

EM1402 Evaluation Module

This user's guide describes the general features, theory of operation, hardware setup, and use of the EM1402EVM. Throughout this user's guide, the abbreviations *EVM*, *EM1402EVM*, and the term *evaluation module* are synonymous with the *EM1402 Evaluation Module*, unless otherwise noted. This EVM is an evaluation board of the *Active Balance* chipset for use in large format Lithium-ion batteries that provides monitoring, balancing, and communications.

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



WARNING

Warning: To minimize risk of fire hazard, always verify and follow any specific safety instructions and application considerations related to the batteries being used in conjunction with this EVM.

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

Save all warnings and instructions for future reference.

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

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

1. **Work Area Safety:**

- (a) Keep work area clean and orderly.
- (b) Qualified observer(s) must be present any time circuits are energized.
- (c) Effective barriers and signage must be present in the area where the TI HV EVM and its interface electronics are energized, indicating operation of accessible high voltages may be present, for the purpose of protecting inadvertent access.
- (d) All interface circuits, power supplies, evaluation modules, instruments, meters, scopes and other related apparatus used in a development environment exceeding 50 V_{RMS} or 75 VDC must be electrically located within a protected Emergency Power Off (EPO) protected power strip.
- (e) Use a stable and non-conductive work surface.
- (f) Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.

2. **Electrical Safety:** As a precautionary measure, it is always a good engineering practice to assume that the entire EVM may have fully accessible and active high voltages.

- (a) De-energize the TI HV EVM and all its inputs, outputs, and electrical loads before performing any electrical or other diagnostic measurements. Revalidate that TI HV EVM power has been safely de-energized.
- (b) With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment hook-ups and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
- (c) Once EVM readiness is complete, energize the EVM as intended.

WARNING: while the EVM is energized, never touch the EVM or its electrical circuits as they could be at high voltages capable of causing electrical shock hazard.

3. Personal Safety:

- (a) Wear personal protective equipment, for example, latex gloves or safety glasses with side shields or protect EVM in an adequate lucent plastic box with interlocks from accidental touch.

4. Limitation for Safe Use:

- (a) EVMs are not to be used as all or part of a production unit.

1 General Description

The Texas Instruments *EM1402EVM Battery Management System* (BMS) is an evaluation board of the *Active Balance* chipset for use in large format Lithium-ion batteries that provides monitoring, balancing, and communications. With precise and robust active balancing, the *Active Balance* BMS is capable of bi-directional power transfer at each cell. Each EM1402EVM can manage 6 to 16 cells (70-V max) for Li-ion battery applications. The EM1402EVM modules can be stacked up to 1300 V. The system provides fast cell balancing, diagnostics, and module to controller communication. Independent protection circuitry is also provided.

The EM1402EVM is equipped with precision measurement and synchronous communication to enable a master controller to perform *State of Charge* (SOC) and *State of Health* (SOH) estimation. Highly accurate cell voltages and a fast sampling time for the entire battery pack allows more efficient operation of battery modules and more accurate SOC and SOH calculations. The user will be able to extend the available capacity of the battery and will benefit from longer pack lifetimes versus passive or dissipative balancing systems.

The EM1402EVM is equipped with smart diagnostic systems. These systems monitor fault events such as undervoltage, overvoltage, and overtemperature. The system is also capable of pack temperature and cell temperature sensing. The fault flagging systems help protect the battery module and alert the user of potential problems.

1.1 Key Features

This EVM includes the following features:

- Active bi-directional cell balancing
- Multi-cell charge and discharge capability
- Isolated communications (5 kV)
- Flexible architecture for up to 16 cells
- UART interface
- High accuracy cell voltage measurement
- Diagnostics

1.2 Key Electrical Parameters

The following table identifies the key electrical parameters:

Maximum battery pack voltage	1300 V
Maximum operating voltage	70 V
Minimum operating voltage	12 V
Maximum cell open circuit voltage	5V
Ambient temperature	-40 °C to 85 °C
Nominal operating temperature	-20 °C to 60 °C
Cell balancing current	up to +/- 5 A

2 Theory of Operation

Figure 1 shows the system stack diagram.

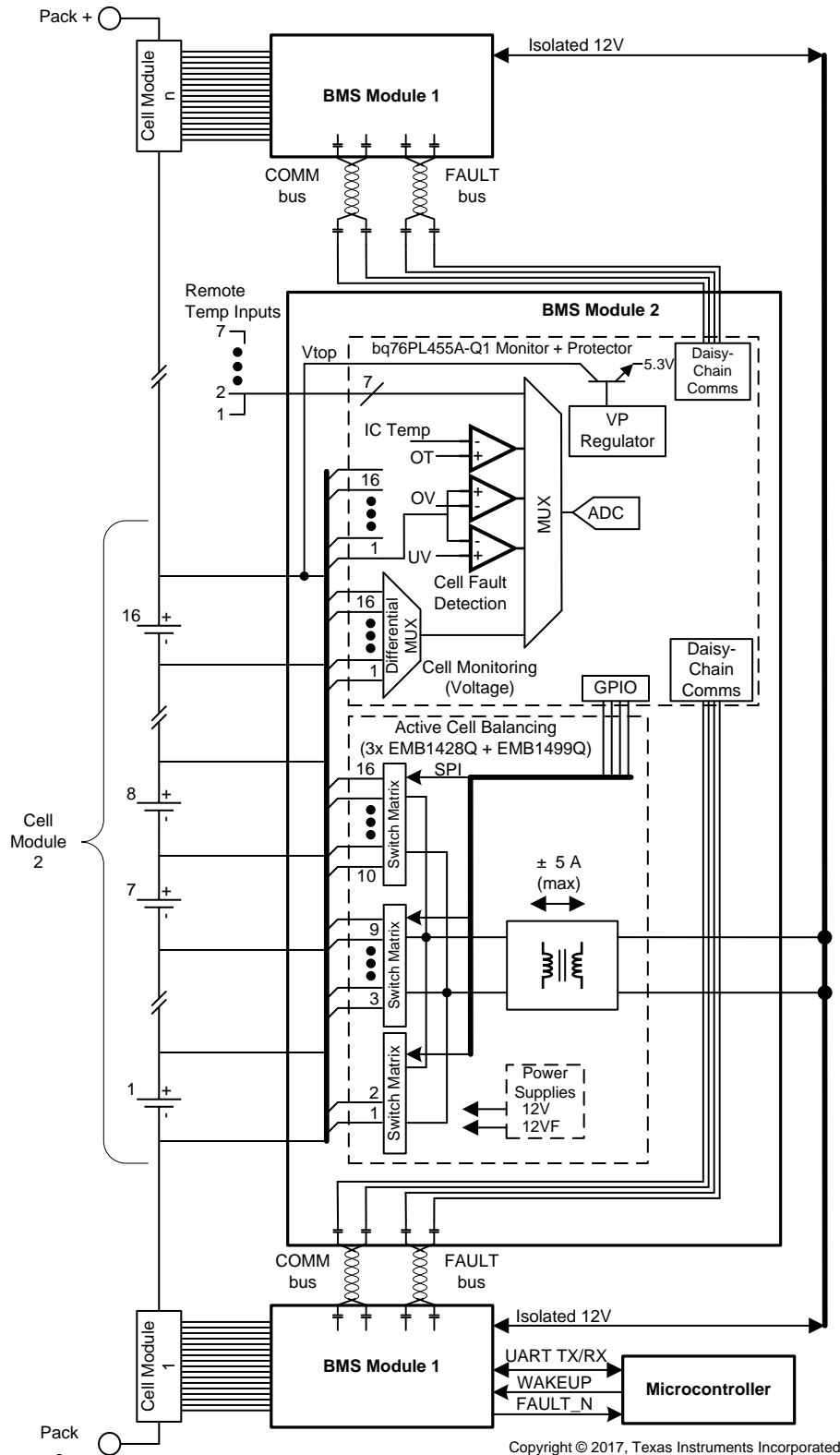


Figure 1. System Stack Diagram

The BMS system is designed to prolong the useful life of Lithium-ion cells in battery packs through active balancing. The battery pack is broken into a series of modules, each of which contains up to 16 cells. This system will monitor voltages of individual battery cells and transfer charge from the module stack to an under-charged cell or take charge from an over-charged cell and transfer it to the module stack. The BMS allows battery powered electric machines to use smaller battery packs and use fewer charging cycles to perform the same amount of work. It also improves the overall lifetime of Li-ion battery packs by preventing under- and overvoltage damage from occurring.

The BMS system has three main sub-systems, as shown in [Figure 1](#):

- Cell voltage monitoring circuitry
- Cell fault detection
- Active cell balancing engine

The cell-monitoring architecture is based on the bq76PL455A-Q1 (16 cell monitor and protection). Each EMB1428Q is designed to control access to up to 7 cells of a typical 16-cell battery module; the full 16-cell module utilizes three EMB1428Q and one to three EMB1499Q ICs. The EM1402EVM is designed with one EMB1499Q IC to allow simultaneous charge and discharge of a single cell (of the up to 16 cells attached) at up to 5 A.

All commands and data are communicated with a host via either a UART or daisy-chain communication connection. The EM1402 will not do anything without being first commanded from the host. The EM1402 can support a host PC or microcontroller (via the UART connection header) or a daisy-chain interface from a bq76PL455A-Q1 implemented as a communication bridge. The EMB1428Q is controlled via an SPI interface implemented on the bq76PL455A-Q1 GPIO.

The EM1402EVM has three EMB1428Q devices sharing control of a single EMB1499Q bi-directional DC-DC converter. The EM1402EVM has connected the cells the EMB1428Q devices as follows:

- EMB1428Q 1 (U2) : cells 1 and 2
- EMB1428Q 2 (U3) : cells 3 to 9
- EMB1428Q 3 (U4) : cells 10 to 16

The typical flow is for the host to go through the following sequence:

1. Wakeup the EM1402 board by sending a WAKEUP pulse when using the UART interface, or sending a WAKE tone when using the EM1402 in a stack of other EM1402 boards for a large battery pack or a bq76PL455A-Q1 configured as a bridge. Initialize the bq76PL455A-Q1 to be ready for use.
2. Send a sample command to the bq76PL455A-Q1 to read the cell measurement results.
3. The host will use the cell measurement data to calculate an average and determine the highest or lowest cells and determine the *one* cell that should be charged or discharged.
4. Send commands to the bq76PL455A-Q1 to initialize the EMB1428Q communication interface on the bq76PL455A-Q1 GPIO.
5. Send commands to the bq76PL455A-Q1 to initialize the SN74AHC595Q I/O expander to enable the chip select for the 8-bit DAC on the EM1402EVM.
6. Send commands to the bq76PL455A-Q1 to initialize the 8-bit DAC on the EM1402EVM which is used to set the charge or discharge current level (an input to EMB1499Q).
7. Send commands to the bq76PL455A-Q1 to initialize the SN74AHC595Q I/O expander to enable the chip select for the EMB1428Q connected to the target cell (determined in step 3).
8. Send commands to the bq76PL455A-Q1 to send the start command to the EMB1428Q to charge or discharge the target cell.
9. When charge or discharge is to be stopped, send commands to the bq76PL455A-Q1 to send the stop command to the EMB1428Q to stop the charge or discharge of the target cell.
 - If no stop command is sent, the EMB1499Q has a built-in timeout of 8 seconds, after which time the charge or discharge will be stopped automatically.
 - If a longer amount of charge or discharge time is needed, the host will need to send a stop command, followed by a start command at least every <8 seconds.
10. The host can then decide to repeat the process (back to step 2) or send commands to shutdown the EM1402EVM and return later.

2.1 Single Board

As a single board the BMS can actively balance up to 16 cells up to 70 V of total voltage. Communication to the EM1402EVM is handled by the daisy-chain communications bus from another bq76PL455A-Q1 or the UART host interface.

2.2 Stacked Systems

The BMS boards may be stacked up to 1300 V. Communication to the EM1402EVM is handled by the daisy-chain communications bus from another bq76PL455A-Q1.

3 Hardware Setup

3.1 Connectors

3.1.1 Battery Connector

The battery cell connections are made from connector J1. Cell voltage measurements and balancing currents use these connections. Short unused channels to the top cell connection in the wiring harness to support less than 16 cells.

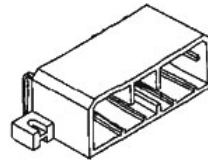


Figure 2. Tyco Electronics 175785-1 (Reference Image Only)

Table 1. Connector Information

Designator	Manufacturer	Part Number	Mating Connector
J1	Tyco Electronics	Manufacturer: 175785-1 Digi-Key: 175785-1-ND	Manufacturer: 174952-1 Digi-Key: 1-174952-1-ND Contacts: Manufacturer: 175027-6 (16-20 AWG) Digi-Key: 175027-6-ND

Table 2. Pin Description

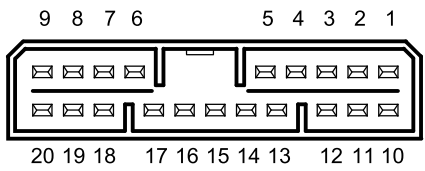
		
Pin	Name	Comments
1	BAT16	Positive terminal of BAT16
2	BAT13	Positive terminal of BAT13, negative terminal of BAT14.
3	BAT12	Positive terminal of BAT12, negative terminal of BAT13.
4	BAT11	Positive terminal of BAT11, negative terminal of BAT12.
5	BAT10	Positive terminal of BAT10, negative terminal of BAT11.
6	BAT5	Positive terminal of BAT5, negative terminal of BAT6.
7	BAT4	Positive terminal of BAT4, negative terminal of BAT5.
8	BAT3	Positive terminal of BAT3, negative terminal of BAT4.
9	BAT0	Negative terminal of BAT1. Local ground for module.

Table 2. Pin Description (continued)

10	BAT15	Positive terminal of BAT16, negative terminal of BAT16.
11	BAT0	Negative terminal of BAT1. Local ground for module.
12	BAT14	Positive terminal of BAT14, negative terminal of BAT15.
13	NC	Not connected
14	BAT9	Positive terminal of BAT9, negative terminal of BAT10.
15	BAT8	Positive terminal of BAT8, negative terminal of BAT9.
16	BAT7	Positive terminal of BAT7, negative terminal of BAT8.
17	BAT6	Positive terminal of BAT6, negative terminal of BAT7.
18	BAT1	Positive terminal of BAT1, negative terminal of BAT2.
19	BAT16	Positive terminal of BAT16
20	BAT2	Positive terminal of BAT2, negative terminal of BAT3.

3.1.2 Host Interface

The 6-pin J3 - Serial connector is used to connect the bq76PL455EVM to a PC running the GUI or to a host controller. Signals at the J3 - Serial connector are 5-V TTL signals. Texas Instruments recommends using FTDI's USB-to-TTL serial converter cable to allow connection with a PC's USB port. The recommended cable is available from FTDI (<http://www.ftdichip.com>), and the appropriate part number for the 1.8-meter cable is TTL-232R-5V.



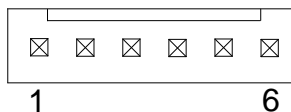
Figure 3. Molex 22-12-4062 (Reference Image Only)

Table 3. Connector Information

Designator	Manufacturer	Part Number	Mating Connector
J3	Molex	Manufacturer: 22-12-4062	Manufacturer: 22-01-2061 Digi-Key: WM1579-ND Contacts: Manufacturer: 08-55-0101 (22-30 AWG) Digi-Key: WM2312CT-ND

Table 4. Pin Description

Pin	Name	Mating Cable Color
1	Ground	Black
2	FAULT signal from bq76PL455A-Q1	Black
3	5-V input from PC	Red
4	RX from PC to bq76PL455A-Q1	Orange
5	TX from bq76PL455A-Q1 to PC	Yellow
6	WAKE signal from PC	Green



3.1.3 Thermistor Inputs

There are 7 thermistor connections. The board provides a 20-kΩ pullup to 3.3 V.

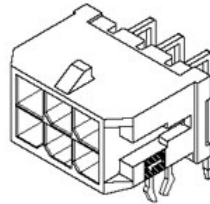
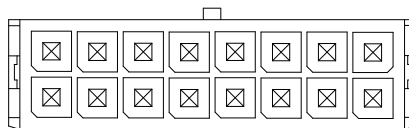


Figure 4. Tyco Electronics 43045-1601 (Reference Image Only)

Table 5. Connector Information

Designator	Manufacturer	Part Number	Mating Connector
TEMP_SENSE	Tyco Electronics	Manufacturer: 43045-1601	Manufacturer: 43025-1600 Digi-Key: WM2490-ND Contacts: Manufacturer: 43030-0012 (22-30 AWG) Digi-Key: WM2779CT-ND

Table 6. Pin Description



Pin	Name	Comments
1	GND	Ground
2	GND	Ground
3	GND	Ground
4	GND	Ground
5	GND	Ground
6	GND	Ground
7	GND	Ground
8	GND	Ground
9	AUX0	Thermistor 1 connection (on-board 20-kΩ pullup to 3.3 V)
10	AUX1	Thermistor 2 connection (on-board 20-kΩ pullup to 3.3 V)
11	AUX2	Thermistor 3 connection (on-board 20-kΩ pullup to 3.3 V)
12	AUX3	Thermistor 4 connection (on-board 20-kΩ pullup to 3.3 V)
13	AUX4	Thermistor 5 connection (on-board 20-kΩ pullup to 3.3 V)
14	AUX5	Thermistor 6 connection (on-board 20-kΩ pullup to 3.3 V)
15	AUX6	Thermistor 7 connection (on-board 20-kΩ pullup to 3.3 V)
16	NC	Not connected

3.1.4 External Isolated Balance Source

This connector provides the isolated supply that all EM1402EVM boards will balance cells to and from.

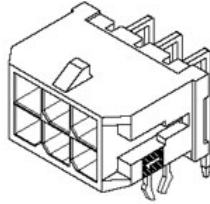


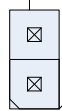
Figure 5. Tyco Electronics 1452625-1 (Reference Image Only)

Table 7. Connector Information

Designator	Manufacturer	Part Number	Mating connector
P2	Molex	Manufacturer: 43045-0222	Manufacturer: 43025-0200 Contacts: Manufacturer: 43030-0003 (20-24 AWG)

Table 8. Pin Description

Pin	Name	Comments
1	12V	Positive external isolated balance source input (shared with all other EM1402EVM modules, but isolated from all cells)
2	GND	GND of external isolated balance source input



4 EM1402EVM Quick Start Guide

4.1 Before You Begin

The following warnings and cautions are noted for the safety of anyone using or working close to the bq76920 EVM. Observe all safety precautions.



Caution Do not leave EVM powered when unattended.



Danger High Voltage The EM1402EVM is not rated as a high voltage EVM, has smaller clearances than normally used on high voltage boards and does not have an isolation boundary. If you apply high voltage to this board, all terminals should be considered high voltage.

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

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

CAUTION

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

CAUTION

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

CAUTION

Some power supplies can be damaged by application of external voltages. If using more than 1 power supply, check your equipment requirements and use blocking diodes or other isolation techniques, as needed, to prevent damage to your equipment.

CAUTION

The communication interface is not isolated on the EVM. Be sure no ground potential exists between the computer and the EVM. Also be aware that the computer will be referenced to the Battery- potential of the EVM.

4.2 Hardware Setup

The system is implemented using the TMS570LS LaunchPad™ board (TMS570LS0432 MCU) and the EM1402EVM.

The part numbers of the evaluation modules are LAUNCHXL-TMS57004 and EM1402EVM. These boards are available from the TI eStore (<https://estore.ti.com/>) or from your local TI sales representative. For more details and information related to these evaluation modules (EVMs), see the specific EVM user's guide.

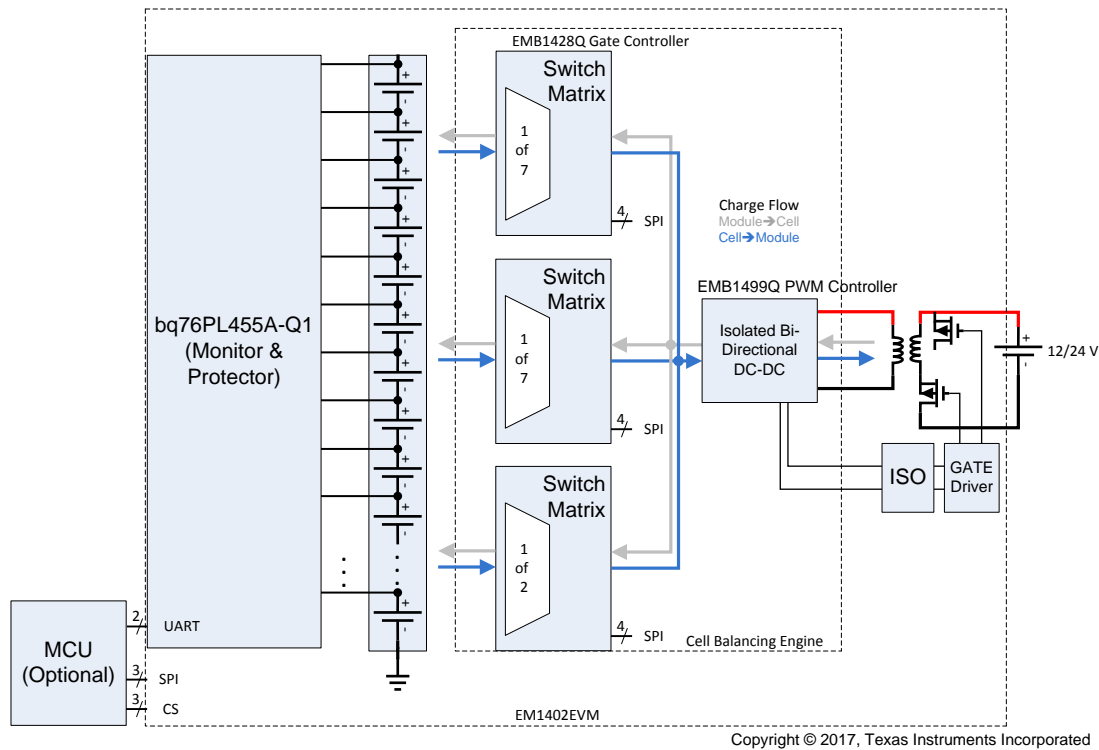


Figure 6. System Block Diagram

4.3 Connecting the Evaluation Modules

The EVMs are connected using a standard wire jumper; Figure 6 shows the connections between the two EVMs. By default, the TMS570 LaunchPad is powered by the USB port on the host computer and the EM1402EVM is powered by a 3.3-V regulator on the TMS570 LaunchPad board.

Table 9. Connections Between EVMs

Connection Name	EM1402EVM	TMS570 LaunchPad
TX	J3 pin 5	J1 pin 3 (SC11_RX)
RX	J3 pin 4	J1 pin 4 (SC11_TX)
nWAKE	J3 pin 6	J2 pin 3 (GIOA0)
nFAULT	J3 pin 2	J2 pin 4 (GIOA1)
VIO	J3 pin 3	J1 pin 1 (+3V3)
GND	J3 pin 1	J2 pin 1 (DGND)

4.4 Software

The software provides command API and drivers that implement the examples provided in *bq76PL455A-Q1 Software Design Reference* (SLVA617). There are comments in the source code that explain the section in the bq76PL455A-Q1 Software Design Reference document the example refers to.

The example code only provides a control interface to the bq76PL455A-Q1 and does not provide any other communications interface to the outside world. The customer is expected to develop their own communication implementation. Examples of communications interfaces available to the TMS570 are SPI, CAN, or UART.

This firmware provided with this application note provides source code examples of the command sequences described in the *bq76PL455A-Q1 Software Design Reference* (SLVA617).

Download sample application code and other information associated with this application report from [tidcci7](#).

Importing a project into *Code Composer Studio*™

1. Launch the provided file: *EM1402EVM Example Code 0.1 Installer.exe* and extract files to the default path provided (C:\ti\EM1402EVM Example Code 0.1).
2. Launch *Code Composer Studio* (CCS):
Start → **Programs** → **Texas Instruments** → **Code Composer Studio v7** → **Code Composer Studio v7**
3. When it launches, CCS requests a workspace is selected, choose "C:\myWorkspace". Once CCS loads, go to:
File → **Import** → **Code Composer Studio** → **Existing CCS Eclipse Projects**
4. In Select search-directory, browse to the folder:
C:\ti\EM1402EVM Example Code 0.1
5. In Discovered projects: Check EM1402EVM Example Code

5 Physical Dimensions

5.1 Board Dimensions

Board dimensions: 5.5 in x 3.75 in

Board height:

- Top - Tallest component (Battery Connector) is 0.64 in (16.3 mm) above PCB.
- Bottom - Tallest component (cell input RC filter cap) is 0.054 in (1.4 mm) above PCB.

5.2 Board Mounting

Figure 7 illustrates the EVM dimension drawing.

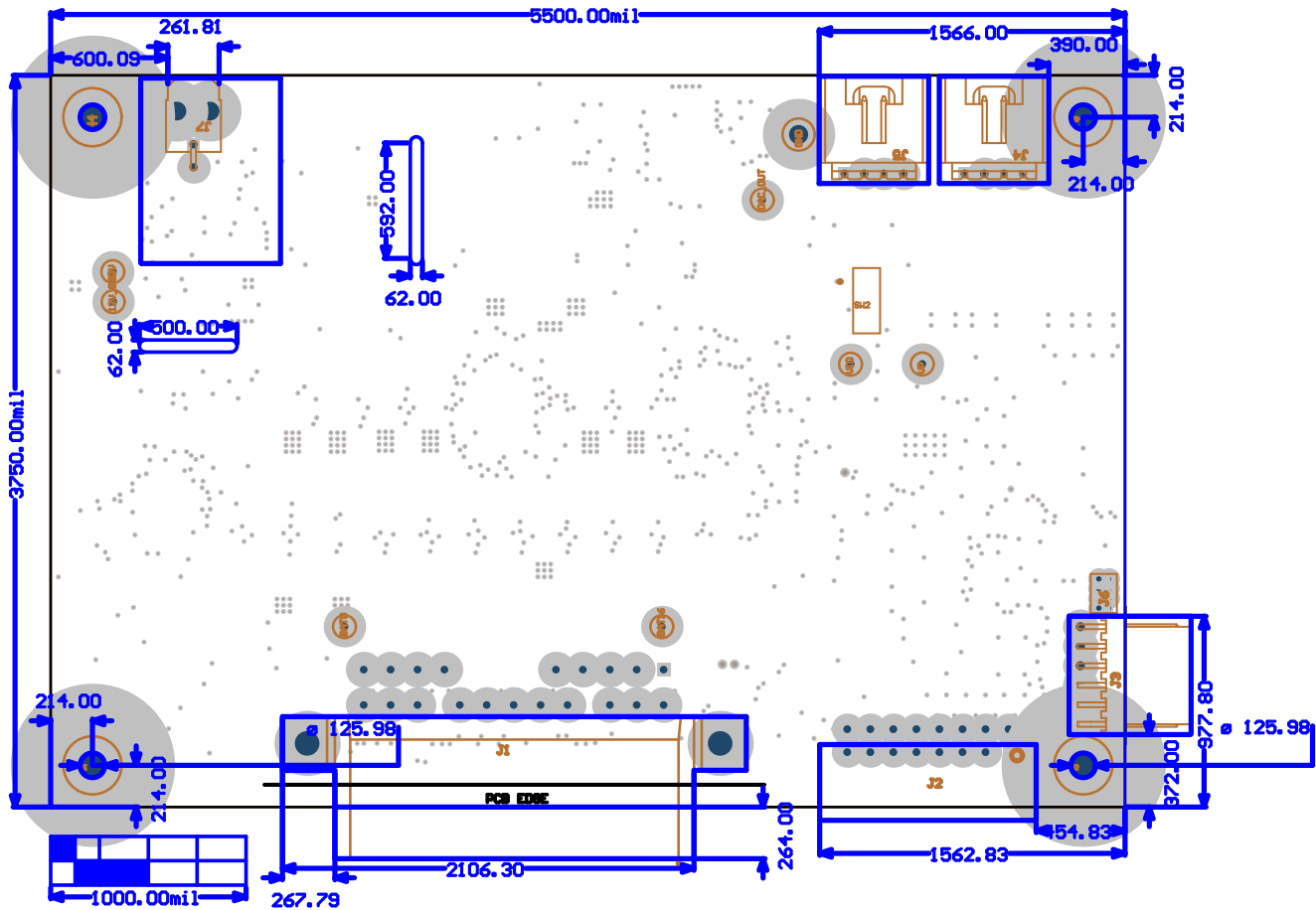


Figure 7. Dimension Drawing

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 semiconductor 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.
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

Concerning EVMs Including Radio Transmitters:

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

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

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

Concernant les EVMs avec antennes détachables

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

3.3 Japan

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

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

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required 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.

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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。

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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:*

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