System-Side Impedance Track™ Fuel Gauge With Dynamic Voltage Correlation

Check for Samples: bq27621-G1

FEATURES

- **Single series cell Li-Ion battery fuel gauge**
  - **Resides on system board**
  - **Supports embedded or removable batteries**
  - **Powered directly from battery with integrated LDO**
- **Easy to configure fuel gauging based on patented Impedance Track™ technology**
  - **Reports Remaining Capacity and State of Charge (SOC) with Smoothing Filter**
  - **Automatically adjusts for battery aging, self-discharge, temperature, and rate changes**
  - **Battery State of Health (aging) estimation**
- **Microcontroller peripheral supports:**
  - **400-kHz I²C serial interface**
  - **Configurable SOC Interrupt, or Battery low digital output warning**
  - **Internal temperature sensor, or Host reported temperature**
- **Support 4.2V, 4.3V, and 4.35V chemistries**
- **9-pin 1,62 × 1,58 mm, 0.5 mm pitch YZF package**

APPLICATIONS

- **Smartphones, Feature phones and Tablets**
- **Digital Still and Video Cameras**
- **Handheld Terminals**
- **MP3 or Multimedia Players**

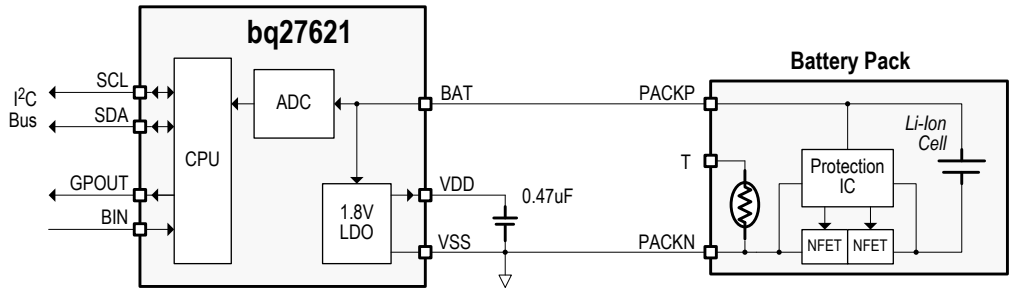
DESCRIPTION

The Texas Instruments bq27621-G1 is an easy to configure microcontroller peripheral that provides system-side fuel gauging for single-cell Li-Ion batteries. The device requires minimal user configuration and system microcontroller firmware development.

The bq27621-G1 uses the patented Impedance Track™ algorithm with Dynamic Voltage Correlation for fuel gauging. This patented process eliminates the need for a sense resistor when calculating remaining battery capacity (mAh), state-of-charge (%), battery voltage (mV),temperature (°C) and state of health (%).

Battery fuel gauging with the bq27621-G1 requires connections only to PACK+ (P+) and PACK– (P–) for a removable battery pack or embedded battery circuit. The tiny 9-pin 1,62 × 1,58 mm, 0.5 mm pitch YZF package is ideal for space constrained applications.

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.

Impedance Track 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.

DEVICE INFORMATION

AVAILABLE OPTIONS

PART NUMBER	BATTERY TYPE	CHEM_ID (1)	FIRMWARE VERSION (2)	PACKAGE (3)	COMM. FORMAT
bq27621YZFR-G1A	$LiCoO_2$ (4.2 V max charge)	0x1202	1.05 (0x0105)	CSP-9	I^2C
	$LiMn_2O_4$ (4.3 V max charge)	0x1210			
	$LiMn_2O_4$ (4.35 V max charge)	0x354			

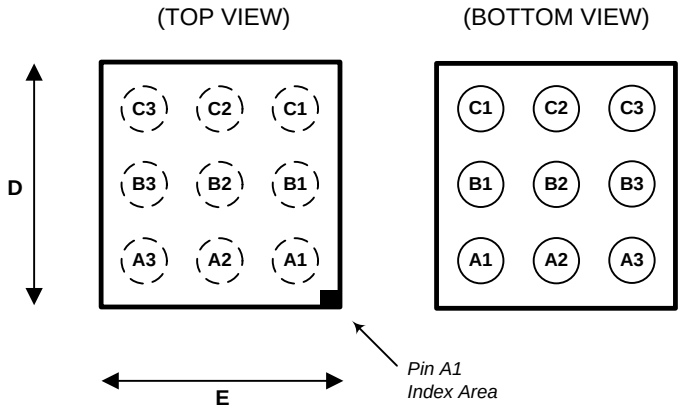
(1) See the CHEM_ID subcommand to confirm the battery chemistry type. See section on alternate chemistry to select different chemistries.
(2) See the FW_VERSION subcommand to confirm the firmware version.
(3) For the most current package and ordering information see the Package Option Addendum at the end of this document; or, see the TI website at www.ti.com.

THERMAL INFORMATION

THERMAL METRIC (1)		bq27621-G1	UNITS
		YZF (9 PINS)	
θ_{JA}	Junction-to-ambient thermal resistance	107.8	°C/W
θ_{JCtop}	Junction-to-case (top) thermal resistance	0.7	
θ_{JB}	Junction-to-board thermal resistance	60.4	
ψ_{JT}	Junction-to-top characterization parameter	3.5	
ψ_{JB}	Junction-to-board characterization parameter	60.4	
θ_{JCbot}	Junction-to-case (bottom) thermal resistance	n/a	

(1) For more information about traditional and new thermal metrics, see the IC Package Thermal Metrics application report, SPRA953

PIN DIAGRAM AND PACKAGE DIMENSIONS



DIM	MIN	TYP	MAX	UNITS
D	1550	1580	1610	µm
E	1590	1620	1650	

PIN FUNCTIONS

PIN		TYPE(1)	DESCRIPTION
NAME	NO.		
BAT	C2,C3	PI, AI	LDO regulator input and battery voltage input typically connected to the PACK+ terminal.
VDD	B3	PO	1.8V Regulator Output. Decouple with 0.47µF ceramic capacitor to Vss.
VSS	B2,C1	PI	Ground pins. The center pin B2 is the actual device ground pin while pin C1 is floating internally and therefore C1 may be used as a bridge to connect to the board ground plane without requiring a via under the device package. Recommend routing the center pin B2 to the corner pin C1 using a top-layer metal trace on the board. Then route the corner pin C1 to the board ground plane.
GPOUT	A1	DO	General Purpose open-drain output. May be configured as a Battery Low indicator or perform SOC interrupt (SOC_INT) function.
SDA	A2	DIO	Slave I^2C serial communications data line for communication with system (Master). Open-drain I/O. Use with 10kΩ pull-up resistor (typical).
SCL	A3	DIO	Slave I^2C serial communications clock input line for communication with system (Master). Use with 10kΩ pull-up resistor (typical).
BIN	B1	DI	Battery-insertion detection input. A logic high to low transition is detected as a battery insertion event. Recommend using a pull-up resistor >1MΩ (4.7 MΩ typical) to V_{DD} for reduced power consumption. An internal pull-up resistor option is also available.

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

ELECTRICAL SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted)(1)

PARAMETER		MIN	MAX	UNIT
V_{BAT}	BAT pin input voltage range	–0.3	6	V
V_{DD}	VDD pin supply voltage range (LDO ouptut)	–0.3	2	V
V_{IOD}	Open-drain I/O pins (SDA, SCL)	–0.3	6	V
V_{IOPP}	Push-Pull I/O pins (BIN)	–0.3	[V_{DD} + 0.3]	V
T_A	Operating free-air temperature range	–40	85	°C
T_{STG}	Storage temperature range	–65	150	°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

T_A = 30°C and V_{REGIN} = V_{BAT} = 3.6V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
C_{BAT} (1)	External input capacitor for internal LDO between BAT and V_{SS}	Nominal capacitor values specified. Recommend a 5% ceramic X5R type capacitor located close to the device.		0.1		µF
C_{LDO18} (1)	External output capacitor for internal LDO between V_{DD} and V_{SS}			0.47		µF
V_{PU} (1)	External pull-up voltage for open-drain pins (SDA, SCL, GPOUT)		1.62		3.6	V

(1) Specified by design. Not production tested.

SUPPLY CURRENT

T_A = 30°C and V_{REGIN} = V_{BAT} = 3.6V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{CC} (1)	NORMAL mode current	I_{LOAD} > ***Sleep Current***		27		µA
I_{SLP} (1)	SLEEP mode current	I_{LOAD} < ***Sleep Current***		21		µA
I_{HIB} (1)	HIBERNATE mode current	I_{LOAD} < ***Hibernate Current***		9		µA
I_{SD} (1)	SHUTDOWN mode current	Fuel gauge in host commanded SHUTDOWN mode. (LDO Regulator Output Disabled.)		0.6		µA

(1) Specified by design. Not production tested.

DIGITAL INPUT AND OUTPUT DC CHARACTERISTICS

T_A = –40°C to 85°C, typical values at T_A = 30°C and V_{REGIN} = 3.6 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{IH(OD)}$	Input voltage, high (2)	External pullup resistor to V_{PU}	V_{PU} x 0.7			V
V_{IL}	Input voltage, low (2) (3)				0.6	V
V_{OL}	Output voltage, low (2)				0.6	V
I_{OH}	Output source current, high (2)				0.5	mA
$I_{OL(OD)}$	Output sink current, low (2)				-3	mA
C_{IN} (1)	Input capacitance (2) (3)				5	pF
I_{lkg}	Input leakage current (SCL, SDA, BIN)				0.1	µA
	Input leakage current (GPOUT)				1	

(1) Specified by design. Not production tested.
(2) Open Drain pins: (SCL, SDA)
(3) Push Pull pin: (BIN)

LDO REGULATOR, WAKE-UP AND AUTO-SHUTDOWN DC CHARACTERISTICS

T_A = –40°C to 85°C, typical values at T_A = 30°C and V_{REGIN} = 3.6 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{BAT}	BAT pin regulator input		2.45		4.5	V
V_{DD}	Regulator output voltage			1.8		V
$UVLO_{IT+}$	V_{BAT} Under Voltage Lock Out LDO Wake-Up Rising Threshold			2		V
$UVLO_{IT-}$	V_{BAT} Under Voltage Lock Out LDO Auto-Shutdown Falling Threshold			1.95		V

(1) Specified by design. Not production tested.

ADC (TEMPERATURE AND CELL MEASUREMENT) CHARACTERISTICS

T_A = –40°C to 85°C; typical values at T_A = 30°C and V_{REGIN} = 3.6 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{IN(BAT)}$	BAT pin voltage measurement range.	Voltage divider enabled.	2.45		4.5	V
t_{ADC_CONV}	Conversion time			125		ms
	Effective Resolution			15		bits

(1) Specified by design. Not tested in production.

I²C-COMPATIBLE INTERFACE COMMUNICATION TIMING CHARACTERISTICS

T_A = –40°C to 85°C; typical values at T_A = 30°C and V_{REGIN} = 3.6 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
Standard Mode (100 kHz)						
$t_{d(STA)}$	Start to first falling edge of SCL		4			µs
$t_{w(L)}$	SCL pulse duration (low)		4.7			µs
$t_{w(H)}$	SCL pulse duration (high)		4			µs
$t_{su(STA)}$	Setup for repeated start		4.7			µs
$t_{su(DAT)}$	Data setup time	Host drives SDA	250			ns
$t_{h(DAT)}$	Data hold time	Host drives SDA	0			ns
$t_{su(STOP)}$	Setup time for stop		4			µs
$t_{(BUF)}$	Bus free time between stop and start	Includes Command Waiting Time	66			µs
t_f	SCL/SDA fall time (1)				300	ns
t_r	SCL/SDA rise time (1)				300	ns
f_{SCL}	Clock frequency(2)				100	kHz
Fast Mode (400 kHz)						
$t_{d(STA)}$	Start to first falling edge of SCL		600			ns
$t_{w(L)}$	SCL pulse duration (low)		1300			ns
$t_{w(H)}$	SCL pulse duration (high)		600			ns
$t_{su(STA)}$	Setup for repeated start		600			ns
$t_{su(DAT)}$	Data setup time	Host drives SDA	100			ns
$t_{h(DAT)}$	Data hold time	Host drives SDA	0			ns
$t_{su(STOP)}$	Setup time for stop		600			ns
$t_{(BUF)}$	Bus free time between stop and start	Includes Command Waiting Time	66			µs
t_f	SCL/SDA fall time (1)				300	ns
t_r	SCL/SDA rise time (1)				300	ns
f_{SCL}	Clock frequency(2)				400	kHz

(1) Specified by design. Not production tested.
(2) If the clock frequency (f_{SCL}) is > 100 kHz, use 1-byte write commands for proper operation. All other transactions types are supported at 400 kHz. (Refer to I²C INTERFACE and I²C Command Waiting Time)

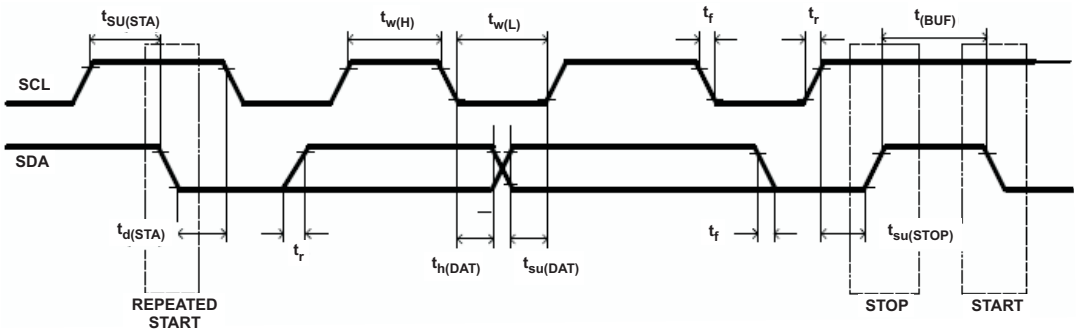


Figure 1. I²C-Compatible Interface Timing Diagrams

GENERAL DESCRIPTION

The bq27621-G1 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 state-of-charge (SOC).

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 bq27621-G1 control and status registers, as well as its data locations. Commands are sent from system to gauge using the bq27621-G1's I^2C serial communications engine, and can be executed during application development, system manufacture, or end-equipment operation.

The key to the bq27621-G1'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 high accuracy across a wide variety of operating conditions and over the lifetime of the battery.

The bq27621-G1 estimates charge/discharge current by monitoring the voltage across the BAT and VSS terminal. When a cell is attached to the bq27621-G1, cell impedance is computed, based on cell current, cell open-circuit voltage (OCV), and cell voltage under loading conditions.

The bq27621-G1 uses an integrated temperature sensor for estimating cell temperature. Alternatively, the host processor can provide temperature data for the bq27621-G1.

To minimize power consumption, the bq27621-G1 has several power modes: INITIALIZATION, NORMAL, SLEEP, and HIBERNATE. The bq27621-G1 passes automatically between these modes, depending upon the occurrence of specific events, though a system processor can initiate some of these modes directly. Additional details are found in the *bq27621-G1 Technical Reference Manual (SLUUAD4)* .

NOTE

FORMATTING CONVENTIONS IN THIS DOCUMENT:

Commands: *italics* with *parentheses* and no breaking spaces, that is, *RemainingCapacity( ).*

NVM Data: *italics*, **bold**, and *breaking spaces*, that is, **Design Capacity**.

Register bits and flags: brackets and *italics*, *that is, [TDA]*

NVM Data bits: brackets, *italics* and **bold**, *that is:* ***[LED1]***

Modes and states: ALL CAPITALS, that is, UNSEALED mode.

DATA COMMANDS

Standard Data Commands

The bq27621-G1 uses a series of 2-byte standard commands to enable system reading and writing of battery information. Each standard command has an associated command-code pair, as indicated in Table 1. Because each command consists of two bytes of data, two consecutive I^2C transmissions must be executed both to initiate the command function, and to read or write the corresponding two bytes of data. Additional details are found in the *bq27621-G1 Technical Reference Manual (SLUUAD4)* .

Note: Data values read by the host may be invalid during initialization for a period of up to 3 seconds.

Table 1. Standard Commands

NAME		COMMAND CODE	UNITS	SEALED ACCESS
Control( )	CNTL	0x00 / 0x01	N/A	R/W
Temperature( )	TEMP	0x02 / 0x03	0.1°K	R/W
Voltage( )	VOLT	0x04 / 0x05	mV	R
Flags( )	FLAGS	0x06 / 0x07	N/A	R
NominalAvailableCapacity( )		0x08 / 0x09	mAh	R
FullAvailableCapacity( )		0x0A / 0x0B	mAh	R
RemainingCapacity( )	RM	0x0C / 0x0D	mAh	R
FullChargeCapacity( )	FCC	0x0E / 0x0F	mAh	R
EffectiveCurrent( )		0x10 / 0x11	mA	R
AveragePower( )		0x18 / 0x19	mW	R
StateOfCharge( )	SOC	0x1c / 0x1d	%	R
IntTemperature( )		0x1e / 0x1f	0.1°K	R
StateOfHealth( )	SOH	0x20 / 0x21	num / %	R
RemainingCapacityTrue( )		0x28 / 0x29	mAh	R
RemainingCapacityFiltered( )		0x2A / 0x2B	mAh	R
FullChargeCapacityTrue( )		0x2C / 0x2D	mAh	R
FullChargeCapacityFiltered( )		0x2E / 0x2F	mAh	R
TrueSoc( )		0x30 / 0x31	mAh	R
OperationConfiguration( )		0x3a / 0x3b	N/A	R

Control( ): 0x00/0x01

Issuing a *Control( )* command requires a subsequent 2-byte subcommand. These additional bytes specify the particular control function desired. The *Control( )* command allows the system to control specific features of the bq27621-G1 during normal operation and additional features when the device is in different access modes. Additional details are found in the *bq27621-G1 Technical Reference Manual (SLUUAD4)*

Table 2. *Control( )* Subcommands

CNTL FUNCTION	CNTL DATA	SEALED ACCESS	DESCRIPTION
CONTROL_STATUS	0x0000	Yes	Reports the status of device.
DEVICE_TYPE	0x0001	Yes	Reports the device type (0x0621).
FW_VERSION	0x0002	Yes	Reports the firmware version of the device.
PREV_MACWRITE	0x0007	Yes	Returns previous MAC command code.
CHEM_ID	0x0008	Yes	Reports the chemical identifier of the Impedance Track™ configuration
BAT_INSERT	0x000c	Yes	Forces the *[BAT_DET]* bit set when the *[BIE]* bit is 0.
BAT_REMOVE	0x000d	Yes	Forces the *[BAT_DET]* bit clear when the *[BIE]* bit is 0.
TOGGLE_POWERMIN	0x0010	Yes	Set CONTROL_STATUS [*POWERMIN*] to 1.
SET_HIBERNATE	0x0011	Yes	Forces CONTROL_STATUS [*HIBERNATE*] to 1.
CLEAR_HIBERNATE	0x0012	Yes	Forces CONTROL_STATUS [*HIBERNATE*] to 0.
SET_CFGUPDATE	0x0013	No	Force CONTROL_STATUS [*CFGUPMODE*] to 1 and gauge enters CONFIG UPDATE mode.
SHUTDOWN_ENABLE	0x001b	No	Enables device SHUTDOWN mode.
SHUTDOWN	0x001c	No	Commands the device to enter SHUTDOWN mode.
SEALED	0x0020	No	Places the device in SEALED access mode.
TOGGLE_GPOUT	0x0023	Yes	Test the GPIO pin by sending a pulse signal
ALT_CHEM1	0x0031	No	Selects alternate chemistry 1 (0x1210)
ALT_CHEM2	0x0032	No	Selects alternate chemistry 2 (0x354)
RESET	0x0041	No	Performs a full device reset.
SOFT_RESET	0x0042	No	Gauge exits CONFIG UPDATE mode.
EXIT_CFGUPDATE	0x0043	No	Exits CONFIG UPDATE mode without an OCV measurement and without resimulating to update *StateOfCharge( ).*
EXIT_RESIM	0x0044	No	Exits CONFIG UPDATE mode without an OCV measurement and resimulates with the updated configuration data to update *StateOfCharge( ).*

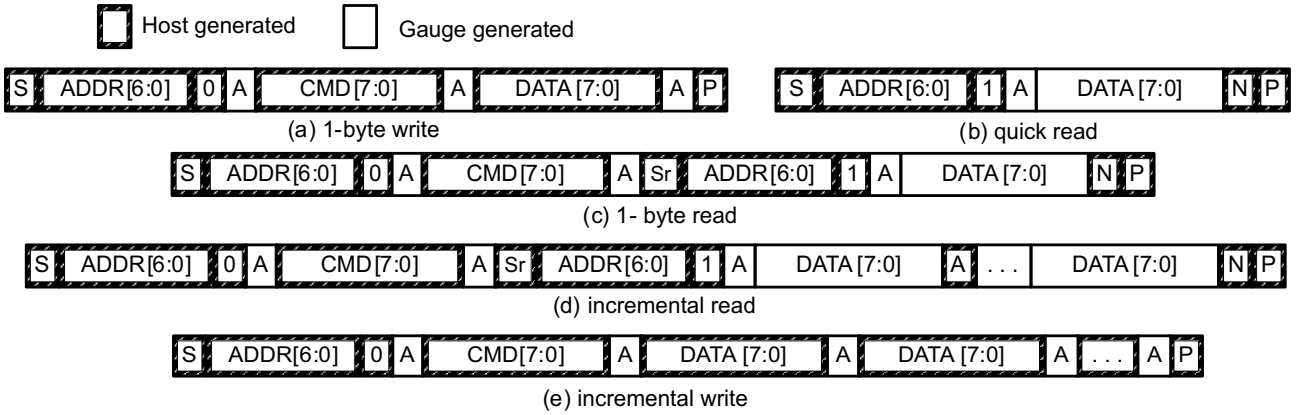
ALTERNATE CHEMISTRY SELECTION

The BQ27621 device allows the user to change the chemistry settings using I2C commands. The default chemistry has a CHEM_ID of 0x1202. The two other CHEM_IDs supported by this device includes CHEM_ID 0x1210 and CHEM_ID0x354.The detailed procedure to change the chemistry is available in the *bq27621-G1 Technical Reference Manual (SLUUAD4).*

FUNCTIONAL DESCRIPTION

I²C INTERFACE

The bq27621-G1 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 first 8 bits of the I²C protocol are, therefore, 0xAA or 0xAB for write or read, respectively.

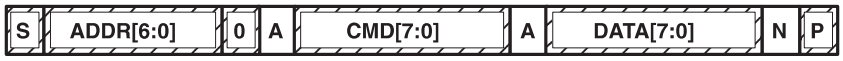


(S = Start, Sr = Repeated Start, A = Acknowledge, N = No Acknowledge, and P = Stop).

The quick read returns data at the address indicated by the address pointer. The address pointer, a register internal to the I²C communication engine, increments whenever data is acknowledged by the bq27621-G1 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):



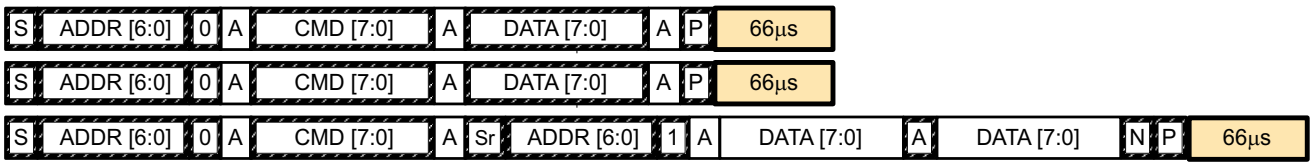
Attempt to read an address above 0x6B (NACK command):

I²C Time Out

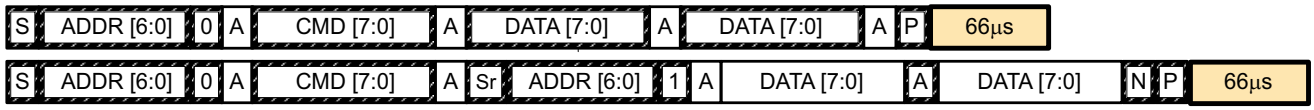
The I²C engine releases both SDA and SCL if the I²C bus is held low for 2 seconds. If the bq27621-G1 is holding the lines, releasing them frees them for the master to drive the lines. If an external condition is holding either of the lines low, the I²C engine enters the low-power sleep mode.

I²C Command Waiting Time

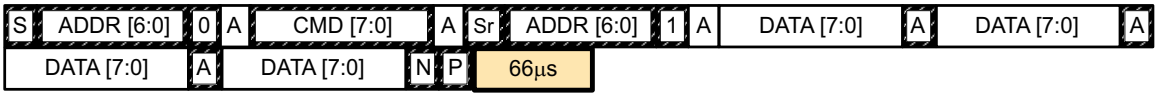
To ensure proper operation at 400 kHz, a $t_{(BUF)}$ ≥ 66 µs bus-free waiting time must be inserted between all packets addressed to the bq27621-G1. In addition, if the SCL clock frequency (f_{SCL}) is > 100 kHz, use individual 1-byte write commands for proper data flow control. The following diagram shows the standard waiting time required between issuing the control subcommand the reading the status 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 must not issue any standard command more than two times per second. Otherwise, the gauge could result in a reset issue due to the expiration of the watchdog timer.



Waiting time inserted between two 1-byte write packets for a subcommand and reading results
(required for 100 kHz < f_{SCL} ≤ 400 kHz)



Waiting time inserted between incremental 2-byte write packet for a subcommand and reading results
(acceptable for f_{SCL} ≤ 100 kHz)



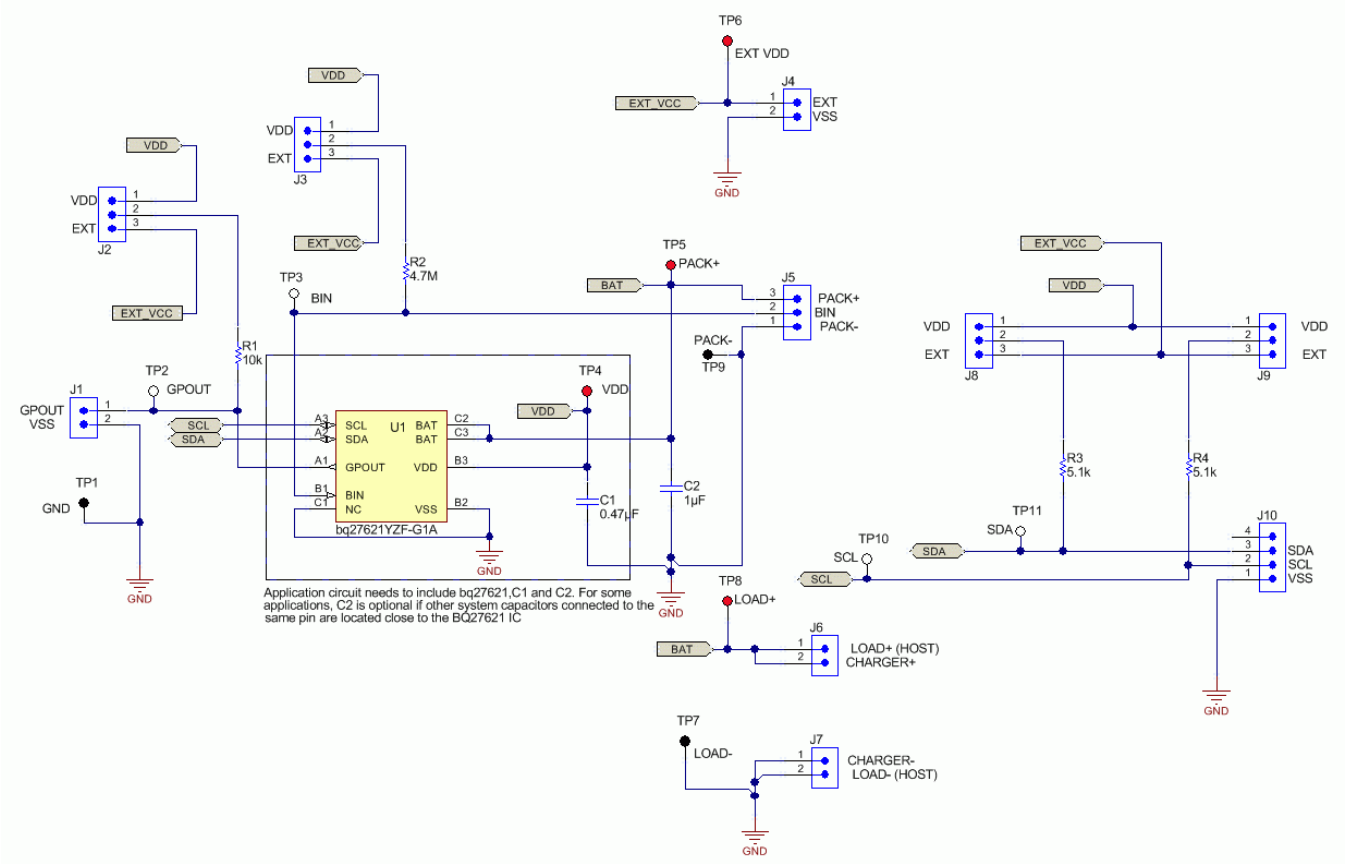
Waiting time inserted after incremental read

I²C Clock Stretching

A clock stretch can occur during all modes of fuel gauge operation. In SLEEP and HIBERNATE modes, a short clock stretch occurs on all I²C traffic as the device must wake-up to process the packet. In the other modes (INITIALIZATION , NORMAL) clock stretching only occurs for packets addressed for the fuel gauge. The majority of clock stretch periods are small as the I²C interface performs normal data flow control. However, less frequent yet more significant clock stretch periods may occur as blocks of NVM are updated. The following table summarizes the approximate clock stretch duration for various fuel gauge operating conditions.

Gauging Mode	Operating Condition / Comment	Approximate Duration
SLEEP HIBERNATE	Clock stretch occurs at the beginning of all traffic as the device wakes up.	≤ 4 ms
INITIALIZATION NORMAL	Clock stretch occurs within the packet for flow control (after a start bit, ACK or first data bit).	≤ 4 ms
	Normal Ra table NVM updates.	24 ms
	NVM block writes.	72 ms
	Restored NVM block write after loss of power.	116 ms
	End of discharge Ra table NVM update.	144 ms

REFERENCE (EVM) SCHEMATIC



REVISION HISTORY

Changes from Revision A (January 2014) to Revision B	Page
• Changed the I_{lkg} Parameters.Split out the GPOUT pin	5

Changes from Original (November 2013) to Revision A	Page
• Changed the device status From: Product Preview To: Production	1
• Changed Feature From: ..CSP package To: ..YZF package	1
• Changed the Description From: ..CSP package To: ..YZF package	1
• Deleted Note 2 From the SUPPLY CURRENT table - "Wake Comparator Disabled"	4

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
BQ27621YZFR-G1A	ACTIVE	DSBGA	YZF	9	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	BQ27621 G1A	Samples
BQ27621YZFT-G1A	ACTIVE	DSBGA	YZF	9	250	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	BQ27621 G1A	Samples

(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.

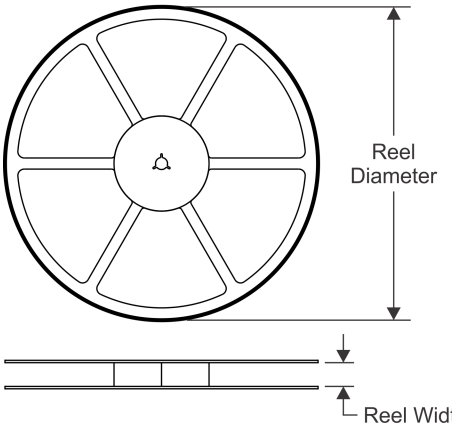
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(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.

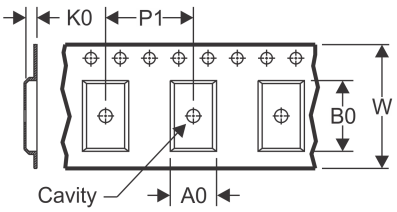
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

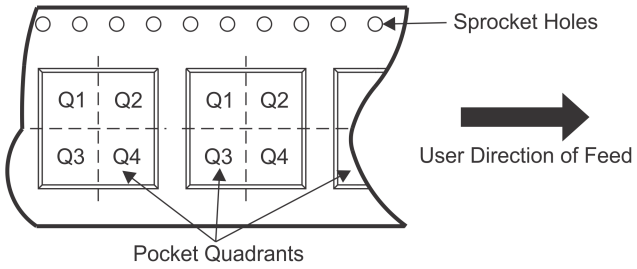


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

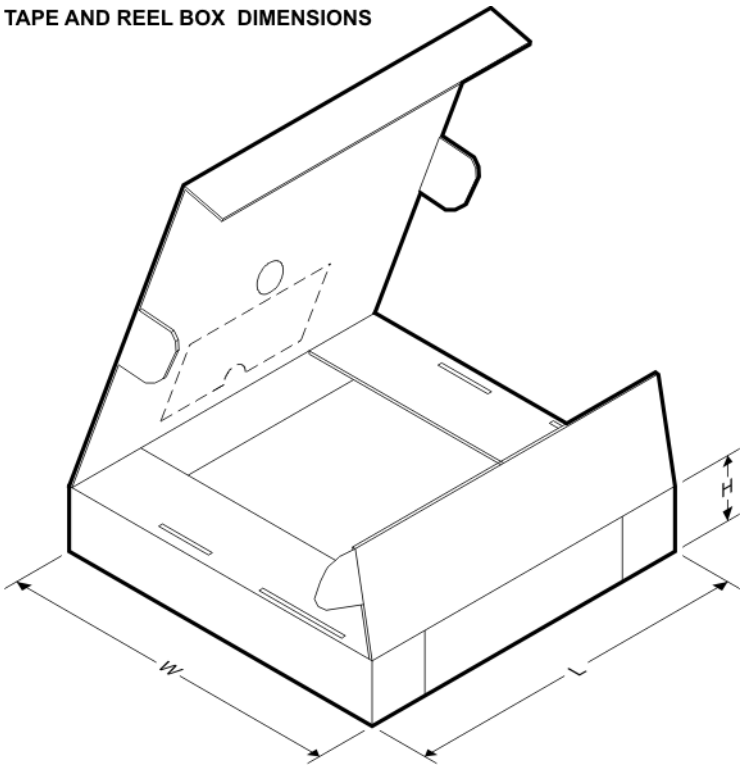
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
BQ27621YZFR-G1A	DSBGA	YZF	9	3000	180.0	8.4	1.78	1.78	0.69	4.0	8.0	Q1
BQ27621YZFT-G1A	DSBGA	YZF	9	250	180.0	8.4	1.78	1.78	0.69	4.0	8.0	Q1

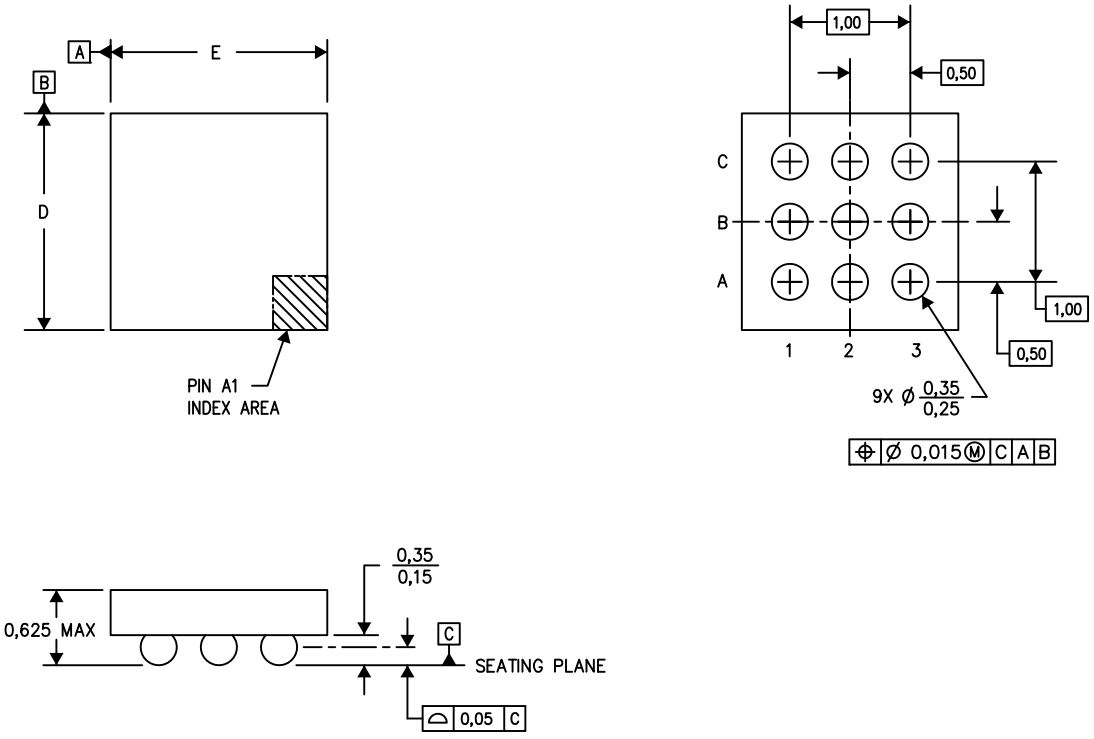
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
BQ27621YZFR-G1A	DSBGA	YZF	9	3000	182.0	182.0	17.0
BQ27621YZFT-G1A	DSBGA	YZF	9	250	182.0	182.0	17.0

YZF (S–XBGA–N9) DIE–SIZE BALL GRID ARRAY



4205058–4/P 07/13

NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. NanoFree™ package configuration.

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