1 INTRODUCTION

1.1 FEATURES

- **Battery Fuel Gauge for 1-Series Li-Ion Applications**
- **Resides on System Main Board**
  - **Works With Embedded or Removable Battery Packs**
- **Uses *PACK*+, *PACK*–, and *T* Battery Terminals**
- **Microcontroller Peripheral Provides:**
  - **Accurate Battery Fuel Gauging**
  - **Internal Temperature Sensor for Battery Temperature Reporting**
  - ***Battery Low* Interrupt Warning**
  - ***Battery Insertion* Indicator**
  - ***Configurable Level of State of Charge (SOC) Interrupts***
  - ***State of Health Indicator***
  - **96 Bytes of Non-Volatile Scratch-Pad FLASH**
- **Battery Fuel Gauge Based on Patented Impedance Track™ Technology**
  - **Models the Battery Discharge Curve for Accurate Time-to-Empty Predictions**
  - **Automatically Adjusts for Battery Aging, Battery Self-Discharge, and Temperature/Rate Inefficiencies**
  - **Low-Value Sense Resistor (10 mΩ or Less)**
- **400-kHz I²C™ Interface for Connection to System Microcontroller Port**
- **In a 12-Pin NanoFree™ (CSP) Packaging**

1.2 APPLICATIONS

- **Smartphones**
- **PDAs**
- **Digital Still and Video Cameras**
- **Handheld Terminals**
- **MP3 or Multimedia Players**

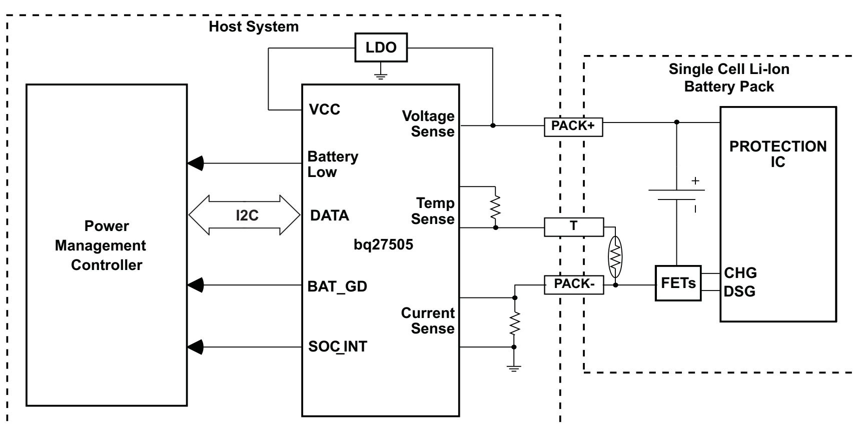
1.3 DESCRIPTION

The Texas Instruments bq27505 system-side Li-Ion battery fuel gauge is a microcontroller peripheral that provides fuel gauging for single-cell Li-Ion battery packs. The device requires little system microcontroller firmware development. The bq27505 resides on the system's main board and manages an embedded battery (non-removable) or a removable battery pack.

The bq27505 uses the patented Impedance Track™ algorithm for fuel gauging, and provides information such as remaining battery capacity (mAh), state-of-charge (%), run-time to empty (min), battery voltage (mV), temperature (°C) and state of health (%).

Battery fuel gauging with the bq27505 requires only PACK+ (P+), PACK– (P–), and Thermistor (T) connections to a removable battery pack or embedded battery circuit. The CSP option is a 12-ball package in the dimensions of 2,43 mm × 1,96 mm with 0,5 mm lead pitch. It is ideal for space constrained applications.

TYPICAL APPLICATION



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.

Contents

2 DEVICE INFORMATION

2.1 AVAILABLE OPTIONS

PART NUMBER	FIRMWARE VERSION	PACKAGE(1)	T_A	COMMUNICATION FORMAT	TAPE and REEL QUANTITY
bq27505YZGR-J2	2.15	CSP-12	–40°C to 85°C	I^2C	3000
bq27505YZGT-J2					250

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.

2.2 DISSIPATION RATINGS

PACKAGE	THERMAL	RESISTANCE(1)(2)	POWER RATING $T_A = 25°C$	DERATING FACTOR ABOVE(1) (2) $T_A = 25°C$
YZG	θ_{JA} = 89°C/W	θ_{JB} = 35°C/W	1.1 W	12 mW/°C

(1) Measured with high-K board.
(2) Maximum power dissipation is a function of $T_{J(max)}$, θ_{JA} and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $PD = (T_{J(max)} - T_A)/ \theta_{JA}$.

2.1 PIN ASSIGNMENT

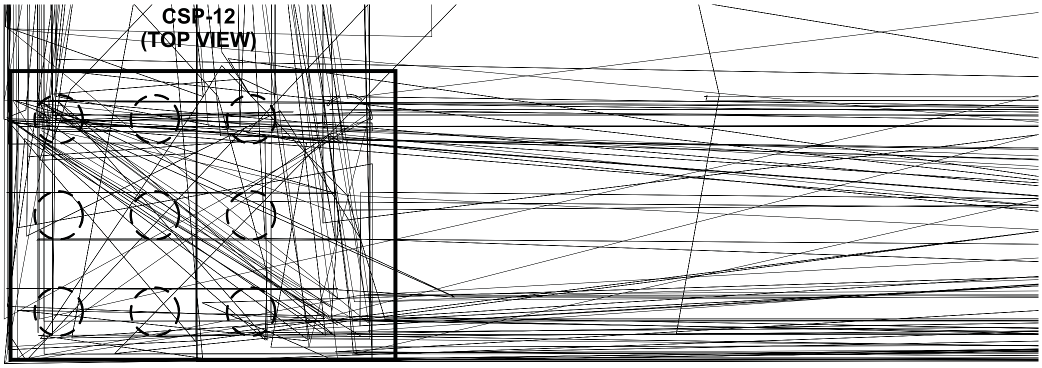


Table 2-1. PIN FUNCTIONS

TERMINAL		TYPE[1]	DESCRIPTION
NAME	NO.		
SRP	A1	IA	Analog input pin connected to the internal coulomb counter where SRP is nearest the PACK– connection. Connect to 5-mΩ to 20-mΩ sense resistor.
SRN	B1	IA	Analog input pin connected to the internal coulomb counter where SRN is nearest the Vss connection. Connect to 5-mΩ to 20-mΩ sense resistor.
BAT_LOW	C1	O	Battery Low output indicator. Active *high* by default, though polarity can be configured through the [BATL_POL] bit of ***Operation Configuration***. Push-pull output.
Vss	D1	P	Device ground
BAT_GD	A2	O	Battery-good indicator. Active-*low* by default, though polarity can be configured through the [BATG_POL] bit of ***Operation Configuration***. Push-pull output.
SOC_INT	B2	I/O	SOC state interrupts output. Generate a pulse under the conditions specified by Table 5-5. Open drain output.
BAT	C2	I	Cell-voltage measurement input. ADC input. Recommend 4.8V maximum for conversion accuracy.
Vcc	D2	P	Processor power input. Decouple with minimum 0.1µF ceramic capacitor.
SDA	A3	I/O	Slave I^2C serial communications data line for communication with system (Master). Open-drain I/O. Use with 10kΩ pull-up resistor (typical).
SCL	B3	I	Slave I^2C serial communications clock input line for communication with system (Master). Use with 10kΩ pull-up resistor (typical).
BI/TOUT	C3	I/O	Battery-insertion detection input. Power pin for pack thermistor network. Thermistor-multiplexer control pin. Use with pull-up resistor >1MΩ (1.8 MΩ typical).
TS	D3	IA	Pack thermistor voltage sense (use 103AT-type thermistor). ADC input

(1) I/O = Digital input/output, IA = Analog input, P = Power connection

3 ELECTRICAL SPECIFICATIONS

3.1 ABSOLUTE MAXIMUM RATINGS

3.2 RECOMMENDED OPERATING CONDITIONS

3.8 ADC (TEMPERATURE AND CELL MEASUREMENT) CHARACTERISTICS

3.10 I²C-COMPATIBLE INTERFACE COMMUNICATION TIMING CHARACTERISTICS

T_A = –40°C to 85°C, 2.4 V < V_{CC} < 2.6 V; typical values at T_A = 25°C and V_{CC} = 2.5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_r	SCL/SDA rise time				300	ns
t_f	SCL/SDA fall time				300	ns
$t_{w(H)}$	SCL pulse duration (high)		600			ns
$t_{w(L)}$	SCL pulse duration (low)		1.3			µs
$t_{su(STA)}$	Setup for repeated start		600			ns
$t_{d(STA)}$	StartSTA)t					

t

UDG−04122

4 GENERAL DESCRIPTION

The bq27505 accurately predicts the battery capacity and other operational characteristics of a single Li-based rechargeable cell. It can be interrogated by a system processor to provide cell information, such as time-to-empty (TTE), time-to-full (TTF) and state-of-charge (SOC) as well as SOC interrupt signal to the host.

Information is accessed through a series of commands, called *Standard Commands*. Further capabilities are provided by the additional *Extended Commands* set. Both sets of commands, indicated by the general format *Command( )*, are used to read and write information contained within the bq27505 control and status registers, as well as its data flash locations. Commands are sent from system to gauge using the bq27505's I^2C serial communications engine, and can be executed during application development, pack manufacture, or end-equipment operation.

Cell information is stored in the bq27505 in non-volatile flash memory. Many of these data flash locations are accessible during application development. They cannot, generally, be accessed directly during end-equipment operation. Access to these locations is achieved by either use of the bq27505's companion evaluation software, through individual commands, or through a sequence of data-flash-access commands. To access a desired data flash location, the correct data flash subclass and offset must be known.

The bq27505 provides two 32-byte user-programmable data flash memory blocks: ***Manufacturer Info Block A*** and ***Manufacturer Info Block B***. This data space is accessed through a data flash interface. For specifics on accessing the data flash, MANUFACTURER INFORMATION BLOCKS.

The key to the bq27505's high-accuracy gas gauging prediction is Texas Instrument's proprietary Impedance Track™ algorithm. This algorithm uses cell measurements, characteristics, and properties to create state-of-charge predictions that can achieve less than 1% error across a wide variety of operating conditions and over the lifetime of the battery.

The bq27505 measures charge/discharge activity by monitoring the voltage across a small-value series sense resistor (5 mΩ to 20 mΩ typ.) located between the system's Vss and the battery's PACK- terminal. When a cell is attached to the bq27505, cell impedance is computed, based on cell current, cell open-circuit voltage (OCV), and cell voltage under loading conditions.

The bq27505 external temperature sensing is optimized with the use of a high accuracy negative temperature coefficient (NTC) thermistor with R_{25}syste2system

4.1 DATA COMMANDS

4.1.1 STANDARD DATA COMMANDS

4.1.1.1.9 CC_INT_OFFSET: 0X000A

Control data of 0x000a instructs the fuel gauge to compute the coulomb counter offset with internal short applied across the SR inputs. The offset value is returned to addresses 0x00/0x01, after a delay of approximately 16 seconds. This function is only available when the fuel gauge is UNSEALED. When SEALED, this command only reads back the CC_INT_OFFSET value stored in data flash.

4.1.1.1.10 WRITE_OFFSET: 0X000B

Control data of 0x000b causes the fuel gauge to write the coulomb counter offset to data flash.

4.1.1.1.11 OCV CMD: 0X000C

This command is to request the gauge to take a OCV reading. This command can only be issued after the *[INICOMP]* has been set, indicating the initialization has been completed. The OCV measurement take place at the beginning of the next repeated 1s firmware synchronization clock. During the same time period, the SOC_INT will pulse. The host should use this signal to reduce the load current below the C/20 in 8ms for a valid OCV reading. The OCV command *[OCVFAIL]* bit will be set if the OCV_CMD is issued when *[CHG_INH]* is set.

4.1.1.1.12 BAT_INSERT: 0X000D

This command is to force the BAT_DET bit to be set when the battery insertion detection is disabled. When the BIE is set to 0, the battery insertion detection is disabled. The gauge relies on the host to inform the battery insertion with this command to set the BAT_DET bit.

4.1.1.1.13 BAT_REMOVE: 0X000E

This command is to force the BAT_DETOCV

4.1.1.6 *Flags( )*: 0x0a/0x0b

This read-word function returns the contents of the fuel-gauge status register, depicting the current operating status.

mAe

Table 4-4. Flags Bit Definitions

	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
High byte	OTC	OTD	–	–	CHG_INH	XCHG	FC	CHG
Low byte	–	–	OCV_GD	WAIT_ID	BAT_DET	SOC1	SYSDOWN	DSG

OTC = Overtemperature in charge condition is detected. True when set.
OTD = Overtemperature in discharge condition is detected. True when set.
CHG_INH = Charge inhibit: unable to begin charging (temperature outside the range ***[Charge Inhibit Temp Low, Charge Inhibit Temp High])***. True when set.
XCHG = Charge suspend alert (temperature outside the range ***[Suspend Temperature Low, Suspend Temperature High]***). True when set.
FC = Full-charged condition reached. Set when charge termination condition is met. (RMFCC=1; Set FC_Set % = -1% when RMFCC = 0). True when set
CHG = (Fast) charging allowed. True when set.
OCV_GD = Good OCV measurement taken. True when set.
WAIT_ID = Waiting to identify inserted battery. True when set.
BAT_DET = Battery detected. True when set.
SOC1 = State-of-charge threshold 1 (***SOC1 Set***) reached. The flag is enabled when BL_INT bit in ***Operation Configuration B*** is set. True when set.
SysDown = SystemDown bit indicating the system shut down. True when set
DSG = Discharging detected. True when set.

4.1.1.7 *NominalAvailableCapacity( )*: 0x0c/0x0d

This read-only command pair returns the uncompensated (less than C/20 load) battery capacity remaining. Units are mAh.

4.1.1.8 *FullAvailableCapacity( )*: 0x0e/0x0f

This read-only command pair returns the uncompensated (less than C/20 load) capacity of the battery when fully charged. Units are mAh. *FullAvailableCapacity( )* is updated at regular intervals, as specified by the IT algorithm.

4.1.1.9 *RemainingCapacity( )*: 0x10/0x11

This read-only command pair returns the compensated battery capacity remaining. Units are mAh.

4.1.1.10 *FullChargeCapacity( )*: 0x12/13

This read-only command pair returns the compensated capacity of the battery when fully charged. Units are mAh. *FullChargeCapacity( )*

4.1.1.11 *AverageCurrent( )*: 0x14/0x15

4.1.1.12 *TimeToEmpty( )*: 0x16/0x17

4.1.1.13 *TimeToFull( )*: 0x18/0x19

4.1.1.14 *StandbyCurrent( )*: 0x1a/0x1b

This read-only function returns a signed integer value of the measured standby current through the sense resistor. The *StandbyCurrent( )* is an adaptive measurement. Initially it reports the standby current programmed in ***Initial Standby***, and after spending several seconds in standby, reports the measured standby current.

The register value is updated every 1 second when the measured current is above the ***Deadband*** and is less than or equal to 2 × ***Initial Standby***. The first and last values that meet this criteria are not averaged in, since they may not be stable values. To approximate a 1 minute time constant, each new *StandbyCurrent( )* value is computed by taking approximate 93% weight of the last standby current and approximate 7% of the current measured average current.

4.1.1.15 *StandbyTimeToEmpty( )*: 0x1c/0x1d

This read-only function returns an unsigned integer value of the predicted remaining battery life at the standby rate of discharge, in minutes. The computation uses *Nominal Available Capacity* (NAC), the uncompensated remaining capacity, for this computation. A value of 65,535 indicates battery is not being discharged.

4.1.1.16 *MaxLoadCurrent( )*: 0x1e/0x1f

This read-only function returns a signed integer value, in units of mA, of the maximum load conditions. *The MaxLoadCurrent( )* is an adaptive measurement which is initially reported as the maximum load current programmed in *Initial Max Load Current*. If the measured current is ever greater than *Initial Max Load Current*, then *MaxLoadCurrent( )* updates to the new current. *MaxLoadCurrent( )* is reduced to the average of the previous value and *Initial Max Load Current* whenever the battery is charged to full after a previous discharge to an SOC less than 50%. This prevents the reported value from maintaining an unusually high value.

4.1.1.17 *MaxLoadTimeToEmpty( )*: 0x20/0x21

This read-only function returns an unsigned integer value of the predicted remaining battery life at the maximum load current discharge rate, in minutes. A value of 65,535 indicates that the battery is not being discharged.

4.1.1.18 *AvailableEnergy( )*: 0x22/0x23

This read-only function returns an unsigned integer value of the predicted charge or energy remaining in the battery. The value is reported in units of mWh.

4.1.1.19 *AveragePower( )*: 0x24/0x25

This read-only function returns an signed integer value of the average power during battery charging and discharging. It is negative during discharge and positive during charge. A value of 0 indicates that the battery is not being discharged. The value is reported in units of mW.

4.1.1.20 *TimeToEmptyAtConstantPower( )*: 0x26/0x27

This read-only function returns an unsigned integer value of the predicted remaining operating time if the battery is discharged at the *AveragePower( )* value in minutes. A value of 65,535 indicates *AveragePower( )* = 0. The fuel gauge automatically updates *TimeToEmptyatContantPower( )* based on the *AveragePower( )* value every 1 s.

4.1.1.21 StateofHealth( ): 0x28/0x29

4.1.1.22 *StateOfCharge( )*: 0x2c/0x2d

4.1.1.23 NormalizedImpedanceCal( ): 0x2e/0x2f

4.1.1.24 InstaneousCurrent Reading( ) 0x30/0x31

4.1.2 EXTENDED DATA COMMANDS

4.1.2.1 *DesignCapacity( )*: 0x3c/0x3d

4.1.2.2 *DataFlashClass( )*: 0x3e

4.1.2.3 *DataFlashBlock( )*: 0x3f

4.1.2.4 *BlockData( )*: 0x40…0x5f

4.1.2.5 *BlockDataChecksum( )*: 0x60

4.1.2.6 *BlockDataControl( )*: 0x61

4.1.2.7 *DeviceNameLength( )*: 0x62

4.1.2.8 *DeviceName( )*: 0x63…0x69

UNSEALED and SEALED Access: This block contains the device name that is programmed in ***Device Name***.

4.1.2.9 *ApplicationStatus( )*: 0x6a

This byte function allows the system to read the bq27505 ***Application Status*** data flash location. See Table 6-1 for specific bit definitions.

4.1.2.10 Reserved — 0x6b–0x7f

4.2 DATA FLASH INTERFACE

4.2.1 ACCESSING THE DATA FLASH

The bq27505 data flash is a non-volatile memory that contains bq27505 initialization, default, cell status, calibration, configuration, and user information. The data flash can be accessed in several different ways, depending on what mode the bq27505 is operating in and what data is being accessed.

Commonly accessed data flash memory locations, frequently read by a system, are conveniently accessed through specific instructions, already described in Section 4.1, *DATA COMMANDS*. These commands are available when the bq27505 is either in UNSEALED or SEALED modes.

Most data flash locations, however, are only accessible in UNSEALED mode by use of the bq27505 evaluation software or by 0 1 428.4 267.4 T0 1 428.4 267.4 T0 1 42(0 1 428.4 267.4 T0 1 428.928.4 267.4 T0 1d)Tj 1

4.3 MANUFACTURER INFORMATION BLOCKS

4.4 ACCESS MODES

The total battery capacity is found by comparing states of charge before and after applying the load with the amount of charge passed. When an application load is applied, the impedance of the cell is measured by comparing the OCV obtained from a predefined function for present SOC with the measured voltage under load. Measurements of OCV and charge integration determine chemical state of charge and chemical capacity (Qmax). The initial Qmax values are taken from a cell manufacturers' data sheet multiplied by the number of parallel cells. It is also used for the value in ***Design Capacity***. The bq27505 acquires and updates the battery-impedance profile during normal battery usage. It uses this profile, along with SOC and the Qmax value, to determine *FullChargeCapacity( )* and *StateOfCharge( )*, specifically for the present load and temperature. *FullChargeCapacity( )* is reported as capacity available from a fully charged battery under the present load and temperature until *Voltage( )* reaches the ***Terminate Voltage***. *NominalAvailableCapacity( )* and *FullAvailableCapacity( )* are the uncompensated (no or light load) versions of *RemainingCapacity( )* and *FullChargeCapacity( )* respectively.

The bq27505 has two flags accessed by the *Flags( )* function that warns when the battery's SOC has fallen to critical levels. When *RemainingCapacity( )* falls below the first capacity threshold, specified in SO***C1 Set Threshold***, the *[SOC1] (State of Charge Initial)* flag is set. The flag is cleared once *RemainingCapacity( )* rises above SOC1 Set Threshold. The bq27505's BAT_LOW pin automatically reflects the status

5.2 IMPEDANCE TRACK™ VARIABLES

5.2.1 Load Mode

5.2.2 Load Select

5.2.3 Reserve Cap-mAh

5.2.4 Reserve Cap-mWh

5.2.5 Dsg Current Threshold

5.2.6 Chg Current Threshold

5.2.7 Quit Current, DSG Relax Time, CHG Relax Time, and Quit Relax Time

5.2.8 Qmax 0 and Qmax 1

5.2.9 Update Status 0 and Update Status 1

5.2.10 Avg I Last Run

5.2.11 Avg P Last Run

[redacted]

[redacted] Delta Voltage

[redacted]nd Ra Tables

[redacted]

5.3.3 BAT_LOW Pin

The BAT_LOW pin provides a system processor with an electrical indicator of battery status. The signaling on the BAT_LOW pin follows the status of the *[SOC1]* bit in the *Flags( )* register. Note that the polarity of the BAT_LOW pin can be inverted via the ***[BATL_POL]*** bit of ***Operation Configuration***.

5.3.4 Power Path Control With the BAT_GD Pin

The bq27505 must operate in conjunction with other electronics in a system appliance, such as chargers or other ICs and application circuits that draw appreciable power. After a battery is inserted into the system, there should be no charging current or a discharging current higher than C/20, so that an accurate OCV can be read. The OCV is used for helping determine which battery profile to use, as it constitutes part of the battery impedance measurement

When a battery is inserted into a system, the Impedance Track™ algorithm requires that no charging of the battery takes place and that any discharge is limited to less than C/20—these conditions are sufficient for the fuel gauge to take an accurate OCV reading. To disable these functions, the BAT_GD pin is merely negated from the default setting. Once an OCV reading has be made, the BAT_GD pin is asserted, thereby enabling battery charging and regular discharge of the battery. The ***Operation Configuration [BATG_POL]*** bit can be used to set the polarity of the battery good signal, should the default configuration need to be changed.

Figure 5-1. Power Mode Diagram

5.3.5 Battery Detection Using the BI/TOUT Pin

5.3.6 SOC_INT pin

5.4 TEMPERATURE MEASUREMENT

The bq27505 measures battery temperature via its TS input, in order to supply battery temperature status information to the fuel gauging algorithm and charger-control sections of the gauge. Alternatively, it can also measure internal temperature via its on-chip temperature sensor, but only if the ***[TEMPS]*** bit of the ***Operation Configuration*** register is cleared. The ***[GNDSEL]*** bit of Operation Configuration B register selects the ground reference of the ADC converter for temperature measurement.

Regardless of which sensor is used for measurement, a system processor can request the

5.5 OVERTEMPERATURE INDICATION

5.5.1 Overtemperature: Charge

5.5.2 Overtemperature: Discharge

5.6 CHARGING AND CHARGE-TERMINATION INDICATION

5.6.1 Detecting Charge Termination

5.6.2 Charge Inhibit and Suspend

The charging should not start when the temperature is below the Charge Inhibit Temp Low or above the Charge Inhibit Temp High. The charging can continue if the charging starts inside the window [Charge Inhibit Temp Low, Charge Inhibit Temp High] until the temperature is either below Suspend Low Temp or above the Suspend Low Temp. Therefore, the window [Charge Inhibit Temp Low, Charge Inhibit Temp High] must be inside the window of [Suspend Low Temp, Suspend High Temp].

5.7 POWER MODES

The bq27505 has different power modes: BAT INSERT CHECK, NORMAL, SLEEP, SLEEP+ and HIBERNATE. In NORMAL mode, the bq27505 is fully powered and can execute any allowable task. In SLEEP+ mode, both low frequency and high frequency oscillators are active. Although the SLEEP+ has higher current consumption than the SLEEP mode, it is also a reduced power mode. In SLEEP mode, the fuel gauge turns off the high frequency oscillator and exists in a reduced-power state, periodically taking measurements and performing calculations. In HIBERNATE mode, the fuel gauge is in a very low power state, but can be woken up by communication or certain I/O activity. Finally, the BAT INSERT CHECK mode is a powered-up, but low-power halted, state, where the bq27505 resides when no battery is inserted into the system.

The relationship between these modes is shown in Figure 5-1.

5.7.1 BAT INSERT CHECK Mode

This mode is a halted-CPU state that occurs when an adapter, or other power source, is present to power the bq27505 (and system), yet no battery has been detected. When battery insertion is detected, a series of initialization activities begin, which include: OCV measurement, setting the BAT_GD pin, and selecting the appropriate battery profiles.

Some commands, issued by a system processor, can be processed while the bq27505 is halted in this mode. The gauge will wake up to process the command, then return to the halted state awaiting battery insertion.

5.7.2 NORMAL MODE

The fuel gauge is in NORMAL mode when not in any other power mode. During this mode, *AverageCurrent( )*, *Voltage( )* and *Temperature( )* measurements are taken, and the interface data set is updated. Decisions to change states are also made. This mode is exited by activating a different power mode.

Because the gauge consumes the most power in NORMAL mode, the Impedance Track™ algorithm minimizes the time the fuel gauge remains in this mode.

5.7.3 SLEEP MODE

SLEEP mode is entered automatically if the feature is enabled (***Operation Configuration [SLEEP]*** = 1) and *AverageCurrent( )* is below the programmable level ***Sleep Current***. Once entry into SLEEP mode has been qualified, but prior to entering it, the bq27505 performs an coulomb counter autocalibration to minimize offset.

During SLEEP mode, the bq27505 periodically takes data measurements and updates its data set. However, a majority of its time is spent in an idle condition.

The bq27505 exits SLEEP if any entry condition is broken, specifically when (1) *AverageCurrent( )* rises above ***Sleep Current***, or (2) a current in excess of I_{WAKE} through R_{SENSE} is detected.

In the event that a battery is removed from the system while a charger is present (and powering the gauge), Impedance Track™ updates are not necessary. Hence, the fuel gauge enters a state that checks for battery insertion and does not continue executing the Impedance Track™ algorithm.

5.7.4 SLEEP+ MODE

Compared to the SLEEP mode, SLEEP+ mode has the high frequency oscillator in operation. The communication delay could be eliminated. The SLEEP+ is entered automatically if the feature is enabled (***CONTROL STATUS [SNOOZE]*** = 1)

5.7.5 HIBERNATE MODE

5.8 POWER CONTROL

5.8.1 WAKE-UP COMPARATOR

5.8.2 FLASH UPDATES

5.9 AUTOCALIBRATION

6 APPLICATION-SPECIFIC INFORMATION

6.1 BATTERY PROFILE STORAGE AND SELECTION

6.1.1 Common Profile Aspects

6.1.2 Activities Upon Pack Insertion

6.1.2.1 First OCV and Impedance Measurement

6.1.3 Reading Application Status

7 COMMUNICATIONS

7.1 I²C INTERFACE

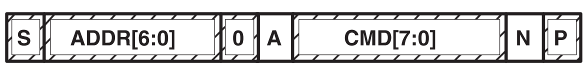
The 27505 supports the standard I²C read, incremental read, quick read, one byte write, and incremental write functions. The 7 bit device address (ADDR) is the most significant 7 bits of the hex address and is fixed as 1010101. The 8-bit device address will; therefore, be 0xAA or 0xAB for write or read, respectively.

The “quick read” returns data at the address indicated by the address pointer. The address pointer, a register internal to the I²C communication engine, will increment whenever data is acknowledged by the bq27505 or the I²C master. “Quick writes” function in the same manner and are a convenient means of sending multiple bytes to consecutive command locations (such as two-byte commands that require two bytes of data)

The following command sequences are not supported:

Attempt to write a read-only address (NACK after data sent by master):

Attempt to read an address above 0x6B (NACK command):



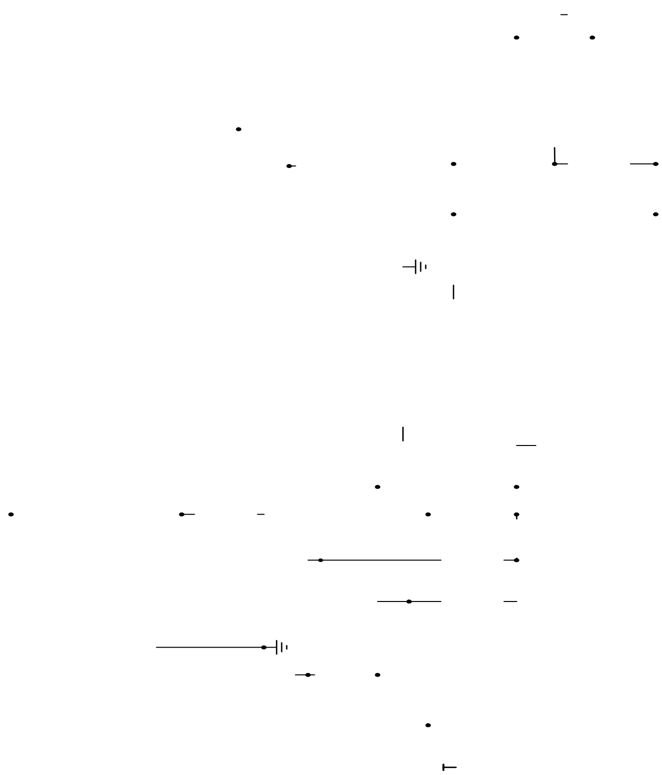
The I^2C engine will release both SDA and SCL if the I^2C bus is held low for the time defined by ***I^2C Timeout*** times 0.5 second. If the bq27505 was holding the lines, releasing them will free for the master to drive the lines. If an external condition is holding either of the lines low, the I^2C engine will enter the low power sleep mode.

To make sure the correct results of a command with the 400KHz I^2C operation, a proper waiting time should be added between issuing command and reading results. For subcommands, the following diagram shows the waiting time required between issuing the control command the reading the status with the exception of checksum and OCV commands. A 100ms waiting time is required between the checksum command and reading result, and a 1.2 second waiting time is required between the OCV command and result. For read-write standard command, a minimum of 2 seconds is required to get the result updated. For read-only standard commands, there is no waiting time required, but the host should not issue all standard commands more than two times per second. Otherwise, the gauge could result in a reset issue due to the expiration of the watchdog timer.

The I^2C clock stretch could happen in a typical application. A maximum 80ms clock stretch could be observed during the flash updates. There is up to 270ms clock stretch after the OCV command is issued.

8 REFERENCE SCHEMATICS

8.1 SCHEMATIC



Eco Plan n1 0 0 -1 38.853n -- onversionreersionsionsionin accord(in) ( ) (a ( ) (cu /F1 12 TfJEDECtion) (edustr [(sion)( )od7rd) ( ) e Free) ( ) 62.sime-buy perip 0 0 -1 38solde() ( ) (.37er) (re -1 0 161.729996 Tm [( )] TJ ET q 1 29 6026))

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
BQ27505YZGR-J2	NRND	DSBGA	YZG	12	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	BQ27505	
BQ27505YZGT-J2	NRND	DSBGA	YZG	12	250	TBD	Call TI	Call TI	-40 to 85	BQ27505	

(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 t.375 (eco-Free) ( ) -42.75 ree hasTf 1 0/F1 G1e (ecof 0 Tc5 ("Pb-2Fr/Brwith( ) -42.75 ree) asTf 1 0/F1 G1e urr 1 0 0 1 0/F1 G1e (no) ( ) 0

DIE–SIZE BALL GP

D	2.46 mm	2.399 m
E	1.986 mm	1.926 m

NOTES:

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI)