets fault mode.
3. Once the battery voltage is above the $V_{(LOWV)}$ threshold, the battery enters fast-charge mode. This EVM is programmed for 0.7 A of fast-charging current.
4. Once the battery reaches voltage regulation (4.2 V), the current tapers down as the battery reaches its full capacity.
5. The battery remains at the fast charge mode until either the charge timer expires or the charge termination current threshold is reached.
6. Once the charge terminates, J7 (TMR jumper) can be removed, putting the IC in LDO mode, and the charger should turn on the supply 4.2 V or the programmed fast-charge current. Replacing the jumper allows the IC to terminate properly. Note that loads across the battery can affect termination.
7. If the battery discharges to the recharge threshold, the charger starts fast charging.

Note: Because of the battery detection circuit, it is difficult to test the different charge phases without a battery (using just resistors); the algorithm sinks and sources current and applies precharge and fast-charge current depending on the mode it is in. Applying a load that would keep the voltage at 3.5 V (3.5 V/0.7 A) would pull the output into precharge mode and keep it there during the battery detection algorithm, which always occurs when the output is discharged to the refresh threshold. Once in precharge mode, a load sufficient to allow the capacitor to charge to $V_{(lowV)}$ would allow the output to jump to voltage regulation once the 0.7-A fast charge function activated.

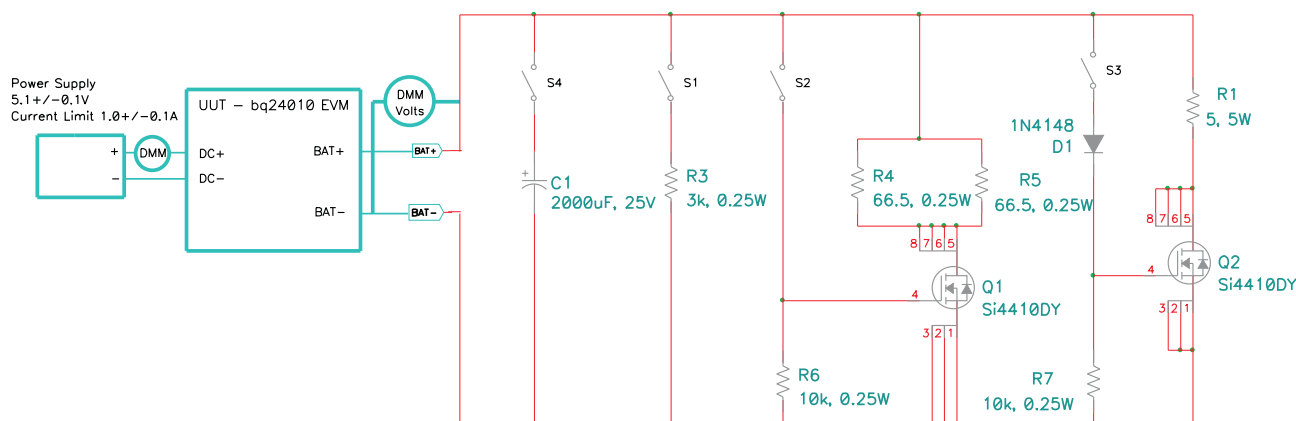
In place of a battery, a source meter that can sink current can easily be adjusted to test each mode.

To briefly see each mode on a scope, connect a 1-mF capacitor in parallel with a 20-k Ω resistor on the output in place of a battery to observe the power up and cycling between voltage regulation and fast charge via the refresh threshold.

This is an alternative way of testing the EVM using a dynamic load board in place of a battery. The circuit is adjusted to work with the displayed parts and their inherent thresholds. The sequence of the test procedure is important due to the active battery detection circuit, refresh feature, precharge, and fast-charge current levels (switching the load in and out in different modes has different results). No damage should occur, but one might get different results than anticipated if the procedure is altered.

2.1.1 EQUIPMENT

1. Power Source: Current-limited 5-V laboratory power supply with its current limit set to 1 A \pm 0.1 A
2. Two Fluke 75 digital multimeters, equivalent or better
3. Oscilloscope – TDS220 or better
4. Load test board:



2.1.2 EQUIPMENT SETUP

1. Connect the load board to the BAT+ and BAT-. Set SW1 through SW4 in the closed position.
2. Connect a voltage meter to the BAT+/BAT- output to monitor the output voltage. (The range is 0 V to 5 V.)
3. Set the laboratory power supply for 5.1 V \pm 0.1 VDC, 1-A \pm 0.1-A current limit and then turn off this supply. Connect the source supply to a current meter and to J1, noting polarity (an internal source current meter can be used if it has 5% or better accuracy).
4. Install shunt jumpers on the **LED** pins 1 and 2 of each header J4, J5, and J6 and also on J7-1/2 TMR.

2.1.3 PROCEDURE

1. Ensure that the preceding Equipment Setup steps are followed (switches should be in the closed position, shunts installed, and the power source set to 5.1 V \pm 0.1 VDC). Turn on the power source.
2. Verify that the output voltage, BAT+, charges to between 2.5 V to 2.9 V and the red LED (D1) is lit (all

Test Summary

- dash numbers).
3. Verify that the green LED (D3) is lit for -001/2/5/6/7.
 4. Verify that the voltage on J2-2 (TS, \overline{CE} , \overline{TE}) to J2-1 (BAT-) is between 2 VDC to 3 VDC for -001/3/5/6, between 0 VDC to 0.4 VDC for -002/7, and between 4.6 VDC to 5.6 VDC for -004.
 5. Verify the voltage between J6-2 (\overline{CE}) and J1-2 (DC-) for -003/4. Jumper should not be shorting J6 pins.
 6. Open switch SW2, and then close it.
 7. Verify that the output voltage, BAT+, settles between 3.2 V to 3.95 V.
 8. Verify that the input current is between 0.69 A to 0.75 A.
 9. Open switch SW3.
 10. Verify that the input current is between 100 mA and 150 mA.
 11. Verify that the output voltage, BAT+, is between 4.150 VDC and 4.250 VDC.
 12. Open switch SW2.
 13. With a scope (250 ms/div, 1 V/div), verify that output, BAT+, charges and discharges between the maximum limits of 3 V and 4.7 V, with a period of between 600 ms to 850 ms.
 14. Verify that the LEDs flash between red (D1) and green (D2, mostly on green).
 15. Remove J7 and verify that voltage on BAT+ is between 4.150 VDC and 4.250 VDC, and the red LED (D1) turns on.
 16. Install J7.
 17. Open SW4, and verify that D1 and D2 are off and D3 is on (D3 does not apply to -003/4).
 18. With a scope on BAT+, verify that a square wave is seen between the maximum limits of 1.3 VDC and 4.35 VDC and between 3.5 Hz and 4.5 Hz.
 19. Close switches SW2, SW3, and SW4 (all switches should be closed now), and power down the supply.

3 Schematic

This section contains the schematic diagram for the EVM.

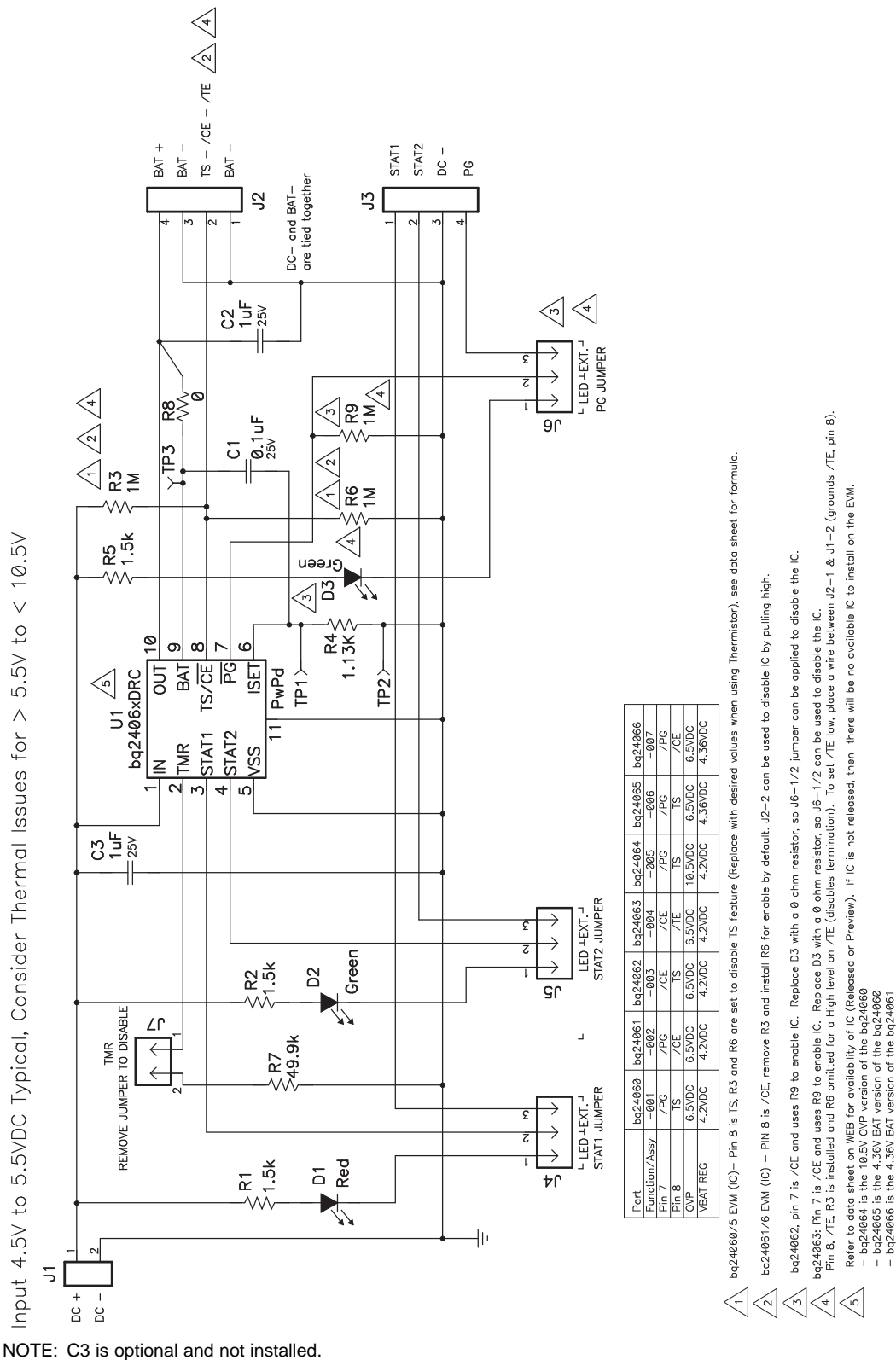


Figure 1. EVM Schematic Diagram

4 Physical Layouts

This section contains the board layout and assembly drawings for the EVM. [Figure 2](#), [Figure 3](#), and [Figure 4](#) show the top layer, the bottom layer, and the top assembly view of the EVM, respectively.

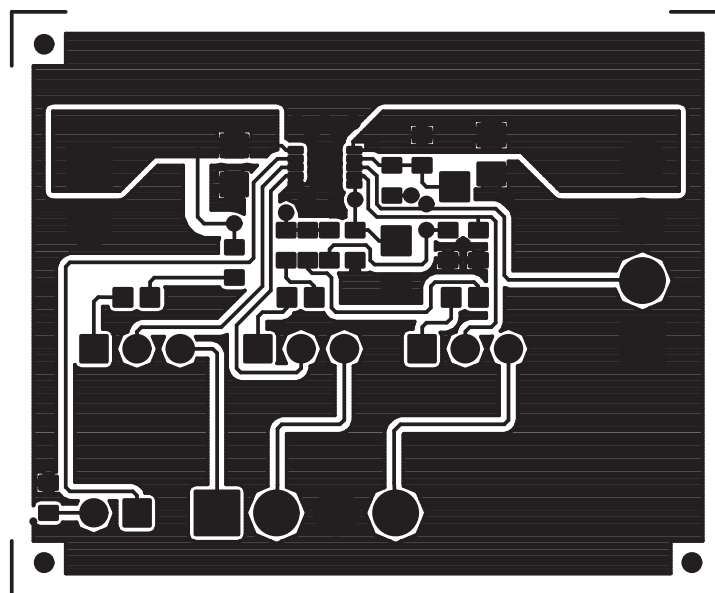


Figure 2. Board Layout Top Layer

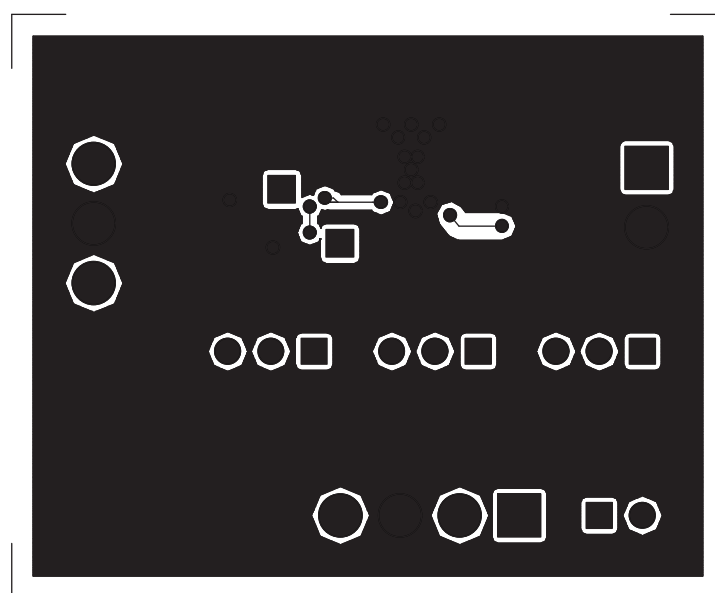


Figure 3. Board Layout Bottom Layer

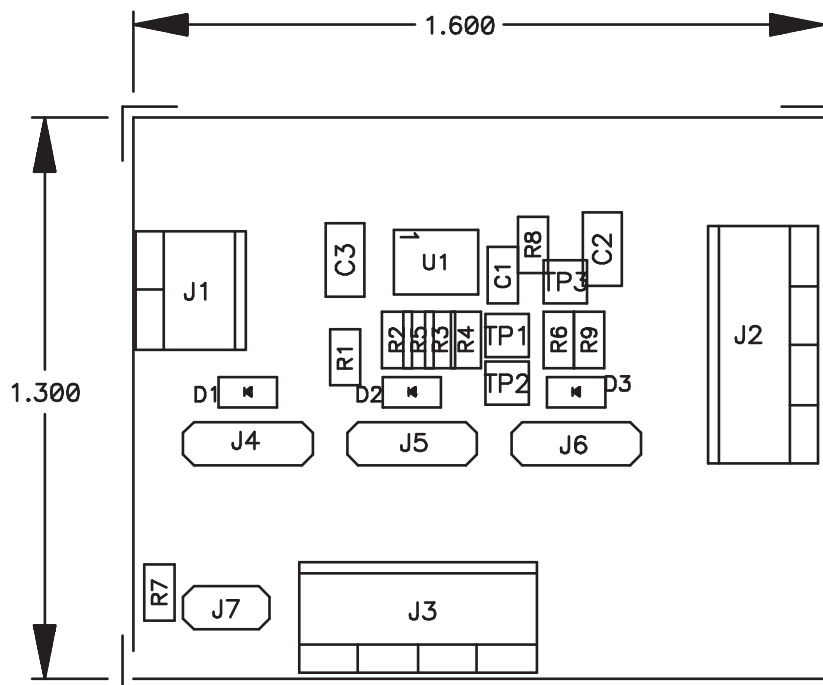


Figure 4. Top Assembly View

5 Bill of Materials

This section contains the bill of materials required for the EVM.

Table 3. HPA149A Bill of Materials, bq2406xEVM⁽¹⁾⁽²⁾⁽³⁾

bq24060 -001	bq24061 -002	bq24064 -005	Ref Des	Value	Description	Size	Part Number	MFR
Count								
1	1	1	C1	0.1 μ F	Capacitor, ceramic, 25V, X7R, 10%	0603	ECJ-1VB1E104K	Panasonic
2	2	2	C2, C3	1 μ F	Capacitor, ceramic, 25V, X5R, 10%	0805	ECJ-2FB1E105K	Panasonic
1	1	1	D1		Diode, LED, red, 1.8-V, 20-mA, 20-mcd	0603	1600-1181-1-ND	Liteon
1	1	1	D2		Diode, LED, green, 2.1-V, 20-mA, 6-mcd	0603	1600-1181-1-ND	Liteon
0	0	0	D3	0	Resistor, Chip, 0- Ω , 1/16-W, 1%	0603	Std	Std
1	1	1	J1		Terminal block, 2-pin, 6-A, 3.5 mm	0.27 \times 0.25	ED1514	OST
2	2	2	J2, J3		Terminal block, 4-pin, 6-A, 3.5 mm	0.55 \times 0.25	ED1516	OST
2	2	2	J4, J5		Header, 3-pin, 100-mil spacing, (36-pin strip)	0.100 \times 3	PTC36SAAN	Sullins
1	1	1	J6		Header, 3-pin, 100-mil spacing, (36-pin strip)	0.100 \times 3	PTC36SAAN	Sullins
0	0	0	J6 ⁽³⁾		Header, 2-pin, 100-mil spacing, (36-pin strip)	0.100 \times 2	PTC36SAAN	Sullins
1	1	1	J7		Header, 2-pin, 100-mil spacing, (36-pin strip)	0.100 in \times 2	PTC36SAAN	Sullins
1	1	1	R8	0	Resistor, chip, 0- Ω , 1/16-W 1%	0603	Std	Std
3	3	3	R1, R2, R5	1.5k	Resistor, chip, 1.5-k Ω , 1/16-W 1%	0603	Std	Std
1	0	1	R3	1M	Resistor, chip, 1-M Ω , 1/16-W 1%	0603	Std	Std
1	1	1	R6	1M	Resistor, chip, 1-M Ω , 1/16-W 1%	0603	Std	Std
0	0	0	R9	1M	Resistor, chip, 1-M Ω , 1/16-W 1%	0603	Std	Std
1	1	1	R4	1.13K	Resistor, chip, 1.13 k Ω , 1/16-W 1%	0603	Std	Std
1	1	1	R7	49.9k	Resistor, chip, 49.9 k Ω , 1/16-W 1%	0603	Std	Std
0	0	0	TP1, TP2, TP3		Test Point, 0.032 hole		Std	Std

⁽¹⁾ When J6 is a 2 pin header, Install in J6-1/2

⁽²⁾ Install Jumper Shunts, for -001/2/5/6/7, on: J4-1/2 (LED), J5-1/2 (LED), J6-1/2 (LED), and J7-1/2.

Install Jumper Shunts, for -003/4, on: J4-1/2 (LED), J5-1/2 (LED), J6-1 (just pin 1), and J7-1/2

⁽³⁾ bq24062/3/5/6 are not released at this time. Check WEB for availability.

References

Table 3. HPA149A Bill of Materials, bq2406xEVM (continued)

bq24060 -001	bq24061 -002	bq24064 -005	Ref Des	Value	Description	Size	Part Number	MFR
Count								
1	0	0	U1		IC, TPOD, \overline{PG} , TS	3×3 mm	bq24060DRC	TI
0	1	0	U1		IC, TPOD, \overline{PG} , \overline{CE}	3×3 mm	bq24061DRC	TI
0	0	0	U1		IC, TPOD, \overline{PG} , \overline{CE}	3×3 mm	bq24062DRC	TI
0	0	0	U1		IC, TPOD, \overline{PG} , \overline{CE}	3×3 mm	bq24063DRC	TI
0	0	1	U1		IC, TPOD, \overline{PG} , \overline{CE}	3×3 mm	bq24064DRC	TI
0	0	0	U1		IC, TPOD, \overline{PG} , \overline{CE}	3×3 mm	bq24065DRC	TI
0	0	0	U1		IC, TPOD, \overline{PG} , \overline{CE}	3×3 mm	bq24066DRC	TI
1	1	1	—		PCB, 1.3 in × 1 in × 0.031 in		HPA149, PCB EVM	Any
4	4	4	Shunt ⁽²⁾	Shunt	Shunt		Guess	

6 References

1. bq24060 data sheet ([SLUS689](#))

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
 - 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 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 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 a nonconforming EVM if (a) the nonconformity was 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, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, 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.

WARNING

Evaluation Kits 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 shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

FCC NOTICE: 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 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. 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/sds/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。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

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 to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

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。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社
東京都新宿区西新宿 6 丁目 2 4 番 1 号
西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/sds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html>

3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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 MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS 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 EPIDEMIC FAILURE WARRANTY OR 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 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, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

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. 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 OR THE USE OF THE EVMS, 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 TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM 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.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2023, Texas Instruments Incorporated

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you fully indemnify TI and its representatives against any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#), [TI's General Quality Guidelines](#), or other applicable terms available either on [ti.com](#) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products. Unless TI explicitly designates a product as custom or customer-specified, TI products are standard, catalog, general purpose devices.

TI objects to and rejects any additional or different terms you may propose.

Copyright © 2026, Texas Instruments Incorporated

Last updated 10/2025