

Standard SBS Commands

The bq20z90/bq20z95 SBS command set meets the SBD v1.1 specification. All SBS Values are updated in 1-second intervals.

A.1 ManufacturerAccess(0x00)

This read- or write-word function provides battery-system level data, access to test controls, and security features.

Table A-1. ManufacturerAccess

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x00	R/W	ManufacturerAccess	hex	2	0x0000	0xffff	-	

A.1.1 System Data

The results of these commands need to be read from *ManufacturerAccess* after a write with the command word to *ManufacturerAccess*.

A.1.1.1 Device Type(0x0001)

Returns the IC part number.

Table A-2. Device Type

Manufacturer Access	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x0001	R	Device Type	hex	2	-	-	0x0900	

A.1.1.2 Firmware Version(0x0002)

Returns the firmware version. The format is most-significant byte (MSB) = Decimal integer, and the least-significant byte (LSB) = sub-decimal integer, e.g.: 0x0120 = version 01.20.

Table A-3. Firmware Version

Manufacturer Access	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x0002	R	Firmware Version	hex	2	-	-	0x0102	

A.1.1.3 Hardware Version(0x0003)

Returns the hardware version stored in a single byte of reserved data flash. e.g.: 0x00a7 = Version A7.

Table A-4. Hardware Version

Manufacturer Access	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x0003	R	Hardware Version	hex	2	-	-	0x00a7	

A.1.1.4 DF Checksum(0x0004)

This function is only available when the bq20z90/bq20z95 is in unsealed mode or full access mode, indicated by the *[SS]* and *[FAS]* flag. A write to this command forces the bq20z90/bq20z95 to generate a checksum of the full Data Flash (DF) array. The generated checksum is then returned within 45 ms.

Note: If another SMBus command is received while the checksum is being generated, the DF Checksum is generated but the response may be time out (<25ms).

Table A-5. DF Checksum

Manufacturer Access	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x0004	R	DF Checksum	hex	2	-	-	-	

A.1.1.5 Manufacturer Status(0x0006)

This function is available while the bq20z90/bq20z95 is in normal operation. This 16-bit word reports the battery status.

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
High Byte	FET1	FET0	PF1	PF0	STATE3	STATE2	STATE1	STATE0
Low Byte	0	0	0	0	1	0	1	0

LEGEND: All bits are read only

Figure A-1. Manufacturer Status

FET1, FET0 — Indicates the state of the charge and discharge FETs

- 0,0 = Both charge and discharge FETs are on.
- 0,1 = CHG FET is off, DSG FET is on.
- 1,0 = Both charge and discharge FETs are off.
- 1,1 = CHG FET is on, DSG FET is off.

PF1, PF0 — Indicates permanent failure cause when permanent failure indicated by STATE3..STATE0

- 0,0 = Fuse is blown if enabled via DF:Configuration:Register(64):Permanent Fail Cfg(6)
- 0,1 = Cell imbalance failure
- 1,0 = Safety voltage failure
- 1,1 = FET failure

STATE3, STATE2, STATE1, STATE0 — Indicates the battery state.

0,0,0,0 = Wake Up
 0,0,0,1 = Normal Discharge
 0,0,1,1 = Pre-Charge
 0,1,0,1 = Charge
 0,1,1,1 = Charge Termination
 1,0,0,0 = Fault Charge Terminate
 1,0,0,1 = Permanent Failure
 1,0,1,0 = Overcurrent
 1,0,1,1 = Overtemperature
 1,1,0,0 = Battery Failure
 1,1,0,1 = Sleep
 1,1,1,0 = Reserved
 1,1,1,1 = Battery Removed

A.1.1.6 Chemistry ID(0x0008)

Returns the OCV table chemistry ID of the battery. The default table ID is 0x0100. For a list of OCV chemistry IDs, refer to "Support of Multiple Li-Ion Chemistries w/Impedance Track(TM) Gas Gauges", application note, (SLUA372).

Table A-6. Chemistry ID

Manufacturer Access	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x0008	R	Chemistry ID	hex	2	0x0000	0xffff	0x0100	

A.1.2 System Control

The commands in this section cause the bq20z90/bq20z95 to take actions when written. No data is returned.

A.1.2.1 Shutdown(0x0010)

Instructs the bq20z90/bq20z95 to verify and enter shutdown mode. This command is only available when the bq20z90/bq20z95 is in Unsealed or Full Access mode. Shutdown will not be entered unless the *PackVoltage* < **Charger Present** and *Current* 0.

Related Variables:

DF:Power:Power(68):Charger Present(8)
 SBS:Current(0x0a)
 SBS:OperationStatus(0x54)[SS],[FAS]
 SBS:PackVoltage(0x5a)

A.1.2.2 Sleep(0x0011)

Instructs the bq20z90/bq20z95 to verify and enter sleep mode if no other command is sent after the *Sleep* command. Any SMB transition will wake up the bq20z90/bq20z95. It takes about 1 min. before the device will go to sleep. This command is only available when the bq20z90/bq20z95 is in Unsealed or Full Access mode.

Related Variables:

DF:Configuration:Registers(64):Operation Cfg A(0)[SLEEP]
SBS:OperationStatus(0x54)[SS],[FAS]

A.1.2.3 Seal Device(0x0020)

Instructs the bq20z90/bq20z95 to limit access to the extended SBS functions and data flash space, sets the [SS] flag, and clears the [FAS] flag.

This command is only available when the bq20z90/bq20z95 is in Unsealed or Full Access mode.

See "Security" chapter in this document for detailed information.

Related Variables:

SBS:OperationStatus(0x54)[SS],[FAS]

A.1.2.4 IT Enable(0x0021)

This command forces the bq20z90/bq20z95 to begin the Impedance Track™ algorithm, changes **Update Status**, and sets the [QEN] flag.

This command is only available when the bq20z90/bq20z95 is in Unsealed or Full Access mode.

Related Variables:

DF:Gas Gauging:State(82):Update Status(12)
SBS:OperationStatus(0x54)[VOK],[QEN],[SS],[FAS]

A.1.2.5 SAFE Activation(0x0030)

This command drives the SAFE pin high.

This command is only available when the bq20z90/bq20z95 is in Unsealed or Full Access mode.

Related Variables:

SBS:OperationStatus(0x54)[SS],[FAS]

A.1.2.6 SAFE Clear(0x0031)

This command sets the SAFE pin back to low.

This command is only available when the bq20z90/bq20z95 is in Unsealed or Full Access mode.

Related Variables:

SBS:OperationStatus(0x54)[SS],[FAS]

A.1.2.7 LEDs ON(0x0032)

Activates all configured LEDs to stay on.

This command is only available when the bq20z90/bq20z95 is in Unsealed or Full Access mode.

Related Variables:

DF:Configuration:Registers(64):Operation Cfg A(0)[LED1],[LED0]
SBS:OperationStatus(0x54)[SS],[FAS]

A.1.2.8 LEDs OFF(0x0033)

Deactivates all configured LEDs.

This command is only available when the bq20z90/bq20z95 is in Unsealed or Full Access mode.

Related Variables:

DF:Configuration:Registers(64)Operation Cfg A(0)[LED1],[LED0]
SBS:OperationStatus(0x54)[SS],[FAS]

A.1.2.9 Display ON(0x0034)

Simulates a H-L transition at $\overline{\text{DISP}}$ pin and activates the LED display to show charge level.
This command is only available when the bq20z90/bq20z95 is in Unsealed or Full Access mode.

Related Variables:

SBS:OperationStatus(0x54)[SS],[FAS]

A.1.2.10 Calibration Mode(0x0040)

Places the bq20z90/bq20z95 into calibration mode. See "Data Flash Programming/Calibrating the bq20z80 Gas Gauges (Rev. A) " application note (SLUA355A) for further details.

This command is only available when the bq20z90/bq20z95 is in Unsealed or Full Access mode.

Related Variables:

SBS:OperationStatus(0x54)[SS],[FAS]

A.1.2.11 Reset(0x0041)

The bq20z90/bq20z95 undergoes a full reset. The bq20z90/bq20z95 holds the clock line down for a few milli-seconds to complete the reset

This command is only available when the bq20z90/bq20z95 is in Unsealed or Full Access mode.

Related Variables:

SBS:OperationStatus(0x54)[SS],[FAS]

A.1.2.12 BootRom(0x0f00)

The bq20z90/bq20z95 goes into BootRom mode.

This command is only available when the bq20z90/bq20z95 is in Full Access mode.

Related Variables:

SBS:OperationStatus(0x54)[FAS]

A.1.2.13 Permanent Fail Clear(PFKey)

This 2 step command needs to be written to *ManufacturerAccess* in following order: 1st word of the *PFKey* first followed by the 2nd word of the *PFKey*. If the command fails 4 seconds must pass before the command can be reissued.

It instructs the bq20z90/bq20z95 to clear the *PFStatus*, clear the *[PF]* flag, clear the **Fuse Flag**, reset the *SAFE* pin, and unlock the data flash for writes.

This command is only available when the bq20z90/bq20z95 is in Unsealed or Full Access mode.

Related Variables:

DF:PF Status:Device Status Data(96):PF Flags 1(0)

DF:PF Status:Device Status Data(96):Fuse Flag(2)

SBS:SafetyStatus(0x51)[PF]

SBS:PFStatus(0x53)

SBS:OperationStatus(0x54)[SS],[FAS]

SBS:PFKey(0x62)

ManufacturerAccess(0x00)

Note: Higher word must be immediately followed by lower word. If clear command fails, command can only be repeated 4 seconds after previous attempt. If communication other than the lower word occurs after the first word is sent, the *Permanent Fail Clear* command fails.

A.1.2.14 Unseal Device (*UnsealKey*)

Instructs the bq20z90/bq20z95 to enable access to the SBS functions and data flash space and clear the *[SS]* flag. This 2 step command needs to be written to *ManufacturerAccess* in the following order: 1st word of the *UnSealKey* first followed by the 2nd word of the *UnSealKey*. If the command fails 4 seconds must pass before the command can be reissued.

This command is only available when the bq20z90/bq20z95 is in Sealed mode.

See "*Security*" chapter in this document for detailed information.

Related Variables:

SBS:OperationStatus(0x54)[SS]
SBS:UnSealKey(0x60)

A.1.2.15 Full Access Device (*FullAccessKey*)

Instructs the bq20z90/bq20z95 to enable full access to all SBS functions and data flash space and set the *[FAS]* flag. This 2 step command needs to be written to *ManufacturerAccess* in the following order: 1st word of the *FullAccessKey* first followed by the 2nd word of the *FullAccessKey*.

This command is only available when the bq20z90/bq20z95 is in Unsealed mode.

See "*Security*" chapter in this document for detailed information.

Related Variables:

SBS:OperationStatus(0x54)[SS],[FAS]
SBS:FullAccessKey(0x61)

A.1.3 Extended SBS Commands

Also available via *ManufacturerAccess* in sealed mode are some of the extended SBS commands. The commands available are listed below.

The result of these commands need to be read from *ManufacturerAccess* after a write to *ManufacturerAccess*.

0x0050 = SBS:SafetyAlert(0x50)
0x0051 = SBS:SafetyStatus(0x51)
0x0052 = SBS:PFAlert(0x52)
0x0053 = SBS:PFStatus(0x53)
0x0054 = SBS:OperationStatus(0x54)
0x0055 = SBS:ChargingStatus(0x55)
0x0057 = SBS:ResetData(0x57)
0x0058 = SBS:WDRResetData(0x58)
0x005a = SBS:PackVoltage(0x5a)
0x005d = SBS:AverageVoltage(0x5d)

A.2 RemainingCapacityAlarm(0x01)

This read- or write-word function sets or gets a low-capacity alarm threshold unsigned integer value with a range of 0 to 65535 and units of either mAh (*CapM* = 0) or 10 mWh (*CapM* = 1). The default value for *RemainingCapacityAlarm* is stored in **Rem Cap Alarm**. If *RemainingCapacityAlarm* is set to 0, the alarm is disabled.

If *RemainingCapacity* < *RemainingCapacityAlarm*, the [*RCA*] flag is set and the bq20z90/bq20z95 sends an *AlarmWarning* message to the SMBUS host.

If *RemainingCapacity* ≥ *RemainingCapacityAlarm* and [*DSG*] is set, the [*RCA*] flag is cleared.

- 0 = Remaining capacity alarm is disabled
- 1..700 = Remaining capacity limit for [*RCA*] flag

Table A-7. RemainingCapacityAlarm

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x01	R/W	RemainingCapacityAlarm	unsigned integer	2	0	700	300	mAh or 10mWh

Related Variables:

DF:SBS Configuration:Data(48):Rem Cap Alarm(0)
 SBS:BatteryMode(0x03)[CapM]
 SBS:RemainingCapacity(0x0f)
 SBS:BatteryStatus(0x16)[RCA],[DSG]

A.3 RemainingTimeAlarm(0x02)

This read- or write-word function sets or gets the *RemainingTimeAlarm* unsigned integer value in minutes with a range of 0 to 65535. The default value of *RemainingTimeAlarm* is stored in **Rem Time Alarm**. If *RemainingTimeAlarm* = 0, this alarm is disabled.

If *AverageTimeToEmpty* < *RemainingTimeAlarm*, the [*RTA*] flag is set and the bq20z90/bq20z95 sends an *AlarmWarning* message to the SMBus host.

If *AverageTimeToEmpty* ≥ *RemainingTimeAlarm*, the [*RTA*] flag is reset

- 0 = Remaining time alarm is disabled
- 1..30 = Remaining time limit for [*RTA*] flag

Table A-8. RemainingTimeAlarm

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x02	R/W	RemainingTimeAlarm	unsigned integer	2	0	30	10	min

Related Variables:

DF:SBS Configuration:Data(48):Rem Time Alarm(4)
 SBS:AverageTimeToEmpty(0x12)
 SBS:BatteryStatus(0x16)[RTA]

A.4 BatteryMode(0x03)

This read- or write-word function selects the various battery operational modes and reports the battery's capabilities and modes and flags minor conditions requiring attention.

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
High Byte	CapM	ChgM	AM	RSVD	RSVD	RSVD	PB	CC
Low Byte	CF	RSVD	RSVD	RSVD	RSVD	RSVD	PBS	ICC

LEGEND: High Byte is Read/Write, Low Byte is Read Only; RSVD = Reserved and **must** be programmed to 0

Figure A-2. BatteryMode

CapM — Sets the units used for capacity information and internal calculation.

- 0 = Reports in mA or mAh (default)
- 1 = Reports in 10mW or 10mWh

Following functions are instantaneously updated after *[CapM]* change:

SBS:RemainingCapacityAlarm(0x01)
 SBS:AtRate(0x04)
 SBS:RemainingCapacity(0x0f)
 SBS:FullChargeCapacity(0x10)
 SBS:DesignCapacity(0x18)

Following functions are recalculated within 1 second after *[CapM]* change:

SBS:RemainingTimeAlarm(0x02)
 SBS:AtRateTimeToEmpty(0x06)
 SBS:AtRateOK(0x07)
 SBS:RunTimeToEmpty(0x11)
 SBS:AverageTimeToEmpty(0x12)
 SBS:BatteryStatus(0x16)

ChgM: — Enables or disables the bq20z90/bq20z95 's transmission of *ChargingCurrent* and *ChargingVoltage* messages to the Smart Battery Charger.

- 0 = Enable *ChargingVoltage* and *ChargingCurrent* broadcasts to the Smart Battery Charger by setting the **[BCAST]** bit in **Operation Cfg B** when charging is desired.
- 1 = Disable *ChargingVoltage* and *ChargingCurrent* broadcasts to the Smart Battery Charger. (default)

Related Variables:

DF:Configuration:Registers(64):Operation Cfg B(2)[BCAST]
 SBS:ChargingCurrent(0x14)
 SBS:ChargingVoltage(0x15)

AM: — Enables or disables *AlarmWarning* broadcasts to the host and Smart Battery Charger

- 0 = Enable *AlarmWarning* broadcast to host and Smart Battery Charger by setting the **[BCAST]** bit in **Operation Cfg B** (default). The bq20z90/bq20z95 sends the *AlarmWarning* messages to the SMBus Host and the Smart Battery Charger any time an alarm condition is detected
- 1 = Disable *AlarmWarning* broadcast to host and Smart BatteryCharger. The bq20z90/bq20z95 does not master the SMBus, and *AlarmWarning* messages are not sent to the SMBus Host and the Smart Battery Charger for a period of no more than 65 seconds and no less than 45 seconds. **[AM]** is automatically cleared by the bq20z90/bq20z95 60 seconds after being set to 1, independent of the **[BCAST]** bit.

Related Variables:

DF:Configuration:Registers(64):Operation Cfg B(2)[BCAST]

Note: The system, as a minimum, is required to poll the Smart Battery Charger every 10 seconds if the **[AM]** flag is set.

PB: —Sets the role of the battery pack. This flag is not used by bq20z90/bq20z95 and should be set to 0.

CC: —Enable or disable internal charge controller. This flag is not used by bq20z90/bq20z95 and should be set to 0.

CF: —This flag is set if *MaxError* > **CF MaxError Limit**

- 0 = Battery OK
- 1 = Condition cycle requested

Related Variables:

DF:SBS Configuration:Data(48):CF MaxError Limit(21)

SBS:MaxError(0x0c)

PBS: — Primary battery support is not supported by bq20z90/bq20z95 and is fixed to 0.

ICC: — This flag indicates if internal charge controller function is supported or not. This value is fixed to 1.

A.5 AtRate(0x04)

This read- or write-word function is the first half of a two-function call set used to set the *AtRate* value used in calculations made by the *AtRateTimeToFull*, *AtRateTimeToEmpty*, and *AtRateOK* functions. The *AtRate* units are in either mA (*[CapM]* = 0) or 10 mW (*[CapM]* = 1).

When the *AtRate* value is positive, the *AtRateTimeToFull* function returns the predicted time to full-charge at the *AtRate* value of charge. When the *AtRate* value is negative, the *AtRateTimeToEmpty* function returns the predicted operating time at the *AtRate* value of discharge. When the *AtRate* value is negative, the *AtRateOK* function returns a Boolean value that predicts the battery's ability to supply the *AtRate* value of additional discharge energy (current or power) for 10 seconds.

The default value for *AtRate* is zero.

Table A-9. AtRate

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x04	R/W	AtRate	signed integer	2	-32768	32767	0	mA or 10mW

Related Variables:

SBS:AtRateTimeToFull(0x05)
 SBS:AtRateTimeToEmpty(0x06)
 SBS:AtRateOK(0x07)
 SBS:BatteryMode(0x03)[CapM]

A.6 AtRateTimeToFull(0x05)

This read-word function returns an unsigned integer value of the predicted remaining time to fully charge the battery using a CC-CV method at the *AtRate* value in minutes, with a range of 0 to 65534. A value of 65535 indicates that the *AtRate* = 0.

AtRateTimeToFull can report time based on constant current (*[CapM]* = 0) or constant power (*[CapM]* = 1), and updates within one second after the SMBus host sets the *AtRate* value. The bq20z90/bq20z95 automatically updates *AtRateTimeToFull* based on the *AtRate* function at one-second intervals.

0..65534 = predicted time to full charge, based on *AtRate*
 65535 = no charge or discharge (*AtRate* is 0)

Table A-10. AtRateTimeToFull

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x05	R	AtRateTimeToFull	unsigned integer	2	0	65535	-	min

Related Variables:

SBS:AtRate(0x04)
 SBS:BatteryMode(0x03)[CapM]

A.7 AtRateTimeToEmpty(0x06)

This read-word function returns an unsigned integer value of the predicted remaining operating time in minutes with a range of 0 to 65534, if the battery is discharged at the *AtRate* value. A value of 65535 indicates that *AtRate* = 0.

AtRateTimeToEmpty can report time based on constant current (*[LDMD]* = 0), or constant power (*[LDMD]* = 1), and is updated within one second after the SMBus host sets the *AtRate* value. The bq20z90/bq20z95 updates *AtRateTimeToEmpty* at one-second intervals.

0..65534 = predicted remaining operating time, based on *AtRate*
 65535 = no charge or discharge (*AtRate* is 0)

Table A-11. AtRateTimeToEmpty

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x06	R	AtRateTimeToEmpty	unsigned integer	2	0	65535	-	min

Related Variables:

SBS:AtRate(0x04)
 SBS:OperationStatus(0x54)[LDMD]

A.8 AtRateOK(0x07)

This read-word function returns a boolean value that indicates whether or not the battery can deliver the *AtRate* value of energy for 10 seconds.

The bq20z90/bq20z95 updates this value within one second after the SMBus host sets the *AtRate* function value. The bq20z90/bq20z95 updates *AtRateOK* at one-second intervals.

If *AtRate* function returns 0, *AtRateOK* always returns TRUE.

0 = FALSE bq20z90/bq20z95 can **not** deliver energy for 10 seconds based on discharge rate indicated in *AtRate*

1..65535 = TRUE bq20z90/bq20z95 deliver can energy for 10 seconds based on discharge rate indicated in *AtRate*

Table A-12. AtRateOK

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x07	R	AtRateOK	unsigned integer	2	0	65535	-	min

Related Variables:

SBS:AtRate(0x04)

A.9 Temperature(0x08)

This read-word function returns an unsigned integer value of the temperature in units of 0.1 K, as measured by the bq20z90/bq20z95. It has a range of 0 to 6553.5 K.

The source of the measured temperature is configured by *[TEMP1]*, *[TEMP0]* bits in the **Operation Cfg A** register.

Table A-13. Temperature

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x08	R	Temperature	unsigned integer	2	0	65535	-	0.1 K

Related Variables:

DF:Configuration:Register(64):Operation Cfg A(0)

A.10 Voltage(0x09)

This read-word function returns an unsigned integer value of the sum of the individual cell voltage measurements in mV with a range of 0 to 20000 mV.

Table A-14. Voltage

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x09	R	Voltage	unsigned integer	2	0	20000	-	mV

A.11 Current(0x0a)

This read-word function returns a signed integer value of the measured current being supplied (or accepted) by the battery in mA, with a range of -32,768 to 32,767. A positive value indicates charge current and a negative value indicates discharge.

Any current value within the **Deadband** will be reported as 0 mA by the *Current* function.

AverageCurrent(0x0b)

Table A-15. Current

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x0a	R	Current	signed integer	2	-32768	32767	-	mA

Related Variables:

DF:Calibration:Current(107):Deadband(1)

Note: *Current* function is the average of 4 internal current measurements over a one-second period.

A.12 AverageCurrent(0x0b)

This read-word function returns a signed integer value that approximates a one-minute rolling average of the current being supplied (or accepted) through the battery terminals in mA, with a range of -32,768 to 32,767.

AverageCurrent is calculated by a rolling IIR filtered average of *Current* function data with a period of 14.5s. During the time after a reset and before 14.5s has elapsed the reported *AverageCurrent* = *Current* function value.

Table A-16. AverageCurrent

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x0b	R	AverageCurrent	signed integer	2	-32768	32767	-	mA

Related Variables:

DF:Calibration:Current(107):Filter(0)

SBS:Current(0x0a)

A.13 MaxError(0x0c)

This read-word function returns an unsigned integer value of the expected margin of error, in %, in the state-of-charge calculation with a range of 1 to 100%.

Max error is incremented internally by 0.05% for every increment of *CycleCount* after the last QMAX update. *MaxError* is incremented in the display by 1% for increment of *CycleCount*.

Event	<i>MaxError</i> Setting
Full Reset	set to 100%
QMAX and Ra table update	set to 1%
QMAX update	set to 3%
Ra table update	set to 5%

Table A-17. MaxError

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x0c	R	MaxError	unsigned integer	1	0	100	-	%

Related Variables:

SBS:CycleCount(0x17)

A.14

RelativeStateOfCharge(0x0d)

This read-word function returns an unsigned integer value of the predicted remaining battery capacity expressed as a percentage of *FullChargeCapacity* with a range of 0 to 100%, with fractions of % rounded up.

If the **[RSOCL]** bit in **Operation Cfg C** is set then *RelativeStateofCharge* and *RemainingCapacity* are held at 99% until primary charge termination occurs and only displays 100% upon entering primary charge termination.

If the **[RSOCL]** bit in **Operation Cfg C** is cleared then *RelativeStateofCharge* and *RemainingCapacity* are **not** held at 99% until primary charge termination occurs. Fractions of % greater than 99% are rounded up to display 100%.

Table A-18. RelativeStateOfCharge

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x0d	R	RelativeStateOfCharge	unsigned integer	1	0	100	-	%

Related Variables:

DF:Configuration:Registers(64):Operation Cfg C(4)[RSOCL]

SBS:FullChargeCapacity(0x10)

A.15 AbsoluteStateOfCharge(0x0e)

This read-word function returns an unsigned integer value of the predicted remaining battery capacity expressed in %, with a range of 0 to 100%, with any fractions of % rounded up. The table below shows the calculation used depending on the **[CapM]** flag.

CapM AbsoluteStateOfCharge Calculation

0 = *RemainingCapacity* / **Design Capacity**

1 = *RemainingCapacity* / **Design Energy**

Note: *AbsoluteStateOfCharge* can return values > 100%.

Table A-19. AbsoluteStateOfCharge

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x0e	R	AbsoluteStateOfCharge	unsigned integer	1	0	100+	-	%

Related Variables:

DF:SBS Configuration:Data(48):Design Capacity(22)

DF:SBS Configuration:Data(48):Design Energy(24)

SBS:BatteryMode(0x03)[CapM]

SBS:RemainingCapacity(0x0f)

A.16 RemainingCapacity(0x0f)

This read- or write-word function returns an unsigned integer value, with a range of 0 to 65535, of the predicted charge or energy remaining in the battery. This value is expressed in either charge (mAh) or energy (10 mWh), depending on the setting of the **[CapM]** flag.

Table A-20. RemainingCapacity

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x0f	R/W	RemainingCapacity	unsigned integer	2	0	65535	-	mAh or 10mWh

Related Variables:

SBS:BatteryMode(0x03)[CapM]

A.17 FullChargeCapacity(0x10)

This read-word function returns an unsigned integer value, with a range of 0 to 65535, of the predicted pack capacity when it is fully charged. This value is expressed in either charge (mAh) or power (10 mWh) depending on setting of *[CapM]* flag.

Table A-21. FullChargeCapacity

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x10	R	FullChargeCapacity	unsigned integer	2	0	65535	-	mAh or 10mWh

Related Variables:

SBS:BatteryMode(0x03)[CapM]

A.18 RunTimeToEmpty(0x11)

This read-word function returns an unsigned integer value of the predicted remaining battery life at the present rate of discharge, in minutes, with a range of 0 to 65534 min. A value of 65535 indicates that the battery is not being discharged.

This value is calculated and updated based on current or power, depending on the setting of the *[CapM]* flag.

0..65534 = predicted remaining battery life, based on *Current*

65535 = battery is not being discharged

Table A-22. RunTimeToEmpty

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x11	R	RunTimeToEmpty	unsigned integer	2	0	65535	-	min

Related Variables:

SBS:BatteryMode(0x03)[CapM]

A.19 AverageTimeToEmpty(0x12)

This read-word function returns an unsigned integer value of the predicted remaining battery life, in minutes, based upon *AverageCurrent*, with a range of 0 to 65534. A value of 65535 indicates that the battery is not being discharged.

This value is calculated based on current or power, depending on the setting of the *[CapM]* flag.

0..65534 = predicted remaining battery life, based on *AverageCurrent*

65535 = battery is not being discharged

Table A-23. AverageTimeToEmpty

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x12	R	AverageTimeToEmpty	unsigned integer	2	0	65535	-	min

Related Variables:

SBS:BatteryMode(0x03)[CapM]
SBS:AverageCurrent(0x0b)

A.20 AverageTimeToFull(0x13)

This read-word function returns an unsigned integer value of predicted remaining time until the battery reaches full charge, in minutes, based on *AverageCurrent*, with a range of 0 to 65534. A value of 65535 indicates that the battery is not being charged.

0..65534 = predicted remaining time until full charge
65535 = battery is not being charged

Table A-24. AverageTimeToFull

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x13	R	AverageTimeToFull	unsigned integer	2	0	65535	-	min

Related Variables:

SBS:AverageCurrent(0x0b)

A.21 ChargingCurrent(0x14)

This read-word function returns an unsigned integer value of the desired charging current, in mA, with a range of 0 to 65534. A value of 65535 indicates that a charger should operate as a voltage source outside its maximum regulated current range.

0..65534 = desired charging current in mA
65535 = charger should operate as voltage source outside it's maximum regulated current range

Table A-25. ChargingCurrent

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x14	R	ChargingCurrent	unsigned integer	2	0	65535	-	mA

A.22 ChargingVoltage(0x15)

This read-word function returns an unsigned integer value of the desired charging voltage, in mV, where the range is 0 to 6553. A value of 65535 indicates that the charger should operate as a current source outside its maximum regulated voltage range.

0..65534 = desired charging voltage in mV
65535 = charger should operate as current source outside it's maximum regulated voltage range

Table A-26. ChargingVoltage

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x15	R	ChargingVoltage	unsigned integer	2	0	65535	-	mV

A.23 BatteryStatus(0x16)

This read-word function returns the status of the bq20z90/bq20z95 -based battery.

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
High Byte	OCA	TCA	RSVD	OTA	TDA	RSVD	RCA	RTA
Low Byte	INIT	DSG	FC	FD	EC3	EC2	EC1	EC0

LEGEND: All Values Read Only; RSVD = Reserved

Figure A-3. BatteryStatus

OCA — 1 = Over Charged Alarm

TCA — 1 = Terminate Charge Alarm

OTA — 1 = Over Temperature Alarm

TDA — 1 = Terminate Discharge Alarm

RCA — Remaining Capacity Alarm

1 = Remaining Capacity Alarm is set

see:

SBS:RemainingCapacityAlarm(0x01)

RTA — Remaining Time Alarm

1 = Remaining Time Alarm is set

see:

SBS:RemainingTimeAlarm(0x02)

INIT — 1 = Initialization. This flag is cleared approx. 1 second after device reset, after all SBS parameters have been measured and updated

DSG — Discharging

0 = bq20z90/bq20z95 is in charging mode

1 = bq20z90/bq20z95 is in discharging mode, relaxation mode, or valid charge termination has occurred

see:

"Gas Gauging" chapter in this document

FC — 1 = Fully Charged

FD — 1 = Fully Discharged

EC3, EC2, EC1, EC0 — Error Code, returns status of processed SBS function

0,0,0,0 = OK bq20z90/bq20z95 processed the function code with no errors detected.

0,0,0,1 = BUSY bq20z90/bq20z95 is unable to process the function code at this time.

0,0,1,0 = Reserved bq20z90/bq20z95 detected an attempt to read or write to a function code reserved by this version of the specification or bq20z90/bq20z95 detected an attempt to access an unsupported optional manufacturer function code.

- 0,0,1,1 = Unsupported bq20z90/bq20z95 does not support this function code as defined in this version of the specification.
- 0,1,0,0 = AccessDenied bq20z90/bq20z95 detected an attempt to write to a read-only function code.
- 0,1,0,1 = Over/Underflow bq20z90/bq20z95 detected a data overflow or underflow.
- 0,1,1,0 = BadSize bq20z90/bq20z95 detected an attempt to write to a function code with an incorrect data block.
- 0,1,1,1 = UnknownError bq20z90/bq20z95 detected an unidentifiable error.

A.24 CycleCount(0x17)

This read-word function returns, as an unsigned integer value, the number of cycles the battery has experienced, with a range of 0 to 65535. The default value is stored in the data flash value **Cycle Count**, which is updated each time this variable is incremented. There are 2 different cycle calculations depending on the **[CCT]** bit.

When the bq20z90/bq20z95 is in Unsealed or higher security mode, this block is R/W.

CCT Cycle Count Calculation

- 0 = one cycle count is the accumulated discharge of **CC Threshold**
- 1 = one cycle count is the accumulated discharge of **CC % x FullChargeCapacity**. If **CC Threshold** is greater than **CC % x FullChargeCapacity**, **CC Threshold** is used for the calculation

Table A-27. CycleCount

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x17	R/W	CycleCount	unsigned integer	2	0	65535	0	

Related Variables:

DF:SBS Configuration:Data(48)Cycle Count(16) DF:SBS Configuration:Data(48)CC Threshold(18) DF:SBS Configuration:Data(48)CC %(20)
 DF:Configuration:Registers(64):Operation Cfg B(2)[CCT]
 SBS:FullChargeCapacity(0x10)
 SBS:OperationStatus(0x54)[SS],[FAS]

A.25 DesignCapacity(0x18)

This read-word function returns, as an unsigned integer value, the theoretical or nominal capacity of a new pack, stored in **Design Capacity** or in **Design Energy**.

The *DesignCapacity* value is expressed in either current (mAh at a C/5 discharge rate) or power, (10 mWh at a P/5 discharge rate) depending on the setting of the **[CapM]** bit.

When the bq20z90/bq20z95 is in unsealed or higher security mode, this block is R/W.

Table A-28. DesignCapacity

SBS Cmd.	Mode	Name	CapM	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x18	R/W	DesignCapacity	0	unsigned integer	2	0	65535	4400	mAh
			1	unsigned integer	2	0	65535	6336	10 mWh

DesignVoltage(0x19)

Related Variables:

DF:SBS Configuration:Data(48):Design Capacity(22)
DF:SBS Configuration:Data(48):Design Energy(24)
SBS:BatteryMode(0x03)[CapM]
SBS:OperationStatus(0x54)[SS],[FAS]

A.26 DesignVoltage(0x19)

This read-word function returns an unsigned integer value of the theoretical voltage of a new pack, in mV, with a range of 0 to 65535. The default value is stored in **Design Voltage**.

When the bq20z90/bq20z95 is in Unsealed or higher security mode, this block is R/W.

Table A-29. DesignVoltage

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x19	R/W	DesignVoltage	unsigned integer	2	7000	18000	14400	mV

Related Variables:

DF:SBS Configuration:Data(48):Design Voltage(8)
SBS:OperationStatus(0x54)[SS],[FAS]

A.27 SpecificationInfo(0x1a)

This read-word function returns, as an unsigned integer value, the version number of the Smart Battery Specification the battery pack supports, as well as voltage- and current-scaling information.

Power-scaling is the product of the voltage-scaling times the current-scaling. The data is packed in the following fashion:

$IPScale \times 0x1000 + VScale \times 0x0100 + SpecID_H \times 0x0010 + SpecID_L$

VScale (voltage scaling) and IPScale (current scaling) should always be set to zero. The default setting is stored in **Spec Info**.

When the bq20z90/bq20z95 is in Unsealed or higher security mode, this block is R/W.

Table A-30. SpecificationInfo

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x1a	R/W	SpecificationInfo	hex	2	0x0000	0xffff	0x0031	

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
IPScale (0) (multiplies current by $10^{IPScale}$)				VScale (0) (multiplies voltage by 10^{VScale})				SpecID_H (0..15)				SpecID_L (0..15)			

LEGEND: R/W = Read/Write; R = Read only; - n = value after reset

Figure A-4. SpecificationInfo

Related Variables:

DF:SBS Configuration:Data(48):Spec Info(10)
 SBS:OperationStatus(0x54)[SS],[FAS]

A.28 ManufactureDate(0x1b)

This read-word function returns the date the pack was manufactured in a packed integer. The date is packed in the following fashion:

$(\text{year}-1980) \times 512 + \text{month} \times 32 + \text{day}$

The default value for this function is stored in **Manuf Date**.

When the bq20z90/bq20z95 is in Unsealed or higher security mode, this block is R/W.

Table A-31. ManufactureDate

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x1b	R/W	ManufacturerDate	unsigned integer	2	0	65535	0	

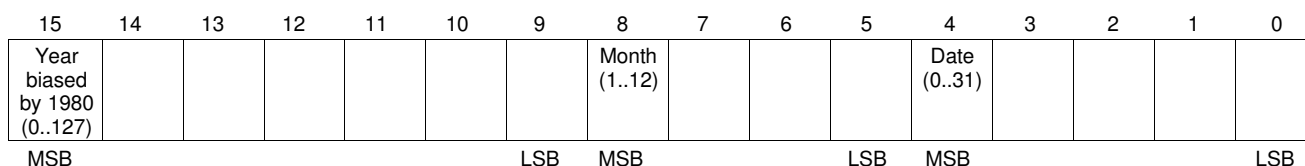


Figure A-5. ManufacturerDate

Related Variables:

DF:SBS Configuration:Data(48):Manuf Date(12)
 SBS:OperationStatus(0x54)[SS],[FAS]

A.29 SerialNumber(0x1c)

This read-word function is used to return an unsigned integer serial number. The default value of this function is stored in **Ser. Num.**

When the bq20z90/bq20z95 is in Unsealed or higher security mode, this block is R/W.

Table A-32. SerialNumber

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x1c	R/W	SerialNumber	hex	2	0x0000	0xffff	0x0001	

Related Variables:

DF:SBS Configuration:Data(48):Ser. Num.(14)
 SBS:OperationStatus(0x54)[SS],[FAS]

A.30 ManufacturerName(0x20)

This read-block function returns a character string containing the battery manufacturer's name with a maximum length of 11 characters (11 data + length byte).

The default setting of this function is stored in data flash **Manuf Name**.

When the bq20z90/bq20z95 is in Unsealed or higher security mode, this block is R/W.

Table A-33. ManufacturerName

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x20	R/W	ManufacturerName	String	11+1	-	-	Texas Inst.	ASCII

Related Variables:

DF:SBS Configuration:Data(48):Manuf Name(26)
SBS:OperationStatus(0x54)[SS],[FAS]

A.31 DeviceName(0x21)

This read-block function returns a character string that contains the battery name with a maximum length of 7 characters (7 data + length byte).

The default setting of this function is stored in data flash **Device Name**.

When the bq20z90/bq20z95 is in Unsealed or higher security mode, this block is R/W.

Table A-34. DeviceName

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x21	R/W	DeviceName	String	7+1	-	-	bq20z90/bq20z95	ASCII

Related Variables:

DF:SBS Configuration:Data(48):Device Name(38)
SBS:OperationStatus(0x54)[SS],[FAS]

A.32 DeviceChemistry(0x22)

This read-block function returns a character string that contains the battery chemistry with a maximum length of 4 characters (4 data + length byte).

The default setting of this function is stored in data flash **Device Chemistry**, although it has no use for internal charge control or fuel gauging.

When the bq20z90/bq20z95 is in Unsealed or higher security mode, this block is R/W.

Table A-35. DeviceChemistry

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x22	R/W	DeviceChemistry	String	4+1	-	-	LION	ASCII

Related Variables:

DF:SBS Configuration:Data(48):Device Chemistry(46)
SBS:OperationStatus(0x54)[SS],[FAS]

A.33 ManufacturerData(0x23)

This read-block function returns several configuration data flash elements with an absolute maximum length of 14 Data + 1 length byte (stored in Manufacturer Data Length). The Manufacturing data elements shown below are stored in the Manufacturer Data subclass.

When the bq20z90/bq20z95 is in Unsealed or higher security mode, this block is R/W.

Table A-36. ManufacturerData

Data	Byte	Name	Format
Manufacturer Data	0	Pack Lot Code	hex
	1		
	2	PCB Lot Code	
	3		
	4	Firmware Version	
	5		
	6	Hardware Revision	
	7		
	8	Cell Revision	
	9		
bq20z90/bq20z95 Counter	10	Partial Reset Counter	
	11	Full Reset Counter	
	12	Watchdog Reset Counter	
	13	Check Sum	
	14	String Length Byte	

Related Variables:

DF:System Data:Manufacturer Data(56):Pack Lot Code(0)
 DF:System Data:Manufacturer Data(56):PCB Lot Code(2)
 DF:System Data:Manufacturer Data(56):Firmware Version(4)
 DF:System Data:Manufacturer Data(56):Hardware Revision(6)
 DF:System Data:Manufacturer Data(56):Cell Revision(8)
 SBS:OperationStatus(0x54)[SS],[FAS]

A.34 Authenticate(0x2f)

This read- or write-block function allows the host to authenticate the bq20z90/bq20z95 -based battery using a SHA-1 authentication transform with a length of 20 data bytes + 1 length byte. See *SHA-1 Authentication* chapter and *Using SHA-1 in bq20zxx Family of Gas Gauges* application report ([SLUA359](#)) for detailed information.

Table A-37. Authenticate

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x2f	R/W	Authenticate	String	20+1	-	-	-	

A.35 CellVoltage4..1(0x3c..0x3f)

These read-word functions return an unsigned value of the calculated individual cell voltages, in mV, with a range of 0 to 65535. *CellVoltage1* corresponds to the bottom most series cell element, while *CellVoltage4* corresponds to the top most series cell element.

Table A-38. CellVoltage4..1

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x3c	R	CellVoltage4	unsigned integer	2	0	65535	—	mV
0x3d		CellVoltage3					—	
0x3e		CellVoltage2					—	
0x3f		CellVoltage1					—	

A.36 SBS Command Values

Table A-39. SBS COMMANDS

SBS Cmd	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x00	R/W	ManufacturerAccess	hex	2	0x0000	0xffff	—	
0x01	R/W	RemainingCapacityAlarm	unsigned int	2	0	65535	300	mAh or 10mWh
0x02	R/W	RemainingTimeAlarm	unsigned int	2	0	65535	10	min
0x03	R/W	BatteryMode	hex	2	0x0000	0xe383	—	
0x04	R/W	AtRate	signed int	2	-32768	32767	—	mA or 10mW
0x05	R	AtRateTimeToFull	unsigned int	2	0	65534	—	min
0x06	R	AtRateTimeToEmpty	unsigned int	2	0	65534	—	min
0x07	R	AtRateOK	unsigned int	2	0	65535	—	
0x08	R	Temperature	unsigned int	2	0	65535	—	0.1 K
0x09	R	Voltage	unsigned int	2	0	65535	—	mV
0x0a	R	Current	signed int	2	-32768	32767	—	mA
0x0b	R	AverageCurrent	signed int	2	-32768	32767	—	mA
0x0c	R	MaxError	unsigned int	1	0	100	—	%
0x0d	R	RelativeStateOfCharge	unsigned int	1	0	100	—	%
0x0e	R	AbsoluteStateOfCharge	unsigned int	1	0	100+	—	%
0x0f	R/W	RemainingCapacity	unsigned int	2	0	65535	—	mAh or 10mWh
0x10	R	FullChargeCapacity	unsigned int	2	0	65535	—	mAh or 10mWh
0x11	R	RunTimeToEmpty	unsigned int	2	0	65534	—	min
0x12	R	AverageTimeToEmpty	unsigned int	2	0	65534	—	min
0x13	R	AverageTimeToFull	unsigned int	2	0	65534	—	min
0x14	R	ChargingCurrent	unsigned int	2	0	65534	—	mA
0x15	R	ChargingVoltage	unsigned int	2	0	65534	—	mV
0x16	R	BatteryStatus	unsigned int	2	0x0000	0xdbff	—	
0x17	R/W	CycleCount	unsigned int	2	0	65535	—	
0x18	R/W	DesignCapacity	unsigned int	2	0	65535	4400	mAh or 10mWh
0x19	R/W	DesignVoltage	unsigned int	2	0	65535	14400	mV
0x1a	R/W	SpecificationInfo	hex	2	0x0000	0xffff	0x0031	
0x1b	R/W	ManufactureDate	unsigned int	2	—	—	01-Jan-1980	ASCII
0x1c	R/W	SerialNumber	hex	2	0x0000	0xffff	0x0001	
0x20	R/W	ManufacturerName	String	11+1	—	—	Texas Inst.	ASCII
0x21	R/W	DeviceName	String	7+1	—	—	bq20z90/bq20z95	ASCII
0x22	R/W	DeviceChemistry	String	4+1	—	—	LION	ASCII
0x23	R/W	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

