Application Report
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Configuring the bq20z80 Data Flash

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ABSTRACT

This application report presents the data flash constants for configuring the bq20z80 Smart Battery System (SBS)–compliant gas gauge device. A brief explanation of each option for the various features is included.

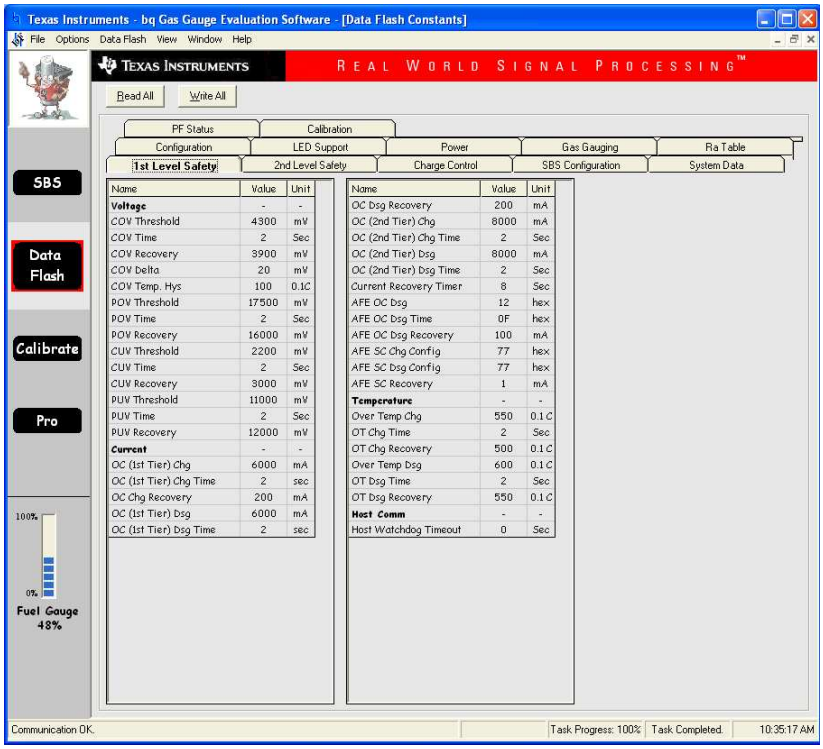
Contents

1 Introduction

The bq20z80 has numerous data flash constants that can configure the device with a variety of different options for most features. The bq20z80 data flash is organized into easy-to-read sections or classes with individual tabs highlighting each class. The existing classes and a description of each class are listed in the following pages.

2 Data Flash Descriptions

2.1 1st Level Safety



2.1.1 Voltage

COV Threshold

When any cell voltage reaches this threshold, then the Cell Over Voltage (COV) protection is triggered if the period when the threshold is exceeded is longer than programmed value in COV Time.

COV Time

See COV Threshold.

COV Recovery

To recover from COV protection, all cell voltages must be below the COV Threshold.

COV Delta

The COV Threshold is adjusted downward by this amount when SBS.Temperature( ) is within one COV Temp Hys. value of Over Temperature Threshold. If this time is set to 0, then the COV threshold is not modified based on temperature.

COV Temp Hys

See COV Delta.

POV Threshold

When the pack voltage rises up to this threshold, then the Pack Over Voltage (POV) protection is triggered if the period when the threshold is exceeded is longer than the POV Time.

POV Time

If POV Threshold is exceeded for this period of time, then the POV protection is triggered. If this time is set to 0, then the POV function is disabled.

POV Recovery

To recover from POV protection, the pack voltage must be below this threshold.

CUV Threshold

When any cell voltage decreases to this threshold, then the Cell Under Voltage (CUV) protection is triggered if the period when the threshold is exceeded is longer than the CUV Time.

CUV Time

If the CUV Threshold is exceeded for this period of time, then the CUV protection is triggered. If this time is set to 0, then the CUV function is disabled.

CUV Recovery

To recover from CUV protection, all cell voltages must exceed this threshold.

PUV Threshold

When the pack voltage decreases to this threshold, then the Pack Under Voltage (PUV) protection is triggered if the period when the threshold is exceeded is longer than the PUV Time.

PUV Time

If the PUV Threshold is exceeded for this period of time, then the PUV protection is triggered. If this time is set to 0, then the PUV function is disabled

PUV Recovery

To recover from PUV protection, SBS.Voltage( ) must be above this threshold.

2.1.2 Current

OC (1st Tier) Chg

When SBS.Current( ) reaches or exceeds this threshold during charging and remains there for a period of OC(1st Tier) Time Chg, then the 1st Tier Over Current Chg protection is triggered.

OC (1st Tier) Chg Time

If this time is set to 0, then the OC (1st Tier) Chg function is disabled.

OC Chg Recovery

To recover from either OC(1st Tier) Chg or OC(2nd Tier) Chg, SBS.Current( ) during charge must fall below this level.

OC (1st Tier) Dsg

When SBS.Current( ) reaches or exceeds this threshold during discharging and remains there for a period of OC(1st Tier) Time Dsg, then the 1st Tier Over Current Dsg protection is triggered.

OC (1st Tier) Dsg Time

If this time is set to 0, then the OC (1st Tier) Dsg function is disabled.

OC Dsg Recovery

To recover from either OC(1st Tier) Dsg or OC(2nd Tier) Dsg, SBS.Current( ) during discharge must fall below this level. This recovery method only works when DF.Operation Configuration, NR is set.

OC (2nd Tier) Chg

When SBS.Current( ) reaches or exceeds this threshold during charging and remains there for a period of OC(2nd Tier) Time Chg, then the 2nd Tier Over Current Chg protection is triggered.

OC (2nd Tier) Chg Time

If this time is set to 0, then the OC (2nd Tier) Chg function is disabled.

OC (2nd Tier) Dsg

When SBS.Current( ) reaches or exceeds this threshold during discharging and remains there for a period of OC(2nd Tier) Time Dsg, then the 2nd Tier Over Current Dsg protection is triggered.

OC (2nd Tier) Dsg Time

If this time is set to 0, then the OC (2nd Tier) Dsg function is disabled.

Current Recovery Timer

If the DF.Operation Config, NR bit is cleared, then OC (1st Tier) Dsg, OC (2nd Tier) Dsg, AFE OC Dsg, and AFE SC Dsg recover after this timer has expired. The timer begins when the first instance of the respective current threshold is exceeded.

AFE OC Dsg

The bq29312 Over Current protection threshold is set here. See the bq29312 data sheet (SLUS546) for further details.

AFE OC Dsg Time

The bq29312 Over Current protection delay time is set here. See the bq29312 data sheet (SLUS546) for further details.

AFE OC Dsg Recovery

To recover from AFE Over Current Discharge protection, SBS.Current( ) must fall below this threshold. This recovery method only works when DF.Operation Configuration, NR is set.

AFE SC Chg Config

The bq29312 Short Circuit in Charge protection threshold and delay is set here. See the bq29312 data sheet (SLUS546) for further details.

AFE SC Dsg Config

The bq29312 Short Circuit in Discharge protection threshold and delay is set here. See the bq29312 data sheet (SLUS546) for further details.

AFE SC Recovery

To recover from either AFE Short Circuit protection in charge or discharge, SBS.Current( ) must fall below this threshold. This recovery method only works when DF.Operation Configuration, NR is set.

2.1.3 Temperature

Over Temp Chg

When SBS.Temperature( ) reaches or exceeds this threshold during charging for a period and remains there for a period of OT Chg Time, then the Over Temperature in Charge protection is triggered.

OT Chg Time

If this time is set to 0, then the Over Temp Chg function is disabled

OT Chg Recovery

To recover from Over Temperature in Charge protection, SBS.Temperature( ) must fall below this threshold.

Over Temp Dsg

When SBS.Temperature( ) reaches or exceeds this threshold during discharging for a period and remains there for a period of OT Dsg Time, then the Over Temperature in Discharge protection is triggered.

OT Dsg Time

If this time is set to 0, then the Over Temp Dsg function is disabled.

OT Dsg Recovery

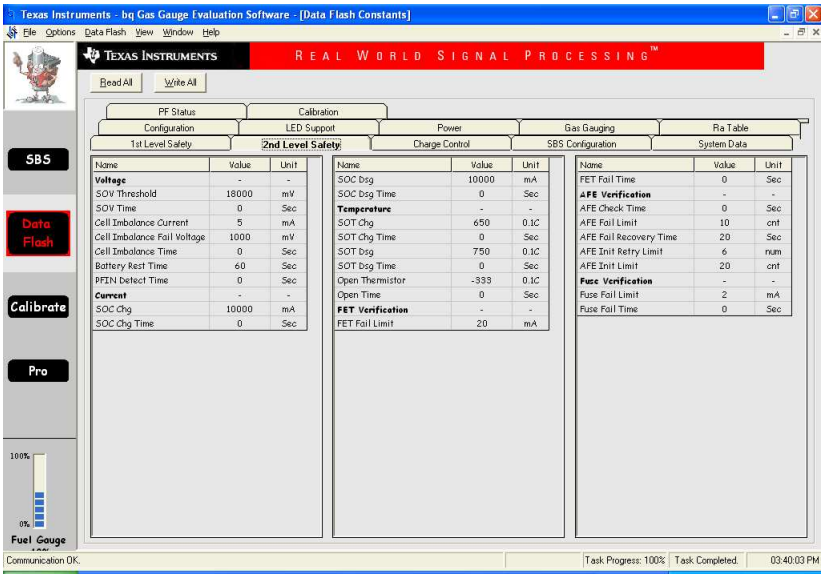
To recover from Over Temperature in Discharge protection, SBS.Temperature( ) must fall below this threshold.

2.1.4 Host Comm

Host Watchdog Timeout

If the host system does not communicate with the bq20z80 via the SMBus during this time, then the Host Watchdog protection is triggered.

2.2 2nd Level Safety



2.2.1 Voltage

SOV Threshold

When the pack voltage reaches this threshold, then the Safety Over Voltage (SOV) permanent failure protection is triggered if the period when the threshold is exceeded is longer than the SOV Delay.

SOV Time

If this time is set to 0, then the SOV function is disabled.

Cell Imbalance Current

Before detection of a Cell Imbalance fault, SBS.Current( ) must be at or below this value for the period of Battery Rest Time.

Cell Imbalance Fail Voltage

When the extremes of the SBS.VCELLx( ) are equal to or greater than this value for a time equal to or greater than the Cell Imbalance Time, then the Cell Imbalance Failure protection is triggered.

Cell Imbalance Time

See Cell Imbalance Fail Voltage.

Battery Rest Time

See Cell Imbalance Current

PFIN Detect Time

If the /PFIN input is detected to be low for this period, then the Permanent Failure Input protection is triggered. If this time is set to 0, then this feature is disabled.

2.2.2 Current

SOC Chg

When SBS.Current( ) reaches or exceeds this threshold during charging and remains there for a period of Safety Over Current (SOC) Chg Time, then the SOC Chg permanent failure is triggered.

SOC Chg Time

If this time is set to 0, then the SOC Chg function is disabled.

SOC Dsg

When SBS.Current( ) reaches or exceeds this threshold during discharging and remains there for a period of SOC Dsg Time, then the SOC Dsg permanent failure is triggered.

SOC Dsg Time

If this time is set to 0, then the SOC Dsg permanent failure is disabled.

2.2.3 Temperature

SOT Chg

When SBS.Temperature( ) reaches or exceeds this threshold during charging for a period and remains there for a period of Safety Over Temperature (SOT) Chg Time, then the SOT in Charge permanent failure is triggered.

SOT Chg Time

If this time is set to 0, then the SOT in Charge function is disabled.

SOT Dsg

When SBS.Temperature( ) reaches or exceeds this threshold during discharging and remains there for a period of SOT Dsg Time, then the SOT in Discharge permanent failure is triggered.

SOT Dsg Time

If this time is set to 0, then the SOT in Discharge function is disabled.

Open Thermistor

When SBS.Temperature( ) reports this value for a period of DF.OpenThermistorTime, then the Open Thermistor permanent failure is triggered.

Open Time

See Open Thermistor.

2.2.4 FET Verification

FET Fail Limit

If both the CHG and ZVCHG FETs are intended to be off, yet a charge current at or above this limit is measured for a period of FET Fail Time, then the Charge FET Permanent Failure is triggered. If the DSG FET is intended to be turned off, yet a discharge current greater than this is measured for a period of FET Fail Time, then the Discharge FET Permanent Failure is triggered.

FET Fail Time

If this time is set to 0, then the FET Fail function is disabled for both charge and discharge.

2.2.5 AFE Verification

AFE Check Time

This is the period at which the AFE memory is verified versus data flash settings and expected control settings.

AFE Fail Limit

This is the limit of allowable fails with any AFE Fail Recovery Time. If this limit is exceeded, then the AFE Verification permanent failure is triggered.

AFE Fail Recovery Time

If this time is set to 0, then it is not disabled but the AFE Fail function is triggered at 1.

AFE Init Retry Limit

AFE Init Limit

2.2.6 Fuse Verification

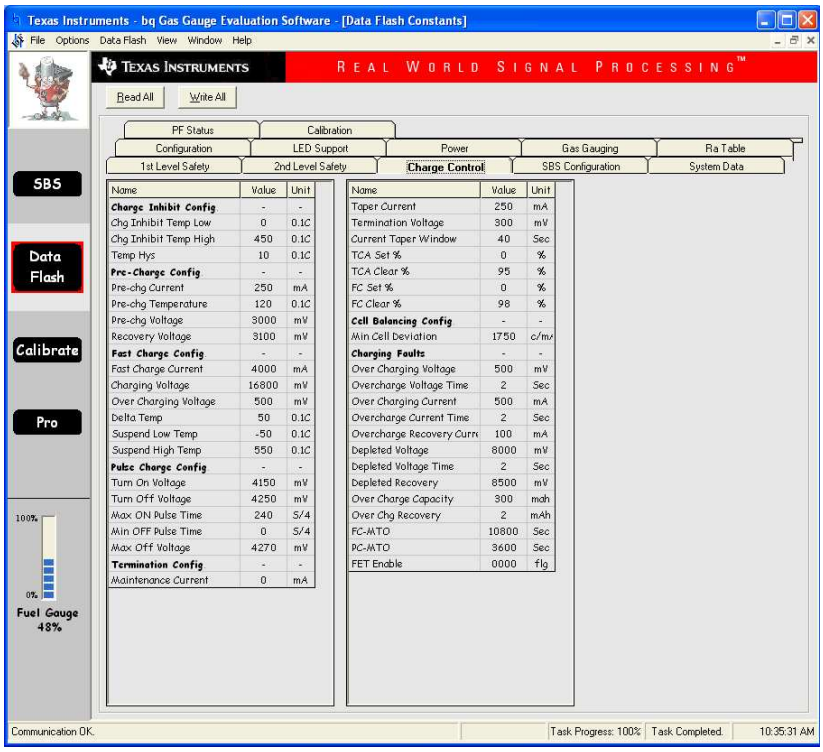
Fuse Fail Limit

If the fuse ($\overline{\text{SAFE}}$ output) is intended to be triggered, yet a current at or above this limit is measured for a period of Fuse Fail Time, then the Fuse Fail Permanent Failure is triggered.

Fuse Fail Time

If this time is set to 0, then the Fuse Fail function is disabled.

2.3 Charge Control



2.3.1 Charge Inhibit Config

Chg Inhibit Temp Low

Charging is inhibited if SBS.Temperature( ) is at or below this value.

Chg Inhibit Temp High (XCHGTH)

Charging is inhibited if SBS.Temperature( ) is at or above this value.

Temp Hys

To remove the charge inhibit state, SBS.Temperature( ) must rise (from Temp Low) or fall (from Temp High) by this value.

2.3.2 Pre-Charge Config

Pre-chg Current

SBS.ChargingCurrent( ) is programmed with this value when in precharge mode.

Pre-chg Temperature

Precharge mode is entered if SBS.Temperature( ) is at or below this level.

Pre-chg Voltage

Precharge mode is entered if any SBS.VCELLx( ) is below this value

Recovery Voltage

To recover from precharge mode when entry was due to low voltage, all SBS.VCELLx( ) must be above this value.

2.3.3 Fast Charge Config

Fast Charge Current

When in fast charge mode, this value is programmed into SBS.ChargingCurrent( ).

Charging Voltage

When in fast charge mode or other normal charging modes, this value is programmed into SBS.ChargingVoltage( ).

Over Charging Voltage

If SBS.Voltage( ) reaches or exceeds the sum of charging voltage + over charging voltage, then an Over Charging Fault is triggered.

Delta Temp

During fast charging, if SBS.Temperature( ) reaches the sum of {Suspend High Temp – 2 x his value}, then SBS.ChargingCurrent( ) is set to the sum of {(Fast Charge Current - Pre-Charge Current) / 2}. Also, if SBS.Temperature( ) reaches the sum of { Suspend High Temp – 1 x this value}, then SBS.ChargingCurrent( ) is set to Pre-Charge Current. However, if this value is 0, then this function is not enabled.

Suspend Low Temp

If SBS.Temperature( ) falls to or below this level once charging has begun, the charging is suspended.

Suspend High Temp

If SBS.Temperature( ) rises to or above this level once charging has begun, the charging is suspended.

2.3.4 Pulse Charge Config

Turn On Voltage

The charge (CHG) FET remains ON until the maximum cell voltage has reached or exceeded this threshold for a period of Max On Pulse Time.

Turn Off Voltage

The charge (CHG) FET remains OFF until the maximum cell voltage has reached or fallen below this threshold for a period on Max OFF Pulse Time.

Max On Pulse Time

See Turn On Voltage.

Min Off Pulse Time

See Turn Off Voltage

Max Off Voltage

The charge (CHG) FET is turned OFF when the highest cell voltage reaches this threshold. No time period is involved.

2.3.5 Termination Config

Maintenance Current

This value is programmed into SBS.ChargingCurrent( ) when a valid charge termination is detected.

Taper Current (CHGTI)

During charging, SBS.Current( ) tapers down. Once it reaches or falls below this threshold, then a valid charge termination may occur.

Termination Voltage

For a valid charge termination to occur, the value of SBS.Voltage( ) must also have reached or exceeded this threshold.

Current Taper Window

A valid charge termination requires the Taper Current and Termination Voltage to be OK for a valid termination for 2 counts of this period.

TCA Set %

If set to a value of 100 or below, then when SBS.RSOC( ) reaches this value the SBS.BatteryStatus( ) TCA bit is set.

TCA Clear %

If set to a value of nonzero, then when SBS.RSOC( ) reaches this value, the SBS.BatteryStatus( ) TCA bit is cleared.

FC Set %

If set to a value of 100 or below, then when SBS.RSOC( ) reaches this value, the SBS.BatteryStatus( ) FC bit is set.

FC Clear %

If set to a value of nonzero, then when SBS.RSOC( ) reaches this value, the SBS.BatteryStatus( ) FC bit is cleared.

2.3.6 Cell Balancing Config

Min Cell Deviation

The cell-balancing algorithm is activated when the capacity difference between the maximum and minimum capacity cells reaches or exceeds this value.

2.3.7 Charging Faults

Over Charging Voltage

When SBS.Voltage( ) reaches or exceeds the sum of SBS.ChargingVoltage( ) + this value for a period of at least Over Charge Voltage Time, then the Over Charging Voltage protection is triggered.

Overcharge Voltage Time

See Over Charging Voltage.

Over Charging Current

When SBS.Current( ) reaches or exceeds the sum of SBS.ChargingCurrent( ) + this value for a period of at least Over CurrentChargeTime, then the Over Charging Current protection is triggered.

Overcharge Current Time

See Over Charging Current.

Overcharge Recovery Current

When SBS.Current( ) reaches this value in discharge, then the Overcharge fault is cleared.

Depleted Voltage

When SBS.Voltage( ) falls to this level or below for a period of time equal to Depleted Voltage Time, then the bq20z80 enters the Battery Depleted fault.

Depleted Voltage Time

See Depleted Voltage.

Depleted Recovery

When SBS.Voltage( ) reaches or exceeds this level, the bq20z80 clears the Battery Depleted Fault.

Over Charge Capacity

When SBS.RemainingCapacity( ) exceeds the sum of this value + SBS.FullChargeCapacity( ), then an over charge fault is triggered.

Over Chg Recovery

When the battery has been discharged by this amount, then the Overcharge fault is cleared.

FC-MTO

This is the timeout value for the fast charge. If the internal charge timer reaches or exceeds this value, then the Fast Charge Timeout fault is triggered.

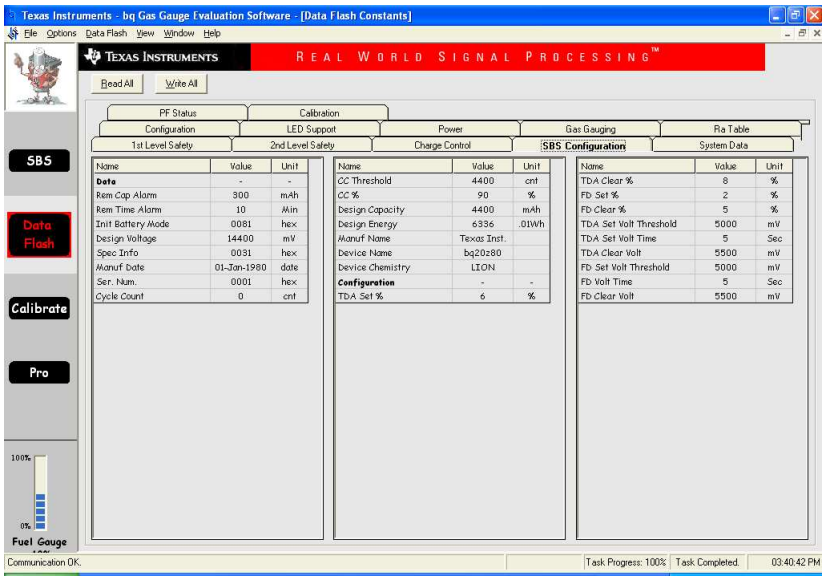
PC-MTO

This is the timeout value for the precharge. If the internal charge timer reaches or exceeds this value, then the Pre-Charge Timeout fault is triggered.

FET Enable

The configuration location enables or disables FET actions when charging faults are triggered.

2.4 SBS Configuration



2.4.1 Data

Rem Cap Alarm

This value is programmed into SBS.RemainingCapacityAlarm( ) on device initialization.

Rem Time Alarm

This value is programmed into SBS.RemainingTimeAlarm( ) on device initialization.

Init Battery Mode

This is the configuration of SBS.BatteryMode( ) on device initialization.

Design Voltage

This value is programmed into SBS.DesignVoltage( ) on device initialization.

Spec Info

This value is programmed into SBS.SpecificationInfo( ) on device initialization.

Manuf Date

This value is programmed into SBS.ManufactureDate( ) on device initialization.

Ser. Num

This value is programmed into SBS.SerialNumber( ) on device initialization.

Cycle Count

This is the number of cycles reported by SBS.CycleCount( ).

CC Threshold

This is the mAh value used, if DF.OperationConfig, CCT is cleared, to calculate the increment SBS.CycleCount( ) where the increment is this value in mAh.

CC%

This % value is used, if DF.OperationConfig, CCT is set, to calculate the increment of SBS.CycleCount( ) where the increment is this value as a % of SBS.FullChargeCapacity( ).

Design Capacity

This value is programmed into SBS.DesignCapacity( ) on device initialization.

Design Energy

This value is used for use in 10mWh mode data reporting.

Manuf Name

This value is programmed into SBS.ManufacturerName( ) on device initialization.

Device Name

This value is programmed into SBS.DeviceName( ) on device initialization.

Device Chemistry

This value is programmed into SBS.DeviceChemistry( ) on device initialization.

2.4.2 Configuration

TDA Set %

If set to a value of 100 or below, then when SBS.RSOC( ) reaches this value, the SBS.BatteryStatus( ) TDA bit is set.

TDA Clear %

If set to a value of nonzero, then when SBS.RSOC( ) reaches this value, the SBS.BatteryStatus( ) TDA bit is cleared.

FD Set %

If set to a value of 100 or below, then when SBS.RSOC( ) reaches this value, the SBS.BatteryStatus( ) FD bit is set.

FD Clear %

If set to a value of nonzero, then when SBS.RSOC( ) reaches this value, the SBS.BatteryStatus( ) FD bit is cleared.

TDA Set Volt Threshold

If DF.TDASet% = -1, then when SBS.Voltage( ) reaches below this value for a period of DF.TDASetVoltTime, the SBS.BatteryStatus( ) TDA bit is set.

TDA Set Volt Time

See TDA Set Volt.

TDA Clear Volt

If DF.TDASet% = -1, then when SBS.Voltage( ) exceeds this value, the SBS.BatteryStatus( ) TDA bit is cleared.

FD Set Volt Threshold

If DF.FDSet% = -1, then when SBS.Voltage( ) reaches below this value for a period of DF.FDSetVoltTime, the SBS.BatteryStatus( ) FD bit is set.

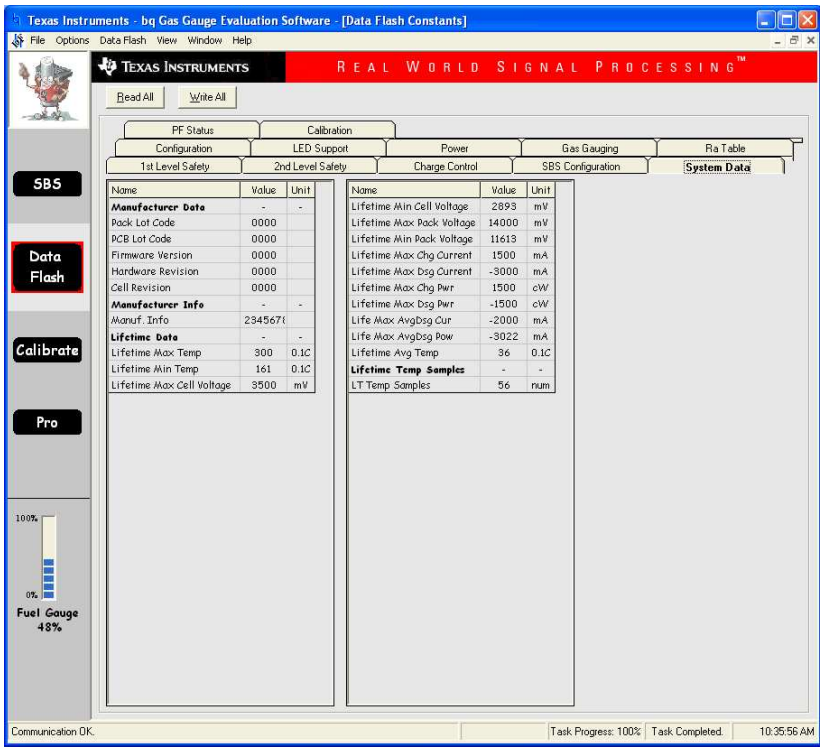
FD Set Volt Time

See FD Set Volt.

FD Clear Volt

If DF.FDSet% = -1, then when SBS.Voltage( ) reaches above this value, the SBS.BatteryStatus( ) FD bit is cleared.

2.5 System Data



2.5.1 Manufacturer Data

Pack Lot Code

Independent data reported via SBS.ManufacturerData( ).

PCB Lot Code

Independent data reported via SBS.ManfuacturerData( ).

Firmware Version

Independent data reported via SBS.ManfuacturerData( ).

Hardware Revision

Independent data reported via SBS.ManfuacturerData( ).

Cell Revision

Independent data reported via SBS.ManfuacturerData( ).

2.5.2 Manufacturing Info

Manufacturing Info

The Manufacturing Info space is available for the pack maker to store any information which is then available by the SBS.ManufacturingInfo() command. The data in these locations has no bearing on the operation of the device.

2.5.3 Lifetime Data

Lifetime Max Temp

Maximum value of SBS.Temperature( ) measured during the lifetime of the battery.

Lifetime Min Temp

Minimum value of SBS.Temperature( ) measured during the lifetime of the battery.

Lifetime Max Cell Voltage

Maximum value of SBS.VCELLx( ) measured during the lifetime of the battery.

Lifetime Min Cell Voltage

Minimum value of SBS.VCELLx( ) measured during the lifetime of the battery.

Lifetime Max Pack Voltage

Maximum value of SBS.Voltage( ) measured during the lifetime of the battery.

Lifetime Min Pack Voltage

Minimum value of SBS.Voltage( ) measured during the lifetime of the battery.

Lifetime Max Chg Current

Maximum value of SBS.Current( ) in charge measured during the lifetime of the battery.

Lifetime Max Dsg Current

Maximum value of SBS.Current( ) in discharge measured during the lifetime of the battery.

Lifetime Max Chg Pwr

Maximum value of SBS. Power( ) in charge measured during the lifetime of the battery.

Lifetime Max Dsg Pwr

Maximum value of SBS.Power( ) in discharge measured during the lifetime of the battery.

Life Max AvgDsg Cur

Maximum value of SBS.AveragePower( ) in discharge measured during the lifetime of the battery.

Life Min AvgDsg Pow

Maximum value of SBS.AveragePower( ) in discharge measured during the lifetime of the battery.

Lifetime Avg Temp

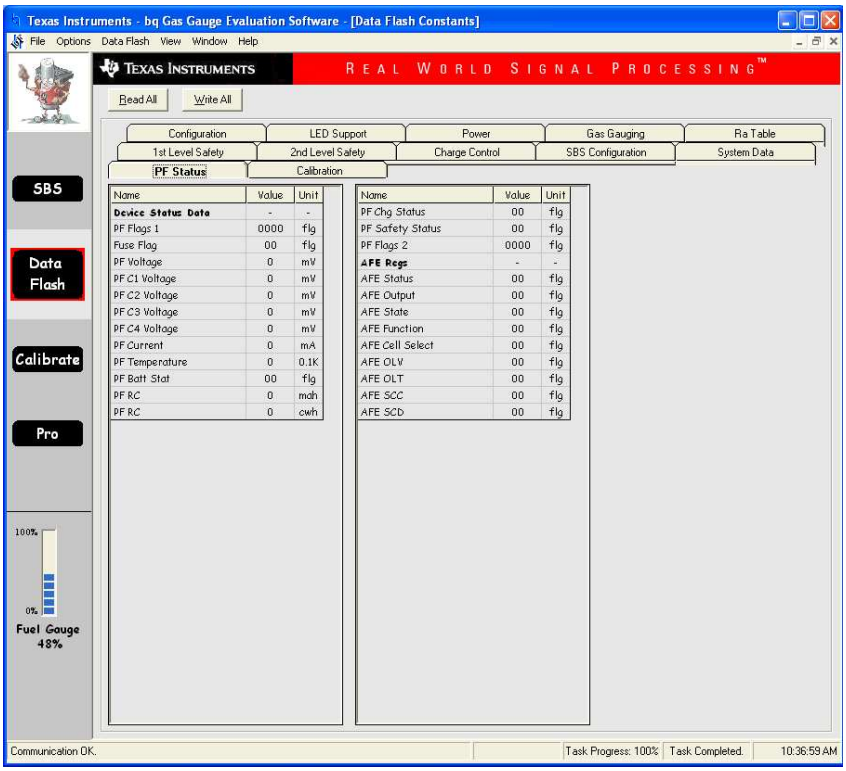
Calculated maximum average value of SBS.Temperature( ) measured during the lifetime of the battery.

2.5.4 Lifetime Temp Samples

LT Temp Samples

This is the number of samples used to calculate the average temperature for Life Time Avg Temp.

2.6 PF Status



2.6.1 Device Status Data

PF Flags 1

This location indicates all the causes of permanent failure that have occurred. If a permanent fault is repeated, the appropriate bit remains set.

Fuse Flag

This is set to 0x3672 if the device is in permanent failure. Otherwise, it is 0x0000.

PF Voltage

Captures SBS.Voltage( ) when the device enters permanent failure.

PF C1 Voltage

Captures SBS.VCell1( ) when the device enters permanent failure.

PF C2 Voltage

Captures SBS.VCell2( ) when the device enters permanent failure.

PF C3 Voltage

Captures SBS.VCell3( ) when the device enters permanent failure.

PF C4 Voltage

Captures SBS.VCell4( ) when the device enters permanent failure.

PF Current

Captures SBS.Current( ) when the device enters permanent failure.

PF Temperature

Captures SBS.Temperature( ) when the device enters permanent failure.

PF Batt Stat

Captures SBS.BatteryStatus( ) when the device enters permanent failure.

PF RC (mAh)

Captures SBS.RemainingCapacity( ) in units of mAh when the device enters permanent failure.

PF RC (10mWh)

Captures SBS.RemainingCapacity( ) in units of 10mWh when the device enters permanent failure.

PF Chg Status

Captures SBS.ChargingStatus( ) when the device enters permanent failure.

PF Safety Status

Captures SBS.SafetyStatus( ) when the device enters permanent failure.

PF Flags 2

On the first occurrence of detection of permanent failure, the PF.Status is stored here and is not able to be overwritten.

2.6.2 AFE Regs

AFE Status

Captures the state of the AFE Status register when the device enters permanent failure.

AFE Output

Captures the state of the AFE Output register when the device enters permanent failure.

AFE State

Captures the state of the AFE State register when the device enters permanent failure.

AFE Function

Captures the state of the AFE Function register when the device enters permanent failure.

AFE Cell Select

Captures the state of the AFE Cell Select register when the device enters permanent failure.

AFE OLV

Captures the state of the AFE OLV register when the device enters permanent failure.

AFE OLT

Captures the state of the AFE OLT register when the device enters permanent failure.

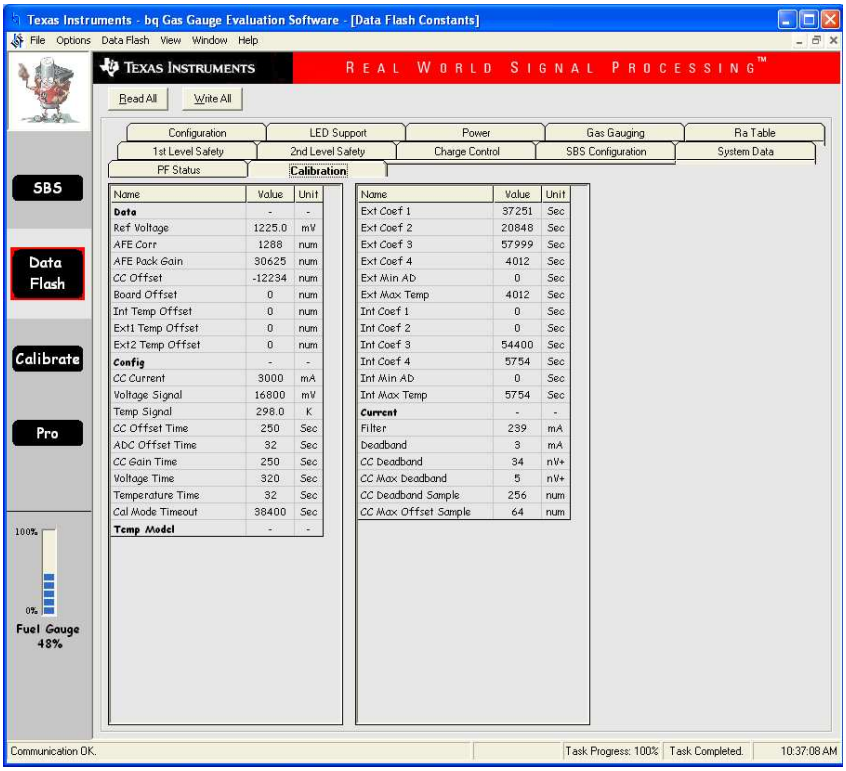
AFE SCC

Captures the state of the AFE SCC register when the device enters permanent failure.

AFE SCD

Captures the state of the AFE SCD register when the device enters permanent failure.

2.7 Calibration



2.7.1 Data

Ref Voltage

This is the calibrated AFE reference voltage.

AFE Corr

This is the calibrated AFE correction factor.

AFE Pack Gain

This is the calibrated gain of the AFE when measuring the PACK input of the AFE.

CC Offset

This is the calibrated coulomb counter offset.

Board Offset

This is the PCB board offset.

Int Temp Offset

This is the temperature offset for the internal temperature sensor.

Ext1 Temp Offset

This is the calibrated temperature offset for the first external temperature sensor.

Ext2 Temp Offset

This is the calibrated temperature offset for the second external temperature sensor.

2.7.2 Config

CC Current, Voltage Signal, Temp Signal, CC Offset Time, ADC Offset Time, CC Gain Time, Voltage Time, Temperature Time, and Cal Mode Timeout

These are all used during the calibration process and are explained in detail in the application report *Data Flash Programming and Calibrating the bq20zXX Family of Gas Gauges* (SLUA355).

2.7.3 Temp Model

Ext Coef 1, Ext Coef 2, Ext Coef 3, Ext Coef 4, Ext Min AD, and Ext Max Temp

These are the curve coefficients and limits to characterize the external thermistor and should not be edited without consulting Texas Instruments.

Int Coef 1, Int Coef 2, Int Coef 3, Int Coef 4, Int Min AD, and Int Max Temp

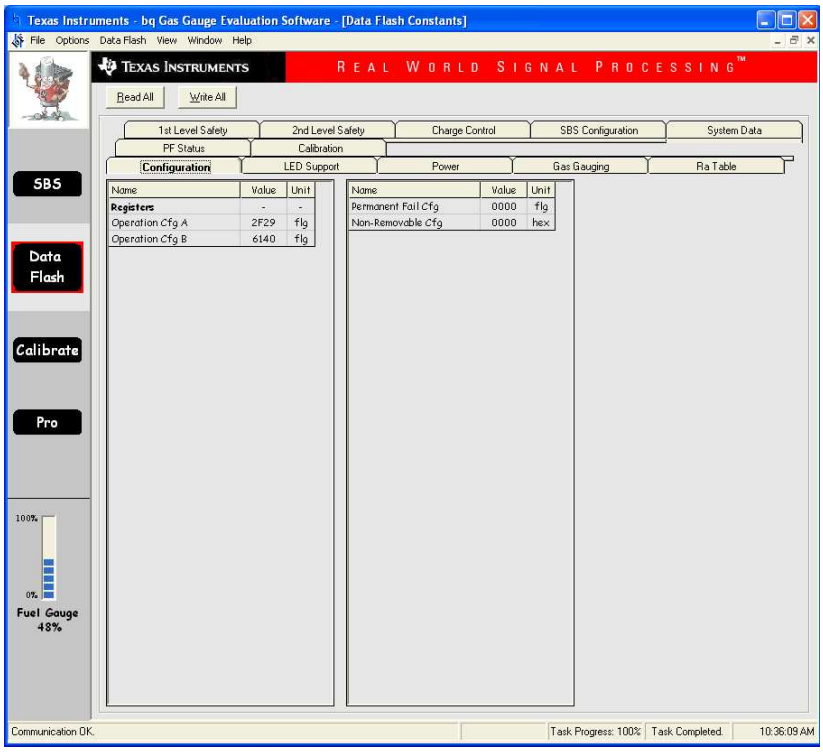
These are the curve coefficients and limits to characterize the internal temperature sensor and should not be edited without consulting Texas Instruments.

2.7.4 Current

Filter, Deadband, CC Deadband, CC Max Deadband, CC Deadband Sample, and CC Max Offset Sample

These are all updated during the calibration process and are explained in detail in the application report *Data Flash Programming and Calibrating the bq20zXX Family of Gas Gauges* (SLUA355).

2.8 Configuration



2.8.1 Registers

Operation Cfg A

This stores 2 bytes of device configuration data.

Operation Cfg B

This stores a second 2 bytes of device configuration data.

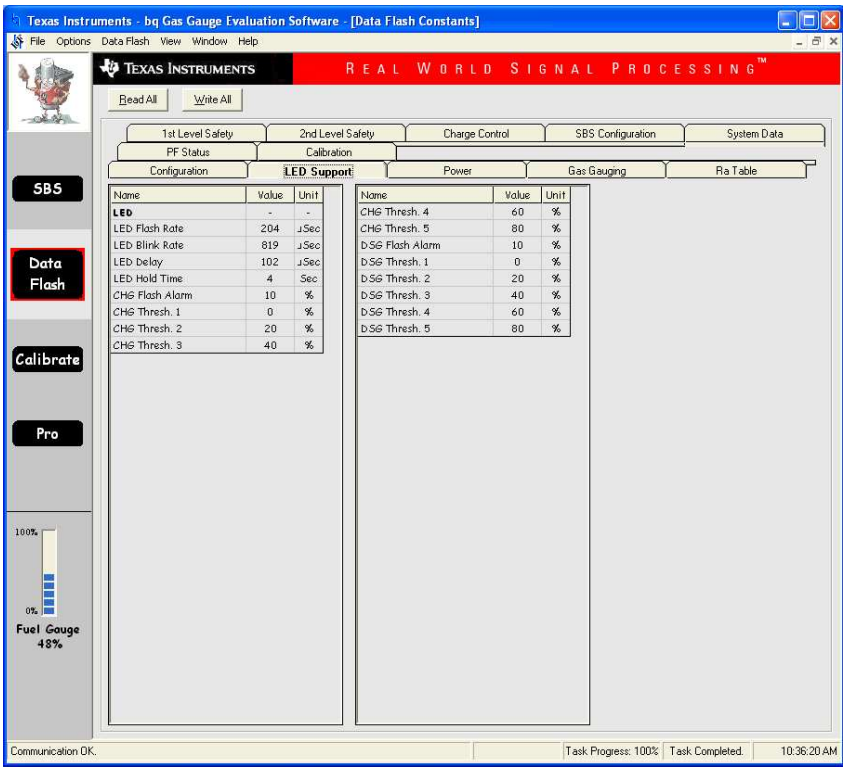
Permanent Fail Cfg

This enables or disables the various permanent failure protection functions to activate the $\overline{\text{SAFE}}$ output or not when the function is triggered.

Non-Removable Cfg

This configures the protection recovery mode for the first level current-based protection features when the Operation Cfg, NR is set.

2.9 LED Support



2.9.1 LED

LED Flash Rate

This value determines the LED ON time at a 50% duty cycle when flashing. Typically used in low-capacity situations.

LED Blink Rate

This value determines the LED ON time at a 50% duty cycle when blinking. Typically used to indicate charging of a particular section of SBS.RSOC( ).

LED Delay

This is the delay time between each LED being illuminated after the display is activated.

LED Hold Time

Once all valid LEDs are ON, then the display is active during this time.

CHG Flash Alarm

When SBS.RSOC( ) during charge is below this level, the LED display flashes if Operation Cfg, LEDRCA is cleared.

CHG Thresh. 1

This is the threshold below which LED 1 is off during charging when enabled by DF.OperationConfiguration, LED0..1.

CHG Thresh. 2

This is the threshold below which LED 2 is off during charging when enabled by DF.OperationConfiguration, LED0..1.

CHG Thresh. 3

This is the threshold below which LED 3 is off during charging when enabled by DF.OperationConfiguration, LED0..1.

CHG Thresh. 4

This is the threshold below which LED 4 is off during charging when enabled by DF.OperationConfiguration, LED0..1.

CHG Thresh. 5

This is the threshold below which LED 5 is off during charging when enabled by DF.OperationConfiguration, LED0..1.

DSG Flash Alarm

When SBS.RSOC( ) during discharge is below this level, the LED display flashes if DF.OperationConfiguration, LEDRCA is cleared.

DSG Thresh. 1

This is the threshold below which LED 1 is off during discharging when enabled by DF.OperationConfiguration, LED0..1.

DSG Thresh. 2

This is the threshold below which LED 2 is off during discharging when enabled by DF.OperationConfiguration, LED0..1.

DSG Thresh. 3

This is the threshold below which LED 3 is off during discharging when enabled by DF.OperationConfiguration, LED0..1.

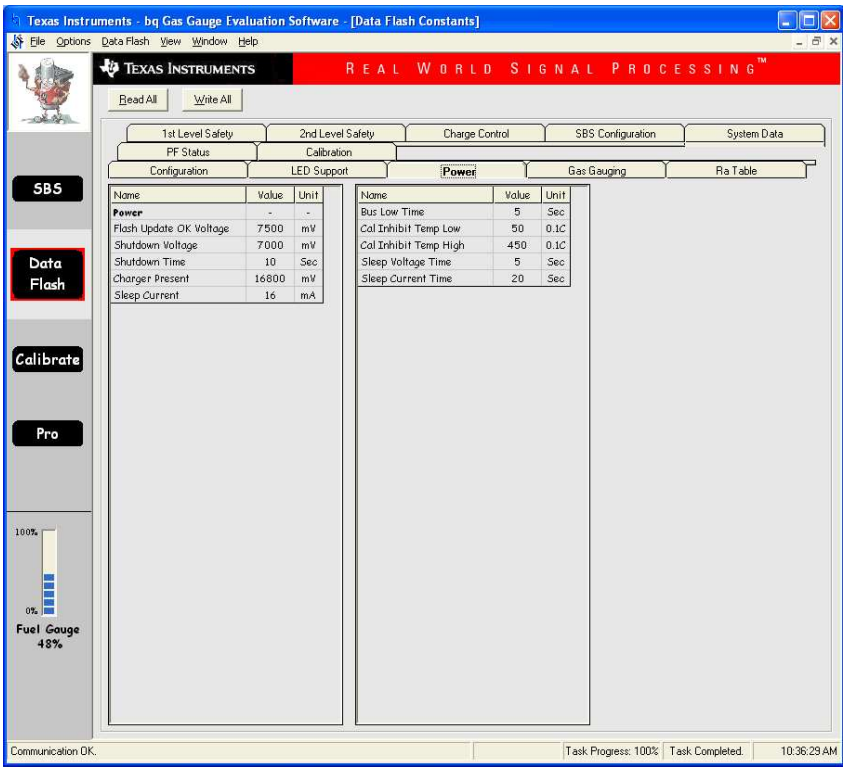
DSG Thresh. 4

This is the threshold below which LED 4 is off during discharging when enabled by DF.OperationConfiguration, LED0..1.

DSG Thresh. 5

This is the threshold below which LED 5 is off during discharging when enabled by DF.OperationConfiguration, LED0..1.

2.10 Power



2.10.1 Power

Flash Update OK Voltage

If SBS.Voltage( ) is below this threshold, then data flash is not updated.

Shutdown Voltage

When SBS.Voltage( ) falls to or below this level, then the Shutdown mode is entered if the device has not exited Shutdown mode with a period of Shutdown Time.

Shutdown Time

See Shutdown Voltage.

Charger Present

A charger is deemed present when SBS.PackVoltage( ) reaches or exceeds this level. This could restrict the device entering Shutdown mode via the SBS.ManufacturesAccess( ) command.

Sleep Current

Sleep mode can be entered if SBS.Current( ) is at or below this level.

Bus Low Time

Sleep mode can be entered if the SMBus inputs are low for a period equal to or exceeding this value.

Cal Inhibit Temp Low

On entry into sleep mode, auto calibration is typically initiated. However, if SBS.Temperature( ) is at or below this level, then it is not initiated.

Cal Inhibit Temp High

On entry into sleep mode, auto calibration is typically initiated. However, if SBS.Temperature( ) is at or above this level, then it is not initiated.

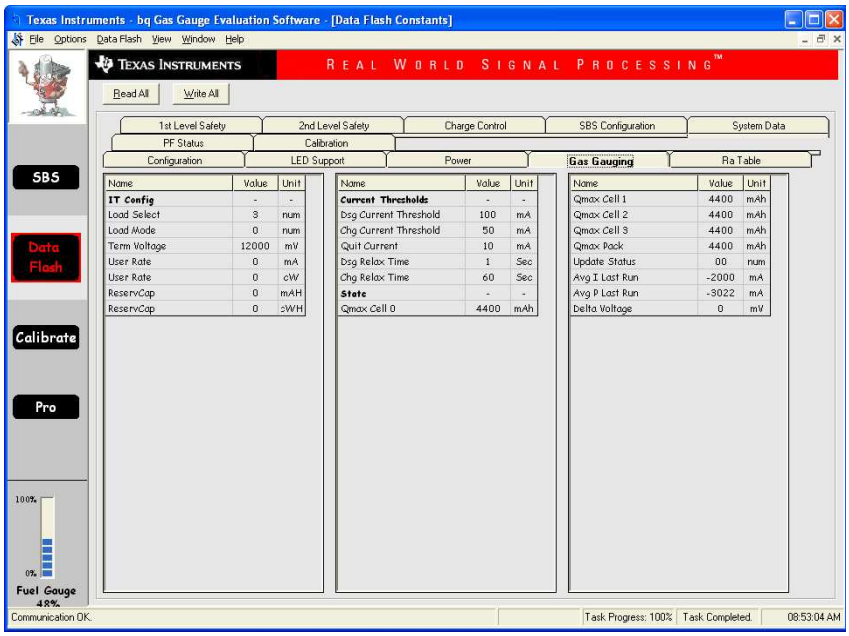
Sleep Voltage Time

During sleep mode, SBS.Voltage( ), SBSVCELL1( ), SBSVCELL2( ), SBSVCELL3( ), and SBSVCELL4( ) are updated at this period. This also counts as a fault time multiplier for the voltage-based protection functions.

Sleep Current Time

During sleep mode, SBS.Current( ) and SBS.AverageCurrent( ) are updated at this period. This also counts as a fault time multiplier for the current-based protection functions. The current-based protection functions of the AFE are not affected by this value.

2.11 Gas Gauging



2.11.1 IT Config

Load Select

Defines use of average current for remaining capacity Impedance Track™ simulation.

0 – Average current from previous discharge

1 – Average current from present discharge

2 – Instantaneous current

3 – Average current as defined by SBS.AverageCurrent( )

4 – Current defined as C/5

Load Mode

Defines constant current or constant power mode of Impedance Track™ simulation

0 – Constant current

1 – Constant power

Term Voltage

Voltage used for determining end of discharge during Impedance Track™ simulation for finding remaining capacity. It should be set to the minimum system input voltage after addition of expected I x R drop in the PCB traces and FETs.

User Rate-mAh

Current used in determining reserve capacity function.

User Rate-10mWh

Power used in determining reserve capacity function.

ReservCap-mAh

Reserve capacity determines how much the actual remaining capacity after reaching SBS.RSOC( ) = 0% before DF.TermVoltage is reached. Depending on setting of “remaining capacity mode,” it can be interpreted in two ways:

- If DF.OperationConfigurationB, RESCAP = 0, then the reserve capacity is compensated for a low rate mode, i.e., C/20.
- If DF.OperationConfigurationB, RESCAP = 1, then the reserve capacity is compensated for average rate mode

ReservCap-10mWh

Same as DF.ReservCap (mAh) but it is only set to average rate compensation.

2.11.2 Current Thresholds

Dsg Current Threshold

Current used to determine that discharging has started.

Chg Current Threshold

Current used to determine that charging has started.

Quit Current

If current goes below DF.QuitCurrent, termination of discharge is detected. OCV reading occurs if current is below this threshold.

Dsg Relax Time

Time used to detect Discharging state.

Chg Relax Time

Time used to detect Discharging state.

NOTE: DF.User Rate should be greater than DF.DSGDetectionThreshold which should be greater that DF.QuitCurrent

2.11.3 State

Qmax Cell 0 through Qmax Cell 3

Maximum chemical capacity of the cell. It also corresponds to capacity at a low rate of discharge such as the C/20 rate. Initially, this should be set to data-sheet capacity of the cells. The remaining Qmax Cell x constants are similar.

Qmax Pack

Minimal chemical capacity from all cells.

Update Status

This indicates if the Impedance Track™ algorithm is running.

Avg I Last Run

Average current of previous discharge.

Avg P Last Run

Average power of previous discharge.

Delta Voltage

Thermal time constant used in thermal modeling.

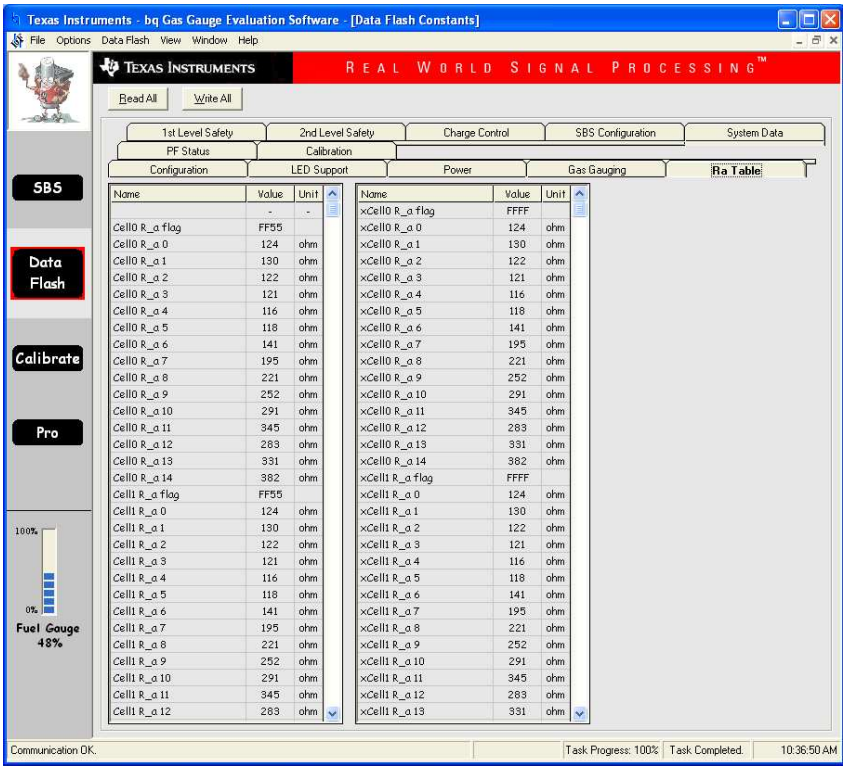
2.12 Ra Table

This data is the table of impedance profiles for each cell. CellN and xCellN entries are used interchangeably by the bq20z80. The valid entries have flags 0x0055, 0xFF55, and invalid entries have flags 0x0000, 0xFFFF. For example, if CellN has flag 0x0000, disregard its values, and use xCellN values instead. Flags 0xFF55 and 0xFFFF are used for default parameters before learning occurs.

This table is automatically updated during device operation. No user changes should be made except for reading the values from other pre-learned packs for creating defaults. See application report *Preparing Optimized Default Flash Constants for Specific Battery Types* (SLUA334).

Profiles have format CellN R_a M where N is the cell serial number (from ground up), and M is the number indicating state of charge (SOC) to which the value corresponds. The corresponding SOC can be calculated using following rules:

if $0 \le M \le 8$, SOC = $M \times 10\%$; if $9 \le M \le 14$, SOC = $80\% + (M - 8) \times 3.3\%$



Cell0 R_a flag

Flag indicating if subsequent entry is valid (if 0x0055 or 0xFF55) or invalid (if 0x0000 or 0xFFFF).

Cell0 R_a 0 through Cell0 R_a 14

Impedance profile for Cell0.

Cell1 R_a flag

Flag indicating if subsequent entry is valid (if 0x0055 or 0xFF55) or invalid (if 0x0000 or 0xFFFF).

Cell1 R_a 0 through Cell1 R_a 14

Impedance profile for Cell1.

Cell2 R_a flag

Flag indicating if subsequent entry is valid (if 0x0055 or 0xFF55) or invalid (if 0x0000 or 0xFFFF).

Cell2 R_a 0 through Cell2 R_a 14

Impedance profile for Cell2.

Cell3 R_a flag

Flag indicating if subsequent entry is valid (if 0x0055 or 0xFF55) or invalid (if 0x0000 or 0xFFFF).

Cell3 R_a 0 through Cell3 R_a 14

Impedance profile for Cell3.

xCell0 R_a flag

Flag indicating if subsequent entry is valid (if 0x0055 or 0xFF55) or invalid (if 0x0000 or 0xFFFF).

xCell0 R_a 0 through xCell0 R_a 14

Alternative impedance profile for Cell0.

xCell1 R_a flag

Flag indicating if subsequent entry is valid (if 0x0055 or 0xFF55) or invalid (if 0x0000 or 0xFFFF).

xCell1 R_a 0 through xCell1 R_a 14

Alternative impedance profile for Cell1.

xCell2 R_a flag

Flag indicating if subsequent entry is valid (if 0x0055 or 0xFF55) or invalid (if 0x0000 or 0xFFFF).

xCell2 R_a 0 through xCell2 R_a 14

Alternative impedance profile for Cell2.

xCell3 R_a flag

Flag indicating if subsequent entry is valid (if 0x0055 or 0xFF55) or invalid (if 0x0000 or 0xFFFF).

xCell3 R_a 0 through xCell3 R_a 14

Alternative impedance profile for Cell3.

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