

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

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**

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.

APPLICATIONS

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

AVAILABLE OPTIONS

| T _A | PACKAGE | |
|----------------|--------------------------|-------------------------------|
| | 20-PIN TSSOP (PW) Tube | 20-PIN TSSOP (PW) Tape & Reel |
| –40°C to 85°C | bq20z40PW ⁽¹⁾ | bq20z40PWR ⁽²⁾ |

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



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.

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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

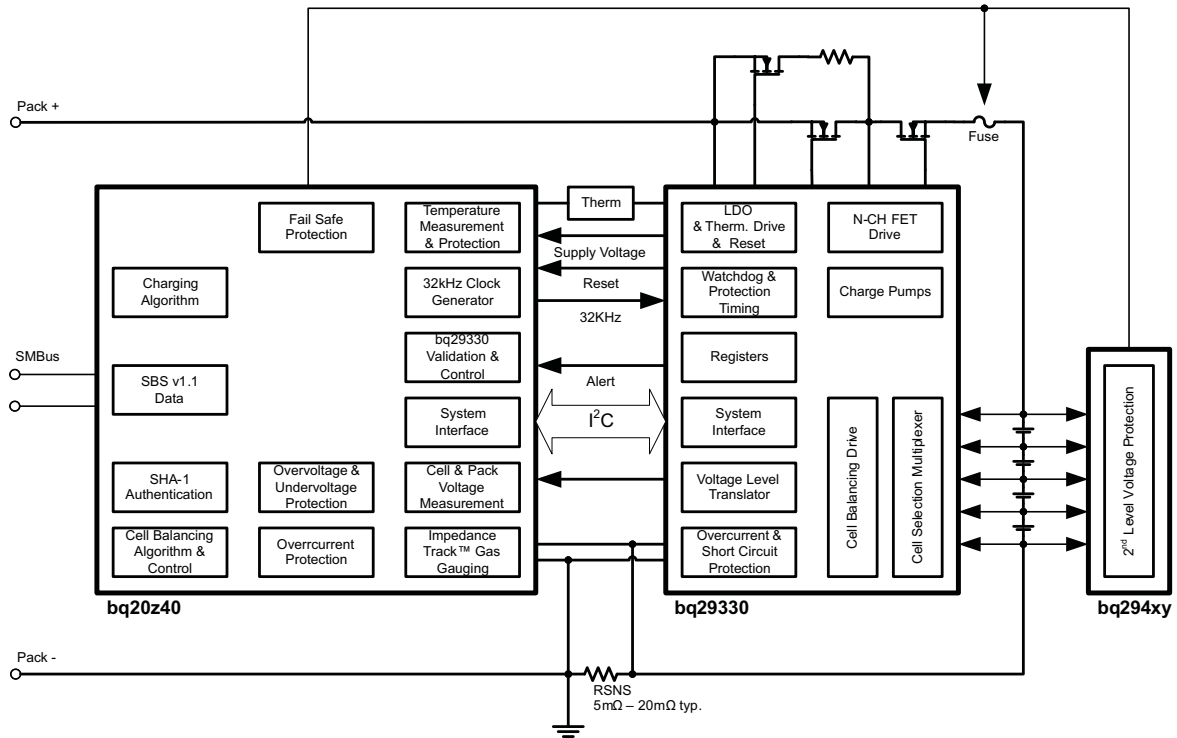


Figure 1.

**TSSOP (PW)
(TOP VIEW)**

| | | | |
|--------|----|----|--------|
| XALERT | 1 | 20 | VCELL- |
| TS2 | 2 | 19 | VCELL+ |
| TS1 | 3 | 18 | VCC |
| CLKOUT | 4 | 17 | VSS |
| PRES | 5 | 16 | MRST |
| PFIN | 6 | 15 | SRN |
| SAFE | 7 | 14 | SRP |
| SMBD | 8 | 13 | VSS |
| NC | 9 | 12 | SCLK |
| SMBC | 10 | 11 | SDATA |

PIN FUNCTIONS

| PIN | | I/O ⁽¹⁾ | DESCRIPTION |
|-----|--------|--------------------|--|
| NO. | NAME | | |
| 1 | XALERT | I | Input from bq29330 XALERT output. |
| 2 | TS2 | I | 2 nd Thermistor voltage input connection to monitor temperature |
| 3 | TS1 | I | 1 st Thermistor voltage input connection to monitor temperature |
| 4 | CLKOUT | O | 32.768-kHz output for the bq29330. This pin should be directly connected to the AFE. |
| 5 | PRES | I | Active low input to sense system insertion. Typically requires additional ESD protection. |
| 6 | PFIN | I | Active low input to detect secondary protector output status, and to allow the bq20z40 to report the status of the 2 nd level protection output |
| 7 | SAFE | O | Active high output to enforce additional level of safety protection; e.g., fuse blow. |
| 8 | SMBD | I/OD | SMBus data open-drain bidirectional pin used to transfer address and data to and from the bq20z40 |
| 9 | NC | – | Not used— leave floating |
| 10 | SMBC | I/OD | SMBus clock open-drain bidirectional pin used to clock the data transfer to and from the bq20z40 |
| 11 | SDATA | I/O | Data transfer to and from bq29330 |
| 12 | SCLK | I/O | Communication clock to the bq29330 |
| 13 | VSS | – | Connected I/O pin to VSS |
| 14 | SRP | IA | Connections for a small-value sense resistor to monitor the battery charge- and discharge-current flow |
| 15 | SRN | IA | Connections for a small-value sense resistor to monitor the battery charge- and discharge-current flow |
| 16 | MRST | I | Master reset input that forces the device into reset when held low. Must be held high for normal operation |
| 17 | VSS | P | Negative Supply Voltage |
| 18 | VCC | P | Positive Supply Voltage |
| 19 | VCELL+ | I | Input from bq29330 used to read a scaled value of individual cell voltages |
| 20 | VCELL– | I | Input from bq29330 used to read a scaled value of individual cell voltages |

(1) I = Input, IA = Analog input, I/O = Input/output, I/OD = Input/Open-drain output, O = Output, OA = Analog output, P = Power

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ABSOLUTE MAXIMUM RATINGS

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

| | | RANGE |
|--|---------------------------------------|-----------------------------------|
| V _{CC} relative to V _{SS} | Supply voltage range | -0.3 V to 2.75 V |
| V _(IOD) relative to V _{SS} | Open-drain I/O pins | -0.3 V to 6 V |
| V _I relative to V _{SS} | Input voltage range to all other pins | -0.3 V to V _{CC} + 0.3 V |
| T _A | Operating free-air temperature range | -40°C to 85°C |
| T _{stg} | Storage temperature range | -65°C to 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.

ELECTRICAL CHARACTERISTICS

 V_{CC} = 2.4 V to 2.6 V, T_A = -40°C to 85°C (unless otherwise noted)

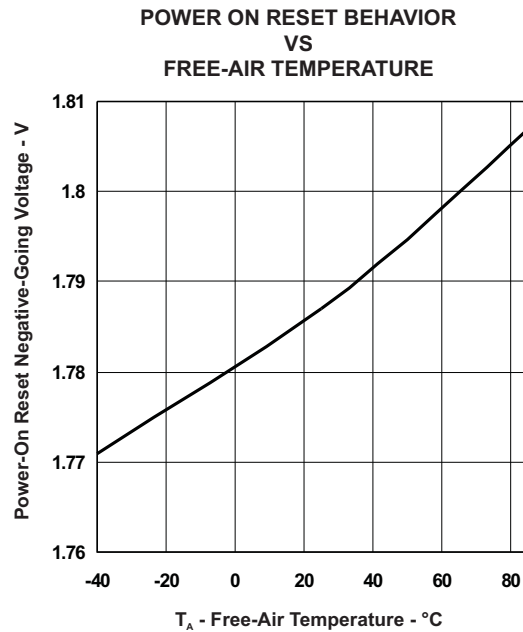
| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--------------------|--|--------------------------|-----------------------|--------------------|---------------------|------|
| V _{CC} | Supply voltage | | 2.4 | 2.5 | 2.6 | V |
| I _{CC} | Operating mode current | No flash programming | | 400 ⁽¹⁾ | | μA |
| | | bq20z40 + bq29330 | | 475 | | |
| I _(SLP) | Low-power storage mode current | Sleep mode | | 8 ⁽¹⁾ | | μA |
| | | bq20z40 + bq29330 | | 51 | | |
| I _(SD) | Shutdown Mode Current | Shutdown mode | | 0.1 ⁽¹⁾ | | μA |
| | | bq20z40 + bq29330 | | 0.2 | | |
| V _{OL} | Output voltage low SMBC, SMBD, SDATA, SCLK, SAFE | I _{OL} = 0.5 mA | | | 0.4 | V |
| V _{OH} | Output high voltage, SMBC, SMBD, SDATA, SCLK, SAFE | I _{OH} = -1 mA | V _{CC} - 0.5 | | | V |
| V _{IL} | Input voltage low SMBC, SMBD, SDATA, SCLK, XALERT, PRES, PFIN | | -0.3 | | 0.8 | V |
| V _{IH} | Input voltage high SMBC, SMBD, SDATA, SCLK, XALERT, PRES, PFIN | | 2 | | 6 | V |
| C _{IN} | Input capacitance | | | 5 | | pF |
| V _(AI1) | Input voltage range VCELL+, VCELL-, TS1, TS2 | | -0.2 | | 0.8xV _{CC} | V |
| V _(AI2) | Input voltage range SRN, SRP | | -0.20 | | 0.20 | |
| Z _(AI2) | Input impedance VCELL+, VCELL-, TS1, TS2 | 0 V-1 V | | 8 | | MΩ |
| Z _(AI1) | Input impedance SRN, SRP | 0 V-1 V | | 2.5 | | MΩ |

(1) This value does not include the bq29330

POWER-ON RESET

 V_{CC} = 2.4V to 2.6 V, T_A = -40°C to 85°C (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|------------------|------------------------------|-----------------|-----|-----|-----|------|
| V _{IT-} | Negative-going voltage input | | 1.7 | 1.8 | 1.9 | V |
| V _{HYS} | Power-on reset hysteresis | | 50 | 125 | 200 | mV |



INTEGRATING ADC (Coulomb Counter) CHARACTERISTICS

V_{CC} = 2.4V to 2.6 V, T_A = -40°C to 85°C (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|---|------|--------|--------|------|
| V _(SR) Input voltage range, V _(SRN) and V _(SRP) | V _(SR) = V _(SRN) – V _(SRP) | -0.2 | | 0.2 | V |
| V _(SROS) Input offset | | | 10 | | μV |
| INL Integral nonlinearity error | | | 0.007% | 0.034% | |

OSCILLATOR

V_{CC} = 2.4 V to 2.6 V, T_A = -40°C to 85°C (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|-------------------------------|-------|--------|-------|------|
| HIGH FREQUENCY OSCILLATOR | | | | | |
| f _(OSC) Operating Frequency | | | | 4.194 | MHz |
| f _(EIO) Frequency Error ⁽¹⁾⁽²⁾ | | -3% | 0.25% | 3% | |
| | T _A = 20°C to 70°C | -2% | 0.25% | 2% | |
| t _(SXO) Start-up Time ⁽³⁾ | | | 2.5 | 5 | ms |
| LOW FREQUENCY OSCILLATOR | | | | | |
| f _(LOSC) Operating Frequency | | | 32.768 | | KHz |
| f _(LEIO) Frequency Error ⁽²⁾⁽⁴⁾ | | -2.5% | 0.25% | 2.5% | |
| | T _A = 20°C to 70°C | -1.5% | 0.25% | 1.5% | |
| t _(LSXO) Start-up time ⁽⁵⁾ | | | | 500 | μs |

(1) The frequency error is measured from 4.194 MHz.

(2) The frequency drift is included and measured from the trimmed frequency at V_{CC} = 2.5 V, T_A = 25°C.

(3) The start-up time is defined as the time it takes for the oscillator output frequency to be within 1 % of the specified frequency.

(4) The frequency error is measured from 32.768 kHz.

(5) The start-up time is defined as the time it takes for the oscillator output frequency to be ± 3%.

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DATA FLASH MEMORY CHARACTERISTICS

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

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|------------------|--------------------------------|--------------------|--------|-----|-----|--------|
| t_{DR} | Data retention | See ⁽¹⁾ | 10 | | | Years |
| | Flash programming write-cycles | See ⁽¹⁾ | 20,000 | | | Cycles |
| $t_{(WORDPROG)}$ | Word programming time | See ⁽¹⁾ | | | 2 | ms |
| $I_{(DDdPROG)}$ | Flash-write supply current | See ⁽¹⁾ | | 5 | 10 | mA |

(1) Specified by design. Not production tested.

SMBus TIMING SPECIFICATIONS

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

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|----------------|---|--|-----|------|------|---------------|
| f_{SMB} | SMBus operating frequency | Slave mode, SMBC 50% duty cycle | 10 | | 100 | kHz |
| f_{MAS} | SMBus master clock frequency | Master mode, no clock low slave extend | | 51.2 | | |
| t_{BUF} | Bus free time between start and stop | | 4.7 | | | μs |
| $t_{HD:STA}$ | Hold time after (repeated) start | | 4 | | | |
| $t_{SU:STA}$ | Repeated start setup time | | 4.7 | | | |
| $t_{SU:STO}$ | Stop setup time | | 4 | | | |
| $t_{HD:DAT}$ | Data hold time | Receive mode | 0 | | | ns |
| | | Transmit mode | 300 | | | |
| $t_{SU:DAT}$ | Data setup time | | 250 | | | |
| $t_{TIMEOUT}$ | Error signal/detect | See ⁽¹⁾ | 25 | | 35 | ms |
| t_{LOW} | Clock low period | | 4.7 | | | μs |
| 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 | |

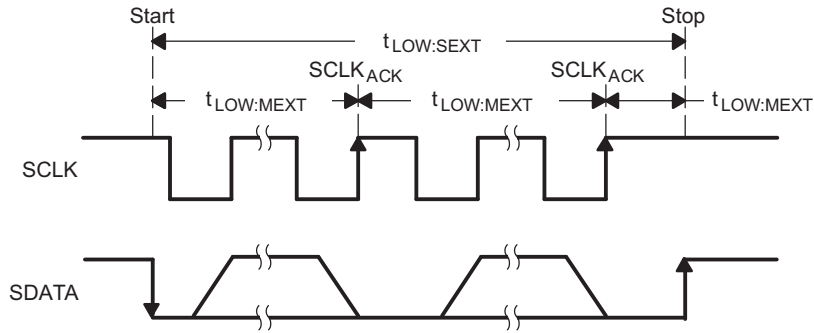
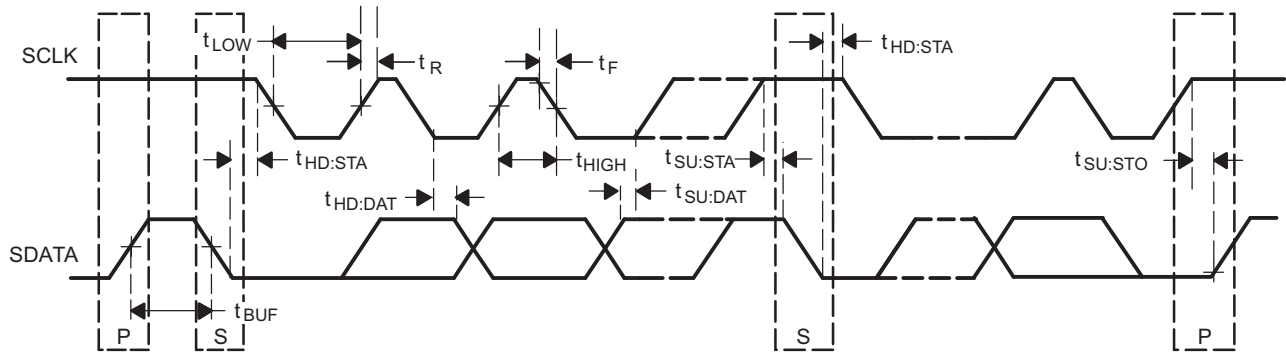
(1) The bq20z40 times out when any clock low exceeds $t_{TIMEOUT}$.

(2) $t_{HIGH:MAX}$ is minimum bus idle time. SMBC = 1 for $t > 50\ \mu\text{s}$ 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.

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 by the host using SHA-1.

Power Modes

The bq20z40 supports 3 different power modes to reduce power consumption:

- In Normal Mode, the bq20z40 performs measurements, calculations, protection decisions and data updates in 1 second intervals. Between these intervals, the bq20z40 is in a reduced power stage.
- In Sleep Mode, the bq20z40 performs measurements, calculations, protection decisions and data update in adjustable time intervals. Between these intervals, the bq20z40 is in a reduced power stage. The bq20z40 has a wake function that enables exit from Sleep mode, when current flow or failure is detected.
- In Shutdown Mode the bq20z40 is completely disabled.

CONFIGURATION

Oscillator Function

The bq20z40 fully integrates the system and processor oscillators and, therefore, requires no pins or components for this feature.

System Present Operation

The bq20z40 periodically verifies the $\overline{\text{PRES}}$ pin and detects that the battery is present in the system via a low state on a PRES input. When this occurs, bq20z40 enters normal operating mode. When the pack is removed from the system and the PRES input is high, the bq20z40 enters the battery-removed state, disabling the charge, discharge and ZVCHG FETs. The $\overline{\text{PRES}}$ input is ignored and can be left floating when non-removal mode is set in the data flash.

BATTERY PARAMETER MEASUREMENTS

The bq20z40 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.

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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.

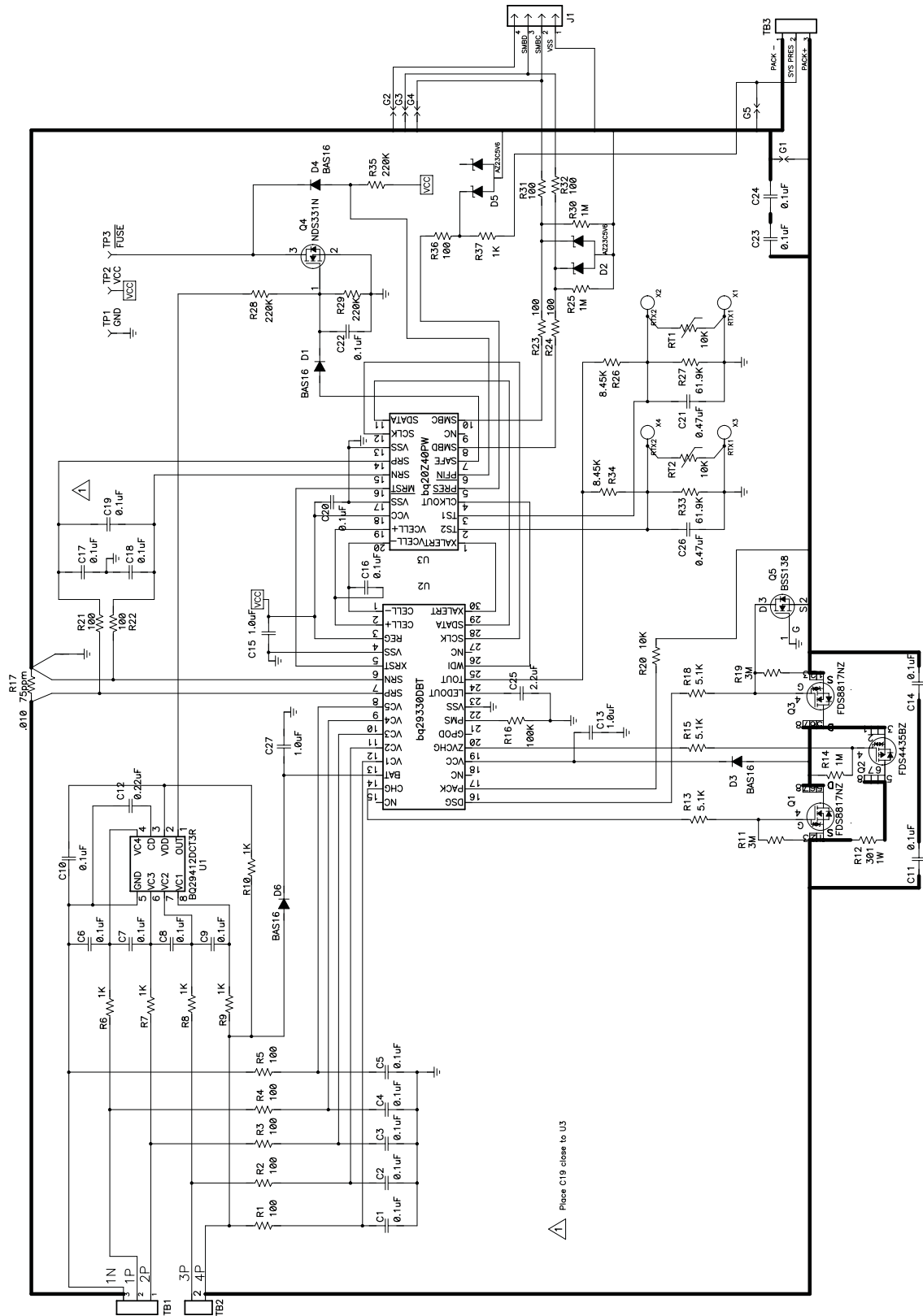
SBS Commands
Table 1. SBS COMMANDS

| SBS Cmd | Mode | Name | Format | Size in Bytes | Min Value | Max Value | Default Value | Unit |
|---------|------|------------------------|--------------|---------------|-----------|-----------|---------------|--------------|
| 0x00 | R/W | ManufacturerAccess | hex | 2 | 0x0000 | 0xffff | — | |
| 0x01 | R/W | RemainingCapacityAlarm | unsigned int | 2 | 0 | 65535 | 300 | mAh or 10mWh |
| 0x02 | R/W | RemainingTimeAlarm | unsigned int | 2 | 0 | 65535 | 10 | min |
| 0x03 | R/W | BatteryMode | hex | 2 | 0x0000 | 0xe383 | — | |
| 0x04 | R/W | AtRate | signed int | 2 | -32768 | 32767 | — | mA or 10mW |
| 0x05 | R | AtRateTimeToFull | unsigned int | 2 | 0 | 65534 | — | min |
| 0x06 | R | AtRateTimeToEmpty | unsigned int | 2 | 0 | 65534 | — | min |
| 0x07 | R | AtRateOK | unsigned int | 2 | 0 | 65535 | — | |
| 0x08 | R | Temperature | unsigned int | 2 | 0 | 65535 | — | 0.1°K |
| 0x09 | R | Voltage | unsigned int | 2 | 0 | 65535 | — | mV |
| 0x0a | R | Current | signed int | 2 | -32768 | 32767 | — | mA |
| 0x0b | R | AverageCurrent | signed int | 2 | -32768 | 32767 | — | mA |
| 0x0c | R | MaxError | unsigned int | 1 | 0 | 100 | — | % |
| 0x0d | R | RelativeStateOfCharge | unsigned int | 1 | 0 | 100 | — | % |
| 0x0e | R | AbsoluteStateOfCharge | unsigned int | 1 | 0 | 100+ | — | % |
| 0x0f | R/W | RemainingCapacity | unsigned int | 2 | 0 | 65535 | — | mAh or 10mWh |
| 0x10 | R | FullChargeCapacity | unsigned int | 2 | 0 | 65535 | — | mAh or 10mWh |
| 0x11 | R | RunTimeToEmpty | unsigned int | 2 | 0 | 65534 | — | min |
| 0x12 | R | AverageTimeToEmpty | unsigned int | 2 | 0 | 65534 | — | min |
| 0x13 | R | AverageTimeToFull | unsigned int | 2 | 0 | 65534 | — | min |
| 0x14 | R | ChargingCurrent | unsigned int | 2 | 0 | 65534 | — | mA |
| 0x15 | R | ChargingVoltage | unsigned int | 2 | 0 | 65534 | — | mV |
| 0x16 | R | BatteryStatus | hex | 2 | 0x0000 | 0xdbff | — | |
| 0x17 | R/W | CycleCount | unsigned int | 2 | 0 | 65535 | — | |
| 0x18 | R/W | DesignCapacity | unsigned int | 2 | 0 | 65535 | 4400 | mAh or 10mWh |
| 0x19 | R/W | DesignVoltage | unsigned int | 2 | 0 | 65535 | 14400 | mV |
| 0x1a | R/W | SpecificationInfo | hex | 2 | 0x0000 | 0xffff | 0x0031 | |
| 0x1b | R/W | ManufactureDate | unsigned int | 2 | — | — | 01-Jan-1980 | — |
| 0x1c | R/W | SerialNumber | hex | 2 | 0x0000 | 0xffff | 0x0001 | |
| 0x20 | R/W | ManufacturerName | String | 20+1 | — | — | Texas Inst. | — |
| 0x21 | R/W | DeviceName | String | 20+1 | — | — | bq20z40 | — |
| 0x22 | R/W | DeviceChemistry | String | 4+1 | — | — | LION | — |
| 0x23 | R/W | ManufacturerData | String | 14+1 | — | — | — | — |
| 0x2f | R/W | Authenticate | String | 20+1 | — | — | — | — |
| 0x3c | R | CellVoltage4 | unsigned int | 2 | 0 | 65535 | — | mV |
| 0x3d | R | CellVoltage3 | unsigned int | 2 | 0 | 65535 | — | mV |
| 0x3e | R | CellVoltage2 | unsigned int | 2 | 0 | 65535 | — | mV |
| 0x3f | R | CellVoltage1 | unsigned int | 2 | 0 | 65535 | — | mV |

Table 2. EXTENDED SBS COMMANDS

| SBS Cmd | Mode | Name | Format | Size in Bytes | Min Value | Max Value | Default Value | Unit |
|---------|------|------------------------|--------------|---------------|------------|------------|---------------|-------|
| 0x45 | R | AFEData | 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 | — | μΩ |
| 0x72 | R | TempRange | hex | 2 | — | — | — | — |
| 0x73 | R | LifetimeData | String | 32+1 | — | — | — | — |
| 0x77 | R/W | DataFlashSubClassID | hex | 2 | 0x0000 | 0xffff | — | — |
| 0x78 | R/W | DataFlashSubClassPage1 | hex | 32 | — | — | — | — |
| 0x79 | R/W | DataFlashSubClassPage2 | hex | 32 | — | — | — | — |
| 0x7a | R/W | DataFlashSubClassPage3 | hex | 32 | — | — | — | — |
| 0x7b | R/W | DataFlashSubClassPage4 | hex | 32 | — | — | — | — |
| 0x7c | R/W | DataFlashSubClassPage5 | hex | 32 | — | — | — | — |
| 0x7d | R/W | DataFlashSubClassPage6 | hex | 32 | — | — | — | — |
| 0x7e | R/W | DataFlashSubClassPage7 | hex | 32 | — | — | — | — |
| 0x7f | R/W | DataFlashSubClassPage8 | hex | 32 | — | — | — | — |

APPLICATION SCHEMATIC



▲ Piece C19 close to U3

PACKAGING INFORMATION

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

⁽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.

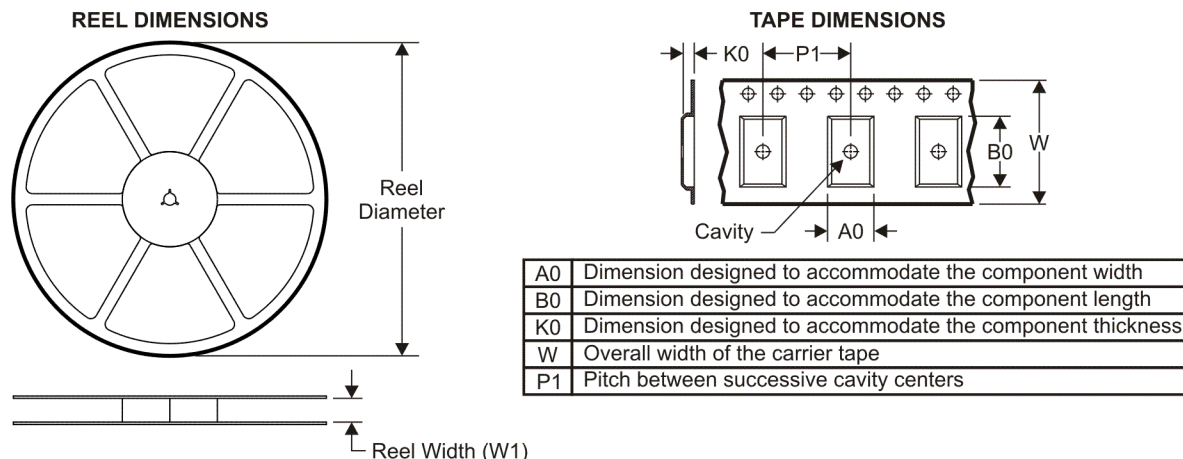
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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TAPE AND REEL INFORMATION



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 |
|------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| BQ20Z40PWR | TSSOP | PW | 20 | 2000 | 330.0 | 16.4 | 6.95 | 7.1 | 1.6 | 8.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS



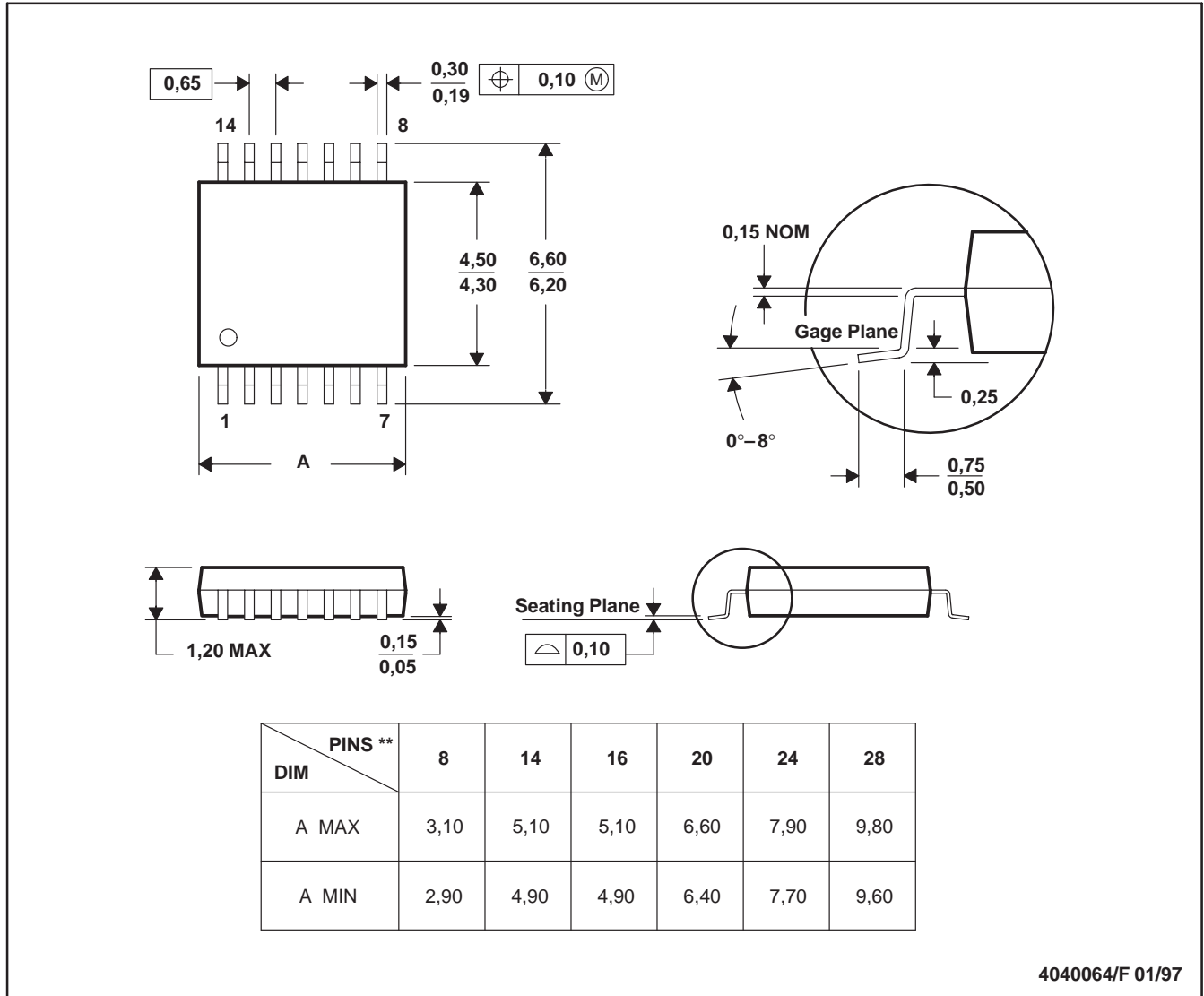
*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|------------|--------------|-----------------|------|------|-------------|------------|-------------|
| BQ20Z40PWR | TSSOP | PW | 20 | 2000 | 346.0 | 346.0 | 33.0 |

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



- 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 not to exceed 0,15.
 D. Falls within JEDEC MO-153

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