

## SBS 1.1-COMPLIANT GAS GAUGE AND PROTECTION-ENABLED IC WITH IMPEDANCE TRACK™

Check for Samples: [bq20z75](#)

### FEATURES

- **Next Generation Patented Impedance Track™ Technology accurately Measures Available Charge in Li-Ion and Li-Polymer Batteries**
  - Better than 1% Error Over Lifetime of the Battery
  - Instant Accuracy – No Learning Cycle Required
- **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 Ultra-Low Power Modes**
- **Full Array of Programmable Protection Features**
  - Voltage, Current and Temperature
- **Supports SHA-1 Authentication**
- **small 38-Pin TSSOP (DBT) Package**

### APPLICATIONS

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

### DESCRIPTION

The bq20z75 SBS-compliant gas gauge and protection IC is a single IC solution designed for battery-pack or in-system installation. The bq20z75 measures and maintains an accurate record of available charge in Li-ion or Li-polymer batteries using its integrated high-performance analog peripherals, monitors capacity change, battery impedance, open-circuit voltage, and other critical parameters of the battery pack as well and reports the information to the system host controller over a serial-communication bus. Together with the integrated analog front-end (AFE) short-circuit and overload protection the bq20z75 maximizes functionality, safety and minimize external component count, cost and size in smart battery circuits.

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

**Table 1. AVAILABLE OPTIONS**

| T <sub>A</sub> | PACKAGE                                |   |
|----------------|--|---|
|                | 38-PIN TSSOP (DBT) Tube <sup>(1)</sup> | 38-PIN TSSOP (DBT) Tape and Reel <sup>(2)</sup> |
| –40°C to 85°C  | bq20z75DBT                             | bq20z75DBTR                                     |
|                | bq20z75DBT-v160                        | bq20z75DBTR-v160                                |

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



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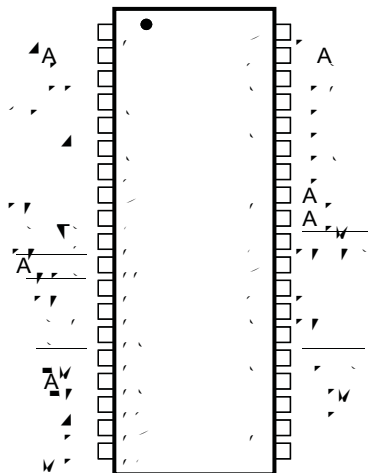


This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

### SYSTEM PARTITIONING DIAGRAM

TSSOP (PW)  
(TOP VIEW)

















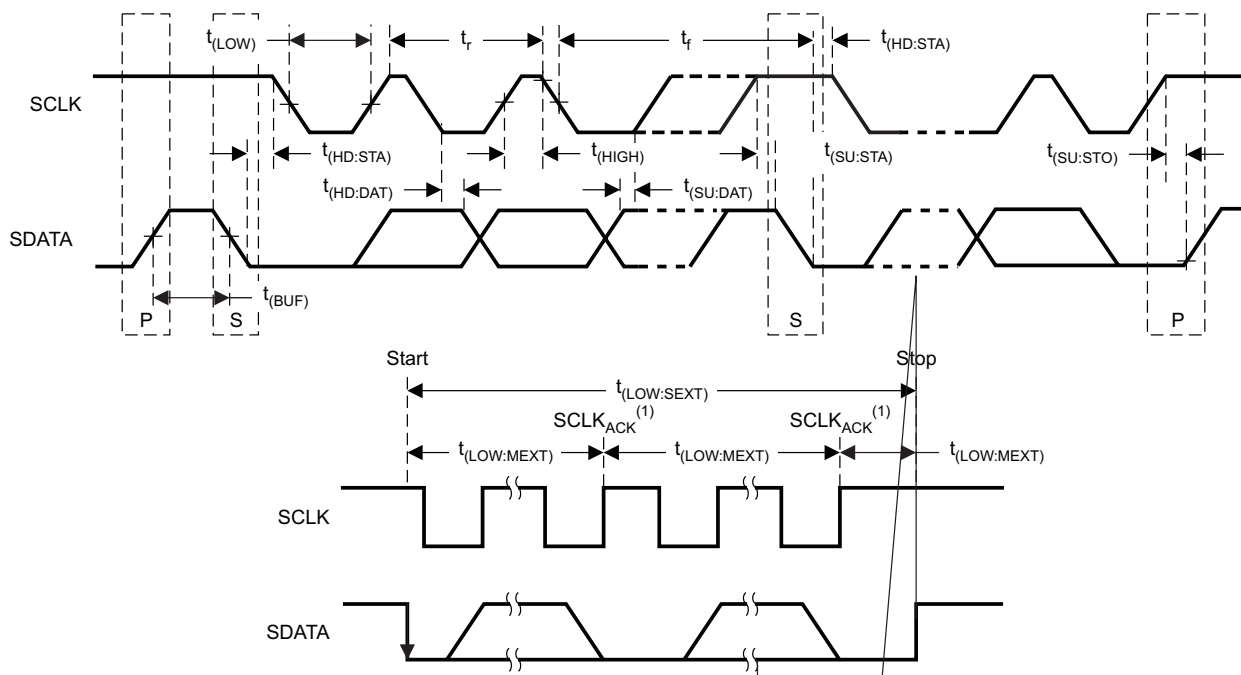


### SMBus Timing Characteristics (continued)

T<sub>A</sub> = -40°C to 85°C Typical Values at T<sub>A</sub> = 25°C and V<sub>(REG25)</sub> = 2.5 V (Unless Otherwise Noted)

| PARAMETER               |  | TEST CONDITIONS | MIN | TYP | MAX  | UNIT |
|-------------------------|--|-----------------|-----|-----|------|------|
| t <sub>(TIMEOUT)</sub>  | Error signal/detect (see Figure 1)                     | See (1)         | 25  |     | 35   | μs   |
| t <sub>(LOW)</sub>      | Clock low period (see Figure 1)                        |                 | 4.7 |     |      | μs   |
| t <sub>(HIGH)</sub>     | Clock high period (see Figure 1)                       | See (2)         | 4.0 |     | 50   | μs   |
| t <sub>(LOW:SEXT)</sub> | Cumulative clock low slave extend time                 | See (3)         |     |     | 25   | μs   |
| t <sub>(LOW:MEXT)</sub> | Cumulative clock low master extend time (see Figure 1) | See (4)         |     |     | 10   | μs   |
| t <sub>f</sub>          | Clock/data fall time                                   | See (5)         |     |     | 300  | ns   |
| t <sub>r</sub>          | Clock/data rise time                                   | See (6)         |     |     | 1000 | ns   |

- (1) The bq20z75 times out when any clock low exceeds t<sub>(TIMEOUT)</sub>.
- (2) t<sub>(HIGH)</sub>, Max, is the minimum bus idle time. SMBC = SMBD = 1 for t > 50 ms causes reset of any transaction involving bq20z75 that is in progress. This specification is valid when the NC\_SMB control bit remains in the default cleared state (CLK[0]=0).
- (3) t<sub>(LOW:SEXT)</sub> 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<sub>(LOW:MEXT)</sub> is the cumulative time a master device is allowed to extend the clock cycles in one message from initial start to the stop.
- (5) Rise time t<sub>r</sub> = VILMAX - 0.15 to (VIHMIN + 0.15)
- (6) Fall time t<sub>f</sub> = 0.9V<sub>DD</sub> to (VILMAX - 0.15)



(1) SCLK<sub>ACK</sub> is the acknowledge-related clock pulse generated by the master.

Figure 1. SMBus Timing Diagram

## FEATURE SET

### Primary (1st Level) Safety Features

The bq20z75 supports a wide range of battery and system protection features that can easily be configured. The primary safety features include:

- Cell over/under voltage protection
- Charge and Discharge over current
- Short Circuit
- Charge and Discharge Over temperature
- AFE Watchdog

### Secondary (2nd Level) Safety Features

The secondary safety features of the bq20z75 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 overcurrent in Charge and Discharge
- Safety overtemperature in Charge and Discharge
- Charge FET and 0 Volt Charge FET fault
- Discharge FET fault
- AFE communication fault

### Charge Control Features

The bq20z75 charge control features include:

- 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
- Support fast 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 bq20z75 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.

### Authentication

The bq20z75 supports authentication by the host using SHA-1.

### Power Modes

The bq20z75 supports 3 different power modes to reduce power consumption:

- In Normal Mode, the bq20z75 performs measurements, calculations, protection decisions and data updates in 1 second intervals. Between these intervals, the bq20z75 is in a reduced power stage.

- In Sleep Mode, the bq20z75 performs measurements, calculations, protection decisions and data update in adjustable time intervals. Between these intervals, the bq20z75 is in a reduced power stage. The bq20z75 has a wake function that enables exit from Sleep mode, when current flow or failure is detected.
- In Shutdown Mode the bq20z75 is completely disabled.

## CONFIGURATION

### Oscillator Function

The bq20z75 fully integrates the system oscillators. Therefore the bq20z75 requires no external components for this feature.

### System Present Operation

The bq20z75 checks the  $\overline{\text{PRES}}$  pin periodically (1 s). Connect the  $\overline{\text{PRES}}$  pin to TOUT with a 100k  $\Omega$  resistor. If  $\overline{\text{PRES}}$  input is pulled to ground by external system host, the bq20z75 detects this as system present.

## BATTERY PARAMETER MEASUREMENTS

The bq20z75 uses an integrating delta-sigma analog-to-digital converter (ADC) for current measurement, and a second delta-sigma ADC for individual cell and battery voltage, and temperature measurement.

### 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  $-0.25\text{ V}$  to  $0.25\text{ V}$ . The bq20z75 detects charge activity when  $V_{\text{SR}} = V_{(\text{SRP})} - V_{(\text{SRN})}$  is positive and discharge activity when  $V_{\text{SR}} = V_{(\text{SRP})} - V_{(\text{SRN})}$  is negative. The bq20z75 continuously integrates the signal over time, using an internal counter. The fundamental rate of the counter is 0.65 nVh.

### Voltage

The bq20z75 updates the individual series cell voltages at one second intervals. The internal ADC of the bq20z75 measures the voltage, scales and calibrates it appropriately. This data is also used to calculate the impedance of the cell for the Impedance Track™ gas-gauging.

### Current

The bq20z75 uses the GSRP and GSRN inputs to measure and calculate the battery charge and discharge current using a 5 m $\Omega$  to 20 m $\Omega$  typ. sense resistor.

### Auto Calibration

The bq20z75 provides an auto-calibration feature to cancel the voltage offset error across GSRN and GSRP for maximum charge measurement accuracy. The bq20z75 performs auto-calibration when the SMBus lines stay low continuously for a minimum of 5 s.

### Temperature

The bq20z75 has an internal temperature sensor and 2 external temperature sensor inputs TS1 and TS2 used in conjunction with two identical NTC thermistors (default are Semitec 103AT) to sense the battery environmental temperature. The bq20z75 can be configured to use internal or external temperature sensors.

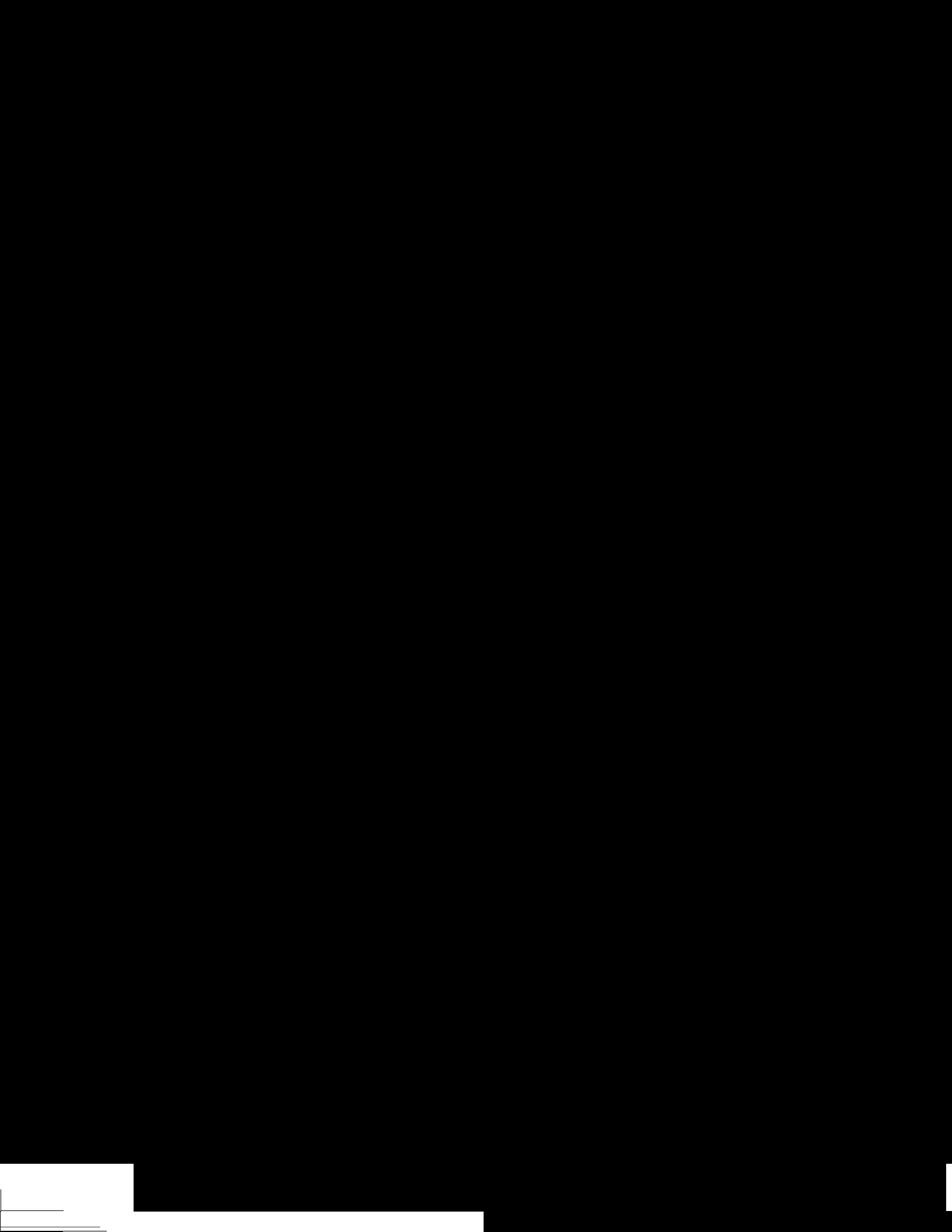
## COMMUNICATIONS

The bq20z75 uses SMBus v1.1 with Master Mode and package error checking (PEC) options per the SBS specification.

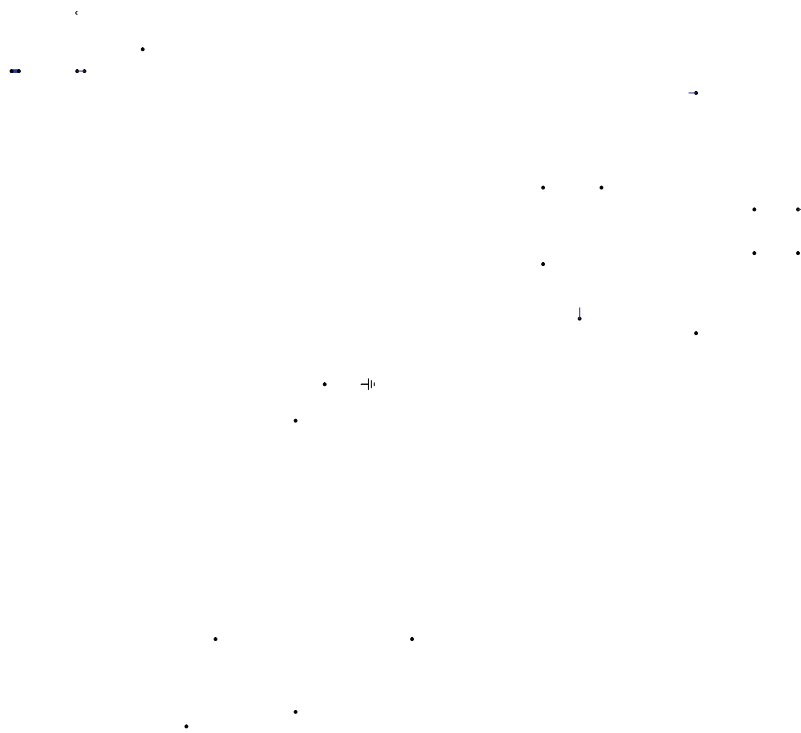
### SMBus On and Off State

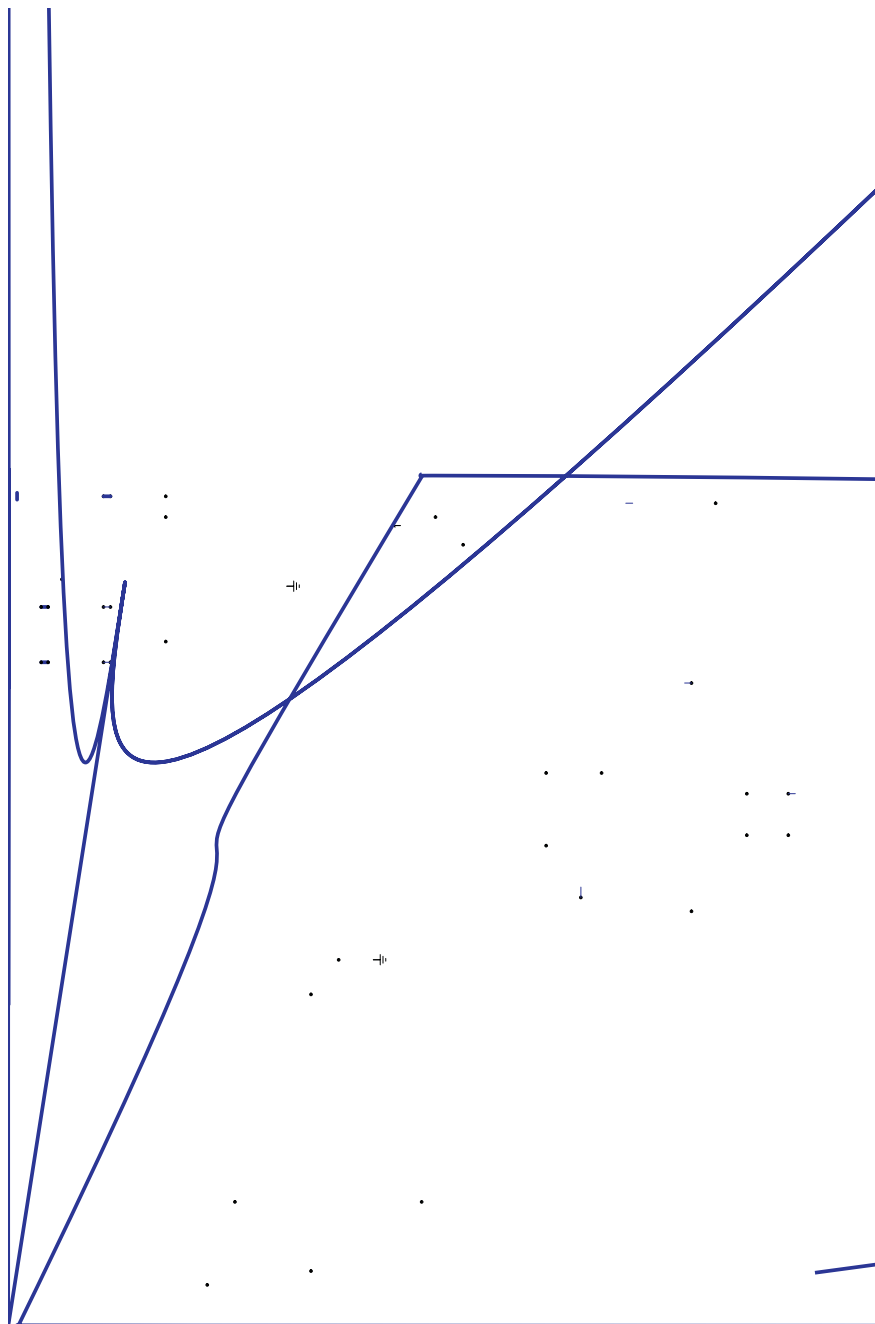
The bq20z75 detects an SMBus off state when SMBC and SMBD are logic-low for 2 seconds. Clearing this state requires either SMBC or SMBD to transition high. Within 1 ms, the communication bus is available.





## Application Schematics







**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> | Samples (Requires Login) |
|--------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|-------------------|------------------------------|--------------------------|
| BQ20Z75DBT-V160    | NRND                  | TSSOP        | DBT             | 38   | 50          | Green (RoHS & no Sb/Br) | CU NIPDAU         | Level-2-260C-1 YEAR          |                          |
| BQ20Z75DBT-V160G4  | NRND                  | TSSOP        | DBT             | 38   | 50          | Green (RoHS & no Sb/Br) | CU NIPDAU         | Level-2-260C-1 YEAR          |                          |
| BQ20Z75DBTR-V160   | NRND                  | TSSOP        | DBT             | 38   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU         | Level-2-260C-1 YEAR          |                          |
| BQ20Z75DBTR-V160G4 | NRND                  | TSSOP        | DBT             | 38   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU         | Level-2-260C-1 YEAR          |                          |

<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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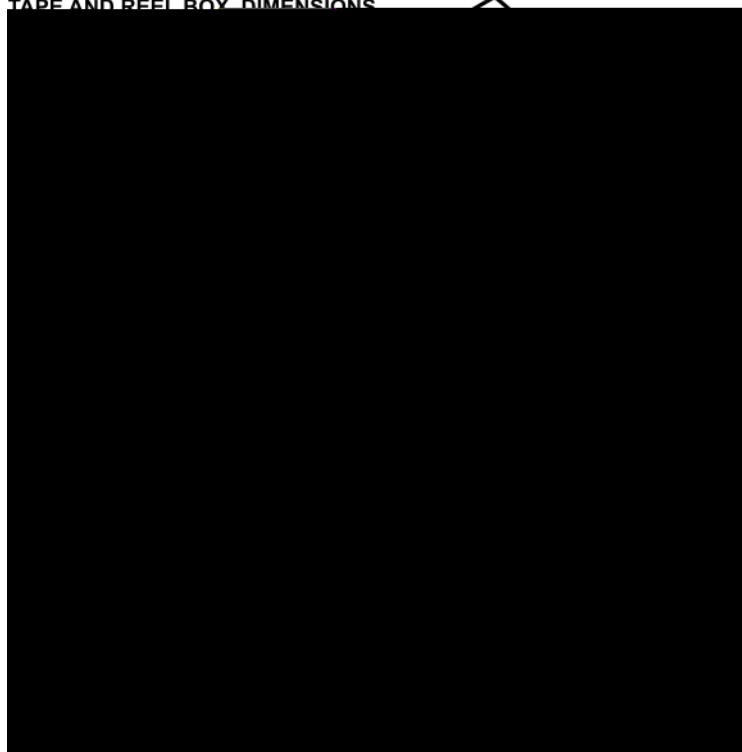
**TAPE AND REEL INFORMATION**



\*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 |
|------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| BQ20Z75DBTR-V160 | TSSOP        | DBT             | 38   | 2000 | 330.0              | 16.4               | 6.9     | 10.2    | 1.8     | 12.0    | 16.0   | Q1            |

**TAPE AND REEL BOX DIMENSIONS**



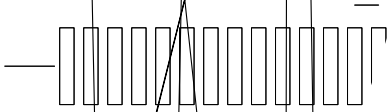
\*All dimensions are nominal

| Device           | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| BQ20Z75DBTR-V160 | TSSOP        | DBT             | 38   | 2000 | 367.0       | 367.0      | 38.0        |

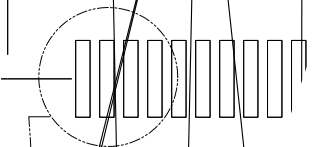


(R-PDSO-G38)

(Note C)



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