

## SBS 1.1-COMPLIANT GAS GAUGE ENABLED WITH IMPEDANCE TRACK™ TECHNOLOGY FOR USE WITH THE bq29312A

### FEATURES

- 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
- Works With the TI bq29312A Analog Front-End (AFE) Protection IC to Provide Complete Pack Electronics Solution
- Full Array of Programmable Voltage, Current, and Temperature Protection Features
- Integrated Time Base Removes Need for External Crystal with Optional Crystal Input
- Electronics for 7.2-V, 10.8-V or 14.4-V Battery Packs With Few External Components
- Based on a Powerful Low-Power RISC CPU Core With High-Performance Peripherals
- Integrated Field Programmable FLASH Memory Eliminates the Need for External Configuration Memory
- Measures Charge Flow Using a High-Resolution, 16-Bit Integrating Delta-Sigma Converter
  - Better Than 0.65 nVh of Resolution
  - Self-Calibrating
  - Offset Error Less Than 1  $\mu$ V
- Uses 16-Bit Delta-Sigma Converter for Accurate Voltage and Temperature Measurements
- Extensive Data Reporting Options For Improved System Interaction

- Optional Pulse Charging Feature for Improved Charge Times
- Drives 3-, 4- or 5-Segment LED Display for Remaining Capacity Indication
- Supports SHA-1 Authentication
- Lifetime Data Logging
- 38-Pin TSSOP (DBT)

### APPLICATIONS

- Notebook PCs
- Medical and Test Equipment
- Portable Instrumentation

### DESCRIPTION

The bq20z80 SBS-compliant gas gauge IC, incorporating patented Impedance Track™ technology, is designed for battery-pack or in-system installation. The bq20z80 measures and maintains an accurate record of available charge in Li-ion or Li-polymer batteries using its integrated high-performance analog peripherals. The bq20z80 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 bq29312A 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

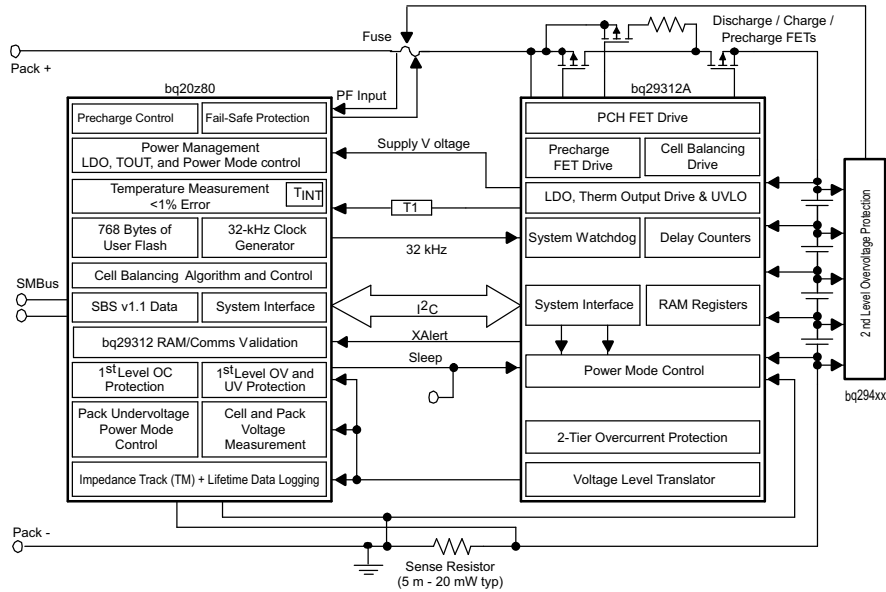
T <sub>A</sub>	PACKAGE	
	38-PIN TSSOP (DBT) Tube	38-PIN TSSOP (DBT) Tape & Reel
-40°C to 85°C	bq20z80DBT-V102 <sup>(1)</sup>	bq20z80DBTR-V102 <sup>(2)</sup>

(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.

**SYSTEM PARTITIONING DIAGRAM**



**TSSOP (DBT)  
(TOP VIEW)**

VIN	1	38	VSSD
TS1	2	37	NC
TS2	3	36	NC
PU	4	35	CLKOUT
PRES	5	34	XCK1 / VSSA
SCLK	6	33	XCK2 / ROSC
SAFE	7	32	FILT
VDDD	8	31	VDDA
RBI	9	30	VSSA
SDATA	10	29	VSSA
VSSD	11	28	SR1
SAFE	12	27	SR2
NC	13	26	MRST
NC	14	25	XALERT
SMBC	15	24	LED1
SMBD	16	23	LED2
DISP	17	22	LED3
PFIN	18	21	LED4
VSSD	19	20	LED5

NC - No internal connection

**TERMINAL FUNCTIONS**

TERMINAL		I/O <sup>(1)</sup>	DESCRIPTION
NO.	NAME		
1	VIN	I	Voltage measurement input from the AFE
2	TS1	I	1 <sup>st</sup> Thermistor voltage input connection to monitor temperature
3	TS2	I	2 <sup>nd</sup> Thermistor voltage input connection to monitor temperature
4	PU	O	Output to pull up the $\overline{\text{PRES}}$ pin for system detection
5	$\overline{\text{PRES}}$	I	Active low input to sense system insertion and typically requires additional ESD protection
6	SCLK	I/OD	Communication clock to the AFE
7	SAFE	O	Active high output to enforce additional level of safety protection; e.g., fuse blow. (Inverse of pin 12)
8	VDDD	P	Positive supply for digital circuitry and I/O pins
9	RBI	P	Backup power to the bq20z80 data registers during periods of low operating voltage. RBI accepts a storage capacitor or a battery input.
10	SDATA	I/O	Data transfer to and from the AFE
12	$\overline{\text{SAFE}}$	O	Active low output to enforce additional level of safety protection; e.g., fuse blow. (Inverse of pin 7)
13	NC	–	Not used— leave floating
14	NC	–	Not used— leave floating
15	SMBC	I/OD	SMBus clock open-drain bidirectional pin used to clock the data transfer to and from the bq20z80
16	SMBD	I/OD	SMBus data open-drain bidirectional pin used to transfer address and data to and from the bq20z80
17	$\overline{\text{DISP}}$	I	Display control for the LEDs. This pin is typically connected to bq29312A REG via a 100-k $\Omega$ resistor and a push-button switch to VSSD.
18	PFIN	I	Active low input to detect secondary protector output status and allows the bq20z80 to report the status of the 2 <sup>nd</sup> level protection output
20	LED5	O	LED5 display segment that drives an external LED depending on the firmware configuration
21	LED4	O	LED4 display segment that drives an external LED depending on the firmware configuration
22	LED3	O	LED3 display segment that drives an external LED depending on the firmware configuration
23	LED2	O	LED2 display segment that drives an external LED depending on the firmware configuration
24	LED1	O	LED1 display segment that drives an external LED depending on the firmware configuration
25	XALERT	I	Input from bq29312A XALERT output.
26	MRST	I	Master reset input that forces the device into reset when held high
27	SR2	IA	Connections for a small-value sense resistor to monitor the battery charge- and discharge-current flow
28	SR1	IA	Connections for a small-value sense resistor to monitor the battery charge- and discharge-current flow
31	VDDA	P	Positive supply for analog circuitry
32	FILT	IA	Analog input connected to the external PLL filter components which are a 150-pF capacitor to V <sub>SSA</sub> , in parallel with a 61.9-k $\Omega$ resistor and a 2200-pF capacitor in series. Place these components as close as possible to the bq20z80 to ensure optimal performance.
33	XCK2/ROSC	O	32.768-kHz crystal oscillator output pin or connected to a 100k, 50ppm or better resistor if the internal oscillator is used
34	XCK1/VSSA	I	32.768-kHz crystal oscillator input pin or connected to VSSA if the internal oscillator is used
35	CLKOUT	O	32.768-kHz output for the bq29312. This pin should be directly connected to the AFE.
36, 37	NC	-	Not used— leave floating
11, 19, 38	VSSD	P	Negative supply for digital circuitry
29, 30	VSSA	P	Negative supply for analog circuitry.

(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)<sup>(1)</sup>

		RANGE
$V_{DDA}$ and $V_{DDD}$ relative to $V_{SS}^{(2)}$	Supply voltage range	-0.3 V to 4.1 V
$V_{(IOD)}$ relative to $V_{SS}^{(2)}$	Open-drain I/O pins	-0.3 V to 6 V
$V_I$ relative to $V_{SS}^{(2)}$	Input voltage range to all other pins	-0.3 V to $V_{DDA} + 0.3$ 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 the common node of  $V_{(SSA)}$  and  $V_{(SSD)}$ .

### ELECTRICAL CHARACTERISTICS

$V_{DD} = 3$  V to 3.6 V,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  (unless otherwise noted)

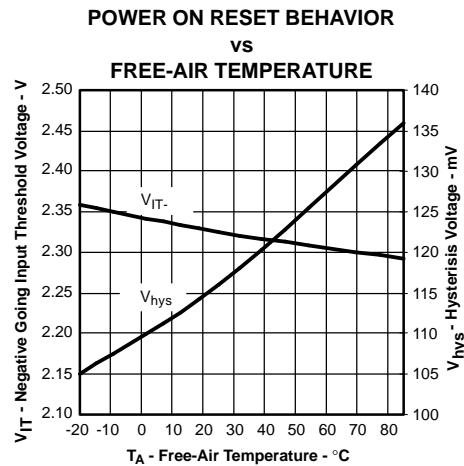
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{DD}$	Supply voltage	$V_{DDA}$ and $V_{DDD}$	3	3.3	3.6	V
$I_{DD}$	Operating mode current	No flash programming		350 <sup>(1)</sup>		$\mu\text{A}$
		bq20z80 + bq29312A		375		
$I_{(SLP)}$	Low-power storage mode current	Sleep mode		8 <sup>(1)</sup>		$\mu\text{A}$
		bq20z80 + bq29312A		28		
$I_{(SLP)}$	Shutdown Current	Shutdown Mode		0.1 <sup>(1)</sup>		$\mu\text{A}$
		bq20z80 + bq29312A		0.2		
$V_{OL}$	Output voltage low SMBC, SMBD, SDATA, SCLK, <u>SAFE</u> , SAFE, PU	$I_{OL} = 0.5$ mA			0.4	V
	LED1 – LED5	$I_{OL} = 10$ mA			0.4	V
$V_{OH}$	Output high voltage, SMBC, SMBD, SDATA, SCLK, <u>SAFE</u> , SAFE, PU	$I_{OH} = -1$ mA	$V_{DD} - 0.5$			V
$V_{IL}$	Input voltage low SMBC, SMBD, SDATA, SCLK, XALERT, PRES, PFIN		-0.3		0.8	V
	DISP		-0.3		0.8	V
$V_{IH}$	Input voltage high SMBC, SMBD, SDATA, SCLK, XALERT, PRES, PFIN		2		6	V
	DISP		2	$V_{CC} + 0.3$		V
$C_{IN}$	Input capacitance			5		pF
$V_{(AI1)}$	Input voltage range VIN, TS1, TS2		$V_{SS} - 0.3$		1	V
$V_{(AI2)}$	Input voltage range SR1, SR2		$V_{SS} - 0.25$		0.25	V
$Z_{(AI1)}$	Input impedance SR1, SR2	0 V–1 V	2.5			M $\Omega$
$Z_{(AI2)}$	Input impedance VIN, TS1, TS2	0 V–1 V	8			M $\Omega$

(1) This value does not include the bq29312A

## POWER-ON RESET

$V_{DD} = 3\text{ V to }3.6\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{IT-}$ Negative-going voltage input		2.1	2.3	2.5	V
$V_{HYS}$ Power-on reset hysteresis		50	150	200	mV



## INTEGRATING ADC (Coulomb Counter) CHARACTERISTICS

$V_{DD} = 3\text{ V to }3.6\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(SR)}$ Input voltage range, $V_{(SR2)}$ and $V_{(SR1)}$	$V_{(SR)} = V_{(SR2)} - V_{(SR1)}$	-0.25		0.25	V
$V_{(SROS)}$ Input offset			1		$\mu\text{V}$
INL Integral nonlinearity error			0.004%	0.019%	

## PLL SWITCHING CHARACTERISTICS

$V_{DD} = 3\text{ V to }3.6\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{(SP)}$ Start-up time <sup>(1)</sup>	0.5% frequency error		2	5	ms

- (1) The frequency error is measured from the trimmed frequency of the internal system clock which is 128 oscillator frequency, nominally 4.194 MHz.

## OSCILLATOR

$V_{DD} = 3\text{ V to }3.6\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$f_{(exo)}$ Frequency error from 32.768 kHz	ROSC = 100 k $\Omega$	-2%	0.25%	2%	
	ROSC = 100 k $\Omega$ , $V_{DD} = 3.3\text{ V}$	-1%	0.25%	1%	
	XCK1 = 12-pF XTAL	-0.25%		0.25%	
$f_{(sxo)}$ Start-up time <sup>(1)</sup>	ROSC = 100 k $\Omega$			250	$\mu\text{s}$
	XCK1 = 12-pF XTAL			200	ms

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

**DATA FLASH MEMORY CHARACTERISTICS**

$V_{DD} = 3\text{ V to }3.6\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (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 supply current	See (1)		8	15	mA

(1) Assured by design. Not production tested

**REGISTER BACKUP**

$V_{DD} = 3\text{ V to }3.6\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$I_{(RBI)}$	RBI data-retention input current	$V_{(RBI)} > 3\text{ V}$ , $V_{DD} < V_{IT}$		10	100	nA
$V_{(RBI)}$	RBI data-retention voltage <sup>(1)</sup>		1.3			V

(1) Specified by design. Not production tested.

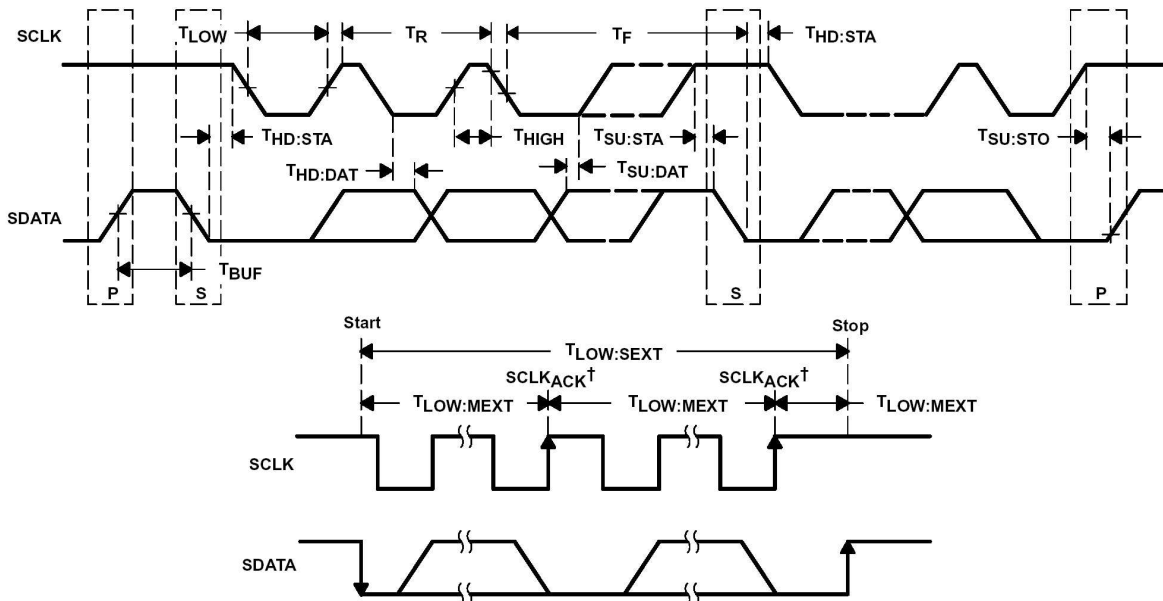
**SMBus TIMING SPECIFICATIONS**

$V_{DD} = 3\text{ V to }3.6\text{ V}$ ,  $T_A = -40^\circ\text{C to }85^\circ\text{C}$  (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		$\mu\text{s}$
$t_{HD:STA}$	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		$\mu\text{s}$
$t_{HIGH}$	Clock high period	See (2)	4	50	
$t_{LOW:SEXT}$	Cumulative clock low slave extend time	See (3)		25	ms
$t_{LOW:MEXT}$	Cumulative clock low master extend time	See (4)		10	
$t_F$	Clock/data fall time	$(V_{ILMAX} - 0.15\text{ V})$ to $(V_{IHMIN} + 0.15\text{ V})$		300	ns
$t_R$	Clock/data rise time	$0.9\text{ V}_{DD}$ to $(V_{ILMAX} - 0.15\text{ V})$		1000	

- (1) The bq20z80 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 bq20z80 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**



$^\dagger SCLKACK$  is the acknowledge-related clock pulse generated by the master.

## FEATURE SET

### Primary (1st Level) Safety Features

The bq20z80 supports a wide range of battery and system protection features that can easily be configured. The primary safety features includes:

- Battery cell over/under voltage protection
- Battery pack over/under voltage protection
- 2 independent charge overcurrent protection
- 3 independent discharge overcurrent protection
- Short circuit protection
- Over temperature protection
- Host watchdog

### Secondary (2nd Level) Safety Features

The secondary safety features of the bq20z80 can be used to indicate more serious faults via the SAFE (pin 7) and  $\overline{\text{SAFE}}$  (pin 12) pins. These pins can be used to blow a in-line fuse to permanently disable the battery pack from charging or discharging. The secondary safety features includes:

- Safety over voltage
- Battery cell imbalance
- 2nd level protection IC input
- Safety over current
- Safety over temperature
- Open thermistor
- Charge FET and 0 Volt Charge FET fault
- Discharge FET fault
- Fuse blow failure detection
- AFE communication error
- Internal flash data error

### Charge Control Features

The bq20z80 charge control features includes:

- Report 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.
- Determine 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 causing excessive degradation and also increases the usable pack energy by preventing to early charge termination
- supports pre-charging/zero-volt charging
- support fast charging
- report charging faults and also indicate charge status via charge and discharge alarms.

### Gas Gauging

The bq20z80 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.



## FEATURE SET (continued)

### LED Display

The bq20z80 can drive 3-, 4-, or 5- segment LED display for remaining capacity indication.

### LifeTime Data Logging Features

The bq20z80 offers a lifetime data logging array, where all important measurements are stored for warranty and analysis purposes. The data monitored includes:

- 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 bq20z80 supports authentication by the host using SHA-1.

### Power Modes

The bq20z80 supports 3 different power modes to reduce power consumption:

- In Normal Mode, the bq20z80 performs measurements, calculations, protection decisions, data update in 1 second intervals. Between these intervals, the bq20z80 is in a reduced power stage.
- In Sleep Mode, the bq20z80 performs measurements, calculations, protection decisions, data update in adjustable time intervals. Between these intervals, the bq20z80 is in a reduced power stage.
- In Shutdown Mode the bq20z80 is completely disabled.

## CONFIGURATION

### Oscillator Function

The oscillator of the bq20z80 can be set up for internal or external operation. On power up, the bq20z80 automatically attempts to start the internal oscillator. If a 100-k $\Omega$  resistor is not connected to ROSC (pin 33), then it attempts to start the oscillator using an external 32.768-kHz crystal.

#### NOTE:

Install either the 100-k $\Omega$  ROSC resistor *or* the 12-pF, 32.768-kHz crystal. Do not install both.

The performance of the internal oscillator depends on the tolerance of the 100-k $\Omega$  resistor between RSOC (pin 33) and VSSA (pin 34). Choose a resistor with a tolerance of  $\pm 0.1\%$ , and 50-ppm or better temperature drift. Place this resistor as close as possible to the bq20z80. If a 12-pF crystal is used, place it as close as possible to the XCK1 (pin 34) and XCK2 (pin 33) pins. If not properly implemented, the PCB layout in this area can degrade oscillator performance.

## FEATURE SET (continued)

### System Present Operation

The bq20z80 pulls the PU pin high periodically (1 s). Connect this pin to the  $\overline{\text{PRES}}$  pin of the bq20z80 via a resistor of approximately 5 k $\Omega$ . The bq20z80 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 bq20z80 detects this as system present.

### BATTERY PARAMETER MEASUREMENTS

The bq20z80 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 bq20z80 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 bq20z80 continuously integrates the signal over time, using an internal counter. The fundamental rate of the counter is 0.65 nVh.

#### Voltage

The bq20z80 updates the individual series cell voltages through the bq29312A at one second intervals. The bq20z80 configures the bq29312A to connect the selected cell, cell offset, or bq29312A VREF to the CELL pin of the bq29312A, which is required to be connected to VIN of the bq20z80. The internal ADC of the bq20z80 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 bq20z80 uses the SR1 and SR2 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 bq20z80 provides an auto-calibration feature to cancel the voltage offset error across SR1 and SR2 for maximum charge measurement accuracy. The bq20z80 performs auto-calibration when the SMBus lines stay low continuously for a minimum of 5 s.

#### Temperature

The bq20z80 TS1 and TS2 inputs, in conjunction with two identical NTC thermistors (default are Semitec 103AT), measure the battery environmental temperature. The bq20z80 can also be configured to use its internal temperature sensor.

### COMMUNICATIONS

The bq20z80 uses SMBus v1.1 with Master Mode and package error checking (PEC) options per the SBS specification.

#### SMBus On and Off State

The bq20z80 detects an SMBus off state when SMBC and SMBD are logic-low for  $\geq 2$  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	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	—	—	bq20z80	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	—	%
0x50	R	SafetyAlert	hex	2	0x0000	0xffff	—	
0x51	R	SafetyStatus	hex	2	0x0000	0xffff	—	
0x52	R	PFAlert	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
0x60	R/W	UnSealKey	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	—	μΩ
0x77	R/W	DataflashClass	hex	2	0x0000	0xffff	—	
0x78	R/W	DataFlashSubClass1	hex	32	—	—	—	
0x79	R/W	DataFlashSubClass2	hex	32	—	—	—	
0x7a	R/W	DataFlashSubClass3	hex	32	—	—	—	
0x7b	R/W	DataFlashSubClass4	hex	32	—	—	—	
0x7c	R/W	DataFlashSubClass5	hex	32	—	—	—	
0x7d	R/W	DataFlashSubClass6	hex	32	—	—	—	
0x7e	R/W	DataFlashSubClass7	hex	32	—	—	—	
0x7f	R/W	DataFlashSubClass8	hex	32	—	—	—	

**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	U2	3700	5000	4300	mV
			2	COV Time	U1	0	60	2	Sec
			3	COV Recovery	U2	0	4400	3900	mV
			5	COV Delta	U1	0	200	20	mV
			6	COV Temp. Hys	U1	0	250	100	0.1°C
			7	POV Threshold	U2	0	18000	17500	mV
			9	POV Time	U1	0	60	2	Sec
			10	POV Recovery	U2	0	17000	16000	mV
			12	CUV Threshold	U2	0	3500	2200	mV
			14	CUV Time	U1	0	60	2	Sec
			15	CUV Recovery	U2	0	3600	3000	mV
			17	PUV Threshold	U2	0	16000	11000	mV
			19	PUV Time	U1	0	60	2	Sec
			20	PUV Recovery	U2	0	16000	12000	mV

**Table 3. DATAFLASH VALUES (continued)**

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
1st Level Safety	1	Current	0	OC (1st Tier) Chg	U2	0	20000	6000	mA
			2	OC (1st Tier) Chg Time	U1	0	60	2	sec
			3	OC Chg Recovery	I2	-1000	1000	200	mA
			5	OC (1st Tier) Dsg	U2	0	20000	6000	mA
			7	OC (1st Tier) Dsg Time	U1	0	60	2	sec
			8	OC Dsg Recovery	U2	0	1000	200	mA
			10	OC (2nd Tier) Chg	U2	0	20000	8000	mA
			12	OC (2nd Tier) Chg Time	U1	0	60	2	Sec
			13	OC (2nd Tier) Dsg	U2	0	22000	8000	mA
			15	OC (2nd Tier) Dsg Time	U1	0	60	2	Sec
			16	Current Recovery Time	U1	0	60	8	Sec
			17	AFE OC Dsg	H1	0x00	0xff	0x12	hex
			18	AFE OC Dsg Time	H1	0x00	0xff	0xff	hex
			19	AFE OC Dsg Recovery	U2	10	1000	100	mA
			21	AFE SC Chg Cfg	H1	0x00	0xff	0x77	hex
			22	AFE SC Dsg Cfg	H1	0x00	0xff	0x77	hex
23	AFE SC Recovery	U2	0	200	1	mA			
1st Level Safety	2	Temperature	0	Over Temp Chg	U2	0	1200	550	0.1°C
			2	OT Chg Time	U1	0	60	2	Sec
			3	OT Chg Recovery	U2	0	1200	500	0.1°C
			5	Over Temp Dsg	U2	0	1200	600	0.1°C
			7	OT Dsg Time	U1	0	60	2	Sec
			8	OT Dsg Recovery	U2	0	1200	550	0.1°C
1st Level Safety	3	Host Comm	0	Host Watchdog Timeout	U1	0	255	0	Sec
2nd Level Safety	16	Voltage	0	SOV Threshold	U2	0	20000	18000	mV
			2	SOV Time	U1	0	30	0	Sec
			3	Cell Imbalance Current	U1	0	200	5	mA
			4	Cell Imbalance Fail Voltage	U2	0	5000	1000	mV
			6	Cell Imbalance Time	U1	0	30	0	Sec
			7	Battery Rest Time	U2	0	65535	1800	Sec
			9	PFIN Detect Time	U1	0	30	0	Sec
			2nd Level Safety	17	Current	0	SOC Chg	U2	0
2	SOC Chg Time	U1				0	30	0	Sec
3	SOC Dsg	U2				0	30000	10000	mA
5	SOC Dsg Time	U1				0	30	0	Sec
2nd Level Safety	18	Temperature	0	SOT Chg	U2	0	1200	650	0.1°C
			2	SOT Chg Time	U1	0	30	0	Sec
			3	SOT Dsg	U2	0	1200	750	0.1°C
			5	SOT Dsg Time	U1	0	30	0	Sec
			6	Open Thermistor	I2	-1000	1200	-333	0.1°C
			8	Open Time	I1	0	30	0	Sec
2nd Level Safety	19	FET Verification	0	FET Fail Limit	U2	0	500	20	mA
			2	FET Fail Time	U1	0	30	0	Sec
2nd Level Safety	20	AFE Verification	0	AFE Check Time	U1	0	255	0	Sec
			1	AFE Fail Limit	U1	0	255	10	cnt
			2	AFE Fail Recovery Time	U1	0	255	20	Sec
			3	AFE Init Retry Limit	U1	0	255	6	num
			4	AFE Init Limit	U1	0	255	20	cnt
2nd Level Safety	21	Fuse Verification	0	Fuse Fail Limit	U2	0	20	2	mA
			2	Fuse Fail Time	U1	0	30	0	Sec

**Table 3. DATAFLASH VALUES (continued)**

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
Charge Control	32	Charge Inhibit Cfg	0	Chg Inhibit Temp Low	I2	-400	1200	0	0.1°C
			2	Chg Inhibit Temp High	I2	-400	1200	450	0.1°C
			4	Temp Hys	I2	0	100	10	0.1°C
Charge Control	33	Pre-Charge Cfg	0	Pre-chg Current	U2	0	2000	250	mA
			2	Pre-chg Temp	I2	-400	1200	120	0.1°C
			4	Pre-chg Voltage	U2	0	20000	3000	mV
			6	Recovery Voltage	U2	0	20000	3100	mV
Charge Control	34	Fast Charge Cfg	0	Fast Charge Current	U2	0	10000	4000	mA
			2	Charging Voltage	U2	0	20000	16800	mV
			4	Over Charging Voltage	U2	0	2000	500	mV
			6	Delta Temp	I2	0	500	50	0.1°C
			8	Suspend Low Temp	I2	-400	1200	-50	0.1°C
			10	Suspend High Temp	I2	-400	1200	550	0.1°C
Charge Control	35	Pulse Charge Cfg	0	Turn ON Voltage	U2	0	5000	4150	mV
			2	Turn OFF Voltage	U2	0	5000	4250	mV
			4	Max ON Pulse Time	U1	0	240	240	S/4
			5	Min OFF Pulse Time	U1	0	240	0	S/4
			6	Max OFF Voltage	U2	0	5000	4270	mV
Charge Control	36	Termination Cfg.	0	Maintenance Current	U2	0	1000	0	mA
			2	Taper Current	U2	0	1000	250	mA
			4	Min Taper Capacity	U2	0	1000	64	mAh
			6	Termination Voltage	U2	0	1000	300	mV
			8	Current Taper Window	U1	0	60	40	Sec
			9	TCA Set %	I1	-1	100	-1	%
			10	TCA Clear %	I1	-1	100	95	%
			11	FC Set %	I1	-1	100	-1	%
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	0	Over Charging Voltage	U2	0	3000	500	mV
			2	Over Charging Volt Time	U1	0	60	2	Sec
			3	Over Charging Current	U2	0	2000	500	mA
			5	Over Charging Curr Time	U1	0	60	2	Sec
			6	Over Charging Curr Recov	U2	0	2000	100	mA
			8	Depleted Voltage	U2	0	16000	8000	mV
			10	Depleted Voltage Time	U1	0	60	2	Sec
			11	Depleted Recovery	U2	0	16000	8500	mV
			13	Over Charge Capacity	U2	0	4000	300	mAh
			15	Over Charge Recovery	U2	0	100	2	mAh
			17	FC-MTO	U2	0	65535	10800	Sec
			19	PC-MTO	U2	0	65535	3600	Sec
			21	Charge Fault Cfg	H1	0x00	0xff	0	fig

**Table 3. DATAFLASH VALUES (continued)**

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
SBS Configuration	48	Data	0	Rem Cap Alarm	U2	0	700	300	mAh
			2	Rem Time Alarm	U2	0	30	10	Min
			4	Init Battery Mode	H2	0x0000	0xffff	0x0081	hex
			6	Design Voltage	U2	7000	18000	14400	mV
			8	Spec Info	H2	0x0000	0xffff	0x0031	hex
			10	Manuf Date	U2	0	65355	0	date
			12	Ser. Num.	H2	0x0000	0xffff	0x0001	hex
			14	Cycle Count	U2	0	65355	0	cnt
			16	CC Threshold	I2	100	32767	4400	mAh
			18	CC %	U1	0	100	90	%
			19	CF MaxError Limit	U1	0	100	100	%
			20	Design Capacity	U2	0	65355	4400	mAh
			22	Design Energy	U2	0	65355	6336	10mWh
			24	Manuf Name	S12	-	-	Texas Inst.	
36	Device Name	S8	-	-	bq20z80				
44	Device Chemistry	S5	-	-	LION				
SBS Configuration	49	Configuration	0	TDA Set %	I1	-1	100	6	%
			1	TDA Clear %	I1	-1	100	8	%
			2	FD Set %	I1	-1	100	2	%
			3	FD Clear %	I1	-1	100	5	%
			4	TDA Set Volt Threshold	U2	0	16800	5000	mV
			6	TDA Set Volt Time	U1	0	60	5	Sec
			7	TDA Clear Volt	U2	0	16800	5500	mV
			9	FD Set Volt Threshold	U2	0	16800	5000	mV
			11	FD Volt Time	U1	0	60	5	Sec
			12	FD Clear Volt	U2	0	16800	5500	mV
System Data	56	Manufacturer Data	0	Pack Lot Code	H2	0x0000	0xffff	0x0000	
			2	PCB Lot Code	H2	0x0000	0xffff	0x0000	
			4	Firmware Version	H2	0x0000	0xffff	0x0000	
			6	Hardware Revision	H2	0x0000	0xffff	0x0000	
			8	Cell Revision	H2	0x0000	0xffff	0x0000	
System Data	58	Manufacturer Info	0	Manuf. Info	S9	-	-	12345678	
System Data	59	LifeTime Data	0	Lifetime Max Temp	I2	0	1400	300	0.1°C
			2	Lifetime Min Temp	I2	-600	1400	200	0.1°C
			4	Lifetime Max Cell Voltage	U2	0	65535	3500	mV
			6	Lifetime Min Cell Voltage	U2	0	65535	3200	mV
			8	Lifetime Max Pack Voltage	U2	0	65535	14000	mV
			10	Lifetime Min Pack Voltage	U2	0	65535	12800	mV
			12	Lifetime Max Chg Current	I2	-32768	32767	1500	mA
			14	Lifetime Max Dsg Current	I2	-32768	32767	-3000	mA
			16	Lifetime Max Chg Power	I2	-32768	32767	1500	0.1W
			18	Lifetime Max Dsg Power	I2	-32768	32767	-1500	0.1W
			22	Life Max AvgDsg Cur	I2	-32768	32767	-1000	mA
			26	Life Max AvgDsg Pow	I2	-32768	32767	-1500	0.1W
			28	Lifetime Avg Temp	I2	0	1400	250	0.1°C
System Data	60	LifeTime Temp Samples	0	LT Temp Samples	U4	0	14000000	0	num
Configuration	64	Registers	0	Operation Cfg A	H2	0x0000	0xffff	0x0F29	flg
			2	Operation Cfg B	H2	0x0000	0xffff	0x6440	flg
			4	Permanent Fail Cfg	H2	0x0000	0xffff	0x0000	flg
			6	Non-Removable Cfg	H2	0x0000	0xffff	0x0000	hex

**Table 3. DATAFLASH VALUES (continued)**

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units			
LED Support	67	LED Cfg	0	LED Flash Rate	U2	0	65535	512	500us			
			2	LED Blink Rate	U2	0	65535	1024	500us			
			4	LED Delay	U2	1	65535	100	500us			
			6	LED Hold Time	U1	0	255	4	s			
			7	CHG Flash Alarm	I1	-1	101	10	%			
			8	CHG Thresh 1	I1	-1	101	0	%			
			9	CHG Thresh 2	I1	-1	101	20	%			
			10	CHG Thresh 3	I1	-1	101	40	%			
			11	CHG Thresh 4	I1	-1	101	60	%			
			12	CHG Thresh 5	I1	-1	101	80	%			
			13	DSG Flash Alarm	I1	-1	101	10	%			
			14	DSG Thresh 1	I1	-1	101	0	%			
			15	DSG Thresh 2	I1	-1	101	20	%			
			16	DSG Thresh 3	I1	-1	101	40	%			
			17	DSG Thresh 4	I1	-1	101	60	%			
			18	DSG Thresh 5	I1	-1	101	60	%			
			Power	68	Power	0	Flash Update OK Voltage	U2	6000	20000	7500	mV
						2	Shutdown Voltage	U2	5000	20000	7000	mV
4	Shutdown Time	U1				0	60	10	Sec			
5	Charger Present	U2				0	23000	12000	mV			
7	Sleep Current	U2				0	100	10	mA			
9	Bus Low Time	U1				0	255	5	Sec			
10	Cal Inhibit Temp Low	I2				-400	1200	50	0.1°C			
12	Cal Inhibit Temp High	I2				-400	1200	450	0.1°C			
14	Sleep Voltage Time	U1				0	100	5	Sec			
15	Sleep Current Time	U1				0	255	20	Sec			
Gas Gauging	80	IT Cfg	0	Load Select	U1	0	255	3	num			
			1	Load Mode	U1	0	255	0	num			
			45	Term Voltage	I2	-32768	32767	12000	mV			
			60	User Rate-mA	I2	-9000	-2000	0	mA			
			62	User Rate-mW	I2	-14000	-3000	0	mW			
			64	Reserve Cap-mAh	I2	0	9000	0	mAh			
			66	Reserve Cap-mWh	I2	0	14000	0	mWh			
Gas Gauging	81	Current Thresholds	0	Dsg Current Threshold	U2	0	2000	100	mA			
			2	Chg Current Threshold	U2	0	2000	50	mA			
			4	Quit Current	U2	0	1000	10	mA			
			6	Dsg Relax Time	U1	0	255	1	Sec			
			7	Chg Relax Time	U1	0	255	60	Sec			
Gas Gauging	82	State	0	Qmax Cell 0	U2	0	65535	4400	mAh			
			2	Qmax Cell 1	U2	0	65535	4400	mAh			
			4	Qmax Cell 2	U2	0	65535	4400	mAh			
			6	Qmax Cell 3	U2	0	65535	4400	mAh			
			8	Qmax Pack	U2	0	65535	4400	mAh			
			12	Update Status	H1	0x00	0x04	0x00	num			
			21	Avg I Last Run	I2	-32768	32767	-2000	mA			
			23	Avg P Last Run	I2	-32768	32767	-3022	10mW			
			25	Delta Voltage	I2	-32768	32767	0	mV			



**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	0	Cell0 R_a flag	H2	0x0000	0xffff	0xff55	
			2	Cell0 R_a 0	I2	-32768	32767	160	num
			4	Cell0 R_a 1	I2	-32768	32767	166	num
			6	Cell0 R_a 2	I2	-32768	32767	153	num
			8	Cell0 R_a 3	I2	-32768	32767	151	num
			10	Cell0 R_a 4	I2	-32768	32767	145	num
			12	Cell0 R_a 5	I2	-32768	32767	152	num
			14	Cell0 R_a 6	I2	-32768	32767	176	num
			16	Cell0 R_a 7	I2	-32768	32767	204	num
			18	Cell0 R_a 8	I2	-32768	32767	222	num
			20	Cell0 R_a 9	I2	-32768	32767	254	num
			22	Cell0 R_a 10	I2	-32768	32767	315	num
			24	Cell0 R_a 11	I2	-32768	32767	437	num
			26	Cell0 R_a 12	I2	-32768	32767	651	num
			28	Cell0 R_a 13	I2	-32768	32767	1001	num
30	Cell0 R_a 14	I2	-32768	32767	1458	num			
Ra Table	89	R_a1	0	Cell1 R_a flag	H2	0x0000	0xffff	0xff55	
			2	Cell1 R_a 0	I2	-32768	32767	160	num
			4	Cell1 R_a 1	I2	-32768	32767	166	num
			6	Cell1 R_a 2	I2	-32768	32767	153	num
			8	Cell1 R_a 3	I2	-32768	32767	151	num
			10	Cell1 R_a 4	I2	-32768	32767	145	num
			12	Cell1 R_a 5	I2	-32768	32767	152	num
			14	Cell1 R_a 6	I2	-32768	32767	176	num
			16	Cell1 R_a 7	I2	-32768	32767	204	num
			18	Cell1 R_a 8	I2	-32768	32767	222	num
			20	Cell1 R_a 9	I2	-32768	32767	254	num
			22	Cell1 R_a 10	I2	-32768	32767	315	num
			24	Cell1 R_a 11	I2	-32768	32767	437	num
			26	Cell1 R_a 12	I2	-32768	32767	651	num
			28	Cell1 R_a 13	I2	-32768	32767	1001	num
30	Cell1 R_a 14	I2	-32768	32767	1458	num			
Ra Table	90	R_a2	0	Cell2 R_a flag	H2	0x0000	0xffff	0xff55	
			2	Cell2 R_a 0	I2	-32768	32767	160	num
			4	Cell2 R_a 1	I2	-32768	32767	166	num
			6	Cell2 R_a 2	I2	-32768	32767	153	num
			8	Cell2 R_a 3	I2	-32768	32767	151	num
			10	Cell2 R_a 4	I2	-32768	32767	145	num
			12	Cell2 R_a 5	I2	-32768	32767	152	num
			14	Cell2 R_a 6	I2	-32768	32767	176	num
			16	Cell2 R_a 7	I2	-32768	32767	204	num
			18	Cell2 R_a 8	I2	-32768	32767	222	num
			20	Cell2 R_a 9	I2	-32768	32767	254	num
			22	Cell2 R_a 10	I2	-32768	32767	315	num
			24	Cell2 R_a 11	I2	-32768	32767	437	num
			26	Cell2 R_a 12	I2	-32768	32767	651	num
			28	Cell2 R_a 13	I2	-32768	32767	1001	num
30	Cell2 R_a 14	I2	-32768	32767	1458	num			
Ra Table	91	R_a3	0	Cell3 R_a flag	H2	0x0000	0xffff	0xff55	
			2	Cell3 R_a 0	I2	-32768	32767	160	num

**Table 3. DATAFLASH VALUES (continued)**

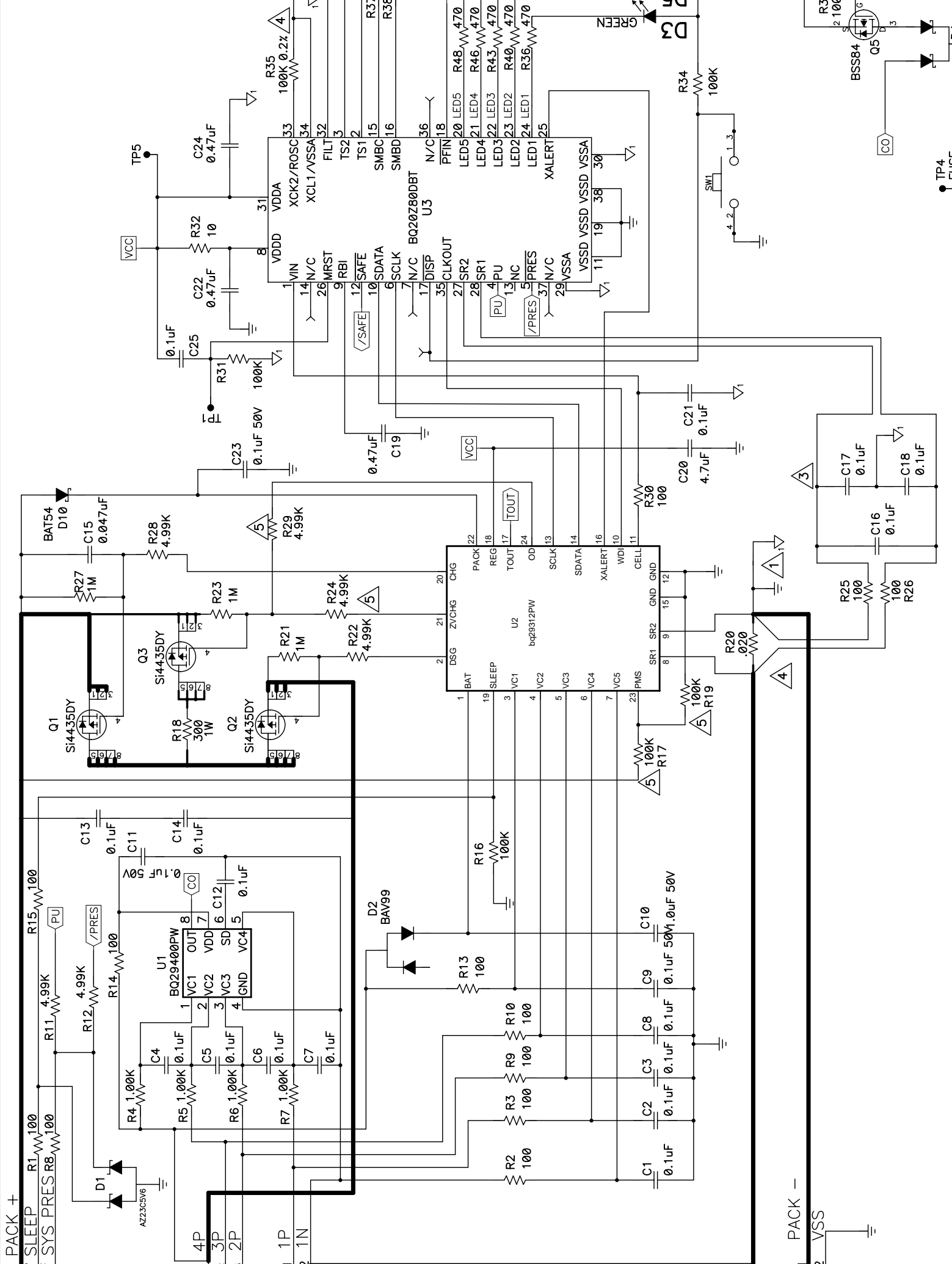
Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
			4	Cell3 R_a 1	I2	-32768	32767	166	num
			6	Cell3 R_a 2	I2	-32768	32767	153	num
			8	Cell3 R_a 3	I2	-32768	32767	151	num
			10	Cell3 R_a 4	I2	-32768	32767	145	num
			12	Cell3 R_a 5	I2	-32768	32767	152	num
			14	Cell3 R_a 6	I2	-32768	32767	176	num
			16	Cell3 R_a 7	I2	-32768	32767	204	num
			18	Cell3 R_a 8	I2	-32768	32767	222	num
			20	Cell3 R_a 9	I2	-32768	32767	254	num
			22	Cell3 R_a 10	I2	-32768	32767	315	num
			24	Cell3 R_a 11	I2	-32768	32767	437	num
			26	Cell3 R_a 12	I2	-32768	32767	651	num
			28	Cell3 R_a 13	I2	-32768	32767	1001	num
			30	Cell3 R_a 14	I2	-32768	32767	1458	num
Ra Table	92	R_a0x	0	xCell0 R_a flag	H2	0x0000	0xffff	0xffff	
			2	xCell0 R_a 0	I2	-32768	32767	160	num
			4	xCell0 R_a 1	I2	-32768	32767	166	num
			6	xCell0 R_a 2	I2	-32768	32767	153	num
			8	xCell0 R_a 3	I2	-32768	32767	151	num
			10	xCell0 R_a 4	I2	-32768	32767	145	num
			12	xCell0 R_a 5	I2	-32768	32767	152	num
			14	xCell0 R_a 6	I2	-32768	32767	176	num
			16	xCell0 R_a 7	I2	-32768	32767	204	num
			18	xCell0 R_a 8	I2	-32768	32767	222	num
			20	xCell0 R_a 9	I2	-32768	32767	254	num
			22	xCell0 R_a 10	I2	-32768	32767	315	num
			24	xCell0 R_a 11	I2	-32768	32767	437	num
			26	xCell0 R_a 12	I2	-32768	32767	651	num
			28	xCell0 R_a 13	I2	-32768	32767	1001	num
			30	xCell0 R_a 14	I2	-32768	32767	1458	num
Ra Table	93	R_a1x	0	xCell1 R_a flag	H2	0x0000	0xffff	0xffff	
			2	xCell1 R_a 0	I2	-32768	32767	160	num
			4	xCell1 R_a 1	I2	-32768	32767	166	num
			6	xCell1 R_a 2	I2	-32768	32767	153	num
			8	xCell1 R_a 3	I2	-32768	32767	151	num
			10	xCell1 R_a 4	I2	-32768	32767	145	num
			12	xCell1 R_a 5	I2	-32768	32767	152	num
			14	xCell1 R_a 6	I2	-32768	32767	176	num
			16	xCell1 R_a 7	I2	-32768	32767	204	num
			18	xCell1 R_a 8	I2	-32768	32767	222	num
			20	xCell1 R_a 9	I2	-32768	32767	254	num
			22	xCell1 R_a 10	I2	-32768	32767	315	num
			24	xCell1 R_a 11	I2	-32768	32767	437	num
			26	xCell1 R_a 12	I2	-32768	32767	651	num
			28	xCell1 R_a 13	I2	-32768	32767	1001	num
			30	xCell1 R_a 14	I2	-32768	32767	1458	num
Ra Table	94	R_a2x	0	xCell2 R_a flag	H2	0x0000	0xffff	0xffff	
			2	xCell2 R_a 0	I2	-32768	32767	160	num
			4	xCell2 R_a 1	I2	-32768	32767	166	num
			6	xCell2 R_a 2	I2	-32768	32767	153	num

**Table 3. DATAFLASH VALUES (continued)**

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
			8	xCell2_R_a 3	I2	-32768	32767	151	num
			10	xCell2_R_a 4	I2	-32768	32767	145	num
			12	xCell2_R_a 5	I2	-32768	32767	152	num
			14	xCell2_R_a 6	I2	-32768	32767	176	num
			16	xCell2_R_a 7	I2	-32768	32767	204	num
			18	xCell2_R_a 8	I2	-32768	32767	222	num
			20	xCell2_R_a 9	I2	-32768	32767	254	num
			22	xCell2_R_a 10	I2	-32768	32767	315	num
			24	xCell2_R_a 11	I2	-32768	32767	437	num
			26	xCell2_R_a 12	I2	-32768	32767	651	num
			28	xCell2_R_a 13	I2	-32768	32767	1001	num
			30	xCell2_R_a 14	I2	-32768	32767	1458	num
Ra Table	95	R_a3x	0	xCell3_R_a flag	H2	0x0000	0xffff	0xffff	
			2	xCell3_R_a 0	I2	-32768	32767	160	num
			4	xCell3_R_a 1	I2	-32768	32767	166	num
			6	xCell3_R_a 2	I2	-32768	32767	153	num
			8	xCell3_R_a 3	I2	-32768	32767	151	num
			10	xCell3_R_a 4	I2	-32768	32767	145	num
			12	xCell3_R_a 5	I2	-32768	32767	152	num
			14	xCell3_R_a 6	I2	-32768	32767	176	num
			16	xCell3_R_a 7	I2	-32768	32767	204	num
			18	xCell3_R_a 8	I2	-32768	32767	222	num
			20	xCell3_R_a 9	I2	-32768	32767	254	num
			22	xCell3_R_a 10	I2	-32768	32767	315	num
			24	xCell3_R_a 11	I2	-32768	32767	437	num
			26	xCell3_R_a 12	I2	-32768	32767	651	num
			28	xCell3_R_a 13	I2	-32768	32767	1001	num
			30	xCell3_R_a 14	I2	-32768	32767	1458	num
PF Status	96	Device Status Data	0	PF Flags 1	H2	0x0000	0xffff	0x0000	flg
			2	Fuse Flag	H2	0x0000	0xffff	0x0000	flg
			4	PF Voltage	U2	0	65535	0	mV
			6	PF C4 Voltage	U2	0	9999	0	mV
			8	PF C3 Voltage	U2	0	9999	0	mV
			10	PF C2 Voltage	U2	0	9999	0	mV
			12	PF C1 Voltage	U2	0	9999	0	mV
			14	PF Current	I2	-32768	32767	0	mA
			16	PF Temperature	U2	0	9999	0	0.1°K
			18	PF Batt Stat	H2	0x0000	0xffff	0x0000	flg
			20	PF RC-mAh	U2	0	65535	0	mAh
			22	PF RC-10mWh	U2	0	65535	0	10mWh
			24	PF Chg Status	H2	0x0000	0xffff	0x0000	flg
			26	PF Safety Status	H2	0x0000	0xffff	0x0000	flg
			28	PF Flags 2	H2	0x0000	0xffff	0x0000	flg
PF Status	97	AFE Regs	0	AFE Status	H1	0x00	0xffff	0x00	flg
			1	AFE Output	H1	0x00	0xffff	0x00	flg
			2	AFE State	H1	0x00	0xffff	0x00	flg
			3	AFE Function	H1	0x00	0xffff	0x00	flg
			4	AFE Cell Select	H1	0x00	0xffff	0x00	flg
			5	AFE OLV	H1	0x00	0xffff	0x00	flg
			6	AFE OLT	H1	0x00	0xffff	0x00	flg

**Table 3. DATAFLASH VALUES (continued)**

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
			7	AFE SCC	H1	0x00	0xffff	0x00	flg
			8	AFE SCD	H1	0x00	0xffff	0x00	flg
Calibration	104	Data	0	CC Gain	F4	-1.00E+128	1.00E+128	0.471	num
			4	CC Delta	F4	-1.00E+128	1.00E+128	140500	num
			8	Ref Voltage	I2	0	32767	24500	50uV
			10	AFE Corr	U2	0	65535	1288	num
			12	AFE Pack Gain	U2	0	65535	30625	num
			14	CC Offset	I2	-32768	32767	-12250	num
			16	Board Offset	I1	-128	127	0	num
			17	Int Temp Offset	I1	-128	127	0	num
			18	Ext1 Temp Offset	I1	-128	127	0	num
			19	Ext2 Temp Offset	I1	-128	127	0	num
Calibration	105	Config	0	CC Current	U2	0	65535	3000	mA
			2	Voltage Signal	U2	0	65535	16800	mV
			4	Temp Signal	U2	0	65535	2980	K
			6	CC Offset Time	U2	0	65535	250	ms
			8	ADC Offset Time	U2	0	65535	32	ms
			10	CC Gain Time	U2	0	65535	250	ms
			12	Voltage Time	U2	0	65535	1984	ms
			14	Temperature Time	U2	0	65535	32	ms
Calibration	106	Temp Model	0	Ext Coef 1	I2	-32768	32767	-28285	Sec
			2	Ext Coef 2	I2	-32768	32767	20848	Sec
			4	Ext Coef 3	I2	-32768	32767	-7537	Sec
			6	Ext Coef 4	I2	-32768	32767	4012	Sec
			8	Ext Min AD	I2	-32768	32767	0	Sec
			10	Ext Max Temp	I2	-32768	32767	4012	Sec
			12	Int Coef 1	I2	-32768	32767	0	Sec
			14	Int Coef 2	I2	-32768	32767	0	Sec
			16	Int Coef 3	I2	-32768	32767	-11136	Sec
			18	Int Coef 4	I2	-32768	32767	5754	Sec
			20	Int Min AD	I2	-32768	32767	0	Sec
			22	Int Max Temp	I2	-32768	32767	5754	Sec
Calibration	107	Current	0	Filter	U1	0	255	239	mA
			1	Deadband	U1	0	255	3	mA
			2	CC Deadband	U1	0	255	34	nV+
			3	CC Max Deadband	U1	0	255	5	nV+
			4	CC Deadband Sample	U2	0	65535	256	num
			6	CC Max Offset Sample	U2	0	65535	64	num



**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>
BQ20Z80DBT-V102	ACTIVE	SM8	DBT	38	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
BQ20Z80DBTR-V102	ACTIVE	SM8	DBT	38	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
BQ20ZDBT-V102G4	ACTIVE	SM8	DBT	38	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
BQ20ZDBTR-V102G4	ACTIVE	SM8	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) 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.

**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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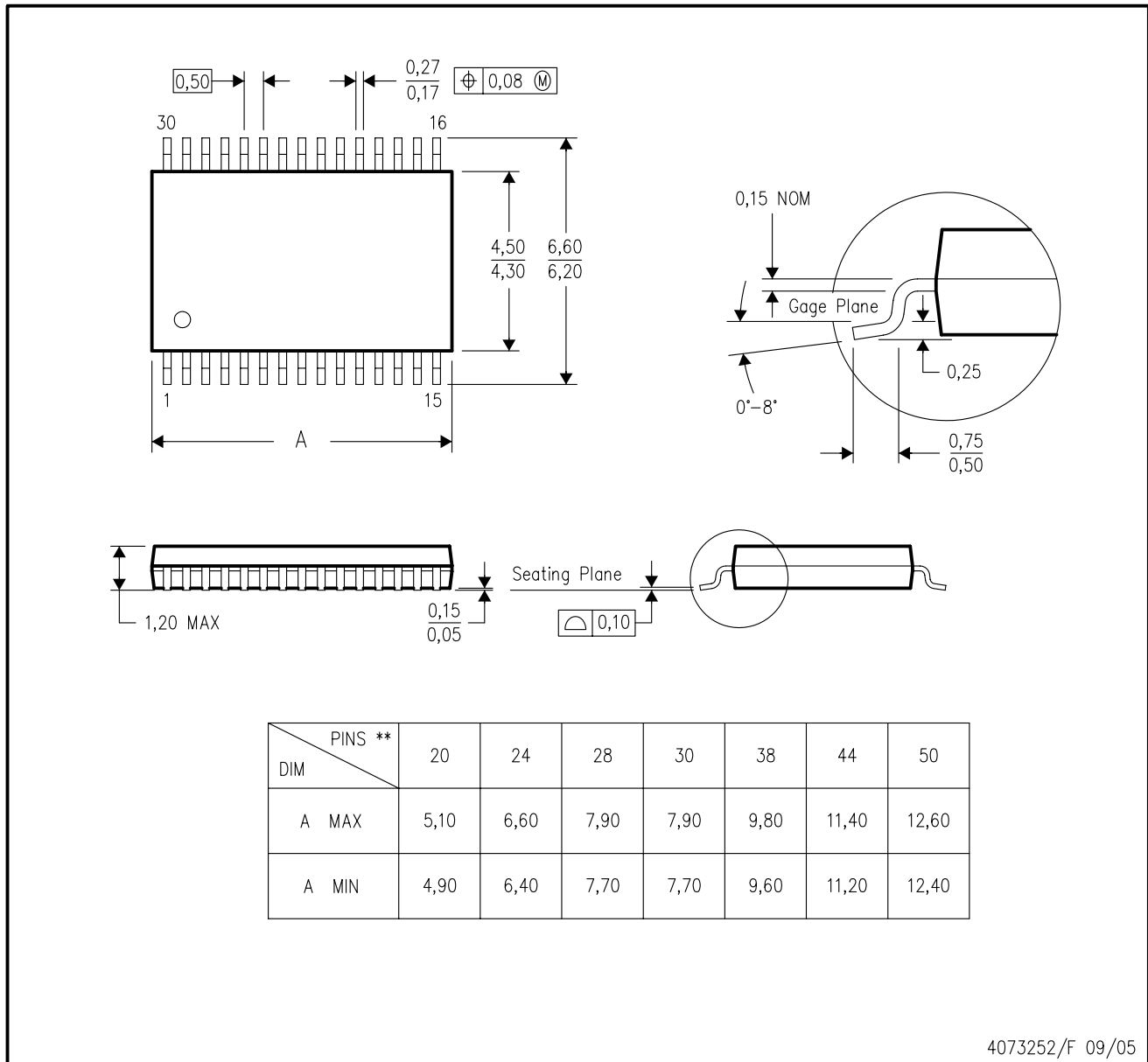
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# MECHANICAL DATA

## DBT (R-PDSO-G\*\*)

30 PINS SHOWN

## PLASTIC SMALL-OUTLINE PACKAGE



4073252/F 09/05

- 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.
  - D. Falls within JEDEC MO-153 except 44 pin package length.

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