

## SBS 1.1-COMPLIANT GAS GAUGE ENABLED WITH IMPEDANCE TRACK™ TECHNOLOGY FOR USE WITH THE bq29330

Check for Samples: [bq20z40](#)

### FEATURES

- **Next Generation Patented Impedance Track™ Technology Accurately Measures Available Charge in Li-Ion and Li-Polymer Batteries**
  - Better Than 1% Error Over the Lifetime of the Battery
- **Supports the Smart Battery Specification SBS V1.1**
- **Flexible Configuration for 2 to 4 Series Li-Ion and Li-Polymer Cells**
- **Powerful 8-Bit RISC CPU With Ultralow Power Modes**
- **Full Array of Programmable Protection Features**
  - Voltage, Current, and Temperature
- **Satisfies JEITA Guidelines**
- **Added Flexibility to Handle More Complex Charging Profiles**
- **Lifetime Data Logging**
- **Supports SHA-1 Authentication**
- **Available in a 20-Pin TSSOP (PW) package**

### APPLICATIONS

- **Notebook PCs**
- **Medical and Test Equipment**
- **Portable Instrumentation**

### DESCRIPTION

The bq20z40 SBS-compliant gas gauge and protection IC, incorporating patented Impedance Track™ technology, is designed for battery-pack or in-system installation. The bq20z40 measures and maintains an accurate record of available charge in Li-ion or Li-polymer batteries using its integrated high-performance analog peripherals. The bq20z40 monitors capacity change, battery impedance, open-circuit voltage, and other critical parameters of the battery pack, and reports the information to the system host controller over a serial-communication bus. It is designed to work with the bq29330 analog front-end (AFE) protection IC to maximize functionality and safety while minimizing external component count and cost in smart battery circuits.

The Impedance Track™ technology continuously analyzes the battery impedance, resulting in superior gas-gauging accuracy. This enables the remaining capacity to be calculated with discharge rate, temperature, and cell aging that are all accounted for during each stage of every cycle.

**Table 1. AVAILABLE OPTIONS**

$T_A$	PACKAGE	
	20-PIN TSSOP (PW) Tube	20-PIN TSSOP (PW) Tape & Reel
–40°C to 85°C	bq20z40PW <sup>(1)</sup>	bq20z40PWR <sup>(2)</sup>

(1) A single tube quantity is 50 units.  
 (2) A single reel quantity is 2000 units



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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.

SYSTEM PARTITIONING DIAGRAM

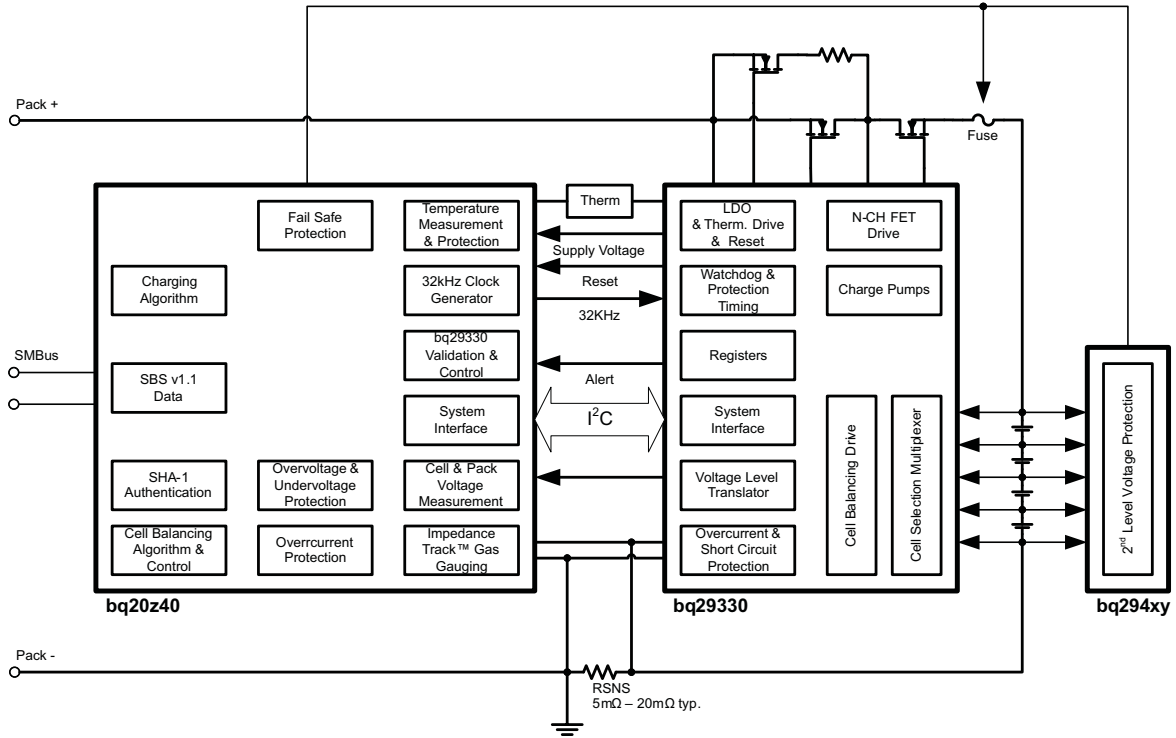
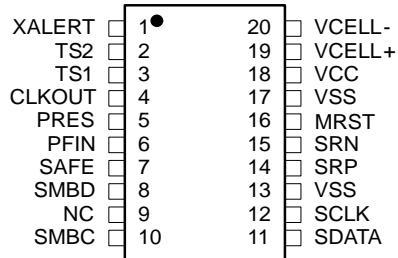




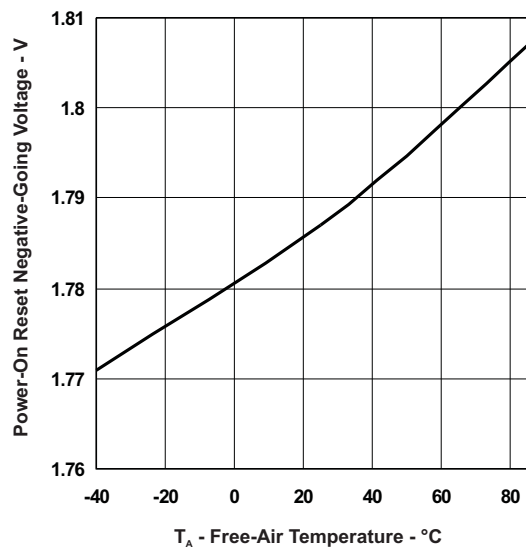
Figure 1.





**POWER ON RESET BEHAVIOR  
VS  
FREE-AIR TEMPERATURE**






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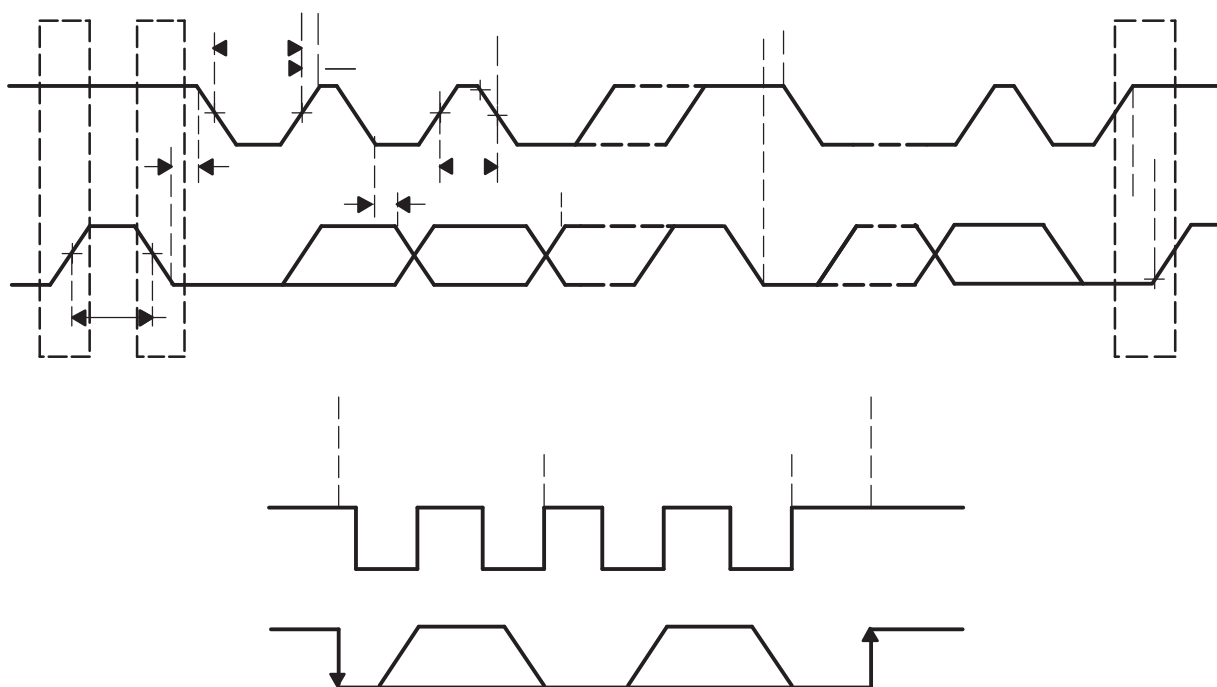
## SMBus TIMING SPECIFICATIONS (continued)

$V_{CC} = 2.4\text{ V to }2.6\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{LOW}$	Clock low period		4.7			s
$t_{HIGH}$	Clock high period	See (2)	4		50	
$t_{LOW:SEXT}$	Cumulative clock low slave extend time	See (3)			25	ms
$t_{LOW:MEXT}$	Cumulative clock low master extend time	See (4)			10	
$t_F$	Clock/data fall time	$(V_{ILMAX} - 0.15\text{ V})$ to $(V_{IHMIN} + 0.15\text{ V})$			300	ns
$t_R$	Clock/data rise time	$0.9 V_{CC}$ to $(V_{ILMAX} - 0.15\text{ V})$			1000	

- (2)  $t_{HIGH:MAX}$  is minimum bus idle time.  $SMBC = 1$  for  $t > 50\text{ s}$  causes reset of any transaction involving the bq20z40 that is in progress.
- (3)  $t_{LOW:SEXT}$  is the cumulative time a slave device is allowed to extend the clock cycles in one message from initial start to the stop.
- (4)  $t_{LOW:MEXT}$  is the cumulative time a master device is allowed to extend the clock cycles in one message from initial start to the stop.

### SMBus TIMING DIAGRAM



## FEATURE SET

### Primary (1st Level) Safety Features

The bq20z40 supports a wide range of battery and system protection features that can easily be configured. The primary safety features include:

- Cell over/undervoltage protection
- Charge and discharge overcurrent
- Short Circuit
- Charge and discharge overtemperature with independent alarms and thresholds for each thermistor
- AFE Watchdog

### Secondary (2nd Level) Safety Features

The secondary safety features of the bq20z40 can be used to indicate more serious faults via the SAFE (pin 7). This pin can be used to blow an in-line fuse to permanently disable the battery pack from charging or discharging. The secondary safety protection features include:

- Safety overvoltage
- Safety undervoltage
- Safety overcurrent in charge and discharge
- Safety overtemperature in charge and discharge with independent alarms and thresholds for each thermistor
- Charge FET and 0 Volt Charge FET fault
- Discharge FET fault
- Cell imbalance detection (active and at rest)
- Open thermistor detection
- AFE communication fault

### Charge Control Features

The bq20z40 charge control features include:

- Supports JEITA temperature ranges. Reports charging voltage and charging current according to the active temperature range.
- Handles more complex charging profiles. Allows for splitting the standard temperature range into 2 sub-ranges and allows for varying the charging current according to the cell voltage.
- Reports the appropriate charging current needed for constant current charging and the appropriate charging voltage needed for constant voltage charging to a smart charger using SMBus broadcasts.
- Determines the chemical state of charge of each battery cell using Impedance Track™ and can reduce the charge difference of the battery cells in fully charged state of the battery pack gradually using cell balancing algorithm during charging. This prevents fully charged cells from overcharging and causing excessive degradation and also increases the usable pack energy by preventing premature charge termination
- Supports pre-charging/zero-volt charging
- Supports charge inhibit and charge suspend if battery pack temperature is out of temperature range
- Reports charging fault and also indicate charge status via charge and discharge alarms.

### Gas Gauging

The bq20z40 uses the Impedance Track™ Technology to measure and calculate the available charge in battery cells. The achievable accuracy is better than 1% error over the lifetime of the battery and there is no full charge discharge learning cycle required.

See *Theory and Implementation of Impedance Track Battery Fuel-Gauging Algorithm* application note ([SLUA364](#)) for further details.

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### Lifetime Data Logging Features

The bq20z40 offers lifetime data logging, where important measurements are stored for warranty and analysis purposes. The data monitored include:

- Lifetime maximum temperature
- Lifetime minimum temperature
- Lifetime maximum battery cell voltage
- Lifetime minimum battery cell voltage
- Lifetime maximum battery pack voltage
- Lifetime minimum battery pack voltage
- Lifetime maximum charge current
- Lifetime maximum discharge current
- Lifetime maximum charge power
- Lifetime maximum discharge power
- Lifetime maximum average discharge current
- Lifetime maximum average discharge power
- Lifetime average temperature

### Authentication

The bq20z40 supports authentication through the I2C interface. The bq20z40 provides a 64-bit authentication code (authcode) that is stored in non-volatile memory (NVM) and is used to verify the integrity of the data stored in the device. The authentication code is updated whenever the device is programmed or the data is updated. The authentication code is also used to verify the integrity of the data stored in the device. The authentication code is updated whenever the device is programmed or the data is updated. The authentication code is also used to verify the integrity of the data stored in the device.





## Charge and Discharge Counting

The integrating delta-sigma ADC measures the charge/discharge flow of the battery by measuring the voltage drop across a small-value sense resistor between the SRP and SRN pins. The integrating ADC measures bipolar signals from -0.25 V to 0.25 V. The bq20z40 detects charge activity when  $V_{SR} = V_{(SRP)} - V_{(SRN)}$  is positive, and discharge activity when  $V_{SR} = V_{(SRP)} - V_{(SRN)}$  is negative. The bq20z40 continuously integrates the signal over time, using an internal counter. The fundamental rate of the counter is 0.65 nVh.

## Voltage

The bq20z40 updates the individual series cell voltages through the bq29330 at one second intervals. The bq20z40 configures the bq29330 to connect the selected cell, cell offset, or bq29330 VREF to the CELL pin of the bq29330, which is required to be connected to VIN of the bq20z40. The internal ADC of the bq20z40 measures the voltage, scales it, and calibrates itself appropriately. This data is also used to calculate the impedance of the cell for the Impedance Track™ gas-gauging.

## Current

The bq20z40 uses the SRP and SRN inputs to measure and calculate the battery charge and discharge current using a 5 mΩ to 20 mΩ typ. sense resistor.

## Wake Function

The bq20z40 can exit sleep mode, if enabled, by the presence of a programmable level of current signal across SRP and SRN.

## Auto Calibration

The bq20z40 provides an auto-calibration feature to cancel the voltage offset error across SRP and SRN for maximum charge measurement accuracy. The bq20z40 performs auto-calibration when the SMBus lines stay low continuously for a minimum of a programmable amount of time.

## Temperature

The bq20z40 has an internal temperature sensor and inputs for 2 external temperature sensors, TS1 and TS2, used in conjunction with two identical NTC thermistors (default are Semitec 103AT) to sense the battery environmental temperature. The bq20z40 can be configured to use internal, or up to 2 external temperature sensors.

## COMMUNICATIONS

The bq20z40 uses SMBus v1.1 with Master Mode and package error checking (PEC) options per the SBS specification.

## SMBus On and Off State

The bq20z40 detects an SMBus off state when SMBC and SMBD are logic-low for 2 seconds. Clearing this state requires either SMBC or SMBD to transition high. Within 1 ms, the communication bus is available.



**Table 3. EXTENDED SBS COMMANDS**

SBS Cmd	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x45	R	AFEDData	String	11+1	—	—	—	—
0x46	R/W	FETControl	hex	2	0x00	0xff	—	—
0x4f	R	StateOfHealth	hex	2	0x0000	0xffff	—	%
0x51	R	SafetyStatus	hex	2	0x0000	0xffff	—	—
0x53	R	PFStatus	hex	2	0x0000	0xffff	—	—
0x54	R	OperationStatus	hex	2	0x0000	0xffff	—	—
0x55	R	ChargingStatus	hex	2	0x0000	0xffff	—	—
0x57	R	ResetData	hex	2	0x0000	0xffff	—	—
0x58	R	WDRResetData	unsigned int	2	0	65535	—	—
0x5a	R	PackVoltage	unsigned int	2	0	65535	—	mV
0x5d	R	AverageVoltage	unsigned int	2	0	65535	—	mV
0x5e	R	TS1Temperature	integer	2	–400	1200	—	0.1°C
0x5f	R	TS2Temperature	integer	2	–400	1200	—	0.1°C
0x60	R/W	UnSealKey	hex	4	0x00000000	0xffffffff	—	—
0x61	R/W	FullAccessKey	hex	4	0x00000000	0xffffffff	—	—
0x62	R/W	PFKey	hex	4	0x00000000	0xffffffff	—	—
0x63	R/W	AuthenKey3	hex	4	0x00000000	0xffffffff	—	—
0x64	R/W	AuthenKey2	hex	4	0x00000000	0xffffffff	—	—
0x65	R/W	AuthenKey1	hex	4	0x00000000	0xffffffff	—	—
0x66	R/W	AuthenKey0	hex	4	0x00000000	0xffffffff	—	—
0x69	R	SafetyStatus2	hex	2	0x0000	0x0003	—	—
0x6b	R	PFStatus2	hex	2	0x0000	0x0003	—	—
0x6c	R/W	ManufBlock1	String	20	—	—	—	—
0x6d	R/W	ManufBlock2	String	20	—	—	—	—
0x6e	R/W	ManufBlock3	String	20	—	—	—	—
0x6f	R/W	ManufBlock4	String	20	—	—	—	—
0x70	R/W	ManufacturerInfo	String	31+1	—	—	—	—
0x71	R/W	SenseResistor	unsigned int	2	0	65535	6 539 Td (mV)5	

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## APPLICATION SCHEMATIC

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• 4P

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
BQ20Z40PW	NRND	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
BQ20Z40PWR	NRND	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> 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.

<sup>(2)</sup> 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)

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

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