EVM User's Guide: BQ21088EVM
BQ21088 Evaluation Module

![Texas Instruments logo]

Description

The BQ21088EVM evaluation module (EVM) to evaluate the BQ21088 device. The EVM supports charge currents up to 1A and SYS currents up to 3A. The BQ21088EVM provides an external MR for device pushbutton functionality evaluation, a TS potentiometer circuit for TS functionality evaluation, and a USB2ANY port for I2C interfacing functionality. The EVM also includes a discrete LDO for digital pull-up rails with jumpers for configurability.

Get Started

1. Order the BQ21088EVM.
2. Order the USB2ANY.
3. Follow this step-by-step guide.

Features

- 1A linear battery charger
- I2C configurable battery regulation voltage with 0.5% accuracy
- Configurable termination current down to 0.5mA
- Programmable thermal charging profile with configurable hot, warm, cool, and cold thresholds
- Power path management for powering the system and charging the battery
- 30nA shutdown mode for longest shelf life
- One button wake-up and reset input with adjustable timers
- I2C communication control

Applications

- TWS headset and charging case
- Smart glasses, AR and VR
- Smart watches and other wearable devices
- Retail automation and payment
- Building automation
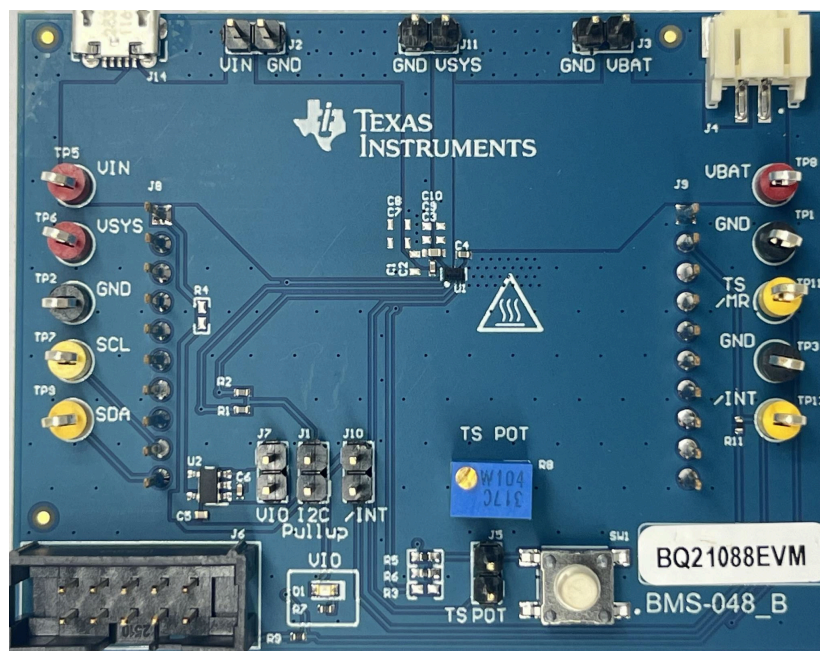
BQ21088EVM Hardware Board

1 Evaluation Module Overview

1.1 Introduction

The BQ21088EVM is an evaluation kit for the BQ21088 integrated battery charge management IC. The BQ21088 is an integrated battery charge management IC that integrates the most common functions for wearable devices: linear charger, regulated output, manual reset with timer, and ship mode function. The low quiescent current (I_Q) during operation and shutdown enables maximum battery life.

This user's guide provides detailed testing instructions for the BQ21088 evaluation module (EVM). Also included are descriptions of the necessary equipment, equipment setup, procedures, the printed-circuit board layouts, schematics, and the bill of materials (BOM). Throughout this user's guide, the abbreviation *EVM, BQ21088EVM,* and the term evaluation module are synonymous with the BQ21088 evaluation module, unless otherwise noted.

WARNING

⚠️

Hot surface! Contact can cause burns. Do not touch!

Some components can reach high temperatures >55°C when the board is powered on. The user must not touch the board at any point during operation or immediately after operating, as high temperatures can be present.

1.2 Kit Contents

The kit includes the following:

• 1 - BQ21088EVM

1.3 Specification

Table 1-1. Recommended Operating Conditions

		MIN	NOM	MAX	UNIT
VBAT	Battery voltage range	2.2		4.6	V
VIN	Input voltage range	2.7		5.5	V
IIN	Input current range (IN to SYS)			1.1	A
ISYS (DC)	SYS Discharge Current (DC)			2	A
ISYS (Peak)	SYS discharge current (tpulse < 20mS)			3	A
IBAT	Battery discharge current (BAT to SYS)			3	A
TJ	Operating junction temperature range	-40		125	°C

1.4 Device Information

This EVM does not include the USB2ANY interface board. To evaluate the EVM with the TICharger GUI, a USB2ANY must be ordered separately.

For detailed features and operations, see a list of devices and the corresponding data sheets below.

| Device	Data Sheet	EVM Label
BQ21088	BQ21088 I^{2}C Controlled, 1-Cell, 1A Linear Battery Charger with Power Path, Ship Mode, Shutdown Mode, and Battery Tracking VINDPM	BQ21088EVM

2 Hardware

2.1 EVM Setup

The jumper connections and jumper description are listed in Table 2-1. The recommended operating conditions are listed in Table 1-1.

Table 2-1. Jumper Descriptions

Jumper Name	Description
J1	Provides the I2C Pins a pull-up to 3p3V.
J2	VIN and GND connector. Input voltage from external power supply. Recommended voltage is 5V and OVP is 5.7V. Max input voltage is 25V while in OVP.
J3	VBAT and GND connector. Battery connection using jumper for easy access.
J4	Battery pack connector. Battery connection using JST header.
J5	TS potentiometer connector. Connects TS potentiometer to TS pin. Leaving this jumper open leaves the TS pin open.
J6	USB2ANY connector; for connecting the device to the USB2ANY evaluation board to allow computer to interface with the EVM.
J7	VIO connector to 3p3V.
J8, J9	Board connector to the other module.
J10	/INT connector to 3p3V.
J11	I2C pull-up.
J14	Micro-USB connector (optional for VIN) BQ21088EVM connections.

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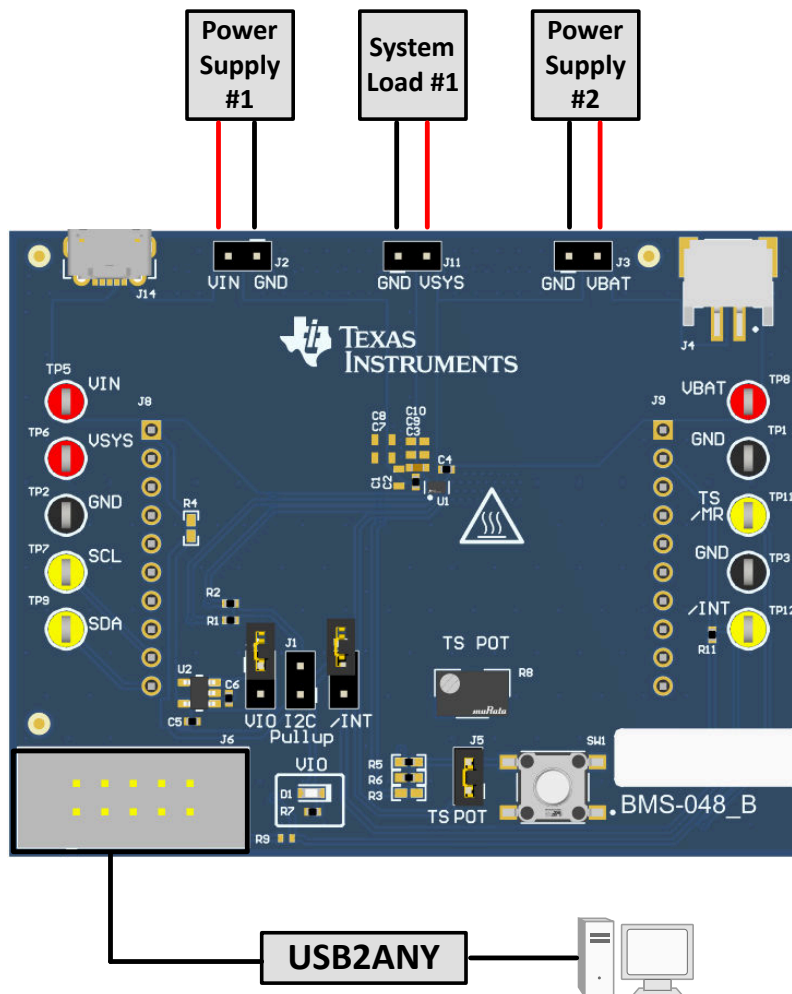
2.2 EVM Connectors and Test Points

The default configuration for connectors is shown in Table 2-2.

Table 2-2. Factory Jumper Settings

Jumper Name	Description	Setting
J1	I2C pullup	NA
J2	VIN and GND connector	NA
J3	VBAT and GND connector	NA
J4	Battery pack connector	NA
J5	TS potentiometer connector	Connected
J6	USB2ANY connector	NA
J7	VIO connector to 3p3V	NA
J8, J9	Board connector to other modules	NA
J10	/INT connector to 3p3V	Connect 3p3V to /INT
J11	VSYS and GND connector	NA
J14	Micro-USB connector (optional for VIN)	NA

Note

Connecting the J7 jumper enables the VIO LED. This LED draws 10mA.

2.3 Testing Procedures

2.3.1 Equipment

This section includes a list of supplies required to perform tests on this EVM

1. *Two Power Supplies*: Keithley 2400 power supply or equivalent.
   a. Power Supply #1 (PS #1) is used as input voltage.
   b. Power Supply #2 (PS #2) is used as battery voltage.
2. *4 Channel Oscilloscope*: To monitor voltages at VIN, VBAT, and VSYS.
   a. Channel 1 (SC #1) is used to probe VIN.
   b. Channel 2 (SC #2) is used to probe VBAT.
   c. Channel 3 (SC #3) is used to probe VSYS.
3. *Computer:* A computer with at least one USB port and a USB cable.
4. *PC communication interface*: USB2ANY with the latest firmware.
5. *Software:* Download the TI Charger GUI from Texas Instruments.

2.3.2 Charge Mode

Connect the equipment as the following:

- Power Supply PS#1: VIN of the BQ21088 at 5V.
- Power supply PS#2: VBAT of the BQ21088 at 3.7V.
- Scope Channel SC#1: VIN
- Scope Channel SC#2: VSYS.
- Scope Channel SC#3: VBAT

Turn the supply PS#2 on, then turn the supply PS#1 on. The VSYS rises to 4.5V. The device begins to charge as long as the TS is left at default configuration and there are no other faults.

Figure 2-1. BQ21088 EVM Connections

To adjust the charge current or change other parameters, connect the USB2ANY to the EVM and then start up the TI Charger GUI.

Note

If the supplies (VIN and VBAT) are turned off, then users need to restart the TI Charger GUI for the correct I^{2}C transactions to be reflected in the TI Charger GUI.

Figure 2-2. TI Charger GUI Device Selection

Select the BQ2518X from the charger selection. Click *Quick Start* or *Register Map*.
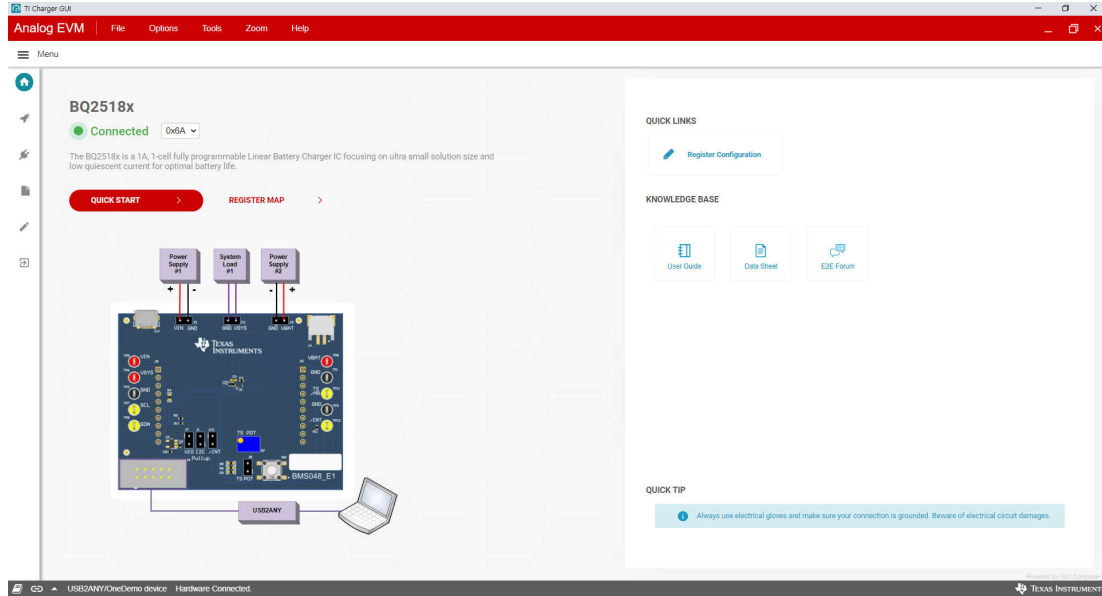
Figure 2-3. BQ21088EVM Connected

The Quick Start is shown in Figure 2-4.
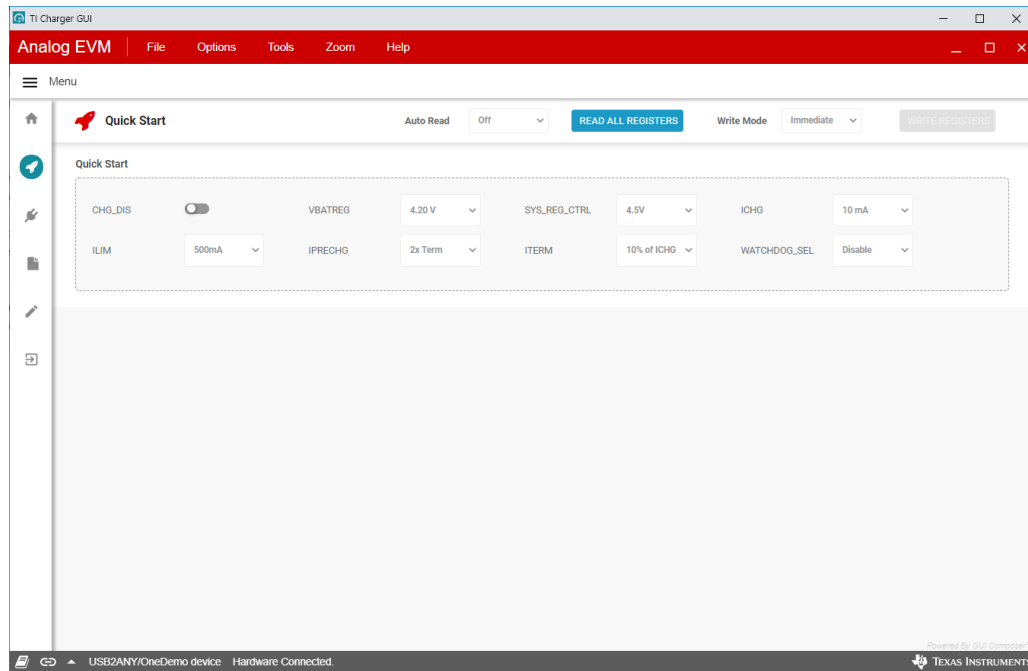
Figure 2-4. Quick Start

The register map is shown in Figure 2-5.

Figure 2-5. Register Map

2.3.3 Ship Mode

To go to Ship Mode, enable through an I^{2}C transaction to set EN_SHIP_RST bits or the PB_LPRESS_ACTION bits as shown in Figure 2-6:

- EN_RST_SHIP = 2b01 (enable Ship mode with wake on button press or adapter insert).
- PB_PRESS_ACTION = 2b10 (enable Ship mode).

Enter Ship mode by removing VIN if setting EN_RST_SHIP to 2b01. If setting PB_LPRESS_ACTION to 2b10 to enable Ship mode, hold the TS/MR button for the configured t$_{LPRESS}$ then remove VIN.
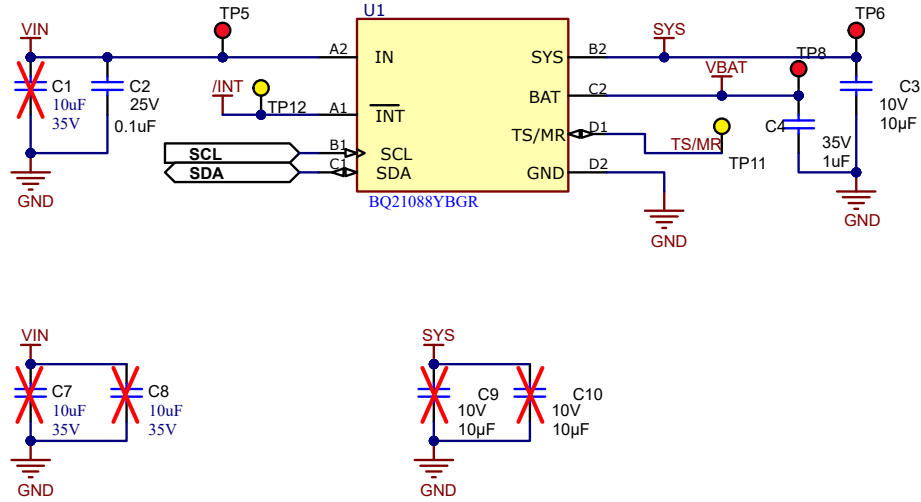
When the voltage on the SYS (SC#2) falls to 0V, Ship mode has been enabled.

Figure 2-6. SHIP_RST Register

Hardware Design Files

www.ti.com

3 Hardware Design Files

3.1 Schematic

The EVM schematic is illustrated in Figure 3-1.

BQ2518x Power Path Battery charger IC
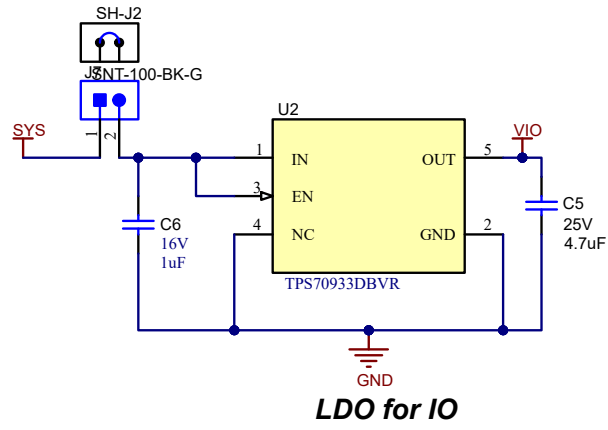
Figure 3-1. BQ21088EVM Schematic

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Connectors and Jumper Options

Figure 3-2. BQ21088EVM Jumper Connectors

LDO for IO

Figure 3-3. LDO for Other Peripherals

3.2 PCB Layouts

The EVM PCB layout images are shown in Figure 3-4 through Figure 3-5.

Figure 3-4. Top Layer
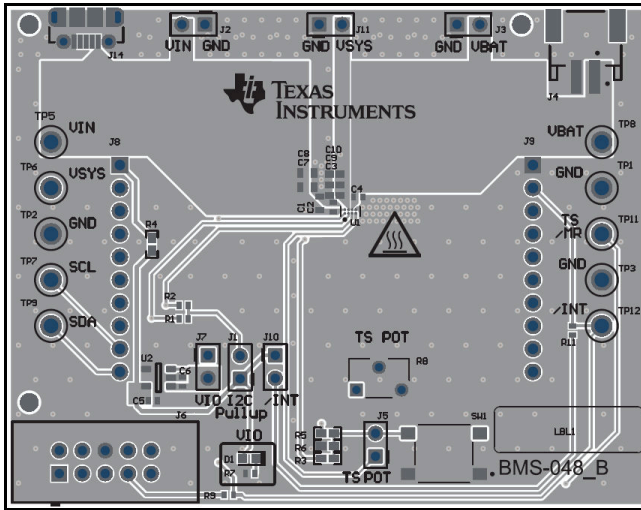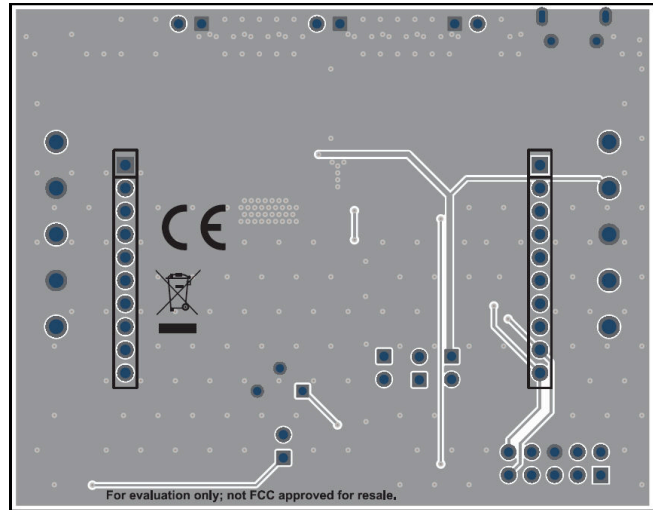

Figure 3-5. Bottom Layer

3.3 Bill of Materials

Table 3-1. Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C2	1	0.1uF	CAP, CERM, 0.1uF, 25V, +/- 10%, X5R, 0402	0402	GRM155R61E104KA87D	MuRata
C3	1	10uF	CAP, CERM, 10μF, 10V,+/- 20%, X5R, 0402	0402	CL05A106MP8NUB8	Samsung Electro-Mechanics
C4	1	1uF	CAP, CERM, 1uF, 35V, +/- 10%, JB, 0402	0402	C1005JB1V105K050BC	TDK
C5	1	4.7uF	CAP, CERM, 4.7uF, 25V, +/- 20%, X5R, 0402	0402	GRM155R61E475ME15	MuRata
C6	1	1uF	CAP, CERM, 1uF, 16V, +/- 10%, X5R, 0402	0402	EMK105BJ105KVHF	Taiyo Yuden
D1	1	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On
FID1, FID2, FID3	3		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
J1, J2, J3, J5, J7, J10, J11	7		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
J4	1		Header (shrouded), 2mm, 2x1, R/A, SMT	Header, 2x1, 2mm, R/A	S2B-PH-SM4-TB(LF)(SN)	JST Manufacturing
J6	1		Header(Shrouded), 2.54mm, 5x2, Gold, TH	Header, 2.54mm, 5x2, TH	AWHW-10G-0202-T	Assman WSW
J8, J9	2		Connector, Receptacle, 100mil, 10x1, Gold plated, TH	10x1 Receptacle	SSW-110-23-F-S	Samtec
J14	1		Connector, Receptacle, Micro-USB Type B, R/A, Bottom Mount SMT	Micro USB receptacle	105017-0001	Molex
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
R1, R2, R11	3	10.0k	RES, 10.0 k, 1%, 0.063 W, 0402	0402	RC0402FR-0710KL	Yageo America
R5	1	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2GE0R00X	Panasonic
R6	1	100k	RES, 100 k, 1%, 0.0625 W, AEC-Q200 Grade 0, 0402	0402	AC0402FR-07100KL	Yageo America
R7	1	120	RES, 120, 5%, 0.063 W, 0402	0402	CRCW0402120RJNED	Vishay-Dale
R8	1	100kΩ	12-Turn Through Hole Trimmer Resistor with Pin Terminations, 10% 1/4W 150ppm/C	PTH_POT_6MM4_4MM0	PV37W104C01B00	Murata
SH-J1, SH-J2, SH-J3	3	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
SW1	1		Tactile Switch SPST-NO Top Actuated Surface Mount	SMT_TACT	4.30152E+11	Wurth Electronics
TP1, TP2, TP3	3		Test Point, Multipurpose, Black, TH	Black Multipurpose Test point	5011	Keystone

Table 3-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
TP5, TP6, TP8	3		Test Point, Multipurpose, Red, TH	Red Multipurpose Test point	5010	Keystone
TP7, TP9, TP11, TP12	4		Test Point, Multipurpose, Yellow, TH	Yellow Multipurpose Test point	5014	Keystone
U1	1		I2C Controlled, 1-Cell, 1A Linear Battery Charger with Power Path, Ship Mode, Shutdown Mode, and Battery Tracking VINDPM	DSBGA8	BQ21088YBGR	Texas Instruments
U2	1		150mA, 30V, Ultra-Low IQ, Wide Input Low-Dropout Regulator with Reverse Current Protection, DBV0005A (SOT-23-5)	DBV0005A	TPS70933DBVR	Texas Instruments
C7, C8	0	10uF	CAP, CERM, 10uF, 35V, +/- 20%, X5R, 0603	0603	GRM188R6YA106MA73D	Murata
C9, C10	0	10uF	CAP, CERM, 10µF, 10V,+/- 20%, X5R, 0402	0402	CL05A106MP8NUB8	Samsung Electro-Mechanics
R3	0	100k	RES, 100 k, 1%, 0.0625 W, AEC-Q200 Grade 0, 0402	0402	AC0402FR-07100KL	Yageo America
R4	0	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2GE0R00X	Panasonic
R9	0	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0ED	Vishay-Dale

4 Additional Information

4.1 Trademarks

All trademarks are the property of their respective owners.

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 DEGREDATION 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/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

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

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1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。

2. 実験局の免許を取得後ご使用いただく。

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

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西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/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.

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