

## BATTERY PACK SECURITY AND AUTHENTICATION IC FOR PORTABLE APPLICATIONS ( bqSECURE™)

Check for Samples: [bq26150](#)

### FEATURES

- Provides Authentication of Battery Packs Through a Programmable CRC With a 96-bit Unique Device ID
- 16 Bytes of User-Programmable Nonvolatile Memory
- 12.5 KV IEC ESD Protection on HDQ Input
- Internal Time-Base Eliminates External Crystal Oscillator
- Low-Power Operating: <30  $\mu$ A
- Single-Wire HDQ Interface
- Powered Directly From the Communication Bus
- Pass-Through HDQ Version Supports Existing Packs With Gas Gauges

- Small 5-Pin SC 70 package

### APPLICATIONS

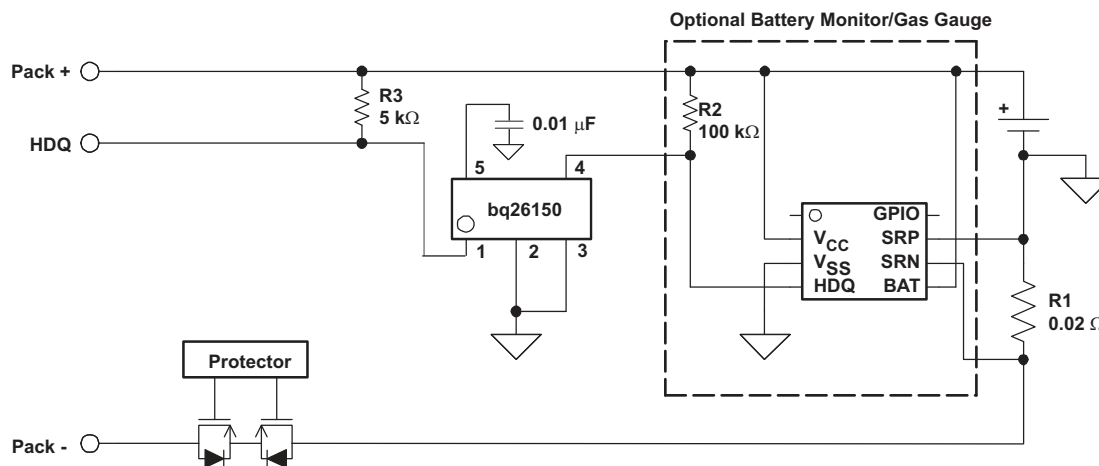
- Cellular Phones
- PDA and Smart Phones
- MP3 Players
- Digital Cameras
- Internet Appliances
- Handheld Devices

### DESCRIPTION

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 96-bit unique device ID, device unique 16-bit seed, and a 16-bit device specific CRC to provide security. The device ID, CRC seed, and CRC polynomial coefficients are stored securely in each bq26150 device, allowing the host to authenticate each pack.

The bq26150 communicates to the system over a simple one-wire, bidirectional serial interface. The 5 kbits/s HDQ bus interfaces reduces communications overhead in the external microcontroller. The bq26150 also uses the HDQ bus to charge an external capacitor that provides power to the bq26150.

### TYPICAL APPLICATION



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

bqSECURE is a trademark of Texas Instruments.



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### AVAILABLE OPTIONS

T <sub>A</sub>	PACKAGE	PART NUMBER
–20°C to 70°C	5-Lead SC 70	bq26150

### ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

	UNIT
V <sub>SS</sub> Supply voltage (HDQ with respect to V <sub>SS</sub> )	–0.3 V to 7.7 V
V <sub>I</sub> Input voltage (HDQP with respect to V <sub>SS</sub> )	–0.3 V to 7 V
I <sub>O</sub> Output current (HDQ and HDQP)	5 mA
T <sub>A</sub> Operating free-air temperature range	–20°C to 70°C
T <sub>stg</sub> Storage temperature range	–65°C to 150°C
T <sub>J</sub> Junction temperature range	–40°C to 125°C

(1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

### RECOMMENDED OPERATING CONDITIONS

	MIN	NOM	MAX	UNIT
Supply voltage, HDQ pull-up	2.5		5	V
T <sub>J</sub> Operating free-air temperature range	–20		70	°C

### ELECTRICAL CHARACTERISTICS

All parameters over recommended operating temperature and supply voltage range (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
C <sub>I</sub> Input capacitance	HDQ		400		pF
t <sub>d1</sub> Power up communication delay	Power capacitor charge time		100		ms
I <sub>CC</sub> V <sub>CC</sub> current	V <sub>CC</sub> > V <sub>CC(min)</sub>		20	30	μA
V <sub>(POR)</sub> POR threshold	Low-to-high			1.5	V
Nonvolatile memory programming voltage		7.0		7.7	V
Nonvolatile memory programming supply current	–40°C and V <sub>CC</sub> = 2.75 V			308	μA

### HDQ AND HDQP PINS

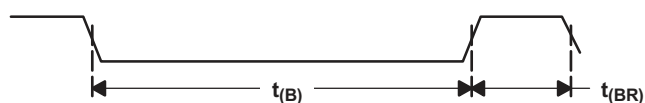
over recommended operating temperature and supply voltage range (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V <sub>IH</sub> Input high voltage		1.8			V
V <sub>IL</sub> Input low voltage				0.7	V
I <sub>OL</sub> Output low sink current	V <sub>OL</sub> = 0.4 V			1	mA

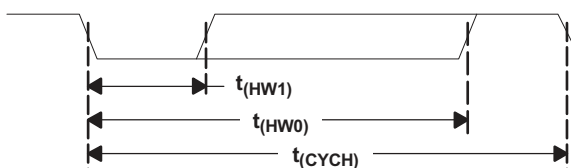
### STANDARD SERIAL COMMUNICATION (HDQ) TIMING

over recommended operating temperature and supply voltage range (unless otherwise noted) See [Figure 1](#)

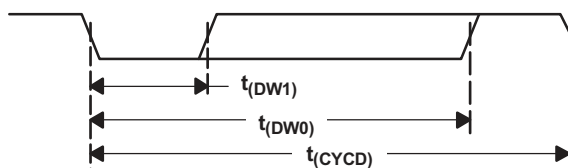
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
Power up delay		Power capacitor charge time	100			ms
$t_{(B)}$	Break timing		190			$\mu$ s
$t_{(BR)}$	Break recovery		40			$\mu$ s
$t_{(CYCH)}$	Host bit window		190			$\mu$ s
$t_{(HW1)}$	Host sends 1		0.5	50		$\mu$ s
$t_{(HW0)}$	Host sends 0		86	145		$\mu$ s
$t_{(RSPS)}$	bq26150 to host response		190	320		$\mu$ s
$t_{(CYCD)}$	bq26150 bit window		190	250		$\mu$ s
$t_{(DW1)}$	bq26150 sends 1		32	50		$\mu$ s
$t_{(DW0)}$	bq26150 sends 0		80	145		$\mu$ s



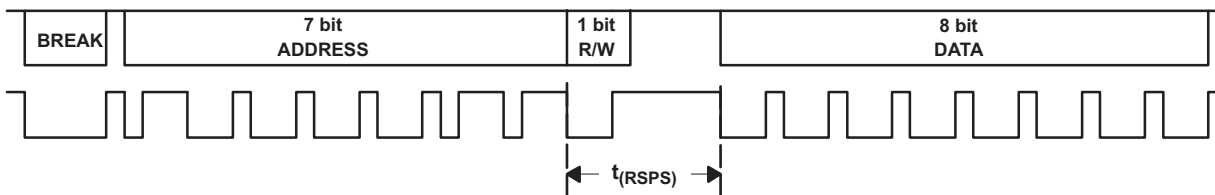
(a) Break and Break Recovery Timing;



(b) Host Transmitted Bit Timing;



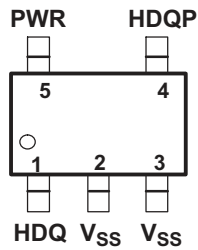
(c) bq26150 Transmitted Bit Timing;



(d) bq26150 to Host Response Timing

Figure 1. HDQ Bit Timing Diagrams

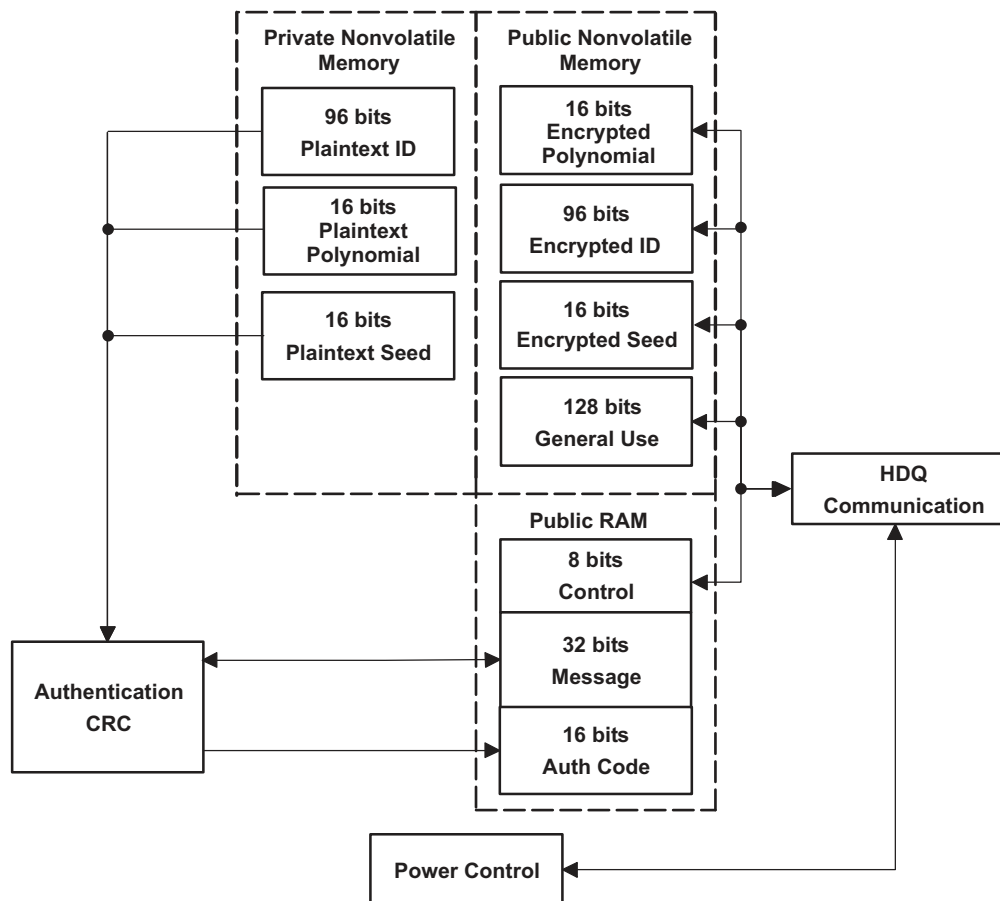
**PIN ASSIGNMENT**



**TERMINAL FUNCTIONS**

TERMINAL		I/O	DESCRIPTION
NAME	NO.		
HDQ	1	I/O	Single-wire HDQ interface to host
VSS	2, 3	I	Ground
HDQP	4	I/O	Single-wire HDQ interface to 2nd HDQ device
PWR	5	I/O	Power capacitor

**FUNCTIONAL BLOCK DIAGRAM**



## APPLICATION INFORMATION

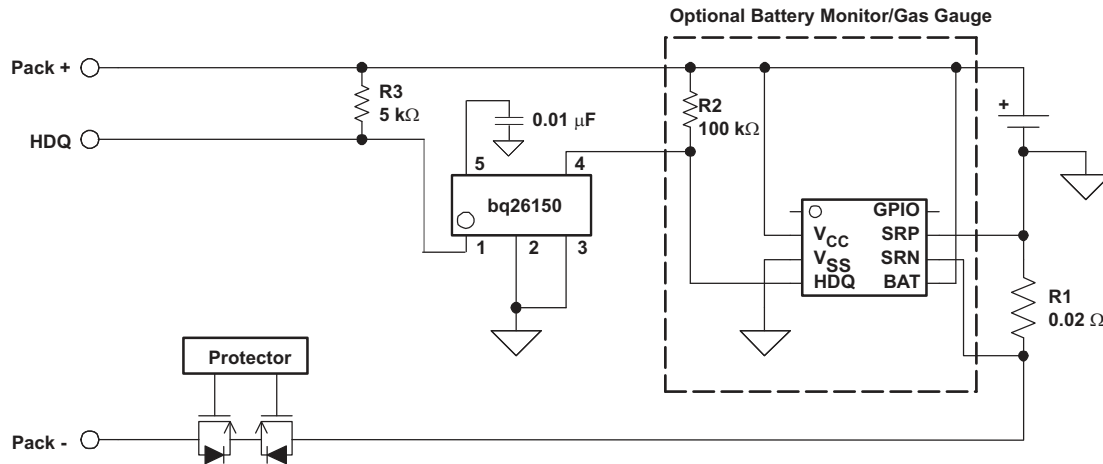


Figure 2. Typical Application Circuit

## FUNCTIONAL DESCRIPTION

The bq26150 provides a simple and cost effective method to authenticate battery packs for end equipment. Security is achieved through the use of a 16-bit CRC, a 16-bit CRC seed, a 96-bit device ID, and a 32-bit random challenge. The CRC polynomial, CRC seed, and 96-bit ID are unique from device to device, and are stored as encrypted text in public memory, and as plain text in private memory. The host system can decrypt the polynomial, seed, and ID values using a shared key that is stored in end-equipments memory. The encryption method and shared key used to store the polynomial coefficients and the device ID can be selected by the manufacturer. *Contact TI for information regarding specifics for encryption of the device ID and CRC polynomial coefficients.*

To authenticate a battery pack, the host reads the encrypted device ID, polynomial, and seed values. It decrypts those values, then generates a 32-bit random challenge, which is transmitted to the bq26150. The bq26150 uses the plain-text version of the polynomial coefficients and device ID, along with the 32-bit random challenge from the host, to calculate the authentication CRC value. The host uses the polynomial coefficients, seed, and device ID that it decrypted, along with the 32-bit random challenge it sent to the bq26150, to calculate the authentication CRC value. When the host and bq26150 have completed the calculations, the host can read the authentication CRC value the bq26150 computed and compare to its own value. If the values match, the battery pack is authenticated.

The bq26150 has a communication pass-through mode that allows it to be used in systems with an existing HDQ based battery monitor or gas gauge. Once the battery pack is authenticated, the bq26150 can be put in continuous pass-through mode, allowing the host system to communicate with a second HDQ device with no additional overhead. A one-time pass-through mode is also available, allowing the host to communicate once to the second HDQ device as needed.

The bq26150 obtains the power needed to run from the HDQ bus. An external capacitor is charged when the bus is high and discharges while the bus is low. If the bq26150 is not authenticating or communicating and the HDQ bus is low, the power is reduced and it enters sleep mode. If the bus is held low until the capacitor fully discharges, the bq26150 is disabled.

## Register Interface

**Table 1. Memory Map**

HDQ ADDRESS	NAME	FUNCTION
<b>NONVOLATILE REGISTERS</b>		
0x7F – 0x70	GEN	General Purpose Memory
0x6F – 0x60	RSVD	Reserved
0x5F – 0x59	RSVD	Reserved
0x58	DL	Device Lock
0x57 – 0x51	RSVD	Reserved
0x50	SKI	Secret Key Index
0x4F – 0x4E	EDS	Encrypted polynomial seed (ES[15:0])
0x4D – 0x4C	EDP	Encrypted polynomial coefficients (EP[15:0])
0x4B – 0x48	EDK1	Encrypted device ID registers (EI[95:64])
0x47 – 0x40	EDK0	Encrypted device ID registers (EI[63:0])
0x3F – 0x3E	PDS	Plaintext polynomial seed(PS[15:0])
0x3D – 0x3C	PDP	Plaintext polynomial coefficients (PP[15:0])
0x3B – 0x38	PDK1	Plaintext device ID registers (PI[95:64])
0x37 – 0x30	PDK0	Plaintext device ID registers (PI[63:0])
<b>RAM REGISTERS</b>		
0x2F – 0x1A	RSVD	Reserved
0x19	FACTORY	Factory Reserved
0x18	CTRL	Authentication control register
0x17 – 0x06	RSVD	Reserved
0x05 – 0x04	AC	Authentication CRC value (AC[15:0])
0x03 – 0x00	RC	Random challenge registers (RC[31:0])

### Memory Descriptions

#### Reserved Registers (RSVD)–Addresses 0x6F–0x59, 0x57–0x51, 0x2F–0x1A, 0x17–0x06

Registers reserved for future use. Any read from these registers returns 0xFF.

#### General Use (GEN) – Addresses 0x7F – 0x70

General use memory allows battery manufacturer or other pack information to be stored in nonvolatile memory.

#### Device Lock (DL) – Addresses 0x58

When DL[7:4] is nonzero, any attempt to write the EDS, EDP, EDK1, PDS, PDP, or PDK1 registers is blocked. When DL[3:0] is nonzero, any attempt to write to EDK0 or PDK0 is blocked. This feature allowed two entities to write device information, providing for more secure programming. The lock takes effect immediately after the DL register is written.

#### Secret Key Index (SKI) – Addresses 0x50

This non-volatile register can be used in the event that more than a single key is used by the host to decrypt the EDP and EDK registers. For example, multiple pack manufacturers may be utilized to assembly packs for the end equipment. Each pack manufacturer can be given a separate key ( $K_S$ ), and key index value (I), to encrypt the plaintext polynomial and device ID values. The host end equipment is then programmed with each secret key ( $K_S$ ) used by the various pack manufacturers. When authentication is attempted, the host reads the encrypted polynomial, device ID, and key index values. The  $K_S$  used by the manufacturer with key index is then selected to decrypt the values to plaintext.

### Encrypted Device Seed (EDS) – Addresses 0x4F – 0x4E

The unique 16-bit CRC seed stored as ciphertext in public nonvolatile memory. The host reads this seed and decrypts it using the shared key. The output of the decryption is the plaintext CRC seed that is used by the host to initialize the authentication CRC.

### Encrypted Device Polynomial Coefficients (EDP) – Addresses 0x4D – 0x4C

The unique 16-bit CRC polynomial stored as ciphertext in public nonvolatile memory. The host reads this register pair and decrypts it using the shared key. The output of the decryption is the plaintext polynomial coefficients that are used by the host to define the authentication CRC.

### Encrypted Device ID (EDK) – Addresses 0x4B – 0x40

The unique 96 bit device ID used stored as ciphertext in public nonvolatile memory. The host reads this register pair and decrypts it using the shared key. The output of the decryption is the plaintext device ID that are used by the host to define the authentication CRC.

### Plaintext Device Seed (PDS) – Addresses 0x3F – 0x3E

The unique 16 bit CRC seed stored as plaintext in private non-volatile memory. The seed registers are written to the OTP at pack manufacturing or IC test. The plaintext seed is used by the bq26150 to initialize the authentication CRC. Any attempt to read the plaintext seed registers will return data 0xFF.

### Plaintext Device Polynomial Coefficients (PDP) – Addresses 0x3D – 0x3C

The unique 16 bit CRC polynomial stored as plaintext in private nonvolatile memory. The coefficients are written to the OTP at pack manufacturing or IC test. The plaintext polynomial coefficients are used by the bq26150 to define the authentication CRC. Any attempt to read the plaintext polynomial coefficients returns data 0xFF.

### Plaintext Device ID (PDK) – Addresses 0x3B – 0x30

The unique 96 bit device ID used stored as plaintext in public nonvolatile memory. The device is written to the OTP at pack manufacturing or IC test. The plaintext device ID is used by the bq26150 to calculate the authentication CRC value. Any attempt to read the plaintext device ID returns data 0xFF.

### Factory Reserved (FACTORY) – Address 0x19

This register is used internally to TI for simple identification. Writes are not permitted, and reads return a random value.

### Control Register (CTRL) – Address 0x18

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
NAME	CPASS	OPASS	RSVD	RSVD	RSVD	POR	DONE	AUTH
POR STATUS	0	0	0	0	0	1	0	0

**CPASS** Writing the bit to a **1** enables the Continuous HDQ Pass Through mode. All communication then passes through the HDQP pin, allowing the host to reach a 2<sup>nd</sup> HDQ based device. The CPASS bit is cleared when the bq26150 detects three consecutive breaks.

**OPASS** Writing this bit to a **1** enables the One Time HDQ Pass Through mode. The next 16 valid bits of communication passes through the HDQP pin, allowing the host to reach a 2<sup>nd</sup> HDQ based device. The OPASS bit is cleared following the 16<sup>th</sup> valid data bit or when three consecutive breaks are sent from the host.

**RSVD** Reserved – These bits are available for future functions. These bits (5, 4, and 3) should be written to **0** when the host system writes to the control register. These bits always return a **0** when the host reads from the control register

**POR** The POR bit is set to **1** by the bq26150 following a Power on Reset. This is a flag to the host that  $V_{CC}$  was less than  $V_{(POR)}$  for some period of time. The device undergoes a full reset on a POR condition. The host must clear the bit. The host may set this bit, but it has no effect on the bq26150.

**DONE** DONE is set when bq26150 has completed calculating the CRC after AUTH bit has been set. This is a

flag to the host system that the message/authentication registers contain the calculated CRC value. The bit is automatically cleared when the AUTH bit is set.

**AUTH** Writing this bit to **1** initiates the CRC calculation. The message written to the message/digest registers, 0x03 – 0x00, are used as input. This bit is automatically cleared when the CRC calculation is complete and the authentication value has been written to the message/authentication registers.

#### **Authentication CRC Value (AC) – Addresses 0x05 – 0x04**

The value computed from the CRC. The register is cleared on POR. This register cannot be written by the host system

#### **Random Challenge (RC) – Addresses 0x03 – 0x00**

The host system writes this register set with a random challenge that is used to calculate the CRC value (see below for details on the CRC calculation). The bq26150 uses the entire 4 bytes to calculate the CRC when the AUTH bit (CTRL[0]) is written to 1. After the authentication value is calculated, bq26150 writes the digest to the AC registers, clear the AUTH bit and set the DONE bit (CTRL[1]).

#### **CRC Description**

A CRC, or cyclic redundancy check, is normally used to detect small errors in the transmission of data. A CRC calculation is a form of polynomial modulo 2 arithmetic, so a CRC is usually referenced by means of a polynomial, i.e.,  $1 + x^4 + x^5 + x^{16}$ . Most *correct* CRC polynomials ensure that the highest and lowest polynomial orders have a coefficient of 1. The highest order coefficient represents the number of bits in the final CRC value and the other terms with a coefficient of 1 represent the tap points where an XOR is performed. The example CRC  $1 + x^4 + x^5 + x^{16}$  would then represent a 16 bit CRC value, with tap points at the  $x^5$ ,  $x^4$ , and  $x^0$  stages. The bq26150 uses a 16 bit type 2 linear feedback shift register with programmable tap points. This allows the CRC polynomial to vary from device to device.



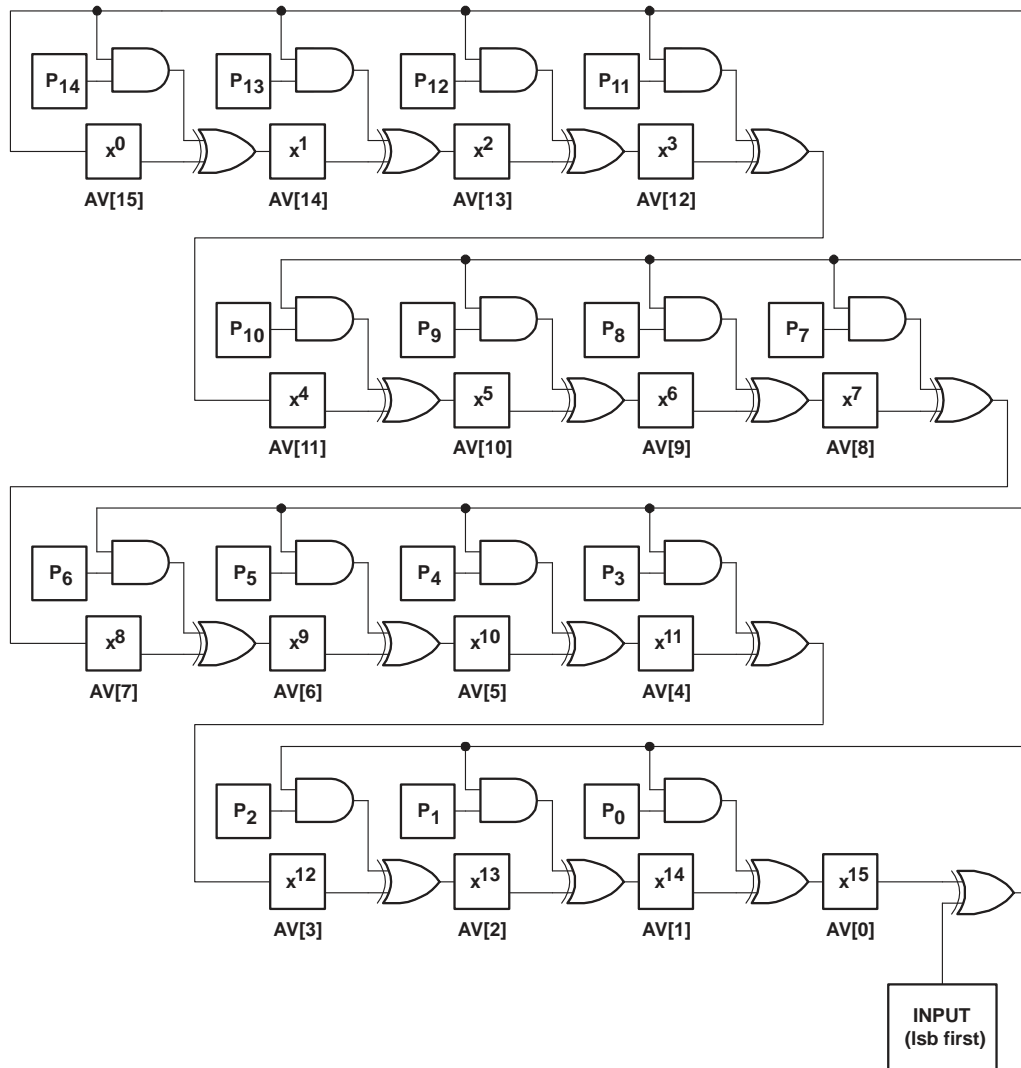


Figure 3. bq26150 Programmable CRC Hardware Implementation

The generic polynomial used in the bq26150 can be written as:

$$1 + P_{14}x^1 + P_{13}x^2 + P_{12}x^3 + P_{11}x^4 + P_{10}x^5 + P_9x^6 + P_8x^7 + P_7x^8 + P_6x^9 + P_5x^{10} + P_4x^{11} + P_3x^{12} + P_2x^{13} + P_1x^{14} + P_0x^{15} + x^{16}$$

Figure 3 shows the hardware implementation of the CRC, with the corresponding bits of the authentication value shown below each stage of the shift register. This configuration assumes that the  $x^0$  term coefficient, which is  $P_{15}$ , is always 1, which was stated as an assumption of a *normal* CRC polynomial. This means that there are  $2^{15}$ , or 32768, possible CRC polynomial values. In actuality, the number of possible CRC polynomial will be less than 32758 because some values, such as all 0, do not provide sufficient mixing of the results to be secure.

To authenticate a battery pack using the bq26150, the host must reproduce the CRC calculation in software. This is done by reading the encrypted device ID and encrypted polynomial coefficients, and encrypted seed. All values are decrypted by the host to provide the 16-bit polynomial, 16-bit seed, and 96 of the 128 bits of calculation's input. The CRC input is:

	Device ID [95:0]	Random Challenge [31:0]
Input MSB		Input LSB

Figure 4 provides a pseudo-code example of calculating the CRC in software and Figure 5 shows an example of the CRC calculations inputs and associated output.

```

poly = P [15 : 0] ;
strcpy (input, key [63 : 0] ) ;
strcat (input, challenge [31 : 0] ) ;
for ( i = 0 ; i < 96 ; i ++ )
{
  if (crc [0] ^ input [i] )
    crc = ( crc >> 1 ) ^ poly ;
  else
    crc = crc >> 1 ;
}

```

Figure 4. Pseudo-C Code for CRC Calculation

Polynomial = $1 + x^2 + x^5 + x^{11} + x^{16}$	
P [ 15 : 0 ] = 1010010000010000	(binary)
= A410	(hex)
Seed [15:0] = 6a9f	(hex)
Decrypted Device ID = 65a9b4f38dcc217d	(hex)
Random Challenge = a0071d8e	(hex)
CRC input = a0071d8e65a9b4f38dcc217d	(hex)
CRC output = 7ef8	

Figure 5. Example Inputs and Output of CRC Calculation

## Writing and Reading Nonvolatile Memory

The bq26150 has sixteen bytes of nonvolatile one time programmable memory for general use and 32 bytes for authentication information that can be programmed by the HDQ engine. All OTP registers are cleared at final test, allowing for programming at pack manufacturing.

Programming a nonvolatile memory location requires sending the HDQ write command to that location and then pulling the HDQ line up to 7 V for 300  $\mu$ s. If the programming pulse is not provided, the data transmitted by the host will not be programmed into the OTP. Figure 6 shows an example of writing and programming address 0x71 with data 0x55 (*timings are not drawn to scale*). Figure 6, Figure 7 and Table 2 provide more information on the programming pulse specifications.

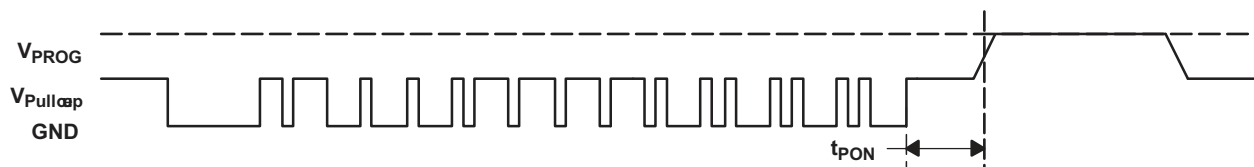


Figure 6. Writing and Programming OTP Example

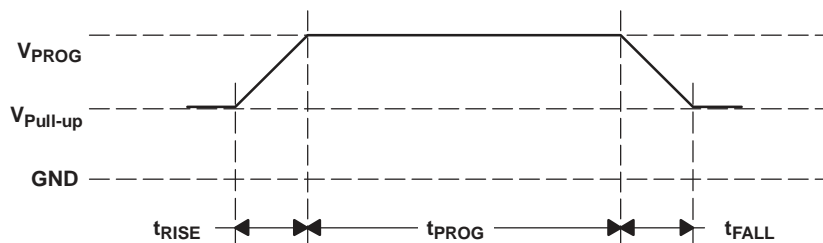


Figure 7. OTP Programming Pulse

Table 2. OTP Programming Specifications

PARAMETER	TEST CONDITIONS	MIN	MAX	UNIT
t <sub>PON</sub> Write to pulse rise		2		μs
t <sub>RISE</sub> Pulse rise time	No overshoot above 7.7 V	1	10	μs
t <sub>PROG</sub> Pulse high time		300		μs
t <sub>FALL</sub> Pulse fall time		1	10	μs

The nonvolatile memory can be written to more than once. However, the data already in the byte goes through a logical bitwise OR with the new data. For example, if address 0x71 was programmed with data 0x55 initially and a second program to address 0x71 with data 0xAA was performed, subsequent reads of address 0x71 would return data 0xFF (0x55 OR 0xAA = 0xFF).

### Communication With a 2<sup>nd</sup> HDQ Device

The bq26150 has two communication pass through modes to allow communication to a second HDQ based device from Texas Instruments. These modes allow the bq26150 to be put in an existing system utilizing a bq2018, bq2019, bq262xx, or bq27xxx device. The pass through modes can be enabled by setting the CPASS or OPASS bits in the control register.

The Continuous Pass Through (CPT) mode is enabled when the CPASS bit is set. While in this mode the bq26150 passes all communication through to the 2<sup>nd</sup> device on the bus. The CPT mode is cancelled when the host transmits three consecutive breaks. Note that the 2<sup>nd</sup> device on the bus may only see two of these three breaks. The CPASS bit automatically clears after the third break is received.

The One Pass Through (OPT) mode is enabled when the OPASS bit is set. While in this mode, the bq26150 passes 16 valid HDQ bits. This allows the host to perform a single read or write to the 2<sup>nd</sup> HDQ device. The OPT mode is cleared after the 16<sup>th</sup> valid HDQ bit passes through the bq26150 or when 3 consecutive breaks are received from the host. Note that the 2<sup>nd</sup> HDQ device may only see two of these three breaks. The OPASS bit is automatically cleared after the 16<sup>th</sup> bit or the third break.

The OPT mode is useful for putting a 2<sup>nd</sup> HDQ device to sleep. The OPASS bit can be set in the bq26150, allowing the sleep command to be passed to the 2<sup>nd</sup> HDQ device. After the 16<sup>th</sup> bit is received from the host, communication reverts to the bq26150. The HDQP line will not be disturbed and the 2<sup>nd</sup> device enters sleep mode as expected.

If the host writes both the CPASS and OPASS bits, the CPASS bit has priority and remains set after the first pass through is completed. The OPASS bit is cleared.

#### *Sending a Break During a Pass Through Read:*

The bq26150 pass through mode is implemented in logic rather than connecting the HDQ/HDQP pads directly through an analog transmission gate. This means the bq26150 cannot transmit the first break it receives to the 2<sup>nd</sup> device while the data is being driven from the 2<sup>nd</sup> device to the master. To transmit a break to the 2<sup>nd</sup> device while it is transmitting, the host is required to send 2 breaks. The first resets the bq26150 engine and prepares it to transmit from the host to the 2<sup>nd</sup> device. The second break actually reaches the 2<sup>nd</sup> HDQ device.

#### *Putting a bq262x0 to Sleep using Pass Through:*

A system using the bq26150 and a bq26200 or bq26220 communicates to the monitor during normal usage. This means that the continuous pass-through mode is used. To put the bq262x0 to sleep, the host should exit continuous pass through mode and put the bq26150 in one-time-pass-through mode. The host can then communicate to the bq262x0 to issue the sleep command and communication control reverts to the bq26150. The HDQP is not disturbed, allowing the bq262x0 to enter the low power mode. To wake the bq262x0, the bq26150 can be put in either continuous or one-time-pass-through mode and a break can be issued from the host.

## Communicating With bq26150

The bq26150 includes a single-wire HDQ serial data interface. Host processors, configured for either polled or interrupt processing, can use the interface to access various bq26150 registers. The HDQ pin is an open drain device, which requires an external pull-up or pull-down resistor. The interface uses a command-based protocol, where the host processor sends a command byte to the bq26150. The command directs the bq26150 either to store the next eight bits of data received to a register specified by the command byte, or to output the eight bits of data from a register specified by the command byte.

The communication protocol is asynchronous return-to-one and is referenced to  $V_{SS}$ . Command and data bytes consist of a stream of eight bits that have a maximum transmission rate of 5 Kbits/s. The least-significant bit of a command or data byte is transmitted first. Data input from the bq26150 may be sampled using the pulse-width capture timers available on some microcontrollers. A UART can also be configured to communicate with the bq26150.

If a communication time-out occurs, for example, if the host waits longer than  $t_{(RSPS)}$  for the bq26150 to respond or if this is the first access command, then a BREAK should be sent by the host. The host may then re-send the command. The bq26150 detects a BREAK when the HDQ pin is driven to a logic-low state for a time  $t_{(B)}$  or greater. The bq26150 is ready for a command from the host processor  $t_{(BR)}$  seconds after the HDQ line is released from the break.

The return-to-one data-bit frame consists of three distinct sections:

1. The first section starts the transmission by either the host or the bq26150 taking the HDQ pin to a logic-low state for a period equal to  $t_{(HW1)}$  or  $t_{(DW1)}$ .
2. The next section is the actual data transmission, where the data should be valid for  $t_{(HW0)} - t_{(HW1)}$  or  $t_{(DW0)} - t_{(DW1)}$ .
3. The final section stops the transmission by returning the HDQ pin to a logic-high state and holding it high until the time from bit start to bit end is equal to  $t_{(CYCH)}$  or  $t_{(CYCD)}$ .

The HDQ line may remain high for an indefinite period of time between each bit of address or between each bit of data on a write cycle. After the last bit of address is sent on a read cycle, the bq26150 starts outputting the data after  $t_{(RSPS)}$  with timing as specified. The serial communication timing specification and illustration sections give the timings for data and break communication. Communication with the bq26150 always occurs with the least-significant bit being transmitted first.

Plugging in the battery pack may be seen as the start of a communication due to contact bounce. It is recommended that each communication or string of communications be preceded by a break to reset the bq26150s HDQ engine.

## Command Byte

The Command byte of the bq26150 consists of eight contiguous valid command bits. The command byte contains two fields: W/R Command and address. The Command byte values are shown in the following table:

7	6	5	4	3	2	1	0
W/R	AD6	AD5	AD4	AD3	AD2	AD1	AD0

**W/R** Indicates whether the Command bytes is a read or write command. A **1** indicates a write command and that the following eight bits should be written to the register specified by the address field of the Command byte, while a **0** indicates that the command is a read. On a read command, the bq26150 outputs the requested register contents specified by the address field portion of the Command byte.

**AD6–AD0** The seven bits labeled AD6–AD0 containing the address portion of the register to be accessed.

## Cryptography Glossary

This glossary is not intended to be exhaustive, but provides a quick reference to some of the terms included in this document.

### Plaintext

Data in an immediately usable form. *Texas Instruments Incorporated* is an example of a plaintext string.

### Ciphertext

Data that has been encrypted with any of a number of cipher algorithms. If *bq26150* is the plaintext, the ciphertext string might be represented as \*)d\*0dsF.

### Shared Secret Key

A key used by both Texas Instruments Incorporated and the host manufacturer to encrypt or decrypt the unique device ID. Contact the factory for more specific information.

### Unique Device ID

A 96-bit value used to calculate the CRC authentication value.

### Encrypted Polynomial Coefficients

Encrypted version of the 16-bit device specific CRC polynomial.

### Encrypted Device ID

The encrypted version of the 96-bit unique device ID.

## REVISION HISTORY

<b>Changes from Original (January 2005) to Revision A</b>	<b>Page</b>				
<ul style="list-style-type: none"> <li>• Changed Text and illustration throughout the data sheet ..... 1</li> </ul>	1				
<table border="0"> <thead> <tr> <th style="text-align: left;"><b>Changes from Revision A (July 2005) to Revision B</b></th> <th style="text-align: right;"><b>Page</b></th> </tr> </thead> <tbody> <tr> <td style="border-top: 1px solid black;"> <ul style="list-style-type: none"> <li>• Changed the data sheet status from Product Preview to Production ..... 1</li> </ul> </td> <td style="border-top: 1px solid black; text-align: right; vertical-align: bottom;">1</td> </tr> </tbody> </table>		<b>Changes from Revision A (July 2005) to Revision B</b>	<b>Page</b>	<ul style="list-style-type: none"> <li>• Changed the data sheet status from Product Preview to Production ..... 1</li> </ul>	1
<b>Changes from Revision A (July 2005) to Revision B</b>	<b>Page</b>				
<ul style="list-style-type: none"> <li>• Changed the data sheet status from Product Preview to Production ..... 1</li> </ul>	1				

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
BQ26150DCKR	OBSOLETE	SC70	DCK	5		TBD	Call TI	Call TI	-20 to 70		
BQ26150DCKRG4	OBSOLETE	SC70	DCK	5		TBD	Call TI	Call TI	-20 to 70		

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

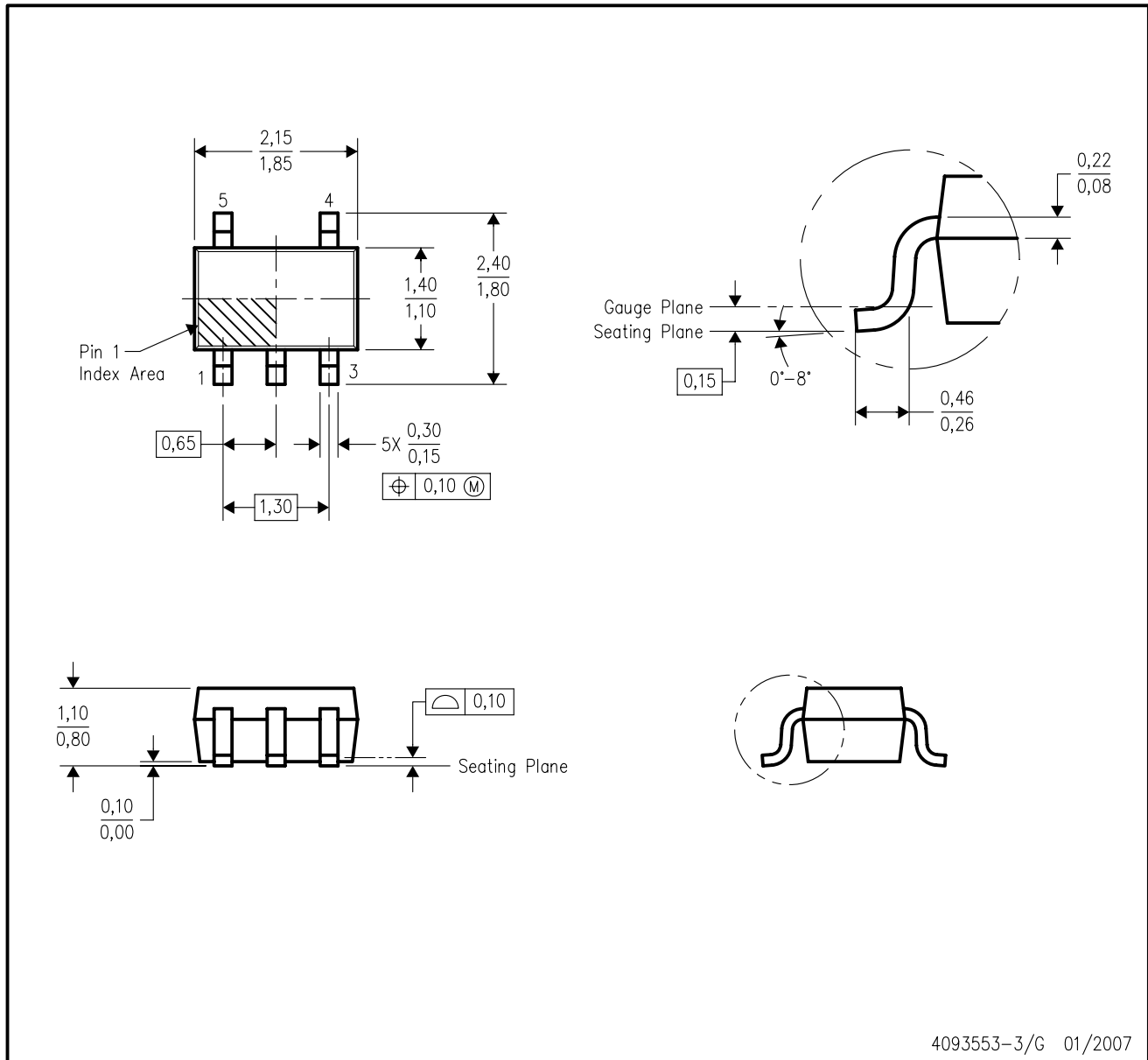
**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.



DCK (R-PDSO-G5)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
  - D. Falls within JEDEC MO-203 variation AA.



## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)