SBS 1.1-Compliant Gas Gauge and Protection Enabled With Impedance Track™

Check for Samples: bq20z45-R1

FEATURES

- **Next Generation Patented Impedance Track™ Technology Accurately Measures Available Charge in Li-Ion and Li-Polymer Batteries**
  - **Better Than 1% Error Over the Lifetime of the Battery**
- **Supports the Smart Battery Specification SBS V1.1**
- **Flexible Configuration for 2 to 4 Series Li-Ion and Li-Polymer Cells**
- **Powerful 8-Bit RISC CPU With Ultralow Power Modes**
- **Full Array of Programmable Protection Features**
  - **Voltage, Current, and Temperature**
- **Satisfies JEITA Guidelines**
- **Added Flexibility to Handle More Complex Charging Profiles**
- **Lifetime Data Logging**
- **Supports SHA-1 Authentication**
- **Complete Battery Protection and Gas Gauge Solution in One Package**
- **Available in a 38-Pin TSSOP (DBT) package**

APPLICATIONS

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

DESCRIPTION

The bq20z45-R1 SBS-compliant gas gauge and protection IC is a single IC solution designed for battery-pack or in-system installation. The bq20z45-R1 measures and maintains an accurate record of available charge in Li-ion or Li-polymer batteries using its integrated high-performance analog peripherals, monitors capacity change, battery impedance, open-circuit voltage, and other critical parameters of the battery pack as well and reports the information to the system host controller over a serial-communication bus. Together with the integrated analog front-end (AFE) short-circuit and overload protection, the bq20z45-R1 maximizes functionality and safety while minimizing external component count, cost, and size in smart battery circuits.

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

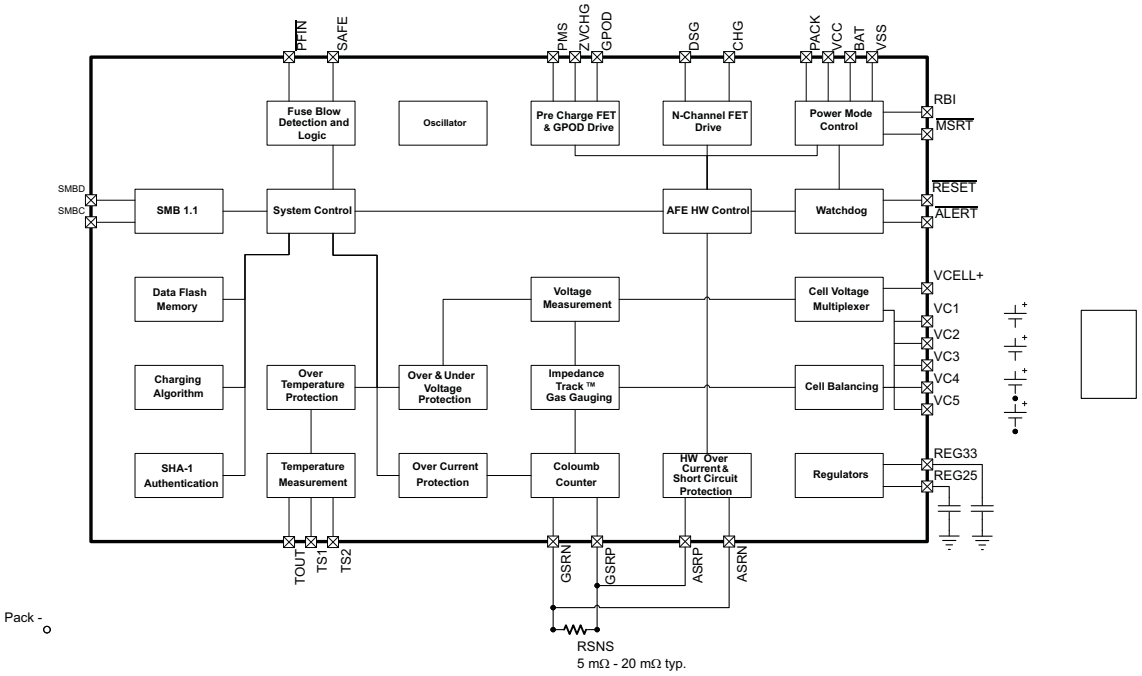
Table 1. AVAILABLE OPTIONS

T_A	PACKAGE(1)	
	38-PIN TSSOP (DBT) Tube	38-PIN TSSOP (DBT) Tape and Reel
–40°C to 85°C	bq20z45-R1DBT(2)	bq20z45-R1DBTR(3)

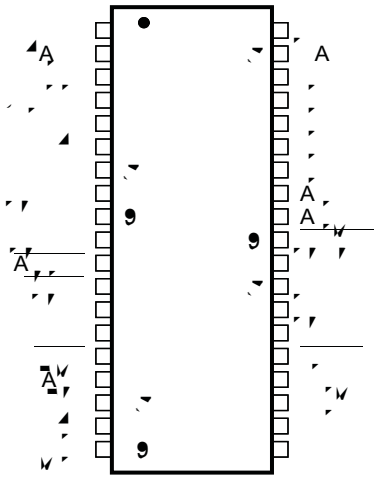
(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.
(2) A single tube quantity is 50 units.
(3) A single reel quantity is 2000 units

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

SYSTEM PARTITIONING DIAGRAM



bq20z45-R1
DBT PACKAGE
(TOP VIEW)



PIN FUNCTIONS

PIN		I/O(1)	DESCRIPTION
NO.	NAME		
1	DSG	O	High side N-chan discharge FET gate drive
2	PACK	IA, P	Battery pack input voltage sense input. It also serves as device wake up when device is in shutdown mode.
3	VCC	P	Positive device supply input. Connect to the center connection of the CHG FET and DSG FET to ensure device supply either from battery stack or battery pack input
4	ZVCHG	O	P-chan pre-charge

Positive device as4

Positive device supply input. Connect to the center connection of the CHG FET and DSG FET to ensure device supply either from battery stack or battery pack input

CHG

ELECTRICAL CHARACTERISTICS

over operating free-air temperature range (unless otherwise noted), T_A = –40°C to 85°C, $V_{(RE}$[redacted]
$V_{(BAT)}$ = 14 V, $C_{(REG25)}$ = 1 µF, $C_{(REG33)}$ = 2.2 µF; typical values at T_A = 25°C (unless otherwise[redacted]

PARAMETER		TEST CONDITIONS				
SUPPLY CURRENT						
$I_{(NORMAL)}$	Firmware running		[redacted]			
$I_{(SLEEP)}$	Sleep Mode	CHG FET on; DSG FET on	[redacted]			
		CHG FET off; DSG FET on	[redacted]			
		CHG FET off; DSG FET off	[redacted]			
$I_{(SHUTDOWN)}$	Shutdown Mode		[redacted]			
SHUTDOWN WAKE; T_A = 25°C (unless otherwise noted)						
$I_{(PACK)}$	Shutdown exit at $V_{STARTUP}$ threshold		[redacted]			
SRx WAKE FROM SLEEP; T_A = 25°C (unless otherwise noted)						
$V_{(WAKE)}$	Positive or negative wake threshold with 1.00 mV, 2.25 mV, 4.5 mV and 9 mV programmable options		1.25	[redacted]		
$V_{(WAKE\_ACR)}$	Accuracy of $V_{(WAKE)}$	$V_{(WAKE)}$ = 1 mV; $I_{(WAKE)}$= 0, RSNS1 = 0, RSNS0 = 1;	-0.7	[redacted]		
		$V_{(WAKE)}$ = 2.25 mV; $I_{(WAKE)}$ = 1, RSNS1 = 0, RSNS0 = 1; $I_{(WAKE)}$ = 0, RSNS1 = 1, RSNS0 = 0;	-0.8	[redacted]		
		$V_{(WAKE)}$ = 4.5 mV; $I_{(WAKE)}$ = 1, RSNS1 = 1, RSNS0 = 1; $I_{(WAKE)}$ = 0, RSNS1 = 1, RSNS0 = 0;	-1.0	[redacted]		
		$V_{(WAKE)}$ = 9 mV; $I_{(WAKE)}$ = 1, RSNS1 = 1, RSNS0 = 1;	-1.4	[redacted]		
$V_{(WAKE\_TCO)}$	Temperature drift of $V_{(WAKE)}$ accuracy			0.5	[redacted]	
$t_{(WAKE)}$	Time from application of current and wake of bq20z45-R1			1	[redacted]	
POWER-ON RESET						
V_{IT-}	Negative-going voltage input	Voltage at REG25 pin	1.70	1.80	[redacted]	
V_{hys}	Hysteresis	$V_{IT+} – V_{IT-}$	50	150	[redacted]	
t_{RST}	$\overline{RESET}$ active low time	active low time after power up or watchdog reset	100	250	[redacted]	
WATCHDOG TIMER						
t_{WDTINT}	Watchdog start up detect time		250	500	10[redacted]	
t_{WDWT}	Watchdog detect time		50	100	[redacted]	
2.5V LDO;						
					[redacted]	

LDO;1100 Tz 81. (2.5V)Tj 16.5 0 Td (LDO;)Tj 19 57 281.2 Td V

1.25

overoperatingfree-airtemperaturerange(unlessotherwisenoted),T
V

[redacted]

[redacted]

		100	

m1olta400Td 2442.4 Td (m;0Td 6200Td (REG33)Tj 25.0.200Td (to7 Tf09 0 Tz.3 re 0 0 1f7 39 85.0.20,)Tj VCELL+REF8 00TdTd (V)Tj /F f5 Tf 4.64-1.7 Td 85.0.2f09 0 TzTrans ET BT /F236 (=)Tj 75

1000

[redacted]

ELECTRICAL CHARACTERISTICS (continued)

over operating free-air temperature range (unless otherwise noted), T_A = –40°C to 85°C, $V_{(REG25)}$ = 2.41 V to 2.59 V, $V_{(BAT)}$ = 14 V, $C_{(REG25)}$ = 1 µF, $C_{(REG33)}$ = 2.2 µF; typical values at T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
	Effective input resistance(10)	T_A = 25°C to 85°C	2.5			MΩ
INTERNAL TEMPERATURE SENSOR						
$V_{(TEMP)}$	Temperature sensor voltage(11)			-2.0		mV/°C
VOLTAGE REFERENCE						
	Output voltage		1.215	1.225	1.230	V
	Output voltage drift			65		PPM/°C
HIGH FREQUENCY OSCILLATOR						
$f_{(OSC)}$	Operating frequency			4.194		MHz
$f_{(EIO)}$	Frequency error (12) (13)		–3%	0.25%	3%	
		T_A = 20°C to 70°C	–2%	0.25%	2%	
$t_{(SXO)}$	Start-up time(14)			2.5	5	ms
LOW FREQUENCY OSCILLATOR						
$f_{(LOSC)}$	Operating frequency			32.768		kHz
$f_{(LEIO)}$	Frequency error(13) (15)		–2.5%	0.25%	2.5%	
		T_A = 20°C to 70°C	–1.5%	0.25%	1.5%	
$t_{(LSXO)}$	Start-up time(14)				500	µs

(10) The CC input is a switched capacitor input. Since the input is switched, the effective input resistance is a measure of the average resistance.
(11) –53.7 LSB/°C
(12) The frequency error is measured from 4.194 MHz.
(13) The frequency drift is included and measured from the trimmed frequency at $V_{(REG25)}$ = 2.5V, T_A = 25°C
(14) The startup time is defined as the time it takes for the oscillator output frequency to be ±3%
(15) The frequency error is measured from 32.768 kHz.

DATA FLASH CHARACTERISTICS OVER RECOMMENDED OPERATING TEMPERATURE AND SUPPLY VOLTAGE

Typical Values at T_A = 25°C and $V_{(REG25)}$ = 2.5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
	Data retention	See (1)	10			Years
	Flash programming write-cycles		20k			Cycles
$t_{(ROWPROG)}$	Row programming time				2	ms
$t_{(MASSERASE)}$	Mass-erase time				200	ms
$t_{(PAGEERASE)}$	Page-erase time				20	ms
$I_{(DDPROG)}$	Flash-write supply current			5	10	mA
$I_{(DDERASE)}$	Flash-erase supply current			5	10	mA
RAM BACKUP						
$I_{(RB)}$	RB data-retention input current	$V_{(RBI)} > V_{(RBI)MIN}$, $V_{REG25} < V_{IT-}$, T_A = 85°C		1000	2500	nA
		$V_{(RBI)} > V_{(RBI)MIN}$, $V_{REG25} < V_{IT-}$, T_A = 25°C		90	220	
$V_{(RB)}$	RB data-retention input voltage (1)		1.7			V

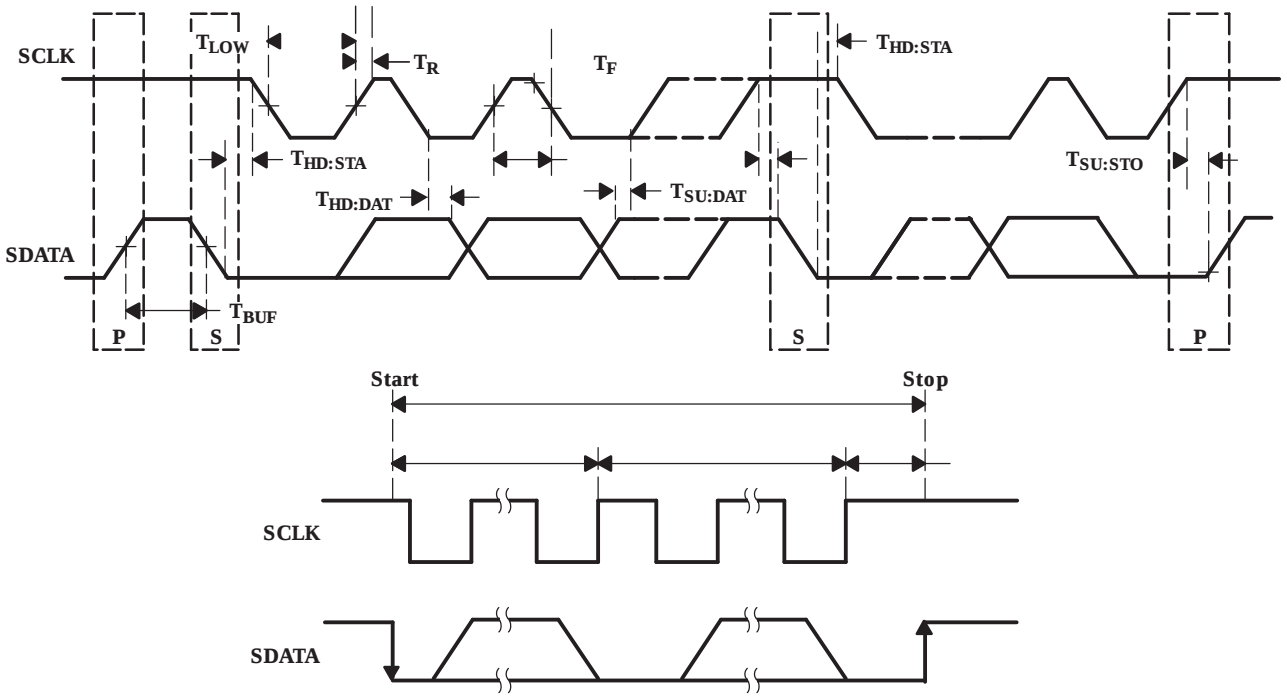
(1) Specified by design. Not production tested.

SMBus TIMING CHARACTERISTICS

T_A = –40°C to 85°C Typical Values at T_A = 25°C and V_{REG25} = 2.5 V (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		kHz
$t_{(BUF)}$	Bus free time between start and stop (see Figure 1)		4.7			µs
$t_{(HD:STA)}$	Hold time after (repeated) start (see Figure 1)		4			µs
$t_{(SU:STA)}$	Repeated start setup time (see Figure 1)		4.7			µs
$t_{(SU:STO)}$	Stop setup time (see Figure 1)		4			µs
$t_{(HD:DAT)}$	Data hold time (see Figure 1)	Receive mode	0			ns
		Transmit mode	300			
$t_{(SU:DAT)}$	Data setup time (see Figure 1)		250			ns
$t_{(TIMEOUT)}$	Error signal/detect (see Figure 1)	See (1)	25		35	µs
$t_{(LOW)}$	Clock low period (see Figure 1)		4.7			µs
$t_{(HIGH)}$	Clock high period (see Figure 1)	See (2)	4		50	µs
$t_{(LOW:SEXT)}$	Cumulative clock low slave extend time	See (3)			25	ms
$t_{(LOW:MEXT)}$	Cumulative clock low master extend time (see Figure 1)	See (4)			10	ms
t_f	Clock/data fall time	See (5)			300	ns
t_r	Clock/data rise time	See (6)			1000	ns

(1) The bq20z45-R1 times out when any clock low exceeds $t_{(TIMEOUT)}$.
(2) $t_{(HIGH)}$, Max, is the minimum bus idle time. SMBC = SMBD = 1 for t > 50 ms causes reset of any transaction involving bq20z45-R1 that is in progress. This specification is valid when the NC_SMB control bit remains in the default cleared state (CLK[0]=0).
(3) $t_{(LOW:SEXT)}$ 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.
(5) Rise time $t_r = V_{IL}MAX – 0.15)$ to $(V_{IH}MIN + 0.15)$
(6) Fall time $t_f = 0.9V_{DD}$ to $(V_{IL}MAX – 0.15)$



A. SCLKACK is the acknowledge-related clock pulse generated by the master.

Figure 1. SMBus Timing Diagram

FEATURE SET

Primary (1st Level) Safety Features

The bq20z45-R1 supports a wide range of battery and system protection features that can easily be configured. The primary safety features include:

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

Secondary (2nd Level) Safety Features

The secondary safety features of the bq20z45-R1 can be used to indicate more serious faults via the SAFE (pin 7). This pin can be used to blow an in-line fuse to permanently disable the battery pack from charging or discharging. The secondary safety protection features include:

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

Charge Control Features

The bq20z45-R1 charge control features include:

- Supports JEITA temperature ranges. Reports charging voltage and charging current according to the active temperature range.
- Handles more complex charging profiles. Allows for splitting the

Lifetime Data Logging Features

The bq20z45-R1 offers lifetime data logging, where important measurements are stored for warranty and analysis purposes. The data monitored include:

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

Authentication

The bq20z45-R1 supports authentication by the host using SHA-1.

Power Modes

The bq20z45-R1 supports 3 different power modes to reduce power consumption:

- In Normal Mode, the bq20z45-R1 performs measurements, calculations, protection decisions and data updates in 1 second intervals. Between these intervals, the bq20z45-R1 is in a reduced power stage.
- In Sleep Mode, the bq20z45-R1 performs measurements, calculations, protection decisions and data update in adjustable time intervals. Between these intervals, the bq20z45-R1 is in a reduced power stage. The bq20z45-R1 has a wake function that enables exit from Sleep mode, when current flow or failure is detected.
- In Shutdown Mode the bq20z45-R1 is completely disabled.

CONFIGURATION

Oscillator Function

BatteryMode

RelativeStateOfCharge

65434

APPLICATION SCHEMATIC

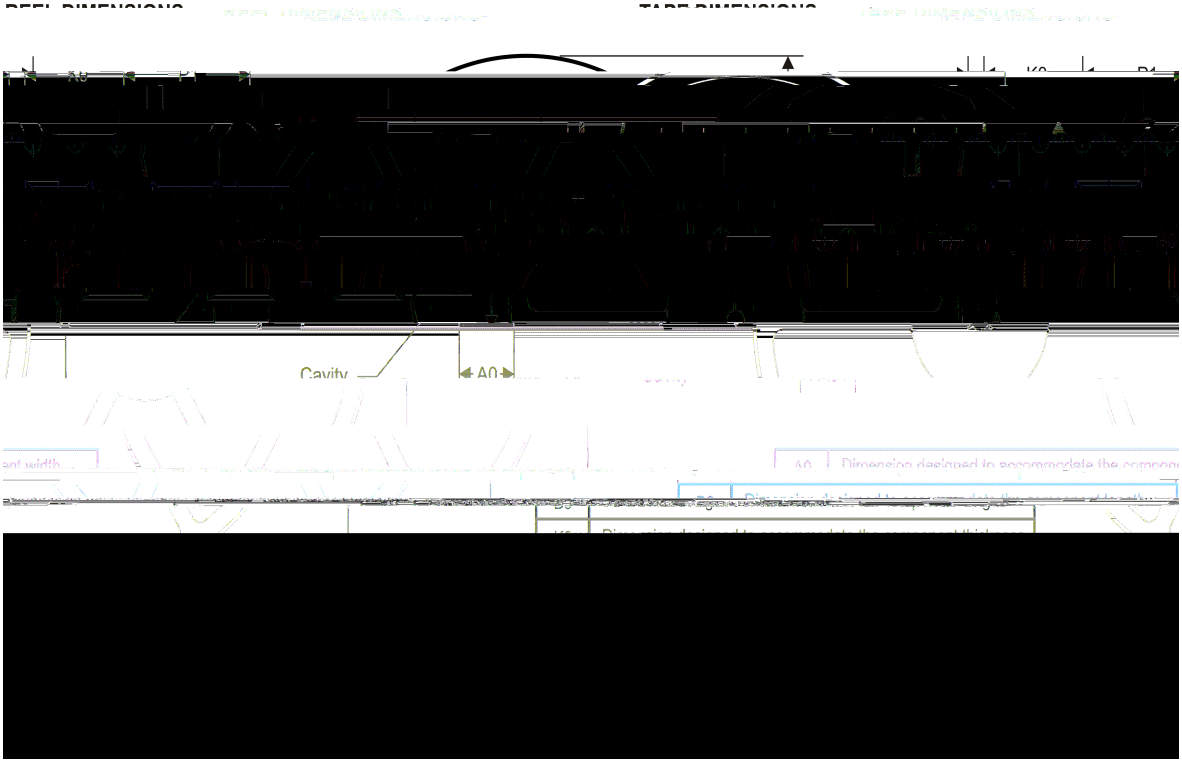
PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/ Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
BQ20Z45DBT-R1	ACTIVE	TSSOP	DBT	38	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	
BQ20Z45DBTR-R1	ACTIVE	TSSOP	DBT	38	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	

(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.

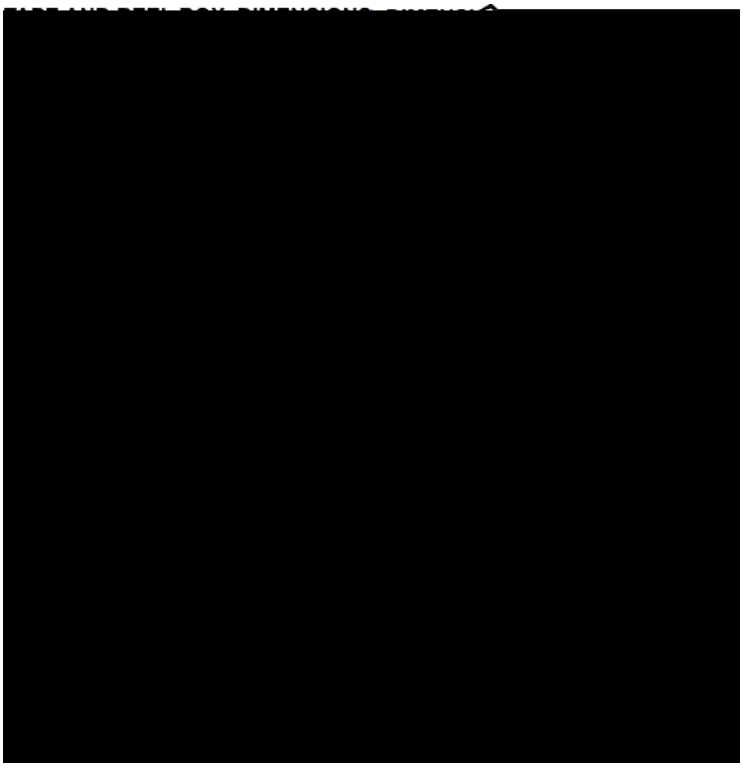
(2)

TAPE AND REEL INFORMATION



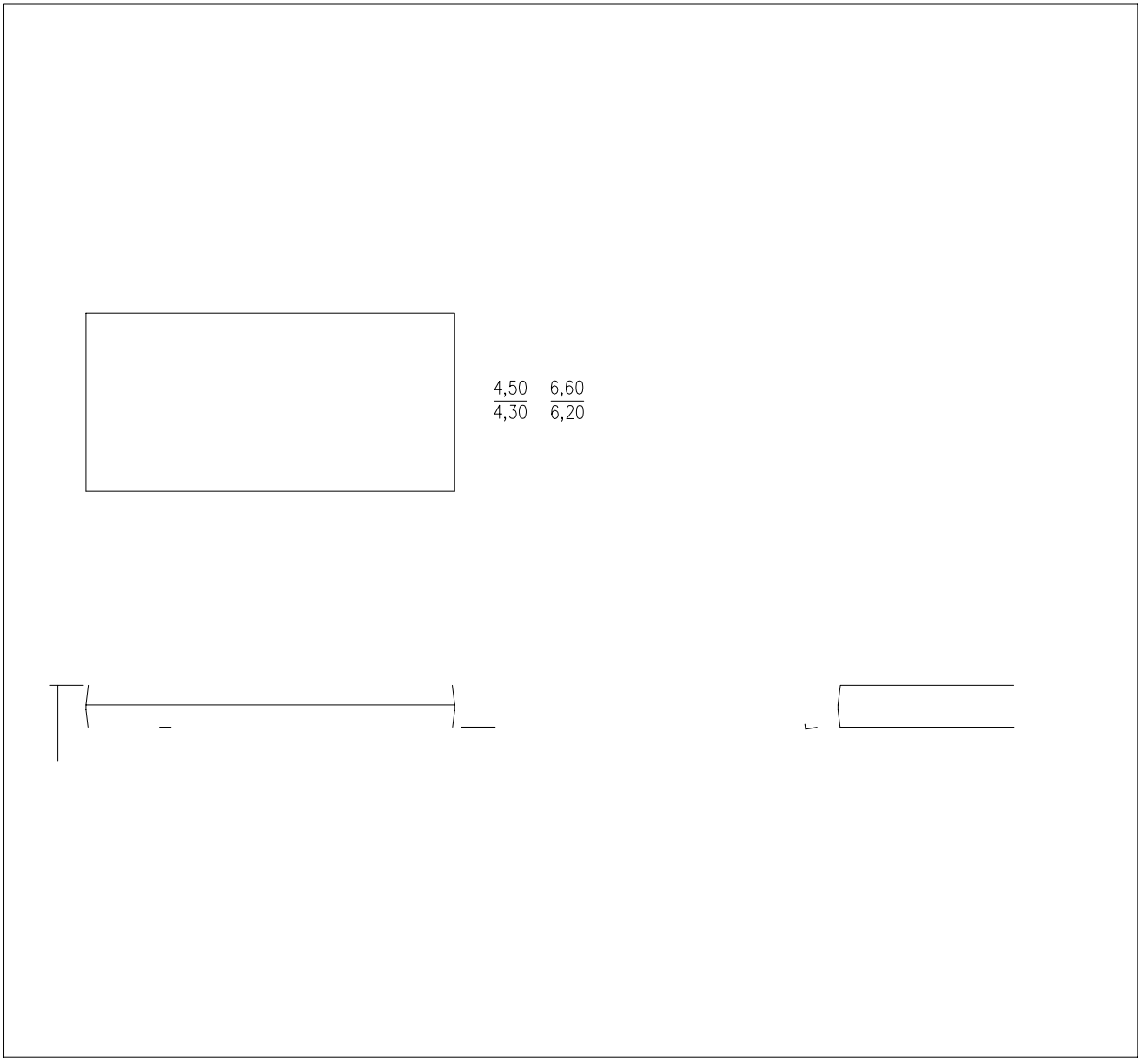
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
BQ20Z45DBTR-R1	TSSOP	DBT	38	2000	330.0	16.4	6.9	10.2	1.8	12.0	16.0	Q1



*All dimensions are nominal

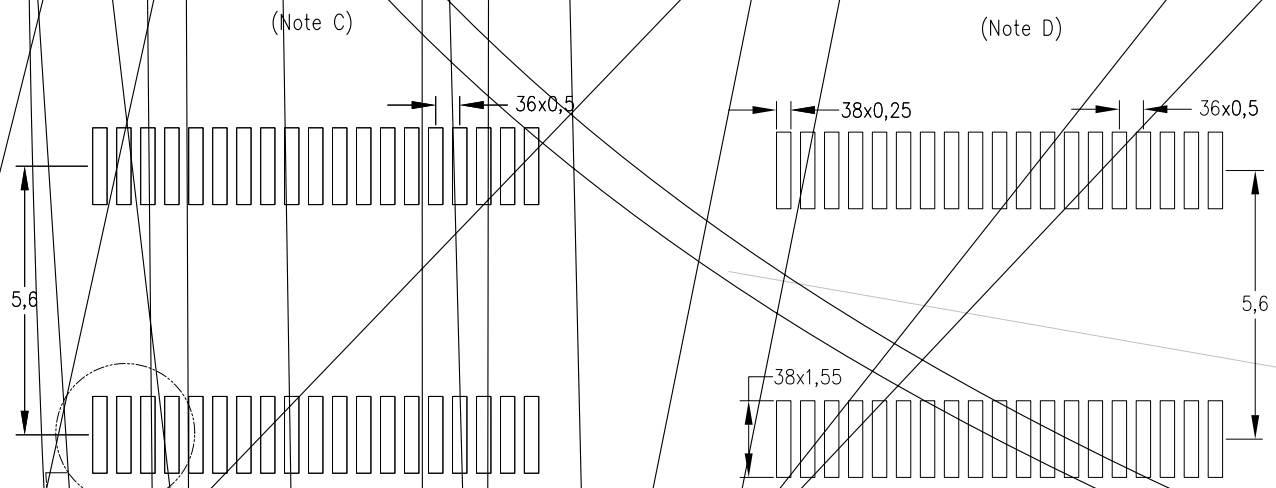
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
BQ20Z45DBTR-R1	TSSOP	DBT	38	2000	367.0	367.0	38.0



D. Falls within JEDEC MO–153.

LAND PATTERN DATA

PLASTIC SMALL OUTLINE



Example
Non Solder mask Defined Pad

(Note E)

4211881/A 06/11

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 d
D. ures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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