

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

Check for Samples: [bq20z655-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-Series to 4-Series Li-Ion and Li-Polymer Cells
- ‡ Powerful 8-Bit RISC CPU with Ultralow Power Modes
- ‡ Charge Enable (CE) Affects the Normal Operation on the Charge FET when the Battery Is in Charge/Relax Mode
- ‡ Full Array of Programmable Protection Features
 - ± Voltage, Current, and Temperature
- ‡ Satisfies JEITA Guidelines
- ‡ Added Flexibility to Handle More Complex Charging Profiles
- ‡ Lifetime Data Logging
- ‡ Drives 3, 4, or 5 Segment Liquid Crystal Display and LED for Battery-Pack Conditions
- ‡ Supports SHA-1 Authentication
- ‡ Complete Battery Protection and Gas Gauge Solution in One Package
- ‡ Available in a 44-Pin TSSOP (DBT) Package

APPLICATIONS

- Medical and Test Equipment
- Portable Instrumentation
- Rechargeable Battery Packs
- Industrial Equipment

DESCRIPTION

The bq20z655-R1 SBS-compliant gas gauge and protection IC, incorporating patented Impedance Track CE technology, is a single IC solution designed for battery-pack or in-system installation. The bq20z655-R1 measures and maintains an accurate record of available charge in Li-ion or Li-polymer batteries using its integrated high-performance analog peripherals. The bq20z655-R1 monitors capacity change, battery impedance, open-circuit voltage, and other critical parameters of the battery pack which 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 bq20z655-R1 maximizes functionality and safety while minimizing external component count, cost, and size in smart battery circuits.

The implemented Impedance Track CE 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⁾	
	44-PIN TSSOP (DBT) Tube	44-PIN TSSOP (DBT) Tape and Reel
-40 °C to 85 °C	bq20z655-R1 DBT ⁽²⁾	bq20z655-R1 DBTR ⁽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 40 units.

(3) A single reel quantity is 2000 units.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

Impedance Track is a trademark of Texas Instruments.

PACKAGE PINOUT DIAGRAM

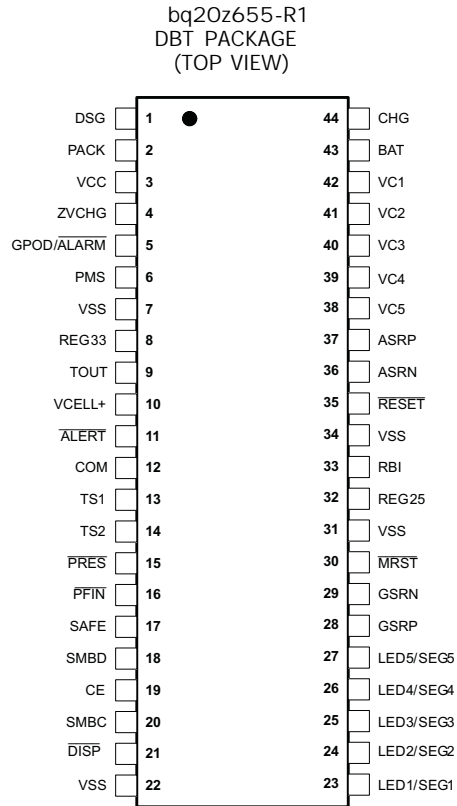


Figure 1. Package Pinout

TYPICAL LCD IMPLEMENTATION

Figure 2 shows a typical LCD implementation.

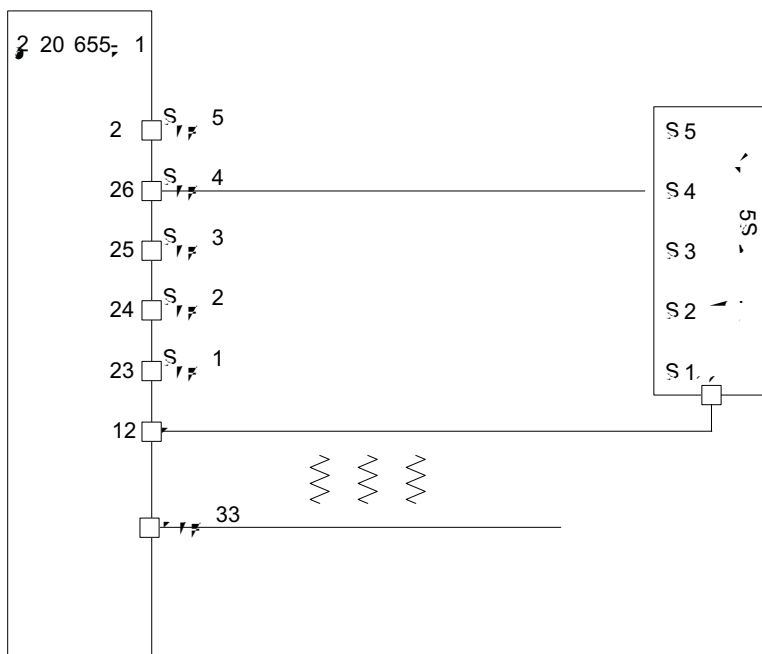
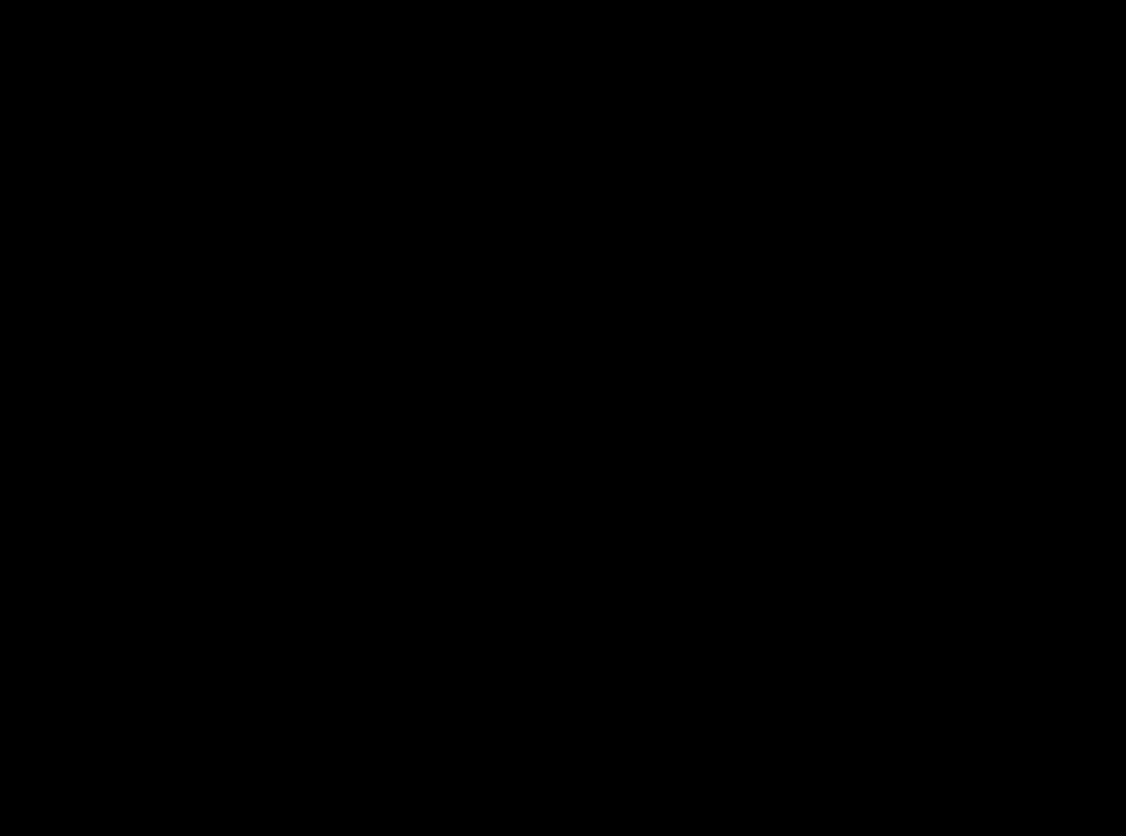


Figure 2. Typical LCD Implementation

TERMINAL FUNCTIONS (continued)

TERMINAL		I/O ⁽¹⁾	DESCRIPTION
NO.	NAME		
38	VC5	IA, P	Cell voltage sense input and cell balancing input for the negative voltage of the bottom cell in cell stack.
			Cell voltage sense input and cell balancing input for the positive input





--	--	--

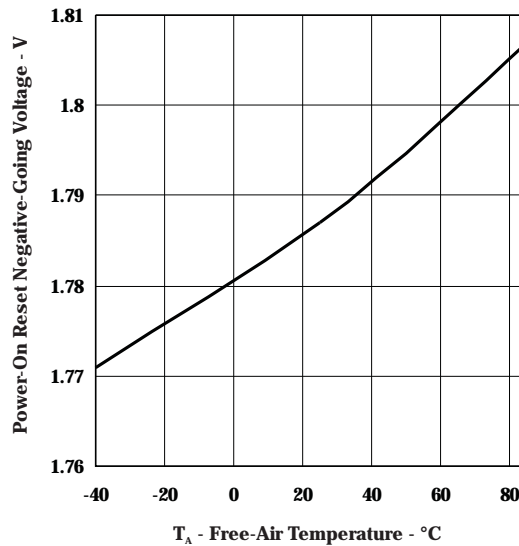
(REG25)(REG33)A

POWER-ON RESET

Over operating free-air temperature range (unless otherwise noted), $T_A = -40\text{ }^{\circ}\text{C}$ to $85\text{ }^{\circ}\text{C}$, $V_{(REG25)} = 2.41\text{ V}$ to 2.59 V , $V_{(BAT)} = 14\text{ V}$, $C_{(REG25)} = 1\text{ }\mu\text{F}$, $C_{(REG33)} = 2.2\text{ }\mu\text{F}$; typical values at $T_A = 25\text{ }^{\circ}\text{C}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
VIT- Negative-going voltage input		1.7	1.8	1.9	V
VHYS Power-on reset hysteresis		5	125	200	mV
t _{RST} $\overline{\text{RESET}}$ active low time	Active low time after power up or watchdog reset	100	250	560	μs

POWER ON RESET BEHAVIOR VS FREE-AIR TEMPERATURE

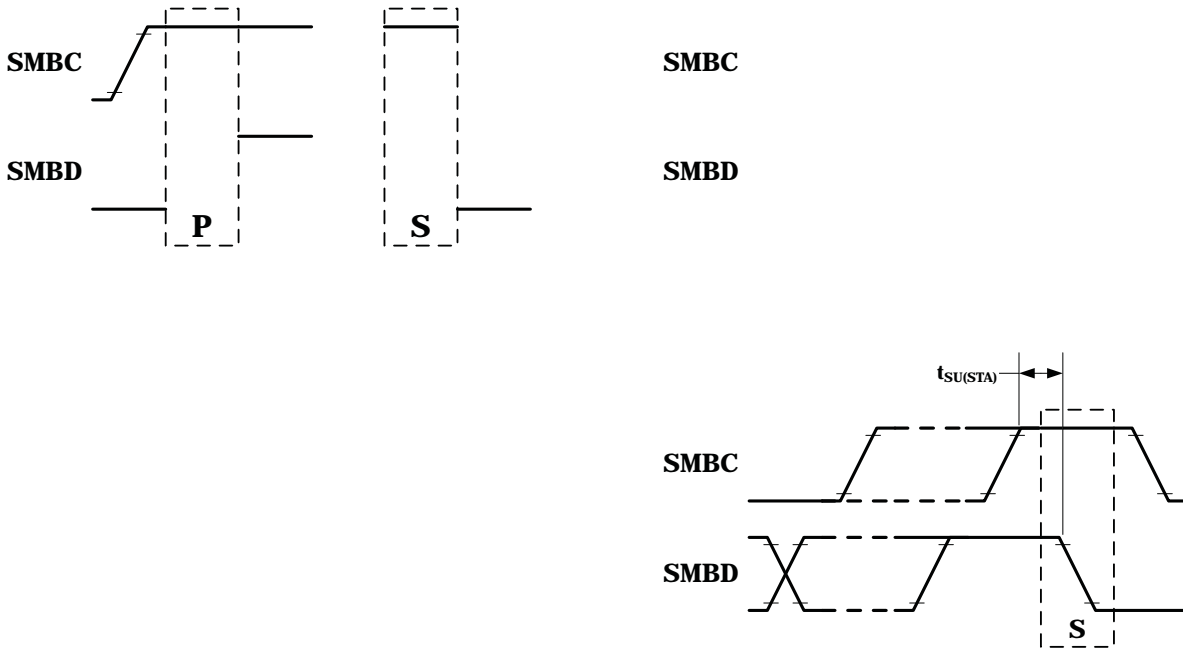


DATA FLASH CHARACTERISTICS OVER RECOMMENDED OPERATING TEMPERATURE AND SUPPLY VOLTAGE

Typical values at $T_A = 25\text{ }^{\circ}\text{C}$ and $V_{(REG25)} = 2.5\text{ V}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Data retention		10			Years
Flash programming write-cycles		20k			Cycles
t _(ROWPROG) Row programming time	See (1)			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/REGISTER BACKUP					
I _(RB) RB data-retention input current	$V_{(RBI)} \neq V_{(RBI)MIN}, V_{REG25} \quad V_{IT} \pm T_A = 85\text{ }^{\circ}\text{C}$		1000	2500	nA
	$V_{(RBI)} \neq V_{(RBI)MIN}, V_{REG25}$				





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

Figure 3. SMBus Timing Diagram

FEATURE SET

Primary (1st Level) Safety Features

The bq20z655-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 protection
- ‡ 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 bq20z655-R1 can be used to indicate more serious faults via the SAFE pin. 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
- ‡ 2nd level protection IC input
- ‡ Safety overcurrent in charge and discharge
- ‡ Safety over-temperature in charge and discharge with independent alarms and thresholds for each thermistor
- ‡ Charge FET and zero-volt charge FET fault
- ‡ Discharge FET fault
- ‡ Cell imbalance detection (active and at rest)
- ‡ Open thermistor detection
- ‡ Fuse blow detection
- ‡ AFE communication fault

Charge Control Features

The bq20z655-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 standard temperature range into two sub-ranges and allows for varying the charging current according to the cell voltage.
- ‡ Reports the appropriate charging current needed for constant current charging and the appropriate charging voltage needed for constant voltage charging to a smart charger using SMBus broadcasts.
- ‡ Determines the chemical state of charge of each battery cell using Impedance Track CE and can reduce the charge difference of the battery cells in fully charged state of the battery pack gradually using cell balancing algorithm during charging. This prevents fully charged cells from overcharging and causing excessive degradation and also increases the usable pack energy by preventing premature charge termination
- ‡ Supports pre-charging/zero-volt charging
- ‡ Supports charge inhibit and charge suspend if battery pack temperature is out of temperature range
- ‡ Reports charging fault and also indicate charge status via charge and discharge alarms.

Gas Gauging

The bq20z655-R1 uses the Impedance Track CE 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 the *Theory and Implementation of Impedance Track Battery Fuel-Gauging Algorithm* application note ([SLUA364](#)) for further details.

Lifetime Data Logging Features

The bq20z655-R1 offers lifetime data logging, where important measurements are stored for warranty and analysis purposes. The data monitored include:

- ‡ Lifetime maximum temperature
- ‡ Lifetime maximum temperature count
- ‡ Lifetime maximum temperature duration
- ‡ Lifetime minimum temperature
- ‡ Lifetime maximum battery cell voltage
- ‡ Lifetime maximum battery cell voltage count
- ‡ Lifetime maximum battery cell voltage duration
- ‡ 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 bq20z655-R1 supports authentication by the host using SHA-1.

Power Modes

The bq20z655-R1 supports three different power modes to reduce power consumption:

- ‡ In Normal Mode, the bq20z655-R1 performs measurements, calculations, protection decisions and data updates in 1 second intervals. Between these intervals, the bq20z655-R1 is in a reduced power stage.
- ‡ In Sleep Mode, the bq20z655-R1 performs measurements, calculations, protection decisions and data update in adjustable time intervals. Between these intervals, the bq20z655-R1 is in a reduced power stage. The bq20z655-R1 has a wake function that enables exit from Sleep mode, when current flow or failure is detected.
- ‡ In Shutdown Mode, the bq20z655-R1 is completely disabled.

CONFIGURATION

Oscillator Function

The bq20z655-R1 fully integrates the system oscillators therefore, no external components are required for this feature.

System Present Operation

The bq20z655-R1 periodically verifies the $\overline{\text{PRES}}$ pin and detects that the battery is present in the system via a low state on a $\overline{\text{PRES}}$ input. When this occurs, the bq20z655-R1 enters normal operating mode. When the pack is removed from the system and the $\overline{\text{PRES}}$ input is high, the bq20z655-R1 enters the battery-removed state, disabling the charge, discharge, and ZVCHG FETs. The $\overline{\text{PRES}}$ input is ignored and can be left floating when non-removal mode is set in the data flash.

BATTERY PARAMETER MEASUREMENTS

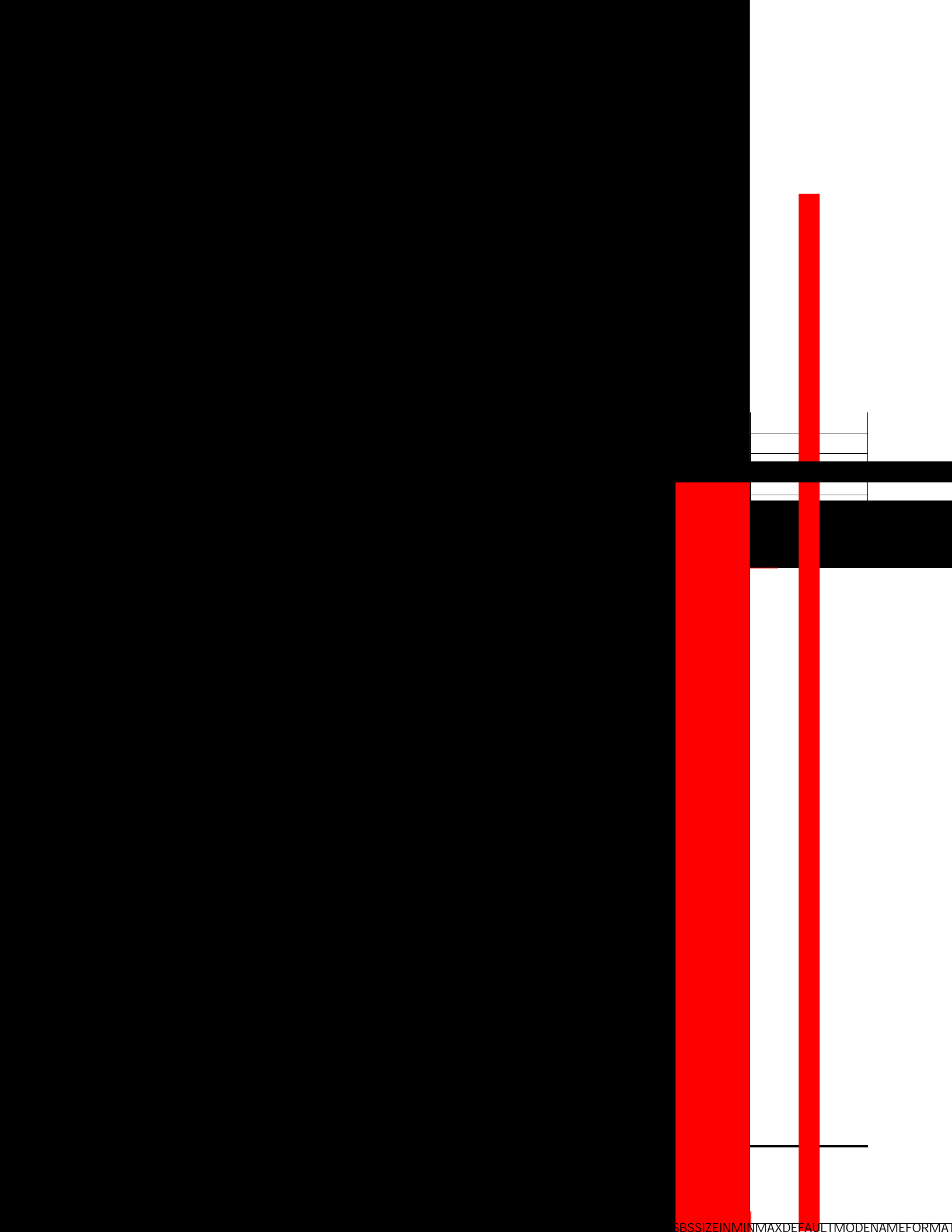
The bq20z655-R1 uses an integrating delta-sigma analog-to-digital

Table 2. SBS COMMANDS (continued)

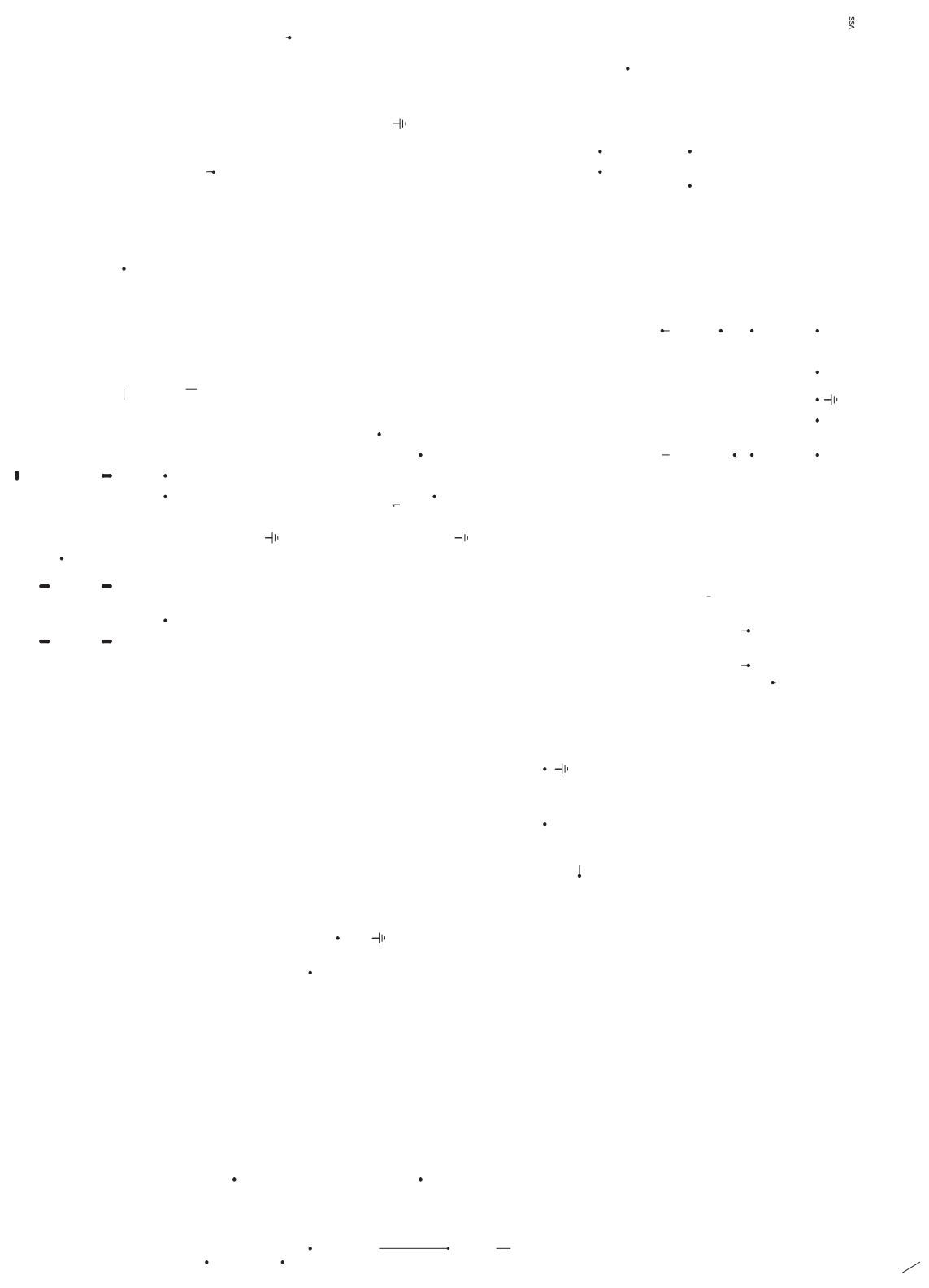
SBS CMD	MODE	NAME	FORMAT	SIZE IN BYTES	MIN VALUE	MAX VALUE	DEFAULT VALUE	UNIT
0x1a	R/W	SpecificationInfo	Hex	2	0x0000	0xffff	0x0031	2
0x1b	R/W	ManufactureDate	Unsigned integer	2	0	65,535	0	2
0x1c	R/W	SerialNumber	Hex	2	0x0000	0xffff	0x0000	2
0x20	R/W	ManufacturerName	String	20+1	2	2	Texas Instruments	2
0x21	R/W	DeviceName	String	20+1	2	2	bq20z655-R1	2
0x22	R/W	DeviceChemistry	String	4+1	2	2	LION	2
0x23	R	ManufacturerData	String	14+1	2	2	2	2
0x2f	R/W	Authenticate	String	20+1	2	2	2	2
0x3c	R	CellVoltage4	Unsigned integer	2	0	65,535	2	mV
0x3d	R	CellVoltage3	Unsigned integer	2	0	65,535	2	mV
0x3e	R	CellVoltage2	Unsigned integer	2	0	65,535	2	mV
0x3f	R	CellVoltage1	Unsigned integer	2	0	65,535	2	mV

Table 3. EXTENDED SBS COMMANDS

SBS CMD	MODE	NAME	FORMAT	SIZE IN BYTES	MIN VALUE	MAX VALUE	DEFAULT VALUE	UNIT
0x45	R	AFEDData	String	11+1	2	2	2	2
0x46	R/W	FETControl	Hex	2	0x00	0xff	2	2
0x4f	R	StateOfHealth	Hex	2	0x0000	0xffff	2	%
0x51	R	SafetyStatus	Hex	2	0x0000	0xffff	2	2
0x52	R	PFAAlert	Hex	2	0x0000	0xffff	2	2
0x53	R	PFStatus	Hex	2	0x0000	0xffff	2	2
0x54	R	OperationStatus	Hex	2	0x0000	0xffff	2	2
0x55	R	ChargingStatus	Hex	2	0x0000	0xffff	2	2
0x57	R	ResetData	Hex	2	0x0000	0xffff	2	2
0x58	R	WDRresetData	Unsigned integer	2	0	65,535	2	2
0x5a	R	PackVoltage	Unsigned integer	2	0	65,535	2	mV
0x5d	R	AverageVoltage	Unsigned integer	2	0	65,535	2	mV
0x5e	R	TS1Temperature	Integer	2	-400	1200	2	0.1 μ C
0x5f	R	TS2Temperature	Integer	2	-400	1200	2	0.1 μ C
0x60	R/W	UnSealKey	Hex	4	0x00000000	0xffffffff	2	2
0x61	R/W	FullAccessKey	Hex	4	0x00000000	0xffffffff	2	2
0x62	R/W	PFKey	Hex	4	0x00000000	0xffffffff	2	2
0x63	R/W	AuthenKey3	Hex	4	0x00000000	0xffffffff	2	2
0x64	R/W	AuthenKey2	Hex	4	0x00000000	0xffffffff	2	2
0x65	R/W	AuthenKey1	Hex	4	0x00000000	0xffffffff	2	2
0x66	R/W	AuthenKey0	Hex	4	0x00000000	0xffffffff	2	2
0x68	R	SafetyAlert2	Hex	2	0x0000	0x000f	2	2
0x69	R	SafetyStatus2	Hex	2	0x0000	0x000f	2	2
0x6a	R	PFAAlert2	Hex	2	0x0000	0x000f	2	2
0x6b	R	PFStatus2	Hex	2	0x0000	0x000f	2	2



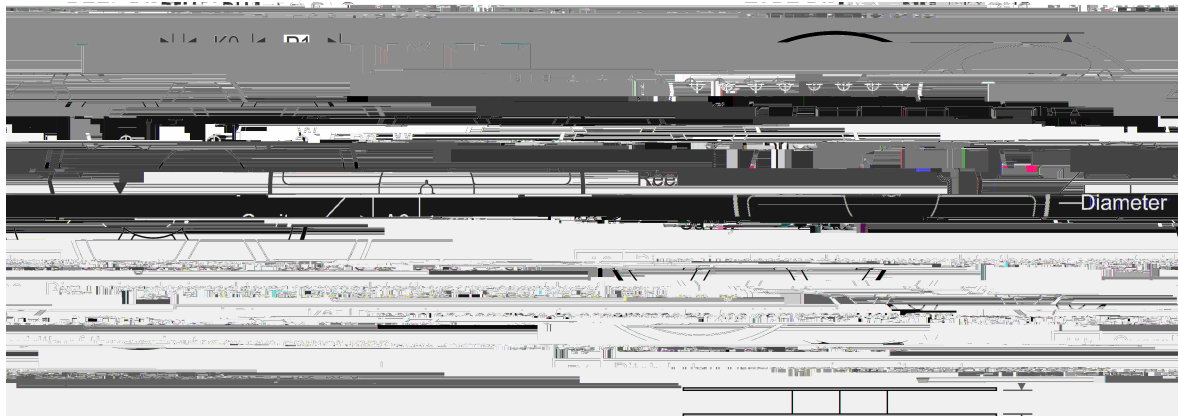
APPLICATION SCHEMATIC



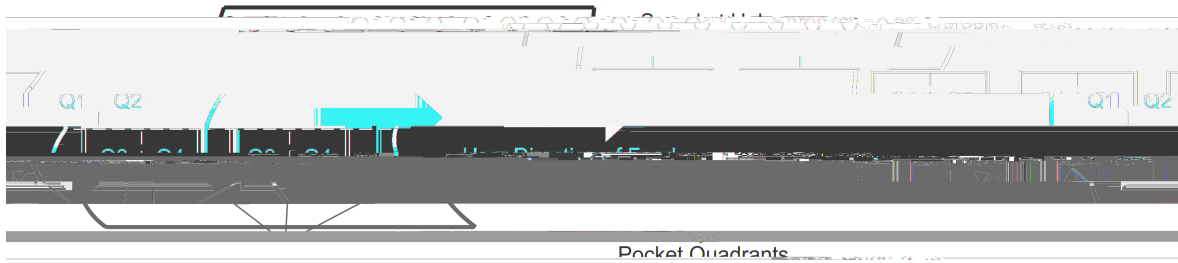
PACKAGING INFORMATION

--

TAPE AND REEL INFORMATION



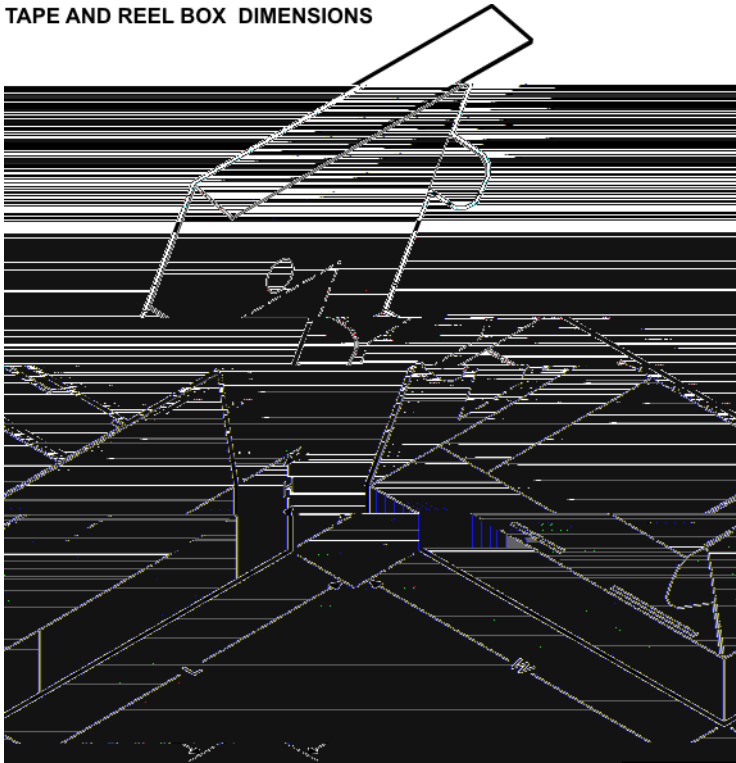
1) [www.ti.com](#)
 ASSIGNMENTS FOR PIN1 ORIENTATION BY TAPE QUADRANT



*All dimensions are nominal

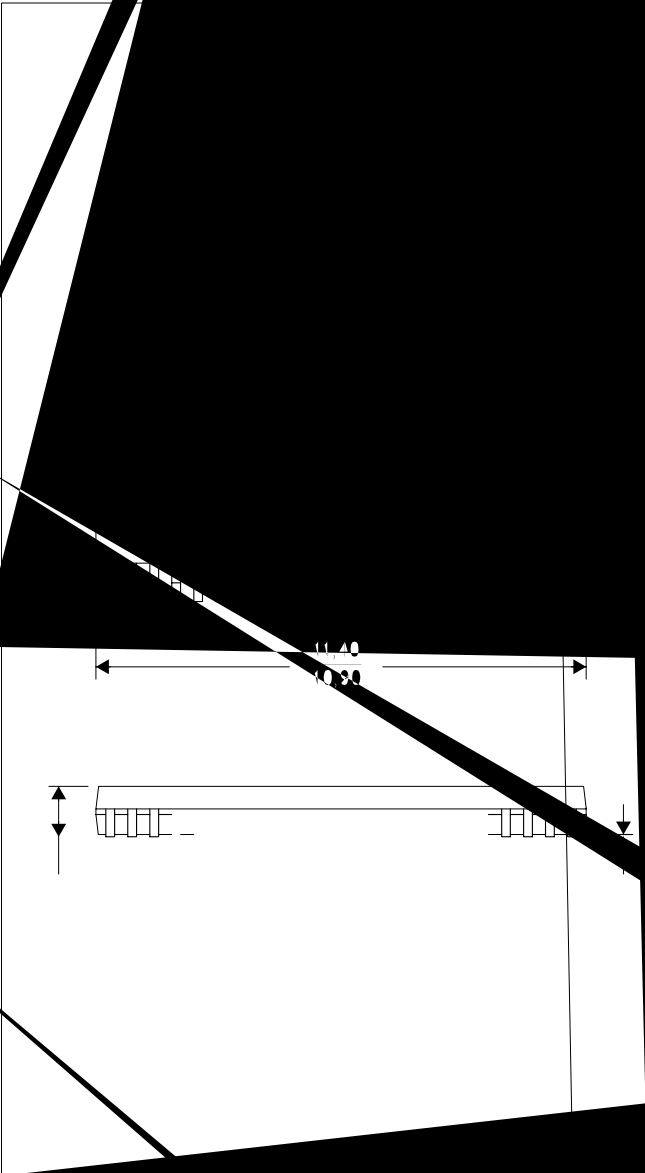
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
BQ20Z655DBTR-R1	TSSOP	DBT	44	2000	330.0	24.4	6.8	11.7	1.6	12.0	24.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
BQ20Z655DBTR-R1	TSSOP	DBT	44	2000	367.0	367.0	45.0



IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated on TI data sheets is not permitted. Contact your TI sales representative for details.