bq20z75-v180 Addendum to bq20z75-v160

Technical Reference Manual

Literature Number: SLUU411
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Preface

This document is an addendum to the *bq20z75-v160 Technical Reference Manual* (SLUU310), and contains the feature additions and changes between the bq20z75-v160 and the bq20z75-v180. The bq20z75-v180 is an Impedance Track™ gas gauge IC that is based on the previously released bq20z75-v160.

1.1 EV Software

The bq20z75-v180 changes the configuration of data flash over the bq20z75-v160; therefore, it is required to have updated evaluation (EV) software compatible with the bq20z75-v180.

1.2 References

- bq20z75-v180 Datasheet: SLUSA22
- bq20z75-v160 Technical Reference Manual: SLUU310
- bq20z75-v160 to bq20z75-v180 Change Document: SLUA578

1.3 Summary of Changes

The bq20z75-v180 contains the following changes, based off of the bq20z75-v160 firmware. Otherwise, the device operates and functions as the bq20z75-v160.

1.4 Features

- Minor enhancements and corrections have been added to the Impedance Track algorithm
- Some previously non-programmable constants have been made programmable

1.5 DF Settings Changes

- Added **CUV Time** DF setting
- Added **OC (1st Tier) Dsg Time DF** setting
- Added **Shutdown Time** DF setting
- Added **Shutdown Cell Time** DF setting
- Added **Average Current Last Run** DF setting
- Added **Average Power Last Run** DF setting

1.6 Gas Gauging Offset Changes

The bq20z75-v180 update adds additional internal use variables to the Gas Gauging section, so the data flash offsets change as follows:

Parameter	from (v160)	to (v180)
Term Voltage	Offset 45	Offset 46
User Rate-mA	Offset 60	Offset 63
User Rate-mW	Offset 63	Offset 65
Reserve Cap-mAh	Offset 64	Offset 67
Reserve Cap-mWh	Offset 66	Offset 69

Feature Description

This section explains the feature changes from the bq20z75-v160 to the bq20z75-v180 devices.

2.1 1st Level Protection Features

2.1.1 Cell Overvoltage and Cell Undervoltage

The bq20z75-v180 can detect cell overvoltage/undervoltage and protect battery cells from damage from battery cell overvoltage/undervoltage. If *Voltage* remains over the corresponding threshold for a period of 2s, the bq20z75-v180 goes into the pack overvoltage condition and switches off the CHG FET. If *Voltage* remains under the corresponding threshold for a period configured in CUV Time, the bq20z75-v180 goes into the pack undervoltage condition and switches off the DSG FET.

The bq20z75-v180 recovers from a cell overvoltage condition if all the cell voltages drop below the cell overvoltage recovery threshold. The bq20z75-v180 recovers from cell undervoltage condition if all the cell voltages rise above the cell undervoltage recovery threshold.

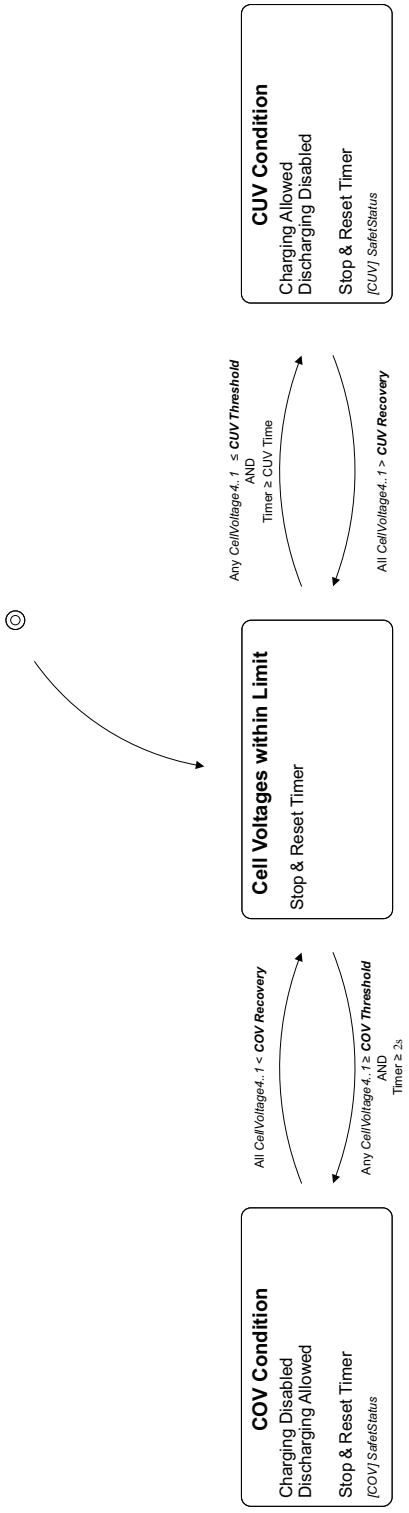

Figure 2-1. COV and CUV

Table 2-1. COV and CUV

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

The bq20z75-v180 indicates cell over voltage condition by setting the *[COV]* flag in *SafetyStatus* if any *CellVoltage4..1* reaches or surpasses the `COV Threshold` limit during charging and stays above `COV Threshold` limit for 2s.

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

The bq20z75-v180 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 the 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 bq20z75-v180 indicates cell under voltage by setting the *[CUV]* flag in *SafetyStatus* if any *CellVoltage4..1* reaches or drops below the `CUV Threshold` limit during discharging and stays below `CUV Threshold` limit `CUV Time`.

In cell under voltage condition, discharging is disabled and DSG FET is turned off and ZVCHG FET (if used) is turned on, *ChargingCurrent* is set to `Pre-chg Current`, *[TDA]* and *[FD]* flags in *BatteryStatus* and the *[CUV]* flag in *SafetyStatus* are set.

The bq20z75-v180 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 the 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 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:SafetyStatus(0x51)[CUV],[COV]

- SBS:OperationStatus(0x54)[XDSG]

2.1.1.1 CUV Time (Offset 14)

If *[CUV]* in *SafetyAlert* time period exceeds ***CUV Time*** the bq20z75-v180 goes into a cell under voltage condition. This function is disabled if ***CUV Time*** is set to 0.

Table 2-2. 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	s

2.2 Over Current (1st Tier) in Discharge Delay Time Programmable

2.2.1 Charge and Discharge Overcurrent

The bq20z75-v180 has overcurrent protection for charge and discharge. This requires that 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 the Over Current Delay.

Table 2-3. Charge and Discharge Overcurrent

Protection	OC Threshold	OC Time Limit	OC Recovery Threshold	*SafetyStatus* Flag
Tier-1 Charge	***OC (1st Tier)Chg***	2 s	100 mA	*[OCC]*
Tier-1 Discharge	***OC (1st Tier) Dsg***	***OC (1st Tier) DsgTime***	–100 mA	*[OCD]*
Tier-3 Discharge	***AFE OC Dsg***	***AFE OC Dsg Time***	–100 mA for ***Current Recovery Time***	*[AOCD]*

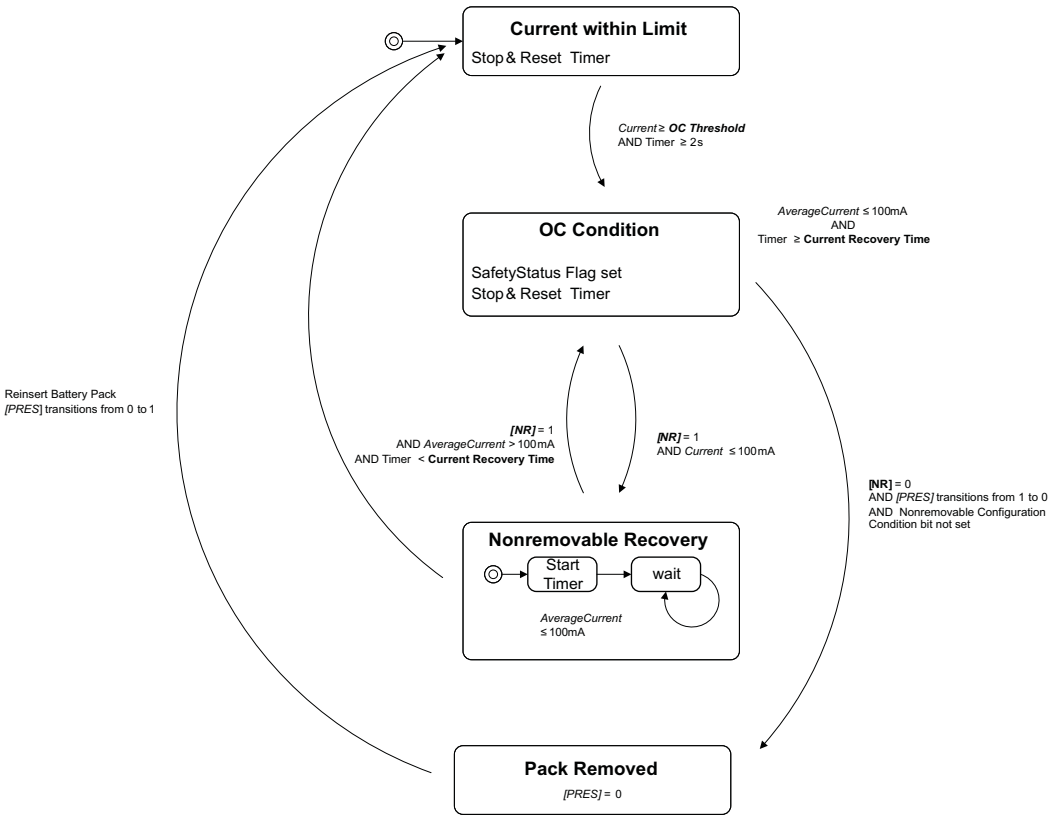

Figure 2-2. OC Protection

For overcurrent protection, the specific flag in *SafetyStatus* is set if the *Current* stays above the OC Threshold limit for at least OC Time Limit.

After 2s of excessive current detection during charging, the CHG FET is turned off and ZVCHG FET (if used) 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 *[OCC]* flag is set.

However, when the bq20z75-v180 has *[OCC]* flag in *SafetyStatus* set, the CHG FET is turned on again during discharge (*Current* ≤ (–) ***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]*** flag.

After ***OC (1st Tier) Dsg Time*** of excessive current detection during discharging, the DSG FET is turned off and the ZVCHG FET (if used) is turned on. When this occurs the *AFE_Current_Fault* timer is started from 0, *ChargingCurrent* is set to `Pre-chg Current`, *[XDSG]* flag is set, *[TDA]* flag is set, and *[OCD]* flag is set.

When the bq29330 detects a discharge-overcurrent fault, the charge and discharge FETs are turned off, the XALERT pin of the bq20z75-v180 is driven low by the XALERT pin of the bq29330, and the bq29330 is interrogated. When the bq20z75-v180 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 bq20z75-v180 has either *[OCD]*, *[AOCD]* set, the DSG FET is turned on again during charging (*Current* ≥ `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 2-4. Overcurrent Conditions

Protection	Condition	Flags			FET	Charging Current	Charging Voltage
		SafetyStatus	*BatteryStatus*	*OperationStatus*			
Tier-1 Charge	OC Condition	*[OCC]*	*[TCA]*		CHG FET disabled, enabled during discharge	0	0
Tier-1 Discharge	OC Condition	*[OCD]*	*[TDA]*	*[XDSG]*	DSG FET disabled, enabled during charge	***Pre-chg Current***	charging algorithm
Tier-3 Discharge	OC Condition	*[AOCD]*	*[TDA]*	*[XDSG]*	CHG FET and DSG FET disabled	0	charging algorithm

The bq20z75-v180 can individually configure each overcurrent-protection feature to recover via two different methods based on ***[NR]*** bit.

Standard Recovery, when ***[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 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 when ***[NR]*** = 1. The state of ***Non-Removable Cfg*** has no consequence. This recovery requires *AverageCurrent* to be ≤ 100 mA during charging and *AverageCurrent* to be ≥ (-) 100 mA during discharging, and for the *AFE_Current_Fault* timer ≥ ***Current Recovery Time***.

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.

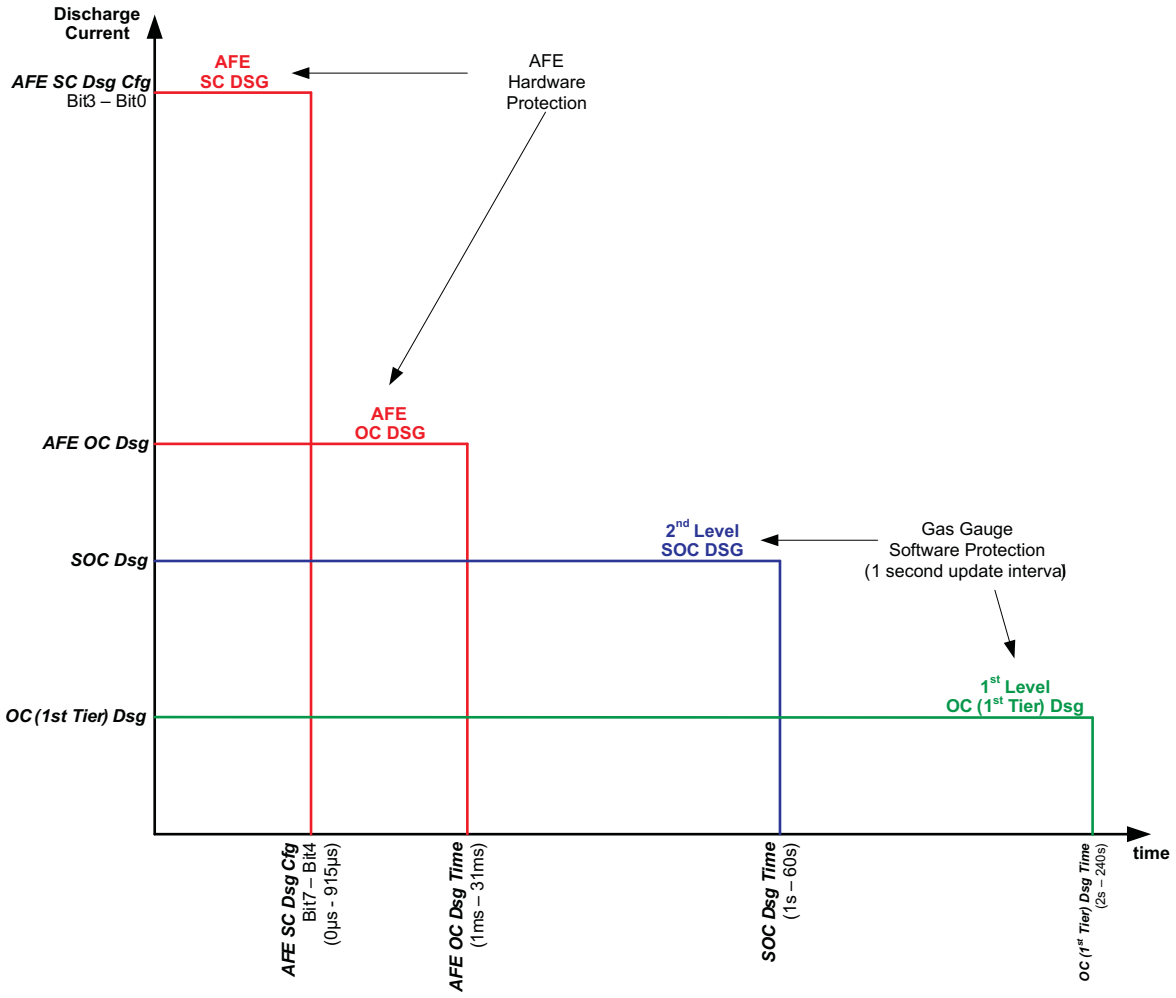

Figure 2-3. Overcurrent Protection Levels

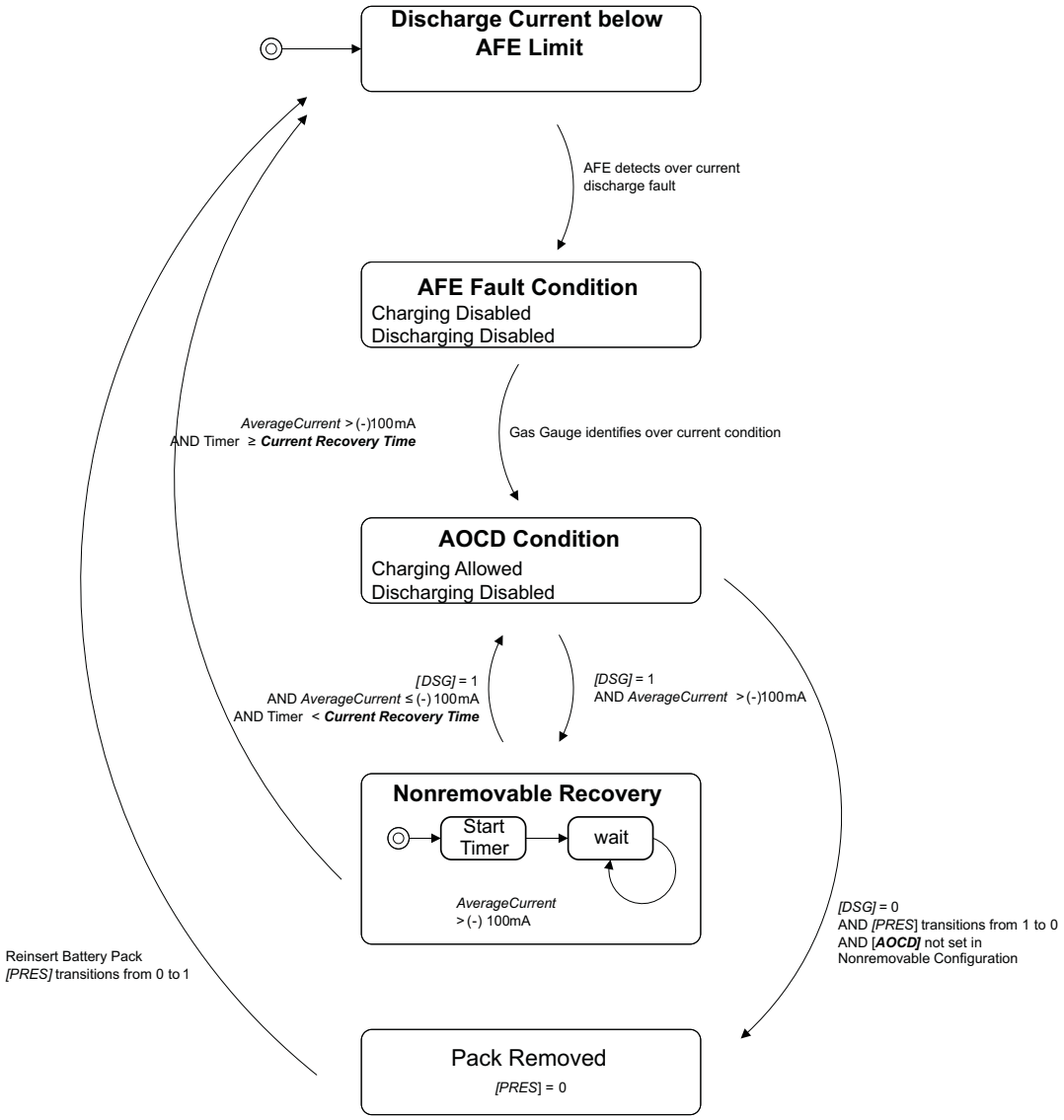

Figure 2-4. AFE Discharge Over Current Protection

Related Variables:

- DF:1st Level Safety:Current(1):OC(1st Tier) Chg(0)
- DF:1st Level Safety:Current(1):OC(1st Tier) Dsg(5)
- DF:1st Level Safety:Current(1):OC(1st Tier) Dsg Time(7)
- 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: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:SafetyStatus(0x51)[OCC],[OCD],[AOCD]
- SBS:OperationStatus(0x54)[XDSG]

2.2.2 OC(1st Tier) Dsg (Offset 7)

The bq20z75-v180 sets the *[OCD] SafetyAlert* if the discharge *Current* is equal to or higher than the ***OC (1st Tier) Dsg*** threshold.

Table 2-5. 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	s

2.3 Shutdown Time and Cell Shutdown Time Programmable

2.3.1 Shutdown Mode

The bq20z75-v180 enters Shutdown mode if the following conditions are met:

- ***[SHUTV]*** in ***Operation Cfg C*** is 0 AND *Voltage* ≤ ***Shutdown Voltage*** AND *Current* ≤ 0 for a period greater than ***Shutdown Time***.

  OR
- ***[SHUTV]*** in ***Operation Cfg C*** is 1 AND Min (*CellVoltage4..1*) ≤ ***Cell Shutdown Voltage*** and *Current* ≤ 0 for a period greater than ***Cell Shutdown Time***.

  OR
- (*ManufacturerAccess* shutdown command received AND *Current* = 0) AND voltage at the bq29330 PACK pin < ***Charger Present*** threshold.

When the bq20z75-v180 meets these conditions, the CHG, DSG, and ZVCHG FETs are turned off, and the bq29330 is commanded to shut down. In Shutdown mode, the bq20z75-v180 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 bq20z75-v180, the *[WAKE]* flag is set, and the bq29330 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):Cell Shutdown Voltage(5)
- DF:Power:Power(68):Cell Shutdown Time(7)
- DF:Power:Power(68):Charger Present(8)
- DF:Configuration:Registers(64):Operation Cfg B(2)[NR]
- DF:Configuration:Registers(64):Operation Cfg C(4)[SHUTV]
- SBS:Voltage(0x09)
- SBS:Current(0x0a)
- SBS:BatteryStatus(0x16)[INIT]
- SBS:CellVoltage4(0x3c)
- SBS:CellVoltage3(0x3d)
- SBS:CellVoltage2(0x3e)

- SBS:CellVoltage1(0x3f)
- SBS:OperationStatus(0x54)[PRES],[WAKE]

2.3.2 Shutdown Time (Offset 4)

The bq20z75-v180 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 2-6. 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	s

2.3.3 Cell Shutdown Time (Offset 7)

The bq20z75-v180 goes into shutdown mode if Min (*CellVoltage4..1*) is equal to or less than ***Cell Shutdown Voltage*** for 10s and has been out of shutdown mode for at least ***Cell Shutdown Time***.

Table 2-7. Shutdown Voltage

Subclass ID	Subclass Name	Offset	Name	Format	Size in Bytes	Min Value	Max Value	Default Value	Unit
68	Power	7	Cell Shutdown Time	unsigned integer	1	0	240	10	s

2.4 Stored Avg I Last Run and Avg P Last Run Accessible

2.4.1 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 bq20z75-v180 needs to be configured for whatever current (or power) will flow in the future. While it can not be exactly known, the bq20z75-v180 can use load history such as the average current of the present discharge to make a sufficiently accurate prediction. The bq20z75-v180 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.

2.4.2 Load Select (Offset 0)

This value defines the load compensation model used by the Impedance Track™ algorithm for remaining capacity calculation.

Load Select	**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	*Current*	*Current* x *Voltage*
3	*AverageCurrent* (default)	*AverageCurrent* x average *Voltage*

4	***Design Capacity*** / 5	***Design Energy*** / 5
5	*AtRate* (mA)	*AtRate* (10 mW)
6	***User Rate-mA***	***User Rate-mWh***

2.4.3 Avg I Last Run (Offset 21)

The bq20z75-v180 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 2-8. 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

2.4.4 Avg P Last Run (Offset 23)

The bq20z75 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 2-9. 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 mA

Data Flash

A.1 Data Flash Values

Table A-1. 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	3500	5000	4300	mV
1st Level Safety	0	Voltage	3	COV Recovery	I2	0	4400	3900	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	1	Current	0	OC (1st Tier) Chg	I2	0	20000	6000	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	16	Current Recovery Time	U1	0	240	8	s
1st Level Safety	1	Current	17	AFE OC Dsg	H1	0x00	0xFF	0x12	hex
1st Level Safety	1	Current	18	AFE OC Dsg Time	H1	0x00	0xFF	0x0F	hex
1st Level Safety	1	Current	21	AFE SC Chg Cfg	H1	0x00	0xFF	0x77	hex
1st Level Safety	1	Current	22	AFE SC Dsg Cfg	H1	0x00	0xFF	0x77	hex
1st Level Safety	2	Temperature	0	Over Temp Chg	I2	0	120	55	°degC
1st Level Safety	2	Temperature	3	OT Chg Recovery	I2	0	120	50	°degC
1st Level Safety	2	Temperature	5	Over Temp Dsg	I2	0	120	60	°degC
1st Level Safety	2	Temperature	8	OT Dsg Recovery	I2	0	120	55	°degC
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	Min CIM-check voltage	U2	0	65535	3000	mV
2nd Level Safety	16	Voltage	11	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	120	65	°degC
2nd Level Safety	18	Temperature	2	SOT Chg Time	U1	0	240	0	s
2nd Level Safety	18	Temperature	3	SOT Dsg	I2	0	120	75	°degC
2nd Level Safety	18	Temperature	5	SOT Dsg Time	U1	0	240	0	s
2nd Level Safety	19	FET Verification	2	FET Fail Time	U1	0	240	0	s
2nd Level Safety	20	AFE Verification	1	AFE Fail Limit	U1	0	255	10	num
Charge Control	32	Charge Inhibit Cfg	0	Chg Inhibit Temp Low	I2	–40	120	0	°degC
Charge Control	32	Charge Inhibit Cfg	2	Chg Inhibit Temp High	I2	–40	120	45	°degC
Charge Control	32	Charge Inhibit Cfg	4	Temp Hys	I2	0	10	5	°degC
Charge Control	33	Pre-Charge Cfg	0	Pre-chg Current	I2	0	2000	250	mA

Table A-1. Data Flash Values (continued)

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
Charge Control	33	Pre-Charge Cfg	2	Pre-chg Temp	I2	–40	120	12	°degC
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	20000	4000	mA
Charge Control	34	Fast Charge Cfg	2	Charging Voltage	I2	0	20000	16800	mV
Charge Control	34	Fast Charge Cfg	6	Suspend Low Temp	I2	–40	120	–5	°degC
Charge Control	34	Fast Charge Cfg	8	Suspend High Temp	I2	–40	120	55	°degC
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.	10	TCA Clear %	I1	–1	100	95	%
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	1350	s/mAH
Charge Control	38	Charging Faults	13	Over Charge Capacity	I2	0	4000	300	mAh
SBS Configuration	48	Data	0	Rem Cap Alarm	I2	0	1200	300	mAh
SBS Configuration	48	Data	2	Rem Energy Alarm	I2	0	1000	432	mWH
SBS Configuration	48	Data	4	Rem Time Alarm	U2	0	240	10	Min
SBS Configuration	48	Data	6	Init Battery Mode	H2	0x0000	0xFFFF	0x0081	hex
SBS Configuration	48	Data	8	Design Voltage	I2	7000	18000	14400	mV
SBS Configuration	48	Data	10	Spec Info	H2	0x0000	0xFFFF	0x0031	hex
SBS Configuration	48	Data	12	Manuf Date	U2	0	65535	0	date
SBS Configuration	48	Data	14	Ser. Num.	H2	0x0000	0xFFFF	0x0001	hex
SBS Configuration	48	Data	16	Cycle Count	U2	0	65535	0	num
SBS Configuration	48	Data	18	CC Threshold	I2	100	32767	4400	mAh
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	mWH
SBS Configuration	48	Data	26	Manuf Name	S12			Texas Instruments	
SBS Configuration	48	Data	38	Device Name	S8			bq20z75	
SBS Configuration	48	Data	46	Device Chemistry	S5			LION	
SBS Configuration	49	Configuration	0	TDA Set %	I1	–1	100	6	%
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	0	s
SBS Configuration	49	Configuration	7	TDA Clear Volt	I2	0	16800	5500	mV
System Data	58	Manufacturer Info	0	Manuf. Info	S33			0123456789ABCDEF 01233456789ABCDE	
System Data	59	Lifetime Data	0	Lifetime Max Temp	I2	0	140	30	°degC
System Data	59	Lifetime Data	2	Lifetime Min Temp	I2	–60	140	20	°degC
Configuration	64	Registers	0	Operation Cfg A	H2	0x0000	0xFFFF	0x0329	flg
Configuration	64	Registers	2	Operation Cfg B	H2	0x0000	0xFFFF	0x2440	flg
Configuration	64	Registers	4	Operation Cfg C	H2	0x0000	0xFFFF	0x0000	flg
Configuration	64	Registers	6	Permanent Fail Cfg	H2	0x0000	0xFFFF	0x0000	flg
Configuration	64	Registers	8	Non-Removable Cfg	H2	0x0000	0xFFFF	0x0000	hex
Configuration	65	AFE	1	AFE.State_CTL	H1	0x00	0xFF	0x00	flg
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	240	10	s
Power	68	Power	5	Cell Shutdown Voltage	I2	0	5000	1750	mV
Power	68	Power	7	Cell Shutdown Time	U1	0	240	10	s

Table A-1. Data Flash Values (continued)

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
Power	68	Power	8	Charger Present	I2	0	23000	3000	mV
Power	68	Power	10	Sleep Current	I2	0	100	10	mA
Power	68	Power	19	Wake Current Reg	H1	0x00	0x255	0x00	num
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	46	Term Voltage	I2	–32768	32767	12000	mV
Gas Gauging	80	IT Cfg	63	User Rate-mA	I2	–9000	0	0	mA
Gas Gauging	80	IT Cfg	65	User Rate-mW	I2	–32768	0	0	mW
Gas Gauging	80	IT Cfg	67	Reserve Cap-mAh	I2	0	9000	0	mAh
Gas Gauging	80	IT Cfg	69	Reserve Cap-mWh	I2	0	14000	0	mWh
Gas Gauging	81	Current Thresholds	0	Dsg Current Threshold	I2	0	2000	50	mA
Gas Gauging	81	Current Thresholds	2	Chg Current Threshold	I2	0	2000	25	mA
Gas Gauging	81	Current Thresholds	4	Quit Current	I2	0	1000	10	mA
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	num
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	mA
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	
Ra Table	88	R_a0	2	Cell0 R_a 0	I2	183	183	160	977 µ
Ra Table	88	R_a0	4	Cell0 R_a 1	I2	181	181	166	977 µ
Ra Table	88	R_a0	6	Cell0 R_a 2	I2	198	198	153	977 µ
Ra Table	88	R_a0	8	Cell0 R_a 3	I2	244	244	151	977 µ
Ra Table	88	R_a0	10	Cell0 R_a 4	I2	254	254	145	977 µ
Ra Table	88	R_a0	12	Cell0 R_a 5	I2	261	261	152	977 µ
Ra Table	88	R_a0	14	Cell0 R_a 6	I2	333	333	176	977 µ
Ra Table	88	R_a0	16	Cell0 R_a 7	I2	338	338	204	977 µ
Ra Table	88	R_a0	18	Cell0 R_a 8	I2	345	345	222	977 µ
Ra Table	88	R_a0	20	Cell0 R_a 9	I2	350	350	254	977 µ
Ra Table	88	R_a0	22	Cell0 R_a 10	I2	382	382	315	977 µ
Ra Table	88	R_a0	24	Cell0 R_a 11	I2	429	429	437	977 µ
Ra Table	88	R_a0	26	Cell0 R_a 12	I2	502	502	651	977 µ
Ra Table	88	R_a0	28	Cell0 R_a 13	I2	545	545	1001	977 µ
Ra Table	88	R_a0	30	Cell0 R_a 14	I2	366	366	1458	977 µ
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	977 µ
Ra Table	89	R_a1	4	Cell1 R_a 1	I2	181	181	166	977 µ
Ra Table	89	R_a1	6	Cell1 R_a 2	I2	198	198	153	977 µ
Ra Table	89	R_a1	8	Cell1 R_a 3	I2	244	244	151	977 µ
Ra Table	89	R_a1	10	Cell1 R_a 4	I2	254	254	145	977 µ
Ra Table	89	R_a1	12	Cell1 R_a 5	I2	261	261	152	977 µ
Ra Table	89	R_a1	14	Cell1 R_a 6	I2	333	333	176	977 µ
Ra Table	89	R_a1	16	Cell1 R_a 7	I2	338	338	204	977 µ
Ra Table	89	R_a1	18	Cell1 R_a 8	I2	345	345	222	977 µ
Ra Table	89	R_a1	20	Cell1 R_a 9	I2	350	350	254	977 µ
Ra Table	89	R_a1	22	Cell1 R_a 10	I2	382	382	315	977 µ
Ra Table	89	R_a1	24	Cell1 R_a 11	I2	429	429	437	977 µ

Table A-1. Data Flash Values (continued)

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
Ra Table	89	R_a1	26	Cell1 R_a 12	I2	502	502	651	977 µ
Ra Table	89	R_a1	28	Cell1 R_a 13	I2	545	545	1001	977 µ
Ra Table	89	R_a1	30	Cell1 R_a 14	I2	366	366	1458	977 µ
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	977 µ
Ra Table	90	R_a2	4	Cell2 R_a 1	I2	181	181	166	977 µ
Ra Table	90	R_a2	6	Cell2 R_a 2	I2	198	198	153	977 µ
Ra Table	90	R_a2	8	Cell2 R_a 3	I2	244	244	151	977 µ
Ra Table	90	R_a2	10	Cell2 R_a 4	I2	254	254	145	977 µ
Ra Table	90	R_a2	12	Cell2 R_a 5	I2	261	261	152	977 µ
Ra Table	90	R_a2	14	Cell2 R_a 6	I2	333	333	176	977 µ
Ra Table	90	R_a2	16	Cell2 R_a 7	I2	338	338	204	977 µ
Ra Table	90	R_a2	18	Cell2 R_a 8	I2	345	345	222	977 µ
Ra Table	90	R_a2	20	Cell2 R_a 9	I2	350	350	254	977 µ
Ra Table	90	R_a2	22	Cell2 R_a 10	I2	382	382	315	977 µ
Ra Table	90	R_a2	24	Cell2 R_a 11	I2	429	429	437	977 µ
Ra Table	90	R_a2	26	Cell2 R_a 12	I2	502	502	651	977 µ
Ra Table	90	R_a2	28	Cell2 R_a 13	I2	545	545	1001	977 µ
Ra Table	90	R_a2	30	Cell2 R_a 14	I2	366	366	1458	977 µ
Ra Table	91	R_a3	0	Cell3 R_a flag	H2	0x0000	0x0000	0xFF55	
Ra Table	91	R_a3	2	Cell3 R_a 0	I2	183	183	160	977 µ
Ra Table	91	R_a3	4	Cell3 R_a 1	I2	181	181	166	977 µ
Ra Table	91	R_a3	6	Cell3 R_a 2	I2	198	198	153	977 µ
Ra Table	91	R_a3	8	Cell3 R_a 3	I2	244	244	151	977 µ
Ra Table	91	R_a3	10	Cell3 R_a 4	I2	254	254	145	977 µ
Ra Table	91	R_a3	12	Cell3 R_a 5	I2	261	261	152	977 µ
Ra Table	91	R_a3	14	Cell3 R_a 6	I2	333	333	176	977 µ
Ra Table	91	R_a3	16	Cell3 R_a 7	I2	338	338	204	977 µ
Ra Table	91	R_a3	18	Cell3 R_a 8	I2	345	345	222	977 µ
Ra Table	91	R_a3	20	Cell3 R_a 9	I2	350	350	254	977 µ
Ra Table	91	R_a3	22	Cell3 R_a 10	I2	382	382	315	977 µ
Ra Table	91	R_a3	24	Cell3 R_a 11	I2	429	429	437	977 µ
Ra Table	91	R_a3	26	Cell3 R_a 12	I2	502	502	651	977 µ
Ra Table	91	R_a3	28	Cell3 R_a 13	I2	545	545	1001	977 µ
Ra Table	91	R_a3	30	Cell3 R_a 14	I2	366	366	1458	977 µ
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	977 µ
Ra Table	92	R_a0x	4	xCell0 R_a 1	I2	181	181	166	977 µ
Ra Table	92	R_a0x	6	xCell0 R_a 2	I2	198	198	153	977 µ
Ra Table	92	R_a0x	8	xCell0 R_a 3	I2	244	244	151	977 µ
Ra Table	92	R_a0x	10	xCell0 R_a 4	I2	254	254	145	977 µ
Ra Table	92	R_a0x	12	xCell0 R_a 5	I2	261	261	152	977 µ
Ra Table	92	R_a0x	14	xCell0 R_a 6	I2	333	333	176	977 µ
Ra Table	92	R_a0x	16	xCell0 R_a 7	I2	338	338	204	977 µ
Ra Table	92	R_a0x	18	xCell0 R_a 8	I2	345	345	222	977 µ
Ra Table	92	R_a0x	20	xCell0 R_a 9	I2	350	350	254	977 µ
Ra Table	92	R_a0x	22	xCell0 R_a 10	I2	382	382	315	977 µ
Ra Table	92	R_a0x	24	xCell0 R_a 11	I2	429	429	437	977 µ
Ra Table	92	R_a0x	26	xCell0 R_a 12	I2	502	502	651	977 µ
Ra Table	92	R_a0x	28	xCell0 R_a 13	I2	545	545	1001	977 µ
Ra Table	92	R_a0x	30	xCell0 R_a 14	I2	366	366	1458	977 µ

Table A-1. Data Flash Values (continued)

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
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	977 µ
Ra Table	93	R_a1x	4	xCell1 R_a 1	I2	181	181	166	977 µ
Ra Table	93	R_a1x	6	xCell1 R_a 2	I2	198	198	153	977 µ
Ra Table	93	R_a1x	8	xCell1 R_a 3	I2	244	244	151	977 µ
Ra Table	93	R_a1x	10	xCell1 R_a 4	I2	254	254	145	977 µ
Ra Table	93	R_a1x	12	xCell1 R_a 5	I2	261	261	152	977 µ
Ra Table	93	R_a1x	14	xCell1 R_a 6	I2	333	333	176	977 µ
Ra Table	93	R_a1x	16	xCell1 R_a 7	I2	338	338	204	977 µ
Ra Table	93	R_a1x	18	xCell1 R_a 8	I2	345	345	222	977 µ
Ra Table	93	R_a1x	20	xCell1 R_a 9	I2	350	350	254	977 µ
Ra Table	93	R_a1x	22	xCell1 R_a 10	I2	382	382	315	977 µ
Ra Table	93	R_a1x	24	xCell1 R_a 11	I2	429	429	437	977 µ
Ra Table	93	R_a1x	26	xCell1 R_a 12	I2	502	502	651	977 µ
Ra Table	93	R_a1x	28	xCell1 R_a 13	I2	545	545	1001	977 µ
Ra Table	93	R_a1x	30	xCell1 R_a 14	I2	366	366	1458	977 µ
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	977 µ
Ra Table	94	R_a2x	4	xCell2 R_a 1	I2	181	181	166	977 µ
Ra Table	94	R_a2x	6	xCell2 R_a 2	I2	198	198	153	977 µ
Ra Table	94	R_a2x	8	xCell2 R_a 3	I2	244	244	151	977 µ
Ra Table	94	R_a2x	10	xCell2 R_a 4	I2	254	254	145	977 µ
Ra Table	94	R_a2x	12	xCell2 R_a 5	I2	261	261	152	977 µ
Ra Table	94	R_a2x	14	xCell2 R_a 6	I2	333	333	176	977 µ
Ra Table	94	R_a2x	16	xCell2 R_a 7	I2	338	338	204	977 µ
Ra Table	94	R_a2x	18	xCell2 R_a 8	I2	345	345	222	977 µ
Ra Table	94	R_a2x	20	xCell2 R_a 9	I2	350	350	254	977 µ
Ra Table	94	R_a2x	22	xCell2 R_a 10	I2	382	382	315	977 µ
Ra Table	94	R_a2x	24	xCell2 R_a 11	I2	429	429	437	977 µ
Ra Table	94	R_a2x	26	xCell2 R_a 12	I2	502	502	651	977 µ
Ra Table	94	R_a2x	28	xCell2 R_a 13	I2	545	545	1001	977 µ
Ra Table	94	R_a2x	30	xCell2 R_a 14	I2	366	366	1458	977 µ
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	977 µ
Ra Table	95	R_a3x	4	xCell3 R_a 1	I2	181	181	166	977 µ
Ra Table	95	R_a3x	6	xCell3 R_a 2	I2	198	198	153	977 µ
Ra Table	95	R_a3x	8	xCell3 R_a 3	I2	244	244	151	977 µ
Ra Table	95	R_a3x	10	xCell3 R_a 4	I2	254	254	145	977 µ
Ra Table	95	R_a3x	12	xCell3 R_a 5	I2	261	261	152	977 µ
Ra Table	95	R_a3x	14	xCell3 R_a 6	I2	333	333	176	977 µ
Ra Table	95	R_a3x	16	xCell3 R_a 7	I2	338	338	204	977 µ
Ra Table	95	R_a3x	18	xCell3 R_a 8	I2	345	345	222	977 µ
Ra Table	95	R_a3x	20	xCell3 R_a 9	I2	350	350	254	977 µ
Ra Table	95	R_a3x	22	xCell3 R_a 10	I2	382	382	315	977 µ
Ra Table	95	R_a3x	24	xCell3 R_a 11	I2	429	429	437	977 µ
Ra Table	95	R_a3x	26	xCell3 R_a 12	I2	502	502	651	977 µ
Ra Table	95	R_a3x	28	xCell3 R_a 13	I2	545	545	1001	977 µ
Ra Table	95	R_a3x	30	xCell3 R_a 14	I2	366	366	1458	977 µ
PF Status	96	Device Status Data	0	PF Flags 1	H2	0x0000	0xFFFF	0x0000	flg
PF Status	96	Device Status Data	28	PF Flags 2	H2	0x0000	0xFFFF	0x0000	flg
Calibration	104	Data	0	CC Gain	F4	0.1	4	0.9419	mohm

Table A-1. Data Flash Values (continued)

Class	Subclass ID	Subclass	Offset	Name	Data Type	Min Value	Max Value	Default Value	Units
Calibration	104	Data	4	CC Delta	F4	29826	1193046	280932.6	mohm
Calibration	104	Data	8	Ref Voltage	I2	0	32767	24500	mV
Calibration	104	Data	12	AFE Pack Gain	I2	0	32767	22050	µV/cnt
Calibration	104	Data	14	CC Offset	I2	–32768	32767	–1667	mV
Calibration	104	Data	16	Board Offset	I2	–32768	32767	0	µV
Calibration	104	Data	18	Int Temp Offset	I1	–128	127	0	degC
Calibration	104	Data	19	Ext1 Temp Offset	I1	–128	127	0	degC
Calibration	104	Data	20	Ext2 Temp Offset	I1	–128	127	0	degC
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	3276	298	°degK
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	ms
Calibration	105	Config	17	Cal Mode Timeout	U2	0	65535	38400	s
Calibration	106	Temp Model	0	Ext Coef 1	I2	–32768	32767	–28285	num
Calibration	106	Temp Model	2	Ext Coef 2	I2	–32768	32767	20848	num
Calibration	106	Temp Model	4	Ext Coef 3	I2	–32768	32767	–7537	num
Calibration	106	Temp Model	6	Ext Coef 4	I2	–32768	32767	4012	degK
Calibration	106	Temp Model	8	Ext Min AD	I2	–32768	32767	0	cnt
Calibration	106	Temp Model	10	Ext Max Temp	I2	–32768	32767	4012	°degK
Calibration	106	Temp Model	12	Int Coef 1	I2	–32768	32767	0	num
Calibration	106	Temp Model	14	Int Coef 2	I2	–32768	32767	0	num
Calibration	106	Temp Model	16	Int Coef 3	I2	–32768	32767	–11136	num
Calibration	106	Temp Model	18	Int Coef 4	I2	–32768	32767	5754	°degK
Calibration	106	Temp Model	20	Int Min AD	I2	–32768	32767	0	cnt
Calibration	106	Temp Model	22	Int Max Temp	I2	–32768	32767	5754	degK
Calibration	107	Current	0	Filter	U1	0	255	239	num
Calibration	107	Current	1	Deadband	U1	0	255	3	mA
Calibration	107	Current	2	CC Deadband	U1	0	255	34	µV

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