

bq26150 Evaluation Software

The bq26150 provides a method to authenticate battery packs, ensuring that only packs manufactured by authorized sub-contractors are used in the end application. The bq26150 uses a unique 96-bit device key and a device-specific 16-bit CRC to provide security. The device key, CRC polynomial seed, and CRC polynomial coefficients are stored securely in each bq26150 device, allowing the host to authenticate each pack.

The purpose of the evaluation software is to demonstrate the functionality of the bq26150. The bq26150 test board can be used stand alone or with a second HDQ device.

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1 Kits Contents

1. bq26150, HPA116 board
2. CD-ROM including Windows® Operating System software and support documentation

2 bq26150 Based Circuit Module

The bq26150EVM based circuit module is an example circuit for authentication of a single cell Li-Ion battery pack. There are two separate circuits on the EVM module. One is the active bq26150 authenticating circuitry; the other is the logic and power control to program the on-chip One Time Programmable (OTP) memory. In a typical application, only the active authenticating circuitry is required. The OTP programming circuitry would be required in a test setup to configure the bq26150 for the application by programming the OTP.

Contacts on the circuit module provide direct connection to the cell (J3-1, J2-3), the serial communications port (J3-2). A second HDQ device connects at (J4-2, J4-1).

Table 1. Test Points

TEST POINT	SIGNAL NAME	DESCRIPTION
J2-1	SUPPLY	High voltage for OTP programming
J2-2	PROG	Input for timing of OTP programming
J2-3	VSS	System ground
J3-1	PACK+	Cell positive/pack positive
J3-2	HDQ	Single wire HDQ line
J4-1	VSS	System ground
J4-2	HDQP	Connection for second HDQ device

3 bq26150 Circuit Module Schematic

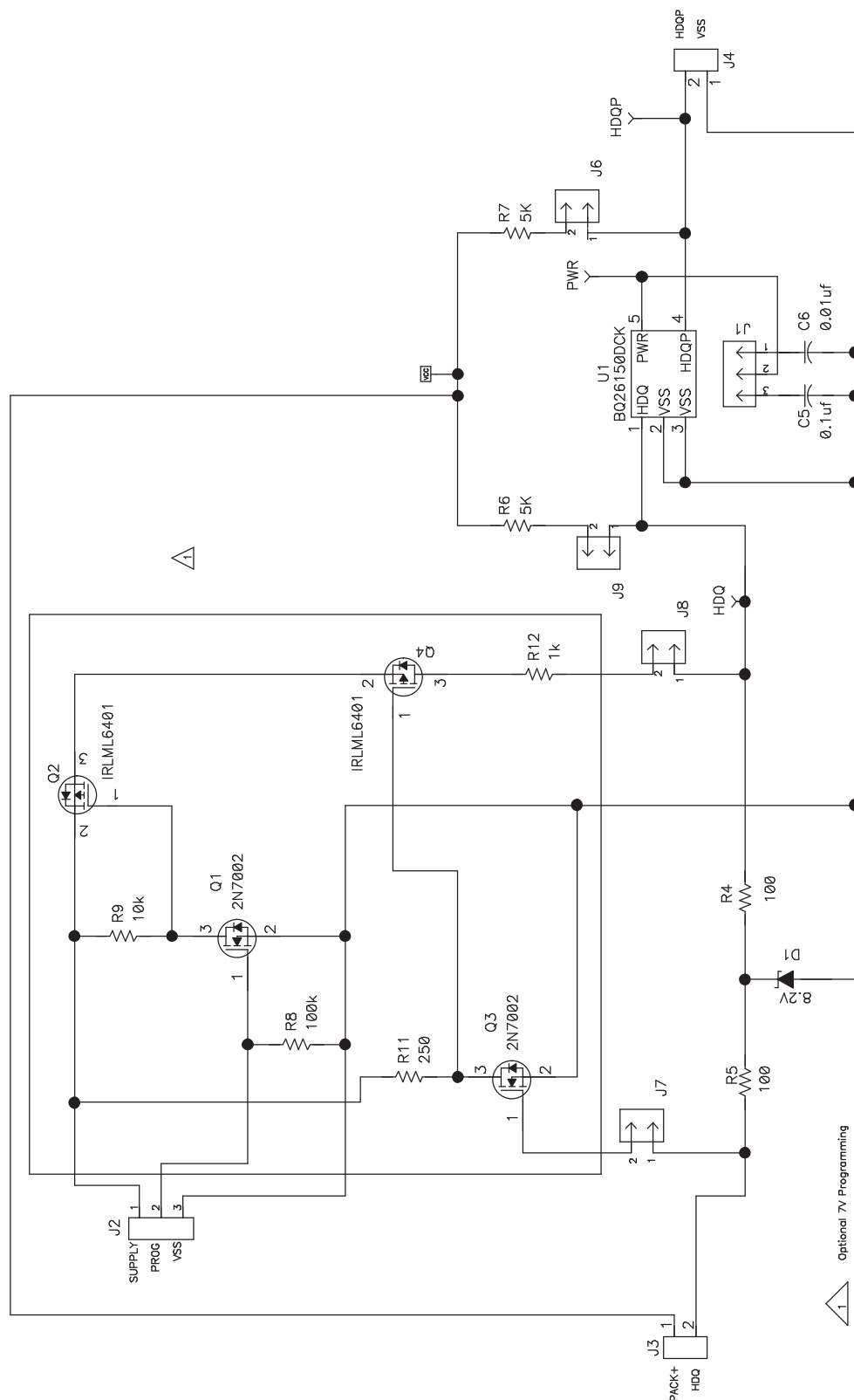


Figure 1. EVM Schematic

4 Circuit Module Physical Layouts

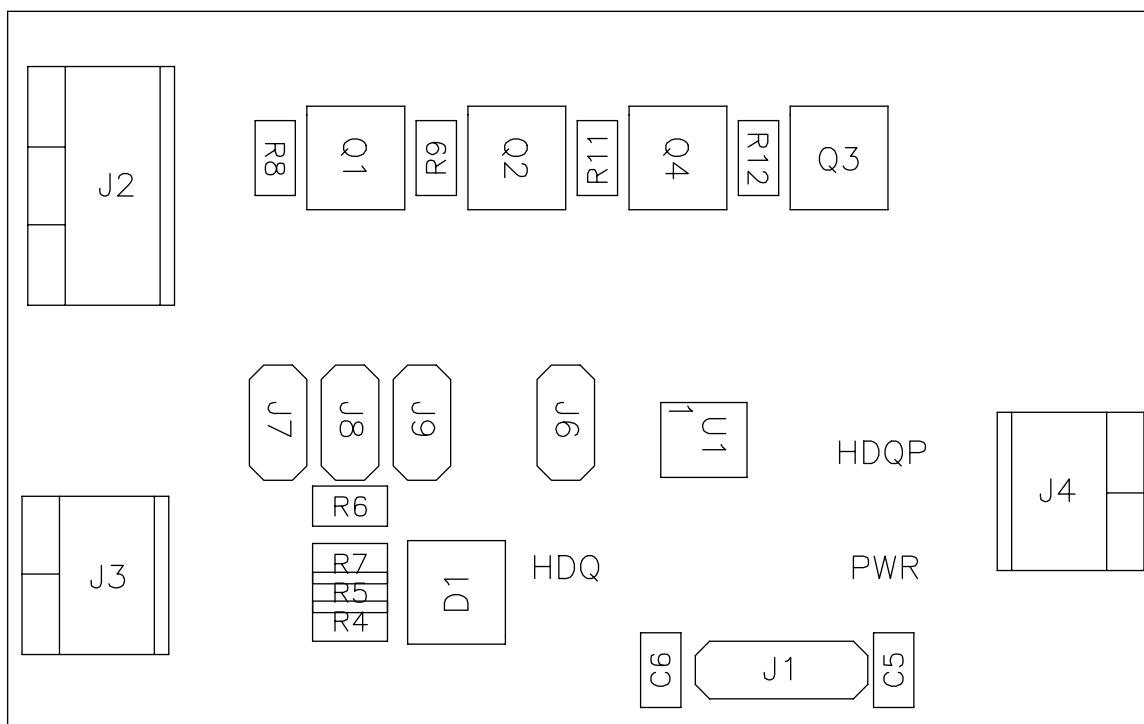


Figure 2. Topside Assembly

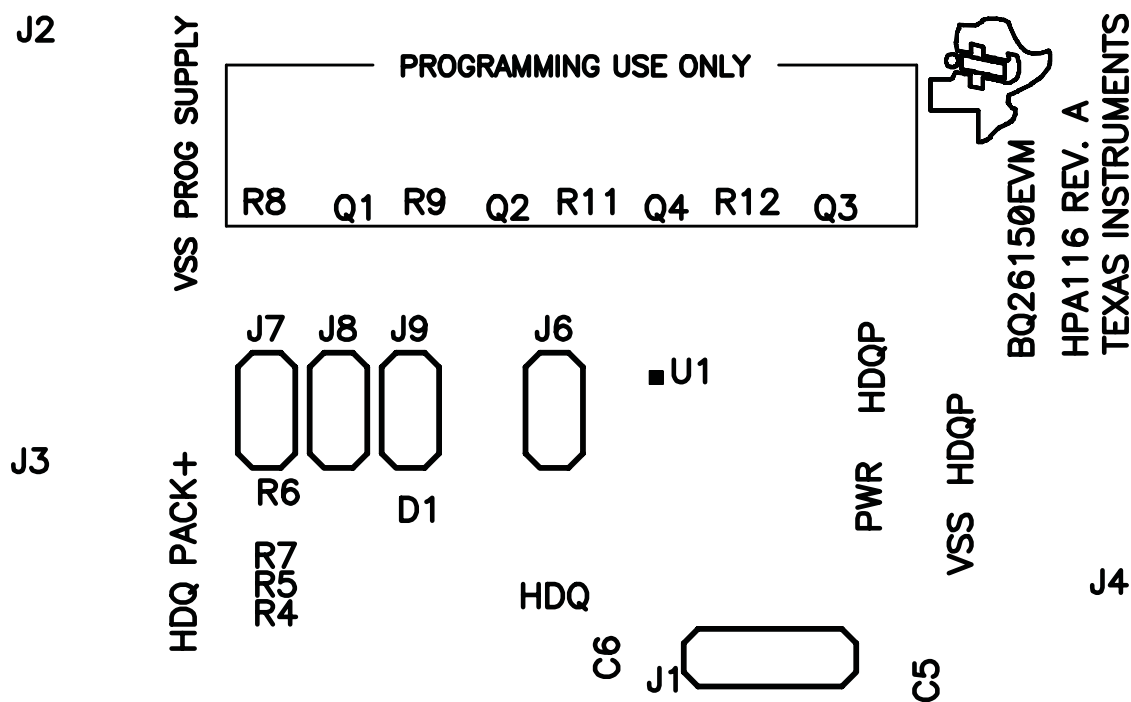


Figure 3. Silkscreen

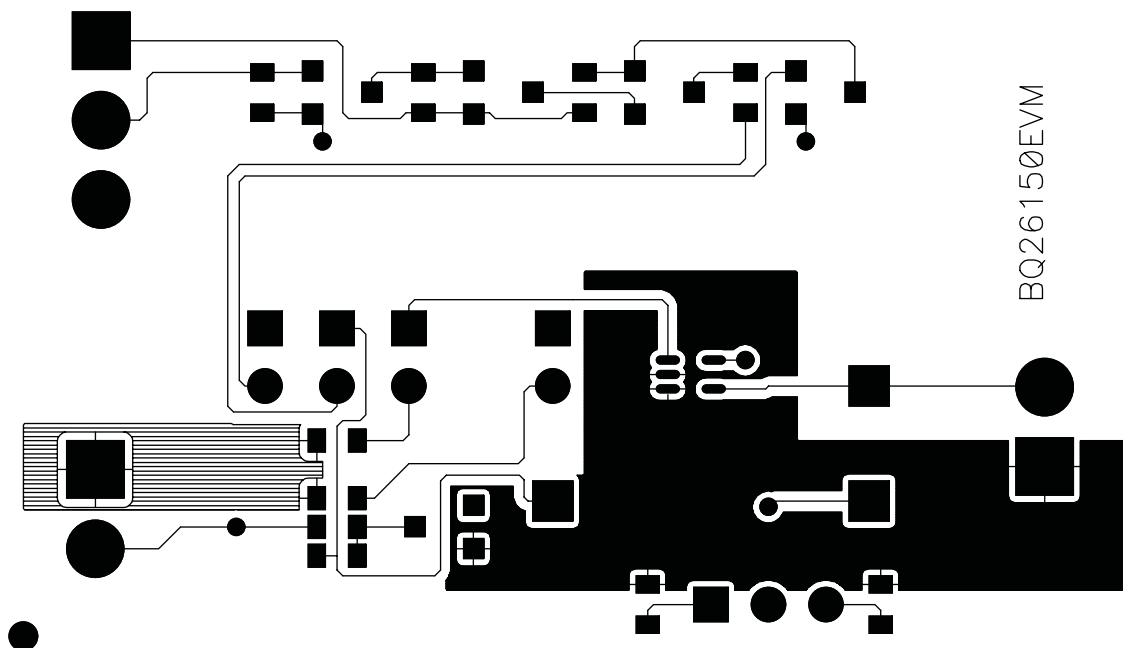


Figure 4. Top Layer

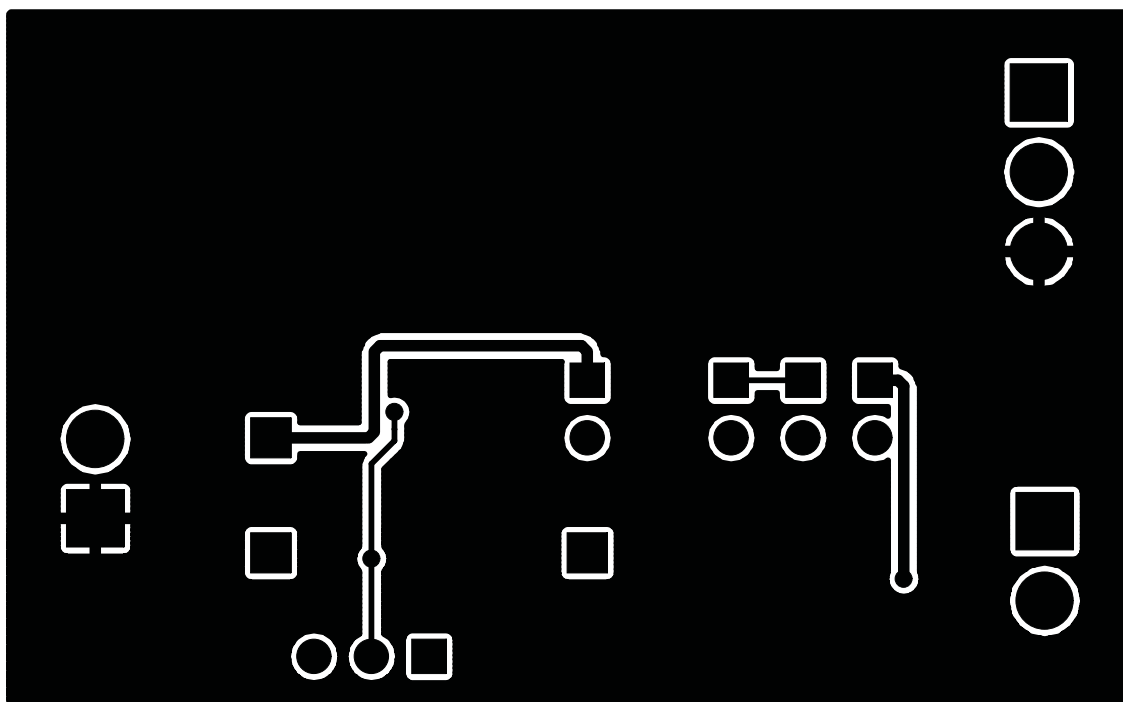


Figure 5. Bottom Layer

5 bq26150 Circuit Module List of Materials

Table 2 contains the list of materials required for the bq26150EVM circuit module.

Table 2. List of Materials

REF DES	QTY	DESCRIPTION	MFR	PART NUMBER
C5	1	Capacitor, Ceramic, 0.1-uF, 16-V, [X7R]	muRata	Std
C6	1	Capacitor, Ceramic, 0.01-uF, 16-V, [X7R]	muRata	Std
D1	1	Diode, Zener, 8.2-V, 350-mW	Diodes, Inc.	BZX84C8V2
J1	1	Header, 3-pin, 100mil spacing, (36-pin strip)	Sullins	PTC36SAAN
J2	1	Terminal Block, 3-pin, 6-A, 3.5mm	OST	ED1515
J3, J4	2	Terminal Block, 2-pin, 6-A, 3.5mm	OST	ED1514
J6, J7, J8, J9	4	Header, 2-pin, 100mil spacing, (36-pin strip)	Sullins	PTC36SAAN
Q1, Q3	2	MOSFET, N-ch, 60-V, 115-mA, 1.2-Ohms	Vishay-Liteon	2N7002DICT
Q2, Q4	2	MOSFET, Pch, -12V, -3.4A, 50 milliohm	IR	IRLML6401
R11	1	Resistor, Chip, 250-Ohms, 1/16-W	Std	Std
R12	1	Resistor, Chip, 1k-Ohms, 1/16-W	Std	Std
R4, R5	2	Resistor, Chip, 100-Ohms, 1/16-W	Std	Std
R6, R7	2	Resistor, Chip, 5.1k-Ohms, 1/16-W	Std	Std
R8	1	Resistor, Chip, 100k-Ohms, 1/16-W	Std	Std
R9	1	Resistor, Chip, 10k-Ohms, 1/16-W	Std	Std
N/A	5	Shunt, 100mil, Black	3M	929950-00
U1	1	IC, Battery Pack Security and Authentication	TI	BQ26150DCK

6 EVM Hardware and Software Setup

6.1 Software Installation

This section describes how to install the bq26150EVM PC software and how to connect the different components of the EVM.

The following steps install the bq26150 evaluation software:

1. Insert CD ROM into a CD ROM drive.
2. Select the CD ROM drive using **My Computer** on the desktop or the **File Manager** or **Explorer** utility.
3. Open the ReadMeFirst.txt file, and follow the instructions to install the USB drivers for EV2300.
4. When USB installation completes, double-click on the Setup.exe icon.
5. The setup program installs an application group in the programs menu.

6.2 Hardware Connection

The EVM work environment includes three hardware components:

- bq26150EVM circuit module
- PC interface board (EV2300 – available separately)
- Host PC

A second HDQ device can be connected with the bq26150, permitting communication between the second HDQ device and the EV2300.

The following steps configure the hardware for interface to the PC:

1. Connect colored wires that are included with EV2300 to bq26150EVM using Table 1 as a guide.
2. Connect the connector with colored wires to the HDQ connector that is on EV2300. HDQ connection is located on the top right of EV2300.
3. Connect the PC USB cable to the EV2300 and the PC USB port.

The bq26150EVM is now set up for operation.

Table 3. Wire Connection

bq26150 EVM	Wire Color
HDQ	Brown
VSS	Black
PROG	White

To program the OTP of bq26150 a 7 V pulse must be generated on the HDQ line. The HPA116 board has an additional circuit included that permits generating this pulse when using a Power Supply set to 8.5 V and the VOUT output of the EV2300. The evaluation software controls this pulse for OTP programming.

When programming of OTP is expected the 8.5 V supply must be connected to the HPA116 board at the SUPPLY input of the board. Ensure that the ground of the power supply is connected to VSS of the board.

There are five jumpers that can be connected. Depending on what functionality of the system is going to be used then the jumpers should be connected in a specific configuration.

6.2.1 Normal Operation

Normal operation includes reading registers from bq26150, writing to RAM registers such as Random Challenge registers and Authentication Control register. If using the EV2300 to communicate with the bq26150 do not connect J9. This jumper is for using a pull-up resistor on the HDQ line. The EV2300 already provides a pull-up resistor that allows HDQ communication.

6.2.2 OTP Programming

To program OTP registers it is required to send a 7V pulse across the HDQ line after sending the appropriate write command. See datasheet for specific description of OTP programming requirements. When programming OTP registers is expected, the following must be ensured:

- Jumpers J7 and J8 are connected
- VOUT output of EV2300 is connected to PROG input of HPA116 board.
- Power supply set to 8.5V is connected across the SUPPLY and VSS inputs of HPA116 board. Supply must be on when mentioned jumpers are connected to allow valid HDQ communication.

7 Software Operation

Run the program from the **Start|Programs|Texas Instruments|bq26150 EVSW** menu sequence. If the EV2300 is not connected to a USB port, the program will display a USB error message and then display the initial REGISTERS data screen.

7.1 Evaluation Software Pages

This section describes the function of each page of the EVSW.

7.2 REGISTERS

Within this page is where all the authentication functions of bq26150 take place ([Figure 6](#)).

Sections Within the Registers Page

Polynomial Seed – This section is to read the encrypted Polynomial Seed and enter the plaintext Polynomial Seed values that are used to initialize the authentication CRC.

Polynomial Coefficients – This section is to read the encrypted Polynomial Coefficient and enter the plaintext Polynomial Coefficient values that define the CRC circuit used during authentication.

Device ID Registers – This section is to read the Encrypted Device ID and enter the Plaintext Device ID values.

Random Challenge – The 32 bit random challenge is generated and sent to the bq26150.

Authentication Control Register – This section determines if the system goes into continuous pass or one time pass mode. The POR bit can be read and cleared. The DONE bit gives status of authentication process. The AUTH bit initiates an authentication process. The continuous or one time pass modes can be initiated from this register. Once CPASS or OPASS have been set they may be canceled so that communication directly to the bq26150 is allowed by clicking on the CANCEL button shared by both features.

Reset bq26150 – Resets the IC by pulling HDQ line low for a determined time.

Authentication CRC by bq26150 – Reads the Authentication CRC registers from the bq26150.

Authentication CRC by Host – Calculates the CRC based on the decryption done by host and the random challenge.

Once a bq26150 has the Encrypted and Plaintext versions of the Polynomial and Device ID registers programmed in OTP as desired by the customer or Texas Instruments Inc representative then the user can go through the steps required to authenticate. The user can use these steps as a guide to how to develop later on system host firmware.

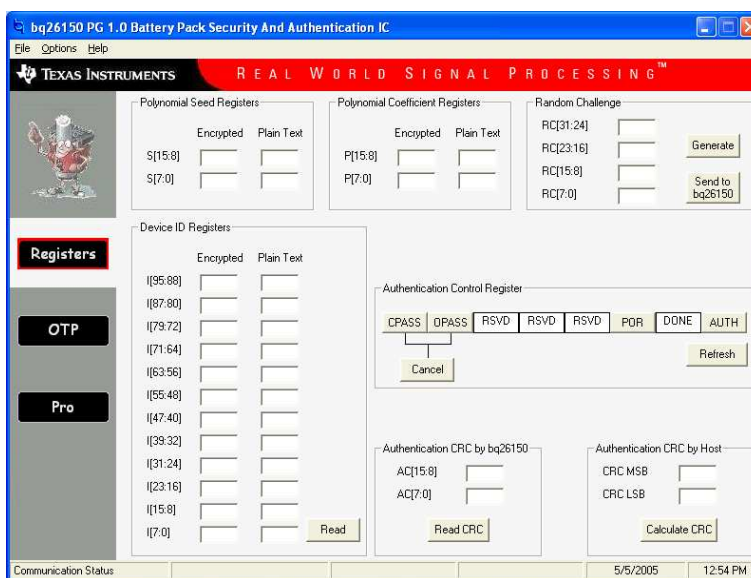
Steps to authenticate using Evaluation Software:

1. Select the Read command. This will read all encrypted version of Polynomial Seed, Polynomial Coefficients and Device ID registers.
2. The user must decrypt the values read in the previous step based on whatever cryptography scheme was used to obtain the cipher text versions of these registers.
3. Select the Generate command that is in the Random Challenge section.
4. Select the Send to bq26150 command. This will send the random challenge value obtained in the previous step of this sequence and write it into the Random Challenge registers of the bq26150.
5. Select the Authentication command (AUTH). This will instruct the bq26150 to calculate a CRC of the Plaintext Device ID (96 bit) and Random Challenge (32 bit) based on the Plaintext Polynomial Seed

and Plaintext Polynomial Coefficients.

6. If DONE at the Authentication Control register is set (red and bold) then a CRC has been calculated by the bq26150. Select the Read CRC command to get the values of the Authentication CRC Value registers.
7. Select the Calculate CRC command to have the host, in this case the PC determine the CRC value of the deciphered Device ID values and the Random Challenge registers based on the deciphered Polynomial values.
8. Compare the CRC read from the bq26150 and the CRC calculated by the PC to determine if authentication is successful.

Make variations to the steps described above to prove that only a correct combination of deciphered Polynomial Seed, Polynomial Coefficients and Device ID are needed so that authentication is successful.



The screenshot displays the 'Registers' page of the bq26150 PG 1.0 Battery Pack Security And Authentication IC software. The interface is organized into several sections:

- Polynomial Seed Registers:** Includes fields for Encrypted and Plain Text for S[15:8] and S[7:0].
- Polynomial Coefficient Registers:** Includes fields for Encrypted and Plain Text for P[15:8] and P[7:0].
- Random Challenge:** Includes fields for RC[31:24], RC[23:16], RC[15:8], and RC[7:0], with buttons for 'Generate' and 'Send to bq26150'.
- Device ID Registers:** A large section with multiple rows of Encrypted and Plain Text fields for various nibbles (e.g., I[95:88], I[87:80], ..., I[7:0]).
- Authentication Control Register:** Features buttons for CPASS, DPASS, RSVD, POR, DONE, and AUTH, along with 'Cancel' and 'Refresh' buttons.
- Authentication CRC by bq26150:** Includes fields for AC[15:8] and AC[7:0], with a 'Read CRC' button.
- Authentication CRC by Host:** Includes fields for CRC MSB and CRC LSB, with a 'Calculate CRC' button.

A sidebar on the left contains buttons for 'Registers', 'OTP', and 'Pro'. The bottom status bar shows 'Communication Status' and the date/time '5/5/2005 12:54 PM'.

Figure 6. Registers Page

7.3 OTP

This page (Figure 7) allows the user to program the OTP with desired values. It requires that the hardware is setup as described in section 2.2.2 of this user's guide.

Sections Within the OTP Page

General Purpose Memory – The user can program any values to these registers.

Encrypted Registers – The encrypted version of the Polynomial Seed, Polynomial Coefficients and Device ID registers are programmed in this section. The values must be predetermined by the user by using any encryption scheme that it may see suitable. After a write attempt, the evaluation software reads back and displays the values of these registers.

Plaintext Registers – The plain-text version of the Polynomial Seed, Polynomial Coefficients and Device ID registers are programmed in this section. These values tend to be chosen by the user before encrypting them so that they can be used in the Encrypted versions. After a write attempt to the Plain-text registers the evaluation software displays 00.

OTP File Import – A file with extension .otp containing the OTP registers' values can be loaded to the text fields so that the values can be programmed to OTP. The evaluation software comes with an example OTP file.

Device Lock – These buttons write a value to nibbles of Device Lock register. When writing to a specific nibble of the Device Lock register certain OTP registers will be locked so that no further programming is allowed. After locking the device, writes to the Polynomial Seed, Polynomial Coefficients and Device ID are not allowed. See datasheet for details on Device Lock.

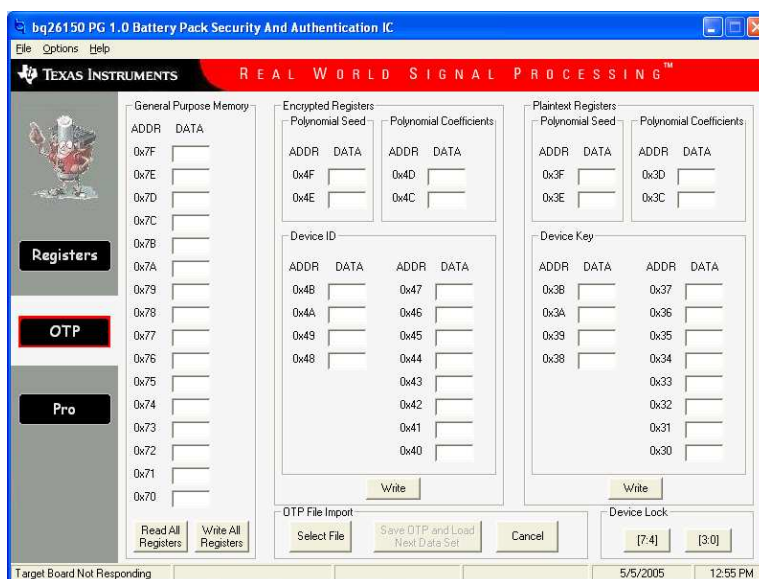


Figure 7. OTP Page

7.4 PRO

This page (Figure 8) allows the user to read from or write to the bq26150 when in normal operation or read from or write to a second HDQ device when in CPASS or OPASS mode.

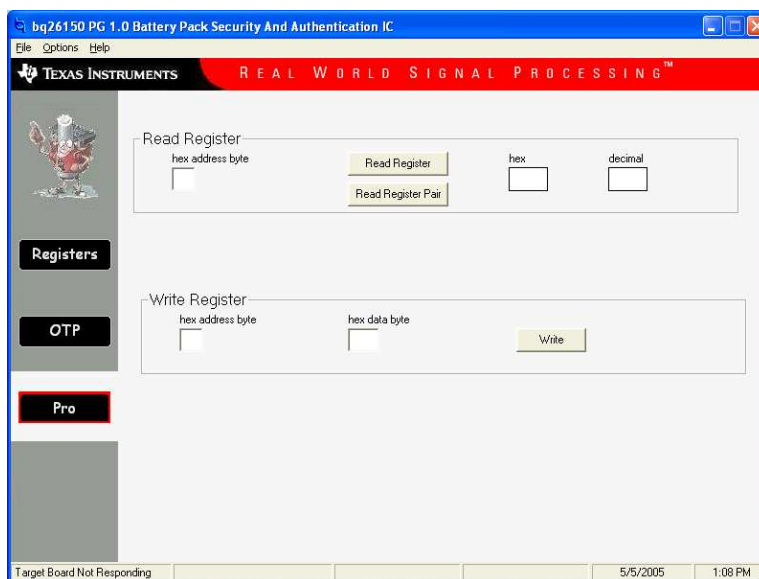


Figure 8. PRO Page

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

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

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

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

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

General Statement for EVMs including a radio

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

For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant

Caution

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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

FCC Interference Statement for Class A EVM devices

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

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

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

Concerning EVMs including radio transmitters

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

Concerning EVMs including detachable antennas

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

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

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

Concernant les EVMs avec appareils radio

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

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

【Important Notice for Users of EVMs for RF Products in Japan】

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

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

1. Use this product in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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

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

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard.
3. Since the EVM is not a completed product, it may not meet all applicable regulatory and safety compliance standards (such as UL, CSA, VDE, CE, RoHS and WEEE) which may normally be associated with similar items. You assume full responsibility to determine and/or assure compliance with any such standards and related certifications as may be applicable. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

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

Agreement to Defend, Indemnify and Hold Harmless. You agree to defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of or in connection with any use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

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