

bq20z90-V110 + bq29330 Chipset

Technical Reference Manual

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Preface

1.1 Read this First

This manual discusses modules and peripherals of the bq20z90-V110 device and the use with the bq29330 device to build a complete battery pack gas gauge and protection solution.

1.2 Notational Conventions

Following notation is used, if SBS commands and Data Flash values are mentioned within a text block:

- SBS commands are set in italic, e.g.: *Voltage*
- SBS bits and flags are capitalized, set in italic and enclosed with square brackets, e.g.: *[LED1]*
- Data Flash values are set in bold italic e.g.: ***COV Threshold***
- All Data Flash bits and flags are capitalized, set in bold italic and enclosed with square brackets, e.g.: ***[NR]***

All SBS commands, Data Flash values and flags mentioned in a chapter are listed at the end of each chapter for reference.

The reference format for SBS commands is: SBS:Command Name(Command No.):Manufacturer Access(MA No.)[Flag], for example:

SBS:Voltage(0x09), or SBS:ManufacturerAccess(0x00):Seal Device(0x0020)

The reference format for Data Flash values is: DF:Class Name:Subclass Name(Subclass ID):Value Name(Offset)[Flag], for example:

DF:1st Level Safety:Voltage(0):COV Threshold(0), or

DF:Configuration:Registers(64):Operation A Cfg(0)[LED1].

Detailed Description

2.1 1st Level Protection Features

The bq20z90-V110 supports a wide range of battery and system protection features that are easily configured or enabled via the integrated data flash.

2.1.1 *Cell Overvoltage and Cell Undervoltage*

The bq20z90-V110 can detect cell overvoltage/undervoltage and protect battery cells from damage from battery cell overvoltage/undervoltage. If the over/under voltage remains over an adjustable time period, the bq20z90-V110 goes into pack overvoltage/undervoltage condition and switches off the CHG/DSG FET. The bq20z90-V110 recovers from a cell overvoltage condition if all the cell voltages drops below the cell overvoltage recovery threshold. The bq20z90-V110 recovers from cell undervoltage condition if all the cell voltages rise above the cell undervoltage recovery threshold.

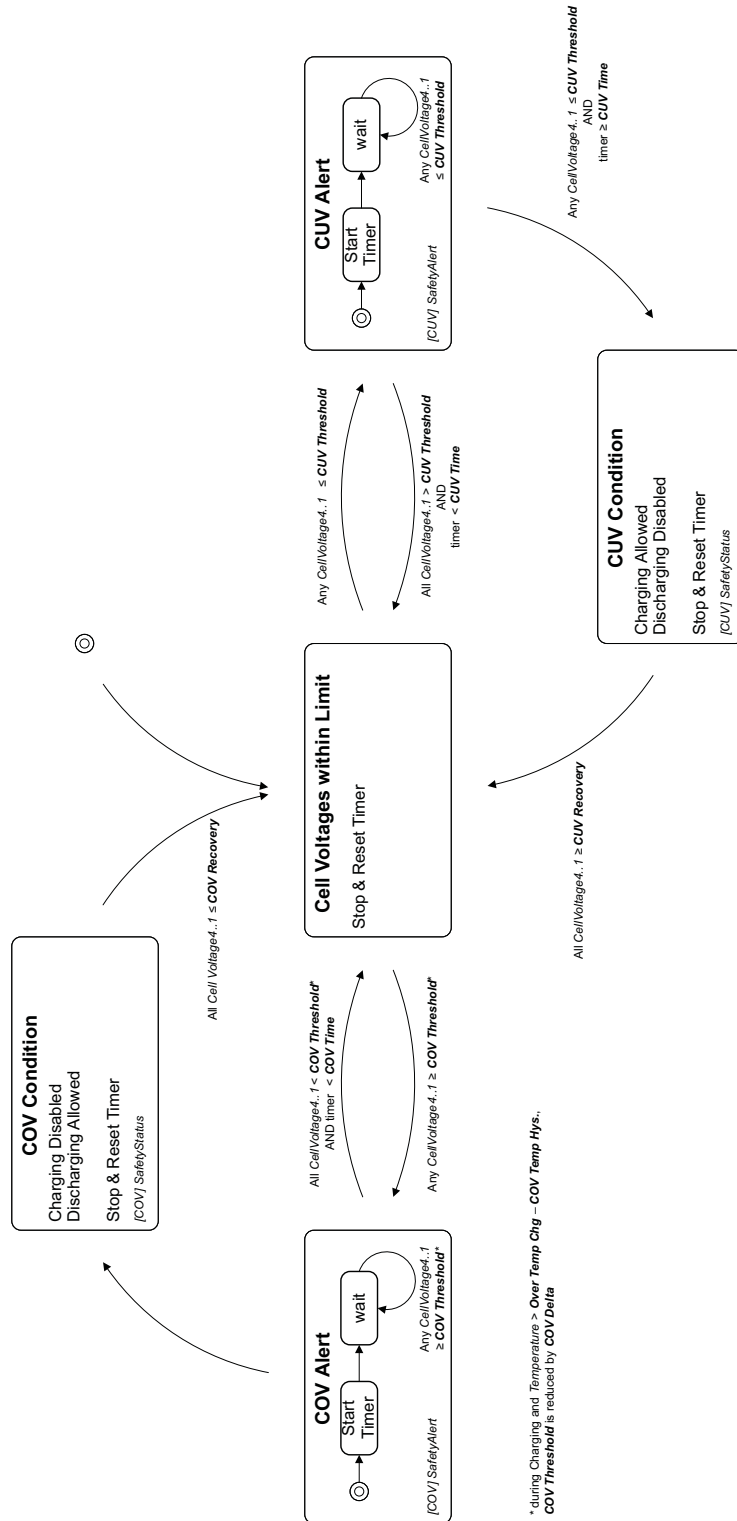


Figure 2-1. COV and CUV

Table 2-1. COV and CUV

Condition:		COV Condition	COV Alert	Normal	CUV Alert	CUV Condition
Flags:	<i>BatteryStatus</i>	[TCA]				[TDA], [FD]
	<i>SafetyAlert</i>		[COV]		[CUV]	
	<i>SafetyStatus</i>	[COV]				[CUV]
	<i>OperationStatus</i>					[XDSG]
FET:		CHG FET disabled, enabled during discharge	normal	normal	normal	DSG FET disabled, enabled during charge
SBS Command:	<i>ChargingCurrent</i>	0	charging algorithm	charging algorithm	charging algorithm	Pre-chg Current
	<i>ChargingVoltage</i>	0	charging algorithm	charging algorithm	charging algorithm	charging algorithm

The bq20z90-V110 indicates cell over voltage by setting the [COV] flag in *SafetyAlert* if any *CellVoltage4..1* reaches or surpasses the **COV Threshold** limit during charging. The bq20z90-V110 goes into cell over voltage condition and changes the [COV] flag in *SafetyAlert* to the [COV] flag in *SafetyStatus* if any of *CellVoltage4..1* stays above **COV Threshold** limit for a minimum time period of **COV Time**. This function is disabled if **COV Time** is set to zero.

In cell over voltage condition, charging is disabled and CHG FET and ZVCHG FET (if used) are turned off, *ChargingCurrent* and *ChargingVoltage* are set to zero, [COV] flag in *SafetyAlert* is reset, [TCA] flag in *BatteryStatus* and [COV] flag in *SafetyStatus* are set.

The bq20z90-V110 recovers from cell over voltage condition if all *CellVoltages4..1* are equal to or lower than **COV Recovery** limit. On recovery the [COV] flag in *SafetyStatus* is reset, [TCA] flag is reset, and *ChargingCurrent* and *ChargingVoltage* are set back to appropriate value per charging algorithm.

In cell over voltage condition the CHG FET is turned on during discharging to prevent overheating of the CHG FET body diode.

The bq20z90-V110 indicates cell under voltage by setting the [CUV] flag in *SafetyAlert* if any *CellVoltage4..1* reaches or drops below the **CUV Threshold** limit during discharging. The bq20z90-V110 goes into cell under voltage condition and changes the [CUV] flag in *SafetyAlert* to the [CUV] flag in *SafetyStatus* if any of *CellVoltage4..1* stays below **CUV Threshold** limit for a minimum time period of **CUV Time**. This function is disabled if **CUV Time** is set to zero.

In cell under voltage condition, discharging is disabled and DSG FET is turned off, *ChargingCurrent* is set to **Pre-chg Current**, the [CUV] flag in *SafetyAlert* is reset, the [TDA] and [FD] flags in *BatteryStatus* and the [CUV] flag in *SafetyStatus* are set.

The bq20z90-V110 recovers from cell under voltage condition if all *CellVoltages4..1* are equal to or higher than **CUV Recovery** limit. On recovery the [CUV] flag in *SafetyStatus* is reset, [XDSG] flag is reset, the [TDA] and [FD] flags are reset, and *ChargingCurrent* and *ChargingVoltage* are set back to appropriate value per charging algorithm.

In cell under voltage condition, the DSG FET is turned on during charging to prevent overheating of the DSG FET body diode.

Related Variables:

- DF:1st Level Safety:Voltage(0):COV Threshold(0)
- DF:1st Level Safety:Voltage(0):COV Time(2)
- DF:1st Level Safety:Voltage(0):COV Recovery(3)
- DF:1st Level Safety:Voltage(0):CUV Threshold(12)
- DF:1st Level Safety:Voltage(0):CUV Time(14)
- DF:1st Level Safety:Voltage(0):CUV Recovery(15)
- DF:Charge Control:Pre-Charge Cfg(33):Pre-chg Current(0)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)

- SBS:BatteryStatus(0x16)[TCA],[TDA],[FD],[DSG]
- SBS:CellVoltage4(0x3c)
- SBS:CellVoltage3(0x3d)
- SBS:CellVoltage2(0x3e)
- SBS:CellVoltage1(0x3f)
- SBS:SafetyAlert(0x50)[CUV],[COV]
- SBS:SafetyStatus(0x51)[CUV],[COV]
- SBS:OperationStatus(0x54)[XDSG]

2.1.2 Cell Overvoltage Threshold Compensation

In charging mode, the actual threshold for cell-overvoltage detection may be reduced, based on the SBS *Temperature* function. If **COV Delta** is set to zero, the compensation is disabled.

Table 2-2. Cell Overvoltage Threshold Compensation

Temperature:	COV Threshold used:
\leq <i>Over Temp Chg - COV Temp. Hys</i>	<i>COV Threshold</i>
$>$ <i>Over Temp Chg - COV Temp. Hys</i>	<i>COV Threshold - COV Delta</i>

Related Variables:

- DF:1st Level Safety:Voltage(0):COV Threshold(0)
- DF:1st Level Safety:Voltage(0):COV Delta(5)
- DF:1st Level Safety:Voltage(0):COV Temp. Hys(6)
- DF:1st Level Safety:Temperature(2):Over Temp Chg(0)
- SBS:Temperature(0x08)

2.1.3 Pack Overvoltage and Undervoltage

The bq20z90-V110 can detect battery pack overvoltage/undervoltage and protect the battery pack from damage from battery pack overvoltage/undervoltage. If the overvoltage/undervoltage remains over an adjustable time period, the bq20z90-V110 goes into pack overvoltage/undervoltage condition and switches off the CHG/DSG FET. The bq20z90-V110 recovers from a pack overvoltage condition if the pack voltage drops below the pack overvoltage recovery threshold and recovers from a pack undervoltage condition if the pack voltage rises above the pack undervoltage recovery threshold.

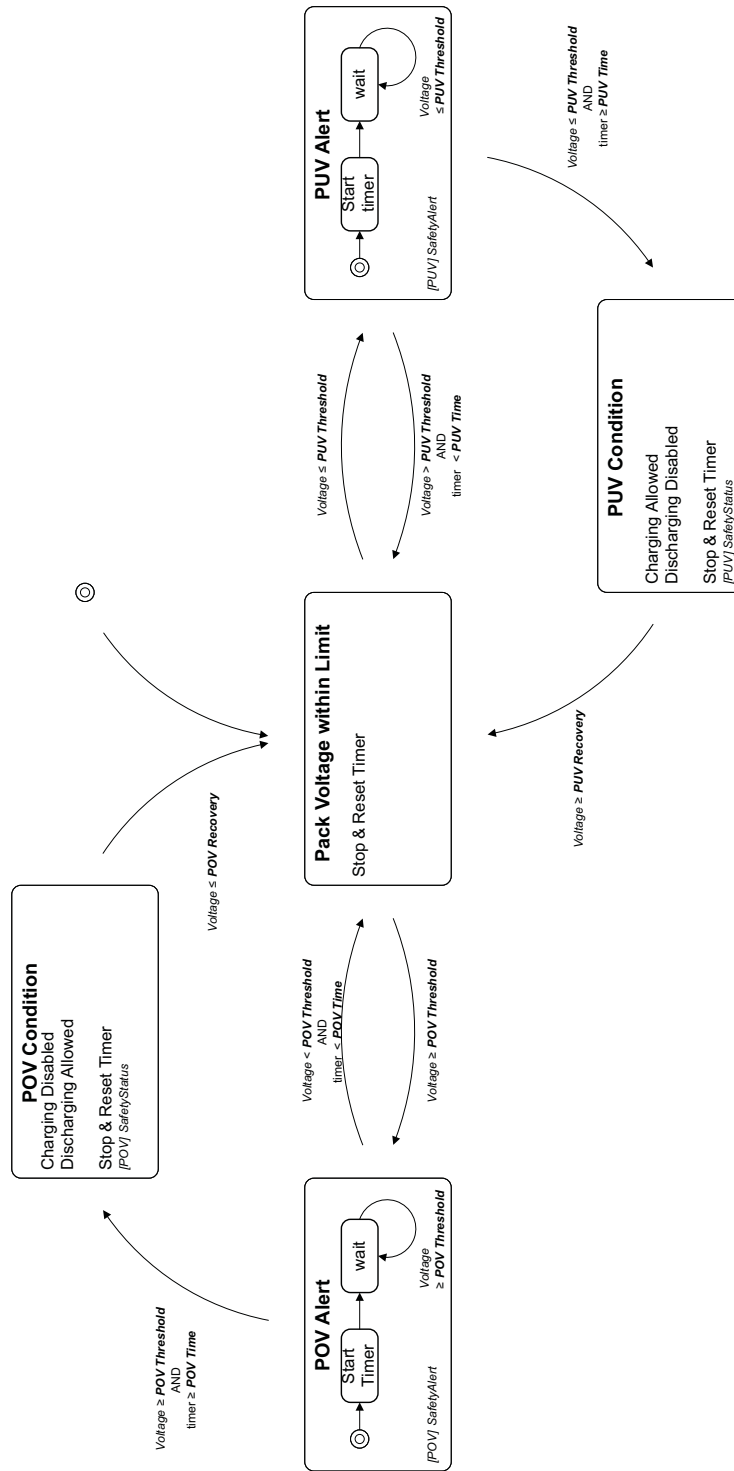


Figure 2-2. POV and PUV

Table 2-3. POV and PUV

Condition:		POV Condition	POV Alert	Normal	PUV Alert	PUV Condition
Flags:	<i>BatteryStatus</i>	[TCA]				[TDA], [FD]
	<i>SafetyAlert</i>		[POV]		[PUV]	
	<i>SafetyStatus</i>	[POV]				[PUV]
	<i>OperationStatus</i>					[XDSG]
FET:		CHG FET disabled, enabled during discharge	normal	normal	normal	DSG FET disabled, enabled during charge
SBS Command:	<i>ChargingCurrent</i>	0	charging algorithm	charging algorithm	charging algorithm	Pre-chg Current
	<i>ChargingVoltage</i>	0	charging algorithm	charging algorithm	charging algorithm	charging algorithm

The bq20z90-V110 sets the pack over voltage [POV] flag in *SafetyAlert* if pack *Voltage* reaches or surpasses **POV Threshold** limit during charging. The bq20z90-V110 changes [POV] in *SafetyAlert* to [POV] in *SafetyStatus*, if the pack *Voltage* stays above **POV Threshold** limit for a time period of **POV Time**. This function is disabled if **POV Time** is set to zero.

In pack overvoltage condition, charging is disabled and CHG FET is turned off, *ChargingCurrent* and *ChargingVoltage* are set to zero, [POV] flag in *SafetyAlert* is reset, [TCA] flag in *BatteryStatus* and [POV] flag in *SafetyStatus* are set.

The bq20z90-V110 recovers from pack over voltage condition, if pack *Voltage* is equal to or below **POV Recovery** limit. On recovery [POV] flag in *SafetyStatus* is reset, [TCA] is reset, *ChargingCurrent* and *ChargingVoltage* are set back to appropriate value per charging algorithm.

In pack over voltage condition, the CHG FET is turned on during discharging to prevent overheating of the CHG FET body diode.

The bq20z90-V110 sets the pack under voltage [PUV] flag in *SafetyAlert* if pack *Voltage* reaches or drops below **PUV Threshold** limit during discharging. The bq20z90-V110 changes pack under voltage alert to pack undervoltage condition if pack *Voltage* stays below **PUV Threshold** limit for a time period of **PUV Time**. This function is disabled if **PUV Time** is set to zero.

In pack under voltage condition, the discharging is disabled and the DSG FET is turned off, the ZVCHG FET is turned on (if configured), *ChargingCurrent* is set to **Pre-chg Current**, [PUV] flag in *SafetyAlert* is reset, [TDA] and [FD] flags are set, [XDSG] flag is set, and [PUV] flag in *SafetyStatus* is set.

The bq20z90-V110 recovers from pack under voltage condition, if the pack *Voltage* is equal to or above **PUV Recovery** limit. On recovery [PUV] flag in *SafetyStatus* is reset, [XDSG] flag is reset, [TDA] and [FD] flags are reset, and *ChargingCurrent* and *ChargingVoltage* are set back to appropriate value per charging algorithm.

In pack under voltage condition, the DSG FET is turned on during charging to prevent overheating of the DSG FET body diode.

Related Variables:

- DF:1st Level Safety:Voltage(0):POV Threshold(7)
- DF:1st Level Safety:Voltage(0):POV Time(9)
- DF:1st Level Safety:Voltage(0):POV Recovery(10)
- DF:1st Level Safety:Voltage(0):PUV Threshold(17)
- DF:1st Level Safety:Voltage(0):PUV Time(19)
- DF:1st Level Safety:Voltage(0):PUV Recovery(20)
- DF:Charge Control:Pre-Charge Cfg(33):Pre-chg Current(0)
- DF:Power:Power(68):Shutdown Voltage(2)
- DF:Power:Power(68):Shutdown Time(4)
- SBS:Voltage(0x09)
- SBS:ChargingCurrent(0x14)

- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[TCA], [TDA], [FD], [DSG]
- SBS:SafetyAlert(0x50)[PUV], [POV]
- SBS:SafetyStatus(0x51)[PUV], [POV]
- SBS:OperationStatus(0x54)[XDSG]

2.1.4 Charge and Discharge Overcurrent

The bq20z90-V110 has two independent tiers (levels) of overcurrent protection for charge and discharge. These two tiers require the *Current* value to be greater than or equal to a programmed OC Threshold in either charge or discharge current for a period greater than OC Time Limit. If the OC Time Limit for any of the overcurrent protections is set to 0, that specific feature is disabled.

Table 2-4. Charge and Discharge Overcurrent

Protection	OC Threshold	OC Time Limit	OC Recovery Threshold	SafetyAlert Flag	SafetyStatus Flag
Tier-1 Charge	OC (1st Tier)Chg	OC(1st Tier) Chg Time	OC Chg Recovery	[OCC]	[OCC]
Tier-2 Charge	OC (2nd Tier) Chg	OC (2nd Tier) Chg Time		[OCC2]	[OCC2]
Tier-1 Discharge	OC (1st Tier) Dsg	OC (1st Tier) Dsg Time	OC Dsg Recovery	[OCD]	[OCD]
Tier-2 Discharge	OC (2nd Tier) Dsg	OC (2nd Tier) Dsg Time		[OCD2]	[OCD2]
Tier-3 Discharge	AFE OC Dsg	AFE OC Dsg Time	AFE OC DsgRecovery for Current Recovery Time	-	[AOCD]

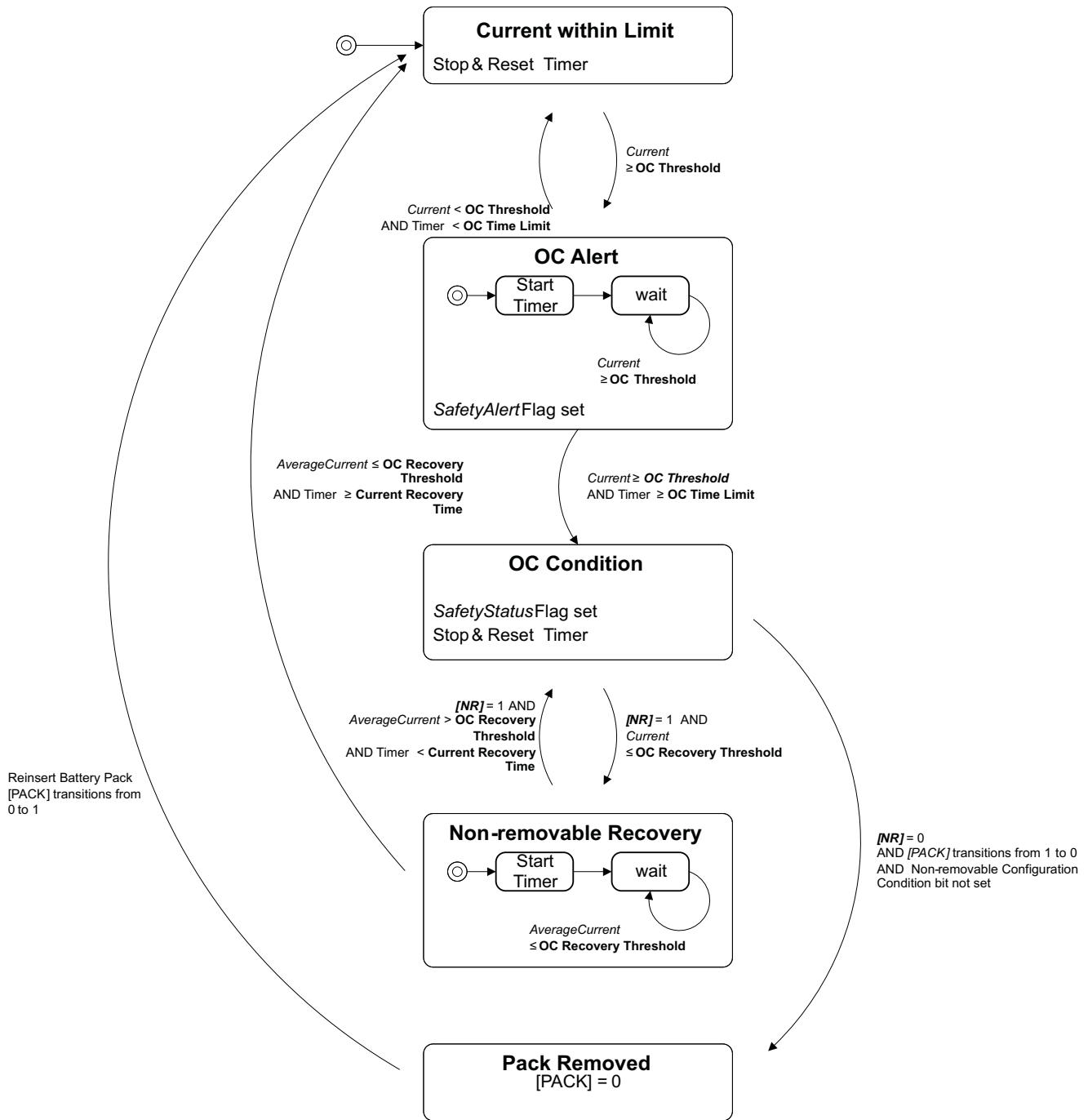


Figure 2-3. OC Protection

For the first two tiers of overcurrent protection, the specific flag in *SafetyAlert* is set if *Current* exceeds the OC Threshold. The bq20z90-V110 changes the specific flag in *SafetyAlert* to the specific flag in *SafetyStatus* if the *Current* stays above the OC Threshold limit for at least OC Time Limit period. This function is disabled if the OC Time Limit is set to zero. The *SafetyStatus* flag is reset if the *Current* falls below the OC Recovery Threshold.

If the timer of any tier expires during charging, the CHG FET is turned off. When this occurs, the internal *AFE_Current_Fault* timer is started from 0, *ChargingCurrent* and *ChargingVoltage* are set to 0, *[TCA]* flag is set and the appropriate *SafetyStatus* tier flag is set.

However, when the bq20z90-V110 has either of *[OCC]* or *[OCC2]* flags in *SafetyStatus* set, the CHG FET is turned on again during discharge ($Current \leq (-) \text{Dsg Current Threshold}$). This prevents overheating of the CHG FET body diode during discharge. No other flags change state until full recovery is reached. This action is not affected by the setting of *[NR]* bit.

If the timer of either of the first two tiers expires during discharging, the DSG FET is turned off and the ZVCHG FET is turned on if used. When this occurs the *AFE_Current_Fault* timer is started from 0, *ChargingCurrent* is set to **Pre-chg Current**, *[XDSGI]* flag is set, *[TDA]* flag is set, and the correct tier flag is set in *SafetyStatus*.

When the bq29330 detects a discharge-overcurrent fault, the charge and discharge FETs are turned off, the XALERT pin of the bq20z90-V110 is driven low by the XALERT pin of the bq29330, and the bq29330 is interrogated. When the bq20z90-V110 identifies the overcurrent condition, the *AFE_Current_Fault* timer is started from 0, *[TDA]* flag is set, *ChargingCurrent* is set to 0, and *[AOCD]* is set.

However, when the bq20z90-V110 has any of *[OCD]*, *[OCD2]*, *[AOCD]* set, the FETs are turned on again during charging ($Current \geq \text{Chg Current Threshold}$). This prevents overheating of the discharge-FET body diode during charge. No other flags change state until full recovery is reached. This action is not affected by the state of *[NR]* bit.

Table 2-5. Overcurrent Conditions

Protection	Condition	Flags				FET	Charging Current	Charging Voltage
		<i>SafetyAlert</i>	<i>SafetyStatus</i>	<i>BatteryStatus</i>	<i>OperationStatus</i>			
Tier-1 Charge	OC Alert	<i>[OCC]</i>				normal	charging algorithm	charging algorithm
	OC Condition		<i>[OCC]</i>	<i>[TCA]</i>		CHG FET disabled, enabled during discharge	0	0
Tier-2 Charge	OC Alert	<i>[OCC2]</i>				normal	charging algorithm	charging algorithm
	OC Condition		<i>[OCC2]</i>	<i>[TCA]</i>		CHG FET disabled, enabled during discharge	0	0
Tier-1 Dis-charge	OC Alert	<i>[OCD]</i>				normal	charging algorithm	charging algorithm
	OC Condition		<i>[OCD]</i>	<i>[TDA]</i>	<i>[XDSGI]</i>	DSG FET disabled, enabled during charge	Pre-chg Current	charging algorithm
Tier-2 Dis-charge	OC Alert	<i>[OCD2]</i>				normal	charging algorithm	charging algorithm
	OC Condition		<i>[OCD2]</i>	<i>[TDA]</i>	<i>[XDSGI]</i>	DSG FET disabled, enabled during charge	Pre-chg Current	charging algorithm
Tier-3 Dis-charge	OC Condition		<i>[AOCD]</i>	<i>[TDA]</i>	<i>[XDSGI]</i>	CHG FET and DSG FET disabled	0	charging algorithm

The bq20z90-V110 can individually configure each overcurrent-protection feature to recover via two different methods based on *[NR]* bit.

Standard Recovery, where *[NR]* = 0 and the overcurrent tier is not selected in **Non-Removable Cfg** register. When the pack is removed and reinserted the condition is cleared. Pack removal and reinsertion is detected by a low-to-high-to-low transition on the $\overline{\text{PRES}}$ input. When the overcurrent tier is selected in **Non-Removable Cfg**, that particular feature uses the Non-Removable Battery Mode recovery.

Non-removable Battery Mode Recovery where *[NR]* = 1. The state of **Non-Removable Cfg** has no consequence. This recovery requires *AverageCurrent* to be \leq the respective recovery threshold, and for the *AFE_Current_Fault* timer \geq **Current Recovery Time**.

1st Level Protection Features

When a charging-fault recovery condition is detected, then the CHG FET is allowed to be turned on, if other safety and configuration states permit, $[TCA]$ is reset, $ChargingCurrent$ and $ChargingVoltage$ are set to the appropriate value per the charging algorithm, and the appropriate $SafetyStatus$ flag is reset.

When a discharging-fault recovery condition is detected, the DSG FET is allowed to be turned on if other safety and configuration states permit, $[TDA]$ flag is reset, $ChargingCurrent$ and $ChargingVoltage$ are set to the appropriate value per the charging algorithm and the $[XDSG]$ and the appropriate $SafetyStatus$ flag is reset.

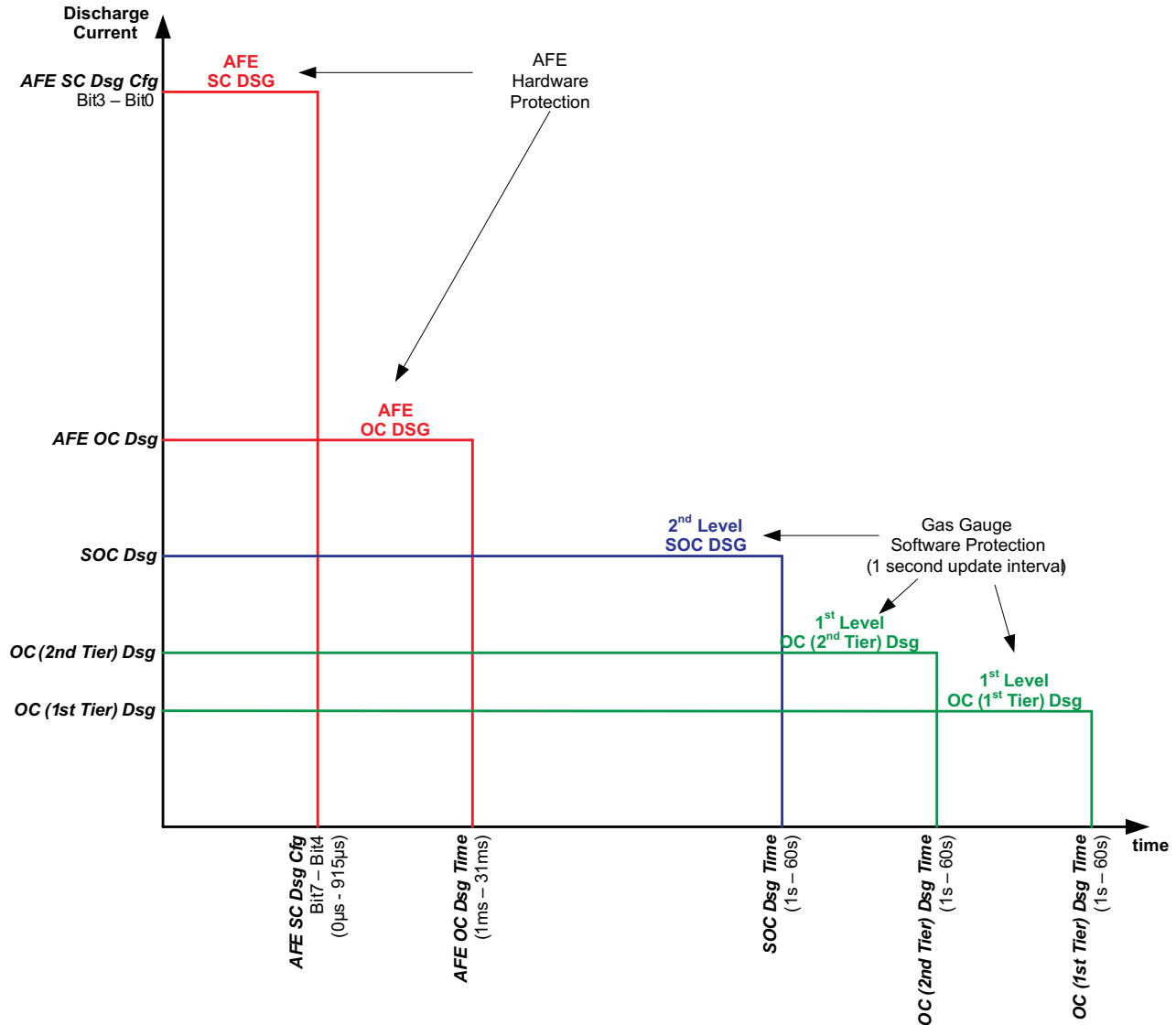


Figure 2-4. Overcurrent Protection Levels

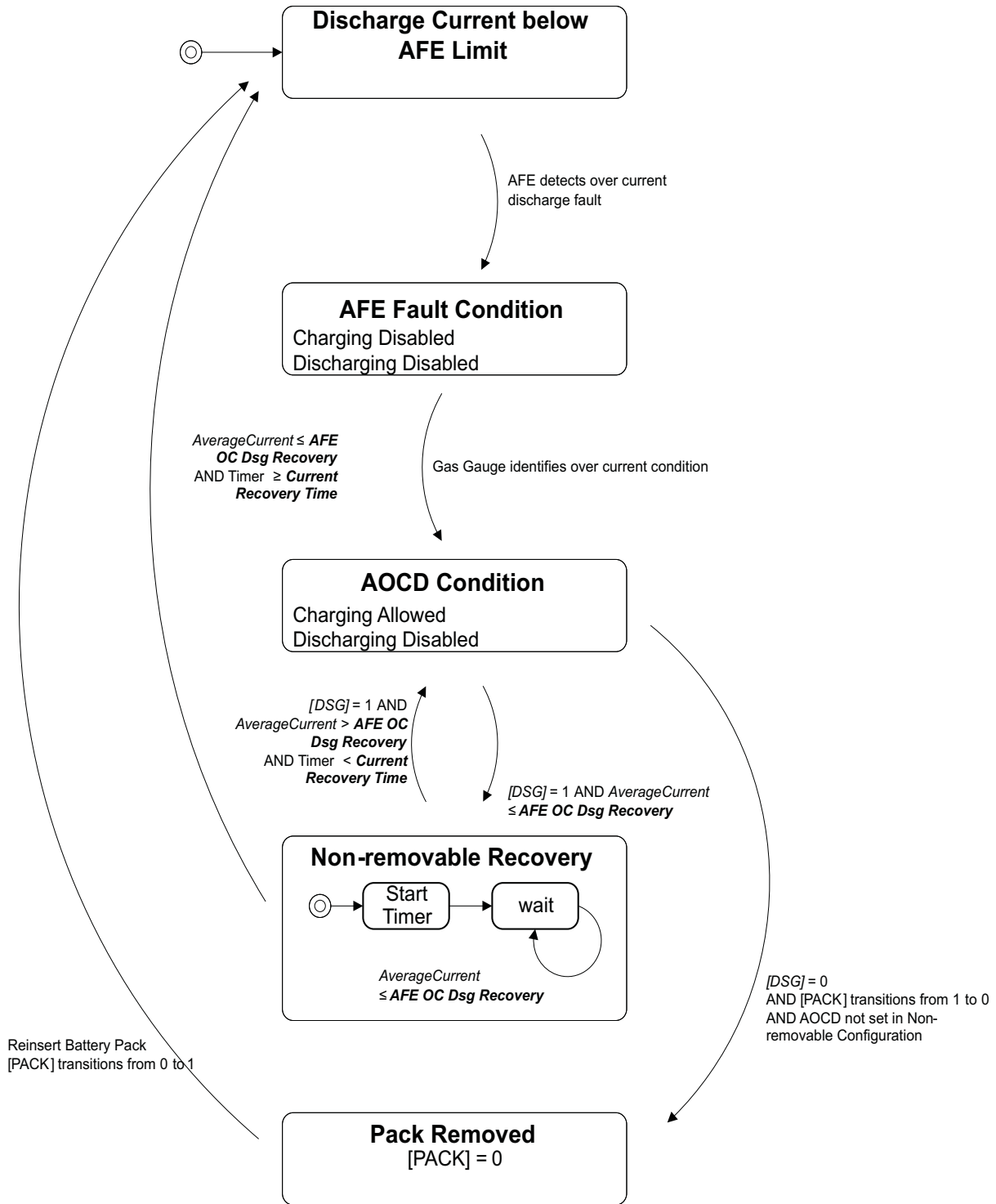


Figure 2-5. AFE Discharge Over Current Protection

Related Variables:

- DF:1st Level Safety:Current(1):OC(1st Tier) Chg(0)
- DF:1st Level Safety:Current(1):OC(1st Tier) Chg Time(2)
- DF:1st Level Safety:Current(1):OC Chg Recovery(3)
- DF:1st Level Safety:Current(1):OC(1st Tier) Dsg(5)

- DF:1st Level Safety:Current(1):OC(1st Tier) Dsg Time(7)
- DF:1st Level Safety:Current(1):OC Dsg Recovery(8)
- DF:1st Level Safety:Current(1):OC(2nd Tier) Chg(10)
- DF:1st Level Safety:Current(1):OC(2nd Tier) Chg Time(12)
- DF:1st Level Safety:Current(1):OC(2nd Tier) Dsg(13)
- DF:1st Level Safety:Current(1):OC(2nd Tier) Dsg Time(15)
- DF:1st Level Safety:Current(1):Current Recovery Time(16)
- DF:1st Level Safety:Current(1):AFE OC Dsg(17)
- DF:1st Level Safety:Current(1):AFE OC Dsg Time(18)
- DF:1st Level Safety:Current(1):AFE OC Dsg Recovery(19)
- DF:Charge Control:Pre-Charge Cfg(33):Pre-chg Current(0)
- DF:Configuration:Registers(64):Operation Cfg B(2)[NR]
- DF:Configuration:Registers(64):Non-Removable Cfg(8)
- SBS:Current(0x0a)
- SBS:AverageCurrent(0x0b)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[TCA],[TDA]
- SBS:SafetyAlert(0x50)
- SBS:SafetyStatus(0x51)
- SBS:OperationStatus(0x54)[XDSGI]

2.1.5 Short-Circuit Protection

The bq20z90-V110 short-circuit protection is controlled by the bq29330, but is recovered by the bq20z90-V110. This allows different recovery methods to accommodate various applications.

The bq29330 charge short-circuit and discharge short-circuit protection are configured by the bq20z90-V110 data flash **AFE SC Chg Cfg** and **AFE SC Dsg Cfg** registers, respectively.

When the bq29330 detects a short circuit in charge or short circuit in discharge fault, the charge and discharge FETs are turned off, the XALERT pin of the bq20z90-V110 is driven low by the XALERT pin of the bq29330 and the bq29330 is interrogated. When the bq20z90-V110 identifies the short-circuit condition (charge or discharge current direction), the internal *AFE_Current_Fault* timer is started from 0, either [TCA] or [TDA] battery status is set, *ChargingCurrent* and *ChargingVoltage* is set to 0 and either [SCC] or [SCD] is set. If the short-circuit condition is in discharge, then [XDSG] flag is also set.

Each bq20z90-V110 short-circuit protection feature can be individually configured to recover via two different methods, based on [NR] bit.

Standard Recovery is where [NR] = 0 and the overcurrent tier is not selected in **Non-Removable Cfg**. When the pack is removed and re-inserted, the condition is cleared. Pack removal and re-insertion is detected by transition on the $\overline{\text{PRES}}$ input from low to high to low. When the overcurrent tier is selected in **Non-Removable Cfg**, that particular feature uses the Non-removable Battery Mode recovery.

Non-removable Battery Mode Recovery is where [NR] = 1. The state of **Non-Removable Cfg** has no consequence when [NR] bit is set to 1. This recovery requires *AverageCurrent* to be \leq **AFE SC Recovery** threshold and for the internal *AFE_Current_Fault* timer to be \geq **Current Recovery Time**.

When the recovery condition for a charging fault is detected, the CHG FET is allowed to be turned on if other safety and configuration states permit. The ZVCHG FET also returns to previous state. When this occurs, [TCA] is reset, *ChargingCurrent* and *ChargingVoltage* are set to the appropriate values per the charging algorithm, and the appropriate *SafetyStatus* flag is reset.

When the recovery condition for a discharging fault is detected, the DSG FET is allowed to be turned on if other safety and configuration states permit. The ZVCHG FET also returns to previous state. When this occurs [TDA] is reset, *ChargingCurrent* and *ChargingVoltage* are set to the appropriate value per the charging algorithm, and [XDSG] and the appropriate *SafetyStatus* flags are reset.

Table 2-6. Short Circuit Protection

Short Circuit	Condition	Flags set	FET	Charging Current	Charging Voltage	Clear Threshold
Charge	AFE SC Chg Cfg	[SCC]SafetyStatus, [TCA]	CHG FET disabled, enabled during discharge	0	0	AFE SC Recovery
Discharge	AFE SC Dsg Cfg	[SCD]SafetyStatus, [TDA], [XDSG]	DSG FET disabled, enabled during charge	0	0	

Related Variables:

- DF:1st Level Safety:Current(1):AFE SC Chg Cfg(21)
- DF:1st Level Safety:Current(1):AFE SC Dsg Cfg(22)
- DF:1st Level Safety:Current(1):AFE SC Recovery(23)
- DF:Configuration:Registers(64):Operation Cfg B(2)[NR]
- DF:Configuration:Registers(64):Non-Removable Cfg(8)
- SBS:AverageCurrent(0x0b)
- SBS:BatteryStatus(0x16)[TCA],[TDA]
- SBS:SafetyStatus(0x51)[SCC],[SCD]
- SBS:OperationStatus(0x54)[XDSG]

2.1.6 Overtemperature Protection

The bq20z90-V110 has overtemperature protection for both charge and discharge conditions.

The bq20z90-V110 sets the over temperature charging [OTC] SafetyAlert flag, if pack temperature reaches or surpasses **Over Temp Chg** limit during charging. The bq20z90-V110 changes [OTC] SafetyAlert to over temperature condition, if pack temperature stays above **Over Temp Chg** limit for a time period of **OT Chg Time**. This function is disabled if **OT Chg Time** is set to zero.

If [OTFET] is set and bq20z90-V110 is in [OTC] condition, charging is disabled and CHG FET is turned off, ZVCHG FET is turned off if configured for use, ChargingCurrent and ChargingVoltage are set to zero, the [OTC] flag in SafetyAlert is reset, [TCA] and [OTC] in SafetyStatus are set.

The bq20z90-V110 recovers from an [OTC] condition if Temperature is equal to or below **OTC Chg Recovery** limit. On recovery the [OTC] flag in SafetyStatus is reset, [TCA] is reset, ChargingCurrent and ChargingVoltage are set back to their appropriate value per the charging algorithm, and the CHG FET returns to previous state.

In an [OTC] condition, the CHG FET is turned on during discharging to prevent overheating of the CHG FET body diode.

The bq20z90-V110 sets the over temperature discharging [OTD] SafetyAlert flag, if pack temperature reaches or surpasses **Over Temp Dsg** limit during discharging. The bq20z90-V110 changes [OTD] SafetyAlert to over temperature condition, if pack temperature stays above **Over Temp Dsg** limit for a time period of **OT Dsg Time**. This function is disabled if **OT Dsg Time** is set to zero.

If [OTFET] is set and bq20z90-V110 is in [OTD] condition, discharging is disabled and DSG FET is turned off, ChargingCurrent is set to zero, the [OTD] SafetyAlert flag is reset, [TDA] is set, [XDSG] flag is set and the [OTD] flag in SafetyStatus is set.

The bq20z90-V110 recovers from an [OTD] condition if pack temperature is equal to or below **OTD Chg Recovery** limit. On recovery [OTD] in SafetyStatus is reset, [TDA] is reset, ChargingCurrent is set back to the appropriate value per the charging algorithm, and the DSG FET is allowed to switch on again.

In an [OTD] condition, the DSG FET is turned on during charging to prevent overheating of the DSG FET body diode.

Table 2-7. Overtemperature Protection

	Alert Threshold	Alert Time Limit	SafetyAlert Flags set	Overtemp Condition	Recovery Threshold
Charge	Over Temp Chg	OT Chg Time	[OTC]	[OTC] SafetyStatus Flag, [TCA] set, ChargingCurrent =0, ChargingVoltage = 0, (CHG FET off if [OTFET] set)	OT Chg Recovery
Discharge	Over Temp Dsg	OT Dsg Time	[OTD]	[OTD] SafetyStatus Flag, [TDA] Set, ChargingCurrent =0, ([XDSG] set and DSG FET off if [OTFET] flag set)	OT Dsg Recovery

Related Variables:

- DF:1st Level Safety:Temperature(2):Over Temp Chg(0)
- DF:1st Level Safety:Temperature(2):OT Chg Time(2)
- DF:1st Level Safety:Temperature(2):OT Chg Recovery(3)
- DF:1st Level Safety:Temperature(2):Over Temp Dsg(5)
- DF:1st Level Safety:Temperature(2):OT Dsg Time(7)
- DF:1st Level Safety:Temperature(2):OT Dsg Recovery(8)
- DF:Configuration:Registers(64):Operation Cfg B(2)[OTFET]
- SBS:Temperature(0x08)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[TCA],[TDA]
- SBS:SafetyAlert(0x50)[OTC],[OTD]
- SBS:SafetyStatus(0x51)[OTC],[OTD]
- SBS:OperationStatus(0x54)[XDSG]

2.1.7 Host Watchdog

The bq20z90-V110 can be configured to require the host system to communicate with the battery periodically, else the battery disables charging and discharging. The Host Watchdog function is only active in Normal Power mode and is disabled if **Host Watchdog Timeout** is set to 0.

If the bq20z90-V110 does not receive any valid SMBus communications for **Host Watchdog Timeout** period of time, the FETs are turned off, *ChargingVoltage* and *ChargingCurrent* are set to 0, [TCA] and [TDA] in *BatteryStatus*, [XDSG] in *OperationStatus*, and [HWDG] in *SafetyStatus* are all set.

For normal recovery to be achieved, normal SMBus communication must be resumed. When this occurs, the FETs are returned to the normal operating state, [TCA] and [TDA] in *BatteryStatus* are cleared, *ChargingCurrent* and *ChargingVoltage* are set to the appropriate value per the charging algorithm, and [XDSG] and [HWDG] are cleared.

Related Variables:

- DF:1st Level Safety:Host Comm(3):Host Watchdog Timeout(0)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[TCA],[TDA]
- SBS:SafetyStatus(0x51)[HWDG]
- SBS:OperationStatus(0x54)[XDSG]

2.1.8 AFE Watchdog

The bq29330 automatically turns off the CHG FET, DSG FET and ZVCHG FET (if used), if the bq29330 does not receive the appropriate frequency on the WDI pin from bq20z90-V110. The bq20z90-V110 has no warning that this is about to happen, but it can report the occurrence once the bq20z90-V110 is able to interrogate the bq29330.

When the XALERT input of the bq20z90-V110 is triggered by the XALERT pin of the bq29330, the bq20z90-V110 reads the STATUS register of the bq29330. If *[WDF]* is set, the bq20z90-V110 also sets *[WDF]* in *SafetyStatus* and periodic verification of the bq29330 RAM is undertaken. If verification of the bq29330 RAM fails then the FETs will turn off. Verification of the bq29330 RAM will continue once every second. If the periodic verification passes, then *[WDF]* in *SafetyStatus* is cleared and the FETs return to normal operation.

Related Variables:

- SBS:SafetyStatus(0x51)[WDF]

2.2 2nd Level Protection Features

The bq20z90-V110 provides features that can be used to indicate a more serious fault via the SAFE output. These outputs can be used to blow an in-line fuse to permanently disable the battery pack from charge or discharge activity.

If any PF Threshold condition is met, the appropriate flag is set in *PFAAlert*. If the PF Threshold condition is cleared within the PF time limit, the appropriate PFAAlert flag is cleared in *PFAAlert*. But if the PF Threshold condition continues over the PF Time Limit or Alert Limit, then the bq20z90-V110 goes into permanent failure condition and the appropriate flag is set in *PFStatus* and reset in *PFAAlert*.

When any NEW cause of a permanent failure is set in *PFStatus* function, the NEW cause is added to **PF Flags 1** register. This allows **PF Flags 1** register to show ALL permanent failure conditions that have occurred.

On the first occasion of a permanent failure indicated by *PFStatus* change from 0x00, the *PFStatus* value is stored in **PF Flags 2**.

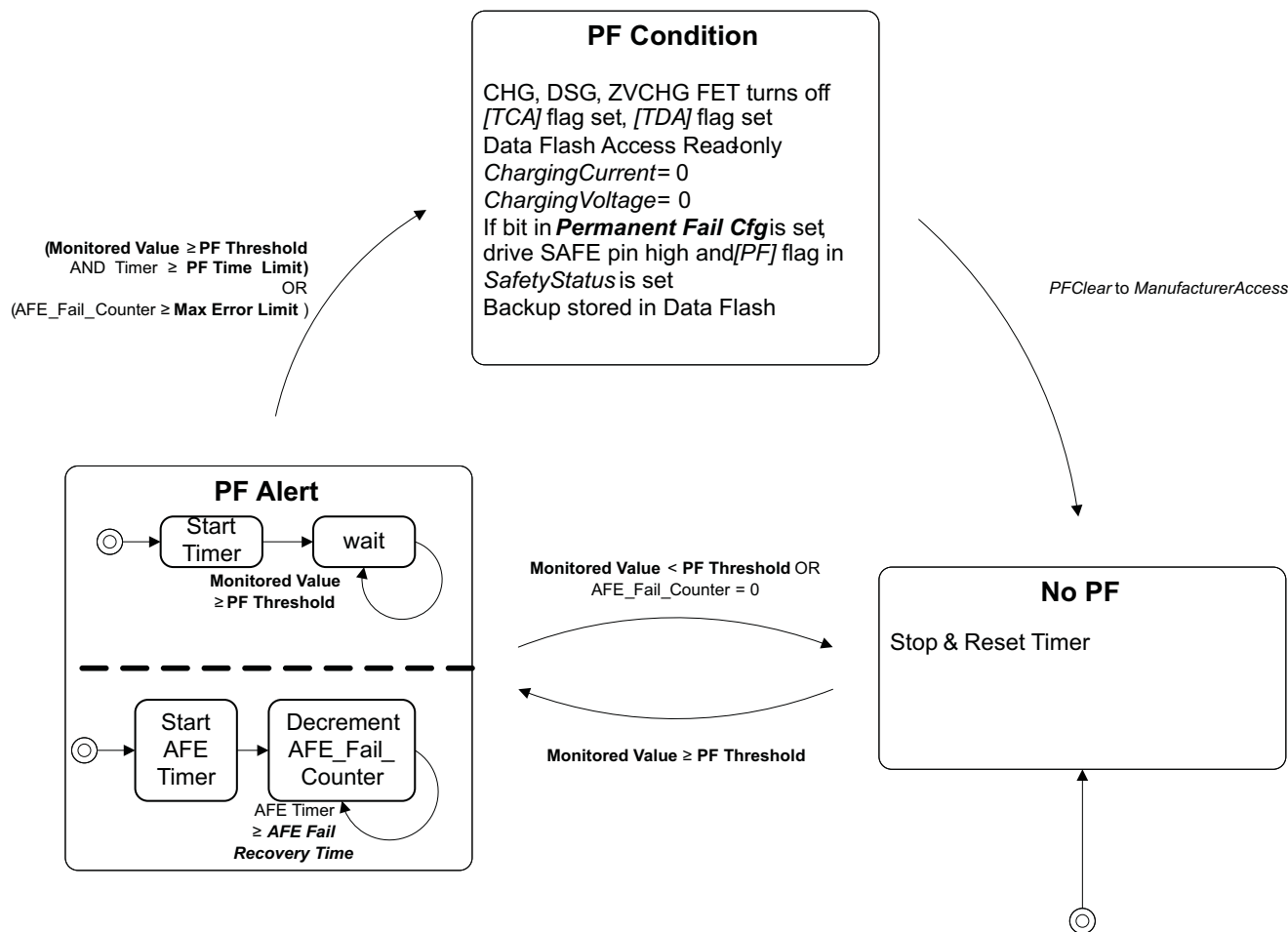


Figure 2-6. 2nd Level Protection

2.2.1 2nd Level (Permanent) Failure Actions

When the *PFStatus* register changes from 0x00 to indicate a permanent failure then the following actions are taken in sequence.

- CHG, DSG, and ZVCHG FETs are turned OFF.
- [TCA], [TDA] flags in *BatteryStatus* are set.
- A backup of SBS data and the complete memory map of the bq29330 is stored to data flash.
- Data Flash write access is then disabled, but the data flash can be read.
- *ChargingCurrent* and *ChargingVoltage* are set to 0.
- The appropriate bit in *PF Flags 1* is set.
- If the appropriate bit in **Permanent Fail Cfg** is set, then 0x3672 is programmed to **Fuse Flag**, and the SAFE pin is driven and latched high. The [PF] flag in *SafetyStatus* is also set.

Table 2-8. Permanent Fail Backup

SBS Value	Data Flash Backup
SBS:Voltage(0x09)	DF:PF Status:Device Status Data(96):PF Voltage(4)
SBS:CellVoltage4(0x3c)	DF:PF Status:Device Status Data(96):PF C4 Voltage(6)
SBS:CellVoltage3(0x3d)	DF:PF Status:Device Status Data(96):PF C3 Voltage(8)
SBS:CellVoltage2(0x3e)	DF:PF Status:Device Status Data(96):PF C2 Voltage(10)

Table 2-8. Permanent Fail Backup (continued)

SBS Value	Data Flash Backup
SBS:CellVoltage1(0x3f)	DF:PF Status:Device Status Data(96):PF C1 Voltage(12)
SBS:Current(0x0a)	DF:PF Status:Device Status Data(96):PF Current(14)
SBS:Temperature(0x08)	DF:PF Status:Device Status Data(96):PF Temperature(16)
SBS:BatteryStatus(0x16)	DF:PF Status:Device Status Data(96):PF Batt Stat(18)
SBS:RemainingCapacity(0x0f)	DF:PF Status:Device Status Data(96):PF RC-mAh(20)
	DF:PF Status:Device Status Data(96):PF RC-10mWh(22)
SBS:ChargingStatus(0x55)	DF:PF Status:Device Status Data(96):PF Chg Status(24)
SBS:SafetyStatus(0x51)	DF:PF Status:Device Status Data(96):PF Safety Status(26)
bq29330 Memory Map	
	DF:PF Status:AFE Regs(97):AFE Status(0)
	DF:PF Status:AFE Regs(97):AFE Output(1)
	DF:PF Status:AFE Regs(97):AFE State(2)
	DF:PF Status:AFE Regs(97):AFE Function(3)
	DF:PF Status:AFE Regs(97):AFE Cell Select(4)
	DF:PF Status:AFE Regs(97):AFE OLV(5)
	DF:PF Status:AFE Regs(97):AFE OLT(6)
	DF:PF Status:AFE Regs(97):AFE SCC(7)
	DF:PF Status:AFE Regs(97):AFE SCD(8)

Related Variables:

- DF:Configuration:Registers(64):Permanent Fail Cfg(6)
- DF:PF Status:Device Status Data(96):PF Flags 1(0)
- DF:PF Status:Device Status Data(96):Fuse Flag(2)
- DF:PF Status:Device Status Data(96):PF Flags 2(28)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[TCA],[TDA]
- SBS:SafetyStatus(0x51)[PF]
- SBS:PFStatus(0x53)

2.2.2 Time Limit Based Protection

bq20z90-V110 reports a 2nd level protection alert by setting the appropriate flag in the *PFA* alert function if the monitored value reaches or rises above the Protection Threshold. If the monitored value stays above the Protection Threshold over the Max Alert duration, the bq20z90-V110 reports a 2nd level permanent failure, clears the appropriate *PFA* alert flag, and sets the appropriate *PF* status flag. See the table for all Protection Thresholds and Max Alert durations.

Safety Overvoltage Protection — The bq20z90-V110 monitors the pack voltage for extreme values.

Cell Imbalance Fault — The bq20z90-V110 starts cell imbalance fault detection when *Current* is lesser or equal to **Cell Imbalance Current** for **Battery Rest Time** period. The difference between highest cell voltage and lowest cell voltage is monitored. If **Battery Rest Time** is set to zero or **Cell Imbalance Time** is set to zero, this function is disabled.

2nd Level Protection IC Input — The \overline{PFIN} input of the bq20z90-V110 can be used to determine the state of an external protection device such as the bq294xx. The bq20z90-V110 watches for \overline{PFIN} pin being driven low by an external device.

2nd Level Protection Features

Safety Overcurrent Protection — The bq20z90-V110 monitors the current during charging and discharging. The overcurrent thresholds and time limits can be set independently for charging and discharging.

Safety Overtemperature Protection — The bq20z90-V110 monitors the pack temperature during charging and discharging. The overtemperature thresholds and time limits can be set independently for charging and discharging.

Open Thermistor — The bq20z90-V110 can detect an open thermistor condition if the temperature function reports extreme temperature values.

Charge and Zero-Volt Charge FET Fault Protection — The bq20z90-V110 monitors if there is, at any time, an attempt to turn off the CHG FET or ZVCHG FET or the CHG bit in the bq29330 OUTPUT register is set and the current still continues to flow.

Discharge FET Fault Protection — The bq20z90-V110 monitors if there is, at any time, an attempt to turn off the DSG FET or the DSG bit in the bq29330 OUTPUT register is set and the current still continues to flow.

Fuse State Detection — The bq20z90-V110 can detect if an attempt has been made to blow the fuse, but this has failed. The bq20z90-V110 monitors if the **Fuse Flag** is set to 0x3672 and current is still flowing.

Table 2-9. Time Limit Based 2nd Level Protection

Protection	Monitored Value	Requirement	PF Threshold	PF Time Limit (set to 0 to disable Protection)	PFAAlert Flag, PFStatus Flag,	Permanent Fail Cfg Flag
Safety Overvoltage	Voltage	-	SOV Threshold	SOV Time	[SOV]	[XSOV]
Cell Imbalance Fault	Difference of highest and lowest of CellVoltage4..1	Current ≤ Cell Imbalance Current for Battery Rest Time	Cell Imbalance Fail Voltage	Cell Imbalance Time	[CIM]	[XCIM]
2nd Level Protection IC Input	PFIN pin	-	PFIN pin low	PFIN Detect Time	[PFIN]	[XPFIN]
Safety Overcurrent Charge	Current	Current > 0	SOC Chg	SOC Chg Time	[SOCC]	[XSOCC]
Safety Overcurrent Discharge	(-)Current	Current < 0	SOC Dsg	SOC Dsg Time	[SOCD]	[XSOC D]
Safety Overtemperature Chg	Temperature	Current > 0	SOT Chg	SOT Chg Time	[SOTC]	[XSOTC]
Safety Overtemperature Dsg	Temperature	Current < 0	SOT Dsg	SOT Dsg Time	[SOTD]	[XSOTD]
Open Thermistor	Temperature	-	Open Thermist or	Open Time	[OTS]	[XOTS]
Charge and Zero-Volt Charge FET Fault	Current	(CHG FET or ZVCHG FET turn off attempt or CHG Flag in bq29330 OUTPUT register set) and Current >0	FET Fail Limit	FET Fail Time	[CFETF]	[XCFETF]
Discharge FET Fault	(-)Current	(DSG FET turn off attempt or DSG Flag in bq29330 OUTPUT register set) and Current < 0	FET Fail Limit	FET Fail Time	[DFETF]	[XDFETF]
Fuse State	Current	Fuse Flag = 0x3672	Fuse Fail Limit	Fuse Fail Time	[FBF]	[XFBF]

Related Variables:

- DF:2nd Level Safety:Voltage(16):SOV Threshold(0)
- DF:2nd Level Safety:Voltage(16):SOV Time(2)
- DF:2nd Level Safety:Voltage(16):Cell Imbalance Current(3)
- DF:2nd Level Safety:Voltage(16):Cell Imbalance Fail Voltage(4)
- DF:2nd Level Safety:Voltage(16):Cell Imbalance Time(6)
- DF:2nd Level Safety:Voltage(16):Battery Rest Time(7)

- DF:2nd Level Safety:Voltage(16):PFIN Detect Time(9)
- DF:2nd Level Safety:Current(17):SOC Chg(0)
- DF:2nd Level Safety:Current(17):SOC Chg Time(2)
- DF:2nd Level Safety:Current(17):SOC Dsg(3)
- DF:2nd Level Safety:Current(17):SOC Dsg Time(5)
- DF:2nd Level Safety:Temperature(18):SOT Chg(0)
- DF:2nd Level Safety:Temperature(18):SOT Chg Time(2)
- DF:2nd Level Safety:Temperature(18):SOT Dsg(3)
- DF:2nd Level Safety:Temperature(18):SOT Dsg Time(5)
- DF:2nd Level Safety:Temperature(18):Open Thermistor(6)
- DF:2nd Level Safety:Temperature(18):Open Time(8)
- DF:2nd Level Safety:FET Verification(19):FET Fail Limit(0)
- DF:2nd Level Safety:FET Verification(19):FET Fail Time(2)
- DF:2nd Level Safety:Fuse Verification(21):Fuse Fail Limit(0)
- DF:2nd Level Safety:Fuse Verification(21):Fuse Fail Time(2)
- DF:Configuration:Registers(64):Permanent Fail Cfg(6)
- DF:PF Status:Device Status Data(96):PF Flags 1(0)
- SBS:Temperature(0x08)
- SBS:Voltage(0x09)
- SBS:Current(0x0a)
- SBS:CellVoltage4..1(0x3c..0x3f)
- SBS:PFStatus(0x53)

2.2.3 Limit Based Protection

The bq20z90-V110 reports a 2nd level permanent failure and sets the appropriate *PFStatus* flag if the internal error counter reaches the max error limit. The internal error counter is incremented by one if the error happens and decremented by one each fail recovery period.

bq29330 AFE Communication Fault Protection — The bq20z90-V110 periodically validates its read and write communications with the bq29330. If either a read or write verify fails, an internal *AFE_Fail_Counter* is incremented. If the *AFE_Fail_Counter* reaches **AFE Fail Limit**, the bq20z90-V110 reports a [*AFE_C*] permanent failure. If the **AFE Fail Limit** is set to 0, this feature is disabled. An [*AFE_C*] fault can also be declared if, after a full reset, the initial gain and offset values read from the AFE cannot be verified. These values are A/D readings of the bq29330 VCELL output. The bq29330 offset values are verified by reading the values twice and confirming that the readings are within acceptable limits. The max difference between 2 readings is set with **AFE Init Limit**. The maximum number of read retries, if offset and gain value verification fails and [*AFE_C*] fault is declared, is set in **AFE Fail Limit**.

Periodic bq29330 AFE Verification — The bq20z90-V110 periodically (**AFE Check Time**) compares certain RAM content of the bq29330 AFE with that of the bq20z90-V110 data flash and the expected control-bit states. This function is disabled if **AFE Check Time** is set to 0. If an error is detected, the internal *AFE_Fail_Counter* is incremented. If the internal *AFE_Fail_Counter* reaches the **AFE Fail Limit**, the bq20z90-V110 reports a permanent failure.

bq29330 AFE Init Verification — After a full reset the bq20z90-V110 and the AFE offset and gain values are read twice and compared. The **AFE Init Limit** sets the maximum difference in A/D counts of two successful readings of offset and gain, which the bq20z90-V110 still considers as the same value. If the gain and offset values are still not considered the same after **AFE Init Retry Limit** comparison retries, the bq20z90-V110 reports a permanent failure error.

Data Flash Failure — The bq20z90-V110 can detect if the data flash is not operating correctly. A permanent failure is reported when either: (i) After a full reset the instruction flash checksum does not verify; (ii) if any data flash write does not verify; or (iii) if any data flash erase does not verify.

Table 2-10. Error Based 2nd Level Protection

Protection	Monitored Value	Fail Recovery	Max Error Limit (set to 0 to disable Protection)	PFAlert Flag, PFStatus Flag,	Permanent Fail Cfg Flag
AFE Communication Fault	Periodic Communication with bq29330	decrement of internal AFE_Fail_Counter by one per AFE Fail Recovery Time period	AFE Fail Limit	[AFE_C]	[XAFE_C]
Periodic AFE Verification	Check RAM of bq29330 with AFE Check Time period	decrement of internal AFE_Fail_Counter by one per AFE Fail Recovery Time period	AFE Fail Limit	[AFE_P]	[XAFE_P]
AFE Initialization	Initial gain and offset values from bq29330 after full reset	-	AFE Init Retry Limit	[AFE_C]	[XAFE_C]
Data Flash Failure	Data Flash	-	false flash checksum after reset, data flash write not verified, data flash erase not verified	[DFF]	[XDFF]

Related Variables:

- DF:2nd Level Safety:FET Verification(19):FET Fail Limit(0)
- DF:2nd Level Safety:FET Verification(19):FET Fail Time(2)
- DF:2nd Level Safety:AFE Verification(20):AFE Check Time(0)
- DF:2nd Level Safety:AFE Verification(20):AFE Fail Limit(1)
- DF:2nd Level Safety:AFE Verification(20):AFE Fail Recovery Time(2)
- DF:2nd Level Safety:AFE Verification(20):AFE Init Retry Limit(3)
- DF:2nd Level Safety:AFE Verification(20):AFE Init Limit (4)
- DF:Configuration:Registers(64):Permanent Fail Cfg(6)
- DF:PF Status:Device Status Data(96):PF Flags 1(0)
- SBS:PFStatus(0x53)

2.2.4 Clearing Permanent Failure

The bq20z90-V110 permanent failure can be cleared by sending two *ManufacturerAccess* commands in sequence: the first word of the *PFKey* followed by the second word of the *PFKey*. After sending these two commands in sequence, *PFStatus* flags are cleared. Refer to Permanent Fail Clear (*PFKey*) Manufacturer access for further details.

Related Variables:

- SBS:ManufacturerAccess(0x00)
- SBS:PFStatus(0x53)

2.3 Gas Gauging

The bq20z90-V110 measures individual cell voltages, pack voltage, temperature, and current using features of the bq29330 AFE device. The bq20z90-V110 determines battery state of charge by analyzing individual cell voltages when a time exceeding 35 minutes has passed since the batteries last charge or discharge activity. The bq20z90-V110 measures charge and discharge activity by monitoring the voltage across a small-value series sense resistor (10 mΩ typ.) between the cell stack negative terminal and the negative terminal of the battery pack. The battery state of charge is subsequently adjusted during load or charger application using the integrated charge passed through the battery.

2.3.1 Impedance Track Configuration

Load Mode — During normal operation, the battery-impedance profile compensation of the Impedance Track algorithm can provide more accurate full-charge and remaining state-of-charge information if the typical load type is known. The two selectable options are constant current (**Load Mode** = 0) and constant power (**Load Mode** = 1).

Load Select — In order to compensate for the I x R drop near the end of discharge, the bq20z90-V110 needs to be configured for whatever current (or power) will flow in the future. While it can not be exactly known, the bq20z90-V110 can use load history such as the average current of the present discharge to make a sufficiently accurate prediction. The bq20z90-V110 can be configured to use several methods of this prediction by setting the **Load Select** value. Because this estimate has only a second-order effect on remaining capacity accuracy, different measurement based methods (0x00 to 0x03) result in only minor differences in accuracy. However, methods 0x04 - 0x06, where an estimate is arbitrarily assigned by the user, can result in significant error if a fixed estimate is far from the actual load.

Constant Current (Load Mode = 0)	Constant Power (Load Mode = 1)
0 = Avg I Last Run	Avg P Last Run
1 = present average discharge current	present average discharge power
2 = <i>Current</i>	<i>Current x Voltage</i>
3 = <i>AverageCurrent</i> (default)	<i>AverageCurrent x average Voltage</i>
4 = Design Capacity / 5	Design Energy / 5
5 = <i>AtRate</i> (mA)	<i>AtRate</i> (10 mW)
6 = User Rate-mA	User Rate-mW

Pulsed Load Compensation and Termination Voltage — In order to take into account pulsed loads, while calculating remaining capacity until **Term Voltage** threshold is reached, the bq20z90-V110 monitors not only average load but also short load spikes. The maximum voltage deviation during a load spike is continuously updated during discharge and stored in **Delta Voltage**.

Reserve Battery Capacity — The bq20z90-V110 allows an amount of capacity to be reserved in either mAh (**Reserve Cap-mAh, Load Mode = 0**) or 10 mWh (**Reserve Cap-mWh, Load Mode = 1**) units between the point where *RemainingCapacity* function reports zero capacity, and the absolute minimum pack voltage, **Term Voltage**. This enables a system to report zero energy, but still have enough reserve energy to perform a controlled shutdown, or to provide an extended sleep period for the host system.

Also, if **[RESCAP]** bit is set to 0, the reserve capacity is compensated at a no-load condition. However, if **[RESCAP]** bit is set to 1, then the reserve capacity is compensated at the present discharge rate as selected by **Load Select**.

Related Variables:

- DF:SBS Configuration:Data(48):Design Capacity(22)
- DF:SBS Configuration:Data(48):Design Energy(24)
- DF:Configuration:Operation Cfg B(2)[RESCAP]
- DF:Gas Gauging:IT Cfg(80):Load Select(0)
- DF:Gas Gauging:IT Cfg(80):Load Mode(1)
- DF:Gas Gauging:IT Cfg(80):Term Voltage(45)
- DF:Gas Gauging:IT Cfg(80):User Rate-mA(60)
- DF:Gas Gauging:IT Cfg(80):User Rate-mW(62)
- DF:Gas Gauging:IT Cfg(80):Reserve Cap-mAh(64)
- DF:Gas Gauging:IT Cfg(80):Reserve Cap-mWh(66)
- DF:Gas Gauging:State(82):Avg I Last Run(21)
- DF:Gas Gauging:State(82):Avg P Last Run(23)
- DF:Gas Gauging:State(82):Delta Voltage(25)
- SBS:BatteryMode(0x03)[CapM]
- SBS:Voltage(0x09)
- SBS:Current(0x0a)
- SBS:AverageCurrent(0x0b)

- SBS:OperationStatus(0x54)[LDMD]

2.3.2 Gas Gauge Modes

Resistance updates take place only in discharge mode, while OCV and Qmax updates only take place in relaxation mode. Entry and exit of each mode is controlled by data flash parameters in the subclass 'Gas Gauging: Current Thresholds' section. In Relaxation Mode or Discharge Mode, the DSG flag in *BatteryStatus* is set.

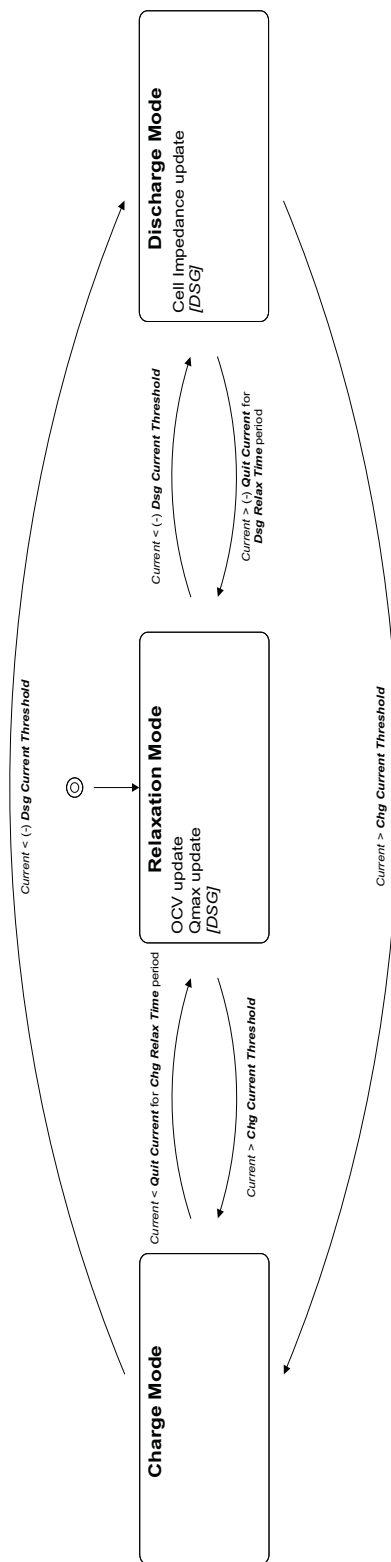


Figure 2-7. Gas Gauge Operating Modes

Gas Gauging

Charge mode is exited and Relaxation mode is entered when *Current* goes below **Quit Current** for a period of **Chg Relax Time**. Discharge mode is entered when *Current* goes below **(-)Dsg Current Threshold**. Discharge mode is exited and Relaxation mode is entered when *Current* goes above **(-)Quit Current** threshold for a period of **Dsg Relax Time**. Charge mode is entered when *Current* goes above **Chg Current Threshold**.

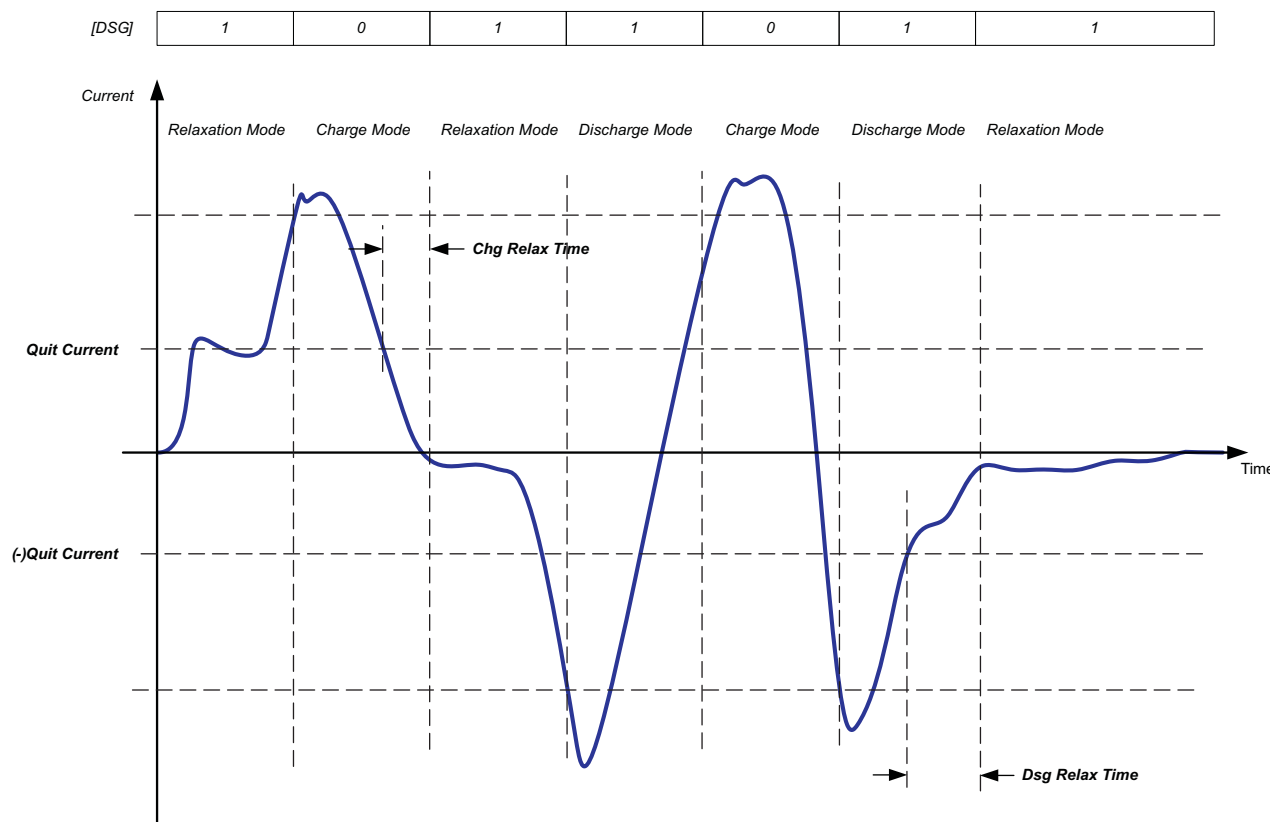


Figure 2-8. Gas Gauge Operating Mode Example

Related Variables:

- DF:Gas Gauging:Current Thresholds(81):Dsg Current Threshold(0)
- DF:Gas Gauging:Current Thresholds(81):Chg Current Threshold(2)
- DF:Gas Gauging:Current Thresholds(81):Quit Current(4)
- DF:Gas Gauging:Current Thresholds(81):Dsg Relax Time(6)
- DF:Gas Gauging:Current Thresholds(81):Chg Relax Time(7)
- SBS:Current(0x0a)
- SBS:BatteryStatus(0x16)[DSG]
- SBS:OperationStatus(0x54)[VOK],[R_DIS],[QEN]

2.3.3 Qmax

The total battery capacity is found by comparing states of charge before and after applying the load with the amount of charge passed. When an applications load is applied, the impedance of each cell is measured by comparing the open circuit voltage (OCV) obtained from a predefined function for present state of charge with the measured voltage under load.

Measurements of OCV and charge integration determine chemical state of charge and Chemical Capacity (*Qmax*).

The bq20z90-V110 acquires and updates the battery-impedance profile during normal battery usage. It uses this profile, along with state-of-charge and the *Qmax* values, to determine *FullChargeCapacity* and *RelativeStateOfCharge* specifically for the present load and temperature. *FullChargeCapacity* reports a capacity or energy available from a fully charged battery reduced by **Reserve Cap-mAh** or **Reserve Cap-mWh** under the present load and present temperature until *Voltage* reaches the **Term Voltage**.

Related Variables:

- DF:Gas Gauging:IT Config(80):Term Voltage(45)
- SBS:Voltage(0x09)
- SBS:RelativeStateOfCharge(0x0d)
- SBS:FullChargeCapacity(0x10)

2.3.3.1 Qmax initial Values

The initial **Qmax Pack**, **Qmax Cell 0**, **Qmax Cell 1**, **Qmax Cell 2**, and **Qmax Cell 3** values should be taken from the cell manufacturers' data sheet multiplied by the number of parallel cells, and are also used for the *DesignCapacity* function value in the **Design Capacity** data flash value.

See "Theory and Implementation of Impedance Track Battery Fuel-Gauging Algorithm" application note (SLUA364) for further details.

Related Variables:

- DF:SBS Configuration:Data(48):Design Capacity(22)
- DF:Gas Gauging:State(82):Qmax Cell 0(0)
- DF:Gas Gauging:State(82):Qmax Cell 1(2)
- DF:Gas Gauging:State(82):Qmax Cell 2(4)
- DF:Gas Gauging:State(82):Qmax Cell 3(6)
- DF:Gas Gauging:State(82):Qmax Pack(8)
- SBS:DesignCapacity(0x18)

2.3.3.2 Qmax Update Conditions

The bq20z90-V110 updates the no-load full capacity (QMAX) when two open circuit voltage (OCV) readings are taken. These OCV readings are taken when the battery is in a relaxed state before and after charge or discharge activity. A relaxed state is achieved if the battery voltage has a dV/dt of < 4 μV/s. Typically it takes 2 hrs in a charged state and 5 hrs in a discharged state to ensure that the dV/dt condition is satisfied. If 5 hrs is exceeded, a reading will be taken even if the dV/dt condition was not satisfied. A QMAX update is disqualified under the following conditions:

Temperature — If *Temperature* is outside of the range 10°C to 40°C.

Delta Capacity — If the capacity change between suitable battery rest periods is less than 37%.

Voltage — If *CellVoltage4..1* is within the range of 3737mV and 3800mV for the default LION chemistry. (Refer to "Support of Multiple Li-Ion Chemistries w/Impedance Track(TM) Gas Gauges", application note, (SLUA372) for the voltage ranges of other chemistries.)

Related Variables:

- SBS:Temperature(0x08)
- SBS:RelativeStateOfCharge(0x0d)
- SBS:AbsoluteStateOfCharge(0x0e)
- SBS:CellVoltage4(0x3c)
- SBS:CellVoltage3(0x3d)
- SBS:CellVoltage2(0x3e)
- SBS:CellVoltage1(0x3f)
- SBS:OperationStatus(0x54)[VOK],[QEN]

2.4 Charge Control

The bq20z90-V110 can report the appropriate charging current needed for the constant charging current and the charging voltage needed for constant voltage charging per charging algorithm to a smart charger using the *ChargingCurrent* and the *ChargingVoltage* functions. The actual charging status of bq20z90-V110 is indicated with flags and can be read out with the *ChargingStatus* function.

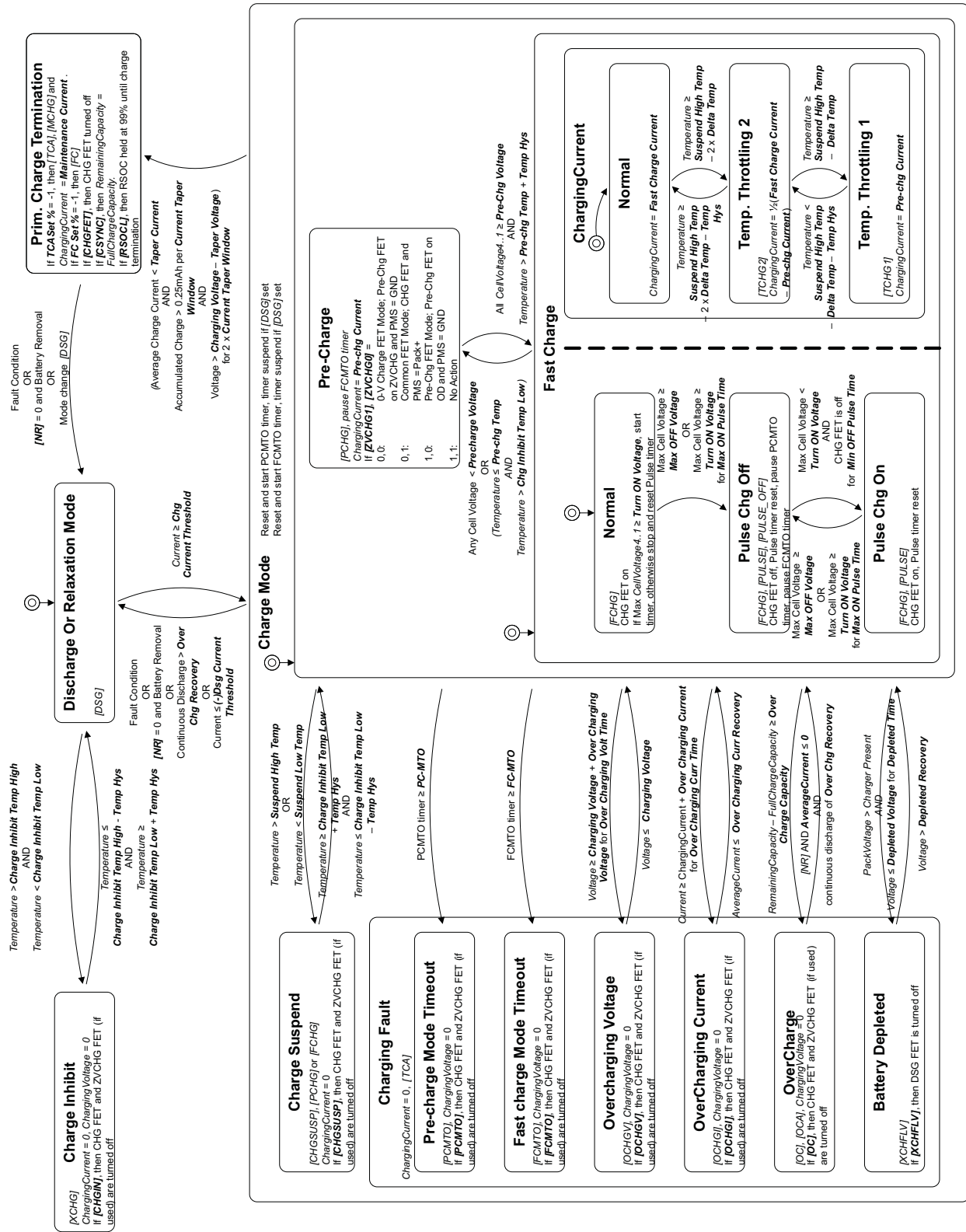


Figure 2-9. Charging

- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)

- SBS:ChargingStatus(0x55)

2.4.1 Charge Control SMBus Broadcasts

All broadcasts to a host or a smart charger are enabled by the **[BCAST]** bit. If the **[HPE]** bit is enabled, Master-Mode broadcasts to the Host address are PEC enabled. If the **[CPE]** bit is enabled, Master-Mode broadcasts to the Smart-Charger address are PEC enabled. When broadcast is enabled, the following broadcasts are sent:

- *ChargingVoltage* and *ChargingCurrent* broadcasts are sent to the Smart-Charger device address (0x12) every 10 to 60 seconds.
- If any of the **[OCA]**, **[TCA]**, **[OTA]**, **[TDA]**, **[RCA]**, **[RTA]** flags are set, the *AlarmWarning* broadcast is sent to the host device address (0x14) every 10 seconds. Broadcasts stop when all flags above have been cleared.
- If any of the **[OCA]**, **[TCA]**, **[OTA]** or **[TDA]** flags are set, the *AlarmWarning* broadcast is sent to Smart-Charger device address every 10 seconds. Broadcasts stop when all flags above have been cleared.

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg B(2)[CPE],[HPE],[BCAST]
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[OCA],[TCA],[OTA],[TDA],[RCA],[RTA]

2.4.2 Cell Balancing

The bq20z90-V110 can determine the chemical state of charge of each cell using the Impedance Track™ algorithm. The cell balancing algorithm used in the bq20z90-V110 decreases the differences in imbalanced cells in a fully charged state gradually, which prevents fully charged cells from becoming overcharged causing excessive degradation. This increases overall pack energy by preventing premature charge termination. More Information can be found in the "Cell Balancing Using the bq20z90" Application Report (SLUA340).

The algorithm determines the amount of charge needed to fully charge each cell. There is a bypass FET in parallel with each cell connected to the bq29330. The FET is enabled for each cell with charge greater than the lowest charged cell to reduce charge current through those cells. Each FET is enabled for a precalculated time as calculated by the cell balancing algorithm. When any bypass FET is turned on, then the **[CB]** charging status flag is set, otherwise the **[CB]** flag is cleared.

If **Min Cell Deviation** is set to 0 cell balancing is disabled and all bypass FETs stay OFF.

The bypass time needed for each cell is calculated as:

$$\text{Min Cell Deviation} = R / (\text{duty_cycle} * V_avg) * 3.6 \text{ s/mAh}$$

Where:

R = internal bypass FET resistance of 500Ω (typ.) of bq29330 + 2 series input filter resistors, R_{χ} . For example: if input filter R_{χ} value is 100 Ω, $R = 500 + 2 * R_{\chi} = 700 \Omega$.

$V_avg = 3.6V$

$\text{duty_cycle} = 0.4 \text{ typ.}$

Using default values, the formula calculates the default value for **Min Cell Deviation**:

$$\text{Min Cell Deviation} = (500\Omega + (2 * R_{\chi})) / (0.4 * 3.6V) * 3.6 \text{ s/mAh} = 1750 \text{ s/mAh,}$$

Related Variables:

- DF:Charge Control:Cell Balancing Cfg(37):Min Cell Deviation(0)
- SBS:ChargingStatus(0x55)[CB]

2.4.3 Charge Inhibit Mode

If the bq20z90-V110 is in discharge mode or relaxation mode ($[DSG] = 1$) the bq20z90-V110 goes into charge inhibit mode and sets the *ChargingCurrent* and *ChargingVoltage* values to 0 to inhibit charging if:

- $Temperature < \mathbf{Charge\ Inhibit\ Temp\ Low}$ limit OR
- $Temperature > \mathbf{Charge\ Inhibit\ Temp\ High}$ limit

In charge inhibit mode the $[XCHG]$ flag in *ChargingStatus* is set. If $[CHGIN]$ bit in **Operation Cfg B** is set, the CHG FET and ZVCHG FET (if used) are also turned off when the bq20z90-V110 is in charge-inhibit mode.

The bq20z90-V110 allows charging to resume when:

- $Temperature \geq \mathbf{Charge\ Inhibit\ Temp\ Low} + \mathbf{Temp\ Hys}$ AND
- $Temperature \leq \mathbf{Charge\ Inhibit\ Temp\ High} - \mathbf{Temp\ Hys}$

The FETs also return to their previous states at that time. The $[XCHG]$ flag is cleared when the above conditions are met, when a fault condition is detected, or when the battery is removed if in removable mode ($[NR] = 0$).

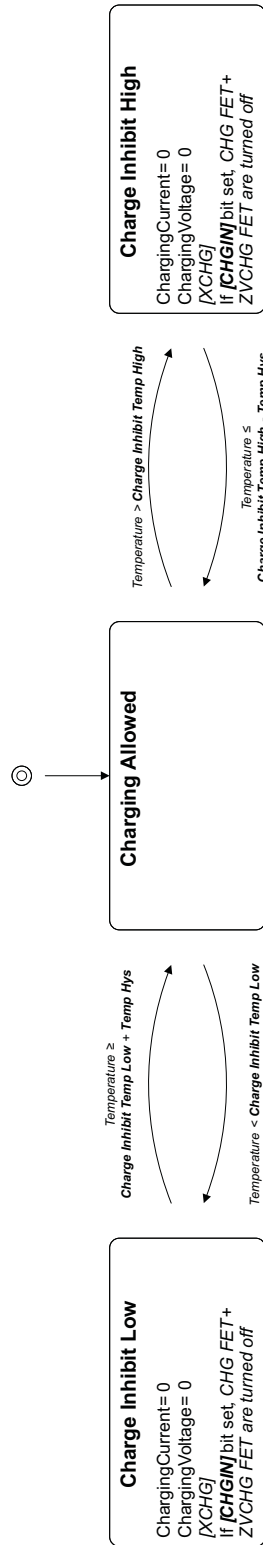


Figure 2-10. Charge Inhibit

Related Variables:

- DF:Charge Control:Charge Inhibit Cfg(32):Chg Inhibit Temp Low(0)
- DF:Charge Control:Charge Inhibit Cfg(32):Chg Inhibit Temp High(2)
- DF:Charge Control:Charge Inhibit Cfg(32):Temp Hys(4)
- DF:Configuration:Registers(64):Operation Cfg B(2)[CHGIN],[NR]
- SBS:Temperature(0x08)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[DSG]
- SBS:ChargingStatus(0x55)[XCHG]

2.4.4 Charge Suspend Mode

The bq20z90-V110 suspends charging when:

- $Temperature < \mathbf{Suspend\ Low\ Temp}$, OR
- $Temperature > \mathbf{Suspend\ High\ Temp}$

In charge suspend mode the *[CHGSUSP]* flag in *ChargingStatus* is set, and *ChargingCurrent* is set to 0. The CHG FET and ZVCHG FET(if used) are also turned off if *[CHGSUSP]* bit in **Operation Cfg B** register is set.

The bq20z90-V110 resumes charging if:

- $Temperature \geq \mathbf{Charge\ Inhibit\ Temp\ Low} + \mathbf{Temp\ Hys}$, AND
- $Temperature \leq \mathbf{Charge\ Inhibit\ Temp\ High} - \mathbf{Temp\ Hys}$.

Upon resuming, the bq20z90-V110 clears the *[CHGSUSP]* status flag, sets *ChargingCurrent* according to the appropriate charging mode entered and the CHG and ZVCHG FETs (if used) return to their previous state.

The bq20z90-V110 also leaves charge suspend mode and clears the *[CHGSUSP]* flag when a protection condition is detected or when the battery is removed in removable battery mode (*[NR]* = 0)

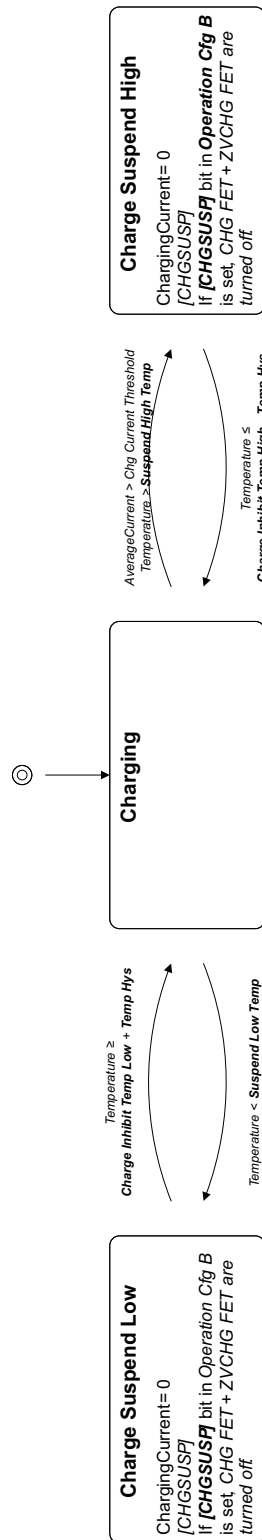


Figure 2-11. Charge Suspend

Related Variables:

- DF:Charge Control:Charge Inhibit Cfg(32):Chg Inhibit Temp Low(0)
- DF:Charge Control:Charge Inhibit Cfg(32):Chg Inhibit Temp High(2)

- DF:Charge Control:Charge Inhibit Cfg(32):Temp Hys(4)
- DF:Charge Control:Fast Charge Cfg(34):Suspend Low Temp(6)
- DF:Charge Control:Fast Charge Cfg(34):Suspend High Temp(8)
- DF:Configuration:Registers(64):Operation Cfg B(2)[CHGSUSP],[NR]
- DF:Gas Gauging:Current Thresholds(81):Chg Current Threshold(2)
- SBS:Temperature(0x08)
- SBS:AverageCurrent(0x0b)
- SBS:ChargingCurrent(0x14)
- SBS:BatteryStatus(0x16)[DSG]
- SBS:ChargingStatus(0x55)[CHGSUSP]

2.4.5 Precharge

The bq20z90-V110 enters precharge mode during charging if the *Temperature* function reports a temperature between **Charge Inhibit Temp Low** limit and **Pre-chg Temp** limit or any cell voltages are below **Pre-chg Voltage** limit. Precharge mode is also entered if any of the *SafetyStatus* flags [CUV], [PUV], [OCD] or [OCD2] are set.

Depending on the setting of the [ZVCHG1] and [ZVCHG0] bits, different FETs can be used in pre-charge mode.

Table 2-11. Precharge FET

ZVCHG1	ZVCHG0	FET used
0	0	ZVCHG FET
0	1	CHG FET
1	0	GPOD Pin on bq29330
1	1	No Action

In precharge mode the *[PCHG]* flag is set and *ChargingCurrent* is set to **Pre-chg Current**.

The bq20z90-V110 leaves Pre-charge mode and clears the *[PCHG]* flag if all cell voltages reach or rise above **Recovery Voltage** and the reported *Temperature* is equal to or greater than **Pre-chg Temp + Temp Hys**. Pre-charge mode is also exited if charge suspend mode is entered, any fault condition is detected, or the pack is removed in removable mode.

Related Variables:

- DF:Charge Control:Charge Inhibit Cfg(32):Chg Inhibit Temp Low(0)
- DF:Charge Control:Pre-Charge Cfg(33):Pre-chg Current(0)
- DF:Charge Control:Pre-Charge Cfg(33):Pre-chg Temp(2)
- DF:Charge Control:Pre-Charge Cfg(33):Pre-chg Voltage(4)
- DF:Charge Control:Pre-Charge Cfg(33):Recovery Voltage(6)
- DF:Configuration:Registers(64):Operation Cfg A(0)[ZVCHG1],[ZVCHG0]
- SBS:Temperature(0x08)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:CellVoltage4..1(0x3c..0x3f)
- SBS:SafetyStatus(0x51)[CUV],[PUV],[OCD],[OCD2]
- SBS:ChargingStatus(0x55)[PCHG]

2.4.6 Fast Charge

The bq20z90-V110 enters fast charge mode and sets *ChargingCurrent* to **Fast Charge Current** and *ChargingVoltage* to **Charging Voltage** when all of the following conditions are met.

- $Temperature \geq \text{Pre-chg Temp}$
- $Temperature \leq \text{Charge Suspend Temp High} - (2 \times \text{Delta Temp})$
- $CellVoltage4..1 \geq \text{Pre-chg Voltage}$
- $Voltage \leq \text{Charging Voltage} + \text{Over Charging Voltage}$

During fast charge, *[FCHG]* *ChargingStatus* flag is set and the CHG FET is turned on if no protection conditions are detected.

Related Variables:

- DF:Charge Control:Pre-Charge Cfg(33):Pre-chg Temp(2)
- DF:Charge Control:Pre-Charge Cfg(33):Pre-chg Voltage(4)
- DF:Charge Control:Fast Charge Cfg(34):Fast Charge Current(0)
- DF:Charge Control:Fast Charge Cfg(34):Charging Voltage(2)
- DF:Charge Control:Fast Charge Cfg(34):Delta Temp(4)
- DF:Charge Control:Fast Charge Cfg(34):Suspend Temp High(8)
- SBS:Temperature(0x08)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:CellVoltage4..1(0x3c..0x3f)
- SBS:ChargingStatus(0x55)[FCHG]

2.4.7 Fast Charge Temperature Throttling

The bq20z90-V110 alters *ChargingCurrent* and sets *ChargingStatus*[TCHG2], [TCHG1] flags during fast charge in response to changing temperature conditions.

ChargingStatus [TCHG2], [TCHG1] are also cleared when another charging mode is entered, a protection condition is detected, or the battery is removed while [NR] flag is set.

However, if **Delta Temp** is set to 0, *ChargingCurrent* remains **Fast Charge Current** during fast charge.

Table 2-12. Fast Charge Temperature Throttling

Temperature	ChargingCurrent	ChargingStatus Flag
\leq Charge Suspend Temp High AND \geq (Charge Suspend Temp High - Delta Temp)	Pre-chg Current	[TCHG1]
$<$ (Charge Suspend Temp High - Delta Temp) AND \geq (Charge Suspend Temp High- (2 x Delta Temp)),	(Charging Current-Pre-chg Current) / 2	[TCHG2]
$<$ (Charge Suspend Temp High- (2 x Delta Temp)) AND \geq Pre-Chg Temp	Charging Current	[FCHG]

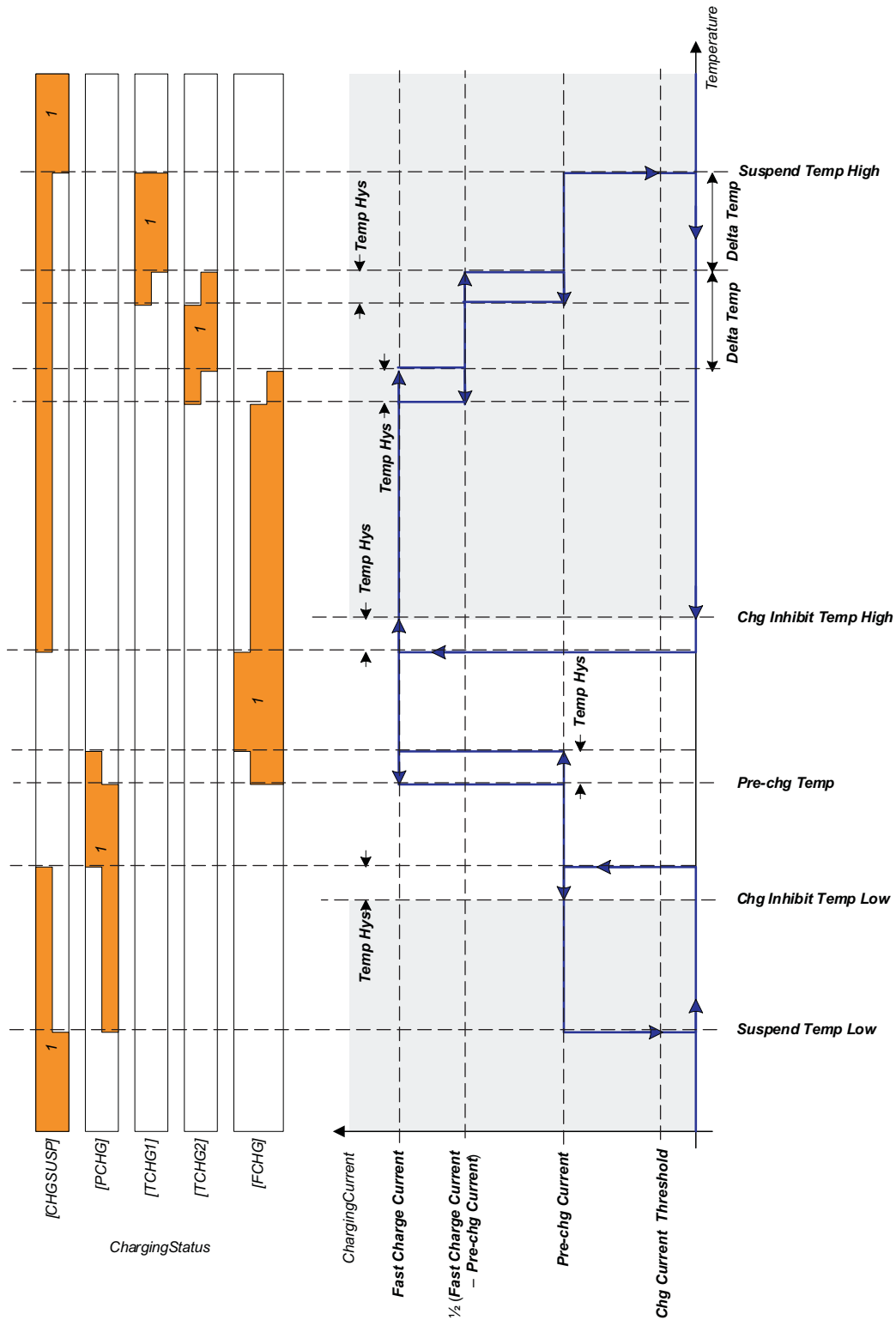


Figure 2-12. Fast Charge Temperature Throttling

Related Variables:

- DF:Charge Control:Pre-Charge Cfg(33):Pre-chg Current(0)
- DF:Charge Control:Pre-Charge Cfg(33):Pre-chg Temp(2)

- DF:Charge Control:Pre-Charge Cfg(33):Pre-chg Voltage(4)
- DF:Charge Control:Fast Charge Cfg(34):Fast Charge Current(0)
- DF:Charge Control:Fast Charge Cfg(34):Charging Voltage(2)
- DF:Charge Control:Fast Charge Cfg(34):Delta Temp(4)
- DF:Charge Control:Fast Charge Cfg(34):Suspend Low Temp(6)
- DF:Charge Control:Fast Charge Cfg(34):Suspend High Temp(8)
- SBS:Temperature(0x08)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingStatus(0x55)[FCHG],[TCHG1],[TCHG2]

2.4.8 Fast Charge Pulse Charging

Pulse charging is part of the fast charging mode and is a loop. During the loop, the measured cell voltages are calculated every 250 ms. This data is not reported via the *CellVoltage4..1* commands.

The pulse charging loop is entered when:

- maximum *CellVoltage4..1* \geq **Max OFF Voltage** OR
- maximum *CellVoltage4..1* \geq **Turn OFF Voltage** for **Max ON Pulse Time**

When these conditions are met, the CHG FET is turned off, and the *[PULSE]* and *[PLSOFF]* flags in *ChargingStatus* are set.

If the maximum *CellVoltage4..1* is $<$ **Turn ON Voltage** AND the CHG FET is off for **Min OFF Pulse Time**, the CHG FET is turned on and *[PLSOFF]* flag is cleared.

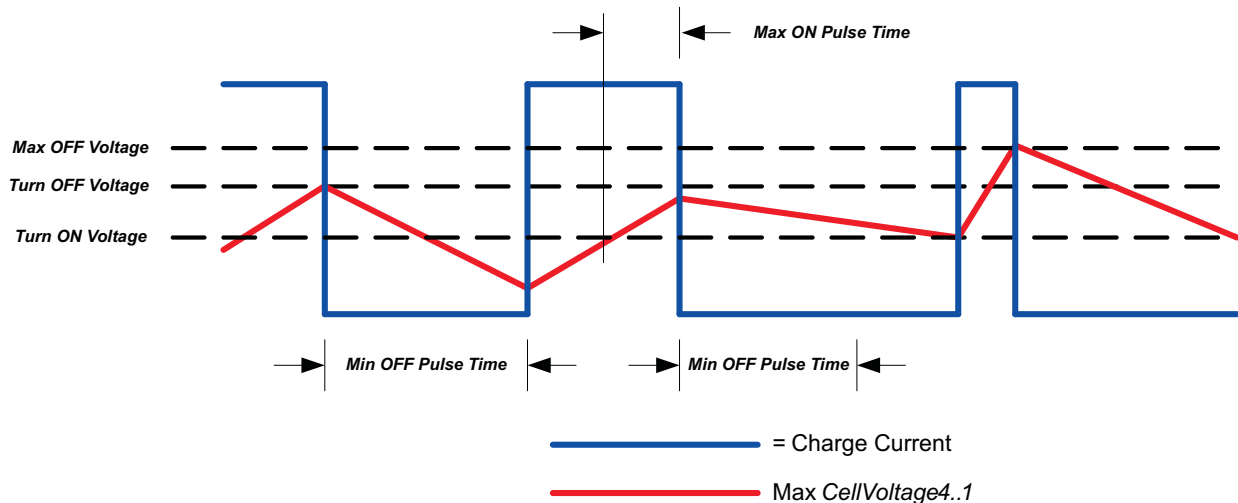


Figure 2-13. Pulse Charging Example

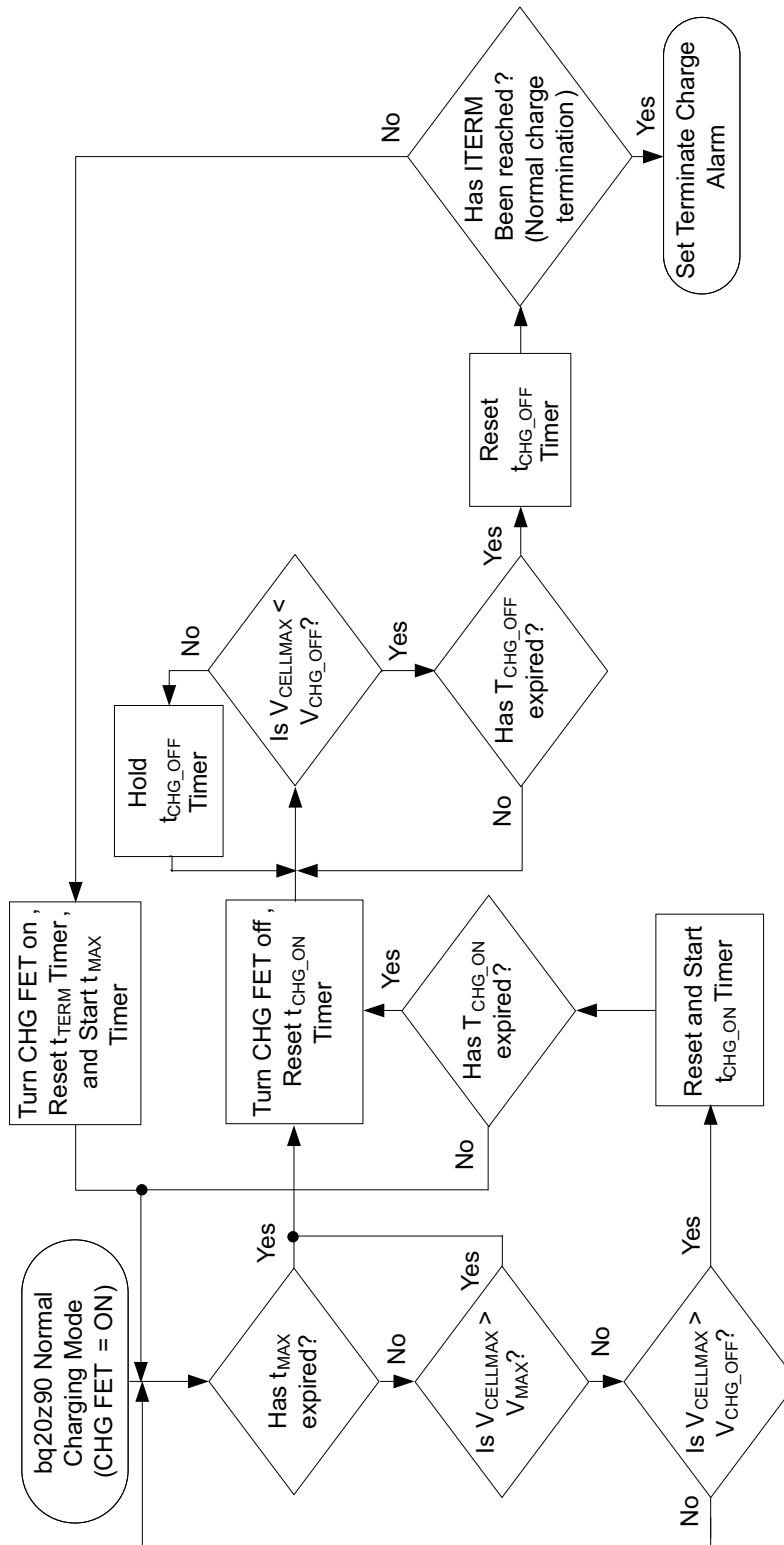


Figure 2-14. Pulse Charging

The pulse-charging loop is exited and $[PULSE]$ is cleared if another charging mode is entered, a protection condition is detected, or the battery is removed when $[NR] = 0$.

Related Variables:

- DF:Charge Control:Pulse Charge Cfg(35):Turn ON Voltage(0)
- DF:Charge Control:Pulse Charge Cfg(35):Turn OFF Voltage(2)
- DF:Charge Control:Pulse Charge Cfg(35):Max ON Pulse Time(4)
- DF:Charge Control:Pulse Charge Cfg(35):Max OFF Pulse Time(5)
- DF:Charge Control:Pulse Charge Cfg(35):Max OFF Voltage(6)
- SBS:CellVoltage4..1(0x3c..0xef)
- SBS:ChargingStatus(0x55)[FCHG],[PULSE],[PLSOFF]

2.4.9 Primary Charge Termination

The bq20z90-V110 determines charge termination if:

- Average Charge Current < **Taper Current** during 2 consecutive **Current Taper Window** time periods, AND
- the accumulated change in capacity must be > 0.25mAh per period during 2 consecutive **Current Taper Window** time periods, AND
- Voltage + **Taper Voltage** ≥ **Charging Voltage**

The following parameters change the behavior of bq20z90-V110 on charge termination:

Table 2-13. Primary Charge Termination

Parameter	Behavior on Primary Charge Termination
TCA Set % = -1	[TCA] flag set, MCHG flag set, ChargingCurrent = Maintenance Current
FC Set % = -1	[FC] flag set
[CHGFET] set	CHG FET turned off
[CSYNC] set	RemainingCapacity = FullChargeCapacity regardless of TCA Set % value
[RSOCL] set	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.
[RSOCL] clear	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%.

Related Variables:

- DF:Charge Control:Fast Charge Cfg(34):Charging Voltage(2)
- DF:Charge Control:Termination Cfg.(36):Maintenance Current(0)
- DF:Charge Control:Termination Cfg.(36):Taper Current(2)
- DF:Charge Control:Termination Cfg.(36):Taper Voltage(6)
- DF:Charge Control:Termination Cfg.(36):Current Taper Window(8)
- DF:Charge Control:Termination Cfg.(36):TCA Set %(9)
- DF:Charge Control:Termination Cfg.(36):FC Set %(11)
- DF:Configuration:Registers(64):Operation Cfg B(2)[CHGFET],[CSYNC]
- DF:Configuration:Registers(64):Operation Cfg C(4)[RSOCL]
- SBS:Voltage(0x09)
- SBS:Current(0x0a)
- SBS:RemainingCapacity(0x0f)
- SBS:FullChargeCapacity(0x10)
- SBS:ChargingCurrent(0x14)
- SBS:BatteryStatus(0x16)[TCA],[FC]
- SBS:ChargingStatus(0x55)[MCHG]

2.4.10 Charging Faults

The bq20z90-V110 can report charging faults in the *ChargingStatus* register. When the **[OCHG1]** bit in **Charge Fault Cfg** is set, the CHG FET is turned OFF and the ZVCHG FET is turned ON if the **[ZVCHG1, ZVCHG0]** bits in **Operation Cfg A** are set appropriately. If the ZVCHG FET is not used the CHG FET remains ON, regardless of the bits set in **Charge Fault Cfg**, because it acts as the ZVCHG FET.

On occurrence of a charging fault the bq20z90-V110 sets:

- The appropriate *ChargingStatus* flag
- If the flag in *Charge Fault Cfg* and *ChargingStatus* matches, CHG FET is turned off and ZVCHG FET (if used) is turned on. The DSG FET is also turned off if charging fault is a Battery Depleted fault.
- *ChargingCurrent* = 0, *ChargingVoltage* = 0; *ChargingVoltage* is not set to zero if it is a Battery Depleted fault.
- **[TCA]** flag in *BatteryStatus*
- **[OC]** flag in *BatteryStatus* if it's an Overcharge fault

On Recovery the bq20z90-V110:

- Resets the appropriate *ChargingStatus* flags
- CHG FET and ZVCHG FET (if used) return to previous states. (DSG FET is also allowed to turn on again on recovery from Battery Depleted fault).
- Sets *ChargingCurrent* and *ChargingVoltage* back to previous state according to charging algorithm.
- Resets **[TCA]***BatteryStatus* flag

Precharge Mode Timeout

When *Current* is \geq **Chg Current Threshold** the bq20z90-V110 starts the Precharge Timer. The Precharge Timer is suspended during off the phase in pulse charging (**[PLSOFF]** = 1) and when precharge mode is not active (**[PCHG]** = 0). Set **PC-MTO** to zero to disable this feature.

The bq20z90-V110 goes into precharge mode charging timeout if:

- Precharge timer \geq **PC-MTO**

The bq20z90-V110 recovers if:

- *Current* \leq **(-)Dsg Current Threshold**, OR
- Pack is removed and reinserted, if **[NR]** = 0

Fast Charge Mode Timeout

When *Current* is \geq **Chg Current Threshold**, the bq20z90-V110 starts the Fast Charge timer. The Fast Charge Timer is suspended during the off phase in pulse charge mode (**[PLSOFF]** = 1), fast charge is not active (**[FCHG]** = 0), or when **[DSG]** = 1. The Fast Charge Timer is reset when an amount of discharge greater than **Over Charge Recovery** is detected or the pack is removed and reinserted when **NR** = 0. Set **FC-MTO** to 0 to disable this feature.

The bq20z90-V110 goes into fast charge mode charging timeout if:

- Fast charge timer \geq **FC-MTO**

The bq20z90-V110 recovers if:

- *Current* \leq **(-)Dsg Current Threshold** OR
- Pack is removed and reinserted if **[NR]** = 0

Overcharging Voltage

The bq20z90-V110 goes into overcharging voltage mode if:

- *Voltage* \geq **Charging Voltage** + **Over Charging Voltage** for min. **Over Charging Volt Time** period.

The bq20z90-V110 recovers, if:

- *Voltage* \leq **Charging Voltage**

Overcharging Current

The bq20z90-V110 goes into overcharging current mode if:

- *Current* \geq **ChargingCurrent** + **Over Charging Current** for min. **Over Charging Curr Time** period.

The bq20z90-V110 recovers, if:

- $AverageCurrent \leq \text{Over Charging Curr Recov}$

Overcharge

The bq20z90-V110 goes into overcharge mode if the battery pack is charged in excess of *FullChargeCapacity* by **Over Charge Capacity**.

The bq20z90-V110 recovers if any of the following conditions are met:

- Pack removed and reinserted (**[NR]** = 0)
- Continuous amount of discharge over **Over Charge Recovery** and $AverageCurrent < 0$, when **[NR]** = 1
- $RemainingCapacity \leq \text{FC Clear \%}$

Battery Depleted

The bq20z90-V110 goes into battery depleted mode if:

- $Voltage \leq \text{Depleted Voltage}$ for **Depleted Voltage Time** and charger is present

The bq20z90-V110 recovers, if:

- $Voltage > \text{Depleted Voltage Recovery}$

Table 2-14. Charging Faults

Charge Fault	Fault Condition	Recovery Condition	ChargingStatus Flag, Charge Fault Configuration Flag
Precharge Timeout	Precharge Timer $\geq \text{PC-MTO}$	$Current \leq (-)Dsg \text{ Current Threshold}$, OR Pack removed and reinserted if $[NR] = 0$	[PCMTO]
Fast charge Timeout	Fast charge Timer $\geq \text{FC-MTO}$		[FCMTO]
Overcharging Voltage	$Voltage \geq \text{Charging Voltage} + \text{Over Charging Voltage}$ for min. Over Charging Volt Time	$Voltage \leq \text{Charging Voltage}$	[OCHGV]
Overcharging Current	$Current \geq \text{Charging Current} + \text{Over Charging Current}$ for min. Over Charging Curr Time	$AverageCurrent \leq \text{Over Charging Curr Recov}$	[OCHGI]
Overcharge	$\frac{RemainingCapacity - FullChargeCapacity}{FullChargeCapacity} \geq \text{Over Charge Capacity}$	Pack removed and reinserted if $[NR] = 0$, OR continuous amount of discharge of Over Charge Recovery if $[NR] = 1$, OR $RemainingCapacity \leq \text{FC Clear \%}$	[OC]
Battery Depleted	$Voltage \leq \text{Depleted Voltage}$ for min Depleted Voltage Time	$Voltage > \text{Depleted Voltage Recovery}$	[XCHGLV]

Related Variables:

- DF:Charge Control:Fast Charge Cfg(34):Charging Voltage(2)
- DF:Charge Control:Termination Cfg.(36):FC Clear %(12)
- DF:Charge Control:Charging Faults(38):Over Charging Voltage(0)
- DF:Charge Control:Charging Faults(38):Over Charging Volt Time(2)
- DF:Charge Control:Charging Faults(38):Over Charging Current(3)
- DF:Charge Control:Charging Faults(38):Over Charging Curr Time(5)
- DF:Charge Control:Charging Faults(38):Over Charging Curr Recov(6)
- DF:Charge Control:Charging Faults(38):Depleted Voltage(8)
- DF:Charge Control:Charging Faults(38):Depleted Voltage Time(10)
- DF:Charge Control:Charging Faults(38):Depleted Recovery(11)
- DF:Charge Control:Charging Faults(38):Over Charge Capacity(13)
- DF:Charge Control:Charging Faults(38):Over Charge Recovery(15)
- DF:Charge Control:Charging Faults(38):FC-MTO(17)
- DF:Charge Control:Charging Faults(38):PC-MTO(19)
- DF:Charge Control:Charging Faults(38):Charge Fault Cfg(21)
- DF:Configuration:Registers(64):Operation Cfg B(2)[NR]
- SBS:Voltage(0x09)
- SBS:Current(0x0a)
- SBS:AverageCurrent(0x0b)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[TDA],[TCA],[OCA]
- SBS:ChargingStatus(0x55)[FCHG],[PLSOFF],[PULSE]

2.4.11 Discharge and Charge Alarms

The bq20z90-V110 enables *[TDA]*, *[FD]*, *[TCA]* and *[FC]* flags in *BatteryStatus* to be set or cleared on the following thresholds based on *RelativeStateOfCharge*. All thresholds can be disabled by setting them to -1. **FC Clear %** should not be disabled by setting to -1.

	Threshold	BatteryStatus Flag
<i>RelativeStateOfCharge</i>	\leq TDA Set %	<i>[TDA]</i> is set
	\geq TDA Clear %	<i>[TDA]</i> is cleared
	\leq FD Set %	<i>[FD]</i> is set
	\geq FD Clear %	<i>[FD]</i> is cleared
	\geq TCA Set %	<i>[TCA]</i> is set
	\leq TCA Clear %	<i>[TCA]</i> is cleared
	\geq FC Set %	<i>[FC]</i> is set
	\leq FC Clear %	<i>[FC]</i> is cleared

The *[TDA]* and *[FD]* flags in *BatteryStatus* can also be set or cleared based on *Voltage*. If the voltage settings are not used then they should be set to extreme range values.

	Threshold	BatteryStatus Flag
<i>Voltage</i>	\leq TDA Volt Threshold for a period of TDA Volt Time	<i>[TDA]</i> is set
	\geq TDA Clear Volt	<i>[TDA]</i> is cleared
	\leq FD Volt Threshold for a period of FD Volt Time	<i>[FD]</i> is set
	\geq FD Clear Volt	<i>[FD]</i> is cleared

Related Variables:

- DF:Charge Control:Termination Cfg.(36):TCA Set %(9)
- DF:Charge Control:Termination Cfg.(36):TCA Clear %(10)
- DF:Charge Control:Termination Cfg.(36):FC Set %(11)
- DF:Charge Control:Termination Cfg.(36):FC Clear %(12)
- DF:SBS Configuration:Configuration(49):TDA Set %(0)
- DF:SBS Configuration:Configuration(49):TDA Clear %(1)
- DF:SBS Configuration:Configuration(49):FD Set %(2)
- DF:SBS Configuration:Configuration(49):FD Clear %(3)
- DF:SBS Configuration:Configuration(49):TDA Set Volt Threshold(4)
- DF:SBS Configuration:Configuration(49):TDA Set Volt Time(6)
- DF:SBS Configuration:Configuration(49):TDA Clear Volt(7)
- DF:SBS Configuration:Configuration(49):FD Set Volt Threshold(9)
- DF:SBS Configuration:Configuration(49):FD Volt Time(11)
- DF:SBS Configuration:Configuration(49):FD Clear Volt(12)
- SBS:Voltage(0x09)
- SBS:RelativeStateOfCharge(0x0d)

2.5 LED Display

2.5.1 Display Activation

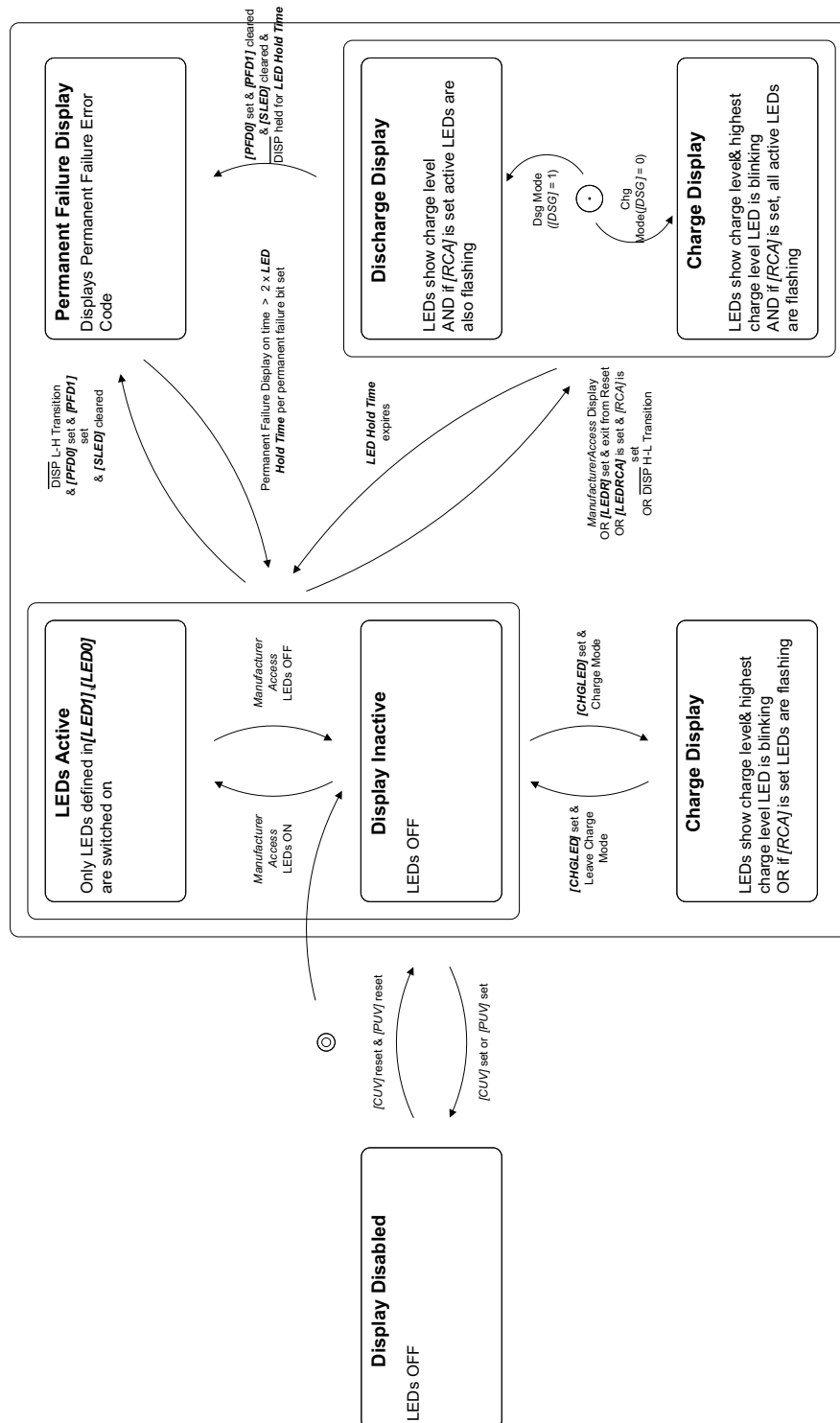


Figure 2-15. Display Activation

The LED display is activated with a H-L transition at the $\overline{\text{DISP}}$ pin. The following flags configure additional display activation settings.

If [CUV] or [PUV] flags are set, the display is disabled.

LEDR — Set this flag to activate the display on exit from reset of bq20z90-V110.

LEDRCA — Set this flag to let all active LEDs flash with **LED Flash Rate** if [RCA] flag is set.

CHGLED — Set this flag to let the display stay activated during charging.

PFD1, PFD0 — If [PFD0] is set, the permanent failure can be activated in two different ways depending on the [PFD1] flag. If [PFD1] is cleared, the permanent failure display is active after normal capacity display, if $\overline{\text{DISP}}$ is held low after H-L transition for **LED Hold Time** period. If [PFD1] is set, the permanent failure display is activated with a H-L transition at $\overline{\text{DISP}}$ pin. The permanent failure display stays active $2 \times \text{LED Hold Time}$ for each flag set in *PFStatus* register. See "Permanent Failure Error Codes" chapter for available error codes.

LEDs ON, LEDs OFF, Display ON — The display can be tested with these *ManufacturerAccess* commands, *LEDs ON* and *LEDs OFF* switches all configured LEDs on or off. The *Display ON* command simulates a H-L transition at the $\overline{\text{DISP}}$ pin.

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[LEDR],[LEDRCA],[CHGLED]
- DF:Configuration:Registers(64):Operation Cfg B(2)[PFD1],[PFD0]
- DF:LED Support:LED Cfg(67):LED Hold Time(6)
- SBS:ManufacturerAccess(0x00):LEDs ON(0x0032)
- SBS:ManufacturerAccess(0x00):LEDs OFF(0x0033)
- SBS:ManufacturerAccess(0x00):Display ON(0x0034)
- SBS:BatteryStatus(0x16)[RCA]
- SBS:SafetyStatus(0x51)[CUV],[PUV]
- SBS:PFStatus(0x53)

2.5.2 Display Configuration

The following parameters configures the display in various ways.

DMODE — The charge level display can be configured to show either relative state of charge or absolute state of charge.

LED1, LED0 — These bits configure the number of LEDs and the charge threshold levels used in the LED display. The bq20z90-V110 can use predefined charge levels for 3,4, or 5 LEDs or user defined levels.

SLED — The serial LED option can be used to implement a much brighter display at the expense of additional hardware components. With the parallel connection, the 3.3 V output from the bq29330 is used to power the LEDs. Using that approach, current in each LED should be limited to 3 mA maximum. With the serial option, all LEDs can be powered from the battery voltage and driven in series through a simple constant current regulator. The current is then diverted to ground at the various nodes between the series LEDs in order to program the desired pattern.

LED Blink Rate — During charging, the top LED segment flashes with the **LED Blink Rate** time period; e.g. if battery charge is 36% and the display uses 5 LEDs, LED 2 will blink. [LEDRCA], **CHG Flash Alarm** and **DSG Flash Alarm** will override this setting if active.

LED Flash Rate — During discharge alarm, the remaining LED segments flash with **LED Flash Rate** time period; e.g. if battery charge is 36% and the display uses 5 LEDs, LED 1 and LED 2 will blink.

LED Delay — An activation delay from one LED to another LED can be set with this value.

LED Hold Time — After display activation the display will stay on **LED Hold Time** period. The permanent failure display will stay on double the **LED Hold Time** period for each permanent failure bit set.

Related Variables:

LED Display

- DF:Configuration:Registers(64):Operation Cfg A(0)[DMODE],[LED1],[LED0],[SLED],[LEDRCA]
- DF:LED Support:LED Cfg(67):LED Flash Rate(0)
- DF:LED Support:LED Cfg(67):LED Blink Rate(2)
- DF:LED Support:LED Cfg(67):LED Delay(4)
- DF:LED Support:LED Cfg(67):LED Hold Time(6)
- SBS:RelativeStateOfCharge(0x0d)
- SBS:AbsoluteStateOfCharge(0x0e)

2.5.3 Display Format

The bq20z90-V110 can show state of charge using the LED display. Predefined levels for 3, 4 or 5 LEDs or user configurable levels can be selected. State of charge levels can be configured for charging and discharging.

If the display is activated during charging the display shows the state of charge and the top LED segment flashes at the rate of **LED Blink Rate** (eg: if *RelativeStateOfCharge* = 36% and 5 LEDs are being used then LED2 will blink). The blinking is overridden with **CHG Flash Alarm** or **[LEDRCA]**

If state of charge falls below the flash alarm level, all remaining active LEDs will flash at the **LED Flash Rate**. The flash alarm can be disabled by setting it to -1.

Table 2-15. Display Charge Level Threshold

LED1, LED0 Setting:	3 LED	4 LED	5 LED	USER	
Threshold Level:	charge + discharge level			charging level	discharging level
Flash Alarm active	0% - 10%	0% - 10%	0% - 10%	0% - CHG Flash Alarm	0% - DSG Flash Alarm
LED 1 active	0% - 100%	0% - 100%	0% - 100%	CHG Thresh 1 - 100%	DSG Thresh 1 - 100%
LED 2 active	34% - 100%	25% - 100%	20% - 100%	CHG Thresh 2 - 100%	DSG Thresh 2 - 100%
LED 3 active	67% - 100%	50% - 100%	40% - 100%	CHG Thresh 3 - 100%	DSG Thresh 3 - 100%
LED 4 active	-	75% - 100%	60% - 100%	CHG Thresh 4 - 100%	DSG Thresh 4 - 100%
LED 5 active	-	-	80% - 100%	CHG Thresh 5 - 100%	DSG Thresh 5 - 100%

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[DMODE],[LED1],[LED0],[LEDRCA]
- DF:LED Support:LED Cfg(67):LED Flash Rate(0)
- DF:LED Support:LED Cfg(67):LED Blink Rate(2)
- DF:LED Support:LED Cfg(67):CHG Flash Alarm(7)
- DF:LED Support:LED Cfg(67):CHG Thresh 1(8)
- DF:LED Support:LED Cfg(67):CHG Thresh 2(9)
- DF:LED Support:LED Cfg(67):CHG Thresh 3(10)
- DF:LED Support:LED Cfg(67):CHG Thresh 4(11)
- DF:LED Support:LED Cfg(67):CHG Thresh 5(12)
- DF:LED Support:LED Cfg(67):DSG Flash Alarm(13)
- DF:LED Support:LED Cfg(67):DSG Thresh 1(14)
- DF:LED Support:LED Cfg(67):DSG Thresh 2(15)
- DF:LED Support:LED Cfg(67):DSG Thresh 3(16)
- DF:LED Support:LED Cfg(67):DSG Thresh 4(17)
- DF:LED Support:LED Cfg(67):DSG Thresh 5(18)
- SBS:RelativeStateOfCharge(0x0d)
- SBS:AbsoluteStateOfCharge(0x0e)
- SBS:BatteryStatus(0x16)[DSG]

2.5.4 Permanent Failure Error Codes

When a permanent failure occurs, the type of permanent failure error can be shown on the display. The table below shows available error codes. The permanent failure display requires proper setting of **[PFD1]** and **[PFD0]** bits. The permanent failure code display is disabled if **[SLED]** bit is set.

PFFstatus	LED3	LED2	LED1
No PF Fault	Flashing with LED Blink Rate	Off	Off
[FBF]	On	Flashing with LED Blink Rate	Flashing with LED Flash Rate
[PFVSHUT]	Off	Flashing with LED Blink Rate	Flashing with LED Flash Rate
Reserved	Flashing with LED Flash Rate	Flashing with LED Blink Rate	On
[SOPT]	On	Flashing with LED Blink Rate	On
[SOCD]	Off	Flashing with LED Blink Rate	On
[SOCC]	Flashing with LED Flash Rate	Flashing with LED Blink Rate	Off
[AFE_P]	On	Flashing with LED Blink Rate	Off
[AFE_C]	Off	Flashing with LED Blink Rate	Off
[DFF]	Flashing with LED Blink Rate	Flashing with LED Flash Rate	Flashing with LED Flash Rate
[DFETF]	Flashing with LED Blink Rate	On	Flashing with LED Flash Rate
[CFETF]	Flashing with LED Blink Rate	Off	Flashing with LED Flash Rate
[CIM]	Flashing with LED Blink Rate	Flashing with LED Flash Rate	On

PFStatus	LED3	LED2	LED1
[SOTD]	Flashing with LED Blink Rate	On	On
[SOTC]	Flashing with LED Blink Rate	Off	On
[SOV]	Flashing with LED Blink Rate	Flashing with LED Flash Rate	Off
[PFIN]	Flashing with LED Blink Rate	On	Off

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg B(2)[PFD1],[PFD0]
- DF:LED Support:LED Cfg(67):LED Flash Rate(0)
- DF:LED Support:LED Cfg(67):LED Blink Rate(2)

2.5.5 LED Current Configuration

The sink current setting of the LED inputs to the bq20z90-V110 can be programmed with the following settings. All of the LEDs are programmed with the same current level.

Table 2-16. LED Current Configuration

ILED1	ILED0	Sink Current
0	0	0 mA
0	1	3 mA
1	0	4 mA
1	1	5 mA (default)

Related Variables:

- DF:LED Support:LED Cfg(67):Sink Current(19)

2.6 Device Operating Mode

The bq20z90-V110 has several device power modes. During these modes, the bq20z90-V110 modifies its operation to minimize power consumption from the battery.

2.6.1 Normal Mode

During normal operation, the bq20z90-V110 takes *Current*, *Voltage*, and *Temperature* measurements, performs calculations, updates SBS data, and makes protection and status decisions at one-second intervals. Between these periods of activity, the bq20z90-V110 is in a reduced power state.

\overline{PRES} is sampled once per second and if \overline{PRES} is high, the *OperationStatus[PRES]* flag is cleared. If $PRES$ is low, the *OperationStatus [PRES]* flag is set indicating the system is present (the battery is inserted).

If the **[NR]** bit is set, the \overline{PRES} input can be left floating as it is not monitored.

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg B(2)[NR]
- SBS:OperationStatus(0x54)[PRES]

2.6.2 Battery Pack Removed Mode/System Present Detection

2.6.2.1 Battery Pack Removed

The bq20z90-V110 detects the Battery Pack Removed state if **[NR]** bit is set to 0 AND the \overline{PRES} input is high ($[PRES] = 0$).

On entry to the Battery Pack Removed state, *[TCA]* and *[TDA]* flags are set, *ChargingCurrent* and *ChargingVoltage* are set to 0, the CHG and DSG FETs are turned off, and the ZVCHG FET is turned off (if used).

Polling of the \overline{PRES} pin continues at a rate of once every 1 s.

The bq20z90-V110 exits the Battery Pack Removed state if **[NR]** flag is set to 0, AND the \overline{PRES} input is low ($[PRES] = 1$). When this occurs, *[TCA]* and *[TDA]* flags are reset.

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg B(2)[NR]
- SBS:BatteryStatus(0x16)[TCA],[TDA]
- SBS:OperationStatus(0x54)[PRES]

2.6.2.2 System Present

\overline{PRES} is sampled once per second and if \overline{PRES} is high, the *OperationStatus [PRES]* flag is cleared. If $PRES$ is low, the *OperationStatus [PRES]* flag is set indicating the system is present (the battery is inserted). If the **[NR]** bit is set, the $PRES$ input is ignored and can be left floating.

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg B(2)[NR]
- SBS:OperationStatus(0x54)[PRES]

2.6.3 Sleep Mode

In Sleep mode the bq20z90-V110 measures *Voltage* and *Temperature* in **Sleep Voltage Time** intervals and *Current* at **Sleep Current Time** intervals. At each interval the bq20z90-V110 performs calculations, updates SBS data, and makes protection and status decisions. Between these periods of activity, the bq20z90-V110 is in a reduced-power state.

The bq20z90-V110 enters Sleep mode when the following conditions exist:

- If **[NR]** bit is set to 0, $[PRES]$ must also be set to 0, for the bq20z90-V110 to enter sleep.

AND one of the following conditions:

- ($|Current| \leq \text{Sleep Current}$) AND (SMBus is low for **Bus Low Time**) AND (**[SLEEP]** bit is set)
OR
- ($|Current| \leq \text{Sleep Current}$) AND (*ManufacturerAccess* Sleep command is received) AND (**[SLEEP]** is set).

Entry to Sleep mode is blocked if any of the *PFStatus* flags are set. If **Sleep Voltage Time** = 0 or **Sleep Current Time** = 0, sleep mode is not entered, and the bq20z90-V110 remains in Normal mode.

On entry to sleep, if **[NR]** = 0, the CHG and DSG FETs are turned off, and the ZVCHG FET is turned off (if used) regardless of **[NRCHG]** setting. If **[NR]** = 1, the CHG FET is turned off, and the ZVCHG FET is turned off (if used). However, if **[NRCHG]** is set then the CHG FET remains on.

Also, on entry to Sleep mode, the auto calibration of the A/DC begins. However, if *Temperature* is $\leq \text{Cal Inhibit Temp Low}$ or $\geq \text{Cal Inhibit Temp High}$, Auto Calibration is not started on entry to sleep mode. The activation of auto calibration is not affected by the state of **[SLEEP]**, **Sleep Voltage Time**, **Sleep Current Time**, or *Current*.

The bq20z90-V110 exits Sleep mode when one or more of the following conditions exist:

- If the **[NR]** bit is set to 0 and **[PRES]** is set to 1.
- ($|Current| > \text{Sleep Current}$)
- SMBC or SMBD inputs transition high
- *OperationStatus*, *ChargingStatus* or *SafetyStatus* are set
- Wake function enabled by setting **Wake Current Reg** and a voltage across SRP and SRN is detected

The bq20z90-V110 exits Sleep mode if absolute value of *Current* is greater than **Sleep Current**, OR the SMBC or SMBD inputs transition high, OR any *OperationStatus*, *ChargingStatus*, or *SafetyStatus* flags change state.

In addition, if **[NR]** is cleared, the bq20z90-V110 exits Sleep mode when **[PRES]** = 1.

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[SLEEP]
- DF:Configuration:Registers(64):Operation Cfg B(2)[NR],[NRCHG]
- DF:Power:Power(68):Sleep Current(7)
- DF:Power:Power(68):Bus Low Time(9)
- DF:Power:Power(68):Cal Inhibit Temp Low(10)
- DF:Power:Power(68):Cal Inhibit Temp Low(12)
- DF:Power:Power(68):Sleep Voltage Time(14)
- DF:Power:Power(68):Sleep Current Time(15)
- DF:Power:Power(68):Wake Current Reg(16)
- SBS:ManufacturerAccess(0x00):Sleep(0x0011)
- SBS:Current(0x0a)
- SBS:SafetyStatus(0x51)
- SBS:OperationStatus(0x54)[PRES]

2.6.4 Wake Function

The bq20z90-V110 can exit sleep mode, if enabled, by the presence of a voltage across SRP and SRN. The level of the current signal needed is programmed in **Wake Current Reg**.

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
Low Byte	RSVD	RSVD	RSVD	RSVD	RSVD	IWAKE	RSNS1	RSNS0

LEGEND: RSVD = Reserved and **must** be programmed to 0

Figure 2-16. Wake Current Reg

IWAKE — This bit sets the current threshold for the Wake function.

0 = 0.5A (or if RSNS0=RSNS1=0 then this function is disabled)

1 = 1.0A (or if RSNS0=RSNS1=0 then this function is disabled)

Table 2-17. Wake Current Reg

RSNS1	RSNS0	Resistance
0	0	Disabled (default)
0	1	2.5 mΩ
1	0	5 mΩ
1	1	10mΩ

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[SLEEP]
- DF:Power:Power(68):Wake Current Reg(16)
- SBS:Current(0x0a)

2.6.5 Shutdown Mode

The bq20z90-V110 enters Shutdown mode if the following conditions are met:

- Voltage \leq **Shutdown Voltage** AND Current \leq 0 for a period of **Shutdown Time**
OR
- (ManufacturerAccess shutdown command received AND Current = 0) AND PackVoltage < **Charger Present** threshold.

When the bq20z90-V110 meets these conditions, the CHG, DSG, and ZVCHG FETs are turned off, and the bq29330 is commanded to shut down. In Shutdown mode, the bq20z90-V110 is completely powered down because its supply is removed.

To exit Shutdown mode the voltage at the PACK pin of the bq29330 must be greater than its minimum operating voltage. When this occurs, the bq29330 returns power to the bq20z90-V110, the [WAKE] flag is set, and the bq29330 is configured. The [INIT] and [WAKE] flags are cleared after approximately 1 s when all SBS parameters have been measured and updated.

Related Variables:

- DF:Power:Power(68):Shutdown Voltage(2)
- DF:Power:Power(68):Shutdown Time(4)
- DF:Power:Power(68):Charger Present(5)
- DF:Configuration:Registers(64):Operation Cfg B(2)[NR]
- SBS:Voltage(0x09)
- SBS:Current(0x0a)
- SBS:BatteryStatus(0x16)[INIT]
- SBS:OperationStatus(0x54)[PRES],[WAKE]
- SBS:PackVoltage(0x5a)

2.7 Security (Enables and Disables Features)

There are three levels of secured operation within the bq20z90-V110. To switch between the levels, different operations are needed with different codes. The three levels are Sealed, Unsealed, and Full Access.

- 1. Full Access or Unsealed to Sealed** — The use of the *Seal Device* command instructs the bq20z90-V110 to limit access to the SBS functions and data flash space and sets the *[SS]* flag. In sealed mode, standard SBS functions have access per the Smart Battery Data Specification - Appendix A. Extended SBS Functions and data flash are not accessible. Once in sealed mode, the part can never permanently return to Unsealed or Full Access modes.
- 2. Sealed to Unsealed** — Instructs the bq20z90-V110 to extend access to the SBS and data flash space and clears the *[SS]* flag. In unsealed mode, all data, SBS, and DF have read/write access. Unsealing is a 2 step command performed by writing the 1st word of the *UnSealKey* to *ManufacturerAccess* followed by the second word of the *UnSealKey* to *ManufacturerAccess*. The unseal key can be read and changed via the extended SBS block command *UnSealKey* when in Full Access Mode. To return to the Sealed mode, either a hardware reset is needed, or the *ManufacturerAccess* seal device command is needed to transit from Full Access or Unsealed to Sealed.
- 3. Unsealed to Full Access** — Instructs the bq20z90-V110 to allow Full Access to all SBS commands and data flash. The bq20z90-V110 is shipped from TI in this mode. The keys for Unsealed to Full Access can be read and changed via the extended SBS block command *FullAccessKey* when in Full Access mode. Changing from Unsealed to Full Access is performed by using the *ManufacturerAccess* command, by writing the 1st word of the *FullAccessKey* to *ManufacturerAccess* followed by the second word of the *FullAccessKey* to *ManufacturerAccess*. The full access key can be read and changed via the extended SBS block command *FullAccessKey* when in Full Access Mode. In Full Access mode, the command to go to Boot ROM can be sent.

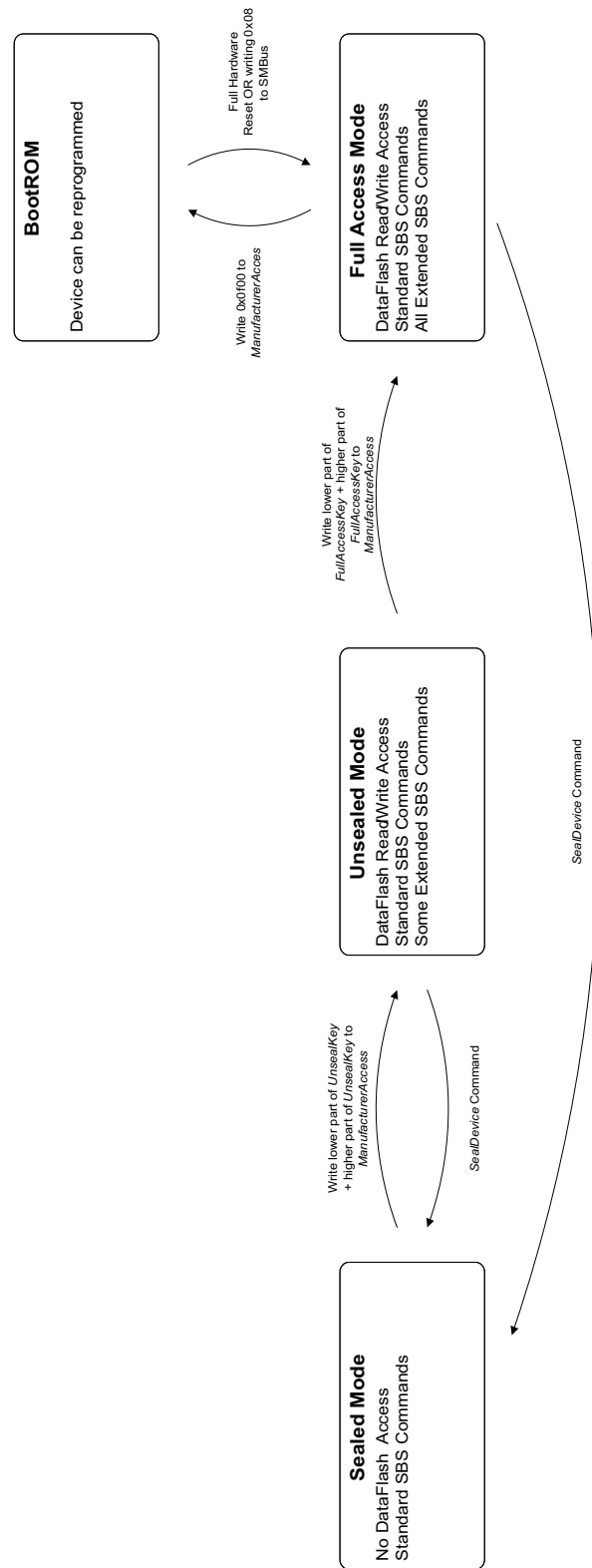


Figure 2-17. Security

Related Variables:

- SBS:ManufacturerAccess(0x00):Seal Device(0x0020)

- SBS:OperationStatus(0x54)[SS],[FAS]
- SBS:UnSealKey(0x60)
- SBS:FullAccessKey(0x61)

2.8 Calibration

2.8.1 Coulomb Counter Dead Band

The bq20z90-V110 does not accumulate charge or discharge for gas gauging when the current input is below the dead-band current threshold. The threshold is programmed in **CC Deadband** (Coulomb Counter Deadband) and should be set sufficiently high to prevent false signal detection with no charge or discharge flowing through the sense resistor.

Related Variables:

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

2.8.2 Auto Calibration

The bq20z90-V110 provides an auto-calibration feature to cancel the voltage offset error across SRP and SRN for maximum charge measurement accuracy. The bq20z90-V110 performs auto-calibration when the SMBus lines stay low continuously for a minimum of 5 s and *Temperature* is within bounds of **Cal Inhibit Temp Low** and **Cal Inhibit Temp High**.

Related Variables:

- DF:Power:Power(68):Cal Inhibit Temp Low(10)
- DF:Power:Power(68):Cal Inhibit Temp High(12)
- SBS:Temperature(0x08)

2.9 Communications

The bq20z90-V110 uses SMBus v1.1 with Master Mode and packet error checking (PEC) options per the SBS specification.

2.9.1 SMBus On and Off State

The bq20z90-V110 detects an SMBus off state when SMBC and SMBD are logic-low for ≥ 2 seconds. Clearing this state requires either SMBC or SMBD to transition high. Within 1 ms, the communication bus is available.

2.9.2 Packet Error Checking

The bq20z90-V110 can receive or transmit data with or without PEC.

In the write-word protocol, if the host does not support PEC, the last byte of data is followed by a stop condition. If the host does not support PEC, the **[HPE]** bit should be set to 0 (default).

In the write-word protocol, the bq20z90-V110 receives the PEC after the last byte of data from the host. If the host does not support PEC, the last byte of data is followed by a stop condition. After receipt of the PEC, the bq20z90-V110 compares the value to its calculation. If the PEC is correct, the bq20z90-V110 responds with an ACKNOWLEDGE. If it is not correct, the bq20z90-V110 responds with a NOT ACKNOWLEDGE and sets an error code. If the host supports PEC, the **[HPE]** bit should be set to 1.

In the read-word and block-read in master mode, the host generates an ACKNOWLEDGE after the last byte of data sent by the bq20z90-V110. The bq20z90-V110 then sends the PEC, and the host, acting as a master-receiver, generates a NOT ACKNOWLEDGE and a stop condition.

Related Variables:

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

2.9.3 *bq20z90-V110 Slave Address*

The bq20z90-V110 uses the address 0x16 on SMB for communication.

2.9.4 *Broadcasts to Smart Charger and Smart Battery Host*

The bq20z90-V110 can broadcast messages to the smart battery charger and smart battery host. This can be enabled with the **[BCAST]** bit.

PEC byte for alarm transmissions in master-mode to charger can be enabled with the **[CPE]** bit.

PEC byte for alarm transmissions in master-mode to smart battery host and the PEC byte for receiving communications from all sources in slave-mode can be enabled with the **[HPE]** bit.

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg B(2)[CPE],[HPE],[BCAST]

Standard SBS Commands

The bq20z90-V110 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-V110 is in unsealed mode or full access mode, indicated by the *[SS]* and *[FAS]* flag. A write to this command forces the bq20z90-V110 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-V110 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-V110 to take actions when written. No data is returned.

A.1.2.1 Shutdown(0x0010)

Instructs the bq20z90-V110 to verify and enter shutdown mode. This command is only available when the bq20z90-V110 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(5)
- SBS:Current(0x0a)
- SBS:OperationStatus(0x54)[SS],[FAS]
- SBS:PackVoltage(0x5a)

A.1.2.2 Sleep(0x0011)

Instructs the bq20z90-V110 to verify and enter sleep mode if no other command is sent after the *Sleep* command. Any SMB transition will wake up the bq20z90-V110. It takes about 1 min. before the device will go to sleep. This command is only available when the bq20z90-V110 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-V110 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-V110 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-V110 to begin the Impedance Track™ algorithm, changes **Update Status**, and sets the [QEN] flag.

This command is only available when the bq20z90-V110 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-V110 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-V110 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-V110 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-V110 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-V110 is in Unsealed or Full Access mode.

Related Variables:

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

A.1.2.10 Calibration Mode(0x0040)

Places the bq20z90-V110 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-V110 is in Unsealed or Full Access mode.

Related Variables:

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

A.1.2.11 Reset(0x0041)

The bq20z90-V110 undergoes a full reset. The bq20z90-V110 holds the clock line down for a few milli-seconds to complete the reset

This command is only available when the bq20z90-V110 is in Unsealed or Full Access mode.

Related Variables:

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

A.1.2.12 BootRom(0x0f00)

The bq20z90-V110 goes into BootRom mode.

This command is only available when the bq20z90-V110 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-V110 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-V110 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)

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-V110 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-V110 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-V110 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-V110 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-V110 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-V110 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-V110 '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-V110 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-V110 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-V110 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-V110 and should be set to 0.

CC: —Enable or disable internal charge controller. This flag is not used by bq20z90-V110 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-V110 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-V110 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-V110 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-V110 updates this value within one second after the SMBus host sets the *AtRate* function value. The bq20z90-V110 updates *AtRateOK* at one-second intervals.

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

0 = FALSE bq20z90-V110 can **not** deliver energy for 10 seconds based on discharge rate indicated in *AtRate*

1..65535 = TRUE bq20z90-V110 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-V110. 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.

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	MaxError 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

$$0 = \text{RemainingCapacity} / \text{Design Capacity}$$

$$1 = \text{RemainingCapacity} / \text{Design Energy}$$

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-V110 -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-V110 is in charging mode

1 = bq20z90-V110 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-V110 processed the function code with no errors detected.

0,0,0,1 = BUSY bq20z90-V110 is unable to process the function code at this time.

0,0,1,0 = Reserved bq20z90-V110 detected an attempt to read or write to a function code reserved by this version of the specification or bq20z90-V110 detected an attempt to access an unsupported optional manufacturer function code.

0,0,1,1 = Unsupported bq20z90-V110 does not support this function code as defined in this version of the specification.

0,1,0,0 = AccessDenied bq20z90-V110 detected an attempt to write to a read-only function code.

0,1,0,1 = Over/Underflow bq20z90-V110 detected a data overflow or underflow.

0,1,1,0 = BadSize bq20z90-V110 detected an attempt to write to a function code with an incorrect data block.

0,1,1,1 = UnknownError bq20z90-V110 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-V110 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-V110 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

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-V110 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:

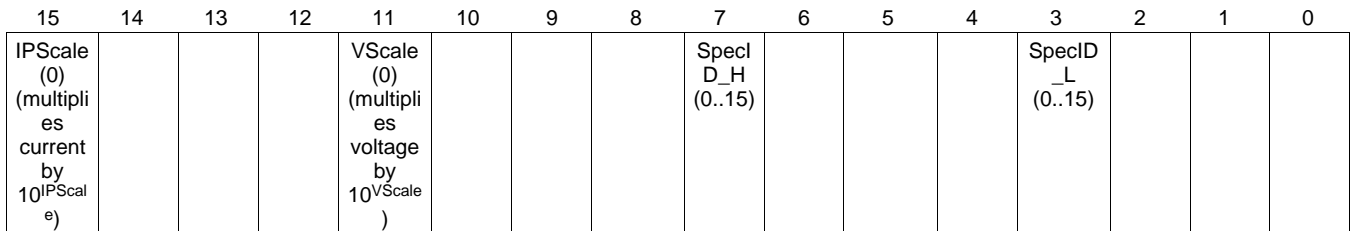
$$IPScale \times 0x1000 + VScale \times 0x0100 + SpecID_H \times 0x0010 + SpecID_L$$

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

When the bq20z90-V110 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	



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-V110 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	

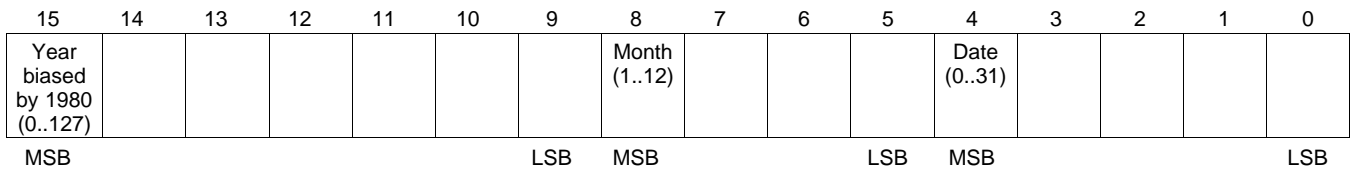


Figure A-5. ManufacturerDate

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-V110 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-V110 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-V110 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-V110	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-V110 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-V110 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-V110 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]

Authenticate(0x2f)

A.34 Authenticate(0x2f)

This read- or write-block function allows the host to authenticate the bq20z90-V110 -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

Table A-39. SBS COMMANDS (continued)

SBS Cmd	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
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-V110	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

Extended SBS Commands

The extended SBS commands are only available when the bq20z90-V110 device is in unsealed or full access mode.

Related Variables:

- SBS:ManufacturerAccess(0x00):Seal Access(0x0020)
- SBS:OperationStatus(0x54)[SS],[FAS]
- SBS:UnSealKey(0x60)
- SBS:FullAccessKey(0x61)

B.1 AFEData(0x45)

This read-block function returns a string of 11 data bytes + 1 length byte. The first 9 bytes are the bq29330 memory map followed by 2 bytes of the internal bq20z90-V110 AFE_Fail_Counter.

Table B-1. AFEData

Data	Byte	Name	Format
bq29330	0	AFE Status	hex
	1	AFE Output	
	2	AFE State	
	3	AFE Function	
	4	AFE Cell Select	
	5	AFE OLV	
	6	AFE OLT	
	7	AFE SCC	
	8	AFE SCD	
bq20z90-V110	9	internal AFE_Fail_Counter high byte	
	10	internal AFE_Fail_Counter low byte	
	11	String Length Byte	

Related Variables:

- DF:2nd Level Safety:AFE Verification(20):AFE Fail Limit(1)
- DF:PF Status:AFE Regs(97)

B.2 FETControl(0x46)

This read- or write-word function allows direct control of the FETs for test purposes.

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
FETControl	RSVD	RSVD	RSVD	OD	ZVCHG	CHG	DSG	RSVD

LEGEND: RSVD = Reserved and **must** be programmed to 0

Figure B-1. FETControl

StateOfHealth(0x4f)

OD —bq29330 GPOD pin control.

- 0 = disable GPOD pin (high-Z)
- 1 = enable GPOD pin (open drain)

ZVCHG —Zero-Volt (Pre-Charge) charge FET Control

- 0 = turn OFF pre-charge FET
- 1 = turn ON pre-charge FET

CHG —Charge FET Control

- 0 = turn OFF CHG FET. CHG FET doesn't turn off in discharge mode to protect the FET body diode.
- 1 = turn ON CHG FET

DSG —Discharge FET Control

- 0 = turn OFF DSG FET. DSG FET doesn't turn of in charge mode to protect the FET body diode.
- 1 = turn ON DSG FET

B.3 StateOfHealth(0x4f)

This read word function returns the state of health of the battery in %. The calculation formula depends on the *[CapM]* flag.

CapM StateOfHealth

- 0 = $FullChargeCapacity / Design\ Capacity$
- 1 = $FullChargeCapacity / Design\ Energy$

Related Variables:

- DF:SBS Configuration:Data(48):Design Capacity(22)
- DF:SBS Configuration:Data(48):Design Energy(24)
- SBS:FullChargeCapacity(0x10)
- SBS:BatteryMode(0x03)[CapM]

B.4 SafetyAlert(0x50)

This read-word function returns indications of pending safety issues, such as running safety timers, or fail counters that are nonzero but have not reached the required time or value to trigger a *SafetyStatus* failure.

See the "1st Level Protection Features" chapter for further details.

Related Variables:

- SBS:SafetyStatus(0x51)

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
High Byte	OTD	OTC	OCD	OCC	OCD2	OCC2	PUV	POV
Low Byte	CUV	COV	PF	HWDG	WDF	AOCD	SCC	SCD

LEGEND: All Values Read-Only

Figure B-2. SafetyAlert

- OTD** — 1 = Discharge overtemperature alert
- OTC** — 1 = Charge overtemperature alert
- OCD** — 1 = Discharge overcurrent alert
- OCC** — 1 = Charge overcurrent alert
- OCD2** — 1 = Tier-2 discharge overcurrent alert
- OCC2** — 1 = Tier-2 charge overcurrent alert
- PUV** — 1 = Pack undervoltage alert
- POV** — 1 = Pack overvoltage alert
- CUV** — 1 = Cell undervoltage alert
- PF** — 1 = Permanent failure alert
- COV** — 1 = Cell overvoltage alert
- HWDG** — 1 = Host watchdog alert
- WDF** — 1 = AFE watchdog alert
- AOCD** — 1 = AFE discharge overcurrent alert
- SCC** — 1 = Charge short-circuit alert
- SCD** — 1 = Discharge short-circuit alert

B.5 SafetyStatus(0x51)

This read word function returns the status of the 1st level safety features.

See the "1st Level Protection Features" chapter for further details.

Related Variables:

- SBS:SafetyAlert(0x50)

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
High Byte	OTD	OTC	OCD	OCC	OCD2	OCC2	PUV	POV
Low Byte	CUV	COV	PF	HWDG	WDF	AOCD	SCC	SCD

LEGEND: All Values Read-Only

Figure B-3. SafetyStatus

- OTD** — 1 = Discharge overtemperature condition
- OTC** — 1 = Charge overtemperature condition
- OCD** — 1 = Discharge overcurrent condition
- OCC** — 1 = Charge overcurrent condition
- OCD2** — 1 = Tier-2 discharge overcurrent condition

PFAAlert(0x52)

- OCC2** — 1 = Tier-2 charge overcurrent condition
- PUV** — 1 = Pack undervoltage condition
- POV** — 1 = Pack overvoltage condition
- CUV** — 1 = Cell undervoltage condition
- COV** — 1 = Cell overvoltage condition
- PF** — 1 = Permanent failure and SAFE pin has been driven high.
- HWDG** — 1 = Host watchdog condition
- WDF** — 1 = AFE watchdog condition
- AOCD** — 1 = AFE discharge overcurrent condition
- SCC** — 1 = Charge short-circuit condition
- SCD** — 1 = Discharge short-circuit condition

B.6 PFAAlert(0x52)

This read-word function returns indications of pending safety issues, such as running safety timers that have not reached the required time to trigger a *PFAAlert* failure.

See the "2nd Level Protection Features" chapter for further details.

Related Variables:

- DF:Configuration:Registers(64):Permanent Fail Cfg(6)
- DF:PF Status:Device Status Data(96):Fuse Flag(2)
- DF:PF Status:Device Status Data(96):PF Flags 2(28)
- SBS:Current(0x0a)
- SBS:Voltage(0x09)
- SBS:PFStatus(0x53)

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
High Byte	FBF	RSVD	RSVD	SOPT	SOCD	SOCC	AFE_P	ACE_C
Low Byte	DFF	DFETF	CFETF	CIM	SOTD	SOTC	SOV	PFIN

LEGEND: All Values Read-Only; RSVD = Reserved

Figure B-4. PFAAlert

- FBF** — = 1: Fuse Blow Failure alert
- SOPT** — = 1: Open Thermistor permanent failure alert
- SOCD** — = 1: Discharge Safety Overcurrent permanent failure alert
- SOCC** — = 1: Charge Safety-Overcurrent permanent failure alert
- AFE_P** — = 1: Periodic AFE Communications permanent failure alert
- AFE_C** — = 1: Permanent AFE Communications failure alert
- DFF** — 1 = Data Flash Fault permanent failure alert
- DFETF** — = 1: Discharge-FET-Failure permanent failure alert
- CFETF** — = 1: Charge-FET-Failure permanent failure alert
- CIM** — = 1: Cell-Imbalance permanent failure alert

- SOTD** — = 1: Discharge Safety Overtemperature permanent failure alert
- SOTC** — = 1: Charge Safety Overtemperature permanent failure alert
- SOV** — = 1: Safety-Overvoltage permanent failure alert
- PFIN** — = 1: External Input Indication of permanent failure alert

B.7 PFStatus(0x53)

The permanent failure status register indicates the source of the bq20z90-V110 permanent-failure condition.

Any new permanent failure is added to **PF Flags 1** register to show all permanent failures that have occurred.

See the "2nd Level Protection Features" chapter for further details.

Related Variables:

- DF:Configuration:Registers(64):Permanent Fail Cfg(6)
- DF:PF Status:Device Status Data(96):Fuse Flag(2)
- DF:PF Status:Device Status Data(96):PF Flags 1(0)
- DF:PF Status:Device Status Data(96):PF Flags 2(28)
- SBS:PFAlert(0x52)

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
High Byte	FBF	RSVD	RSVD	SOPT	S OCD	SOCC	AFE_P	AFE_C
Low Byte	DFF	DFETF	CFETF	CIM	SOTD	SOTC	SOV	PFIN

LEGEND: All Values Read-Only; RSVD = Reserved

Figure B-5. PFStatus

- FBF** — 1 = Fuse Blow Failure
- SOPT** — 1 = Open Thermistor permanent failure
- S OCD** — 1 = Discharge Safety Overcurrent permanent failure
- SOCC** — 1 = Charge Safety-Overcurrent permanent failure
- AFE_P** — 1 = Periodic AFE Communications permanent failure
- AFE_C** — 1 = Permanent AFE Communications failure
- DFF** — 1 = Data Flash Fault permanent failure
- DFETF** — 1 = Discharge-FET-Failure permanent failure
- CFETF** — 1 = Charge-FET-Failure permanent failure
- CIM** — 1 = Cell-Imbalance permanent failure
- SOTD** — 1 = Discharge Safety Overtemperature permanent failure
- SOTC** — 1 = Charge Safety Overtemperature permanent failure
- SOV** — 1 = Safety-Overvoltage permanent failure
- PFIN** — 1 = External Input Indication of permanent failure

B.8 OperationStatus(0x54)

This read-word function returns the current operation status of the bq20z90-V110.

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
High Byte	PRES	FAS	SS	CSV	RSVD	LDMD	RSVD	RSVD
Low Byte	WAKE	DSG	XDSG	XDSGI	RSVD	R_DIS	VOK	QEN

LEGEND: All Values Read-Only; RSVD = Reserved

Figure B-6. OperationStatus

PRES — 1 = $\overline{\text{PRES}}$ is low, indicating that the system is present (battery inserted).

FAS — 0 = Full access security mode

SS — 1 = Sealed security mode

CSV — 1 = Data Flash checksum value has been generated

LDMD — Load mode for Impedance Track modeling. 0 = constant current, 1 = constant power

WAKE — 1 = bq20z90-V110 WAKE mode

DSG — Replica of the SBS:BatteryStatus(0x16)[DSG] flag.

XDSG — 1 = Discharge fault

XDSGI — 1 = Discharge disabled due to a current issue

R_DIS — 1 = Ra Table resistance updates are disabled

VOK — 1 = Voltages are OK for a QMAX update

QEN — 1 = QMAX updates are enabled

B.9 ChargingStatus(0x55)

This read-word function returns the current status of the charging functions.

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
High Byte	XCHG	CHGSUSP	PCHG	MCHG	TCHG1	TCHG2	FCHG	PULSE
Low Byte	PLSOFF	CB	PCMTO	FCMTO	OCHGV	OCHGI	OC	XCHGLV

LEGEND: All Values Read-Only

Figure B-7. ChargingStatus

XCHG — 1 = Charging disabled

CHGSUSP — 1 = Charging suspend conditions exist

PCHG — 1 = Precharging conditions exist

MCHG — 1 = Maintenance charging conditions exist

TCHG1, TCHG2 — 1 = Temperature-based throttling of charging current conditions exist

FCHG — 1 = Fast charging conditions exist

PULSE — 1 = Pulse charging in progress

PLSOFF — 1 = Pulse charging has turned CHG FET OFF

CB — 1 = Cell balancing in progress

- PCMTO** — 1 = Precharge timeout fault
- FCMTO** — 1 = Fast-charge timeout fault
- OCHGV** — 1 = Overcharge voltage fault
- OCHGI** — 1 = Overcharge current fault
- OC** — 1 = Overcharge fault
- XCHGLV** — 1 = Battery is depleted

B.10 ResetData(0x57)

This read-word function returns the number of partial resets (low byte) and full resets (high byte) the device has experienced.

Table B-2. ResetData

SBS Cmd.	Mode	Name			Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x57	R	ResetData	partial resets	low byte	unsigned integer	1	0	255	-	
			full resets	high byte	unsigned integer	1	0	255	-	

B.11 WDRResetData(0x58)

This read-word function returns the number of watchdog resets the device has experienced.

Table B-3. WDRResetData

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x58	R	WDRResetData	unsigned integer	2	0	65535	-	

B.12 PackVoltage(0x5a)

This read-word function returns an unsigned integer value representing the measure voltage from the AFE PACK pin, in mV, with a range of 0 to 65535.

Table B-4. PackVoltage

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x5a	R	PackVoltage	unsigned integer	2	0	65535	-	mV

B.13 AverageVoltage(0x5d)

This read-word function returns an unsigned integer value that approximates a one-minute rolling average of the sum of the cell voltages in mV, with a range of 0 to 65535.

Table B-5. AverageVoltage

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x5d	R	AverageVoltage	unsigned integer	2	0	65535	-	mV

Related Variables:

- SBS:Voltage(0x09)

B.14 UnSealKey(0x60)

This read- or write-block command allows the user to change the Unseal key for the Sealed-to-Unsealed security-state transition. This function is only available when the bq20z90-V110 is in the Full-Access mode, indicated by a cleared *[FAS]* flag.

The order of the bytes, when entered in *ManufacturerAccess*, is the reverse of what is written to or read from the part. For example, if the 1st and 2nd word of the *UnSealKey* block read returns 0x1234 and 0x5678, then in *ManufacturerAccess*, 0x3412 and 0x7856 should be entered to unseal the part.

Table B-6. UnSealKey

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x60	R/W	UnSealKey	hex	4	0x00000000	0xffffffff	-	

Related Variables:

- SBS:OperationStatus(0x54)[FAS]

B.15 FullAccessKey(0x61)

This read- or write-block command allows the user to change the Full-Access security key for the Unsealed-to-Full-Access security-state transition. This function is only available when the bq20z90-V110 is in the Full-Access mode, indicated by a cleared *[FAS]* flag.

The order of the bytes, when entered in *ManufacturerAccess*, is the reverse of what is written to or read from the part. For example, if the 1st and 2nd word of the *FullAccessKey* block read returns 0x1234 and 0x5678, then in *ManufacturerAccess*, 0x3412 and 0x7856 should be entered to put the part in full access mode.

Table B-7. FullAccessKey

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x61	R/W	FullAccessKey	hex	4	0x00000000	0xffffffff	-	

Related Variables:

- SBS:OperationStatus(0x54)[FAS]

B.16 PFKey(0x62)

This read- or write-block command allows the user to change the Permanent-Failure-Clear key. This function is only available when the bq20z90-V110 is in the Full Access mode, indicated by a cleared *[FAS]* flag.

The order of the bytes, when entered in *ManufacturerAccess*, is the reverse of what is written to or read from the part. For example, if the 1st and 2nd word of the *PFKey* block read returns 0x1234 and 0x5678, then in *ManufacturerAccess*, 0x3412 and 0x7856 should be entered to clear a permanent failure.

Table B-8. PFKey

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x62	R/W	PFKey	hex	4	0x00000000	0xffffffff	-	

Related Variables:

- SBS:OperationStatus(0x54)[FAS]

B.17 AuthenKey3(0x63)

This read- or write-block command stores Byte 12 - Byte 15 of the 16 Byte long authentication key. This function is only available when the bq20z90-V110 is in the Full Access mode, indicated by a cleared *[FAS]* flag.

Table B-9. AuthenKey3

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x63	R/W	AuthenKey3	hex	4	0x00000000	0xffffffff	0x10325476	

Related Variables:

- SBS:AuthenKey2(0x64)
- SBS:AuthenKey1(0x65)
- SBS:AuthenKey0(0x66)

B.18 AuthenKey2(0x64)

This read- or write-block command stores Byte 8 - Byte 11 of the 16 Byte long authentication key. This function is only available when the bq20z90-V110 is in the Full Access mode, indicated by a cleared *[FAS]* flag.

Table B-10. AuthenKey2

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x64	R/W	AuthenKey2	hex	4	0x00000000	0xffffffff	0x98abdcae	

Related Variables:

- SBS:AuthenKey3(0x63)
- SBS:AuthenKey1(0x65)
- SBS:AuthenKey0(0x66)

B.19 AuthenKey1(0x65)

This read- or write-block command stores Byte 4 - Byte 7 of the 16 Byte long authentication key. This function is only available when the bq20z90-V110 is in the Full Access mode, indicated by a cleared *[FAS]* flag.

Table B-11. AuthenKey1

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x65	R/W	AuthenKey1	hex	4	0x00000000	0xffffffff	0xdfceab89	

Related Variables:

- SBS:AuthenKey3(0x63)
- SBS:AuthenKey2(0x64)
- SBS:AuthenKey0(0x66)

B.20 AuthenKey0(0x66)

This read- or write-block command stores Byte 0 - Byte 3 of the 16 Byte long authentication key. This function is only available when the bq20z90-V110 is in the Full Access mode, indicated by a cleared *[FAS]* flag.

Table B-12. AuthenKey0

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x66	R/W	AuthenKey0	hex	4	0x00000000	0xffffffff	0x67452301	

Related Variables:

- SBS:AuthenKey3(0x63)
- SBS:AuthenKey2(0x64)
- SBS:AuthenKey1(0x65)

B.21 ManufacturerInfo(0x70)

This read-block function returns the data stored in **Manuf. Info** where byte 0 is the MSB with a maximum length of 8 data + 1 length byte. When the bq20z90-V110 is in Unsealed or Full Access mode, this block is R/W.

Table B-13. ManufacturerInfo

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x70	R/W	ManufacturerInfo	String	8+1	-	-	-	

Related Variables:

- DF:System Data:Manufacturer Info(58):Manuf. Info(0)
- SBS:OperationStatus(0x54)[SS],[FAS]

B.22 SenseResistor(0x71)

This read- or write-word command allows the user to change the sense resistor value used in $\mu\Omega$. The bq20z90-V110 automatically updates the respective calibration data on receipt of a new sense resistor value.

Table B-14. SenseResistor

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x71	R/W	SenseResistor	unsigned integer	2	0	65535	10000	$\mu\Omega$

B.23 DataFlashSubClassID(0x77)

This write word function sets the bq20z90-V110 data flash subclass, where data can be accessed by following the *DataFlashSubClass1..8* commands.

See "Accessing Data Flash" chapter for further information.

A *NACK* is returned to this command if the value of the class is outside of the allowed range. The subclasses are defined in the Data Flash.

Table B-15. DataFlashSubClassID

SBS Cmd.	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x77	W	DataFlashSubClassID	hex	2	0x0000	0xffff	-	

Related Variables:

- SBS:DataFlashSubClassPage1..8(0x78..0x7f)

B.24 DataFlashSubClassPage1..8(0x78..0x7f)

These commands are used to access the consecutive 32-byte pages of each subclass.

DataFlashSubClassPage1 gets bytes 0 to 31 of the subclass, *DataFlashSubClassPage2* gets bytes 32 to 63, and so on.

Note: Any DF location deemed Reserved responds with a *NACK* unless the bq20z90-V110 is in the correct security state to allow access.

Table B-16. DataFlashSubClass1..8

SBS Cmd.	Mode	Name	Format	Size in Bytes	Subclass Offset	Subclass Offset	Default Value	Unit
0x78	R/W	DataFlashSubClassPage1	hex	32	0	31	-	
0x79	R/W	DataFlashSubClassPage2	hex	32	32	63	-	
0x7a	R/W	DataFlashSubClassPage3	hex	32	64	95	-	
0x7b	R/W	DataFlashSubClassPage4	hex	32	96	127	-	
0x7c	R/W	DataFlashSubClassPage5	hex	32	128	159	-	
0x7d	R/W	DataFlashSubClassPage6	hex	32	160	191	-	
0x7e	R/W	DataFlashSubClassPage7	hex	32	192	223	-	
0x7f	R/W	DataFlashSubClassPage8	hex	32	224	255	-	

Related Variables:

- SBS:DataFlashSubClassID(0x77)

B.25 Extended SBS Command Values

Table B-17. EXTENDED SBS COMMANDS

SBS Cmd	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x45	R	AFEData	String	11+1	—	—	—	ASCII
0x46	R/W	FETControl	hex	1	0x00	0x1e	—	
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	0x9fff	—	
0x53	R	PFStatus	hex	2	0x0000	0x9fff	—	
0x54	R	OperationStatus	hex	2	0x0000	0xf7f7	—	
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	—	
0x61	R/W	FullAccessKey	hex	4	0x00000000	0xffffffff	—	
0x62	R/W	PFKey	hex	4	0x00000000	0xffffffff	—	
0x63	R/W	AuthenKey3	hex	4	0x00000000	0xffffffff	—	
0x64	R/W	AuthenKey2	hex	4	0x00000000	0xffffffff	—	
0x65	R/W	AuthenKey1	hex	4	0x00000000	0xffffffff	—	
0x66	R/W	AuthenKey0	hex	4	0x00000000	0xffffffff	—	
0x70	R/W	ManufacturerInfo	String	8+1	—	—	—	ASCII

Table B-17. EXTENDED SBS COMMANDS (continued)

SBS Cmd	Mode	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0x71	R/W	SenseResistor	unsigned int	2	0	65535	—	$\mu\Omega$
0x77	R/W	DataFlashSubClassID	hex	2	0x0000	0xffff	—	
0x78	R/W	DataFlashSubClassPage1	hex	32	—	—	—	
0x79	R/W	DataFlashSubClassPage2	hex	32	—	—	—	
0x7a	R/W	DataFlashSubClassPage3	hex	32	—	—	—	
0x7b	R/W	DataFlashSubClassPage4	hex	32	—	—	—	
0x7c	R/W	DataFlashSubClassPage5	hex	32	—	—	—	
0x7d	R/W	DataFlashSubClassPage6	hex	32	—	—	—	
0x7e	R/W	DataFlashSubClassPage7	hex	32	—	—	—	
0x7f	R/W	DataFlashSubClassPage8	hex	32	—	—	—	

Data Flash

CAUTION

Care should be taken when mass programming the data flash space using previous versions of data flash memory map files (such as *.gg files) to ensure all public locations are updated correctly.

Data Flash can only be updated if *Voltage* ≥ **Flash Update OK Voltage** or *PackVoltage* ≥ **Charger Present**. Data flash reads and writes are verified according to the method detailed in the "2nd Level Protection Features" section of this data sheet.

Note: Data Flash updates are disabled when the *[PF]SafetyStatus* flag is set.

C.1 Accessing Data Flash

In different security modes, the data flash access conditions change. See *ManufacturerAccess* and "Security" chapter for further details.

SECURITY MODE	NORMAL DATA FLASH ACCESS
BootROM	N/A
Full Access	R/W
Unsealed	R/W
Sealed	N/A

C.1.1 Data Flash Interface

The bq20z90-V110 data flash is organized into subclasses where each data flash variable is assigned an offset within its numbered subclass. For example: the **Pre-chg Temp** threshold location is defined as:

- Class = Charge Control
- SubClass = Pre-Charge Cfg = 33
- Offset = 2

Note: Data Flash commands are NACK'ed if the bq20z90-V110 is in sealed mode (*[SS]* flag is set).

Each subclass can be addressed individually by using the *DataFlashSubClassID* command and the data within each subclass is accessed by using the *DataFlashSubClassPage1..8* commands.

Reading and Writing subclass data are block operations which are each 32 Bytes long. Data can be written in shorter block sizes, however. The final block in one subclass can be shorter than 32 bytes so care must be taken not to write over the subclass boundary. None of the values written are bounded by the bq20z90-V110 and the values are not rejected by the gas gauge. Writing an incorrect value may result in hardware failure due to firmware program interpretation of the invalid data. The data written is persistent, so a Power On Reset does resolve the fault.

Related Variables:

- SBS:DataFlashSubClassID(0x77)

- SBS:DataFlashSubClassPage1..8(0x78..0x7f)

C.1.2 Reading a SubClass

Information required:

- SubClassID
- Number of bytes in the subclass
- Variable Offset

Procedure:

1. Write the SubClassID to bq20z90-V110 using *DataFlashSubClassID* command.
2. Read a block of data using *DataFlashSubClassPage1..8* command. A subclass can hold up to 256 bytes of data, but subclass data can only be read in 32 byte long data blocks. The *DataFlashSubClassPage1* command reads only the first 32 bytes in a subclass, the *DataFlashSubClassPage2* command reads the second 32 bytes in a subclass, and so on. For example if the subclass has 40 bytes, *DataFlashSubClassPage1* + *DataFlashSubClassPage2* is needed to read the whole subclass.

C.1.3 Writing a SubClass

Information required:

- SubClassID
- Number of bytes in the subclass
- 32 bytes of initialized data to be written. Less than 32 bytes is acceptable if a subclass contains less than 32 bytes in the last block.

Procedure:

1. Write the SubClassID to bq20z90-V110 using *DataFlashSubClassID* command.
2. Write a block of data using *DataFlashSubClassPage1..8* command. A subclass can hold up to 256 bytes of data, but subclass data can only be write in 32 byte long data blocks. The *DataFlashSubClassPage1* command writes only the first 32 bytes in a subclass, the *DataFlashSubClassPage2* command writes the second 32 bytes in a subclass, and so on. For example, if the subclass has 40 bytes and data in offset 34 of the subclass needs to be changed, use *DataFlashSubClassPage2* to write data from byte 32 - 40 of the subclass.

C.1.4 Example

To write the value of **Term Voltage** to a value of 8.7 V the following sequence is used.

Read complete Gas Gauging-IT Config subclass (SubclassID = 80) into RAM:

- Write Subclass ID
 - SMB Slave Address (0x16)
 - SMB CMD 0x77 with 0x0050 as data (=80 decimal)
- Read Subclass (2 blocks are needed as its over 32 bytes long)
 - SMBSlave Address (0x16)
 - SMB CMD 0x78 receiving 32 bytes of data
 - SMB CMD 0x79 receiving 32 bytes of data

Overwrite offset 45 of received data with 8.7 V:

- Update offset 45 of second block with 0x21fc (=8700 decimal)

Write the complete subclass back to the bq20z90-V110:

- Write Subclass ID
 - SMB Slave Address (0x16)
 - SMB CMD 0x77 with 0x0050 as data
- Write Subclass

- SMB Slave Address (0x17)
- SMB CMD 0x78 with 32 bytes of data
- SMB CMD 0x79 with 32 bytes of data

Alternatively, only the required block rather than the full subclass can be accessed.

Read required block of Gas Gauging-IT Config subclass (SubclassID = 80) into RAM:

- Write Subclass ID
 - SMB Slave Address (0x17)
 - SMB CMD 0x77 with 0x0050 as data (=80 decimal)
- Read Subclass (2nd block is needed as its offset 45)
 - SMB Slave Address (0x16)
 - SMB CMD 0x79 receiving 32 bytes of data

Overwrite offset (45 - 32 = 13) of received data with 8.7 V:

- Update offset 45 with 0x21fc (= 8700 decimal)

Write the updated block back to the bq20z90-V110:

- Write Subclass ID
 - SMB Slave Address (0x17) SMB CMD 0x77 with 0x0050 as data
- Write Subclass
 - SMB Slave Address (0x17)
 - SMB CMD 0x79 with 32 bytes of data

C.2 1st Level Safety Class

C.2.1 Voltage (Subclass 0)

C.2.1.1 COV Threshold (Offset 0)

The bq20z90-V110 sets the [COV] flag in *SafetyAlert* if any *CellVoltage4..1* is equal to or higher than the **COV Threshold**.

Table C-1. COV Threshold

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0	Voltage	0	COV Threshold	unsigned integer	2	3700	5000	4300	mV

Related Variables:

- DF:1st Level Safety:Voltage(0):COV Time(2)
- SBS:CellVoltage4(0x3c)
- SBS:CellVoltage3(0x3d)
- SBS:CellVoltage2(0x3e)
- SBS:CellVoltage1(0x3f)
- SBS:SafetyAlert(0x50)[COV]

C.2.1.2 COV Time (Offset 2)

If the [COV] *SafetyAlert* time period exceeds **COV Time** the bq20z90-V110 goes into a cell over voltage condition. This function is disabled if **COV Time** is set to 0.

In a cell over voltage condition the CHG FET is turned off, the *ChargingCurrent* and *ChargingVoltage* are set to 0, [TCA] is set, the [COV] *SafetyAlert* flag is reset, and the [COV] *SafetyStatus* flag is set.

Table C-2. COV Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0	Voltage	2	COV Time	unsigned integer	1	0	240	2	Sec

Related Variables:

- DF:1st Level Safety:Voltage(0):COV Threshold(0)
- SBS:Charging Current(0x14)
- SBS:Charging Voltage(0x15)
- SBS:BatteryStatus(0x16)[TCA]
- SBS:CellVoltage4(0x3c)
- SBS:CellVoltage3(0x3d)
- SBS:CellVoltage2(0x3e)
- SBS:CellVoltage1(0x3f)
- SBS:SafetyAlert(0x50)[COV]
- SBS:SafetyStatus(0x51)[COV]

C.2.1.3 COV Recovery (Offset 3)

The bq20z90-V110 recovers from a cell over voltage condition if all cell voltages are lower than the **COV Recovery** threshold level. On recovery, the *ChargingCurrent* and *ChargingVoltage* are set to their appropriate values per the charging algorithm, [TCA] is cleared, and the [COV] in *SafetyStatus* is reset.

Table C-3. COV Recovery

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0	Voltage	3	COV Recovery	unsigned integer	2	0	4400	3900	mV

Related Variables:

- DF:1st Level Safety:Voltage(0):COV Threshold(0)
- SBS:BatteryStatus(0x16)[TCA]
- SBS:CellVoltage4(0x3c)
- SBS:CellVoltage3(0x3d)
- SBS:CellVoltage2(0x3e)
- SBS:CellVoltage1(0x3f)
- SBS:SafetyStatus(0x51)[COV]

C.2.1.4 COV Delta (Offset 5)

The **COV Delta** reduces the **COV Threshold** limit when charging takes place above the over temperature limit. **COV Threshold** compensation is disabled when **COV Delta** is set to 0. The temperature limit is defined by the following formula:

$$\text{Temperature} > \text{Over Temp Chg} - \text{COV Temp Hys}$$

Table C-4. COV Delta

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0	Voltage	5	COV Delta	unsigned integer	1	0	200	20	mV

Related Variables:

- DF:1st Level Safety:Voltage(0):COV Threshold(0)
- DF:1st Level Safety:Voltage(0):COV Temp. Hys(6)
- DF:1st Level Safety:Temperature(2):Over Temp Chg(0)
- SBS:Temperature(0x08)
- SBS:BatteryStatus(0x16)[DSG]

C.2.1.5 COV Temp. Hys (Offset 6)

The **COV Temp. Hys** reduces the **Over Temp Chg** threshold used by COV threshold compensation.

Table C-5. COV Temp. Hys

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0	Voltage	6	COV Temp. Hys	unsigned integer	1	0	250	100	0.1°C

Related Variables:

- DF:1st Level Safety:Voltage(0):COV Threshold(0)
- DF:1st Level Safety:Voltage(0):COV Delta(5)
- DF:1st Level Safety:Temperature(2):Over Temp Chg(0)
- SBS:Temperature(0x08)
- SBS:BatteryStatus(0x16)[DSG]

C.2.1.6 POV Threshold (Offset 7)

The bq20z90-V110 sets the *[POV]* in *SafetyAlert* if *Voltage* is equal to or higher than **POV Threshold**.

Table C-6. POV Threshold

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0	Voltage	7	POV Threshold	unsigned integer	2	0	18000	17500	mV

Related Variables:

- DF:1st Level Safety:Voltage(0):POV Time(9)
- SBS:Voltage(0x09)
- SBS:SafetyAlert(0x50)[POV]

C.2.1.7 POV Time (Offset 9)

If the *[POV]* in *SafetyAlert* time period exceeds **POV Time** the bq20z90-V110 goes into a pack over voltage condition. This function is disabled if **POV Time** is set to 0.

In a pack over voltage condition the CHG FET is turned off, the *ChargingCurrent* is set to 0, the *ChargingVoltage* is set to 0, *[TCA]* is set, the *[POV]* *SafetyAlert* is reset, and the *[POV]* in *SafetyStatus* is set.

Table C-7. POV Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0	Voltage	9	POV Time	unsigned integer	1	0	240	2	Sec

Related Variables:

- DF:1st Level Safety:Voltage(0):POV Threshold(7)
- DF:1st Level Safety:Voltage(0):POV Recovery(10)
- SBS:Voltage(0x09)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[TCA]
- SBS:SafetyAlert(0x50)[POV]
- SBS:SafetyStatus(0x51)[POV]

C.2.1.8 POV Recovery (Offset 10)

The bq20z90-V110 recovers from a pack over voltage condition if the *Voltage* is lower than the **POV Recovery** threshold level. On recovery the *ChargingCurrent* and *ChargingVoltage* are set to appropriate values per the charging algorithm, [TCA] is reset, and the [POV] in *SafetyStatus* is reset.

Table C-8. POV Recovery

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0	Voltage	10	POV Recovery	unsigned integer	2	0	17000	16000	mV

Related Variables:

- DF:1st Level Safety:Voltage(0):POV Threshold(7)
- SBS:Voltage(0x09)
- SBS:Charging Current(0x14)
- SBS:Charging Voltage(0x15)
- SBS:BatteryStatus(0x16)[TCA]
- SBS:SafetyStatus(0x51)[POV]

C.2.1.9 CUV Threshold (Offset 12)

The bq20z90-V110 sets the [CUV] *SafetyAlert* if any *CellVoltage4..1* is equal to or lower than the **CUV Threshold**.

Table C-9. CUV Threshold

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0	Voltage	12	CUV Threshold	unsigned integer	2	0	3500	2200	mV

Related Variables:

- DF:1st Level Safety:Voltage(0):CUV Time(14)
- SBS:CellVoltage4(0x3c)
- SBS:CellVoltage3(0x3d)
- SBS:CellVoltage2(0x3e)
- SBS:CellVoltage1(0x3f)
- SBS:SafetyAlert(0x50)[CUV]

C.2.1.10 CUV Time (Offset 14)

If *[CUV]* in *SafetyAlert* time period exceeds **CUV Time** the bq20z90-V110 goes into a cell under voltage condition. This function is disabled if **CUV Time** is set to 0.

Table C-10. CUV Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0	Voltage	14	CUV Time	unsigned integer	1	0	240	2	Sec

Related Variables:

- DF:1st Level Safety:Voltage(0):CUV Threshold(12)
- DF:Charge Control:Pre-Charge Cfg(33):Pre-chg Current(0)
- SBS:Charging Current(0x14)
- SBS:BatteryStatus(0x16)[TDA],[FD]
- SBS:CellVoltage4(0x3c)
- SBS:CellVoltage3(0x3d)
- SBS:CellVoltage2(0x3e)
- SBS:CellVoltage1(0x3f)
- SBS:SafetyAlert(0x50)[CUV]
- SBS:SafetyStatus(0x51)[CUV]
- SBS:OperationStatus(0x54)[XDMSG]

C.2.1.11 CUV Recovery (Offset 15)

The bq20z90-V110 recovers from a cell under voltage condition, if all *CellVoltage4..1* are higher than the **CUV Recovery** threshold. On recovery, the *ChargingCurrent* and *ChargingVoltage* are set to their appropriate value per the charging algorithm, the *[TDA]* and *[FD]* flags are reset, the *[CUV]* in *SafetyStatus* is reset, and the *[XDMSG]* flag in *OperationStatus* is reset.

Table C-11. CUV Recovery

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0	Voltage	15	CUV Recovery	unsigned integer	2	0	3600	3000	mV

Related Variables:

- DF:1st Level Safety:Voltage(0):CUV Threshold(12)
- SBS:Charging Current(0x14)
- SBS:Charging Voltage(0x15)
- SBS:BatteryStatus(0x16)[TDA],[FD]
- SBS:CellVoltage4(0x3c)
- SBS:CellVoltage3(0x3d)
- SBS:CellVoltage2(0x3e)
- SBS:CellVoltage1(0x3f)
- SBS:SafetyStatus(0x51)[CUV]
- SBS:OperationStatus(0x54)[XDMSG]

C.2.1.12 PUV Threshold (Offset 17)

The bq20z90-V110 sets the *[PUV]* in *SafetyAlert* if *Voltage* is equal to or lower than **PUV Threshold**.

Table C-12. PUV Threshold

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0	Voltage	17	PUV Threshold	unsigned integer	2	0	16000	11000	mV

Related Variables:

- DF:1st Level Safety:Voltage(0):PUV Time(19)
- SBS:Voltage(0x09)
- SBS:SafetyAlert(0x50)[PUV]

C.2.1.13 PUV Time (Offset 19)

If the [PUV] in *SafetyAlert* time period exceeds **PUV Time** the bq20z90-V110 goes into a pack under voltage condition. This function is disabled if **PUV Time** is set to 0.

In a pack under voltage condition the DSG FET is turned off, the *ChargingCurrent* is set to the **Pre-chg Current** value, the [TDA] and [FD] flags are set, the [PUV] in *SafetyAlert* is cleared, the [PUV] in *SafetyStatus* is set, and the [XDSG] flag is set.

Table C-13. PUV Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0	Voltage	19	PUV Time	unsigned integer	1	0	240	2	Sec

Related Variables:

- DF:1st Level Safety:Voltage(0):PUV Threshold(17)
- DF:Charge Control:Pre-Charge Cfg(33):Pre-chg Current(0)
- SBS:Voltage(0x09)
- SBS:Charging Current(0x14)
- SBS:BatteryStatus(0x16)[TDA],[FD]
- SBS:SafetyAlert(0x50)[PUV]
- SBS:SafetyStatus(0x51)[PUV]
- SBS:OperationStatus(0x54)[XDSG]

C.2.1.14 PUV Recovery (Offset 20)

The bq20z90-V110 recovers from a pack under voltage condition if the pack voltage is higher than the **PUV Recovery** threshold level. On recovery, the [TDA] and [FD] flags are reset, the [PUV] *SafetyStatus* is reset, and the [XDSG] flag is reset.

Table C-14. PUV Recovery

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
0	Voltage	20	PUV Recovery	unsigned integer	2	0	16000	12000	mV

Related Variables:

- DF:1st Level Safety:Voltage(0):PUV Threshold(17)
- SBS:Voltage(0x09)
- SBS:BatteryStatus(0x16)[TDA]
- SBS:SafetyStatus(0x51)[PUV]
- SBS:OperationStatus(0x54)[XDSG]

C.2.2 Current (Subclass 1)

C.2.2.1 OC (1st Tier) Chg (Offset 0)

The bq20z90-V110 sets the [OCC] *SafetyAlert* if charge *Current* is equal to or higher than the **OC (1st Tier) Chg** threshold.

Table C-15. OC (1st Tier) Chg

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
1	Current	0	OC (1st Tier) Chg	unsigned integer	2	0	20000	6000	mA

Related Variables:

- DF:1st Level Safety:Current(1):OC (1st Tier) Chg Time(2)
- SBS:Current(0x0a)
- SBS:SafetyAlert(0x50)[OCC]

C.2.2.2 OC (1st Tier) Chg Time (Offset 2)

If the [OCC] in *SafetyAlert* time period exceeds the **OC (1st Tier) Chg Time** time the bq20z90-V110 goes into an overcurrent charge condition. This function is disabled if **OC (1st Tier) Chg Time** is set to 0.

In an overcurrent while charging condition the CHG FET is turned off, the *ChargeCurrent* and *ChargeVoltage* are set to 0, the [TCA] flag is set, the [OCC] flag in *SafetyAlert* is cleared, and the [OCC] flag in *SafetyStatus* is set.

Table C-16. OC (1st Tier) Chg Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
1	Current	2	OC (1st Tier) Chg Time	unsigned integer	1	0	240	2	Sec

Related Variables:

- DF:1st Level Safety:Current(1):OC (1st Tier) Chg(0)
- SBS:Charging Current(0x14)
- SBS:Charging Voltage(0x15)
- SBS:BatteryStatus(0x16)[TCA]
- SBS:SafetyAlert(0x50)[OCC]
- SBS:SafetyStatus(0x51)[OCC]

C.2.2.3 OC Chg Recovery (Offset 3)

The bq20z90-V110 recovers from an over current charge condition in non-removable battery mode if the *AverageCurrent* is equal to or lower than the **OC Chg Recovery** threshold for a length of **Current Recovery Time**. The bq20z90-V110 recovers in removable battery mode by removing and reinserting the battery pack. On recovery, the *ChargingCurrent* and *ChargingVoltage* are set to appropriate their values per the charging algorithm, [TCA] is reset, and the [OCC] flag in *SafetyStatus* is reset.

Table C-17. OC Chg Recovery

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
1	Current	3	OC Chg Recovery	signed integer	2	-1000	1000	200	mA

Related Variables:

- DF:1st Level Safety:Current(1):OC (1st Tier) Chg(0)
- DF:1st Level Safety:Current Recovery Time(16)
- DF:Configuration:Registers(64):Operation Cfg B(2)[NR]
- SBS:AverageCurrent(0x0b)
- SBS:BatteryStatus(0x16)[TCA]
- SBS:SafetyStatus(0x51)[OCC]

C.2.2.4 OC (1st Tier) Dsg (Offset 5)

The bq20z90-V110 sets the *[OCD] SafetyAlert* if the discharge *Current* is equal to or higher than the **OC (1st Tier) Dsg** threshold.

Table C-18. OC (1st Tier) Dsg

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
1	Current	5	OC (1st Tier) Dsg	unsigned integer	2	0	20000	6000	mA

Related Variables:

- DF:1st Level Safety:Current(1):OC (1st Tier) Dsg Time(7)
- SBS:Current(0x0a)
- SBS:SafetyAlert(0x50)[OCD]

C.2.2.5 OC (1st Tier) Dsg Time (Offset 7)

If the *[OCD]* in *SafetyAlert* time period exceeds the **OC (1st Tier) Dsg Time** bq20z90-V110 goes into an overcurrent discharge condition. This function is disabled if **OC (1st Tier) Dsg Time** is set to 0.

In an overcurrent discharge condition the DSG FET is turned off, the *ChargeCurrent* is set to **Pre-chg Current**, the *[TDA]* flag is set, the *[OCD]* flag in *SafetyAlert* is reset, the *[OCD]* flag in *SafetyStatus* is set, and the *[XDSDG]* flag is set.

Table C-19. OC (1st Tier) Dsg Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
1	Current	7	OC (1st Tier) Dsg Time	unsigned integer	1	0	240	2	Sec

Related Variables:

- DF:1st Level Safety:Current(1):OC (1st Tier) Dsg(5)
- DF:Charge Control:Pre-Charge Cfg(33):Pre-chg Current(0)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[TDA]
- SBS:SafetyAlert(0x50)[OCD]
- SBS:SafetyStatus(0x51)[OCD]
- SBS:OperationStatus(0x54)[XDSDG]

C.2.2.6 OC Dsg Recovery (Offset 8)

The bq20z90-V110 recovers from an over current discharge condition in non-removable battery mode if the *AverageCurrent* is equal to or lower than the **OC Dsg Recovery** current level for a length of **Current Recovery Time**. On recovery, the *ChargingCurrent* and *ChargingVoltage* are set to their appropriate values per the charging algorithm, *[TDA]* is reset, the *[OCD] SafetyStatus* flag is reset, and the *[XDSG]* flag is reset

Table C-20. OC Dsg Recovery

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
1	Current	8	OC Dsg Recovery	signed integer	2	0	1000	200	mA

Related Variables:

- DF:1st Level Safety:Current(1):OC (1st Tier) Dsg(5)
- DF:1st Level Safety:Current Recovery Time(16)
- DF:Configuration:Registers(64):Operation Cfg B(2)[NR]
- SBS:AverageCurrent(0x0b)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[TDA]
- SBS:SafetyStatus(0x51)[OCD]
- SBS:OperationStatus(0x54)[XDSG]

C.2.2.7 OC (2nd Tier) Chg (Offset 10)

The bq20z90-V110 sets *[OCC2] SafetyAlert* if charge *Current* is equal to or higher than the **OC (2nd Tier) Chg** threshold.

Table C-21. OC (2nd Tier) Chg

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
1	Current	10	OC (2nd Tier) Chg	unsigned integer	2	0	20000	8000	mA

Related Variables:

- DF:1st Level Safety:Current(1):OC (2nd Tier) Chg Time(12)
- SBS:Current(0x0a)
- SBS:SafetyAlert(0x50)[OCC2]

C.2.2.8 OC (2nd Tier) Chg Time (Offset 12)

If the *[OCC2] SafetyAlert* time period exceeds the **OC (2nd Tier) Chg Time** the bq20z90-V110 goes into an overcurrent charge condition. This function is disabled if **OC (2nd Tier) Chg Time** is set to 0.

In an overcharge condition the CHG FET is turned off, the *ChargingCurrent* and *ChargingVoltage* are set to 0, the *[TCA]* flag is set, the *[OCC2] SafetyAlert* flag is reset. and the *[OCC2] SafetyStatus* flag is set.

Table C-22. OC (2nd Tier) Chg Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
1	Current	12	OC (2nd Tier) Chg Time	unsigned integer	1	0	240	2	Sec

Related Variables:

- DF:1st Level Safety:Current(1):OC (2nd Tier) Chg(10)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[TCA]
- SBS:SafetyAlert(0x50)[OCC2]
- SBS:SafetyStatus(0x51)[OCC2]

C.2.2.9 OC (2nd Tier) Dsg (Offset 13)

The bq20z90-V110 sets *[OCD2]* in *SafetyAlert* if the discharge *Current* is equal to or higher than the **OC (2nd Tier) Dsg** overcurrent threshold.

Table C-23. OC (2nd Tier) Dsg

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
1	Current	13	OC (2nd Tier) Dsg	unsigned integer	2	0	22000	8000	mA

Related Variables:

- DF:1st Level Safety:Current(1):OC (2nd Tier) Dsg Time(15)
- SBS:Current(0x0a)
- SBS:SafetyAlert(0x50)[OCD2]

C.2.2.10 OC (2nd Tier) Dsg Time (Offset 15)

If the *[OCD2]* in *SafetyAlert* time period exceeds the **OC (2nd Tier) Dsg Time** the bq20z90-V110 goes into an overcurrent discharge condition. This function is disabled if **OC (2nd Tier) Dsg Time** is set to 0.

In an overcurrent discharge condition the DSG FET is turned off, the *ChargingCurrent* is set to *Pre-chg Current*, *[TDA]* is set, the *[OCD2]* flag in *SafetyAlert* is reset, the *[OCD2]* flag in *SafetyStatus* is set, and the *[XDSG]* flag is set.

Table C-24. OC (2nd Tier) Dsg Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
1	Current	15	OC (2nd Tier) Dsg Time	unsigned integer	1	0	240	2	Sec

Related Variables:

- DF:1st Level Safety:Current(1):OC (2nd Tier) Dsg(13)
- DF:Charge Control:Pre-Charge Cfg(33):Pre-chg Current(0)
- SBS:Charging Current(0x14)
- SBS:Charging Voltage(0x15)
- SBS:BatteryStatus(0x16)[TDA]
- SBS:SafetyAlert(0x50)[OCD]
- SBS:SafetyStatus(0x51)[OCD]
- SBS:OperationStatus(0x54)[XDSG]

C.2.2.11 Current Recovery Time (Offset 16)

The **Current Recovery Time** sets the minimum time period where the *AverageCurrent* need to be below the over current charge/discharge recovery threshold to recover from an over current charge/discharge condition.

Table C-25. Current Recovery Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
1	Current	16	Current Recovery Time	unsigned integer	1	0	240	8	Sec

Related Variables:

- DF:1st Level Safety:Current(1):OC Chg Recovery(3)
- DF:1st Level Safety:Current(1):OC Dsg Recovery(8)
- SBS:AverageCurrent(0x0b)

C.2.2.12 AFE OC Dsg (Offset 17)

The **AFE OC Dsg** threshold sets the OLV register of the bq29330 AFE device. See the overload threshold register of the bq29330 datasheet for more details and appropriate values to use.

Table C-26. AFE OC Dsg

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit	
1	Current	17	AFE OC Dsg	hex	1	0x00	0x1f	0x12		
			bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
Low Byte		RSVD	RSVD	RSVD	OLV4	OLV3	OLV2	OLV1	OLV0	

LEGEND: RSVD = Reserved and **must** be programmed to 0

Figure C-1. OLV Register

OLV4, OLV3, OLV2, OLV1, OLV0 — Sets the overload voltage threshold of the bq29330

0x00 - 0x1f = sets the voltage threshold between 50mV and 205mV in 5mV steps.

Related Variables:

- DF:1st Level Safety:Current(1):AFE OC Dsg Time(18)

C.2.2.13 AFE OC Dsg Time (Offset 18)

The **AFE OC Discharge Time** is programmed into the OLT register of the bq29330 AFE device. If an overcurrent discharge condition is reported by the bq29330 *ChargingCurrent* is set to 0, *[TDA]* in **BatteryStatus** is set, and *[AOCD]* in *SafetyStatus* is set.

Table C-27. AFE OC Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit	
1	Current	18	AFE OC Dsg Time	hex	1	0x00	0x0f	0x0f		
			bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
Low Byte		RSVD	RSVD	RSVD	RSVD	OLT3	OLT2	OLT1	OLT0	

LEGEND: RSVD = Reserved and **must** be programmed to 0

Figure C-2. OLT Register

OLT3, OLT2, OLT1, OLT0 — Sets the overload voltage delay of bq29330

0x00 - 0x0f = sets the overvoltage trip delay between 1ms - 31ms in 1ms steps

Related Variables:

- DF:1st Level Safety:Current(1):AFE OC Dsg(17)
- SBS:ChargingCurrent(0x14)
- SBS:BatteryStatus(0x16)[TDA]
- SBS:SafetyStatus(0x51)[AOCD]

C.2.2.14 AFE OC Dsg Recovery (Offset 19)

The bq20z90-V110 recovers from an over current discharge condition in non-removable battery mode if the *AverageCurrent* is equal to or lower than the (-)**AFE OC Dsg Recovery** current level for the length of **Current Recovery Time**. On recovery, the *ChargingCurrent* and *ChargingVoltage* are set to their appropriate values per the charging algorithm, [TDA] is reset, the [AOCD] flag in *SafetyStatus* is reset, and [XDSG] is reset

Table C-28. AFE OC Dsg Recovery

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
1	Current	19	AFE OC Dsg Recovery	signed integer	2	10	1000	5	mA

Related Variables:

- DF:1st Level Safety:Current(1):AFE OC Dsg(17)
- DF:1st Level Safety:Current Recovery Time(16)
- DF:Configuration:Registers(64):Operation Cfg B(2)[NR]
- SBS:AverageCurrent(0x0b)
- SBS:BatteryStatus(0x16)[TCA]
- SBS:SafetyStatus(0x51)[AOCD]
- SBS:OperationStatus(0x54)[XDSG]

C.2.2.15 AFE SC Chg Cfg (Offset 21)

The **AFE SC Charge Cfg** is programmed into the SCC register of the bq29330 AFE device. **AFE SC Charge Cfg** sets the short circuit in charging voltage threshold and the short circuit in charging delay of the bq29330.

If the bq20z90-V110 identifies a charge in short circuit situation from the bq29330 *ChargingCurrent* and *ChargingVoltage* are set to 0, [TCA] in *BatteryStatus* is set, and [SCC] in *SafetyStatus* is set.

Table C-29. AFE SC Chg Cfg

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
1	Current	21	AFE SC Chg Cfg	hex	1	0x00	0xff	0x77	

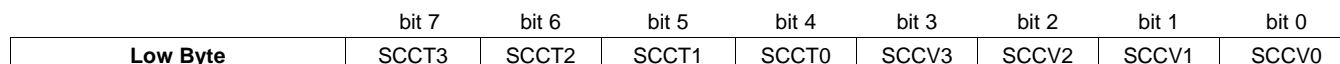


Figure C-3. SCC Register

SCCT3, SCCT2, SCCT1, SCCT0 — Sets the short circuit delay in charging of the bq29330

0x0 - 0xf = sets the short circuit in charging delay between 0 μ s - 915 μ s in 61 μ s steps

SCCV3, SCCV2, SCCV1, SCCV0 — Sets the short circuit voltage threshold in charging of the bq29330

0x0 - 0xf = sets the short circuit voltage threshold between 0.1V and 0.475V in 25mV steps

Related Variables:

- DF:1st Level Safety:Current(1):AFE SC Recovery(23)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[TCA]
- SBS:SafetyStatus(0x51)[SCC]

C.2.2.16 AFE SC Dsg Cfg (Offset 22)

The **AFE SC Dsg Cfg** is programmed into the SCD register of the bq29330 AFE device. The **AFE SC Dsg Cfg** sets the short circuit in discharging voltage threshold and the short circuit in discharging delay of the bq29330.

If the bq20z90-V110 identifies a discharge in short circuit situation from the bq29330 *ChargingCurrent* and *ChargingVoltage* are set to 0, [TDA] in *BatteryStatus* is set, [SCD] in *SafetyStatus* is set, and [XDSG] in *OperationStatus* is set.

Table C-30. AFE SC Dsg Cfg

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
1	Current	22	AFE SC Dsg Cfg	hex	1	0x00	0xff	0x77	

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
Low Byte	SCDT3	SCDT2	SCDT1	SCDT0	SCDV3	SCDV2	SCDV1	SCDV0

Figure C-4. SCD Register

SCDT3, SCDT2, SCDT1, SCDT0 — Sets the short circuit delay in discharging of the bq29330

0x0 - 0xf = sets the short circuit in discharging delay between 0 μ s - 915 μ s in 61 μ s steps

SCDV3, SCDV2, SCDV1, SCDV0 — Sets the short circuit voltage threshold in discharging of the bq29330

0x0 - 0xf = sets the short circuit voltage threshold between 0.1V and 0.475V in 25mV steps

Related Variables:

- DF:1st Level Safety:Current(1):AFE SC Recovery(23)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[TDA]
- SBS:SafetyStatus(0x51)[SCD]
- SBS:OperationStatus(0x54)[XDSG]

C.2.2.17 AFE SC Recovery (Offset 23)

The bq20z90-V110 recovers from a short circuit in charging or discharging condition in non-removable battery mode if the absolute value of *AverageCurrent* is equal to or lower than the **AFE SC Recovery** current level for the length of **Current Recovery Time**. On recovery, the *ChargingCurrent* and *ChargingVoltage* are set to their appropriate values per the charging algorithm, *[TDA]* and *[TCA]* in *BatteryStatus* are reset, *[SCC]* and *[SCD]* in *SafetyStatus* are reset, and *[XDSG]* is reset

Table C-31. AFE SC Recovery

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
1	Current	23	AFE SC Recovery	unsigned integer	2	0	200	1	mA

Related Variables:

- DF:1st Level Safety:Current Recovery Time(16)
- DF:1st Level Safety:Current(1):AFE SC Chg Cfg(21)
- DF:1st Level Safety:Current(1):AFE SC Dsg Cfg(22)
- DF:Configuration:Registers(64):Operation Cfg B(2)[NR]
- SBS:AverageCurrent(0x0b)
- SBS:BatteryStatus(0x16)[TCA],[TDA]
- SBS:SafetyStatus(0x51)[SCC],[SCD]
- SBS:OperationStatus(0x54)[XDSG]

C.2.3 Temperature (Subclass 2)

C.2.3.1 Over Temp Chg (Offset 0)

The bq20z90-V110 sets the *[OTC]* flag in *SafetyAlert* if the pack *Temperature* is equal to or higher than the **Over Temp Chg** threshold.

Table C-32. Over Temp Chg

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
2	Temperature	0	Over Temp Chg	unsigned integer	2	0	1200	550	0.1°C

Related Variables:

- DF:1st Level Safety:Temperature(2):OT Chg Time(2)
- SBS:Temperature(0x08)
- SBS:SafetyAlert(0x50)[OTC]

C.2.3.2 OT Chg Time (Offset 2)

If the *[OTC]* in *SafetyAlert* time period exceeds the **OT Chg Time** period the bq20z90-V110 goes into an over temperature charge condition. This function is disabled if **OT Chg Time** is set to 0.

In and over temperature charge condition the *ChargingVoltage* and *ChargingCurrent* are set to 0, the *[OTA]* flag in *BatteryStatus* is set, *[TCA]* is set, the *[OTC]* flag in *SafetyAlert* is reset, and the *[OTC]* flag in *SafetyStatus* is set. If the *[OTFET]* bit is enabled the CHG FET also turns off.

Table C-33. OT Chg Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
2	Temperature	2	OT Chg Time	unsigned integer	1	0	240	2	Sec

Related Variables:

- DF:1st Level Safety:Temperature(2):Over Temp Chg (0)
- DF:Configuration:Registers(64):Operation Cfg B(2)[OTFET]
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[OTA],[TCA]
- SBS:SafetyAlert(0x50)[OTC]
- SBS:SafetyStatus(0x51)[OTC]

C.2.3.3 OT Chg Recovery (Offset 3)

The bq20z90-V110 recovers from an over temperature charge condition if the *Temperature* is equal to or lower than the **OT Chg Recovery** level. On recovery, the CHG FET returns to its normal operating state, the *ChargingCurrent* and *ChargingVoltage* are set to their appropriate values per the charging algorithm, the [OTA] flag is reset, and the [OTC] flag in *SafetyStatus* is reset.

Table C-34. OT Chg Recovery

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
2	Temperature	3	OT Chg Recovery	unsigned integer	2	0	1200	500	0.1°C

Related Variables:

- DF:1st Level Safety:Temperature(2):Over Temp Chg (0)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[OTA]
- SBS:SafetyStatus(0x51)[OTC]

C.2.3.4 Over Temp Dsg (Offset 5)

The bq20z90-V110 sets the [OTD] in *SafetyAlert* if the pack *Temperature* is equal to or higher than the **Over Temp Dsg** threshold.

Table C-35. Over Temp Dsg

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
2	Temperature	5	Over Temp Dsg	unsigned integer	2	0	1200	600	0.1°C

Related Variables:

- DF:1st Level Safety:Temperature(2):OT Dsg Time(7)
- SBS:Temperature(0x08)
- SBS:SafetyAlert(0x50)[OTD]

C.2.3.5 OT Dsg Time (Offset 7)

If the [OTD] in *SafetyAlert* time period exceeds the **OT Dsg Time** the bq20z90-V110 goes into an over temperature discharge condition. This function is disabled if **OT Dsg Time** is set to 0.

In an over temperature discharge condition the *ChargingCurrent* is set to 0, [OTA] is set, the [OTD] flag in *SafetyAlert* is reset, and the [OTD] *SafetyStatus* flag is set. If the [OTFET] bit is enabled, the DSG FET also turns off and [XDSG] in *OperationStatus* is set.

Table C-36. OT Dsg Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
2	Temperature	7	OT Dsg Time	unsigned integer	1	0	240	2	Sec

Related Variables:

- DF:1st Level Safety:Temperature(2):Over Temp Dsg (5)
- DF:Configuration:Registers(64):Operation Cfg B(2)[OTFET]
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[OTA]
- SBS:SafetyAlert(0x50)[OTD]
- SBS:SafetyStatus(0x51)[OTD]
- SBS:OperationStatus(0x54)[XDSG]

C.2.3.6 OT Dsg Recovery (Offset 8)

The bq20z90-V110 recovers from an over temperature discharge condition if the *Temperature* is equal to or lower than the **OT Dsg Recovery** level. On recovery, the DSG FET returns to its normal operating state, the *ChargingCurrent* and *ChargingVoltage* are set to their appropriate values per the charging algorithm, the [OTA] flag is reset, the [OTD] *SafetyStatus* flag is reset, and the [XDSG] flag in *OperationStatus* is reset.

Table C-37. OT Dsg Recovery

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
2	Temperature	8	OT Dsg Recovery	unsigned integer	2	0	1200	550	0.1°C

Related Variables:

- DF:1st Level Safety:Temperature(2):Over Temp Dsg (5)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[OTA]
- SBS:SafetyStatus(0x51)[OTD]
- SBS:OperationStatus(0x54)[XDSG]

C.2.4 Host Comm (Subclass 3)

C.2.4.1 Host Watchdog Timeout (Offset 0)

If the bq20z90-V110 receives no valid SMBus communication for a time period greater than **Host Watchdog Timeout** the FETs are turned off, *ChargingVoltage* and *ChargingCurrent* are set to 0, [TCA] and [TDA] in *BatteryStatus* are set, [HWDG] in *SafetyStatus* is set, and [XDSG] in *OperationStatus* is set.

The bq20z90-V110 recovers if valid SMBus communication resumes. On recovery, the FETs returns to their normal operating state, *ChargingVoltage* and *ChargingCurrent* are set to their appropriate values per the charging algorithm, *[TCA]* and *[TDA]* in *BatteryStatus* is cleared, *[HWDG]* in *SafetyStatus* is reset, and *[XDMSG]* in *OperationStatus* is reset.

Table C-38. Host Watchdog Timeout

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
3	Host Comm	0	Host Watchdog Timeout	unsigned integer	1	0	255	0	Sec

Related Variables:

- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[TCA],[TDA]
- SBS:SafetyStatus(0x51)[HWDG]
- SBS:OperationStatus(0x54)[XDMSG]

C.3 2nd Level Safety

C.3.1 Voltage (Subclass 16)

C.3.1.1 SOV Threshold (Offset 0)

The bq20z90-V110 sets the *[SOV]* flag in *PFAAlert* if the *Voltage* reports a value equal to or higher than the **SOV Threshold**.

Table C-39. SOV Threshold

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
16	Voltage	0	SOV Threshold	unsigned integer	2	0	20000	18000	mV

Related Variables:

- DF:2nd Level Safety:Voltage(16):SOV Time(2)
- SBS:Voltage(0x09)
- SBS:PFAAlert(0x52)[SOV]

C.3.1.2 SOV Time (Offset 2)

If the *[SOV]* *PFAAlert* time period exceeds the **SOV Time** limit the bq20z90-V110 goes into a safety over voltage condition, *[SOV]* in *PFAAlert* is cleared, *[SOV]* in *PFStatus* is set and, if the **[XSOV]** bit in **Permanent Fail Cfg** is set, the SAFE pin is driven high. This function is disabled if **SOV Time** is set to 0.

Table C-40. SOV Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
16	Voltage	2	POV Time	unsigned integer	1	0	240	0	Sec

Related Variables:

- DF:2nd Level Safety:Voltage(16):SOV Threshold(0)
- DF:Configuration:Registers(64):Permanent Fail Cfg(6)[XSOV]
- SBS:Voltage(0x09)

2nd Level Safety

- SBS:PFAlert(0x52)[SOV]
- SBS:PFStatus(0x53)[SOV]

C.3.1.3 Cell Imbalance Current (Offset 3)

The battery pack *Current* must be below the **Cell Imbalance Current** limit for **Cell Imbalance Time** before the bq20z90-V110 starts detecting cell imbalance.

Table C-41. Cell Imbalance Current

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
16	Voltage	3	Cell Imbalance Current	unsigned integer	1	0	200	5	mA

Related Variables:

- DF:2nd Level Safety:Voltage(16):Cell Imbalance Fail Voltage(4)
- DF:2nd Level Safety:Voltage(16):Cell Imbalance Time(6)
- DF:2nd Level Safety:Voltage(16):Battery Rest Time(7)
- SBS:Current(0x0a)

C.3.1.4 Cell Imbalance Fail Voltage (Offset 4)

If the *Current* goes below **Cell Imbalance Current** for **Battery Rest Time** the bq20z90-V110 starts cell imbalance measurements. The bq20z90-V110 sets the *[CIM]* flag in *PFAlert* if the bq20z90-V110 measures a difference between any *CellVoltage4..1* equal to or higher than the **Cell Imbalance Fail Voltage** threshold.

Table C-42. Cell Imbalance Fail Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
16	Voltage	4	Cell Imbalance Fail Voltage	unsigned integer	2	0	5000	1000	mV

Related Variables:

- DF:2nd Level Safety:Voltage(16):Cell Imbalance Current(3)
- DF:2nd Level Safety:Voltage(16):Cell Imbalance Time(6)
- DF:2nd Level Safety:Voltage(16):Battery Rest Time(7)
- SBS:CellVoltage4(0x3c)
- SBS:CellVoltage3(0x3d)
- SBS:CellVoltage2(0x3e)
- SBS:CellVoltage1(0x3f)
- SBS:PFAlert(0x52)[CIM]

C.3.1.5 Cell Imbalance Time (Offset 6)

If the *[CIM]* *PFAlert* time period exceeds the **Cell Imbalance Time** limit the bq20z90-V110 goes into a cell imbalance condition, *[CIM]* in *PFAlert* is cleared, *[CIM]* in *PFStatus* is set and, if *[XCIM]* in **Permanent Fail Cfg** is set, the SAFE pin is also driven high. This function is disabled if **Cell Imbalance Time** is set to 0.

Table C-43. Cell Imbalance Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
16	Voltage	6	Cell Imbalance Time	unsigned integer	1	0	240	0	Sec

Related Variables:

- DF:2nd Level Safety:Voltage(16):Cell Imbalance Current(3)
- DF:2nd Level Safety:Voltage(16):Cell Imbalance Fail Voltage(4)
- DF:2nd Level Safety:Voltage(16):Battery Rest Time(7)
- DF:Configuration:Registers(64):Permanent Fail Cfg(6)[XSOV]
- SBS:PFAlert(0x52)[CIM]
- SBS:PFStatus(0x53)[CIM]

C.3.1.6 Battery Rest Time (Offset 7)

The battery *Current* must be below **Cell Imbalance Current** limit for at least **Battery Rest Time** period before the bq20z90-V110 starts detecting a cell imbalance. Cell imbalance detection is disabled if **Battery Rest Time** is set to 0.

Table C-44. Battery Rest Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
16	Voltage	7	Battery Rest Time	unsigned integer	2	0	65535	1800	Sec

Related Variables:

- DF:2nd Level Safety:Voltage(16):Cell Imbalance Current(3)
- DF:2nd Level Safety:Voltage(16):Cell Imbalance Fail Voltage(4)
- DF:2nd Level Safety:Voltage(16):Cell Imbalance Time(6)
- SBS:Current(0x0a)

C.3.1.7 PFIN Detect Time (Offset 9)

If the $\overline{\text{PFIN}}$ pin is logic low then $[\text{PFIN}]$ in *PFAlert* is set. If the $[\text{PFIN}]$ PF alert time period exceeds **PFIN Detect Time** $[\text{PFIN}]$ in *PFAlert* is reset, $[\text{PFIN}]$ in *PFStatus* is set and, if $[\text{XPFIN}]$ in **Permanent Fail Cfg** is set, the SAFE pin is also driven high. This function is disabled if **PFIN Detect Time** is set to 0.

Table C-45. PFIN Detect Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
16	Voltage	9	PFIN Detect Time	unsigned integer	1	0	240	0	Sec

Related Variables:

- DF:Configuration:Registers(64):Permanent Fail Cfg(6)[XPFIN]
- SBS:PFAlert(0x52)[PFIN]
- SBS:PFStatus(0x53)[PFIN]

C.3.2 Current (Subclass 17)

C.3.2.1 SOC Chg (Offset 0)

The bq20z90-V110 sets the $[\text{SOCC}]$ in *PFAlert* if *Current* is equal to or higher than the **SOC Chg** threshold.

Table C-46. SOC Chg

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
17	Current	0	SOC Chg	unsigned integer	2	0	30000	10000	mA

Related Variables:

- DF:2nd Level Safety:Current(17):SOC Chg Time(2)
- DF:Configuration:Registers(64):Permanent Fail Cfg(6)[XSOCC]
- SBS:Current(0x0a)
- SBS:PFAlert(0x52)[SOCC]

C.3.2.2 SOC Chg Time (Offset 2)

If the [SOCC] in PFAlert time period exceeds the **SOC Chg Time** the bq20z90-V110 goes into a SOCC condition [SOCC] in PFAlert is cleared, [SOCC] in PFStatus is set and, if [XSOCC] in **Permanent Fail Cfg** is set, the SAFE pin is driven high. This function is disabled if **SOC Chg Time** is set to 0.

Table C-47. SOC Chg Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
17	Current	2	SOC Chg Time	unsigned integer	1	0	240	0	Sec

Related Variables:

- DF:2nd Level Safety:Current(17):SOC Chg(0)
- DF:Configuration:Registers(64):Permanent Fail Cfg(6)[XSOCC]
- SBS:Current(0x0a)
- SBS:PFAlert(0x52)[SOCC]
- SBS:PFStatus(0x53)[SOCC]

C.3.2.3 SOC Dsg (Offset 3)

The bq20z90-V110 sets the [SOCD] PFAlert if discharge Current is equal to or higher than the (-)SOC Dsg threshold.

Table C-48. SOC Dsg

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
17	Current	3	SOC Dsg	unsigned integer	2	0	30000	10000	mA

Related Variables:

- DF:2nd Level Safety:Current(17):SOC Dsg Time(5)
- DF:Configuration:Registers(64):Permanent Fail Cfg(6)[XSOCC]
- SBS:Current(0x0a)
- SBS:PFAlert(0x52)[SOCD]

C.3.2.4 SOC Dsg Time (Offset 5)

If the [SOCD] PFAlert time period exceeds the safety over current charge time the bq20z90-V110 goes into a SOCD condition, [SOCD] in PFAlert is cleared, [SOCD] in PFStatus is set and, if the [XSOCD] bit in **Permanent Fail Cfg** is set, the SAFE pin is driven high. This function is disabled if **SOCD Dsg Time** is set to 0.

Table C-49. SOC Dsg Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
17	Current	5	SOC Dsg Time	unsigned integer	1	0	240	0	Sec

Related Variables:

- DF:2nd Level Safety:Current(17):SOC Dsg(3)
- DF:Configuration:Registers(64):Permanent Fail Cfg(6)[XSOC]
- SBS:Current(0x0a)
- SBS:PFAlert(0x52)[SOC]
- SBS:PFStatus(0x53)[SOC]

C.3.3 Temperature (Subclass 18)

C.3.3.1 SOT Chg (Offset 0)

The bq20z90-V110 sets the *[SOTC]* PFAlert if *Temperature* is equal to or higher than the **SOT Chg** threshold during charging (*[DSG]* = 0).

Table C-50. SOT Chg

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
18	Temperature	0	SOT Chg	unsigned integer	2	0	1200	650	0.1°C

Related Variables:

- DF:2nd Level Safety:Temperature(18):SOT Chg Time(2)
- SBS:Temperature(0x08)
- SBS:BatteryStatus(0x16)[DSG]
- SBS:PFAlert(0x52)[SOTC]

C.3.3.2 SOT Chg Time (Offset 2)

If the *[SOT]* flag in *PFAlert* time period exceeds **SOT Chg Time** the bq20z90-V110 goes into a SOTC condition, *[SOTC]* in *PFAlert* is cleared, *[SOTC]* in *PFStatus* is set and, if *[XSOTC]* in **Permanent Fail Cfg** is set, the SAFE pin is driven high. This function is disabled if **SOT Chg Time** is set to 0.

Table C-51. SOT Chg Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
18	Temperature	2	SOT Chg Time	unsigned integer	1	0	240	0	Sec

Related Variables:

- DF:2nd Level Safety:Temperature(18):SOT Chg(0)
- DF:Configuration:Registers(64):Permanent Fail Cfg(6)[XSOTC]
- SBS:Temperature(0x08)
- SBS:PFAlert(0x52)[SOTC]
- SBS:PFStatus(0x53)[SOTC]

C.3.3.3 SOT Dsg (Offset 3)

The bq20z90-V110 sets the *[SOTD]* PFAlert if *Temperature* is equal to or higher than the **SOT Dsg** threshold during discharging (*[DSG]* = 1).

Table C-52. SOT Dsg

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
18	Temperature	3	SOT Dsg	unsigned integer	2	0	1200	750	0.1°C

Related Variables:

- DF:2nd Level Safety:Temperature(18):SOT Dsg Time(5)
- SBS:Temperature(0x08)
- SBS:BatteryStatus(0x16)[DSG]
- SBS:PFAlert(0x52)[SOTD]

C.3.3.4 SOT Dsg Time (Offset 5)

If the [SOTD] in PFAlert time period exceeds **SOT Dsg Time** the bq20z90-V110 goes into a SOTD condition, [SOTD] in PFAlert is reset, [SOTD] in PFStatus is set and, if [XSOTD] in **Permanent Fail Cfg** is set, the SAFE pin is driven high. This function is disabled if **SOT Dsg Time** is set to 0.

Table C-53. SOT Dsg Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
18	Temperature	5	SOT Dsg Time	unsigned integer	1	0	240	0	Sec

Related Variables:

- DF:2nd Level Safety:Temperature(18):SOT Dsg(3)
- DF:Configuration:Registers(64):Permanent Fail Cfg(6)[XSOTD]
- SBS:Temperature(0x08)
- SBS:PFAlert(0x52)[SOTD]
- SBS:PFStatus(0x53)[SOTD]

C.3.3.5 Open Thermistor (Offset 6)

The bq20z90-V110 sets the [SOPT] flag in PFAlert if the thermistor *Temperature* is equal to or lower than the **Open Thermistor** threshold.

Table C-54. Open Thermistor

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
18	Temperature	6	Open Thermistor	signed integer	2	-1000	1200	-333	0.1°C

Related Variables:

- DF:2nd Level Safety:Temperature(18):Open Time(7)
- SBS:Temperature(0x08)
- SBS:PFAlert(0x52)[SOPT]

C.3.3.6 Open Time (Offset 7)

If the [SOPT] PFAlert time period exceeds **Open Time** period the bq20z90-V110 goes into a safety open thermistor condition, [SOPT] in PFAlert is reset, [SOPT] in PFStatus is set and, if [XSOPT] in **Permanent Fail Cfg** is set, the SAFE pin is driven high. This function is disabled if **Open Time** is set to 0.

Table C-55. Open Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
18	Temperature	8	Open Time	unsigned integer	1	0	240	0	Sec

Related Variables:

- DF:2nd Level Safety:Temperature(18):Open Thermistor(6)
- DF:Configuration:Registers(64):Permanent Fail Cfg(6)[XSOPT]
- SBS:Temperature(0x08)
- SBS:PFAlert(0x52)[SOPT]
- SBS:PFStatus(0x53)[SOPT]

C.3.4 FET Verification (Subclass 19)

C.3.4.1 FET Fail Limit (Offset 0)

The bq20z90-V110 sets the [CFETF] PFAlert if the bq20z90-V110 detects charge Current equal to or higher than the **FET Fail Limit** threshold when the CHG FET is supposed to be off.

The bq20z90-V110 sets the [DFETF] PFAlert if the bq20z90-V110 detects discharge Current equal to or lower than the (-)FET Fail Limit threshold when the DSG FET is supposed to be off.

Table C-56. FET Fail Limit

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
19	FET Verification	0	FET Fail Limit	unsigned integer	2	0	500	20	mA

Related Variables:

- DF:2nd Level Safety:FET Verification(19):FET Fail Time(2)
- SBS:Current(0x0a)
- SBS:PFAlert(0x52)[CFETF],[DFETF]

C.3.4.2 FET Fail Time (Offset 2)

If the [CFETF] alert time period exceeds **FET Fail Time** the bq20z90-V110 goes into a charge FET failure condition, [CFETF] in PFAlert is reset, [CFETF] in PFStatus is set and, if [XCFETF] in **Permanent Fail Cfg** is set, the SAFE pin is driven high. This function is disabled if **FET Fail Time** is set to 0.

If the [DFETF] alert time period exceeds **FET Fail Time** the bq20z90-V110 goes into a discharge FET failure condition, [DFETF] in PFAlert is reset, [DFETF] in PFStatus is set and, if [XDFETF] in **Permanent Fail Cfg** is set, the SAFE pin is driven high. This function is disabled if **FET Fail Time** is set to 0.

Table C-57. FET Fail Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
19	AFE Verification	2	FET Fail Time	unsigned integer	1	0	240	0	Sec

Related Variables:

- DF:2nd Level Safety:FET Verification(19):FET Fail Limit(0)
- DF:Configuration:Registers(64):Permanent Fail Cfg(6)[XCFETF],[XDFETF]
- SBS:Current(0x0a)
- SBS:PFAlert(0x52)[CFETF],[DFETF]
- SBS:PFStatus(0x53)[CFETF],[DFETF]

C.3.5 AFE Verification (Subclass 20)

C.3.5.1 AFE Check Time (Offset 0)

The bq20z90-V110 compares periodically, with a period of **AFE Check Time**, certain RAM content and expected control bit states of the bq29330 AFE with the values stored in data flash. If an error is detected, the internal AFE fail counter is incremented. Set to 0 to disable [AFE_P] faults

Table C-58. AFE Check Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
20	FET Verification	0	AFE Check Time	unsigned integer	1	0	255	0	Sec

Related Variables:

- DF:2nd Level Safety:AFE Verification(20):AFE Fail Limit(1)
- DF:2nd Level Safety:AFE Verification(20):AFE Fail Recovery Time(2)
- SBS:SafetyStatus(0x51)[WDF]
- SBS:PFStatus(0x53)[AFE_P]

C.3.5.2 AFE Fail Limit (Offset 1)

If the internal AFE fail counter reaches the **AFE Fail Limit** the bq20z90-V110 reports a [AFE_C] permanent failure and, if [XAFE_C] in **Permanent Fail Cfg** is set, the SAFE pin is driven high. This function is disabled if **AFE Fail Limit** is set to zero.

Table C-59. AFE Fail Limit

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
20	AFE Verification	1	AFE Fail Limit	unsigned integer	1	0	255	10	

Related Variables:

- DF:2nd Level Safety:AFE Verification(20):AFE Check Time(0)
- DF:2nd Level Safety:AFE Verification(20):AFE Fail Recovery Time(2)
- DF:Configuration:Registers(64):Permanent Fail Cfg(6)[XAFE_C]
- SBS:AFEData(0x45)
- SBS:PFStatus(0x53)[AFE_C]

C.3.5.3 AFE Fail Recovery Time (Offset 2)

The bq20z90-V110 decrements the internal AFE fail counter by one each **AFE Fail Recovery Time** period to a minimum of zero.

Table C-60. AFE Fail Recovery Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
20	AFE Verification	2	AFE Fail Recovery Time	unsigned integer	1	0	255	20	Sec

Related Variables:

- DF:2nd Level Safety:AFE Verification(20):AFE Check Time(0)
- DF:2nd Level Safety:AFE Verification(20):AFE Fail Limit(1)

C.3.5.4 AFE Init Retry Limit (Offset 3)

After a full reset the AFE offset and gain values are read twice and then compared. **AFE Init Retry Limit** is the maximum number of times that the initial AFE offset and gain values will be read, if they are not considered the same, until the [AFE_C] permanent failure occurs.

Table C-61. AFE Init Retry Limit

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
20	AFE Verification	3	AFE Init Retry Limit	unsigned integer	1	0	255	6	

Related Variables:

- DF:2nd Level Safety:AFE Verification(20):AFE Init Limit(4)
- SBS:PFStatus(0x53)[AFE_C]

C.3.5.5 AFE Init Limit (Offset 4)

AFE Init Limit is the difference in A/D counts that two successive readings of AFE offset and gain can be and still considered the be same value, after a full reset.

Table C-62. AFE Init Limit

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
20	AFE Verification	4	AFE Init Limit	unsigned integer	1	0	255	20	

Related Variables:

- DF:2nd Level Safety:AFE Verification(20):AFE Init Retry Limit(3)
- SBS:PFStatus(0x53)[AFE_C]

C.3.6 Fuse Verification(Subclass 21)

C.3.6.1 Fuse Fail Limit (Offset 0)

The bq20z90-V110 sets the [FBF] flag in *PFAAlert* if the absolute value of charge or discharge *Current* is equal to or higher than the fuse fail limit threshold after a fuse blow attempt.

Table C-63. Fuse Fail Limit

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
21	Fuse Verification	0	Fuse Fail Limit	unsigned integer	2	0	20	2	mA

Related Variables:

- DF:2nd Level Safety:Fuse Verification(21):Fuse Fail Time(2)
- SBS:Current(0x0a)
- SBS:PFAAlert(0x52)[FBF]

C.3.6.2 Fuse Fail Time (Offset 2)

If the [FBF] in *PFAAlert* time period exceeds **Fuse Fail Time** the bq20z90-V110 reports a fuse blow failure permanent error, [FBF] in *PFAAlert* is reset, and [FBF] in *PFStatus* is set. This function is disabled if **Fuse Fail Time** is set to 0.

Table C-64. Fuse Fail Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
21	Fuse Verification	2	Fuse Fail Time	unsigned integer	1	0	240	0	Sec

Related Variables:

- DF:2nd Level Safety:Fuse Verification(21):Fuse Fail Limit(0)
- SBS:PFAAlert(0x52)[FBF]
- SBS:PFStatus(0x53)[FBF]

C.4 Charge Control

C.4.1 Charge Inhibit Cfg (Subclass 32)

C.4.1.1 Chg Inhibit Temp Low (Offset 0)

If the *[DSG]* flag is set and the *Temperature* is below the **Chg Inhibit Temp Low** threshold *ChargingCurrent* and *ChargingVoltage* are set to 0. If the **[CHGIN]** bit is also set the CHG FET and ZVCHG FET (if used) are switched off and *[XCHG]* in *ChargingStatus* is set during charge inhibit mode.

Table C-65. Chg Inhibit Temp Low

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
32	Charge Inhibit Cfg	0	Chg Inhibit Temp Low	signed integer	2	-400	1200	0	0.1°C

Related Variables:

- DF:Charge Control:Charge Inhibit Cfg(32):Chg Inhibit Temp High(2)
- DF:Charge Control:Charge Inhibit Cfg(32):Temp Hys(4)
- DF:Configuration:Registers(64):Operation Cfg B(2)[CHGIN]
- SBS:Temperature(0x08)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[DSG]
- SBS:ChargingStatus(0x55)[XCHG]

C.4.1.2 Chg Inhibit Temp High (Offset 2)

If the *[DSG]* flag is set and the *Temperature* is above the **Chg Inhibit Temp High** threshold *ChargingCurrent* and *ChargingVoltage* are set to 0. If the **[CHGIN]** bit is also set the CHG FET and ZVCHG FET (if used) are switched off and *[XCHG]* in *ChargingStatus* is set during charge inhibit mode.

Table C-66. Chg Inhibit Temp High

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
32	Charge Inhibit Cfg	2	Chg Inhibit Temp High	signed integer	2	-400	1200	450	0.1°C

Related Variables:

- DF:Charge Control:Charge Inhibit Cfg(32):Chg Inhibit Temp Low(0)
- DF:Charge Control:Charge Inhibit Cfg(32):Temp Hys(4)
- DF:Configuration:Registers(64):Operation Cfg B(2)[CHGIN]

- SBS:Temperature(0x08)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[DSG]
- SBS:ChargingStatus(0x55)[XCHG]

C.4.1.3 Temp Hys (Offset 4)

If, in charge inhibit mode, the *Temperature* rises above **Chg Inhibit Temp Low + Temp Hys** or falls below **Chg Inhibit Temp High - Temp Hys** charging is allowed to be resumed and [XCHG] in *ChargingStatus* is cleared. If the [NR] flag is cleared the fault condition can be cleared by removing and reinserting the battery pack.

Table C-67. Temp Hys

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
32	Charge Inhibit Cfg	4	Temp Hys	signed integer	2	0	100	10	0.1°C

Related Variables:

- DF:Charge Control:Charge Inhibit Cfg(32):Chg Inhibit Temp Low(0)
- DF:Charge Control:Charge Inhibit Cfg(32):Chg Inhibit Temp High(2)
- DF:Configuration:Registers(64):Operation Cfg B(2)[NR],[CHGIN]
- SBS:Temperature(0x08)
- SBS:ChargingStatus(0x55)[XCHG]

C.4.2 Pre-Charge Cfg (Subclass 33)

C.4.2.1 Pre-chg Current (Offset 0)

The bq20z90-V110 sets the *ChargingCurrent* to the **Pre-chg Current** value when in pre-charge mode.

Table C-68. Pre-chg Current

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
33	Pre-Charge Cfg	0	Pre-chg Current	unsigned integer	2	0	2000	250	mA

Related Variables:

- SBS:ChargingCurrent(0x14)

C.4.2.2 Pre-chg Temp (Offset 2)

If the battery *Temperature* drops below **Pre-chg Temp** the bq20z90-V110 enters pre-charge mode and the [PCHG] flag in *ChargingStatus* is set. The bq20z90-V110 leaves pre-charge mode if *Temperature* rises above **Pre-chg Temp + Temp Hys** and all *CellVoltage4..1* are above the **Recovery Voltage** level. On recovery, [PCHG] in *ChargingStatus* is cleared.

Table C-69. Pre-chg Temp

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
33	Pre-Charge Cfg	2	Pre-chg Temp	signed integer	2	-400	1200	120	0.1°C

Related Variables:

- DF:Charge Control:Charge Inhibit Cfg(32):Temp Hys(4)
- DF:Pre-Charge Cfg(33):Recovery Voltage(6)
- SBS:Temperature(0x08)
- SBS:CellVoltage4(0x3c)
- SBS:CellVoltage3(0x3d)
- SBS:CellVoltage2(0x3e)
- SBS:CellVoltage1(0x3f)
- SBS:ChargingStatus(0x55)[PCHG]

C.4.2.3 Pre-chg Voltage (Offset 4)

The bq20z90-V110 enters pre-charge mode and sets the *[PCHG]* flag in *ChargingStatus* if any *CellVoltage4..1* drops below the **Pre-chg Voltage** threshold.

Table C-70. Pre-chg Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
33	Pre-Charge Cfg	4	Pre-chg Voltage	unsigned integer	2	0	20000	3000	mV

Related Variables:

- SBS:CellVoltage4(0x3c)
- SBS:CellVoltage3(0x3d)
- SBS:CellVoltage2(0x3e)
- SBS:CellVoltage1(0x3f)
- SBS:ChargingStatus(0x55)[PCHG]

C.4.2.4 Recovery Voltage (Offset 6)

The bq20z90-V110 enters fast charge mode from pre charge mode and sets the *[FCHG]* flag in *ChargingStatus* if all *CellVoltage4..1* are equal to or higher than the **Recovery Voltage** threshold and battery *Temperature* is above **Pre-chg Temp + Temp Hys**.

Table C-71. Recovery Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
33	Pre-Charge Cfg	6	Recovery Voltage	unsigned integer	2	0	20000	3100	mV

Related Variables:

- DF:Charge Control:Charge Inhibit Cfg(32):Temp Hys(4)
- DF:Pre-Charge Cfg(33):Pre-chg Temp(2)
- SBS:Temperature(0x08)
- SBS:CellVoltage4(0x3c)
- SBS:CellVoltage3(0x3d)
- SBS:CellVoltage2(0x3e)
- SBS:CellVoltage1(0x3f)
- SBS:ChargingStatus(0x55)[FCHG]

C.4.3 Fast Charge Cfg (Subclass 34)

C.4.3.1 Fast Charge Current (Offset 0)

The bq20z90-V110 sets the *ChargingCurrent* to the **Fast Charge Current** value when in fast charge mode.

Table C-72. Fast Charge Current

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
34	Fast Charge Cfg	0	Fast Charge Current	unsigned integer	2	0	10000	4000	mA

Related Variables:

- SBS:ChargingCurrent(0x14)
- SBS:ChargingStatus(0x55)[FCHG]

C.4.3.2 Charging Voltage (Offset 2)

The bq20z90-V110 sets the *ChargingVoltage* to the **Charging Voltage** value when in fast charge mode..

Table C-73. Charging Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
34	Fast Charge Cfg	2	Charging Voltage	unsigned integer	2	0	20000	16800	mV

Related Variables:

- SBS:ChargingVoltage(0x15)
- SBS:ChargingStatus(0x55)[FCHG]

C.4.3.3 Delta Temp (Offset 4)

Delta Temp defines the temperature range where the *ChargingCurrent* is adjusted based on *Temperature*. The limits are **Suspend High Temp - Delta Temp** and **Suspend High Temp - (2 x Delta Temp)**. If **Delta Temp** is set to 0, the *ChargingCurrent* is not changed during fast charge.

Table C-74. Delta Temp

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
34	Fast Charge Cfg	4	Delta Temp	signed integer	2	0	500	50	0.1°C

Related Variables:

- DF:Charge Control:Fast Charge Cfg(34):Suspend High Temp(8)
- DF:Pre-Charge Cfg(33):Recovery Voltage(6)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingStatus(0x55)[PCHG]

C.4.3.4 Suspend Low Temp (Offset 6)

If the battery pack *Temperature* drops below **Suspend Low Temp**, the *AverageCurrent* is above **Chg Current Threshold**, and the bq20z90-V110 is in charge mode ($[DSG] = 0$), the bq20z90-V110 suspends charging. On suspension, *ChargingCurrent* is set to 0 and the $[CHGSUSP]$ flag in *ChargingStatus* is set. The CHG FET and ZVCHG FET (if used) are also disabled if the $[CHGSUSP]$ bit in **Operation Cfg B** is set. The bq20z90-V110 returns to normal charging and clears $[CHGSUSP]$ if *Temperature* rises above **Chg Inhibit Temp Low + Temp Hys**.

Table C-75. Suspend Low Temp

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
34	Fast Charge Cfg	6	Suspend Low Temp	signed integer	2	-400	1200	-50	0.1°C

Related Variables:

- DF:Charge Control:Charge Inhibit Cfg(32):Chg Inhibit Temp Low(0)
- DF:Charge Control:Charge Inhibit Cfg(32):Chg Inhibit Temp High(2)
- DF:Charge Control:Charge Inhibit Cfg(32):Temp Hys(4)
- DF:Charge Control:Fast Charge Cfg(34):Suspend High Temp(8)
- DF:Configuration:Registers(64):Operation Cfg B(2)[CHGSUSP]
- DF:Gas Gauging:Current Thresholds(81):Chg Current Threshold(2)
- SBS:Temperature(0x08)
- SBS:AverageCurrent(0x0b)
- SBS:BatteryStatus(0x16)[DSG]
- SBS:ChargingStatus(0x55)[CHGSUSP]

C.4.3.5 Suspend High Temp (Offset 8)

If the battery pack *Temperature* rises above **Suspend High Temp**, the *AverageCurrent* is above **Chg Current Threshold**, and the bq20z90-V110 is in charge mode ($[DSG] = 0$), the bq20z90-V110 suspends charging. On suspension, *ChargingCurrent* is set to 0 and the $[CHGSUSP]$ flag in *ChargingStatus* is set. The CHG FET and ZVCHG FET (if used) are also disabled if the $[CHGSUSP]$ bit in **Operation Cfg B** is set. The bq20z90-V110 returns to normal charging and clears $[CHGSUSP]$ if *Temperature* drops below **Chg Inhibit Temp High - Temp Hys**.

Table C-76. Suspend High Temp

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
34	Fast Charge Cfg	10	Suspend High Temp	signed integer	2	-400	1200	550	0.1°C

Related Variables:

- DF:Charge Control:Charge Inhibit Cfg(32):Chg Inhibit Temp Low(0)
- DF:Charge Control:Charge Inhibit Cfg(32):Chg Inhibit Temp High(2)
- DF:Charge Control:Charge Inhibit Cfg(32):Temp Hys(4)
- DF:Charge Control:Fast Charge Cfg(34):Suspend Low Temp(6)
- DF:Gas Gauging:Current Thresholds(81):Chg Current Threshold(2)
- SBS:Temperature(0x08)
- SBS:AverageCurrent(0x0b)
- SBS:BatteryStatus(0x16)[DSG]
- SBS:ChargingStatus(0x55)[CHGSUSP]

C.4.4 Pulse Charge Cfg (Subclass 35)

C.4.4.1 Turn ON Voltage (Offset 0)

If any cell voltage drops below **Turn ON Voltage** while in pulse charge mode ($[PLSOFF] = 1$) and the CHG FET is off for a least **Min OFF Pulse Time**, the bq20z90-V110 turns on the CHG FET again, sets $[PULSE]$ in *ChargingStatus*, and resets $[PLSOFF]$, also in *ChargingStatus*.

Table C-77. Turn ON Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
35	Pulse Charge Cfg	0	Turn ON Voltage	unsigned integer	2	0	5000	4150	mV

Related Variables:

- DF:Charge Control:Pulse Charge Cfg(35):Turn OFF Voltage(2)
- DF:Charge Control:Pulse Charge Cfg(35):Min OFF Pulse Time(5)
- SBS:ChargingStatus(0x55)[PULSE],[PLSOFF]

C.4.4.2 Turn OFF Voltage (Offset 2)

If any cell voltage during charging is equal to or above **Max OFF Voltage** OR **Turn OFF Voltage** for **Max ON Pulse Time** the bq20z90-V110 enters pulse charge mode and sets $[PULSE]$ and $[PLSOFF]$ in *ChargingStatus*.

Table C-78. Turn OFF Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
35	Pulse Charge Cfg	2	Turn OFF Voltage	unsigned integer	2	0	5000	4250	mV

Related Variables:

- DF:Charge Control:Pulse Charge Cfg(35):Max ON Pulse Time(4)
- DF:Charge Control:Pulse Charge Cfg(35):Max OFF Voltage(6)
- SBS:ChargingStatus(0x55)[PULSE],[PLSOFF]

C.4.4.3 Max ON Pulse Time (Offset 4)

This value sets the maximum time the CHG FET is turned on while in pulse charge mode.

Table C-79. Max ON Pulse Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
35	Pulse Charge Cfg	4	Max ON Pulse Time	unsigned integer	1	0	240	240	0.25 Sec

Related Variables:

- DF:Charge Control:Pulse Charge Cfg(35):Turn OFF Voltage(2)
- SBS:ChargingStatus(0x55)[PULSE],[PLSOFF]

C.4.4.4 Min OFF Pulse Time (Offset 5)

This value sets the minimum time the CHG FET stays off in pulse charge mode before it is turned on again

Table C-80. Min OFF Pulse Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
35	Pulse Charge Cfg	5	Min OFF Pulse Time	unsigned integer	1	0	240	0	0.25 Sec

Related Variables:

- DF:Charge Control:Pulse Charge Cfg(35):Turn ON Voltage(0)
- SBS:Charging Status(0x55)[PULSE],[PLSOFF]

C.4.4.5 Max OFF Voltage (Offset 6)

The bq20z90-V110 enters pulse charge mode and sets *[PULSE]* and *[PULSE_OFF]* in *ChargingStatus* if the maximum cell voltage is equal to or above **Max OFF Voltage** or **Turn OFF Voltage** for **Max ON Pulse Time**.

Table C-81. Max OFF Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
35	Pulse Charge Cfg	6	Max OFF Voltage	unsigned integer	2	0	5000	4270	mV

Related Variables:

- DF:Charge Control:Pulse Charge Cfg(35):Turn OFF Voltage(2)
- SBS:Charging Status(0x55)[PULSE],[PLSOFF]

C.4.5 Termination Cfg. (Subclass 36)
C.4.5.1 Maintenance Current (Offset 0)

The *ChargingCurrent* is set to **Maintenance Current** if a primary charge termination is detected or *RelativeStateOfCharge* > **TCA Set %**

Table C-82. Maintenance Current

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
36	Termination Cfg.	0	Maintenance Current	unsigned integer	2	0	1000	0	mA

Related Variables:

- DF:Charge Control:Termination Cfg.(36):TCA Set %(9)
- SBS:RelativeStateOfCharge(0x0d)
- SBS:ChargingCurrent(0x14)
- SBS:ChargingStatus(0x55)[MCHG]

C.4.5.2 Taper Current (Offset 2)

If battery *Current* falls below **Taper Current** for 2 consecutive **Current Taper Window** time periods during charging and *Voltage* is equal to or higher than **Charging Voltage** - **Taper Voltage** the bq20z90-V110 recognizes valid primary charge termination.

Table C-83. Taper Current

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
36	Termination Cfg.	2	Taper Current	unsigned integer	2	0	1000	250	mA

Related Variables:

- DF:Charge Control:Fast Charge Cfg(36):Charging Voltage(2)
- DF:Charge Control:Termination Cfg.(36):Taper Voltage(6)
- DF:Charge Control:Termination Cfg.(36):Current Taper Window(8)
- SBS:Voltage(0x09)
- SBS:Current(0x0a)

C.4.5.3 Taper Voltage (Offset 6)

For valid primary charge termination, pack *Voltage* must be equal to or higher than **Charging Voltage - Taper Voltage**.

Table C-84. Taper Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
36	Termination Cfg.	6	Taper Voltage	unsigned integer	2	0	1000	300	mV

Related Variables:

- DF:Charge Control:Fast Charge Cfg(34):Charging Voltage(2)
- SBS:Voltage(0x09)

C.4.5.4 Current Taper Window (Offset 8)

For a valid primary charge termination, *Current* must fall below **Taper Current** threshold for 2 consecutive **Current Taper Window** time periods.

Table C-85. Current Taper Window

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
36	Termination Cfg.	8	Current Taper Window	unsigned integer	1	0	240	40	Sec

Related Variables:

- DF:Charge Control:Fast Charge Cfg(34):Charging Voltage(2)
- DF:Charge Control:Termination Cfg.(36):Taper Current(2)
- SBS:Current(0x0a)

C.4.5.5 TCA Set % (Offset 9)

When set between 0% and 100%, *[TCA]* in *BatteryStatus* is set if *RelativeStateOfCharge* is equal to or above **TCA Set %**. Set to -1 to disable this function. If set to -1, the *[MCHG]* and *[TCA]* flags are set on primary charge termination and *ChargingCurrent* is set to **Maintenance Current**.

Table C-86. TCA Set %

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
36	Termination Cfg.	9	TCA Set %	signed integer	1	-1	100	-1	%

Related Variables:

- DF:Charge Control:Termination Cfg.(36):Maintenance Current(0)
- DF:Charge Control:Termination Cfg.(36):TCA Clear %(10)
- SBS:RelativeStateOfCharge(0x0d)
- SBS:ChargingCurrent(0x14)

Charge Control

- SBS:BatteryStatus(0x16)[TCA]
- SBS:ChargingStatus(0x55)[MCHG]

C.4.5.6 TCA Clear % (Offset 10)

When set between 0% and 100%, *[TCA]* in *BatteryStatus* is cleared if *RelativeStateOfCharge* is below **TCA Clear %**. Set to -1 to disable this function.

Table C-87. TCA Clear %

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
36	Termination Cfg.	10	TCA Clear %	signed integer	1	-1	100	95	%

Related Variables:

- DF:Charge Control:Termination Cfg.(36):TCA Set %(9)
- SBS:RelativeStateOfCharge(0x0d)
- SBS:BatteryStatus(0x16)[TCA]

C.4.5.7 FC Set % (Offset 11)

When set between 0% and 100%, *[FC]* in *BatteryStatus* is set if *RelativeStateOfCharge* is equal to or above **FC Set %**. Set to -1 to disable this function.

Table C-88. FC Set %

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
36	Termination Cfg.	11	FC Set %	signed integer	1	-1	100	-1	%

Related Variables:

- DF:Charge Control:Termination Cfg.(36):FC Clear %(12)
- SBS:RelativeStateOfCharge(0x0d)
- SBS:BatteryStatus(0x16)[FC]

C.4.5.8 FC Clear % (Offset 12)

When set between 0% and 100%, *[FC]* in *BatteryStatus* is cleared if *RelativeStateOfCharge* reaches or falls below **FC Clear %**. Set to -1 to disable this function. It is recommended, however, not to set **FC Clear %** to -1.

Table C-89. FC Clear %

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
36	Termination Cfg.	12	FC Clear %	signed integer	1	-1	100	98	%

Related Variables:

- DF:Charge Control:Termination Cfg.(36):FC Set %(11)
- SBS:RelativeStateOfCharge(0x0d)
- SBS:BatteryStatus(0x16)[FC]

C.4.6 Cell Balancing Cfg (Subclass 37)

C.4.6.1 Min Cell Deviation (Offset 0)

This value defines the conversion factor for calculating cell balancing time per cell in units of balance time per mAh before the bq20z90-V110 starts balancing cell capacity during charging. If **Min Cell Deviation** is set to 0 cell balancing is disabled.

Table C-90. Min Cell Deviation

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
37	Cell Balancing Cfg	0	Min Cell Deviation	unsigned integer	2	0	65535	1750	Sec/mAh

C.4.7 Charging Faults (Subclass 38)

C.4.7.1 Over Charging Voltage (Offset 0)

If the battery pack *Voltage* is equal to or greater than *ChargingVoltage* + **Over Charging Voltage** for a time period greater than **Over Charging Volt Time**, the *[OCHGV]* flag is set and the CHG FET and ZVCHG FET (if used) are turned off if *[OCHGV]* is also set in **Charge Fault Cfg**.

Table C-91. Over Charging Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
38	Charging Faults	0	Over Charging Voltage	unsigned integer	2	0	3000	500	mV

Related Variables:

- DF:Charge Control:Charging Faults(38):Over Charging Volt Time(2)
- DF:Charge Control:Charging Faults(38):Charge Fault Cfg(21)[OCHGV]
- SBS:Voltage(0x09)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[TCA]
- SBS:ChargingStatus(0x55)[OCHGV]

C.4.7.2 Over Charging Volt Time (Offset 2)

If the battery pack *Voltage* is equal to or greater than *ChargingVoltage* + **Over Charging Voltage** for a time period greater than **Over Charging Volt Time** the *[OCHGV]* flag is set and the CHG FET and ZVCHG FET (if used) are turned off if *[OCHGV]* is also set in **Charge Fault Cfg**. The bq20z90-V110 recovers if the battery pack *Voltage* is equal to or below **Charging Voltage**.

Table C-92. Over Charging Volt Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
38	Charging Faults	2	Over Charging Volt Time	unsigned integer	1	0	240	2	Sec

Related Variables:

- DF:Charge Control:Fast Charge Cfg(34):Charging Voltage(2)
- DF:Charge Control:Charging Faults(38):Over Charging Volt Time(2)
- DF:Charge Control:Charging Faults(38):Charge Fault Cfg(21)[OCHGV]
- SBS:Voltage(0x09)
- SBS:ChargingVoltage(0x15)
- SBS:BatteryStatus(0x16)[TCA]

- SBS:ChargingStatus(0x55)[OCHGV]

C.4.7.3 Over Charging Current (Offset 3)

If the current is equal to or greater than the sum of *ChargingCurrent* and **Over Charging Current** for a time period greater than **Over Charging Curr Time** the bq20z90-V110 goes into an over charging current error, [OCHGI] in *ChargingStatus* set and, if [OCHGI] in **Charge Fault Cfg** is set, the CHG FET turns off and the ZVCHG FET (if used) is turned on. If the ZVCHG FET is not used the CHG FET remains on, regardless of the bits set in **Charge Fault Cfg**, because it acts as the ZVCHG FET.

Table C-93. Over Charging Current

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
38	Charging Faults	3	Over Charging Current	unsigned integer	2	0	2000	500	mA

Related Variables:

- DF:Charge Control:Charging Faults(38):Over Charging Curr Time(5)
- DF:Charge Control:Charging Faults(38):Charge Fault Cfg(21)[OCHGI]
- SBS:Current(0x0a)
- SBS:ChargingCurrent(0x14)
- SBS:BatteryStatus(0x16)[TCA]
- SBS:ChargingStatus(0x55)[OCHGI]

C.4.7.4 Over Charging Curr Time (Offset 5)

If the *Current* is equal to or greater than the sum of *ChargingCurrent* and **Over Charging Current** for a time period greater than **Over Charging Curr Time** the bq20z90-V110 goes into over charging current error, [OCHGI] in *ChargingStatus* set and, if [OCHGI] in **Charge Fault Cfg** is set, the CHG FET turns off and the ZVCHG FET (if used) is turned on. If the ZVCHG FET is not used the CHG FET remains on, regardless of the bits set in **Charge Fault Cfg**, because it acts as the ZVCHG FET. The bq20z90-V110 recovers if *AverageCurrent* is equal to or lower than the **Over Charging Curr Recov** value.

Table C-94. Over Charging Curr Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
38	Charging Faults	5	Over Charging Curr Time	unsigned integer	1	0	240	2	Sec

Related Variables:

- DF:Charge Control:Charging Faults(38):Over Charging Current(3)
- DF:Charge Control:Charging Faults(38):Over Charging Curr Recov(6)
- DF:Charge Control:Charging Faults(38):Charge Fault Cfg(21)[OCHGI]
- SBS:Current(0x0a)
- SBS:AverageCurrent(0x0b)
- SBS:ChargingCurrent(0x14)
- SBS:BatteryStatus(0x16)[TCA]
- SBS:ChargingStatus(0x55)[OCHGI]

C.4.7.5 Over Charging Curr Recov (Offset 6)

The bq20z90-V110 recovers from an over charging current fault if *AverageCurrent* is equal to or lower than **Over Charging Curr Recov**. On recovery, *[OCHG]* in *ChargingStatus* is reset and the CHG and ZVCHG FETs return to their previous states.

Table C-95. Over Charging Curr Recov

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
38	Charging Faults	6	Over Charging Curr Recov	unsigned integer	2	0	2000	100	mA

Related Variables:

- DF:Charge Control:Charging Faults(38):Over Charging Current(3)
- DF:Charge Control:Charging Faults(38):Over Charging Curr Time(5)
- SBS:Current(0x0a)
- SBS:ChargingCurrent(0x14)
- SBS:BatteryStatus(0x16)[TCA]
- SBS:ChargingStatus(0x55)[OCHG]

C.4.7.6 Depleted Voltage (Offset 8)

The bq20z90-V110 goes into a depleted voltage fault and sets *[XCHGLV]* if the charger is present (*PackVoltage* > **Charger Present**) and pack *Voltage* is equal to or lower than **Depleted Voltage** for a period equal to or greater than **Depleted Voltage Time**. The DSG FET is turned off and the CHG and ZVCHG FETs are set according to *[ZVCHG1,ZVCHG0]* bits if *[CS_XCHGLV]* is set in **Charge Fault Cfg**.

Table C-96. Depleted Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
38	Charging Faults	8	Depleted Voltage	unsigned integer	2	0	16000	8000	mV

Related Variables:

- DF:Charge Control:Charging Faults(38):Depleted Voltage Time(10)
- DF:Charge Control:Charging Faults(38):Charge Fault Cfg(21)[CS_XCHGLV]
- DF:Power:Power(68):Charger Present(5)
- SBS:Voltage(0x09)
- SBS:PackVoltage(0x5a)
- SBS:ChargingStatus(0x55)[XCHGLV]

C.4.7.7 Depleted Voltage Time(Offset 10)

The bq20z90-V110 goes into a depleted voltage fault and sets *[XCHGLV]* if the charger is present and pack *Voltage* is equal to or lower than **Depleted Voltage** for a period equal to or greater than **Depleted Voltage Time**. If *[CS_XCHGLV]* is set in **Charge Fault Cfg** the DSG FET is turned off and the CHG and ZVCHG FETs are set according to their pre-charge settings.

Table C-97. Depleted Voltage Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
38	Charging Faults	10	Depleted Voltage Time	unsigned integer	1	0	240	2	Sec

Related Variables:

- DF:Charge Control:Charging Faults(38):Depleted Voltage(8)
- DF:Charge Control:Charging Faults(38):Depleted Recovery(11)
- DF:Charge Control:Charging Faults(38):Charge Fault Cfg(21)[CS_XCHGLV]
- SBS:Voltage(0x09)
- SBS:ChargingStatus(0x55)[XCHGLV]

C.4.7.8 Depleted Recovery (Offset 11)

The bq20z90-V110 recovers from a depleted voltage fault if pack *Voltage* is equal to or higher than the **Depleted Recovery** threshold. On recovery, *[OCHGLV]* is reset and the DSG FET, CHG FET and ZVCHG FET return to their previous states.

Table C-98. Depleted Recovery

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
38	Charging Faults	11	Depleted Recovery	unsigned integer	2	0	16000	8500	mV

Related Variables:

- DF:Charge Control:Charging Faults(38):Depleted Voltage Time(10)
- SBS:Voltage(0x09)
- SBS:ChargingStatus(0x55)[XCHGLV]

C.4.7.9 Over Charge Capacity (Offset 13)

The bq20z90-V110 goes into an overcharge fault and sets the *[OC]* flag in *ChargingStatus* if the internal counted remaining capacity exceeds *FullChargeCapacity* + **Over Charge Capacity**. The CHG FET and ZVCHG FET (if used) are also turned of if the *[OC]* bit is set in **Charge Fault Cfg**.

Table C-99. Over Charge Capacity

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
38	Charging Faults	13	Over Charge Capacity	unsigned integer	2	0	4000	300	mAh

Related Variables:

- DF:Charge Control:Charging Faults(38):Over Charge Recovery(15)
- DF:Charge Control:Charging Faults(38):Charge Fault Cfg(21)[OC]
- SBS:FullChargeCapacity(0x10)
- SBS:ChargingStatus(0x55)[OC]

C.4.7.10 Over Charge Recovery (Offset 15)

The bq20z90-V110 recovers from an over charge in non-removable battery mode(*[NR]* = 1) if it is continuously discharged by an amount of **Over Charge Recovery** charge.

Table C-100. Over Charge Recovery

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
38	Charging Faults	15	Over Charge Recovery	unsigned integer	2	0	100	2	mAh

Related Variables:

- DF:Charge Control:Charging Faults(38):Over Charge Capacity(13)
- DF:Configuration:Registers(64):Operation B Cfg(2)[NR]
- SBS:RemainingCapacity(0x0f)
- SBS:FullChargeCapacity(0x10)
- SBS:ChargingStatus(0x55)[OC]

C.4.7.11 FC-MTO (Offset 17)

If charge *Current* is equal to or greater than **Chg Current Threshold** for **FC-MTO** time period the bq20z90-V110 generates a fast charge mode time out fault and sets the **[FCMTO]** flag. The CHG FET and ZVCHG FET (if used) are also turned of if **[FCMTO]** is set in **Charge Fault Cfg**. Set to 0 to disable **FC-MTO**.

Table C-101. FC-MTO

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
38	Charging Faults	17	FC-MTO	unsigned integer	2	0	65535	10800	Sec

Related Variables:

- DF:Gas Gauging:Current Thresholds(81):Chg Current Threshold(2)
- DF:Charge Control:Charging Faults(38):Charge Fault Cfg(21)[FCMTO]
- SBS:Current(0x0a)
- SBS:ChargingStatus(0x55)[FCMTO]

C.4.7.12 PC-MTO (Offset 19)

If charge *Current* is equal to or greater than **Chg Current Threshold** for **PC-MTO** time period the bq20z90-V110 generates a precharge mode-time out error and sets the **[PCMTO]** flag. The CHG FET and ZVCHG FET (if used) are also turned of if **[PCMTO]** is set in **Charge Fault Cfg**. Set to 0 to disable **PC-MTO**.

Table C-102. PC-MTO

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
38	Charging Faults	19	PC-MTO	unsigned integer	2	0	65535	3600	Sec

Related Variables:

- DF:Gas Gauging:Current Thresholds(81):Chg Current Threshold(2)
- DF:Charge Control:Charging Faults(38):Charge Fault Cfg(21)[PCMTO]
- SBS:Current(0x0a)
- SBS:ChargingStatus(0x55)[PCMTO]

C.4.7.13 Charge Fault Cfg (Offset 21)

This register sets the behavior of the charge, discharge, and zero-volt charge FETs in fault conditions.

Table C-103. Charge Fault Cfg

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
38	Charging Faults	21	Charge Fault Cfg	hex	1	0	0x3f	0x00	

SBS Configuration

7	6	5	4	3	2	1	0
RSVD	RSVD	PCMTO	FCMTO	OCHGV	OCHGI	OC	CS_XCHGLV
R	R	R/W	R/W	R/W	R/W	R/W	R/W

LEGEND: R/W = Read/Write; R = Read only; - n = value after reset; RSVD = Reserved and **must** be programmed to 0

Figure C-5. Charge Fault Cfg Register

PCMTO — If set, CHG FET and ZVCHG FET (if used) are turned off when pre-charge time out fault occurs.

FCMTO — If set, CHG FET and ZVCHG FET (if used) are turned off when fast charge time out fault occurs.

OCHGV — If set, CHG FET and ZVCHG FET (if used) are turned off when charge voltage fault occurs.

OCHGI — If set, CHG FET is turned off and ZVCHG FET (if used) is turned on when charge current fault occurs. If ZVCHG FET is not used, CHG FET remains on, regardless of this bit, because it acts as ZVCHG FET.

OC — If set, CHG FET and ZVCHG FET (if used) are turned off when over charge fault occurs.

CS_XCHGLV — If set, DSG FET is turned off when battery depleted fault occurs.

Related Variables:

- DF:Charge Control:Charging Faults(38):Over Charging Volt Time(2)
- DF:Charge Control:Charging Faults(38):Over Charging Curr Time(5)
- DF:Charge Control:Charging Faults(38):Depleted Voltage Time(10)
- DF:Charge Control:Charging Faults(38):Over Charge Capacity(13)
- DF:Charge Control:Charging Faults(38):FC-MTO(17)
- DF:Charge Control:Charging Faults(38):PC-MTO(19)

C.5 SBS Configuration

C.5.1 Data (Subclass 48)

C.5.1.1 Rem Cap Alarm (Offset 0)

When [CapM] in *BatteryStatus* is set to 0, the default value of *RemainingCapacityAlarm* is stored in **Rem Cap Alarm** and copied to the SBS value upon bq20z90-V110 initialization.

Table C-104. Rem Cap Alarm

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
48	Data	0	Rem Cap Alarm	unsigned integer	2	0	700	300	mAh

Related Variables:

- SBS:RemainingCapacityAlarm(0x01)

C.5.1.2 Rem Energy Alarm (Offset 2)

When [CapM] in *BatteryStatus* is set to 1, the default value of *RemainingCapacityAlarm* is stored in **Rem Energy Alarm** and copied to the SBS value upon the bq20z90-V110 initialization.

Table C-105. Rem Energy Alarm

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
48	Data	2	Rem Energy Alarm	unsigned integer	2	0	1000	432	10mWh

Related Variables:

- SBS:RemainingCapacityAlarm(0x01)

C.5.1.3 Rem Time Alarm (Offset 4)

The default value of *RemainingTimeAlarm* is stored in **Rem Time Alarm** and copied to the SBS value upon bq20z90-V110 initialization.

Table C-106. Rem Time Alarm

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
48	Data	4	Rem Time Alarm	unsigned integer	2	0	30	10	min

Related Variables:

- SBS:RemainingTimeAlarm(0x02)

C.5.1.4 Init Battery Mode (Offset 6)

The default value of *BatteryMode* is stored in **Init Battery Mode** and copied to the SBS value upon bq20z90-V110 initialization.

Table C-107. Init Battery Mode

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
48	Data	6	Init Battery Mode	hex	2	0	0xffff	0x0081	

Related Variables:

- SBS:BatteryMode(0x03)

C.5.1.5 Design Voltage (Offset 8)

The default value of *DesignVoltage* is stored in **Design Voltage** and copied to the SBS value upon bq20z90-V110 initialization.

Table C-108. Design Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
48	Data	8	Design Voltage	unsigned integer	2	7000	18000	14400	mV

Related Variables:

- SBS:DesignVoltage(0x19)

C.5.1.6 Spec Info (Offset 10)

The default value of *SpecificationInfo* is stored in **Spec Info** and copied to the SBS value upon bq20z90-V110 initialization.

Table C-109. Spec Info

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
48	Data	10	Spec Info	hex	2	0x0000	0xffff	0x0031	

Related Variables:

- SBS:SpecificationInfo(0x1a)

C.5.1.7 Manuf Date (Offset 12)

The default value of *ManufacturerDate* is stored in **Manuf Date** and copied to the SBS value upon bq20z90-V110 initialization.

Table C-110. Manuf Date

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
48	Data	12	Manuf Date	unsigned integer	2	0	65535	0	Day + Mo*32 + (Yr -1980)*512

Related Variables:

- SBS:ManufactureDate(0x1b)

C.5.1.8 Ser. Num. (Offset 14)

The default value of *SerialNumber* is stored in **Ser. Num.** and copied to the SBS value upon bq20z90-V110 initialization.

Table C-111. Ser. Num.

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
48	Data	14	Ser. Num.	hex	2	0x0000	0xffff	0x0001	

Related Variables:

- SBS:SerialNumber(0x1c)

C.5.1.9 Cycle Count (Offset 16)

The default value of *CycleCount* is stored in **Cycle Count** and copied to the SBS value upon bq20z90-V110 initialization. When the SBS value changes **Cycle Count** is also updated.

Table C-112. Cycle Count

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
48	Data	16	Cycle Count	unsigned integer	2	0	65535	0	Count

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg B(2)[CCT]
- DF:SBS Configuration:Data(48):CC Threshold(18)
- DF:SBS Configuration:Data(48):CC %(20)
- SBS:CycleCount(0x17)

C.5.1.10 CC Threshold (Offset 18)

If the *[CCT]* bit is cleared the cycle count function counts the accumulated discharge of the **CC Threshold** value as one cycle.

Table C-113. CC Threshold

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
48	Data	18	CC Threshold	signed integer	2	100	32767	4400	mAh

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg B(2)[CCT]
- SBS:CycleCount(0x17)

C.5.1.11 CC % (Offset 20)

If the *[CCT]* bit is set the cycle count function counts the accumulated discharge of (*FullChargeCapacity* x **CC %**) as one cycle. If (*FullChargeCapacity* x **CC %**) is smaller than **CC Threshold**, **CC Threshold** is used for counting.

Table C-114. CC %

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
48	Data	20	CC %	unsigned integer	1	0	100	90	%

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg B(2)[CCT]
- DF:SBS Configuration:Data(48):CC Threshold(18)
- SBS:FullChargeCapacity(0x10)
- SBS:CycleCount(0x17)

C.5.1.12 CF Max Error Limit (Offset 21)

If *MaxError* function value is greater than **CF Max Error Limit**, *[CF]* in *BatteryMode* is set.

Table C-115. CF Max Error Limit

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
48	Data	21	CF Max Error Limit	unsigned integer	1	0	100	100	%

Related Variables:

- SBS:BatteryMode(0x03)[CF]
- SBS:MaxError(0x0c)

C.5.1.13 Design Capacity (Offset 22)

If *[CapM]* in *BatteryMode* is set to 0, the *DesignCapacity* function reports **Design Capacity**.

Table C-116. Design Capacity

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
48	Data	22	Design Capacity	unsigned integer	2	0	65535	4400	mAh

Related Variables:

- DF:Gas Gauging:IT Config(80):Load Select(0)
- SBS:BatteryMode(0x03)[CapM]
- SBS:DesignCapacity(0x18)
- SBS:StateOfHealth(0x4f)

C.5.1.14 Design Energy (Offset 24)

If [CapM] in *BatteryMode* is set to 1, this value the *DesignCapacity* function reports **Design Energy**.

Related Variables:
Table C-117. Design Energy

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
48	Data	24	Design Energy	unsigned integer	2	0	65535	6336	0.1Wh

- DF:Gas Gauging:IT Config(80):Load Select(0)
- SBS:BatteryMode(0x03)[CapM]
- SBS:DesignCapacity(0x18)
- SBS:StateOfHealth(0x4f)

C.5.1.15 Manuf Name (Offset 26)

The *ManufacturerName* function returns a string stored in **Manuf Name**. The maximum text length is 11 characters.

Table C-118. Manuf Name

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
48	Data	26	Manuf Name	string	11 + 1	-	-	Texas Inst.	ASCII

Related Variables:

- SBS:ManufacturerName(0x20)

C.5.1.16 Device Name (Offset 38)

The *DeviceName* function returns a string stored in **Device Name**. The maximum text length is 7 characters.

Table C-119. Device Name

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
48	Data	38	Device Name	string	7 + 1	-	-	bq20z90-V110	ASCII

Related Variables:

- SBS:DeviceName(0x21)

C.5.1.17 Device Chemistry (Offset 46)

The *DeviceChemistry* function returns a string stored in **Device Chemistry**. The maximum text length is 4 characters.

Table C-120. Device Chemistry

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
48	Data	46	Device Chemistry	string	4+1	-	-	LION	ASCII

Related Variables:

- SBS:DeviceChemistry(0x22)

C.5.2 Configuration(Subclass 49)

C.5.2.1 TDA Set % (Offset 0)

If set between 0% and 100% the bq20z90-V110 sets the *[TDA]* flag in *BatteryStatus* if the *RelativeStateOfCharge* reaches or falls below **TDA Set %**. Set to -1 to disable this function.

Table C-121. TDA Set %

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
49	Configuration	0	TDA Set %	signed integer	1	-1	100	6	%

Related Variables:

- SBS:RelativeStateOfCharge(0x0d)
- SBS:BatteryStatus(0x16)[TDA]

C.5.2.2 TDA Clear % (Offset 1)

If set between 0% and 100% the bq20z90-V110 clears the *[TDA]* flag in *BatteryStatus* if the *RelativeStateOfCharge* reaches or rises above **TDA Clear %**. Set to -1 to disable this function.

Table C-122. TDA Clear %

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
49	Configuration	1	TDA Clear %	signed integer	1	-1	100	8	%

Related Variables:

- SBS:RelativeStateOfCharge(0x0d)
- SBS:BatteryStatus(0x16)[TDA]

C.5.2.3 FD Set % (Offset 2)

If set between 0% and 100%, the bq20z90-V110 sets the *[FD]* flag in *BatteryStatus* if the *RelativeStateOfCharge* reaches or falls below **FD Set %**. Set to -1 to disable this function.

Table C-123. FD Set %

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
49	Configuration	2	FD Set %	signed integer	1	-1	100	2	%

Related Variables:

- SBS:RelativeStateOfCharge(0x0d)
- SBS:BatteryStatus(0x16)[FD]

C.5.2.4 FD Clear % (Offset 3)

If set between 0% and 100% the bq20z90-V110 clears the *[FD]* flag in *BatteryStatus* if the *RelativeStateOfCharge* reaches or rises above **FD Clear %**. Set to -1 to disable this function.

Table C-124. FD Clear %

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
49	Configuration	3	FC Clear %	signed integer	1	-1	100	5	%

Related Variables:

- SBS:RelativeStateOfCharge(0x0d)
- SBS:BatteryStatus(0x16)[FD]

C.5.2.5 TDA Set Volt Threshold (Offset 4)

The bq20z90-V110 sets the *[TDA]* flag in *BatteryStatus* if *Voltage* is equal to or lower than **TDA Set Volt Threshold** for a period equal to or greater than **TDA Set Volt Time**.

Table C-125. TDA Set Volt Threshold

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
49	Configuration	4	TDA Set Volt Threshold	unsigned integer	2	0	16800	5000	mV

Related Variables:

- DF:SBS Configuration:Configuration(49):TDA Set Volt Time(6)
- SBS:Voltage(0x09)
- SBS:BatteryStatus(0x16)[TDA]

C.5.2.6 TDA Set Volt Time (Offset 6)

The bq20z90-V110 sets the *[TDA]* flag in *BatteryStatus* if *Voltage* is equal to or lower than **TDA Set Volt Threshold** for a period equal to or greater than **TDA Set Volt Time**. Set to 0 to disable this feature.

Table C-126. TDA Set Volt Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
49	Configuration	6	TDA Set Volt Time	unsigned integer	1	0	240	5	Sec

Related Variables:

- DF:SBS Configuration:Configuration(49):TDA Set Volt Threshold(4)
- SBS:Voltage(0x09)
- SBS:BatteryStatus(0x16)[TDA]

C.5.2.7 TDA Clear Volt (Offset 7)

The bq20z90-V110 clears the *[TDA]* flag if *Voltage* is equal to or greater than **TDA Clear Volt**. **TDA Clear Volt** clears *[TDA]* only if *[TDA]* is set by **TDA Set Volt Threshold**. It will not clear *[TDA]* if *[TDA]* is set by **TDA Set %** or any other function.

Table C-127. TDA Clear Volt

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
49	Configuration	7	TDA Clear Volt	unsigned integer	2	0	16800	5500	mV

Related Variables:

- DF:SBS Configuration:Configuration(49):TDA Set Volt Threshold(4)
- DF:SBS Configuration:Configuration(49):TDA Set Volt Time(6)
- SBS:Voltage(0x09)
- SBS:BatteryStatus(0x16)[TDA]

C.5.2.8 FD Set Volt Threshold (Offset 9)

The bq20z90-V110 sets the *[FD]* flag if *Voltage* is equal to or lower than **FD Set Volt Threshold** for a period equal to or greater than **FD Volt Time**.

Table C-128. FD Set Volt Threshold

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
49	Configuration	9	FD Set Volt Threshold	unsigned integer	2	0	16800	5000	mV

Related Variables:

- DF:SBS Configuration:Configuration(49):FD Volt Time(11)
- SBS:Voltage(0x09)
- SBS:BatteryStatus(0x16)[FD]

C.5.2.9 FD Volt Time (Offset 11)

The bq20z90-V110 sets the *[FD]* flag if *Voltage* is equal to or lower than **FD Set Volt Threshold** for a period equal to or greater than **FD Volt Time**. Set to 0 to disable this feature.

Table C-129. FD Volt Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
49	Configuration	11	FD Volt Time	unsigned integer	1	0	240	5	Sec

Related Variables:

- DF:SBS Configuration:Configuration(49):FD Set Volt Threshold(9)
- SBS:Voltage(0x09)
- SBS:BatteryStatus(0x16)[FD]

C.5.2.10 FD Clear Volt (Offset 12)

The bq20z90-V110 clears the *[FD]* flag if *Voltage* is equal to or greater than **FD Clear Volt**.

Table C-130. FD Clear Volt

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
49	Configuration	12	FD Clear Volt	unsigned integer	2	0	16800	5500	mV

Related Variables:

- DF:SBS Configuration:Configuration(49):FD Set Volt Threshold(9)
- SBS:Voltage(0x09)
- SBS:BatteryStatus(0x16)[FD]

C.6 System Data
C.6.1 Manufacturer Data (Subclass 56)
C.6.1.1 Pack Lot Code (Offset 0)

The *ManufacturerData* function reports **Pack Lot Code** as part of its return value.

Table C-131. Pack Lot Code

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
56	Manufacturer Data	0	Pack Lot Code	hex	2	0x0000	0xffff	0x0000	

Related Variables:

- SBS:ManufacturerData(0x23)

C.6.1.2 PCB Lot Code (Offset 2)

The *ManufacturerData* function reports **PCB Lot Code** as part of its return value.

Table C-132. PCB Lot Code

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
56	Manufacturer Data	2	PCB Lot Code	hex	2	0x0000	0xffff	0x0000	

Related Variables:

- SBS:ManufacturerData(0x23)

C.6.1.3 Firmware Version (Offset 4)

The *ManufacturerData* function reports **Firmware Version** as part of its return value.

Table C-133. Firmware Version

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
56	Manufacturer Data	4	Firmware Version	hex	2	0x0000	0xffff	0x0000	

Related Variables:

- SBS:ManufacturerData(0x23)

C.6.1.4 Hardware Revision (Offset 6)

The *ManufacturerData* function reports **Hardware Version** as part of its return value.

Table C-134. Hardware Revision

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
56	Manufacturer Data	6	Hardware Revision	hex	2	0x0000	0xffff	0x0000	

Related Variables:

- SBS:ManufacturerData(0x23)

C.6.1.5 Cell Revision (Offset 8)

The *ManufacturerData* function reports **Cell Revision** as part of its return value.

Table C-135. Cell Revision

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
56	Manufacturer Data	8	Cell Revision	hex	2	0x0000	0xffff	0x0000	

Related Variables:

- SBS:ManufacturerData(0x23)

C.6.2 Manufacturer Info (Subclass 58)

C.6.2.1 Manuf. Info (Offset 0)

The *ManufacturerInfo* function returns the string stored in **Manuf. Info**. The maximum text length is 20 characters.

Table C-136. Manuf. Info

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
58	Manufacturer Info	0	Manuf. Info	string	20 + 1	-	-	012345678 9abcdef012 3	

Related Variables:

- SBS:ManufacturerInfo(0x70)

C.6.3 Lifetime Data (Subclass 59)

C.6.3.1 Lifetime Max Temp (Offset 0)

If the [QEN] flag is **Lifetime Max Temp** value is updated if one of the following conditions are met:

- internal measurement temperature - **Lifetime Max Temp** > 1 °C.
- internal measurement temperature > **Lifetime Max Temp** for a period > 60 seconds
- internal measurement temperature > **Lifetime Max Temp** AND any other lifetime value is updated.

Table C-137. Lifetime Max Temp

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
59	Lifetime Data	0	Lifetime Max Temp	signed integer	2	0	1400	300	0.1°C

Related Variables:

- DF:Gas Gauging:State(82):Update Status(12)
- SBS:ManufacturerAccess(0x00):IT Enable(0x0021)
- SBS:OperationStatus(0x54)[QEN]

C.6.3.2 Lifetime Min Temp (Offset 2)

If the [QEN] flag is set **Lifetime Min Temp** is updated if one of the following conditions are met:

- **Lifetime Min Temp** - internal measurement temperature > 1 °C.
- **Lifetime Min Temp** > internal measurement temperature for a period > 60 seconds
- **Lifetime Min Temp** > internal measurement temperature > AND any other lifetime value is updated.

Table C-138. Lifetime Min Temp

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
59	Lifetime Data	2	Lifetime Min Temp	signed integer	2	-600	1400	200	0.1°C

Related Variables:

- DF:Gas Gauging:State(82):Update Status(12)
- SBS:ManufacturerAccess(0x00):IT Enable(0x0021)
- SBS:OperationStatus(0x54)[QEN]

C.6.3.3 Lifetime Max Cell Voltage (Offset 4)

If the [QEN] flag is set **Lifetime Max Cell Voltage** is updated if one of the following conditions are met:

- any internally measured cell voltage - **Lifetime Max Cell Voltage** > 25 mV
- any internally measured cell voltage > **Lifetime Max Cell Voltage** for a period > 60 seconds
- any internally measured cell voltage **Lifetime Max Cell Voltage** AND any other lifetime value is updated.

Table C-139. Lifetime Max Cell Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
59	Lifetime Data	4	Lifetime Max Cell Voltage	signed integer	2	-32768	32767	3500	mV

Related Variables:

- DF:Gas Gauging:State(82):Update Status(12)
- SBS:ManufacturerAccess(0x00):IT Enable(0x0021)
- SBS:OperationStatus(0x54)[QEN]

C.6.3.4 Lifetime Min Cell Voltage (Offset 6)

If the [QEN] flag is set **Lifetime Min Cell Voltage** is updated if one of the following conditions are met:

- **Lifetime Min Cell Voltage** - any internally measured cell voltage > 25 mV
- **Lifetime Min Cell Voltage** > any internally measured cell voltage for a period > 60 seconds
- **Lifetime Min Cell Voltage** > any internally measured cell voltage AND any other lifetime value is updated.

Table C-140. Lifetime Min Cell Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
59	Lifetime Data	6	Lifetime Min Cell Voltage	signed integer	2	-32768	32767	3200	mV

Related Variables:

- DF:Gas Gauging:State(82):Update Status(12)
- SBS:ManufacturerAccess(0x00):IT Enable(0x0021)
- SBS:OperationStatus(0x54)[QEN]

C.6.3.5 Lifetime Max Pack Voltage (Offset 8)

If the [QEN] flag is set **Lifetime Max Pack Voltage** is updated if one of the following conditions are met:

- internal measured cell stack voltage - **Lifetime Max Pack Voltage** > 100 mV
- internal measured cell stack voltage > **Lifetime Max Pack Voltage** for a period > 60 seconds
- internal measured cell stack voltage > **Lifetime Max Pack Voltage** AND any other lifetime value is updated.

Table C-141. Lifetime Max Pack Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
59	Lifetime Data	8	Lifetime Max Pack Voltage	signed integer	2	-32768	32767	14000	mV

Related Variables:

- DF:Gas Gauging:State(82):Update Status(12)
- SBS:ManufacturerAccess(0x00):IT Enable(0x0021)
- SBS:OperationStatus(0x54)[QEN]

C.6.3.6 Lifetime Min Pack Voltage (Offset 10)

If the [QEN] flag is set **Lifetime Min Pack Voltage** is updated if one of the following conditions are met:

- **Lifetime Min Pack Voltage** - internal measured cell stack voltage > 100 mV
- **Lifetime Min Pack Voltage** > internal measured cell stack voltage for a period > 60 seconds

- **Lifetime Min Pack Voltage** > internal measured cell stack voltage AND any other lifetime value is updated.

Table C-142. Lifetime Min Pack Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
59	Lifetime Data	10	Lifetime Min Pack Voltage	signed integer	2	-32768	32767	12800	mV

Related Variables:

- DF:Gas Gauging:State(82):Update Status(12)
- SBS:ManufacturerAccess(0x00):IT Enable(0x0021)
- SBS:OperationStatus(0x54)[QEN]

C.6.3.7 Lifetime Max Chg Current (Offset 12)

If the [QEN] flag is set **Lifetime Max Chg Current** is updated if one of the following conditions are met:

- internal charge current - **Lifetime Max Chg Current** > 100 mA
- internal charge current > **Lifetime Max Chg Current** for a period > 60 seconds
- internal charge current > **Lifetime Max Chg Current** AND any other lifetime value is updated.

Table C-143. Lifetime Max Chg Current

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
59	Lifetime Data	12	Lifetime Max Chg Current	signed integer	2	-32768	32767	1500	mA

Related Variables:

- DF:Gas Gauging:State(82):Update Status(12)
- SBS:ManufacturerAccess(0x00):IT Enable(0x0021)
- SBS:OperationStatus(0x54)[QEN]

C.6.3.8 Lifetime Max Dsg Current (Offset 14)

If the [QEN] flag is set **Lifetime Max Dsg Current** is updated if one of the following conditions are met:

- **Lifetime Max Dsg Current** - internal discharge current < -100 mA
- **Lifetime Max Dsg Current** < internal discharge current for a period > 60 seconds
- **Lifetime Max Dsg Current** < internal discharge current AND any other lifetime value is updated.

Table C-144. Lifetime Max Dsg Current

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
59	Lifetime Data	14	Lifetime Max Dsg Current	signed integer	2	-32768	32767	-3000	mA

Related Variables:

- DF:Gas Gauging:State(82):Update Status(12)
- SBS:ManufacturerAccess(0x00):IT Enable(0x0021)
- SBS:OperationStatus(0x54)[QEN]

C.6.3.9 Lifetime Max Chg Power (Offset 16)

If the [QEN] flag is set **Lifetime Max Chg Power** is updated if one of the following conditions are met:

- (internal measured voltage × internal measured current) - **Lifetime Max Chg Power** > 1000 mW
- (internal measured voltage × internal measured current) > **Lifetime Max Chg Power** for a period > 60 seconds
- (internal measured voltage × internal measured current) > **Lifetime Max Chg Power** AND any other lifetime value is updated.

Table C-145. Lifetime Max Dsg Current

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
59	Lifetime Data	16	Lifetime Max Chg Power	signed integer	2	-32768	32767	1500	10 mW

Related Variables:

- DF:Gas Gauging:State(82):Update Status(12)
- SBS:ManufacturerAccess(0x00):IT Enable(0x0021)
- SBS:OperationStatus(0x54)[QEN]

C.6.3.10 Lifetime Max Dsg Power (Offset 18)

If the [QEN] flag is set **Lifetime Max Dsg Power** is updated if one of the following conditions are met:

- **Lifetime Max Dsg Power** - (internal measured voltage × internal measured current) > 1000 mW
- **Lifetime Max Dsg Power** > (internal measured voltage × internal measured current) for a period > 60 seconds
- **Lifetime Max Dsg Power** > (internal measured voltage × internal measured current) AND any other lifetime value is updated.

Table C-146. Lifetime Max Dsg Power

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
59	Lifetime Data	18	Lifetime Max Dsg Power	signed integer	2	-32768	32767	-1500	10 mW

Related Variables:

- DF:Gas Gauging:State(82):Update Status(12)
- SBS:ManufacturerAccess(0x00):IT Enable(0x0021)
- SBS:OperationStatus(0x54)[QEN]

C.6.3.11 Life Max AvgDsg Cur (Offset 22)

If the [QEN] flag is set **Life Max AvgDsg Cur** is updated if one of the following conditions are met:

- **Lifetime Max AvgDsg Cur** - internally measured average discharge current > 100mA
- **Lifetime Max AvgDsg Cur** > internally measured average discharge current > 60 seconds
- **Lifetime Max AvgDsg Cur** > internally measured average discharge current AND any other lifetime value is updated.

Table C-147. Life Max AvgDsg Cur

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
59	Lifetime Data	22	Lifetime Max AvgDsg Power	signed integer	2	-32768	32767	-1000	mA

Related Variables:

- DF:Gas Gauging:State(82):Update Status(12)
- SBS:ManufacturerAccess(0x00):IT Enable(0x0021)
- SBS:OperationStatus(0x54)[QEN]

C.6.3.12 Life Max AvgDsg Pow (Offset 26)

If the [QEN] flag is set **Life Max AvgDsg Pow** is updated if one of the following conditions are met:

- **Life Max AvgDsg Pow** - averaged (internal measured voltage × internal measured current) > 1000 mW
- **Life Max AvgDsg Pow** > averaged (internal measured voltage × internal measured current) for a period > 60 seconds
- **Life Max AvgDsg Pow** > averaged (internal measured voltage × internal measured current) AND any other lifetime value is updated.

Table C-148. Life Max AvgDsg Pow

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
59	Lifetime Data	26	Life Max AvgDsg Pow	signed integer	2	-32768	32767	-1500	10 mW

Related Variables:

- DF:Gas Gauging:State(82):Update Status(12)
- SBS:ManufacturerAccess(0x00):IT Enable(0x0021)
- SBS:OperationStatus(0x54)[QEN]

C.6.3.13 Lifetime Avg Temp (Offset 28)

If the [QEN] flag is set **Lifetime Avg Temp** is updated as follows:

- takes samples of *Temperature* function every 225s, but only updates if any other lifetime value is updated.

Table C-149. Lifetime Avg Temp

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
59	Lifetime Data	28	Lifetime Avg Temp	signed integer	2	0	1400	250	0.1°C

Related Variables:

- DF:Gas Gauging:State(82):Update Status(12)
- DF:System Data:Lifetime Temp Samples(60):LT Temp Samples(0)
- SBS:ManufacturerAccess(0x00):IT Enable(0x0021)
- SBS:Temperature(0x08)
- SBS:OperationStatus(0x54)[QEN]

C.6.4 Lifetime Temp Samples (Subclass 60)

C.6.4.1 LT Temp Samples (Offset 0)

This variable indicates the number of temperature samples used for the **Lifetime Avg Temp** calculation. Multiply this value by 225 seconds to get the total time that the Impedance Track™ algorithm is active.

Table C-150. LT Temp Samples

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
60	Lifetime Temp Samples	0	LT Temp Samples	unsigned integer	4	0	140000000	0	Count

Related Variables:

- DF:System Data:Lifetime Data(59):Lifetime Avg Temp(28)

C.7 Configuration

C.7.1 Registers (Subclass 64)

C.7.1.1 Operation Cfg A (Offset 0)

This register enables, disables or configures various features of the bq20z90-V110.

Table C-151. Operation Cfg A

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
64	Configuration	0	Operation Cfg A	hex	2	0x0000	0xff3f	0x0f29	

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
High Byte	LEDR	LEDRCA	CHGLED	DMODE	LED1	LED0	CC1	CC0
Low Byte	RSVD	RSVD	SLEEP	TEMP1	TEMP0	SLED	ZVCHG1	ZVCHG0

LEGEND: RSVD = Reserved and **must** be programmed to 0

Figure C-6. Operation Cfg A

LEDR — Enables activation of the LED display on device-reset exit.

0 = LED display is not activated on exit from device reset. (default)

1 = LED display is activated (simulates a $\overline{\text{DISP}}$ transition) on exit from device reset.

LEDRCA — Enables flashing of the LED display when the *[RCA]* flag in *BatteryStatus* bit is set.

0 = The LED display is not activated when *[RCA]* is set. (default)

1 = If the LED display is activated when *[RCA]* is set the display flashes with **LED Flash Rate**

Related Variables:

DF:LED Support:LED Cfg(67):LED Flash Rate(0)

SBS:BatteryStatus(0x16)[RCA]

CHGLED — Enables the LED display while charging.

- 0 = Display is not activated by charging; requires push-button event or SMBus command. (default)
- 1 = Display is active during charging.

DMODE — This bit sets the display to show the *RelativeStateOfCharge* or *AbsoluteStateOfCharge* LED representation.

- 0 = Display reflects RelativeStateOfCharge (default)
- 1 = Display reflects AbsoluteStateOfCharge

LED1, LED0 — These bits configure the number of LEDs and threshold levels used in the LED Display.

- 0,0 = User defined threshold
- 0,1 = 3 LEDs used
- 1,0 = 4 LEDs used
- 1,1 = 5 LEDs used (default)

CC1, CC0 — These bits configure the bq20z90-V110 for the number of series cells in the battery stack.

- 0,0 = Reserved
- 0,1 = 2 cell
- 1,0 = 3 cell
- 1,1 = 4 cell (default)

SLEEP — Enables the bq20z90-V110 to enter Sleep mode if the SMBus lines are low.

- 0 = The bq20z90-V110 never enters Sleep mode
- 1 = The bq20z90-V110 enters Sleep mode under normal Sleep entry criteria (default)

Related Variables:

SBS:ManufacturerAccess(0x00):Sleep(0x0011)

TEMP1, TEMP0 — These bits configure the source of the *Temperature* function

- 0,0 = Internal Temperature Sensor
- 0,1 = TS1 Input (default)
- 1,0 = Greater Value of TS1 or TS2 Inputs
- 1,1 = Average of TS1 and TS2 Inputs

Related Variables:

SBS:Temperature(0x08)

SLED — Enables the bq20z90-V110 display to be used in serial or parallel mode. The PF error code display doesn't work in serial LED mode

- 0 = Display is in parallel LED mode (default)
- 1 = Display is in serial LED mode

ZVCHG1, ZVCHG0 — These bits enable or disable the use of the ZVCHG or CHG FET in Zero-Volt/Precharge modes.

- 0,0 = ZVCHG
- 0,1 = CHG (default)
- 1,0 = GPOD of bq29330
- 1,1 = No Action

C.7.1.2 Operation Cfg B (Offset 2)

This register enables, disables, or configures various features of the bq20z90-V110.

Table C-152. Operation Cfg B

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
64	Configuration	2	Operation Cfg B	hex	2	0x0000	0xffff	0x6440	

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
High Byte	PDF1	PDF0	RESCAP	NCSMB	NRCHG	CSYNC	CHGTERM	CCT
Low Byte	CHGSUSP	OTFET	CHGFET	CHGIN	NR	CPE	HPE	BCAST

Figure C-7. Operation Cfg B

PDF1, PDF0 — Configures the Permanent Failure LED display. This function is disabled if the **[SLED]** bit in **Operation Cfg A** is set.

- 0,0 = PF Error Code not available
- 0,1 = PF Error Code is activated after state of charge display if $\overline{\text{DISP}}$ is held low for **LED Hold Time**. (default)
- 1,0 = PF Error Code not available
- 1,1 = PF Error Code is automatically activated after state of charge display

Related Variables:

DF:Configuration:Registers(64):Operation Cfg A(0)[SLED]
 DF:LED Support:LED Cfg(67):LED Hold Time(6)

RESCAP — This bit configures the compensation model of the Impedance Track™ Algorithm for reserve capacity calculation.

- 0 = Light Load Compensation
- 1 = Average Load Compensation defined by **Load Select** (default)

Related Variables:

DF:Gas Gauging:IT Cfg(80):Load Select(0)
 DF:Gas Gauging:IT Cfg(80):Reserve Cap-mAh(64)
 DF:Gas Gauging:IT Cfg(80):Reserve Cap-mWh(68)

NCSMB —Disables extended SMBUS t_{TIMEOUT} feature. Use this bit with caution.

0 = Normal SMBUS t_{TIMEOUT} (default)

1 = Extended SMBUS t_{TIMEOUT}

NRCHG —Enables the CHG FET to remain on during sleep when the bq20z90-V110 is in non-removable battery mode.

0 = CHG FET turns off in Sleep Mode if the **[NR]** bit is set (default)

1 = CHG FET remains on in Sleep Mode if the **[NR]** bit is set

Related Variables:

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

CSYNC —Enables the bq20z90-V110 to write *RemainingCapacity* equal to *FullChargeCapacity* when a valid charge termination is detected.

0 = *RemainingCapacity* is not modified on valid primary charge termination

1 = *RemainingCapacity* is written to equal *FullChargeCapacity* on valid primary charge termination. (default)

Related Variables:

SBS:RemainingCapacity(0x0f)

SBS:FullChargeCapacity(0x10)

CHGTERM —This bit enables or disables the **[TCA]** and **[FC]** flags in *BatteryStatus* to be cleared after charge termination is confirmed.

0 = **[TCA]** and **[FC]** are not cleared by primary charge termination confirmation, but are cleared by other means. (default)

1 = **[TCA]** and **[FC]** flags are cleared on valid primary charge termination. Note: This does not disable clearing the flags by **TCA Clear %** and **FC Clear %**.

Related Variables:

DF:Charge Control:Termination Cfg(36):Taper Current(2)

DF:Charge Control:Termination Cfg(36):Current Taper Window(8)

DF:Charge Control:Termination Cfg(36):TCA Clear %(10)

DF:Charge Control:Termination Cfg(36):FC Clear %(12)

SBS:Current(0x0a)

SBS:BatteryStatus(0x16)[FC],[TCA]

CCT —This bit sets the formula for updating *Cycle Count*.

0 = The bq20z90-V110 uses the **CC Threshold** value. (default)

1 = The bq20z90-V110 uses **CC %** of *FullChargeCapacity*.

Related Variables:

DF:SBS Configuration:Data(48):Cycle Count(16)

DF:SBS Configuration:Data(48):CC Threshold(18)

DF:SBS Configuration Data(48):CC %(18\20)

SBS:FullChargeCapacity(0x10)

CHGSUSP — This bit enables the bq20z90-V110 to turn off the CHG FET (and ZVCHG FET) when in charge suspend mode.

0 = No FETs change in Charge Suspend mode. (default)

1 = CHG FET and ZVCHG FET (if used) turn off in Charge Suspend mode.

OTFET — This bit enables or disables FET actions from reacting to an overtemperature fault.

0 = There is NO FET action when an overtemperature condition is detected.

1 = When the *[OTC]* flag is set, then the CHG FET is turned off, and when the *[OTD]* flag is set, then the DSG FET is turned off. (default)

Related Variables:

SBS:SafetyStatus(0x51)[OTC],[OTD]

CHGFET — This bit enables or disables the CHG FET from reacting to a valid charge termination.

0 = CHG FET stays on at charge termination(*[TCA]* is set). (default)

1 = CHG FET turns off at charge termination.

Related Variables:

SBS:BatteryStatus(0x16)[TCA]

CHGIN — This bit enables the CHG FET and ZVCHG FET (if used) to turn off when the bq20z90-V110 is in charge-inhibit mode.

0 = No FET change in charge-inhibit mode. (default)

1 = CHG and ZVCHG FETs, if used, turn off in charge-inhibit mode.

Related Variables:

SBS:ChargingStatus(0x55)[XCHG]

NR — This bit configures the bq20z90-V110 to be in removable or non-removable battery mode and determines the recovery method for current based Primary Protection features.

0 = Removable battery mode. (default)

1 = Non-removable battery mode.

Related Variables:

DF:Configuration:Registers(64): Non-Removable Cfg(8)

Configuration

CPE — This bit enables or disables PEC transmissions to the smart-battery charger for master-mode alarm messages.

0 = No PEC byte on alarm warning to charger (default)

1 = PEC byte on alarm warning to charger

HPE — This bit enables or disables PEC transmissions to the smart-battery host for master-mode alarm messages and prevents receiving communications from all sources in slave mode. If the host uses PEC this bit should be set.

0 = No PEC byte on alarm warning to host and receiving communications from all sources in slave mode (default)

1 = PEC byte on alarm warning to host and receiving communications from all sources in slave mode. If host uses PEC this bit should be set.

BCAST — This bit enables or disables SBS broadcasts to the smart-battery charger and host.

0 = Broadcasts to host and charger disabled (default)

1 = Broadcasts to host and charger enabled

C.7.1.3 Operation Cfg C (Offset 4)

This register determines the method in which *RelativeStateOfCharge* is updated to 100% when charging is complete.

Table C-153. Operation Cfg C

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
64	Configuration	4	Operation Cfg C	hex	2	0x0000	0x0001	0x0000	

Related Variables:

- SBS:RelativeStateOfCharge(0x0d)

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
High Byte	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD
Low Byte	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	PRE_ZT_P F_En	RSOCL

LEGEND: RSVD = Reserved and **must** be programmed to 0

Figure C-8. Operation Cfg C

PRE_ZT_PF_En — This bit enables or disables permanent failures from occurring before Impedance Tracking is enabled.

0 = All PFs (except DFF) are prevented from occurring until Impedance Tracking is enabled. Shutdown is also disabled.

1 = All PFs are allowed regardless of whether Impedance Tracking has been enabled or not.

RSOCL — This bit determines the method in which *RelativeStateOfCharge* and *RemainingCapacity* are updated to 100% when charging is complete.

0 = 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%.

1 = 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.

Related Variables:

- SBS:Voltage(0x09)
- SBS:RelativeStateOfCharge(0x0d)
- SBS:RemainingCapacity(0x0f)
- SBS:FullChargeCapacity(0x10)
- DF:Charge Control:Fast Charge Cfg(34):Charging Voltage(2)
- DF:Charge Control:Termination Cfg.(36):Taper Current(2)
- DF:Charge Control:Termination Cfg.(36):Taper Voltage(6)
- DF:Charge Control:Termination Cfg.(36):Current Taper Window(8)

C.7.1.4 Permanent Fail Cfg (Offset 6)

The **Permanent Fail Cfg** register enables or disables the use of the SAFE pin when the corresponding permanent fail error occurs. If the SAFE pin is driven high **Fuse Flag** is set to 0x3672.

Table C-154. Permanent Fail Cfg

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
64	Configuration	6	Permanent Fail Cfg	hex	2	0x0000	0x5fff	0x0000	

Related Variables:

- DF:PF Status:Device Status Data(96):PF Flags1(0)
- DF:PF Status:Device Status Data(96):Fuse Flag(2)

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
High Byte	RSVD	XPFVSHU T	RSVD	XSOPT	XSOCD	XSOCC	XAFE_P	XAFE_C
Low Byte	XDFE	XDFETF	XCFETF	XCIM	XSOTD	XSOTC	XSOV	XPFIN

LEGEND: RSVD = Reserved and **must** be programmed to 0

Figure C-9. Permanent Fail Cfg

XPFVSHUT — If this bit is set AND any permanent failure happens AND the bq20z90-V110 goes into shutdown the SAFE pin is driven high.

Related Variables:

DF:PF Status:Device Status Data(96):PF Flags1(0)[SOPT]

XSOPT —If this bit is set AND an open thermistor permanent failure occurs the SAFE pin is driven high.

Related Variables:

DF:PF Status:Device Status Data(96):PF Flags1(0)[SOPT]

XSOCD —If this bit is set AND a discharge safety overcurrent permanent failure occurs the SAFE pin is driven high.

Related Variables:

DF:PF Status:Device Status Data(96):PF Flags1(0)[SOCD]

XSOCC —If this bit is set AND a charge safety overcurrent failure occurs the SAFE pin is driven high.

Related Variables:

DF:PF Status:Device Status Data(96):PF Flags1(0)[SOCC]

XAFE_P —If this bit is set AND a periodic AFE-communications permanent failure occurs the SAFE pin is driven high.

Related Variables:

DF:PF Status:Device Status Data(96):PF Flags1(0)[AFE_P]

XAFE_C —If this bit is set AND an AFE-communications permanent failure occurs the SAFE pin is driven high.

Related Variables:

DF:PF Status:Device Status Data(96):PF Flags1(0)[AFE_C]

XDFF —If this bit is set AND a Data Flash fault permanent failure occurs the SAFE pin is driven high.

Related Variables:

DF:PF Status:Device Status Data(96):PF Flags1(0)[DFF]

XDFETF —If this bit is set AND a DSG FET permanent failure occurs the SAFE pin is driven high.

Related Variables:

DF:PF Status:Device Status Data(96):PF Flags1(0)[DFETF]

XCFETF —If this bit is set AND a CHG FET permanent failure occurs the SAFE pin is driven high.

Related Variables:

DF:PF Status:Device Status Data(96):PF Flags1(0)[CFETF]

XCIM —If this bit is set AND a cell imbalance permanent failure occurs the SAFE pin is driven high.

Related Variables:

DF:PF Status:Device Status Data(96):PF Flags1(0)[CIM]

XSOTD —If this bit is set AND a discharge overtemperature permanent failure occurs the SAFE pin is driven high.

Related Variables:

DF:PF Status:Device Status Data(96):PF Flags1(0)[SOTD]

XSOTC —If this bit is set AND a charge overtemperature permanent failure occurs the SAFE pin is driven high.

Related Variables:

DF:PF Status:Device Status Data(96):PF Flags1(0)[SOTC]

XSOV —If this bit is set AND a safety overvoltage permanent failure occurs the SAFE pin is driven high.

Related Variables:

DF:PF Status:Device Status Data(96):PF Flags1(0)[SOV]

XPFIN —If this bit is set AND an external input indication permanent failure occurs the SAFE pin is driven high.

Related Variables:

DF:PF Status:Device Status Data(96):PF Flags1(0)[PFIN]

C.7.1.5 Non-Removable Cfg (Offset 8)

If the bq20z90-V110 is in removable battery mode (**[NR]** = 0) these bits sets the recovery method from 1st level security errors. If the corresponding bit is set it gives an additional recovery option for the particular fault. If **[NR]** is set to 1 this register has no effect.

Table C-155. Non Removable Cfg

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
64	Configuration	8	Non-Removable Cfg	hex	2	0x0000	0x3b17	0x0000	

Related Variables:

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

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
High Byte	RSVD	RSVD	OCD	OCC	OCD2	OCC2	RSVD	RSVD
Low Byte	RSVD	RSVD	OC	RSVD	RSVD	AOCD	SCC	SCD

LEGEND: RSVD = Reserved and **must** be programmed to 0

Figure C-10. Non-Removable Cfg

- OCD** — Overcurrent in Discharge
- OCC** — Overcurrent in Charge
- OCD2** — Overcurrent in Discharge - Tier 2
- OCC2** — Overcharge
- OC** — Overcurrent in Charge - Tier 2
- AOCD** — AFE Overcurrent in Discharge
- SCC** — Short Circuit in Charge
- SCD** — Short Circuit in Discharge

C.8 LED Support

C.8.1 LED Cfg (Subclass 67)

C.8.1.1 LED Flash Rate (Offset 0)

This value sets the LED flashing time period at a 50% duty cycle for alarm conditions.

Table C-156. LED Flash Rate

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
67	LED Cfg	0	LED Flash Rate	unsigned integer	2	0	65535	512	500μSec

Related Variables:

- DF:LED Support:LED Cfg(67):LED Hold Time(6)

C.8.1.2 LED Blink Rate (Offset 2)

This value sets the LED blinking time period to a 50% duty cycle for the LED indicating the highest actual charge of the battery.

Table C-157. LED Blink Rate

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
67	LED Cfg	2	LED Blink Rate	unsigned integer	2	0	65535	1024	500μSec

Related Variables:

- DF:LED Support:LED Cfg(67):LED Hold Time(6)

C.8.1.3 LED Delay (Offset 4)

This value sets the activation delay time from one LED to the next LED after the display is activated.

Table C-158. LED Delay

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
67	LED Cfg	4	LED Delay	unsigned integer	2	1	65535	100	500μSec

Related Variables:

- DF:LED Support:LED Cfg(67):LED Hold Time(6)

C.8.1.4 LED Hold Time (Offset 6)

This value sets the time the LED stays on after all LEDs required to indicate the state of charge are being activated.

Table C-159. LED Hold Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
67	LED Cfg	6	LED Hold Time	unsigned integer	1	0	255	4	Sec

Related Variables:

- DF:LED Support:LED Cfg(67):LED Delay(4)

C.8.1.5 CHG Flash Alarm (Offset 7)

If the bq20z90-V110 is in charge mode ($[DSG] = 0$) and the battery charge is below this threshold the remaining enabled LEDs start flashing at **LED Flash Rate**. Set to -1 to disable this feature.

Table C-160. CHG Flash Alarm

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
67	LED Cfg	7	CHG Flash Alarm	signed integer	1	-1	101	10	%

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[DMODE],[LED1],[LED0]
- DF:LED Support:LED Cfg(67):LED Flash Rate(0)
- SBS:RelativeStateOfCharge(0x0d)
- SBS:AbsoluteStateOfCharge(0x0e)
- SBS:BatteryStatus(0x16)[DSG]

C.8.1.6 CHG Thresh 1 (Offset 8)

If the bq20z90-V110 is in charge mode ($[DSG] = 0$) and the battery charge is below this threshold LED 1 is disabled.

Table C-161. CHG Thresh 1

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
67	LED Cfg	8	CHG Thresh 1	signed integer	1	-1	101	0	%

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[DMODE],[LED1],[LED0]
- SBS:RelativeStateOfCharge(0x0d)
- SBS:AbsoluteStateOfCharge(0x0e)
- SBS:BatteryStatus(0x16)[DSG]

C.8.1.7 CHG Thresh 2 (Offset 9)

If the bq20z90-V110 is in charge mode ($[DSG] = 0$) and the battery charge is below this threshold LED 2 is disabled.

Table C-162. CHG Thresh 2

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
67	LED Cfg	9	CHG Thresh 2	signed integer	1	-1	101	20	%

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[DMODE],[LED1],[LED0]
- SBS:RelativeStateOfCharge(0x0d)
- SBS:AbsoluteStateOfCharge(0x0e)
- SBS:BatteryStatus(0x16)[DSG]

C.8.1.8 CHG Thresh 3 (Offset 10)

If the bq20z90-V110 is in charge mode ($[DSG] = 0$) and the battery charge is below this threshold LED 3 is disabled.

Table C-163. CHG Thresh 3

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
67	LED Cfg	10	CHG Thresh 3	signed integer	1	-1	101	40	%

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[DMODE],[LED1],[LED0]
- SBS:RelativeStateOfCharge(0x0d)
- SBS:AbsoluteStateOfCharge(0x0e)
- SBS:BatteryStatus(0x16)[DSG]

C.8.1.9 CHG Thresh 4 (Offset 11)

If the bq20z90-V110 is in charge mode ($[DSG] = 0$) and the battery charge is below this threshold LED 4 is disabled.

Table C-164. CHG Thresh 4

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
67	LED Cfg	11	CHG Thresh 4	signed integer	1	-1	101	60	%

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[DMODE],[LED1],[LED0]
- SBS:RelativeStateOfCharge(0x0d)
- SBS:AbsoluteStateOfCharge(0x0e)
- SBS:BatteryStatus(0x16)[DSG]

C.8.1.10 CHG Thresh 5 (Offset 12)

If the bq20z90-V110 is in charge mode ($[DSG] = 0$) and the battery charge is below this threshold LED 5 is disabled.

Related Variables:

Table C-165. CHG Thresh 5

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
67	LED Cfg	12	CHG Thresh 5	signed integer	1	-1	101	80	%

- DF:Configuration:Registers(64):Operation Cfg A(0)[DMODE],[LED1],[LED0]
- SBS:RelativeStateOfCharge(0x0d)
- SBS:AbsoluteStateOfCharge(0x0e)
- SBS:BatteryStatus(0x16)[DSG]

C.8.1.11 DSG Flash Alarm (Offset 13)

If the bq20z90-V110 is in discharge mode ($[DSG] = 1$) and the battery charge is below this threshold the remaining enabled LEDs start flashing with **LED Flash Rate**. Set to -1% to disable this feature.

Table C-166. DSG Flash Alarm

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
67	LED Cfg	13	DSG Flash Alarm	signed integer	1	-1	101	10	%

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[DMODE],[LED1],[LED0]
- SBS:RelativeStateOfCharge(0x0d)
- SBS:AbsoluteStateOfCharge(0x0e)
- SBS:BatteryStatus(0x16)[DSG]

C.8.1.12 DSG Thresh 1 (Offset 14)

If the bq20z90-V110 is in discharge mode ($[DSG] = 1$) and the battery charge is below this threshold LED 1 is disabled.

Table C-167. DSG Thresh 1

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
67	LED Cfg	14	DSG Thresh 1	signed integer	1	-1	101	0	%

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[DMODE],[LED1],[LED0]
- SBS:RelativeStateOfCharge(0x0d)
- SBS:AbsoluteStateOfCharge(0x0e)
- SBS:BatteryStatus(0x16)[DSG]

C.8.1.13 DSG Thresh 2 (Offset 15)

If the bq20z90-V110 is in discharge mode ($[DSG] = 1$) and the battery charge is below this threshold LED 2 is disabled.

Table C-168. DSG Thresh 2

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
67	LED Cfg	15	DSG Thresh 2	signed integer	1	-1	101	20	%

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[DMODE],[LED1],[LED0]
- SBS:RelativeStateOfCharge(0x0d)
- SBS:AbsoluteStateOfCharge(0x0e)
- SBS:BatteryStatus(0x16)[DSG]

C.8.1.14 DSG Thresh 3 (Offset 16)

If the bq20z90-V110 is in discharge mode ($[DSG] = 1$) and the battery charge is below this threshold LED 3 is disabled.

Table C-169. DSG Thresh 3

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
67	LED Cfg	16	DSG Thresh 3	signed integer	1	-1	101	40	%

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[DMODE],[LED1],[LED0]
- SBS:RelativeStateOfCharge(0x0d)
- SBS:AbsoluteStateOfCharge(0x0e)
- SBS:BatteryStatus(0x16)[DSG]

C.8.1.15 DSG Thresh 4 (Offset 17)

If the bq20z90-V110 is in discharge mode ($[DSG] = 1$) and the battery charge is below this threshold LED 4 is disabled.

Table C-170. DSG Thresh 4

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
67	LED Cfg	17	DSG Thresh 4	signed integer	1	-1	101	60	%

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[DMODE],[LED1],[LED0]
- SBS:RelativeStateOfCharge(0x0d)
- SBS:AbsoluteStateOfCharge(0x0e)
- SBS:BatteryStatus(0x16)[DSG]

C.8.1.16 DSG Thresh 5 (Offset 18)

If the bq20z90-V110 is in discharge mode ($[DSG] = 1$) and the battery charge is below this threshold LED 5 is disabled.

Table C-171. DSG Thresh 5

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
67	LED Cfg	18	DSG Thresh 5	signed integer	1	-1	101	80	%

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[DMODE],[LED1],[LED0]
- SBS:RelativeStateOfCharge(0x0d)
- SBS:AbsoluteStateOfCharge(0x0e)
- SBS:BatteryStatus(0x16)[DSG]

C.8.1.17 Sink Current (Offset 19)

The sink current setting of the LED inputs to the bq20z90-V110 can be programmed with the following settings. All of the LEDs are programmed with the same current level.

Table C-172. Sink Current

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
67	LED Cfg	19	Sink Current	unsigned integer	1	0x00	0x03	0x03	

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
Low Byte	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	ILED1	ILED0

LEGEND: RSVD = Reserved and **must** be programmed to 0

Figure C-11. Sink Current

Table C-173. Sink Current Configuration

ILED1	ILED0	Sink Current
0	0	0 mA
0	1	3 mA
1	0	4 mA
1	1	5 mA (default)

C.9 Power

C.9.1 Power (Subclass 68)

C.9.1.1 Flash Update OK Voltage (Offset 0)

This value sets the minimum allowed battery pack voltage for a flash update. If the battery pack *Voltage* is below this threshold no flash update will be made. If a charger is detected with **Charger Present** then **Flash Update OK Voltage** is bypassed and the flash can be updated.

Table C-174. Flash Update OK Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
68	Power	0	Flash Update OK Voltage	unsigned integer	2	6000	20000	7500	mV

Related Variables:

- DF:Power:Power(68):Charger Present(5)
- SBS:Voltage(0x09)

C.9.1.2 Shutdown Voltage (Offset 2)

The bq20z90-V110 goes into shutdown mode if the battery pack *Voltage* is equal to or less than **Shutdown Voltage** for **Shutdown Time** and has been out of shutdown mode for at **Shutdown Time**.

Table C-175. Shutdown Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
68	Power	2	Shutdown Voltage	unsigned integer	2	5000	20000	7000	mV

Related Variables:

- DF:Power:Power(68):Shutdown Time(4)
- SBS:Voltage(0x09)

C.9.1.3 Shutdown Time (Offset 4)

The bq20z90-V110 goes into shutdown mode if the battery pack *Voltage* is equal to or less than **Shutdown Voltage** for **Shutdown Time** and has been out of shutdown mode for at **Shutdown Time**.

Table C-176. Shutdown Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
68	Power	4	Shutdown Time	unsigned integer	1	0	240	10	Sec

Related Variables:

- DF:Power:Power(68):Shutdown Voltage(2)
- SBS:Voltage(0x09)

C.9.1.4 Charger Present (Offset 5)

The bq20z90-V110 detects a charger when the voltage at the PACK pin of the q29330 is above the **Charger Present** threshold. If a charger is detected it overrides **Flash Update OK Voltage** and the flash can be updated.

Table C-177. Charger Present

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
68	Power	5	Charger Present	unsigned integer	2	0	23000	3000	mV

Related Variables:

- DF:Power:Power(68):Flash Update OK Voltage(0)
- SBS:PackVoltage(0x5a)

C.9.1.5 Sleep Current (Offset 7)

The bq20z90-V110 is allowed to go into sleep mode if the charge or discharge current is below **Sleep Current**. Sleep mode can be enabled with the **[SLEEP]** bit. If the absolute value of *Current* is above **Sleep Current** the bq20z90-V110 will return to normal mode.

Table C-178. Sleep Current

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
68	Power	7	Sleep Current	unsigned integer	2	0	100	10	mA

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[SLEEP]
- DF:Power:Power(68):Bus Low Time(9)
- SBS:ManufacturerAccess(0x00):Sleep(0x0011)
- SBS:Current(0x0a)

C.9.1.6 Bus Low Time (Offset 9)

The bq20z90-V110 is allowed to go into sleep mode if it is enabled with the **[SLEEP]** bit if the SMBus lines are low for a period greater than **Bus Low Time**.

Table C-179. Bus low Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
68	Power	9	Bus Low Time	unsigned integer	1	0	255	5	Sec

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[SLEEP]
- DF:Power:Power(68):Sleep Current(7)

C.9.1.7 Cal Inhibit Temp Low (Offset 10)

The bq20z90-V110 does not perform auto-calibration on entry to sleep mode if *Temperature* is below **Cal Inhibit Temp Low** or above **Cal Inhibit Temp High**.

Table C-180. Cal Inhibit Temp Low

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
68	Power	10	Cal Inhibit Temp Low	signed integer	2	-400	1200	50	0.1°C

Related Variables:

- DF:Power:Power(68):Cal Inhibit Temp High(12)
- SBS:Temperature(0x08)

C.9.1.8 Cal Inhibit Temp High (Offset 12)

The bq20z90-V110 does not perform auto-calibration on entry to sleep mode if *Temperature* is below **Cal Inhibit Temp Low** or above **Cal Inhibit Temp High**.

Table C-181. Cal Inhibit Temp High

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
68	Power	12	Cal Inhibit Temp High	signed integer	2	-400	1200	450	0.1°C

Related Variables:

- DF:Power:Power(68):Cal Inhibit Temp Low(10)
- SBS:Temperature(0x08)

C.9.1.9 Sleep Voltage Time (Offset 14)

During sleep mode temperature and voltage measurements will be taken in **Sleep Voltage Time** intervals.

Table C-182. Sleep Voltage Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
68	Power	14	Sleep Voltage Time	unsigned integer	1	0	240	5	Sec

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[SLEEP]
- SBS:Temperature(0x08)
- SBS:Voltage(0x09)
- SBS:CellVoltage4(0x3c)
- SBS:CellVoltage3(0x3d)
- SBS:CellVoltage2(0x3e)
- SBS:CellVoltage1(0x3f)

C.9.1.10 Sleep Current Time (Offset 15)

During sleep mode current will be measured in *Sleep Current Time* intervals.

Table C-183. Sleep Current Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
68	Power	15	Sleep Current Time	unsigned integer	1	0	255	20	Sec

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[SLEEP]
- SBS:Current(0x0a)

C.9.1.11 Wake Current Reg (Offset 16)

Wake Current Reg configures the current threshold required to wake the bq20z90-V110 from sleep mode by detecting voltage across SRP and SRN.

Table C-184. Wake Current Reg

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
68	Power	16	Wake Current Reg	hex	1	0x00	0x07	0x00	

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
Low Byte	RSVD	RSVD	RSVD	RSVD	RSVD	IWAKE	RSNS1	RSNS0

LEGEND: RSVD = Reserved and **must** be programmed to 0

Figure C-12. Wake Current Reg

IWAKE — This bit sets the current threshold for the Wake function.

0 = 0.5A (or if RSNS0=RSNS1=0 then this function is disabled)

1 = 1.0A (or if RSNS0=RSNS1=0 then this function is disabled)

Table C-185. Wake Current Reg

RSNS1	RSNS0	Resistance
0	0	Disabled (default)
0	1	2.5 mΩ
1	0	5 mΩ

Table C-185. Wake Current Reg (continued)

RSNS1	RSNS0	Resistance
1	1	10mΩ

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[SLEEP]
- SBS:Current(0x0a)

C.10 Gas Gauging

C.10.1 IT Cfg (Offset 80)

C.10.1.1 Load Select (Offset 0)

This value defines the load compensation model used by the Impedance Track™ algorithm for the *RemainingCapacity* calculation.

Constant Current (Load Mode = 0)

- 0 = **Avg I Last Run**
- 1 = present average discharge current
- 2 = *Current*
- 3 = *AverageCurrent* (default)
- 4 = **Design Capacity / 5**
- 5 = *AtRate* (mA)
- 6 = **User Rate-mA**

Constant Power (Load Mode = 1)

- Avg P Last Run**
- present average discharge power
- Current x Voltage*
- AverageCurrent x average Voltage*
- Design Energy / 5**
- AtRate* (10 mW)
- User Rate-10mW**

Table C-186. Load Select

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
80	IT Cfg	0	Load Select	unsigned integer	1	0	255	3	

Related Variables:

- DF:SBS Configuration:Data(48):Design Capacity(22)
- DF:SBS Configuration:Data(48):Design Energy(24)
- DF:Gas Gauging:IT Cfg(80):Load Mode(1)
- DF:Gas Gauging:IT Cfg(80):User Rate-mA(60)
- DF:Gas Gauging:IT Cfg(80):User Rate-10mW(62)
- DF:Gas Gauging:State(82):Avg I Last Run(21)
- DF:Gas Gauging:State(82):Avg P Last Run(23)
- SBS.BatteryMode(0x03)[CapM]
- SBS:AtRate(0x04)
- SBS:Voltage(0x09)
- SBS:Current(0x0a)
- SBS:AverageCurrent(0x0b)
- SBS:RemainingCapacity(0x0f)

C.10.1.2 Load Mode (Offset 1)

This value defines the load mode used by the Impedance Track™ algorithm for the *RemainingCapacity* calculation.

- 0 = Constant Current (default)
- 1 = Constant Power

Table C-187. Load Mode

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
80	IT Cfg	1	Load Mode	unsigned integer	1	0	255	0	

Related Variables:

- DF:Gas Gauging:IT Cfg(80):Load Select(0)
- SBS:RemainingCapacity(0x0f)

C.10.1.3 Term Voltage (Offset 45)

This value is the absolute minimum pack voltage used by the Impedance Track™ algorithm for a capacity calculation and should also be set to the absolute minimum pack voltage used by the application. The reserve capacity function also reserves charge where zero *RemainingCapacity* is reported and the **Term Voltage** is reached.

Table C-188. Term Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
80	IT Cfg	45	Term Voltage	signed integer	2	-32768	32767	12000	mV

Related Variables:

- DF:Gas Gauging:IT Cfg(80):Reserve Cap-mAh(64)
- DF:Gas Gauging:IT Cfg(80):Reserve Cap-mWh(66)
- SBS:Voltage(0x09)
- SBS:RemainingCapacity(0x0f)

C.10.1.4 User Rate-mA (Offset 60)

This value specifies the discharge rate used by the Impedance Track™ algorithm for the *RemainingCapacity* calculation if selected by **Load Select**.

Table C-189. User Rate-mA

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
80	IT Cfg	60	User Rate-mA	signed integer	2	2000	9000	0	mA

Related Variables:

- DF:Gas Gauging:IT Cfg(80):Load Select(0)
- DF:Gas Gauging:IT Cfg(80):Load Mode(1)
- SBS:RemainingCapacity(0x0f)

C.10.1.5 User Rate-10mW (Offset 62)

This value specifies the discharge rate in 10 mW used by the Impedance Track™ algorithm for the *RemainingCapacity* calculation if selected by **Load Select**.

Table C-190. User Rate-mW

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
80	IT Cfg	62	User Rate-10mW	signed integer	2	3000	14000	0	10 mW

Related Variables:

- DF:Gas Gauging:IT Cfg(80):Load Select(0)
- DF:Gas Gauging:IT Cfg(80):Load Mode(1)
- SBS:RemainingCapacity(0x0f)

C.10.1.6 Reserve Cap-mAh (Offset 64)

This value reserves an amount of charge, in mAh, ($[CapM] = 0$) for the system to react if the *RemainingCapacity* reports zero energy remaining in the battery. The **Reserve Cap-mAh** reserves an amount of charge between when the final **Term Voltage** is reached and the *RemainingCapacity* reports zero energy. The *FullChargeCapacity* function reports the internal full charge capacity - **Reserve Cap-mAh**.

Table C-191. Reserve Cap-mAh

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
80	IT Cfg	64	Reserve Cap-mAh	signed integer	2	0	9000	0	mAh

Related Variables:

- DF:Gas Gauging:IT Cfg(80):Load Mode(1)
- DF:Gas Gauging:IT Cfg(80):Term Voltage(45)
- DF:Configuration:Registers(64):Operation Cfg B(2)[RESCAP]
- SBS:BatteryMode(0x03):[CapM]
- SBS:RemainingCapacity(0x0f)
- SBS:FullChargeCapacity(0x10)

C.10.1.7 Reserve Cap-mWh (Offset 66)

This value reserves an amount of charge in, 10 mWh, ($[CapM] = 1$) for the system to react if the *RemainingCapacity* reports zero energy remaining in the battery. The **Reserve Cap-mWh** reserves an amount of charge between when the final **Term Voltage** is reached and the *RemainingCapacity* reports zero energy. The *FullChargeCapacity* function reports the internal full charge capacity - **Reserve Cap-mWh**.

Table C-192. Reserve Cap-mAh

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
80	IT Cfg	66	Reserve Cap-mWh	signed integer	2	0	14000	0	10 mWh

Related Variables:

- DF:Gas Gauging:IT Cfg(80):Load Mode(1)
- DF:Gas Gauging:IT Cfg(80):Term Voltage(45)
- DF:Configuration:Registers(64):Operation Cfg B(2)[RESCAP]
- SBS:BatteryMode(0x03):[CapM]

- SBS:RemainingCapacity(0x0f)
- SBS:FullChargeCapacity(0x10)

C.10.2 Current Thresholds (Offset 81)

C.10.2.1 Dsg Current Threshold (Offset 0)

The bq20z90-V110 enters discharge mode from relaxation mode or charge mode if *Current* < (-) **Dsg Current Threshold**.

Table C-193. Dsg Current Threshold

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
81	Current Thresholds	0	Dsg Current Threshold	unsigned integer	2	0	2000	100	mA

Related Variables:

- SBS:Current(0x0a)
- SBS:BatteryStatus(0x16)[DSG]

C.10.2.2 Chg Current Threshold (Offset 2)

The bq20z90-V110 enters charge mode from relaxation mode or discharge mode if *Current* > **Chg Current Threshold**.

Table C-194. Chg Current Threshold

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
81	Current Thresholds	2	Chg Current Threshold	unsigned integer	2	0	2000	50	mA

Related Variables:

- SBS:Current(0x0a)
- SBS:BatteryStatus(0x16)[DSG]

C.10.2.3 Quit Current (Offset 4)

The bq20z90-V110 enters relaxation mode from charge mode if *Current* goes below **Quit Current** for **Chg Relax Time**. The bq20z90-V110 enters relaxation mode from discharge mode if *Current* goes above (-)**Quit Current** for **Dsg Relax Time**.

Table C-195. Quit Current

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
81	Current Thresholds	4	Quit Current	unsigned integer	2	0	1000	10	mA

Related Variables:

- DF:Gas Gauging:Current Thresholds(81):Dsg Relax Time(6)
- DF:Gas Gauging:Current Thresholds(81):Chg Relax Time(7)
- SBS:Current(0x0a)
- SBS:BatteryStatus(0x16)[DSG]

C.10.2.4 Dsg Relax Time (Offset 6)

The bq20z90-V110 enters relaxation mode from discharge mode if *Current* goes above **(-)Quit Current** for at least **Dsg Relax Time**.

Table C-196. Dsg Relax Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
81	Current Thresholds	6	Dsg Relax Time	unsigned integer	1	0	255	1	Sec

Related Variables:

- DF:Gas Gauging:Current Thresholds(81):Quit Current(4)
- SBS:Current(0x0a)
- SBS:BatteryStatus(0x16)[DSG]

C.10.2.5 Chg Relax Time (Offset 7)

The bq20z90-V110 enters relaxation mode from charge mode if *Current* goes below **Quit Current** for at least **Chg Relax Time**.

Table C-197. Chg Relax Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
81	Current Thresholds	7	Chg Relax Time	unsigned integer	1	0	255	60	Sec

Related Variables:

- DF:Gas Gauging:Current Thresholds(81):Quit Current(4)
- SBS:Current(0x0a)
- SBS:BatteryStatus(0x16)[DSG]

C.10.3 State (Offset 82)

C.10.3.1 Qmax Cell 0..3 (Offset 0..6)

These values define the maximum chemical capacity for each cell used for the capacity calculation. The value should be taken directly from the battery cell datasheet.

Table C-198. Qmax Cell 0..3

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
82	State	0	Qmax Cell 0	unsigned integer	2	0	32767	4400	mAh
		2	Qmax Cell 1		2	0	32767	4400	mAh
		4	Qmax Cell 2		2	0	32767	4400	mAh
		6	Qmax Cell 3		2	0	32767	4400	mAh

Related Variables:

- DF:Gas Gauging:State(82):Qmax Pack(8)
- SBS:OperationStatus(0x54)[QEN]

C.10.3.2 Qmax Pack (Offset 8)

This value defines the maximum chemical capacity of the battery pack. It usually gets set to the smallest value of **Qmax Cell 0 .. 3**.

Table C-199. Qmax Pack

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
82	State	8	Qmax Pack	unsigned integer	2	0	32767	4400	mAh

Related Variables:

- DF:Gas Gauging:State(82):Qmax Cell 0(0)
- DF:Gas Gauging:State(82):Qmax Cell 1(2)
- DF:Gas Gauging:State(82):Qmax Cell 2(4)
- DF:Gas Gauging:State(82):Qmax Cell 3(6)
- SBS:OperationStatus(0x54)[QEN]

C.10.3.3 Update Status (Offset 12)

It is recommended to use *ManufacturerAccess* to enable or disable the Impedance Track™ algorithm and lifetime data updating.

0x00 = no Impedance Track™ algorithm and lifetime data updating (default)

0x02 = QMAX updated

0x04 = Impedance Track™ algorithm and lifetime data updating

0x06 = QMAX updated + Impedance Track™ algorithm and lifetime data updating

Table C-200. Update Status

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
82	State	12	Update Status	hex	1	0x00	0x03	0x00	

Related Variables:

- SBS:ManufacturerAccess(0x00):IT Enable(0x0021)

C.10.3.4 Avg I Last Run (Offset 21)

The bq20z90-V110 calculates and stores the average discharge current from the last discharge cycle in this value. This value is used by the Impedance Track™ algorithm for the *RemainingCapacity* calculation. It is not recommended to change this value.

Table C-201. Avg I Last Run

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
82	State	21	Avg I Last Run	signed integer	2	-32768	32767	-2000	mA

Related Variables:

- DF:Gas Gauging:IT Cfg(80):Load Select(0)
- DF:Gas Gauging:IT Cfg(80):Load Mode(1)
- SBS:RemainingCapacity(0x0f)

C.10.3.5 Avg P Last Run (Offset 23)

The bq20z90-V110 calculates and stores the average discharge power from the last discharge cycle in this value. This value is used by the Impedance Track™ algorithm for the *RemainingCapacity* calculation. It is not recommended to change this value.

Table C-202. Avg P Last Run

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
82	State	23	Avg P Last Run	signed integer	2	-32768	32767	-3022	10 mW

Related Variables:

- DF:Gas Gauging:IT Cfg(80):Load Select(0)
- DF:Gas Gauging:IT Cfg(80):Load Mode(1)
- SBS:RemainingCapacity(0x0f)

C.10.3.6 Delta Voltage (Offset 25)

The bq20z90-V110 stores the maximum difference of *Voltage* during short load spikes and normal loads so the Impedance Track™ algorithm can calculate the *RemainingCapacity* for pulsed loads. It is not recommended to change this value.

Table C-203. Delta Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
82	State	25	Delta Voltage	signed integer	2	-32768	32767	0	mV

Related Variables:

- SBS:Voltage(0x09)
- SBS:RemainingCapacity(0x0f)

C.11 Ra Table

C.11.1 R_a0 (Subclass 88)

C.11.1.1 Cell0 R_a flag (Offset 0)

This value indicates the validity of the cell impedance table for cell 0. It is recommended not to change this value.

High Byte

- 0x00 cell impedance & QMAX updated
- 0x05 relaxation mode and QMAX update in progress
- 0x55 discharge mode & cell impedance updated
- 0xff cell impedance newer updated

Low Byte

- 0x00 table not used & QMAX updated
- 0x55 table being used
- 0xff table never used, no QMAX or cell impedance update

Table C-204. Cell0 R_a flag

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
88	R_a0	0	Cell0 R_a flag	hex	2	0x0000	0xffff	0xff55	

Related Variables:

- DF:Ra Table:R_a0(88):Cell0 R_a 0..14(2..30)

C.11.1.2 Cell0 R_a 0..14 (Offset 2..30)

The bq20z90-V110 stores and updates the impedance profile for cell 0 in this table.

Table C-205. Cell0 R_a

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
88	R_a0	2	Cell0 R_a 0	signed integer	2	0	32767	160	2 ⁻¹⁰ Ω
		4	Cell0 R_a 1			0	32767	166	
		6	Cell0 R_a 2			0	32767	153	
		8	Cell0 R_a 3			0	32767	151	
		10	Cell0 R_a 4			0	32767	145	
		12	Cell0 R_a 5			0	32767	152	
		14	Cell0 R_a 6			0	32767	176	
		16	Cell0 R_a 7			0	32767	204	
		18	Cell0 R_a 8			0	32767	222	
		20	Cell0 R_a 9			0	32767	254	
		22	Cell0 R_a 10			0	32767	315	
		24	Cell0 R_a 11			0	32767	437	
		26	Cell0 R_a 12			0	32767	651	
		28	Cell0 R_a 13			0	32767	1001	
30	Cell0 R_a 14	0	32767	1458					

Related Variables:

- DF:Ra Table:R_a0(88):Cell0 R_a flag(0)

C.11.2 R_a1 (Subclass 89)
C.11.2.1 Cell1 R_a flag (Offset 0)

This value indicates the validity of the cell impedance table for cell 1. It is recommended not to change this value.

High Byte

0x00	cell impedance & QMAX updated
0x05	relaxation mode and QMAX update in progress
0x55	discharge mode & cell impedance updated
0xff	cell impedance newer updated

Low Byte

0x00	table not used & QMAX updated
0x55	table being used
0xff	table never used, no QMAX or cell impedance update

Table C-206. Cell1 R_a flag

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
89	R_a1	0	Cell1 R_a flag	hex	2	0x0000	0xffff	0xff55	

Related Variables:

- DF:Ra Table:R_a1(89):Cell1 R_a 0..14(2..30)

C.11.2.2 Cell1 R_a 0..14 (Offset 2..30)

The bq20z90-V110 stores and updates the impedance profile for cell 1 in this table.

Table C-207. Cell1 R_a

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
89	R_a1	2	Cell1 R_a 0	signed integer	2	0	32767	160	2 ¹⁰ Ω
		4	Cell1 R_a 1			0	32767	166	
		6	Cell1 R_a 2			0	32767	153	
		8	Cell1 R_a 3			0	32767	151	
		10	Cell1 R_a 4			0	32767	145	
		12	Cell1 R_a 5			0	32767	152	
		14	Cell1 R_a 6			0	32767	176	
		16	Cell1 R_a 7			0	32767	204	
		18	Cell1 R_a 8			0	32767	222	
		20	Cell1 R_a 9			0	32767	254	
		22	Cell1 R_a 10			0	32767	315	
		24	Cell1 R_a 11			0	32767	437	
		26	Cell1 R_a 12			0	32767	651	
		28	Cell1 R_a 13			0	32767	1001	
30	Cell1 R_a 14	0	32767	1458					

Related Variables:

- DF:Ra Table:R_a1(89):Cell1 R_a flag(0)

C.11.3 R_a2 (Subclass 90)

C.11.3.1 Cell2 R_a flag (Offset 0)

This value indicates the validity of the cell impedance table for cell 2. It is recommended not to change this value.

High Byte

- 0x00 cell impedance & QMAX updated
- 0x05 relaxation mode and QMAX update in progress
- 0x55 discharge mode & cell impedance updated
- 0xff cell impedance newer updated

Low Byte

- 0x00 table not used & QMAX updated
- 0x55 table being used
- 0xff table never used, no QMAX or cell impedance update

Table C-208. Cell2 R_a flag

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
90	R_a2	0	Cell2 R_a flag	hex	2	0x0000	0xffff	0xff55	

Related Variables:

- DF:Ra Table:R_a2(90):Cell2 R_a 0..14(2..30)

C.11.3.2 Cell2 R_a 0..14 (Offset 2..30)

The bq20z90-V110 stores and updates the impedance profile for cell 2 in this table.

Table C-209. Cell2 R_a

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
90	R_a2	2	Cell2 R_a 0	signed integer	2	0	32767	160	2 ⁻¹⁰ Ω
		4	Cell2 R_a 1			0	32767	166	
		6	Cell2 R_a 2			0	32767	153	
		8	Cell2 R_a 3			0	32767	151	
		10	Cell2 R_a 4			0	32767	145	
		12	Cell2 R_a 5			0	32767	152	
		14	Cell2 R_a 6			0	32767	176	
		16	Cell2 R_a 7			0	32767	204	
		18	Cell2 R_a 8			0	32767	222	
		20	Cell2 R_a 9			0	32767	254	
		22	Cell2 R_a 10			0	32767	315	
		24	Cell2 R_a 11			0	32767	437	
		26	Cell2 R_a 12			0	32767	651	
		28	Cell2 R_a 13			0	32767	1001	
30	Cell2 R_a 14	0	32767	1458					

Related Variables:

- DF:Ra Table:R_a2(90):Cell2 R_a flag(0)

C.11.4 R_a3 (Subclass 91)
C.11.4.1 Cell3 R_a flag (Offset 0)

This value indicates the validity of the cell impedance table for cell 3. It is recommended not to change this value.

High Byte

0x00	cell impedance & QMAX updated
0x05	relaxation mode and QMAX update in progress
0x55	discharge mode & cell impedance updated
0xff	cell impedance newer updated

Low Byte

0x00	table not used & QMAX updated
0x55	table being used
0xff	table never used, no QMAX or cell impedance update

Table C-210. Cell3 R_a flag

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
91	R_a3	0	Cell3 R_a flag	hex	2	0x0000	0xffff	0xff55	

Related Variables:

- DF:Ra Table:R_a3(91):Cell3 R_a 0..14(2..30)

C.11.4.2 Cell3 R_a 0..14 (Offset 2..30)

The bq20z90-V110 stores and updates the impedance profile for cell 3 in this table.

Table C-211. Cell3 R_a

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
91	R_a3	2	Cell3 R_a 0	signed integer	2	0	32767	160	2 ⁻¹⁰ Ω
		4	Cell3 R_a 1			0	32767	166	
		6	Cell3 R_a 2			0	32767	153	
		8	Cell3 R_a 3			0	32767	151	
		10	Cell3 R_a 4			0	32767	145	
		12	Cell3 R_a 5			0	32767	152	
		14	Cell3 R_a 6			0	32767	176	
		16	Cell3 R_a 7			0	32767	204	
		18	Cell3 R_a 8			0	32767	222	
		20	Cell3 R_a 9			0	32767	254	
		22	Cell3 R_a 10			0	32767	315	
		24	Cell3 R_a 11			0	32767	437	
		26	Cell3 R_a 12			0	32767	651	
		28	Cell3 R_a 13			0	32767	1001	
30	Cell3 R_a 14	0	32767	1458					

Related Variables:

- DF:Ra Table:R_a3(91):Cell3 R_a flag(0)

C.11.5 R_a0x (Subclass 92)

C.11.5.1 xCell0 R_a flag (Offset 0)

This value indicates the validity of the cell impedance table for cell 0. It is recommended not to change this value.

High Byte

- 0x00 cell impedance & QMAX updated
- 0x05 relaxation mode and QMAX update in progress
- 0x55 discharge mode & cell impedance updated
- 0xff cell impedance newer updated

Low Byte

- 0x00 table not used & QMAX updated
- 0x55 table being used
- 0xff table never used, no QMAX or cell impedance update

Table C-212. xCell0 R_a flag

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
92	R_a0x	0	xCell0 R_a flag	hex	2	0xffff	0xffff	0xffff	

Related Variables:

- DF:Ra Table:R_a0x(92):xCell0 R_a 0..14(2..30)

Ra Table
C.11.5.2 xCell0 R_a 0..14 (Offset 2..30)

The bq20z90-V110 stores and updates the impedance profile for cell 0 in this table.

Table C-213. xCell0 R_a

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
92	R_a0x	2	xCell0 R_a 0	signed integer	2	0	32767	160	2 ⁻¹⁰ Ω
		4	xCell0 R_a 1			0	32767	166	
		6	xCell0 R_a 2			0	32767	153	
		8	xCell0 R_a 3			0	32767	151	
		10	xCell0 R_a 4			0	32767	145	
		12	xCell0 R_a 5			0	32767	152	
		14	xCell0 R_a 6			0	32767	176	
		16	xCell0 R_a 7			0	32767	204	
		18	xCell0 R_a 8			0	32767	222	
		20	xCell0 R_a 9			0	32767	254	
		22	xCell0 R_a 10			0	32767	315	
		24	xCell0 R_a 11			0	32767	437	
		26	xCell0 R_a 12			0	32767	651	
		28	xCell0 R_a 13			0	32767	1001	
30	xCell0 R_a 14	0	32767	1458					

Related Variables:

- DF:Ra Table:R_a0x(92):xCell0 R_a flag(0)

C.11.6 R_a1x (Subclass 93)
C.11.6.1 xCell1 R_a flag (Offset 0)

This value indicates the validity of the cell impedance table for cell 1. It is recommended not to change this value.

High Byte

0x00	cell impedance & QMAX updated
0x05	relaxation mode and QMAX update in progress
0x55	discharge mode & cell impedance updated
0xff	cell impedance newer updated

Low Byte

0x00	table not used & QMAX updated
0x55	table being used
0xff	table never used, no QMAX or cell impedance update

Table C-214. xCell1 R_a flag

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
93	R_a1x	0	xCell1 R_a flag	hex	2	0xffff	0xffff	0xffff	

Related Variables:

- DF:Ra Table:R_a1x(93):xCell1 R_a 0..14(2..30)

C.11.6.2 xCell1 R_a 0..14 (Offset 2..30)

The bq20z90-V110 stores and updates the impedance profile for cell 1 in this table.

Table C-215. xCell1 R_a

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
93	R_a1x	2	xCell1 R_a 0	signed integer	2	0	32767	160	2 ⁻¹⁰ Ω
		4	xCell1 R_a 1			0	32767	166	
		6	xCell1 R_a 2			0	32767	153	
		8	xCell1 R_a 3			0	32767	151	
		10	xCell1 R_a 4			0	32767	145	
		12	xCell1 R_a 5			0	32767	152	
		14	xCell1 R_a 6			0	32767	176	
		16	xCell1 R_a 7			0	32767	204	
		18	xCell1 R_a 8			0	32767	222	
		20	xCell1 R_a 9			0	32767	254	
		22	xCell1 R_a 10			0	32767	315	
		24	xCell1 R_a 11			0	32767	437	
		26	xCell1 R_a 12			0	32767	651	
		28	xCell1 R_a 13			0	32767	1001	
30	xCell1 R_a 14	0	32767	1458					

Related Variables:

- DF:Ra Table:R_a1x(93):xCell1 R_a flag(0)

C.11.7 R_a2x (Subclass 94)

C.11.7.1 xCell2 R_a flag (Offset 0)

This value indicates the validity of the cell impedance table for cell 2. It is recommended not to change this value.

High Byte

- 0x00 cell impedance & QMAX updated
- 0x05 relaxation mode and QMAX update in progress
- 0x55 discharge mode & cell impedance updated
- 0xff cell impedance newer updated

Low Byte

- 0x00 table not used & QMAX updated
- 0x55 table being used
- 0xff table never used, no QMAX or cell impedance update

Table C-216. xCell2 R_a flag

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
94	R_a2x	0	xCell2 R_a flag	hex	2	0xffff	0xffff	0xffff	

Related Variables:

- DF:Ra Table:R_a2x(94):xCell2 R_a 0..14(2..30)

C.11.7.2 xCell2 R_a 0..14 (Offset 2..30)

The bq20z90-V110 stores and updates the impedance profile for cell 2 in this table.

Table C-217. xCell2 R_a

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
94	R_a2x	2	xCell2 R_a 0	signed integer	2	0	32767	160	2 ⁻¹⁰ Ω
		4	xCell2 R_a 1			0	32767	166	
		6	xCell2 R_a 2			0	32767	153	
		8	xCell2 R_a 3			0	32767	151	
		10	xCell2 R_a 4			0	32767	145	
		12	xCell2 R_a 5			0	32767	152	
		14	xCell2 R_a 6			0	32767	176	
		16	xCell2 R_a 7			0	32767	204	
		18	xCell2 R_a 8			0	32767	222	
		20	xCell2 R_a 9			0	32767	254	
		22	xCell2 R_a 10			0	32767	315	
		24	xCell2 R_a 11			0	32767	437	
		26	xCell2 R_a 12			0	32767	651	
		28	xCell2 R_a 13			0	32767	1001	
30	xCell2 R_a 14	0	32767	1458					

Related Variables:

- DF:Ra Table:R_a2x(94):xCell2 R_a flag(0)

C.11.8 R_a3x (Subclass 95)
C.11.8.1 xCell3 R_a flag (Offset 0)

This value indicates the validity of the cell impedance table for cell 3. It is recommended not to change this value.

High Byte

0x00	cell impedance & QMAX updated
0x05	relaxation mode and QMAX update in progress
0x55	discharge mode & cell impedance updated
0xff	cell impedance newer updated

Low Byte

0x00	table not used & QMAX updated
0x55	table being used
0xff	table never used, no QMAX or cell impedance update

Table C-218. xCell3 R_a flag

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
95	R_a3x	0	xCell3 R_a flag	hex	2	0xffff	0xffff	0xffff	

Related Variables:

- DF:Ra Table:R_a3x(95):xCell3 R_a 0..14(2..30)

C.11.8.2 xCell3 R_a 0..14 (Offset 2..30)

The bq20z90-V110 stores and updates the impedance profile for cell 3 in this table.

Table C-219. xCell3 R_a

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
95	R_a3x	2	xCell3 R_a 0	signed integer	2	0	32767	160	2 [~] -10 Ω
		4	xCell3 R_a 1			0	32767	166	
		6	xCell3 R_a 2			0	32767	153	
		8	xCell3 R_a 3			0	32767	151	
		10	xCell3 R_a 4			0	32767	145	
		12	xCell3 R_a 5			0	32767	152	
		14	xCell3 R_a 6			0	32767	176	
		16	xCell3 R_a 7			0	32767	204	
		18	xCell3 R_a 8			0	32767	222	
		20	xCell3 R_a 9			0	32767	254	
		22	xCell3 R_a 10			0	32767	315	
		24	xCell3 R_a 11			0	32767	437	
		26	xCell3 R_a 12			0	32767	651	
		28	xCell3 R_a 13			0	32767	1001	
30	xCell3 R_a 14	0	32767	1458					

Related Variables:

- DF:Ra Table:R_a3x(95):xCell3 R_a flag(0)

C.12 PF Status

C.12.1 Device Status Data (Subclass 96)

C.12.1.1 PF Flags 1 (Offset 0)

The flags in the **PF Flags 1** register indicate the reason that the bq20z90-V110 has entered permanent failure. If the failure flag in **PF Flags 1** matches the bit in **Permanent Fail Cfg** the SAFE pin is driven high and the **Fuse Flag** is set to 0x3672. The SAFE pin can be used to blow an optional fuse in a severe failure condition to prevent more damage of the system.

All permanent failure flags in the failure sequence are stored in **PF Flags 1**. Only the first permanent failure flag in a failure sequence is stored in **PF Flags 2** to indicate the cause of the permanent failure.

Table C-220. PF Flags 1

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
96	Device Status Data	0	PF Flags 1	hex	2	0x0000	0xbfff	0x0000	

Related Variables:

- DF:Configuration:Registers(64):Permanent Fail Cfg(6)
- DF:PF Status:Device Status Data(96):Fuse Flag(2)
- DF:PF Status:Device Status Data(96):PF Flags 2(28)
- SBS:PFAlert(0x52)
- SBS:PFStatus(0x53)

PF Status

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
High Byte	FBF	PFVSHUT	RSVD	SOPT	SOCD	SOCC	AFE_P	AFE_C
Low Byte	DFF	DFETF	CFETF	CIM	SOTD	SOTC	SOV	PFIN

LEGEND: All Values Read Only

Figure C-13. PF Flags 1

FBF — = 1: Fuse Blow Failure. The fuse has not cut off current even though the SAFE pin output has been driven high.

PFVSHUT — = 1: Another permanent failure has occurred AND the device went into shutdown after that event

SOPT — = 1: Open Thermistor permanent failure

SOCD — = 1: Safety Overcurrent in Discharge permanent failure

SOCC — = 1: Safety Overcurrent in Charge permanent failure

AFE_P — = 1: Periodic AFE-Communications permanent failure

AFE_C — =1 AFE-Communications permanent failure

DFF — = 1: Data Flash Fault permanent failure

DFETF — = 1: Discharge FET permanent failure

CFETF — = 1: Charge FET permanent failure

CIM — = 1: Cell-Imbalance permanent failure

SOTD — = 1: Discharge Safety Overtemperature permanent failure

SOTC — = 1: Charge Safety Overtemperature permanent failure

SOV — = 1: Safety Overvoltage permanent failure

PFIN — = 1: External PFIN Input of bq29330 Indication of a Permanent Failure.

C.12.1.2 Fuse Flag (Offset 2)

The **Fuse Flag** is set to 0x3672 when a 2nd level protection failure occurs and the matching bit is set in the **Permanent Fail Cfg** register. The SAFE pin is driven high

0x0000 = No Failure(default)

0x3672 = **Permanent Fail Cfg** flag matches **PF Flags 1** flag and SAFE pin is driven low

Table C-221. Fuse Flag

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
96	Device Status Data	2	Fuse Flag	hex	2	0x0000	0xffff	0x0000	

Related Variables:

- DF:Configuration:Registers(64):Permanent Fail Cfg(6)
- DF:PF Status:Device Status Data(96):PF Flags 1(0)

C.12.1.3 PF Voltage (Offset 4)

When a permanent failure is detected *Voltage* is captured and stored into in **PF Voltage**.

Table C-222. PF Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
96	Device Status Data	4	PF Voltage	unsigned integer	2	0	32767	0	mV

Related Variables:

- SBS:Voltage(0x09)

C.12.1.4 PF C4 Voltage (Offset 6)

When a permanent failure is detected *CellVoltage4* is captured and stored in **PF C4 Voltage**.

Table C-223. PF C4 Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
96	Device Status Data	6	PF C4 Voltage	unsigned integer	2	0	9999	0	mV

Related Variables:

- SBS:CellVoltage4(0x3c)

C.12.1.5 PF C3 Voltage (Offset 8)

When a permanent failure is detected *CellVoltage3* is captured and stored in **PF C3 Voltage**.

Table C-224. PF C3 Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
96	Device Status Data	8	PF C3 Voltage	unsigned integer	2	0	9999	0	mV

Related Variables:

- SBS:CellVoltage3(0x3d)

C.12.1.6 PF C2 Voltage (Offset 10)

When a permanent failure is detected *CellVoltage2* is captured and stored in **PF C2 Voltage**.

Table C-225. PF C2 Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
96	Device Status Data	10	PF C2 Voltage	unsigned integer	2	0	9999	0	mV

Related Variables:

- SBS:CellVoltage2(0x3e)

C.12.1.7 PF C1 Voltage (Offset 12)

When a permanent failure is detected *CellVoltage1* is captured and stored in **PF C1 Voltage**.

Table C-226. PF C1 Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
96	Device Status Data	12	PF C1 Voltage	unsigned integer	2	0	9999	0	mV

Related Variables:

- SBS:CellVoltage1(0x3f)

C.12.1.8 PF Current (Offset 14)

When a permanent failure is detected the pack *Current* is captured and stored in **PF Current**.

Table C-227. PF Current

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
96	Device Status Data	14	PF Current	signed integer	2	-32768	32767	0	mA

Related Variables:

- SBS:Current(0x0a)

C.12.1.9 PF Temperature (Offset 16)

When a permanent failure is detected the pack *Temperature* is captured and stored in **PF Temperature**.

Table C-228. PF Temperature

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
96	Device Status Data	16	PF Temperature	signed integer	2	-9999	9999	0	0.1 K

Related Variables:

- SBS:Temperature(0x08)

C.12.1.10 PF Batt Stat (Offset 18)

When a permanent failure is detected the *BatteryStatus* flags are captured and stored in **PF Batt Stat**.

Table C-229. PF Batt Stat

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
96	Device Status Data	18	PF Batt Stat	unsigned integer	2	0x0000	0xffff	0x0000	

Related Variables:

- SBS:BatteryStatus(0x16)

C.12.1.11 PF RC-mAh (Offset 20)

When a permanent failure is detected *RemainingCapacity*, in mAh, is captured and stored into in **PF RC-mAh**.

Table C-230. PF RC-mAh

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
96	Device Status Data	20	PF RC-mAh	unsigned integer	2	0	32767	0	mAh

Related Variables:

- SBS:BatteryMode(0x03)[CapM]
- SBS:RemainingCapacity(0x0f)

C.12.1.12 PF RC-10mWh (Offset 22)

When a permanent failure is detected *RemainingCapacity*, in 10mWh, is captured and stored in **PF-RC 10mWh**.

Table C-231. PF RC-10mWh

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
96	Device Status Data	22	PF RC-10mWh	unsigned integer	2	0	32767	0	10mWh

Related Variables:

- SBS:BatteryMode(0x03)[CapM]
- SBS:RemainingCapacity(0x0f)

C.12.1.13 PF Chg Status (Offset 24)

When a permanent failure is detected the *ChargingStatus* flags are captured and stored in **PF Chg Status**.

Table C-232. PF Chg Status

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
96	Device Status Data	24	PF Chg Status	hex	2	0x0000	0xffff	0x0000	

Related Variables:

- SBS:ChargingStatus(0x55)

C.12.1.14 PF Safety Status (Offset 26)

When a permanent failure is detected, the *SafetyStatus* flags are captured and stored in **PF Safety Status**.

Table C-233. PF Safety Status

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
96	Device Status Data	26	PF Safety Status	hex	2	0x0000	0xffff	0x0000	

Related Variables:

- SBS:SafetyStatus(0x51)

C.12.1.15 PF Flags 2 (Offset 28)

On the first occurrence of a permanent failure, when PFStatus changes from 0x0000, the *PFStatus* flags will be captured and stored in this value. Only the first permanent failure flag in a failure sequence is stored in **PF Flags 2** to indicate the cause of the permanent failure. All permanent failure flags in the failure sequence are stored in **PF Flags 1**.

Table C-234. PF Flags 2

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
96	Device Status Data	28	PF Flags 2	hex	2	0x0000	0x8000	0x0000	

Related Variables:

- DF:PF Status:Device Status Data(96):PF Flags 1(0)
- SBS:PFStatus(0x53)

C.12.2 AFE Regs (Subclass 97)

When the bq20z90-V110 detects a permanent failure a complete copy of the bq29330 register values is stored **AFE Regs**.

Table C-235. AFE Regs

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
97	AFE Regs	0	AFE Status	hex	1	0x00	0xff	0x00	
		1	AFE Output						
		2	AFE State						
		3	AFE Function						
		4	AFE Cell Select						
		5	AFE OLV						
		6	AFE OLT						
		7	AFE SCC						
		8	AFE SCD						

C.13 Calibration
C.13.1 Data (Subclass 104)
C.13.1.1 CC Gain (Offset 0)

CC Gain sets the mA current scale factor for the coulomb counter. Use calibration routines to set this value.

Table C-236. CC Gain

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
104	Data	0	CC Gain	floating point	4	0.1	4	0.9419	

Related Variables:

- SBS:Current(0x0a)

C.13.1.2 CC Delta (Offset 4)

CC Delta sets the mAh capacity scale factor for the coulomb counter. Use calibration routines to set this value.

Table C-237. CC Delta

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
104	Data	4	CC Delta	floating point	4	29826	1193046	280932.6	

Related Variables:

- SBS:RemainingCapacity(0x0f)
- SBS:FullChargeCapacity(0x10)

C.13.1.3 Ref Voltage (Offset 8)

This register value stores the AFE reference voltage in units of 50 μ V.

Table C-238. Ref Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
104	Data	8	Ref Voltage	signed integer	2	0	32767	24500	50 μ V

C.13.1.4 AFE Pack Gain (Offset 12)

This register value stores the scale factor for the voltage at the PACK pin of the bq29330 AFE.

Table C-239. AFE Pack Gain

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
104	Data	12	AFE Pack Gain	unsigned integer	2	0	32767	22500	μ V/cnt

C.13.1.5 CC Offset (Offset 14)

This register value stores the coulomb counter offset compensation. It is set by automatic calibration of the bq20z90-V110. It is not recommended to change this value.

Table C-240. CC Offset

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
104	Data	14	CC Offset	signed integer	2	-32768	32767	-1667	

C.13.1.6 Board Offset (Offset 16)

This register value stores the compensation for the PCB dependant coulomb counter offset. It is recommended to use characterization data of the actual PCB to set this value.

Table C-241. Board Offset

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
104	Data	16	Board Offset	signed integer	2	-32768	32767	0	

Related Variables:

- Calibration:Data(104):CC Offset(14)

C.13.1.7 Int Temp Offset (Offset 18)

This register value stores the internal temperature sensor offset compensation. Use calibration routines to set this value.

Table C-242. Int Temp Offset

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
104	Data	18	Int Temp Offset	signed integer	1	-128	127	0	

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[TEMP1], [TEMP0]
- SBS:Temperature(0x08)

C.13.1.8 Ext1 Temp Offset (Offset 19)

This register value stores the temperature sensor offset compensation for the external temperature sensor 1 connected at the TS1 pin of the bq20z90-V110. Use calibration routines to set this value.

Table C-243. Ext1 Temp Offset

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
104	Data	19	Ext1 Temp Offset	signed integer	1	-128	127	0	

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[TEMP1], [TEMP0]
- SBS:Temperature(0x08)

C.13.1.9 Ext2 Temp Offset (Offset 20)

This register value stores the temperature sensor offset compensation for the external temperature sensor 2 connected at the TS2 pin of the bq20z90-V110. Use calibration routines to set this value.

Table C-244. Ext2 Temp Offset

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
104	Data	20	Ext2 Temp Offset	signed integer	1	-128	127	0	

Related Variables:

- DF:Configuration:Registers(64):Operation Cfg A(0)[TEMP1], [TEMP0]
- SBS:Temperature(0x08)

C.13.2 Config (Subclass 105)

C.13.2.1 CC Current (Offset 0)

This value sets the current used for the CC calibration when in calibration mode.

Table C-245. CC Current

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
105	Config	0	CC Current	unsigned integer	2	0	32767	3000	mA

Related Variables:

- SBS:Current(0x0a)

C.13.2.2 Voltage Signal (Offset 2)

This value sets the voltage used for calibration when in calibration mode.

Table C-246. Voltage Signal

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
105	Config	2	Voltage Signal	unsigned integer	2	0	32767	16800	mV

Related Variables:

- SBS:Voltage(0x09)

C.13.2.3 Temp Signal (Offset 4)

This value sets the temperature used for the temperature calibration in calibration mode

Table C-247. Temp Signal

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
105	Config	4	Temp Signal	unsigned integer	2	0	32767	2980	0.1K

Related Variables:

- SBS:Temperature(0x08)

C.13.2.4 CC Offset Time (Offset 6)

This value sets the time used for the CC Offset calibration in calibration mode. More time means more accuracy. The legitimate values for this constant are integer multiples of 250. Numbers less than 250 will cause a CC offset calibration error. Numbers greater than 250 will be rounded down to the nearest multiple of 250.

Table C-248. CC Offset Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
105	Config	6	CC Offset Time	unsigned integer	2	0	65535	250	mSec

Related Variables:

- Calibration:Data(104):CC Offset(14)

C.13.2.5 ADC Offset Time (Offset 8)

This constant defines the time for the ADC Offset calibration in calibration mode. More time means more accuracy. The legitimate values for this constant are integer multiples of 32. Numbers less than 32 will cause an ADC offset calibration error. Numbers greater than 32 will be rounded down to the nearest multiple of 32.

Table C-249. ADC Offset Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
105	Config	8	ADC Offset Time	unsigned integer	2	0	65535	32	mSec

C.13.2.6 CC Gain Time (Offset 10)

This constant defines the time for the CC Gain calibration in calibration mode. More time means more accuracy. The legitimate values for this constant are integer multiples of 250. Numbers less than 250 will cause a CC gain calibration error. Numbers greater than 250 will be rounded down to the nearest multiple of 250.

Table C-250. CC Gain Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
105	Config	10	CC Gain Time	unsigned integer	2	0	65535	250	mSec

Related Variables:

- Calibration:Data(104):CC Gain(0)

C.13.2.7 Voltage Time (Offset 12)

This constant defines the time for the voltage calibration in calibration mode. More time means more accuracy. The legitimate values for this constant are integer multiples of 1984. Numbers less than 1984 will cause a voltage calibration error. Numbers greater than 1984 will be rounded down to the nearest multiple of 1984.

Table C-251. Voltage Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
105	Config	12	Voltage Time	unsigned integer	2	0	65535	1984	mSec

Related Variables:

- SBS:Voltage(0x09)

C.13.2.8 Temperature Time (Offset 14)

This constant defines the time for the temperature calibration in calibration mode. More time means more accuracy. The legitimate values for this constant are integer multiples of 32. Numbers less than 32 will cause a temperature calibration error. Numbers greater than 32 will be rounded down to the nearest multiple of 32.

Table C-252. Temperature Time

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
105	Config	14	Temperature Time	unsigned integer	2	0	65535	32	mSec

Related Variables:

- Calibration:Data(104):Int Temp Offset(18)
- Calibration:Data(104):Ext1 Temp Offset(19)
- Calibration:Data(104):Ext2 Temp Offset(20)
- SBS:Temperature(0x08)

C.13.2.9 Cal Mode Timeout (Offset 17)

The bq20z90-V110 will exit calibration mode automatically after a **Cal Mode Timeout** period.

Table C-253. Cal Mode Timeout

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
105	Config	17	Cal Mode Timeout	unsigned integer	2	0	65535	38400	Sec / 128

Related Variables:

- SBS:ManufacturerAccess(0x00):Calibration Mode(0x0040)

C.13.3 Temp Model (Subclass 106)

C.13.3.1 Ext Coef 1..4, Ext Min AD, Ext Max Temp (Offset 0..10)

These values characterize the external thermistor connected to the TS1 pin or the TS2 pin of the bq20z90-V110. The default values characterize the Semitec 103AT NTC thermistor. Do not modify these values without consulting TI.

Table C-254. Ext Coef 1..4, Ext Min AD, Ext Max Temp

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
106	Temp Model	0	Ext Coef 1	signed integer	2	-32768	32767	-28285	Sec
		2	Ext Coef 2					20848	
		4	Ext Coef 3					-7537	
		6	Ext Coef 4					4012	
		8	Ext Min AD					0	
		10	Ext Max Temp					4012	

C.13.3.2 Int Coef 1..4, Int Min AD, Int Max Temp (Offset 12..22)

These values characterize the internal thermistor of the bq20z90-V110. Do not modify these values without consulting TI.

Table C-255. Int Coef 1..4, Int Min AD, Int Max Temp

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
106	Temp Model	12	Int Coef 1	signed integer	2	-32768	32767	0	Sec
		14	Int Coef 2					0	
		16	Int Coef 3					-11136	
		18	Int Coef 4					5754	
		20	Int Min AD					0	
		22	Int Max Temp					5754	

C.13.4 Current (Subclass 107)

C.13.4.1 Filter (Offset 0)

Filter defines the filter constant used in the *AverageCurrent* calculation:

$$AverageCurrent\ new = a \times AverageCurrent\ old + (1 - a) \times Current$$

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with:

$a = \langle Filter \rangle / 256$; the time constant = $1 \text{ sec} / \ln(1/a)$ (default 14.5 sec)

Table C-256. Filter

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
107	Current	0	Filter	unsigned integer	1	0	255	239	mA

Related Variables:

- SBS:Current(0x0a)
- SBS:AverageCurrent(0x0b)

C.13.4.2 Deadband (Offset 1)

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

Table C-257. Deadband

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
107	Current	1	Deadband	unsigned integer	1	0	255	3	mA

Related Variables:

- SBS:Current(0x0a)

C.13.4.3 CC Deadband (Offset 2)

This constant defines the deadband voltage for the measured voltage between the SR1 and SR2 pins used for capacity accumulation in units of 294 nV. Any voltages within \pm **CC Deadband** do not contribute to capacity accumulation.

Table C-258. CC Deadband

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
107	Current	2	CC Deadband	unsigned integer	1	0	255	34	294 nV

Related Variables:

- SBS:RemainingCapacity(0x0f)

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Table C-259. DATA FLASH VALUES

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
1st Level Safety	0	Voltage	0	COV Threshold	I2	3700	5000	4300	mV
1st Level Safety	0	Voltage	2	COV Time	U1	0	240	2	s
1st Level Safety	0	Voltage	3	COV Recovery	I2	0	4400	3900	mV

Table C-259. DATA FLASH VALUES (continued)

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
1st Level Safety	0	Voltage	5	COV Delta	U1	0	200	20	mV
1st Level Safety	0	Voltage	6	COV Temp. Hys	U1	0	250	100	0.1°C
1st Level Safety	0	Voltage	7	POV Threshold	I2	0	18000	17500	mV
1st Level Safety	0	Voltage	9	POV Time	U1	0	240	2	s
1st Level Safety	0	Voltage	10	POV Recovery	I2	0	17000	16000	mV
1st Level Safety	0	Voltage	12	CUV Threshold	I2	0	3500	2200	mV
1st Level Safety	0	Voltage	14	CUV Time	U1	0	240	2	s
1st Level Safety	0	Voltage	15	CUV Recovery	I2	0	3600	3000	mV
1st Level Safety	0	Voltage	17	PUV Threshold	I2	0	16000	11000	mV
1st Level Safety	0	Voltage	19	PUV Time	U1	0	240	2	s
1st Level Safety	0	Voltage	20	PUV Recovery	I2	0	16000	12000	mV
1st Level Safety	1	Current	0	OC (1st Tier) Chg	I2	0	20000	6000	mA
1st Level Safety	1	Current	2	OC (1st Tier) Chg Time	U1	0	240	2	s
1st Level Safety	1	Current	3	OC Chg Recovery	I2	-1000	1000	200	mA
1st Level Safety	1	Current	5	OC (1st Tier) Dsg	I2	0	20000	6000	mA
1st Level Safety	1	Current	7	OC (1st Tier) Dsg Time	U1	0	240	2	s
1st Level Safety	1	Current	8	OC Dsg Recovery	I2	0	1000	200	mA
1st Level Safety	1	Current	10	OC (2nd Tier) Chg	I2	0	20000	8000	mA
1st Level Safety	1	Current	12	OC (2nd Tier) Chg Time	U1	0	240	2	s
1st Level Safety	1	Current	13	OC (2nd Tier) Dsg	I2	0	22000	8000	mA
1st Level Safety	1	Current	15	OC (2nd Tier) Dsg Time	U1	0	240	2	s
1st Level Safety	1	Current	16	Current Recovery Time	U1	0	240	8	s
1st Level Safety	1	Current	17	AFE OC Dsg	H1	0x00	0x1f	0x12	
1st Level Safety	1	Current	18	AFE OC Dsg Time	H1	0x00	0x0f	0x0f	
1st Level Safety	1	Current	19	AFE OC Dsg Recovery	I2	10	1000	5	mA
1st Level Safety	1	Current	21	AFE SC Chg Cfg	H1	0x00	0xff	0x77	
1st Level Safety	1	Current	22	AFE SC Dsg Cfg	H1	0x00	0xff	0x77	
1st Level Safety	1	Current	23	AFE SC Recovery	I2	0	200	1	mA
1st Level Safety	2	Temperature	0	Over Temp Chg	I2	0	1200	550	0.1°C
1st Level Safety	2	Temperature	2	OT Chg Time	U1	0	240	2	s

Table C-259. DATA FLASH VALUES (continued)

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
1st Level Safety	2	Temperature	3	OT Chg Recovery	I2	0	1200	500	0.1°C
1st Level Safety	2	Temperature	5	Over Temp Dsg	I2	0	1200	600	0.1°C
1st Level Safety	2	Temperature	7	OT Dsg Time	U1	0	240	2	s
1st Level Safety	2	Temperature	8	OT Dsg Recovery	I2	0	1200	550	0.1°C
1st Level Safety	3	Host Comm	0	Host Watchdog Timeout	U1	0	255	0	s
2nd Level Safety	16	Voltage	0	SOV Threshold	I2	0	20000	18000	mV
2nd Level Safety	16	Voltage	2	SOV Time	U1	0	240	0	s
2nd Level Safety	16	Voltage	3	Cell Imbalance Current	I1	0	200	5	mA
2nd Level Safety	16	Voltage	4	Cell Imbalance Fail Voltage	I2	0	5000	1000	mV
2nd Level Safety	16	Voltage	6	Cell Imbalance Time	U1	0	240	0	s
2nd Level Safety	16	Voltage	7	Battery Rest Time	U2	0	65535	1800	s
2nd Level Safety	16	Voltage	9	PFIN Detect Time	U1	0	240	0	s
2nd Level Safety	17	Current	0	SOC Chg	I2	0	30000	10000	mA
2nd Level Safety	17	Current	2	SOC Chg Time	U1	0	240	0	s
2nd Level Safety	17	Current	3	SOC Dsg	I2	0	30000	10000	mA
2nd Level Safety	17	Current	5	SOC Dsg Time	U1	0	240	0	s
2nd Level Safety	18	Temperature	0	SOT Chg	I2	0	1200	650	0.1°C
2nd Level Safety	18	Temperature	2	SOT Chg Time	U1	0	240	0	s
2nd Level Safety	18	Temperature	3	SOT Dsg	I2	0	1200	750	0.1°C
2nd Level Safety	18	Temperature	5	SOT Dsg Time	U1	0	240	0	s
2nd Level Safety	18	Temperature	6	Open Thermistor	I2	-1000	1200	-333	0.1°C
2nd Level Safety	18	Temperature	8	Open Time	I1	0	240	0	s
2nd Level Safety	19	FET Verification	0	FET Fail Limit	I2	0	500	20	mA
2nd Level Safety	19	FET Verification	2	FET Fail Time	U1	0	240	0	s
2nd Level Safety	20	AFE Verification	0	AFE Check Time	U1	0	255	0	s
2nd Level Safety	20	AFE Verification	1	AFE Fail Limit	U1	0	255	10	
2nd Level Safety	20	AFE Verification	2	AFE Fail Recovery Time	U1	0	255	20	s
2nd Level Safety	20	AFE Verification	3	AFE Init Retry Limit	U1	0	255	6	
2nd Level Safety	20	AFE Verification	4	AFE Init Limit	U1	0	255	20	
2nd Level Safety	21	Fuse Verification	0	Fuse Fail Limit	I2	0	20	2	mA

Table C-259. DATA FLASH VALUES (continued)

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
2nd Level Safety	21	Fuse Verification	2	Fuse Fail Time	U1	0	240	0	s
Charge Control	32	Charge Inhibit Cfg	0	Chg Inhibit Temp Low	I2	-400	1200	0	0.1°C
Charge Control	32	Charge Inhibit Cfg	2	Chg Inhibit Temp High	I2	-400	1200	450	0.1°C
Charge Control	32	Charge Inhibit Cfg	4	Temp Hys	I2	0	100	10	0.1°C
Charge Control	33	Pre-Charge Cfg	0	Pre-chg Current	I2	0	2000	250	mA
Charge Control	33	Pre-Charge Cfg	2	Pre-chg Temp	I2	-400	1200	120	0.1°C
Charge Control	33	Pre-Charge Cfg	4	Pre-chg Voltage	I2	0	20000	3000	mV
Charge Control	33	Pre-Charge Cfg	6	Recovery Voltage	I2	0	20000	3100	mV
Charge Control	34	Fast Charge Cfg	0	Fast Charge Current	I2	0	10000	4000	mA
Charge Control	34	Fast Charge Cfg	2	Charging Voltage	I2	0	20000	16800	mV
Charge Control	34	Fast Charge Cfg	4	Delta Temp	I2	0	500	50	0.1°C
Charge Control	34	Fast Charge Cfg	6	Suspend Low Temp	I2	-400	1200	-50	0.1°C
Charge Control	34	Fast Charge Cfg	8	Suspend High Temp	I2	-400	1200	550	0.1°C
Charge Control	35	Pulse Charge Cfg	0	Turn ON Voltage	I2	0	5000	4150	mV
Charge Control	35	Pulse Charge Cfg	2	Turn OFF Voltage	I2	0	5000	4250	mV
Charge Control	35	Pulse Charge Cfg	4	Max ON Pulse Time	U1	0	240	240	Seconds/ 4
Charge Control	35	Pulse Charge Cfg	5	Min OFF Pulse Time	U1	0	240	0	Seconds/ 4
Charge Control	35	Pulse Charge Cfg	6	Max OFF Voltage	I2	0	5000	4270	mV
Charge Control	36	Termination Cfg.	0	Maintenance Current	I2	0	1000	0	mA
Charge Control	36	Termination Cfg.	2	Taper Current	I2	0	1000	250	mA
Charge Control	36	Termination Cfg.	6	Taper Voltage	I2	0	1000	300	mV
Charge Control	36	Termination Cfg.	8	Current Taper Window	U1	0	240	40	s
Charge Control	36	Termination Cfg.	9	TCA Set %	I1	-1	100	-1	%
Charge Control	36	Termination Cfg.	10	TCA Clear %	I1	-1	100	95	%
Charge Control	36	Termination Cfg.	11	FC Set %	I1	-1	100	-1	%
Charge Control	36	Termination Cfg.	12	FC Clear %	I1	-1	100	98	%
Charge Control	37	Cell Balancing Cfg	0	Min Cell Deviation	U2	0	65535	1750	s/mAh
Charge Control	38	Charging Faults	0	Over Charging Voltage	I2	0	3000	500	mV
Charge Control	38	Charging Faults	2	Over Charging Volt Time	U1	0	240	2	s
Charge Control	38	Charging Faults	3	Over Charging Current	I2	0	2000	500	mA

Table C-259. DATA FLASH VALUES (continued)

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
Charge Control	38	Charging Faults	5	Over Charging Curr Time	U1	0	240	2	s
Charge Control	38	Charging Faults	6	Over Charging Curr Recov	I2	0	2000	100	mA
Charge Control	38	Charging Faults	8	Depleted Voltage	I2	0	16000	8000	mV
Charge Control	38	Charging Faults	10	Depleted Voltage Time	U1	0	240	2	s
Charge Control	38	Charging Faults	11	Depleted Recovery	I2	0	16000	8500	mV
Charge Control	38	Charging Faults	13	Over Charge Capacity	I2	0	4000	300	mAh
Charge Control	38	Charging Faults	15	Over Charge Recovery	I2	0	100	2	mAh
Charge Control	38	Charging Faults	17	FC-MTO	U2	0	65535	10800	s
Charge Control	38	Charging Faults	19	PC-MTO	U2	0	65535	3600	s
Charge Control	38	Charging Faults	21	Charge Fault Cfg	H1	0x00	0x3f	0x00	
SBS Configuration	48	Data	0	Rem Cap Alarm	I2	0	700	300	mAh
SBS Configuration	48	Data	2	Rem Energy Alarm	I2	0	1000	432	10mW
SBS Configuration	48	Data	4	Rem Time Alarm	U2	0	30	10	min
SBS Configuration	48	Data	6	Init Battery Mode	H2	0x0000	0xffff	0x0081	
SBS Configuration	48	Data	8	Design Voltage	I2	7000	18000	14400	mV
SBS Configuration	48	Data	10	Spec Info	H2	0x0000	0xffff	0x0031	
SBS Configuration	48	Data	12	Manuf Date	U2	0	65535	0	Day + Mo*32 + (Yr - 1980)*256
SBS Configuration	48	Data	14	Ser. Num.	H2	0x0000	0xffff	0x0001	
SBS Configuration	48	Data	16	Cycle Count	U2	0	65535	0	Count
SBS Configuration	48	Data	18	CC Threshold	I2	100	32767	4400	mAh
SBS Configuration	48	Data	20	CC %	U1	0	100	90	%
SBS Configuration	48	Data	21	CF MaxError Limit	U1	0	100	100	%
SBS Configuration	48	Data	22	Design Capacity	I2	0	65535	4400	mAh
SBS Configuration	48	Data	24	Design Energy	I2	0	65535	6336	10mW
SBS Configuration	48	Data	26	Manuf Name	S12	-	-	Texas Inst.	ASCII
SBS Configuration	48	Data	38	Device Name	S8	-	-	bq20z90- V110	ASCII
SBS Configuration	48	Data	46	Device Chemistry	S5	-	-	LION	ASCII
SBS Configuration	49	Configuration	0	TDA Set %	I1	-1	100	6	%

Table C-259. DATA FLASH VALUES (continued)

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
SBS Configuration	49	Configuration	1	TDA Clear %	I1	-1	100	8	%
SBS Configuration	49	Configuration	2	FD Set %	I1	-1	100	2	%
SBS Configuration	49	Configuration	3	FD Clear %	I1	-1	100	5	%
SBS Configuration	49	Configuration	4	TDA Set Volt Threshold	I2	0	16800	5000	mV
SBS Configuration	49	Configuration	6	TDA Set Volt Time	U1	0	240	5	s
SBS Configuration	49	Configuration	7	TDA Clear Volt	I2	0	16800	5500	mV
SBS Configuration	49	Configuration	9	FD Set Volt Threshold	I2	0	16800	5000	mV
SBS Configuration	49	Configuration	11	FD Volt Time	U1	0	240	5	s
SBS Configuration	49	Configuration	12	FD Clear Volt	I2	0	16800	5500	mV
System Data	56	Manufacturer Data	0	Pack Lot Code	H2	0x0000	0xffff	0x0000	
System Data	56	Manufacturer Data	2	PCB Lot Code	H2	0x0000	0xffff	0x0000	
System Data	56	Manufacturer Data	4	Firmware Version	H2	0x0000	0xffff	0x0000	
System Data	56	Manufacturer Data	6	Hardware Revision	H2	0x0000	0xffff	0x0000	
System Data	56	Manufacturer Data	8	Cell Revision	H2	0x0000	0xffff	0x0000	
System Data	58	Manufacturer Info	0	Manuf. Info	S9	-	-	012345678 9abcdef012 3	
System Data	59	Lifetime Data	0	Lifetime Max Temp	I2	0	1400	300	0.1°C
System Data	59	Lifetime Data	2	Lifetime Min Temp	I2	-600	1400	200	0.1°C
System Data	59	Lifetime Data	4	Lifetime Max Cell Voltage	I2	0	32767	3500	mV
System Data	59	Lifetime Data	6	Lifetime Min Cell Voltage	I2	0	32767	3200	mV
System Data	59	Lifetime Data	8	Lifetime Max Pack Voltage	I2	0	32767	14000	mV
System Data	59	Lifetime Data	10	Lifetime Min Pack Voltage	I2	0	32767	12800	mV
System Data	59	Lifetime Data	12	Lifetime Max Chg Current	I2	-32768	32767	1500	mA
System Data	59	Lifetime Data	14	Lifetime Max Dsg Current	I2	-32768	32767	-3000	mA
System Data	59	Lifetime Data	16	Lifetime Max Chg Power	I2	-32768	32767	1500	cWatt
System Data	59	Lifetime Data	18	Lifetime Max Dsg Power	I2	-32768	32767	-1500	cWatt
System Data	59	Lifetime Data	22	Life Max AvgDsg Cur	I2	-32768	32767	-1000	mA
System Data	59	Lifetime Data	26	Life Max AvgDsg Pow	I2	-32768	32767	-1500	cW
System Data	59	Lifetime Data	28	Lifetime Avg Temp	I2	-40	1400	250	0.1°C
System Data	60	Lifetime Temp Samples	0	LT Temp Samples	I4	0	140000000	0	Count
Configuration	64	Registers	0	Operation Cfg A	H2	0x0000	0xffff	0x0f29	
Configuration	64	Registers	2	Operation Cfg B	H2	0x0000	0xffff	0x6440	
Configuration	64	Registers	4	Operation Cfg C	H2	0x0000	0xffff	0x0000	
Configuration	64	Registers	6	Permanent Fail Cfg	H2	0x0000	0xffff	0x0000	
Configuration	64	Registers	8	Non-Removable Cfg	H2	0x0000	0xffff	0x0000	
LED Support	67	LED Cfg	0	LED Flash Rate	U2	0	65535	512	500us
LED Support	67	LED Cfg	2	LED Blink Rate	U2	0	65535	1024	500us
LED Support	67	LED Cfg	4	LED Delay	U2	1	65535	100	500us
LED Support	67	LED Cfg	6	LED Hold Time	U1	0	255	4	sec

Table C-259. DATA FLASH VALUES (continued)

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
LED Support	67	LED Cfg	7	CHG Flash Alarm	I1	-1	101	10	%
LED Support	67	LED Cfg	8	CHG Thresh 1	I1	-1	101	0	%
LED Support	67	LED Cfg	9	CHG Thresh 2	I1	-1	101	20	%
LED Support	67	LED Cfg	10	CHG Thresh 3	I1	-1	101	40	%
LED Support	67	LED Cfg	11	CHG Thresh 4	I1	-1	101	60	%
LED Support	67	LED Cfg	12	CHG Thresh 5	I1	-1	101	80	%
LED Support	67	LED Cfg	13	DSG Flash Alarm	I1	-1	101	10	%
LED Support	67	LED Cfg	14	DSG Thresh 1	I1	-1	101	0	%
LED Support	67	LED Cfg	15	DSG Thresh 2	I1	-1	101	20	%
LED Support	67	LED Cfg	16	DSG Thresh 3	I1	-1	101	40	%
LED Support	67	LED Cfg	17	DSG Thresh 4	I1	-1	101	60	%
LED Support	67	LED Cfg	18	DSG Thresh 5	I1	-1	101	80	%
LED Support	67	LED Cfg	19	Sink Current	U1	0	3	3	
Power	68	Power	0	Flash Update OK Voltage	I2	6000	20000	7500	mV
Power	68	Power	2	Shutdown Voltage	I2	5000	20000	7000	mV
Power	68	Power	4	Shutdown Time	U1	0	2440	10	s
Power	68	Power	5	Charger Present	I2	0	23000	3000	mV
Power	68	Power	7	Sleep Current	I2	0	100	10	mA
Power	68	Power	9	Bus Low Time	U1	0	255	5	s
Power	68	Power	10	Cal Inhibit Temp Low	I2	-400	1200	50	0.1°C
Power	68	Power	12	Cal Inhibit Temp High	I2	-400	1200	450	0.1°C
Power	68	Power	14	Sleep Voltage Time	U1	0	240	5	s
Power	68	Power	15	Sleep Current Time	U1	0	255	20	s
Power	68	Power	16	Wake Current Reg	H1	0x00	0x07	0x00	
Gas Gauging	80	IT Cfg	0	Load Select	U1	0	255	3	
Gas Gauging	80	IT Cfg	1	Load Mode	U1	0	255	0	
Gas Gauging	80	IT Cfg	45	Term Voltage	I2	-32768	32767	12000	mV
Gas Gauging	80	IT Cfg	60	User Rate-mA	I2	2000	9000	0	mA
Gas Gauging	80	IT Cfg	62	User Rate-mW	I2	3000	14000	0	10mW
Gas Gauging	80	IT Cfg	64	Reserve Cap-mAh	I2	0	9000	0	mAh
Gas Gauging	80	IT Cfg	66	Reserve Cap-mWh	I2	0	14000	0	10mWh
Gas Gauging	81	Current Thresholds	0	Dsg Current Threshold	I2	0	2000	100	mA
Gas Gauging	81	Current Thresholds	2	Chg Current Threshold	I2	0	2000	50	mA
Gas Gauging	81	Current Thresholds	4	Quit Current	I2	0	1000	10	mA
Gas Gauging	81	Current Thresholds	6	Dsg Relax Time	U1	0	255	1	s
Gas Gauging	81	Current Thresholds	7	Chg Relax Time	U1	0	255	60	s
Gas Gauging	82	State	0	Qmax Cell 0	I2	0	32767	4400	mAh
Gas Gauging	82	State	2	Qmax Cell 1	I2	0	32767	4400	mAh
Gas Gauging	82	State	4	Qmax Cell 2	I2	0	32767	4400	mAh
Gas Gauging	82	State	6	Qmax Cell 3	I2	0	32767	4400	mAh
Gas Gauging	82	State	8	Qmax Pack	I2	0	32767	4400	mAh
Gas Gauging	82	State	12	Update Status	H1	0x00	0x03	0x00	
Gas Gauging	82	State	21	Avg I Last Run	I2	-32768	32767	-2000	mA
Gas Gauging	82	State	23	Avg P Last Run	I2	-32768	32767	-3022	cWatt
Gas Gauging	82	State	25	Delta Voltage	I2	-32768	32767	0	mV
Ra Table	88	R_a0	0	Cell0 R_a flag	H2	0x0000	0x0000	0xff55	

Table C-259. DATA FLASH VALUES (continued)

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
Ra Table	88	R_a0	2	Cell0 R_a 0	I2	183	183	160	2 [^] -10Ω
Ra Table	88	R_a0	4	Cell0 R_a 1	I2	181	181	166	2 [^] -10Ω
Ra Table	88	R_a0	6	Cell0 R_a 2	I2	198	198	153	2 [^] -10Ω
Ra Table	88	R_a0	8	Cell0 R_a 3	I2	244	244	151	2 [^] -10Ω
Ra Table	88	R_a0	10	Cell0 R_a 4	I2	254	254	145	2 [^] -10Ω
Ra Table	88	R_a0	12	Cell0 R_a 5	I2	261	261	152	2 [^] -10Ω
Ra Table	88	R_a0	14	Cell0 R_a 6	I2	333	333	176	2 [^] -10Ω
Ra Table	88	R_a0	16	Cell0 R_a 7	I2	338	338	204	2 [^] -10Ω
Ra Table	88	R_a0	18	Cell0 R_a 8	I2	345	345	222	2 [^] -10Ω
Ra Table	88	R_a0	20	Cell0 R_a 9	I2	350	350	254	2 [^] -10Ω
Ra Table	88	R_a0	22	Cell0 R_a 10	I2	382	382	315	2 [^] -10Ω
Ra Table	88	R_a0	24	Cell0 R_a 11	I2	429	429	437	2 [^] -10Ω
Ra Table	88	R_a0	26	Cell0 R_a 12	I2	502	502	651	2 [^] -10Ω
Ra Table	88	R_a0	28	Cell0 R_a 13	I2	545	545	1001	2 [^] -10Ω
Ra Table	88	R_a0	30	Cell0 R_a 14	I2	366	366	1458	2 [^] -10Ω
Ra Table	89	R_a1	0	Cell1 R_a flag	H2	0x0000	0x0000	0xff55	
Ra Table	89	R_a1	2	Cell1 R_a 0	I2	183	183	160	2 [^] -10Ω
Ra Table	89	R_a1	4	Cell1 R_a 1	I2	181	181	166	2 [^] -10Ω
Ra Table	89	R_a1	6	Cell1 R_a 2	I2	198	198	153	2 [^] -10Ω
Ra Table	89	R_a1	8	Cell1 R_a 3	I2	244	244	151	2 [^] -10Ω
Ra Table	89	R_a1	10	Cell1 R_a 4	I2	254	254	145	2 [^] -10Ω
Ra Table	89	R_a1	12	Cell1 R_a 5	I2	261	261	152	2 [^] -10Ω
Ra Table	89	R_a1	14	Cell1 R_a 6	I2	333	333	176	2 [^] -10Ω
Ra Table	89	R_a1	16	Cell1 R_a 7	I2	338	338	204	2 [^] -10Ω
Ra Table	89	R_a1	18	Cell1 R_a 8	I2	345	345	222	2 [^] -10Ω
Ra Table	89	R_a1	20	Cell1 R_a 9	I2	350	350	254	2 [^] -10Ω
Ra Table	89	R_a1	22	Cell1 R_a 10	I2	382	382	315	2 [^] -10Ω
Ra Table	89	R_a1	24	Cell1 R_a 11	I2	429	429	437	2 [^] -10Ω
Ra Table	89	R_a1	26	Cell1 R_a 12	I2	502	502	651	2 [^] -10Ω
Ra Table	89	R_a1	28	Cell1 R_a 13	I2	545	545	1001	2 [^] -10Ω
Ra Table	89	R_a1	30	Cell1 R_a 14	I2	366	366	1458	2 [^] -10Ω
Ra Table	90	R_a2	0	Cell2 R_a flag	H2	0x0000	0x0000	0xff55	
Ra Table	90	R_a2	2	Cell2 R_a 0	I2	183	183	160	2 [^] -10Ω
Ra Table	90	R_a2	4	Cell2 R_a 1	I2	181	181	166	2 [^] -10Ω
Ra Table	90	R_a2	6	Cell2 R_a 2	I2	198	198	153	2 [^] -10Ω
Ra Table	90	R_a2	8	Cell2 R_a 3	I2	244	244	151	2 [^] -10Ω
Ra Table	90	R_a2	10	Cell2 R_a 4	I2	254	254	145	2 [^] -10Ω
Ra Table	90	R_a2	12	Cell2 R_a 5	I2	261	261	152	2 [^] -10Ω
Ra Table	90	R_a2	14	Cell2 R_a 6	I2	333	333	176	2 [^] -10Ω
Ra Table	90	R_a2	16	Cell2 R_a 7	I2	338	338	204	2 [^] -10Ω
Ra Table	90	R_a2	18	Cell2 R_a 8	I2	345	345	222	2 [^] -10Ω
Ra Table	90	R_a2	20	Cell2 R_a 9	I2	350	350	254	2 [^] -10Ω
Ra Table	90	R_a2	22	Cell2 R_a 10	I2	382	382	315	2 [^] -10Ω
Ra Table	90	R_a2	24	Cell2 R_a 11	I2	429	429	437	2 [^] -10Ω
Ra Table	90	R_a2	26	Cell2 R_a 12	I2	502	502	651	2 [^] -10Ω
Ra Table	90	R_a2	28	Cell2 R_a 13	I2	545	545	1001	2 [^] -10Ω
Ra Table	90	R_a2	30	Cell2 R_a 14	I2	366	366	1458	2 [^] -10Ω
Ra Table	91	R_a3	0	Cell3 R_a flag	H2	0x0	0x0	0xff55	
Ra Table	91	R_a3	2	Cell3 R_a 0	I2	183	183	160	2 [^] -10Ω

Table C-259. DATA FLASH VALUES (continued)

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
Ra Table	91	R_a3	4	Cell3 R_a 1	I2	181	181	166	2 [^] -10Ω
Ra Table	91	R_a3	6	Cell3 R_a 2	I2	198	198	153	2 [^] -10Ω
Ra Table	91	R_a3	8	Cell3 R_a 3	I2	244	244	151	2 [^] -10Ω
Ra Table	91	R_a3	10	Cell3 R_a 4	I2	254	254	145	2 [^] -10Ω
Ra Table	91	R_a3	12	Cell3 R_a 5	I2	261	261	152	2 [^] -10Ω
Ra Table	91	R_a3	14	Cell3 R_a 6	I2	333	333	176	2 [^] -10Ω
Ra Table	91	R_a3	16	Cell3 R_a 7	I2	338	338	204	2 [^] -10Ω
Ra Table	91	R_a3	18	Cell3 R_a 8	I2	345	345	222	2 [^] -10Ω
Ra Table	91	R_a3	20	Cell3 R_a 9	I2	350	350	254	2 [^] -10Ω
Ra Table	91	R_a3	22	Cell3 R_a 10	I2	382	382	315	2 [^] -10Ω
Ra Table	91	R_a3	24	Cell3 R_a 11	I2	429	429	437	2 [^] -10Ω
Ra Table	91	R_a3	26	Cell3 R_a 12	I2	502	502	651	2 [^] -10Ω
Ra Table	91	R_a3	28	Cell3 R_a 13	I2	545	545	1001	2 [^] -10Ω
Ra Table	91	R_a3	30	Cell3 R_a 14	I2	366	366	1458	2 [^] -10Ω
Ra Table	92	R_a0x	0	xCell0 R_a flag	H2	0xffff	0xffff	0xffff	
Ra Table	92	R_a0x	2	xCell0 R_a 0	I2	183	183	160	2 [^] -10Ω
Ra Table	92	R_a0x	4	xCell0 R_a 1	I2	181	181	166	2 [^] -10Ω
Ra Table	92	R_a0x	6	xCell0 R_a 2	I2	198	198	153	2 [^] -10Ω
Ra Table	92	R_a0x	8	xCell0 R_a 3	I2	244	244	151	2 [^] -10Ω
Ra Table	92	R_a0x	10	xCell0 R_a 4	I2	254	254	145	2 [^] -10Ω
Ra Table	92	R_a0x	12	xCell0 R_a 5	I2	261	261	152	2 [^] -10Ω
Ra Table	92	R_a0x	14	xCell0 R_a 6	I2	333	333	176	2 [^] -10Ω
Ra Table	92	R_a0x	16	xCell0 R_a 7	I2	338	338	204	2 [^] -10Ω
Ra Table	92	R_a0x	18	xCell0 R_a 8	I2	345	345	222	2 [^] -10Ω
Ra Table	92	R_a0x	20	xCell0 R_a 9	I2	350	350	254	2 [^] -10Ω
Ra Table	92	R_a0x	22	xCell0 R_a 10	I2	382	382	315	2 [^] -10Ω
Ra Table	92	R_a0x	24	xCell0 R_a 11	I2	429	429	437	2 [^] -10Ω
Ra Table	92	R_a0x	26	xCell0 R_a 12	I2	502	502	651	2 [^] -10Ω
Ra Table	92	R_a0x	28	xCell0 R_a 13	I2	545	545	1001	2 [^] -10Ω
Ra Table	92	R_a0x	30	xCell0 R_a 14	I2	366	366	1458	2 [^] -10Ω
Ra Table	93	R_a1x	0	xCell1 R_a flag	H2	0xffff	0xffff	0xffff	
Ra Table	93	R_a1x	2	xCell1 R_a 0	I2	183	183	160	2 [^] -10Ω
Ra Table	93	R_a1x	4	xCell1 R_a 1	I2	181	181	166	2 [^] -10Ω
Ra Table	93	R_a1x	6	xCell1 R_a 2	I2	198	198	153	2 [^] -10Ω
Ra Table	93	R_a1x	8	xCell1 R_a 3	I2	244	244	151	2 [^] -10Ω
Ra Table	93	R_a1x	10	xCell1 R_a 4	I2	254	254	145	2 [^] -10Ω
Ra Table	93	R_a1x	12	xCell1 R_a 5	I2	261	261	152	2 [^] -10Ω
Ra Table	93	R_a1x	14	xCell1 R_a 6	I2	333	333	176	2 [^] -10Ω
Ra Table	93	R_a1x	16	xCell1 R_a 7	I2	338	338	204	2 [^] -10Ω
Ra Table	93	R_a1x	18	xCell1 R_a 8	I2	345	345	222	2 [^] -10Ω
Ra Table	93	R_a1x	20	xCell1 R_a 9	I2	350	350	254	2 [^] -10Ω
Ra Table	93	R_a1x	22	xCell1 R_a 10	I2	382	382	315	2 [^] -10Ω
Ra Table	93	R_a1x	24	xCell1 R_a 11	I2	429	429	437	2 [^] -10Ω
Ra Table	93	R_a1x	26	xCell1 R_a 12	I2	502	502	651	2 [^] -10Ω
Ra Table	93	R_a1x	28	xCell1 R_a 13	I2	545	545	1001	2 [^] -10Ω
Ra Table	93	R_a1x	30	xCell1 R_a 14	I2	366	366	1458	2 [^] -10Ω
Ra Table	94	R_a2x	0	xCell2 R_a flag	H2	0xffff	0xffff	0xffff	
Ra Table	94	R_a2x	2	xCell2 R_a 0	I2	183	183	160	2 [^] -10Ω
Ra Table	94	R_a2x	4	xCell2 R_a 1	I2	181	181	166	2 [^] -10Ω

Table C-259. DATA FLASH VALUES (continued)

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
Ra Table	94	R_a2x	6	xCell2 R_a 2	I2	198	198	153	2 [^] -10Ω
Ra Table	94	R_a2x	8	xCell2 R_a 3	I2	244	244	151	2 [^] -10Ω
Ra Table	94	R_a2x	10	xCell2 R_a 4	I2	254	254	145	2 [^] -10Ω
Ra Table	94	R_a2x	12	xCell2 R_a 5	I2	261	261	152	2 [^] -10Ω
Ra Table	94	R_a2x	14	xCell2 R_a 6	I2	333	333	176	2 [^] -10Ω
Ra Table	94	R_a2x	16	xCell2 R_a 7	I2	338	338	204	2 [^] -10Ω
Ra Table	94	R_a2x	18	xCell2 R_a 8	I2	345	345	222	2 [^] -10Ω
Ra Table	94	R_a2x	20	xCell2 R_a 9	I2	350	350	254	2 [^] -10Ω
Ra Table	94	R_a2x	22	xCell2 R_a 10	I2	382	382	315	2 [^] -10Ω
Ra Table	94	R_a2x	24	xCell2 R_a 11	I2	429	429	437	2 [^] -10Ω
Ra Table	94	R_a2x	26	xCell2 R_a 12	I2	502	502	651	2 [^] -10Ω
Ra Table	94	R_a2x	28	xCell2 R_a 13	I2	545	545	1001	2 [^] -10Ω
Ra Table	94	R_a2x	30	xCell2 R_a 14	I2	366	366	1458	2 [^] -10Ω
Ra Table	95	R_a3x	0	xCell3 R_a flag	H2	0xffff	0xffff	0xffff	
Ra Table	95	R_a3x	2	xCell3 R_a 0	I2	183	183	160	2 [^] -10Ω
Ra Table	95	R_a3x	4	xCell3 R_a 1	I2	181	181	166	2 [^] -10Ω
Ra Table	95	R_a3x	6	xCell3 R_a 2	I2	198	198	153	2 [^] -10Ω
Ra Table	95	R_a3x	8	xCell3 R_a 3	I2	244	244	151	2 [^] -10Ω
Ra Table	95	R_a3x	10	xCell3 R_a 4	I2	254	254	145	2 [^] -10Ω
Ra Table	95	R_a3x	12	xCell3 R_a 5	I2	261	261	152	2 [^] -10Ω
Ra Table	95	R_a3x	14	xCell3 R_a 6	I2	333	333	176	2 [^] -10Ω
Ra Table	95	R_a3x	16	xCell3 R_a 7	I2	338	338	204	2 [^] -10Ω
Ra Table	95	R_a3x	18	xCell3 R_a 8	I2	345	345	222	2 [^] -10Ω
Ra Table	95	R_a3x	20	xCell3 R_a 9	I2	350	350	254	2 [^] -10Ω
Ra Table	95	R_a3x	22	xCell3 R_a 10	I2	382	382	315	2 [^] -10Ω
Ra Table	95	R_a3x	24	xCell3 R_a 11	I2	429	429	437	2 [^] -10Ω
Ra Table	95	R_a3x	26	xCell3 R_a 12	I2	502	502	651	2 [^] -10Ω
Ra Table	95	R_a3x	28	xCell3 R_a 13	I2	545	545	1001	2 [^] -10Ω
Ra Table	95	R_a3x	30	xCell3 R_a 14	I2	366	366	1458	2 [^] -10Ω
PF Status	96	Device Status Data	0	PF Flags 1	H2	0x0000	0x6fff	0x0000	
PF Status	96	Device Status Data	2	Fuse Flag	H2	0x0000	0xffff	0x0000	
PF Status	96	Device Status Data	4	PF Voltage	I2	0	32767	0	mV
PF Status	96	Device Status Data	6	PF C4 Voltage	I2	0	9999	0	mV
PF Status	96	Device Status Data	8	PF C3 Voltage	I2	0	9999	0	mV
PF Status	96	Device Status Data	10	PF C2 Voltage	I2	0	9999	0	mV
PF Status	96	Device Status Data	12	PF C1 Voltage	I2	0	9999	0	mV
PF Status	96	Device Status Data	14	PF Current	I2	-32768	32767	0	mA
PF Status	96	Device Status Data	16	PF Temperature	I2	-9999	9999	0	0.1 K
PF Status	96	Device Status Data	18	PF Batt Stat	H2	0x0000	0xffff	0x0000	
PF Status	96	Device Status Data	20	PF RC-mAh	I2	0	32767	0	mAh
PF Status	96	Device Status Data	22	PF RC-10mWh	I2	0	32767	0	cWattHr

Table C-259. DATA FLASH VALUES (continued)

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
PF Status	96	Device Status Data	24	PF Chg Status	H2	0x0000	0xffff	0x0000	
PF Status	96	Device Status Data	26	PF Safety Status	H2	0x0000	0xffff	0x0000	
PF Status	96	Device Status Data	28	PF Flags 2	H2	0x0000	0x8000	0x0000	
PF Status	97	AFE Regs	0	AFE Status	H1	0x00	0xff	0x00	
PF Status	97	AFE Regs	1	AFE Output	H1	0x00	0xff	0x00	
PF Status	97	AFE Regs	2	AFE State	H1	0x00	0xff	0x00	
PF Status	97	AFE Regs	3	AFE Function	H1	0x00	0xff	0x00	
PF Status	97	AFE Regs	4	AFE Cell Select	H1	0x00	0xff	0x00	
PF Status	97	AFE Regs	5	AFE OLV	H1	0x00	0xff	0x00	
PF Status	97	AFE Regs	6	AFE OLT	H1	0x00	0xff	0x00	
PF Status	97	AFE Regs	7	AFE SCC	H1	0x00	0xff	0x00	
PF Status	97	AFE Regs	8	AFE SCD	H1	0x00	0xff	0x00	
Calibration	104	Data	0	CC Gain	F4	0.1	4	0.9419	
Calibration	104	Data	4	CC Delta	F4	29826	1193046	280932.6	
Calibration	104	Data	8	Ref Voltage	I2	0	32767	24500	50 μ V
Calibration	104	Data	12	AFE Pack Gain	I2	0	32767	22050	μ V/cnt
Calibration	104	Data	14	CC Offset	I2	-32768	32767	-1667	
Calibration	104	Data	16	Board Offset	I2	-32767	32767	0	
Calibration	104	Data	18	Int Temp Offset	I1	-128	127	0	
Calibration	104	Data	19	Ext1 Temp Offset	I1	-128	127	0	
Calibration	104	Data	20	Ext2 Temp Offset	I1	-128	127	0	
Calibration	105	Config	0	CC Current	I2	0	32767	3000	mA
Calibration	105	Config	2	Voltage Signal	I2	0	32767	16800	mV
Calibration	105	Config	4	Temp Signal	I2	0	32767	2980	0.1°C
Calibration	105	Config	6	CC Offset Time	U2	0	65535	250	ms
Calibration	105	Config	8	ADC Offset Time	U2	0	65535	32	ms
Calibration	105	Config	10	CC Gain Time	U2	0	65535	250	ms
Calibration	105	Config	12	Voltage Time	U2	0	65535	1984	ms
Calibration	105	Config	14	Temperature Time	U2	0	65535	32	s
Calibration	105	Config	17	Cal Mode Timeout	U2	0	65535	38400	1/128 s
Calibration	106	Temp Model	0	Ext Coef 1	I2	-32768	32767	-28285	s
Calibration	106	Temp Model	2	Ext Coef 2	I2	-32768	32767	20848	s
Calibration	106	Temp Model	4	Ext Coef 3	I2	-32768	32767	-7537	s
Calibration	106	Temp Model	6	Ext Coef 4	I2	-32768	32767	4012	s
Calibration	106	Temp Model	8	Ext Min AD	I2	-32768	32767	0	s
Calibration	106	Temp Model	10	Ext Max Temp	I2	-32768	32767	4012	s
Calibration	106	Temp Model	12	Int Coef 1	I2	-32768	32767	0	s
Calibration	106	Temp Model	14	Int Coef 2	I2	-32768	32767	0	s
Calibration	106	Temp Model	16	Int Coef 3	I2	-32768	32767	-11136	s
Calibration	106	Temp Model	18	Int Coef 4	I2	-32768	32767	5754	s
Calibration	106	Temp Model	20	Int Min AD	I2	-32768	32767	0	s
Calibration	106	Temp Model	22	Int Max Temp	I2	-32768	32767	5754	s
Calibration	107	Current	0	Filter	U1	0	255	239	
Calibration	107	Current	1	Deadband	U1	0	255	3	mA
Calibration	107	Current	2	CC Deadband	U1	0	255	34	294 nV

Glossary

ADC	Analog to Digital Converter
AFE	Analog Front End
alert	a warning set by the bq20z90-V110
bit	a single bit in a SBS command or Data Flash value which can be changed by the user
CC	Coulomb Counter
CHG FET	charge FET, connected to the CHG pin of the bq29330; used by the bq29330 to enable or disable charging
COV	Cell Over Voltage
CPU	Central Processing Unit
CUV	Cell Under Voltage
DF	Data Flash
DSG	flag set by the bq20z90-V110 to indicate charge (DSG= 0) or discharge (DSG=1)
DSG FET	discharge FET, connected to the DSG pin of the bq29330; used by the bq29330 to enable or disable discharging
FAS	Full Access Security
FBF	Fuse Blow Failure
FC	Fully Charged
FCHG	Fast Charge
FCMTO	Fast Charge Timeout
FD	Fully Discharged
flag	a single bit in a SBS command or Data Flash value which is set by the bq20z90-V110 or the bq29330 and indicates a status change
IC	Integrated Circuit
LED	Light Emitting Diode
Li-Ion	Lithium-Ion
NR	Non-Removable
OC	Over Current
OCA	Over Charge Alarm
OCV	Open Circuit Voltage
OTC	Over Temperature Charging
OTD	Over Temperature Discharging

PCHG	Pre-Charge
PCMTO	Pre-Charge Timeout
PEC	Packet Error Checking
PF	Permanent Fail
POV	Pack Over Voltage
PRES	System Present Flag
PUV	Pack Under Voltage
Qmax	Maximum Chemical Capacity
RCA	Remaining Capacity Alarm
RSOC	Relative State of Charge
SBS	Smart Battery System
SCC	Short Circuit Charge
SCD	Short Circuit Discharge
SMBus	System Management Bus
SOC	Safety Over Current
SOT	Safety Over Temperature
SS	Sealed mode flag
TCA	Terminate Charge Alarm
TDA	Terminate Discharge Alarm
ZVCHG FET	pre- charge FET, connected to the ZVCHG pin of the bq29330; depending on the configuration it is used for pre-charging and/or zero-volt charging
XDSG	Discharge Fault flag

Revision History

Changes from Original (June 2006) to A Revision	Page
• Changed COV Time maximum value.....	104
• Changed POV Time maximum value.....	105
• Changed CUV Time maximum value.....	107
• Changed PUV Time maximum value.....	108
• Changed OC (1st Tier) Chg Time maximum value.....	109
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