

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 Lifetime of the Battery
- Instant Accuracy – No Learning Cycle Required
- Supports the Smart Battery Specification SBS V1.1
- Powerful 8-Bit RISC CPU With Ultra-Low Power Modes
- Works With the TI bq29330 Analog Front-End (AFE) Protection IC to Provide Complete Pack Electronics Solution
- Full Array of Programmable Protection Features
 - Voltage, Current and Temperature
- Fully Integrated High Accurate Clock
- Flexible Configuration for 2 to 4 Series Li-Ion and Li-Polymer Cells
- Integrated Field Programmable FLASH Memory Eliminates the Need for External Configuration Memory
- Smart Battery Charger Control Feature
- Two 16-Bit Delta-Sigma Converter
 - Accurate Voltage and Temperature Measurements
 - Integrating Coloumb Counter for Charge Flow
 - Better Than 0.65 nVh of Resolution
 - Self-Calibrating
- Supports SHA-1 Authentication
- 20-Pin TSSOP (PW)

APPLICATIONS

- Notebook PCs
- Medical and Test Equipment
- Portable Instrumentation

DESCRIPTION

The bq20z70-V110 SBS-compliant gas gauge IC, incorporating patented Impedance Track™ technology, is designed for battery-pack or in-system installation. The bq20z70-V110 measures and maintains an accurate record of available charge in Li-ion or Li-polymer batteries using its integrated high-performance analog peripherals. The bq20z70-V110 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, and minimize 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 remaining capacity to be calculated with discharge rate, temperature, and cell aging all accounted for during each stage of every cycle.

AVAILABLE OPTIONS

| T _A | PACKAGE | |
|------------------|-------------------------------|----------------------------------|
| | 20-PIN TSSOP (PW) Tube | 20-PIN TSSOP (PW) Tape & Reel |
| –40°C to 85°C | bq20z70-V110PW ⁽¹⁾ | bq20z70-V110PWR ⁽²⁾ |

(1) A single tube quantity is 50 units.

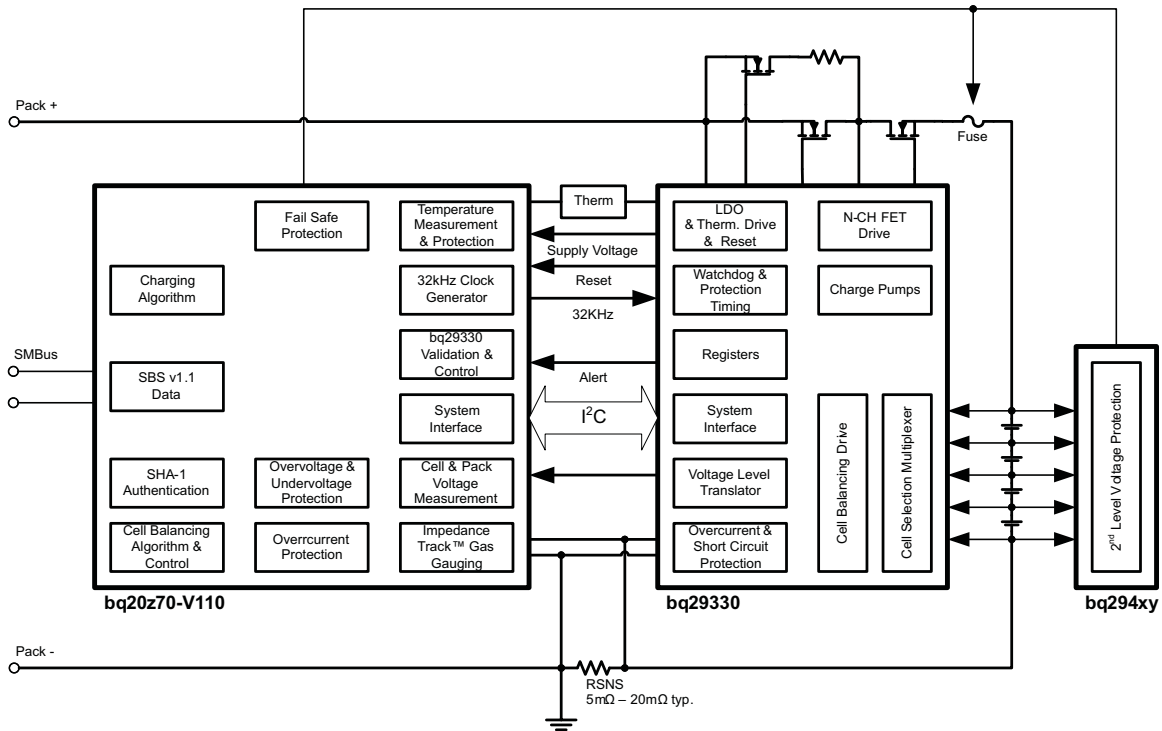
(2) A single reel quantity is 2000 units



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SYSTEM PARTITIONING DIAGRAM



**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 |

TERMINAL FUNCTIONS

| TERMINAL | | I/O ⁽¹⁾ | DESCRIPTION |
|----------|--------|--------------------|-------------------------------------------------------------------------------------------------------------|
| NO. | NAME | | |
| 1 | XALERT | I | Alert interrupt input from bq29330. Connect directly to bq29330 XALERT pin |
| 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 | 32.768kHz output for bq29330 watchdog. Connect directly to bq29330 WDI pin |
| 5 | PRES | I | Active low input to sense system insertion |
| 6 | PFIN | I | Active low input to sense secondary protector output status |
| 7 | SAFE | O | Active high output to enforce additional level of safety, e.g. fuse blow |
| 8 | SMBD | I/OD | SMBus data open drain bidirectional pin used for communication with bq20z70-V110 |
| 9 | NC | – | Not used - leave floating |
| 10 | SMBC | I/OD | SMBus clock open drain bidirectional pin used for communication with bq20z70-V110 |
| 11 | SDATA | I/OD | Data transfer line from and to bq29330. Connect directly to SDATA pin of bq29330 |
| 12 | SCLK | I/OD | Data clock line to bq29330. Connect directly to SCLK pin of bq29330 |
| 13 | VSS | I/OD | VSS |
| 14 | SRP | IA | Connection for a small-value resistor to monitor the battery charge and discharge current flow |
| 15 | SRN | IA | Connection for a small-value 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. Connect directly to XRST pin of bq29330 |
| 17 | VSS | P | Negative supply. Both VSS needs to be connected together |
| 18 | VCC | P | Positive supply |
| 19 | VCELL+ | I | Positive differential cell input. Connect directly to CELL+ pin of bq29330 |
| 20 | VCELL- | I | Negative differential cell input. Connect directly to CELL- pin of bq29330 |

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

ABSOLUTE MAXIMUM RATINGS

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

| | | RANGE |
|---------------------------------------------------------------|--------------------------------------------------------|-----------------------------------|
| V _{CC} relative to V _{SS} ⁽²⁾ | Supply voltage range on VCC pin | –0.3 V to 2.75 V |
| V _(I/O) relative to V _{SS} ⁽²⁾ | XALERT, PFIN, SAFE, SMBD, SMBC, SDATA, SCLK, | –0.3 V to 6.0 V |
| V _I relative to V _{SS} ⁽²⁾ | TS2, TS1, CLKOUT, PRES, SRP, SRN, MRST, VCELL+, VCELL- | –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.

(2) V_{SS} refers to Voltage at VSS pin.

ELECTRICAL CHARACTERISTICS

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

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--------------------|--------------------------------|------------------------|-----|--------------------|-----|------|
| V _{DD} | Supply voltage | VDDA and VDDD | 2.4 | 2.5 | 2.6 | V |
| I _{DD} | Operating mode current | No flash programming | | 400 ⁽¹⁾ | | μA |
| | | bq20z70-V110 + bq29330 | | 475 | | |
| I _(SLP) | Low-power storage mode current | Sleep mode | | 8 ⁽¹⁾ | | μA |
| | | bq20z70-V110 + bq29330 | | 48 | | |

(1) This value does not include the bq29330

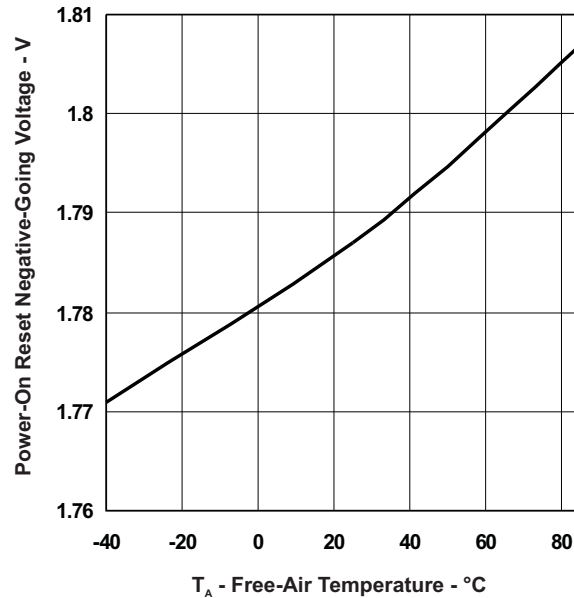
ELECTRICAL CHARACTERISTICS (continued)
 $V_{CC} = 2.4 \text{ V to } 2.6 \text{ V}$, $T_A = -40^\circ\text{C} - 85^\circ\text{C}$ (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-------------|----------------------------------------------------------------------------------------------------------------------|----------------------------|----------------|---------------------|-----|------------------|
| $I_{(SLP)}$ | Shutdown Current | Shutdown Mode | | 0.1 ⁽¹⁾ | | μA |
| | | bq20z70-V110 + bq29330 | | 0.2 | | |
| V_{OL} | Output voltage low CLKOUT, SAFE, SMBD, SMBC, SDATA, SCLK | $I_{OL} = 7 \text{ mA}$ | | | 0.4 | V |
| V_{OH} | Output high voltage CLKOUT, SAFE, SMBD, SMBC, SDATA, SCLK | $I_{OH} = -0.5 \text{ mA}$ | $V_{CC} - 0.5$ | | | V |
| V_{IL} | Input voltage low $\overline{\text{PRES}}$, $\overline{\text{PFIN}}$, SMBD, SMBC, SDATA, $\overline{\text{MRST}}$ | | | | 0.8 | V |
| V_{IH} | Input voltage high $\overline{\text{PRES}}$, $\overline{\text{PFIN}}$, SMBD, SMBC, SDATA, $\overline{\text{MRST}}$ | | 2.0 | | | V |
| C_{IN} | Input capacitance | | | 5 | | pF |
| $V_{(A1)}$ | Input voltage range TS1, TS2, VCELL+, VCELL- | | -0.2 | $0.8 \times V_{CC}$ | | V |
| $V_{(A2)}$ | Input voltage range SRP, SRN | | -0.2 | 0.2 | | |
| $Z_{(A1)}$ | Input impedance TS1, TS2, VCELL+, VCELL - | 0 V – 1 V | | 8 | | $\text{M}\Omega$ |
| $Z_{(A2)}$ | Input impedance SRP, SRN | 0 V – 1 V | | 2.5 | | $\text{M}\Omega$ |

POWER-ON RESET

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

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|----------------------------------------|-----------------|-----|-----|-----|------|
| 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

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

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-------------------------------------------------------------|----------------------------------------------|-------|-------------|-------------|---------------|
| $V_{(SR)}$ Input voltage range, $V_{(SRN)}$ and $V_{(SRP)}$ | $V_{(SR)} = V_{(SRP)} - V_{(SRN)}$ | -0.20 | | 0.20 | V |
| $V_{(SROS)}$ Input offset | $T_A = 25^\circ\text{C to }85^\circ\text{C}$ | | 10 | | μV |
| INL Integral nonlinearity error | | | ± 0.007 | ± 0.037 | % |

OSCILLATOR

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

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|------------------------------------------------|----------------------------------------------|-------|--------|------|---------------|
| HIGH FREQUENCY OSCILLATOR | | | | | |
| $f_{(OSC)}$ Operating frequency | | | 4.194 | | MHz |
| $f_{(EIO)}$ Frequency error ⁽¹⁾⁽²⁾ | | -3% | 0.25% | 3% | |
| | $T_A = 20^\circ\text{C to }70^\circ\text{C}$ | -2% | 0.25% | 2% | |
| $f_{(sxo)}$ 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% | |
| | $T_A = 20^\circ\text{C to }70^\circ\text{C}$ | -1.5% | 0.25% | 1.5% | |
| $f_{(Lsxo)}$ 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 $V_{CC} = 2.5\text{ V}$, $T_A = 25^\circ\text{C}$.

(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 $\pm 3\%$.

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 |
| $I_{(DDPROG)}$ | Flash-write and erase supply current | See ⁽¹⁾ | | 5 | 10 | mA |

(1) Assured by design. Not production tested

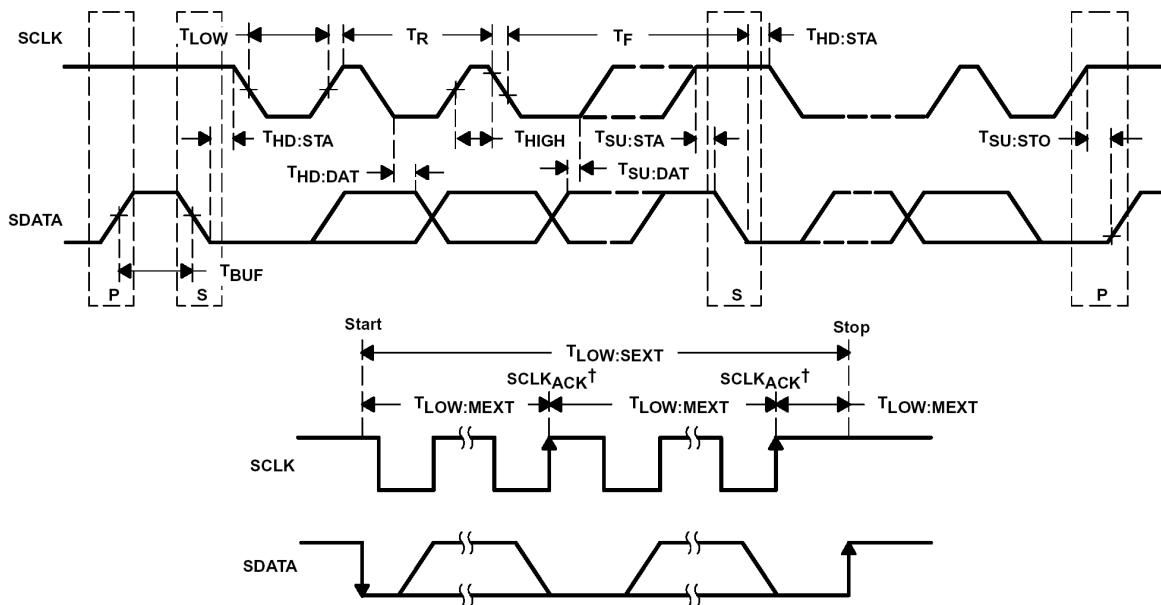
SMBus TIMING SPECIFICATIONS

$V_{CC} = 2.4\text{ V to }2.6\text{ V}$, $T_A = -40^\circ\text{C to }85^\circ\text{C}$ (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 | | | |
| | | 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 | $0.9\text{ VCC to } (V_{ILMAX} - 0.15\text{ V})$ | | | 1000 | |

- (1) The bq20z70-V110 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 bq20z70-V110 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



$^\dagger SCLK_{ACK}$ is the acknowledge-related clock pulse generated by the master.

FEATURE SET

Primary (1st Level) Safety Features

The bq20z70-V110 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 bq20z70-V110 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 over voltage
- Safety over current in Charge and Discharge
- Safety over temperature in Charge and Discharge
- Charge FET and 0 Volt Charge FET fault
- Discharge FET fault
- AFE communication fault

Charge Control Features

The bq20z70-V110 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 bq20z70-V110 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 bq20z70-V110 supports authentication by the host using SHA-1.

Power Modes

The bq20z70-V110 supports 3 different power modes to reduce power consumption:

- In Normal Mode, the bq20z70-V110 performs measurements, calculations, protection decisions and data updates in 1 second intervals. Between these intervals, the bq20z70-V110 is in a reduced power stage.

FEATURE SET (continued)

- In Sleep Mode, the bq20z70-V110 performs measurements, calculations, protection decisions and data update in adjustable time intervals. Between these intervals, the bq20z70-V110 is in a reduced power stage. The bq20z70-V110 has a wake function that enables exit from Sleep mode, when current flow or failure is detected.
- In Shutdown Mode the bq20z70-V110 is completely disabled.

CONFIGURATION

Oscillator Function

The bq20z70-V110 fully integrates the system oscillators. Therefore the bq20z70-V110 requires no external components for this feature.

System Present Operation

The bq20z70-V110 pulls the PU pin high periodically (1 s). Connect this pin to the $\overline{\text{PRES}}$ pin of the bq20z70-V110 via a resistor of approximately 5 k Ω . The bq20z70-V110 measures the $\overline{\text{PRES}}$ input during the PU-active period to determine its state. If $\overline{\text{PRES}}$ input is pulled to ground by external system, the bq20z70-V110 detects this as system present.

BATTERY PARAMETER MEASUREMENTS

The bq20z70-V110 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 SR1 and SR2 pins. The integrating ADC measures bipolar signals from -0.25 V to 0.25 V. The bq20z70-V110 detects charge activity when $V_{\text{SR}} = V_{(\text{SR1})} - V_{(\text{SR2})}$ is positive and discharge activity when $V_{\text{SR}} = V_{(\text{SR1})} - V_{(\text{SR2})}$ is negative. The bq20z70-V110 continuously integrates the signal over time, using an internal counter. The fundamental rate of the counter is 0.65 nVh.

Voltage

The bq20z70-V110 updates the individual series cell voltages through the bq29330 at one second intervals. The bq20z70-V110 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 bq20z70-V110. The internal ADC of the bq20z70-V110 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 bq20z70-V110 uses the SRP and SRN inputs to measure and calculate the battery charge and discharge current using a 5 m Ω to 20 m Ω typ. sense resistor.

Auto Calibration

The bq20z70-V110 provides an auto-calibration feature to cancel the voltage offset error across SRN and SRP for maximum charge measurement accuracy. The bq20z70-V110 performs auto-calibration when the SMBus lines stay low continuously for a minimum of 5 s.

Temperature

The bq20z70-V110 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 bq20z70-V110 can be configured to use internal or external temperature sensors.

FEATURE SET (continued)**COMMUNICATIONS**

The bq20z70-V110 uses SMBus v1.1 with Master Mode and package error checking (PEC) options per the SBS specification.

SMBus On and Off State

The bq20z70-V110 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.

FEATURE SET (continued)
SBS and Dataflash Values
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 | — | mAh or 10mWh |
| 0x02 | R/W | RemainingTimeAlarm | unsigned int | 2 | 0 | 65535 | — | min |
| 0x03 | R/W | BatteryMode | hex | 2 | 0x0000 | 0xffff | — | |
| 0x04 | R/W | AtRate | signed int | 2 | -32768 | 32767 | — | mA or 10mW |
| 0x05 | R | AtRateTimeToFull | unsigned int | 2 | 0 | 65535 | — | min |
| 0x06 | R | AtRateTimeToEmpty | unsigned int | 2 | 0 | 65535 | — | 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 | 20000 | — | 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 | 65535 | — | min |
| 0x12 | R | AverageTimeToEmpty | unsigned int | 2 | 0 | 65535 | — | min |
| 0x13 | R | AverageTimeToFull | unsigned int | 2 | 0 | 65535 | — | min |
| 0x14 | R | ChargingCurrent | unsigned int | 2 | 0 | 65535 | — | mA |
| 0x15 | R | ChargingVoltage | unsigned int | 2 | 0 | 65535 | — | mV |
| 0x16 | R | BatteryStatus | unsigned int | 2 | 0x0000 | 0xffff | — | |
| 0x17 | R/W | CycleCount | unsigned int | 2 | 0 | 65535 | — | |
| 0x18 | R/W | DesignCapacity | unsigned int | 2 | 0 | 65535 | — | mAh or 10mWh |
| 0x19 | R/W | DesignVoltage | unsigned int | 2 | 7000 | 16000 | 14400 | mV |
| 0x1a | R/W | SpecificationInfo | unsigned int | 2 | 0x0000 | 0xffff | 0x0031 | |
| 0x1b | R/W | ManufactureDate | unsigned int | 2 | 0 | 65535 | 0 | |
| 0x1c | R/W | SerialNumber | hex | 2 | 0x0000 | 0xffff | 0x0001 | |
| 0x20 | R/W | ManufacturerName | String | 11+1 | — | — | Texas Instruments | ASCII |
| 0x21 | R/W | DeviceName | String | 7+1 | — | — | bq20z70-V110 | ASCII |
| 0x22 | R/W | DeviceChemistry | String | 4+1 | — | — | LION | ASCII |
| 0x23 | R | ManufacturerData | String | 14+1 | — | — | — | ASCII |
| 0x2f | R/W | Authenticate | String | 20+1 | — | — | — | ASCII |
| 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 | AFEDData | String | 11+1 | — | — | — | ASCII |
| 0x46 | R/W | FETControl | hex | 1 | 0x00 | 0xff | — | |
| 0x4f | R | StateOfHealth | unsigned int | 1 | 0 | 100 | — | % |
| 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 | — | |
| 0x5a | R | PackVoltage | unsigned int | 2 | 0 | 65535 | — | mV |
| 0x5d | R | AverageVoltage | unsigned int | 2 | 0 | 65535 | — | mV |
| 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 | — | |
| 0x70 | R/W | ManufacturerInfo | String | 8+1 | — | — | — | |
| 0x71 | R/W | SenseResistor | unsigned int | 2 | 0 | 65535 | — | $\mu\Omega$ |
| 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 | — | — | — | |

NOTE:

All reserved bits in Data Flash should be written to zero.

Table 3. DATAFLASH VALUES

| Class | Subclass ID | Subclass | Offset | Name | Data Type | Min Value | Max Value | Default Value | Units |
|------------------|-------------|-------------|--------|-----------------------|-----------|-----------|-----------|---------------|-------|
| 1st Level Safety | 0 | Voltage | 0 | COV Threshold | I2 | 3700 | 5000 | 4300 | mV |
| 1st Level Safety | 0 | Voltage | 3 | COV Recovery | I2 | 0 | 4400 | 3900 | mV |
| 1st Level Safety | 0 | Voltage | 12 | CUV Threshold | I2 | 0 | 3500 | 2200 | mV |
| 1st Level Safety | 0 | Voltage | 15 | CUV Recovery | I2 | 0 | 3600 | 3000 | mV |
| 1st Level Safety | 1 | Current | 0 | OC (1st Tier) Chg | I2 | 0 | 20000 | 6000 | mA |
| 1st Level Safety | 1 | Current | 5 | OC (1st Tier) Dsg | I2 | 0 | 20000 | 6000 | mA |
| 1st Level Safety | 1 | Current | 16 | Current Recovery Time | U1 | 0 | 240 | 8 | Sec |
| 1st Level Safety | 1 | Current | 17 | AFE OC Dsg | H1 | 0x00 | 0x1f | 0x12 | |
| 1st Level Safety | 1 | Current | 18 | AFE OC Dsg Time | H1 | 0x00 | 0xff | 0x0f | |
| 1st Level Safety | 1 | Current | 21 | AFE SC Chg Cfg | H1 | 0x00 | 0xff | 0x77 | |
| 1st Level Safety | 1 | Current | 22 | AFE SC Dsg Cfg | H1 | 0x00 | 0xff | 0x77 | |
| 1st Level Safety | 2 | Temperature | 0 | Over Temp Chg | I2 | 0 | 1200 | 550 | 0.1°C |
| 1st Level Safety | 2 | Temperature | 3 | OT Chg Recovery | I2 | 0 | 1200 | 500 | 0.1°C |
| 1st Level Safety | 2 | Temperature | 5 | Over Temp Dsg | I2 | 0 | 1200 | 600 | 0.1°C |

Table 3. DATAFLASH VALUES (continued)

| Class | Subclass ID | Subclass | Offset | Name | Data Type | Min Value | Max Value | Default Value | Units |
|-------------------|-------------|--------------------|--------|-----------------------------|-----------|-----------|-----------|---------------|-------------------------------------------|
| 1st Level Safety | 2 | Temperature | 8 | OT Dsg Recovery | I2 | 0 | 1200 | 550 | 0.1°C |
| 2nd Level Safety | 16 | Voltage | 0 | SOV Threshold | I2 | 0 | 20000 | 18000 | mV |
| 2nd Level Safety | 16 | Voltage | 2 | SOV Time | U1 | 0 | 240 | 0 | Sec |
| 2nd Level Safety | 16 | Voltage | 3 | Cell Imbalance Current | I1 | 0 | 200 | 5 | mA |
| 2nd Level Safety | 16 | Voltage | 4 | Cell Imbalance Fail Voltage | I2 | 0 | 5000 | 1000 | mV |
| 2nd Level Safety | 16 | Voltage | 6 | Cell Imbalance Time | U1 | 0 | 240 | 0 | Sec |
| 2nd Level Safety | 16 | Voltage | 7 | Battery Rest Time | U2 | 0 | 65535 | 1800 | Sec |
| 2nd Level Safety | 16 | Voltage | 9 | PFIN Detect Time | U1 | 0 | 240 | 0 | Sec |
| 2nd Level Safety | 17 | Current | 0 | SOC Chg | I2 | 0 | 30000 | 10000 | mA |
| 2nd Level Safety | 17 | Current | 2 | SOC Chg Time | U1 | 0 | 240 | 0 | Sec |
| 2nd Level Safety | 17 | Current | 3 | SOC Dsg | I2 | 0 | 30000 | 10000 | mA |
| 2nd Level Safety | 17 | Current | 5 | SOC Dsg Time | U1 | 0 | 240 | 0 | Sec |
| 2nd Level Safety | 18 | Temperature | 0 | SOT Chg | I2 | 0 | 1200 | 650 | 0.1°C |
| 2nd Level Safety | 18 | Temperature | 2 | SOT Chg Time | U1 | 0 | 240 | 0 | Sec |
| 2nd Level Safety | 18 | Temperature | 3 | SOT Dsg | I2 | 0 | 1200 | 750 | 0.1°C |
| 2nd Level Safety | 18 | Temperature | 5 | SOT Dsg Time | U1 | 0 | 240 | 0 | Sec |
| 2nd Level Safety | 19 | FET Verification | 2 | FET Fail Time | U1 | 0 | 240 | 0 | Sec |
| 2nd Level Safety | 20 | AFE Verification | 1 | AFE Fail Limit | U1 | 0 | 255 | 10 | |
| Charge Control | 32 | Charge Inhibit Cfg | 0 | Chg Inhibit Temp Low | I2 | -400 | 1200 | 0 | 0.1°C |
| Charge Control | 32 | Charge Inhibit Cfg | 2 | Chg Inhibit Temp High | I2 | -400 | 1200 | 450 | 0.1°C |
| Charge Control | 33 | Pre-Charge Cfg | 0 | Pre-chg Current | I2 | 0 | 2000 | 250 | mA |
| Charge Control | 33 | Pre-Charge Cfg | 2 | Pre-chg Temp | I2 | -400 | 1200 | 120 | 0.1°C |
| Charge Control | 33 | Pre-Charge Cfg | 4 | Pre-chg Voltage | I2 | 0 | 20000 | 3000 | mV |
| Charge Control | 33 | Pre-Charge Cfg | 6 | Recovery Voltage | I2 | 0 | 20000 | 3100 | mV |
| Charge Control | 34 | Fast Charge Cfg | 0 | Fast Charge Current | I2 | 0 | 10000 | 4000 | mA |
| Charge Control | 34 | Fast Charge Cfg | 2 | Charging Voltage | I2 | 0 | 20000 | 16800 | mV |
| Charge Control | 34 | Fast Charge Cfg | 6 | Suspend Low Temp | I2 | -400 | 1200 | -50 | 0.1°C |
| Charge Control | 34 | Fast Charge Cfg | 8 | Suspend High Temp | I2 | -400 | 1200 | 550 | 0.1°C |
| Charge Control | 36 | Termination Cfg. | 2 | Taper Current | I2 | 0 | 1000 | 250 | mA |
| Charge Control | 36 | Termination Cfg. | 6 | Taper Voltage | I2 | 0 | 1000 | 300 | mV |
| Charge Control | 36 | Termination Cfg. | 10 | TCA Clear % | I1 | -1 | 100 | 95 | % |
| Charge Control | 36 | Termination Cfg. | 12 | FC Clear % | I1 | -1 | 100 | 98 | % |
| Charge Control | 37 | Cell Balancing Cfg | 0 | Min Cell Deviation | U2 | 0 | 65535 | 1750 | Sec/mAh |
| Charge Control | 38 | Charging Faults | 13 | Over Charge Capacity | I2 | 0 | 4000 | 300 | mAh |
| Charge Control | 38 | Charging Faults | 21 | Charge Fault Cfg | H1 | 0x00 | 0x02 | 0x00 | |
| SBS Configuration | 48 | Data | 0 | Rem Cap Alarm | I2 | 0 | 700 | 300 | mAh |
| SBS Configuration | 48 | Data | 2 | Rem Energy Alarm | I2 | 0 | 1000 | 432 | 10mWh |
| SBS Configuration | 48 | Data | 4 | Rem Time Alarm | U2 | 0 | 30 | 10 | min |
| SBS Configuration | 48 | Data | 6 | Init Battery Mode | H2 | 0x0000 | 0xffff | 0x0081 | |
| SBS Configuration | 48 | Data | 8 | Design Voltage | I2 | 7000 | 18000 | 14400 | mV |
| SBS Configuration | 48 | Data | 10 | Spec Info | H2 | 0x0000 | 0xffff | 0x0031 | |
| SBS Configuration | 48 | Data | 12 | Manuf Date | U2 | 0 | 65535 | 0 | Day + Mo*32 + (Yr - 1980)*256 |
| SBS Configuration | 48 | Data | 14 | Ser. Num. | H2 | 0x0000 | 0xffff | 0x0001 | |
| SBS Configuration | 48 | Data | 16 | Cycle Count | U2 | 0 | 65535 | 0 | |
| SBS Configuration | 48 | Data | 18 | CC Threshold | I2 | 100 | 32767 | 4400 | mAh |
| SBS Configuration | 48 | Data | 21 | CF MaxError Limit | U1 | 0 | 100 | 100 | % |
| SBS Configuration | 48 | Data | 22 | Design Capacity | I2 | 0 | 65535 | 4400 | mAh |
| SBS Configuration | 48 | Data | 24 | Design Energy | I2 | 0 | 65535 | 6336 | 0.1Wh |

Table 3. DATAFLASH VALUES (continued)

| Class | Subclass ID | Subclass | Offset | Name | Data Type | Min Value | Max Value | Default Value | Units |
|-------------------|-------------|--------------------|--------|-------------------------|-----------|-----------|-----------|------------------------------|---------|
| SBS Configuration | 48 | Data | 26 | Manuf Name | S12 | - | - | Texas Inst. | ASCII |
| SBS Configuration | 48 | Data | 38 | Device Name | S8 | - | - | bq20z70-V110 | ASCII |
| SBS Configuration | 48 | Data | 46 | Device Chemistry | S5 | - | - | LION | ASCII |
| SBS Configuration | 49 | Configuration | 0 | TDA Set % | I1 | -1 | 100 | 6 | % |
| SBS Configuration | 49 | Configuration | 1 | TDA Clear % | I1 | -1 | 100 | 8 | % |
| SBS Configuration | 49 | Configuration | 2 | FD Set % | I1 | -1 | 100 | 2 | % |
| SBS Configuration | 49 | Configuration | 3 | FD Clear % | I1 | -1 | 100 | 5 | % |
| SBS Configuration | 49 | Configuration | 4 | TDA Set Volt Threshold | I2 | 0 | 16800 | 5000 | mV |
| SBS Configuration | 49 | Configuration | 6 | TDA Set Volt Time | U1 | 0 | 240 | 0 | Sec |
| SBS Configuration | 49 | Configuration | 7 | TDA Clear Volt | I2 | 0 | 16800 | 5500 | mV |
| System Data | 58 | Manufacturer Info | 0 | Manuf. Info | S9 | | | 01234567 89abcdef0 123 | ASCII |
| Configuration | 64 | Registers | 0 | Operation Cfg A | H2 | 0x0000 | 0x033b | 0x033b | |
| Configuration | 64 | Registers | 2 | Operation Cfg B | H2 | 0x0000 | 0x3eff | 0x2440 | |
| Configuration | 64 | Registers | 4 | Operation Cfg C | H2 | 0x0000 | 0x0001 | 0x0000 | |
| Configuration | 64 | Registers | 6 | Permanent Fail Cfg | H2 | 0x0000 | 0x4dff | 0x0000 | |
| Configuration | 64 | Registers | 8 | Non-Removable Cfg | H2 | 0x0000 | 0x3027 | 0x0000 | |
| Power | 68 | Power | 0 | Flash Update OK Voltage | I2 | 6000 | 20000 | 7500 | mV |
| Power | 68 | Power | 2 | Shutdown Voltage | I2 | 5000 | 20000 | 7000 | mV |
| Power | 68 | Power | 5 | Charger Present | I2 | 0 | 23000 | 3000 | mV |
| Power | 68 | Power | 16 | Wake Current Reg | H1 | 0x00 | 0xff | 0x00 | |
| Gas Gauging | 80 | IT Cfg | 0 | Load Select | U1 | 0 | 255 | 3 | |
| Gas Gauging | 80 | IT Cfg | 1 | Load Mode | U1 | 0 | 255 | 0 | |
| Gas Gauging | 80 | IT Cfg | 45 | Term Voltage | I2 | -32768 | 32767 | 12000 | mV |
| Gas Gauging | 80 | IT Cfg | 60 | User Rate-mA | I2 | -9000 | -2000 | 0 | mA |
| Gas Gauging | 80 | IT Cfg | 62 | User Rate-mW | I2 | -14000 | -3000 | 0 | 0.1W |
| Gas Gauging | 80 | IT Cfg | 64 | Reserve Cap-mAh | I2 | 0 | 9000 | 0 | mAh |
| Gas Gauging | 80 | IT Cfg | 66 | Reserve Cap-mWh | I2 | 0 | 14000 | 0 | 0.1Wh |
| Gas Gauging | 81 | Current Thresholds | 0 | Dsg Current Threshold | I2 | 0 | 2000 | 50 | mA |
| Gas Gauging | 81 | Current Thresholds | 2 | Chg Current Threshold | I2 | 0 | 2000 | 25 | mA |
| Gas Gauging | 81 | Current Thresholds | 4 | Quit Current | I2 | 0 | 1000 | 10 | mA |
| Gas Gauging | 82 | State | 0 | Qmax Cell0 | I2 | 0 | 65535 | 4400 | mAh |
| Gas Gauging | 82 | State | 2 | Qmax Cell1 | I2 | 0 | 65535 | 4400 | mAh |
| Gas Gauging | 82 | State | 4 | Qmax Cell2 | I2 | 0 | 65535 | 4400 | mAh |
| Gas Gauging | 82 | State | 6 | Qmax Cell3 | I2 | 0 | 65535 | 4400 | mAh |
| Gas Gauging | 82 | State | 8 | Qmax Pack | I2 | 0 | 65535 | 4400 | mAh |
| Gas Gauging | 82 | State | 12 | Update Status | H1 | 0x00 | 0x03 | 0x00 | |
| Gas Gauging | 82 | State | 25 | Delta Voltage | I2 | -32768 | 32767 | 0 | mV |
| Ra Table | 88 | R_a0 | 0 | Cell0 R_a flag | H2 | 0x0000 | 0xffff | 0xff55 | |
| Ra Table | 88 | R_a0 | 2 | Cell0 R_a 0 | I2 | 0 | 32767 | 160 | 2~10ohm |
| Ra Table | 88 | R_a0 | 4 | Cell0 R_a 1 | I2 | 0 | 32767 | 166 | 2~10ohm |
| Ra Table | 88 | R_a0 | 6 | Cell0 R_a 2 | I2 | 0 | 32767 | 153 | 2~10ohm |
| Ra Table | 88 | R_a0 | 8 | Cell0 R_a 3 | I2 | 0 | 32767 | 151 | 2~10ohm |
| Ra Table | 88 | R_a0 | 10 | Cell0 R_a 4 | I2 | 0 | 32767 | 145 | 2~10ohm |
| Ra Table | 88 | R_a0 | 12 | Cell0 R_a 5 | I2 | 0 | 32767 | 152 | 2~10ohm |
| Ra Table | 88 | R_a0 | 14 | Cell0 R_a 6 | I2 | 0 | 32767 | 176 | 2~10ohm |
| Ra Table | 88 | R_a0 | 16 | Cell0 R_a 7 | I2 | 0 | 32767 | 204 | 2~10ohm |

Table 3. DATAFLASH VALUES (continued)

| Class | Subclass ID | Subclass | Offset | Name | Data Type | Min Value | Max Value | Default Value | Units |
|----------|-------------|----------|--------|----------------|-----------|-----------|-----------|---------------|----------------------|
| Ra Table | 88 | R_a0 | 18 | Cell0 R_a 8 | I2 | 0 | 32767 | 222 | 2 [~] 10ohm |
| Ra Table | 88 | R_a0 | 20 | Cell0 R_a 9 | I2 | 0 | 32767 | 254 | 2 [~] 10ohm |
| Ra Table | 88 | R_a0 | 22 | Cell0 R_a 10 | I2 | 0 | 32767 | 315 | 2 [~] 10ohm |
| Ra Table | 88 | R_a0 | 24 | Cell0 R_a 11 | I2 | 0 | 32767 | 437 | 2 [~] 10ohm |
| Ra Table | 88 | R_a0 | 26 | Cell0 R_a 12 | I2 | 0 | 32767 | 651 | 2 [~] 10ohm |
| Ra Table | 88 | R_a0 | 28 | Cell0 R_a 13 | I2 | 0 | 32767 | 1001 | 2 [~] 10ohm |
| Ra Table | 88 | R_a0 | 30 | Cell0 R_a 14 | I2 | 0 | 32767 | 1458 | 2 [~] 10ohm |
| Ra Table | 89 | R_a1 | 0 | Cell1 R_a flag | H2 | 0x0000 | 0xffff | 0xff55 | |
| Ra Table | 89 | R_a1 | 2 | Cell1 R_a 0 | I2 | 0 | 32767 | 160 | 2 [~] 10ohm |
| Ra Table | 89 | R_a1 | 4 | Cell1 R_a 1 | I2 | 0 | 32767 | 166 | 2 [~] 10ohm |
| Ra Table | 89 | R_a1 | 6 | Cell1 R_a 2 | I2 | 0 | 32767 | 153 | 2 [~] 10ohm |
| Ra Table | 89 | R_a1 | 8 | Cell1 R_a 3 | I2 | 0 | 32767 | 151 | 2 [~] 10ohm |
| Ra Table | 89 | R_a1 | 10 | Cell1 R_a 4 | I2 | 0 | 32767 | 145 | 2 [~] 10ohm |
| Ra Table | 89 | R_a1 | 12 | Cell1 R_a 5 | I2 | 0 | 32767 | 152 | 2 [~] 10ohm |
| Ra Table | 89 | R_a1 | 14 | Cell1 R_a 6 | I2 | 0 | 32767 | 176 | 2 [~] 10ohm |
| Ra Table | 89 | R_a1 | 16 | Cell1 R_a 7 | I2 | 0 | 32767 | 204 | 2 [~] 10ohm |
| Ra Table | 89 | R_a1 | 18 | Cell1 R_a 8 | I2 | 0 | 32767 | 222 | 2 [~] 10ohm |
| Ra Table | 89 | R_a1 | 20 | Cell1 R_a 9 | I2 | 0 | 32767 | 254 | 2 [~] 10ohm |
| Ra Table | 89 | R_a1 | 22 | Cell1 R_a 10 | I2 | 0 | 32767 | 315 | 2 [~] 10ohm |
| Ra Table | 89 | R_a1 | 24 | Cell1 R_a 11 | I2 | 0 | 32767 | 437 | 2 [~] 10ohm |
| Ra Table | 89 | R_a1 | 26 | Cell1 R_a 12 | I2 | 0 | 32767 | 651 | 2 [~] 10ohm |
| Ra Table | 89 | R_a1 | 28 | Cell1 R_a 13 | I2 | 0 | 32767 | 1001 | 2 [~] 10ohm |
| Ra Table | 89 | R_a1 | 30 | Cell1 R_a 14 | I2 | 0 | 32767 | 1458 | 2 [~] 10ohm |
| Ra Table | 90 | R_a2 | 0 | Cell2 R_a flag | H2 | 0x0000 | 0xffff | 0xff55 | |
| Ra Table | 90 | R_a2 | 2 | Cell2 R_a 0 | I2 | 0 | 32767 | 160 | 2 [~] 10ohm |
| Ra Table | 90 | R_a2 | 4 | Cell2 R_a 1 | I2 | 0 | 32767 | 166 | 2 [~] 10ohm |
| Ra Table | 90 | R_a2 | 6 | Cell2 R_a 2 | I2 | 0 | 32767 | 153 | 2 [~] 10ohm |
| Ra Table | 90 | R_a2 | 8 | Cell2 R_a 3 | I2 | 0 | 32767 | 151 | 2 [~] 10ohm |
| Ra Table | 90 | R_a2 | 10 | Cell2 R_a 4 | I2 | 0 | 32767 | 145 | 2 [~] 10ohm |
| Ra Table | 90 | R_a2 | 12 | Cell2 R_a 5 | I2 | 0 | 32767 | 152 | 2 [~] 10ohm |
| Ra Table | 90 | R_a2 | 14 | Cell2 R_a 6 | I2 | 0 | 32767 | 176 | 2 [~] 10ohm |
| Ra Table | 90 | R_a2 | 16 | Cell2 R_a 7 | I2 | 0 | 32767 | 204 | 2 [~] 10ohm |
| Ra Table | 90 | R_a2 | 18 | Cell2 R_a 8 | I2 | 0 | 32767 | 222 | 2 [~] 10ohm |
| Ra Table | 90 | R_a2 | 20 | Cell2 R_a 9 | I2 | 0 | 32767 | 254 | 2 [~] 10ohm |
| Ra Table | 90 | R_a2 | 22 | Cell2 R_a 10 | I2 | 0 | 32767 | 315 | 2 [~] 10ohm |
| Ra Table | 90 | R_a2 | 24 | Cell2 R_a 11 | I2 | 0 | 32767 | 437 | 2 [~] 10ohm |
| Ra Table | 90 | R_a2 | 26 | Cell2 R_a 12 | I2 | 0 | 32767 | 651 | 2 [~] 10ohm |
| Ra Table | 90 | R_a2 | 28 | Cell2 R_a 13 | I2 | 0 | 32767 | 1001 | 2 [~] 10ohm |
| Ra Table | 90 | R_a2 | 30 | Cell2 R_a 14 | I2 | 0 | 32767 | 1458 | 2 [~] 10ohm |
| Ra Table | 91 | R_a3 | 0 | Cell3 R_a flag | H2 | 0x0000 | 0xffff | 0xff55 | |
| Ra Table | 91 | R_a3 | 2 | Cell3 R_a 0 | I2 | 0 | 32767 | 160 | 2 [~] 10ohm |
| Ra Table | 91 | R_a3 | 4 | Cell3 R_a 1 | I2 | 0 | 32767 | 166 | 2 [~] 10ohm |
| Ra Table | 91 | R_a3 | 6 | Cell3 R_a 2 | I2 | 0 | 32767 | 153 | 2 [~] 10ohm |
| Ra Table | 91 | R_a3 | 8 | Cell3 R_a 3 | I2 | 0 | 32767 | 151 | 2 [~] 10ohm |
| Ra Table | 91 | R_a3 | 10 | Cell3 R_a 4 | I2 | 0 | 32767 | 145 | 2 [~] 10ohm |
| Ra Table | 91 | R_a3 | 12 | Cell3 R_a 5 | I2 | 0 | 32767 | 152 | 2 [~] 10ohm |
| Ra Table | 91 | R_a3 | 14 | Cell3 R_a 6 | I2 | 0 | 32767 | 176 | 2 [~] 10ohm |
| Ra Table | 91 | R_a3 | 16 | Cell3 R_a 7 | I2 | 0 | 32767 | 204 | 2 [~] 10ohm |
| Ra Table | 91 | R_a3 | 18 | Cell3 R_a 8 | I2 | 0 | 32767 | 222 | 2 [~] 10ohm |
| Ra Table | 91 | R_a3 | 20 | Cell3 R_a 9 | I2 | 0 | 32767 | 254 | 2 [~] 10ohm |

Table 3. DATAFLASH VALUES (continued)

| Class | Subclass ID | Subclass | Offset | Name | Data Type | Min Value | Max Value | Default Value | Units |
|----------|-------------|----------|--------|-----------------|-----------|-----------|-----------|---------------|----------------------|
| Ra Table | 91 | R_a3 | 22 | Cell3 R_a 10 | I2 | 0 | 32767 | 315 | 2 [~] 10ohm |
| Ra Table | 91 | R_a3 | 24 | Cell3 R_a 11 | I2 | 0 | 32767 | 437 | 2 [~] 10ohm |
| Ra Table | 91 | R_a3 | 26 | Cell3 R_a 12 | I2 | 0 | 32767 | 651 | 2 [~] 10ohm |
| Ra Table | 91 | R_a3 | 28 | Cell3 R_a 13 | I2 | 0 | 32767 | 1001 | 2 [~] 10ohm |
| Ra Table | 91 | R_a3 | 30 | Cell3 R_a 14 | I2 | 0 | 32767 | 1458 | 2 [~] 10ohm |
| Ra Table | 92 | R_a0x | 0 | xCell0 R_a flag | H2 | 0x0000 | 0xffff | 0xffff | |
| Ra Table | 92 | R_a0x | 2 | xCell0 R_a 0 | I2 | 0 | 32767 | 160 | 2 [~] 10ohm |
| Ra Table | 92 | R_a0x | 4 | xCell0 R_a 1 | I2 | 0 | 32767 | 166 | 2 [~] 10ohm |
| Ra Table | 92 | R_a0x | 6 | xCell0 R_a 2 | I2 | 0 | 32767 | 153 | 2 [~] 10ohm |
| Ra Table | 92 | R_a0x | 8 | xCell0 R_a 3 | I2 | 0 | 32767 | 151 | 2 [~] 10ohm |
| Ra Table | 92 | R_a0x | 10 | xCell0 R_a 4 | I2 | 0 | 32767 | 145 | 2 [~] 10ohm |
| Ra Table | 92 | R_a0x | 12 | xCell0 R_a 5 | I2 | 0 | 32767 | 152 | 2 [~] 10ohm |
| Ra Table | 92 | R_a0x | 14 | xCell0 R_a 6 | I2 | 0 | 32767 | 176 | 2 [~] 10ohm |
| Ra Table | 92 | R_a0x | 16 | xCell0 R_a 7 | I2 | 0 | 32767 | 204 | 2 [~] 10ohm |
| Ra Table | 92 | R_a0x | 18 | xCell0 R_a 8 | I2 | 0 | 32767 | 222 | 2 [~] 10ohm |
| Ra Table | 92 | R_a0x | 20 | xCell0 R_a 9 | I2 | 0 | 32767 | 254 | 2 [~] 10ohm |
| Ra Table | 92 | R_a0x | 22 | xCell0 R_a 10 | I2 | 0 | 32767 | 315 | 2 [~] 10ohm |
| Ra Table | 92 | R_a0x | 24 | xCell0 R_a 11 | I2 | 0 | 32767 | 437 | 2 [~] 10ohm |
| Ra Table | 92 | R_a0x | 26 | xCell0 R_a 12 | I2 | 0 | 32767 | 651 | 2 [~] 10ohm |
| Ra Table | 92 | R_a0x | 28 | xCell0 R_a 13 | I2 | 0 | 32767 | 1001 | 2 [~] 10ohm |
| Ra Table | 92 | R_a0x | 30 | xCell0 R_a 14 | I2 | 0 | 32767 | 1458 | 2 [~] 10ohm |
| Ra Table | 93 | R_a1x | 0 | xCell1 R_a flag | H2 | 0x0000 | 0xffff | 0xffff | |
| Ra Table | 93 | R_a1x | 2 | xCell1 R_a 0 | I2 | 0 | 32767 | 160 | 2 [~] 10ohm |
| Ra Table | 93 | R_a1x | 4 | xCell1 R_a 1 | I2 | 0 | 32767 | 166 | 2 [~] 10ohm |
| Ra Table | 93 | R_a1x | 6 | xCell1 R_a 2 | I2 | 0 | 32767 | 153 | 2 [~] 10ohm |
| Ra Table | 93 | R_a1x | 8 | xCell1 R_a 3 | I2 | 0 | 32767 | 151 | 2 [~] 10ohm |
| Ra Table | 93 | R_a1x | 10 | xCell1 R_a 4 | I2 | 0 | 32767 | 145 | 2 [~] 10ohm |
| Ra Table | 93 | R_a1x | 12 | xCell1 R_a 5 | I2 | 0 | 32767 | 152 | 2 [~] 10ohm |
| Ra Table | 93 | R_a1x | 14 | xCell1 R_a 6 | I2 | 0 | 32767 | 176 | 2 [~] 10ohm |
| Ra Table | 93 | R_a1x | 16 | xCell1 R_a 7 | I2 | 0 | 32767 | 204 | 2 [~] 10ohm |
| Ra Table | 93 | R_a1x | 18 | xCell1 R_a 8 | I2 | 0 | 32767 | 222 | 2 [~] 10ohm |
| Ra Table | 93 | R_a1x | 20 | xCell1 R_a 9 | I2 | 0 | 32767 | 254 | 2 [~] 10ohm |
| Ra Table | 93 | R_a1x | 22 | xCell1 R_a 10 | I2 | 0 | 32767 | 315 | 2 [~] 10ohm |
| Ra Table | 93 | R_a1x | 24 | xCell1 R_a 11 | I2 | 0 | 32767 | 437 | 2 [~] 10ohm |
| Ra Table | 93 | R_a1x | 26 | xCell1 R_a 12 | I2 | 0 | 32767 | 651 | 2 [~] 10ohm |
| Ra Table | 93 | R_a1x | 28 | xCell1 R_a 13 | I2 | 0 | 32767 | 1001 | 2 [~] 10ohm |
| Ra Table | 93 | R_a1x | 30 | xCell1 R_a 14 | I2 | 0 | 32767 | 1458 | 2 [~] 10ohm |
| Ra Table | 94 | R_a2x | 0 | xCell2 R_a flag | H2 | 0x0000 | 0xffff | 0xffff | |
| Ra Table | 94 | R_a2x | 2 | xCell2 R_a 0 | I2 | 0 | 32767 | 160 | 2 [~] 10ohm |
| Ra Table | 94 | R_a2x | 4 | xCell2 R_a 1 | I2 | 0 | 32767 | 166 | 2 [~] 10ohm |
| Ra Table | 94 | R_a2x | 6 | xCell2 R_a 2 | I2 | 0 | 32767 | 153 | 2 [~] 10ohm |
| Ra Table | 94 | R_a2x | 8 | xCell2 R_a 3 | I2 | 0 | 32767 | 151 | 2 [~] 10ohm |
| Ra Table | 94 | R_a2x | 10 | xCell2 R_a 4 | I2 | 0 | 32767 | 145 | 2 [~] 10ohm |
| Ra Table | 94 | R_a2x | 12 | xCell2 R_a 5 | I2 | 0 | 32767 | 152 | 2 [~] 10ohm |
| Ra Table | 94 | R_a2x | 14 | xCell2 R_a 6 | I2 | 0 | 32767 | 176 | 2 [~] 10ohm |
| Ra Table | 94 | R_a2x | 16 | xCell2 R_a 7 | I2 | 0 | 32767 | 204 | 2 [~] 10ohm |
| Ra Table | 94 | R_a2x | 18 | xCell2 R_a 8 | I2 | 0 | 32767 | 222 | 2 [~] 10ohm |
| Ra Table | 94 | R_a2x | 20 | xCell2 R_a 9 | I2 | 0 | 32767 | 254 | 2 [~] 10ohm |
| Ra Table | 94 | R_a2x | 22 | xCell2 R_a 10 | I2 | 0 | 32767 | 315 | 2 [~] 10ohm |
| Ra Table | 94 | R_a2x | 24 | xCell2 R_a 11 | I2 | 0 | 32767 | 437 | 2 [~] 10ohm |

Table 3. DATAFLASH VALUES (continued)

| Class | Subclass ID | Subclass | Offset | Name | Data Type | Min Value | Max Value | Default Value | Units |
|-------------|-------------|--------------------|--------|------------------|-----------|-----------|-----------|---------------|----------------------|
| Ra Table | 94 | R_a2x | 26 | xCell2 R_a 12 | I2 | 0 | 32767 | 651 | 2 [~] 10ohm |
| Ra Table | 94 | R_a2x | 28 | xCell2 R_a 13 | I2 | 0 | 32767 | 1001 | 2 [~] 10ohm |
| Ra Table | 94 | R_a2x | 30 | xCell2 R_a 14 | I2 | 0 | 32767 | 1458 | 2 [~] 10ohm |
| Ra Table | 95 | R_a3x | 0 | xCell3 R_a flag | H2 | 0x0000 | 0xffff | 0xffff | |
| Ra Table | 95 | R_a3x | 2 | xCell3 R_a 0 | I2 | 0 | 32767 | 160 | 2 [~] 10ohm |
| Ra Table | 95 | R_a3x | 4 | xCell3 R_a 1 | I2 | 0 | 32767 | 166 | 2 [~] 10ohm |
| Ra Table | 95 | R_a3x | 6 | xCell3 R_a 2 | I2 | 0 | 32767 | 153 | 2 [~] 10ohm |
| Ra Table | 95 | R_a3x | 8 | xCell3 R_a 3 | I2 | 0 | 32767 | 151 | 2 [~] 10ohm |
| Ra Table | 95 | R_a3x | 10 | xCell3 R_a 4 | I2 | 0 | 32767 | 145 | 2 [~] 10ohm |
| Ra Table | 95 | R_a3x | 12 | xCell3 R_a 5 | I2 | 0 | 32767 | 152 | 2 [~] 10ohm |
| Ra Table | 95 | R_a3x | 14 | xCell3 R_a 6 | I2 | 0 | 32767 | 176 | 2 [~] 10ohm |
| Ra Table | 95 | R_a3x | 16 | xCell3 R_a 7 | I2 | 0 | 32767 | 204 | 2 [~] 10ohm |
| Ra Table | 95 | R_a3x | 18 | xCell3 R_a 8 | I2 | 0 | 32767 | 222 | 2 [~] 10ohm |
| Ra Table | 95 | R_a3x | 20 | xCell3 R_a 9 | I2 | 0 | 32767 | 254 | 2 [~] 10ohm |
| Ra Table | 95 | R_a3x | 22 | xCell3 R_a 10 | I2 | 0 | 32767 | 315 | 2 [~] 10ohm |
| Ra Table | 95 | R_a3x | 24 | xCell3 R_a 11 | I2 | 0 | 32767 | 437 | 2 [~] 10ohm |
| Ra Table | 95 | R_a3x | 26 | xCell3 R_a 12 | I2 | 0 | 32767 | 651 | 2 [~] 10ohm |
| Ra Table | 95 | R_a3x | 28 | xCell3 R_a 13 | I2 | 0 | 32767 | 1001 | 2 [~] 10ohm |
| Ra Table | 95 | R_a3x | 30 | xCell3 R_a 14 | I2 | 0 | 32767 | 1458 | 2 [~] 10ohm |
| PF Status | 96 | Device Status Data | 0 | PF Flags 1 | H2 | 0x0000 | 0x4dff | 0x0000 | |
| PF Status | 96 | Device Status Data | 28 | PF Flags 2 | H2 | 0x0000 | 0x0dff | 0x0000 | |
| Calibration | 104 | Data | 0 | CC Gain | F4 | 0.1 | 4 | 0.9419 | |
| Calibration | 104 | Data | 4 | CC Delta | F4 | 29826 | 1193046 | 280932.625 | |
| Calibration | 104 | Data | 8 | Ref Voltage | I2 | 0 | 65536 | 24500 | 50uV |
| Calibration | 104 | Data | 12 | AFE Pack Gain | I2 | 0 | 65536 | 22050 | μV/cnt |
| Calibration | 104 | Data | 14 | CC Offset | I2 | -32768 | 32767 | -1667 | |
| Calibration | 104 | Data | 16 | Board Offset | I2 | -32768 | 32767 | 0 | |
| Calibration | 104 | Data | 18 | Int Temp Offset | I1 | -128 | 127 | 0 | |
| Calibration | 104 | Data | 19 | Ext1 Temp Offset | I1 | -128 | 127 | 0 | |
| Calibration | 104 | Data | 20 | Ext2 Temp Offset | I1 | -128 | 127 | 0 | |
| Calibration | 105 | Config | 0 | CC Current | I2 | 0 | 65535 | 3000 | mA |
| Calibration | 105 | Config | 2 | Voltage Signal | I2 | 0 | 65535 | 16800 | mV |
| Calibration | 105 | Config | 4 | Temp Signal | I2 | 0 | 65535 | 2980 | 0.1K |
| Calibration | 105 | Config | 6 | CC Offset Time | U2 | 0 | 65535 | 250 | mSec |
| Calibration | 105 | Config | 8 | ADC Offset Time | U2 | 0 | 65535 | 32 | mSec |
| Calibration | 105 | Config | 10 | CC Gain Time | U2 | 0 | 65535 | 250 | mSec |
| Calibration | 105 | Config | 12 | Voltage Time | U2 | 0 | 65535 | 1984 | mSec |
| Calibration | 105 | Config | 14 | Temperature Time | U2 | 0 | 65535 | 32 | mSec |
| Calibration | 105 | Config | 17 | Cal Mode Timeout | U2 | 0 | 65535 | 38400 | Sec/128 |
| Calibration | 106 | Temp Model | 0 | Ext Coef 1 | I2 | -32768 | 32767 | -28285 | Sec |
| Calibration | 106 | Temp Model | 2 | Ext Coef 2 | I2 | -32768 | 32767 | 20848 | Sec |
| Calibration | 106 | Temp Model | 4 | Ext Coef 3 | I2 | -32768 | 32767 | -7537 | Sec |
| Calibration | 106 | Temp Model | 6 | Ext Coef 4 | I2 | -32768 | 32767 | 4012 | Sec |
| Calibration | 106 | Temp Model | 8 | Ext Min AD | I2 | -32768 | 32767 | 0 | Sec |
| Calibration | 106 | Temp Model | 10 | Ext Max Temp | I2 | -32768 | 32767 | 4012 | Sec |
| Calibration | 106 | Temp Model | 12 | Int Coef 1 | I2 | -32768 | 32767 | 0 | Sec |
| Calibration | 106 | Temp Model | 14 | Int Coef 2 | I2 | -32768 | 32767 | 0 | Sec |
| Calibration | 106 | Temp Model | 16 | Int Coef 3 | I2 | -32768 | 32767 | -11136 | Sec |

Table 3. DATAFLASH VALUES (continued)

| Class | Subclass ID | Subclass | Offset | Name | Data Type | Min Value | Max Value | Default Value | Units |
|-------------|-------------|------------|--------|--------------|-----------|-----------|-----------|---------------|--------|
| Calibration | 106 | Temp Model | 18 | Int Coef 4 | I2 | -32768 | 32767 | 5754 | Sec |
| Calibration | 106 | Temp Model | 20 | Int Min AD | I2 | -32768 | 32767 | 0 | Sec |
| Calibration | 106 | Temp Model | 22 | Int Max Temp | I2 | -32768 | 32767 | 5754 | Sec |
| Calibration | 107 | Current | 0 | Filter | U1 | 0 | 255 | 239 | |
| Calibration | 107 | Current | 1 | Deadband | U1 | 0 | 255 | 3 | mA |
| Calibration | 107 | Current | 2 | CC Deadband | U1 | 0 | 255 | 34 | 294 nV |

Application Schematic

The application schematic is on the following page.

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|-------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| BQ20Z70PW-V110 | NRND | TSSOP | PW | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| BQ20Z70PW-V110G4 | NRND | TSSOP | PW | 20 | 70 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| BQ20Z70PWR-V110 | NRND | TSSOP | PW | 20 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| BQ20Z70PWR-V110G4 | NRND | 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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MECHANICAL DATA

PW (R-PDSO-G20)

PLASTIC SMALL OUTLINE



4040064-5/G 02/11

- 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. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
 - E. Falls within JEDEC MO-153

PW (R-PDSO-G20)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate design.
 - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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