Application Report
SLUA664 – November 2012

Configuring the bq34100 Data Flash

Doug Williams — *BMS – Multi-Cell Solutions*

ABSTRACT

The bq34z100 has many data flash constants that can be used to configure the device with various options to customize the behavior and features of the gas gauge. The data flash of the bq34z100 is divided into sections, which are described in detail in this document.

Contents

Figures

1 Glossary

Flag: This word usually represents a read-only status bit that indicates some action has occurred or is occurring. This bit typically cannot be modified by the user.

FCC: Full-charge capacity

RM: Remaining capacity

SOC: This generic acronym means state-of-charge. It can also mean RSOC (Relative SOC) or percentage of actual chemical capacity.

System: The word system is sometimes used in this document. When used, it always means a host system that is consuming current from the battery pack that includes the bq34z100.

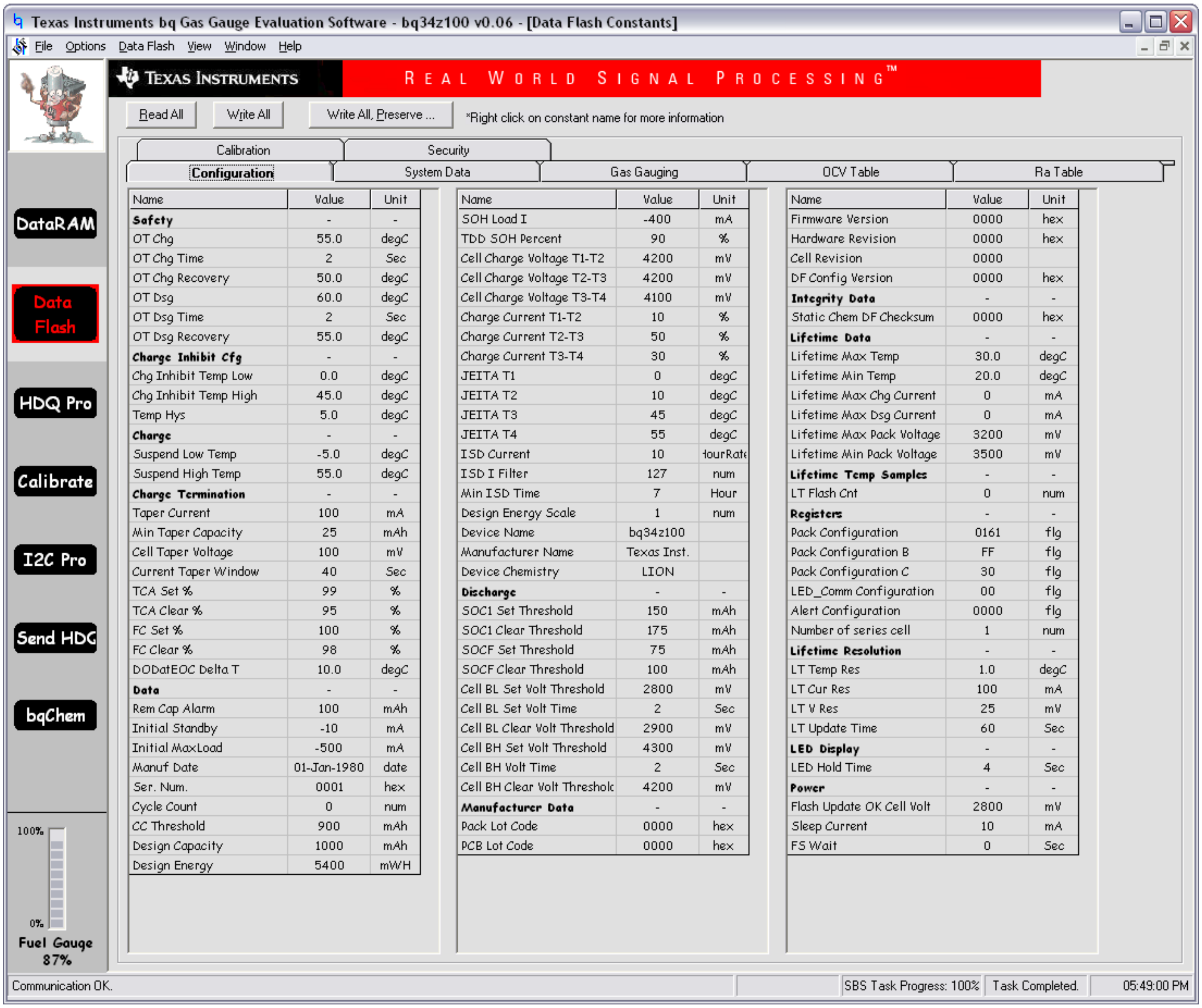
Italics: All words in this document that are in italics represent names of data flash locations exactly as they are shown in the EV software.

Bold Italics: All words that are bold italic represent SBS-compliant registers exactly as they are shown in the EV software.

[brackets]: All words or letters in brackets represent bit/flag names exactly as they are shown in the SBS and data flash in the EV software.

(–): This is commonly used in this document to represent a minus sign. It is written this way to ensure that the sign is not lost in the translation of formulas in the text of this document.

2 Configuration



Name	Value	Unit
Safety	-	-
OT Chg	55.0	degC
OT Chg Time	2	Sec
OT Chg Recovery	50.0	degC
OT Dsg	60.0	degC
OT Dsg Time	2	Sec
OT Dsg Recovery	55.0	degC
Charge Inhibit Cfg	-	-
Chg Inhibit Temp Low	0.0	degC
Chg Inhibit Temp High	45.0	degC
Temp Hys	5.0	degC
Charge	-	-
Suspend Low Temp	-5.0	degC
Suspend High Temp	55.0	degC
Charge Termination	-	-
Taper Current	100	mA
Min Taper Capacity	25	mAh
Cell Taper Voltage	100	mV
Current Taper Window	40	Sec
TCA Set %	99	%
TCA Clear %	95	%
FC Set %	100	%
FC Clear %	98	%
DODatEOC Delta T	10.0	degC
Data	-	-
Rem Cap Alarm	100	mAh
Initial Standby	-10	mA
Initial MaxLoad	-500	mA
Manuf Date	01-Jan-1980	date
Ser. Num.	0001	hex
Cycle Count	0	num
CC Threshold	900	mAh
Design Capacity	1000	mAh
Design Energy	5400	mWH

Name	Value	Unit
SOH Load I	-400	mA
TDD SOH Percent	90	%
Cell Charge Voltage T1-T2	4200	mV
Cell Charge Voltage T2-T3	4200	mV
Cell Charge Voltage T3-T4	4100	mV
Charge Current T1-T2	10	%
Charge Current T2-T3	50	%
Charge Current T3-T4	30	%
JEITA T1	0	degC
JEITA T2	10	degC
JEITA T3	45	degC
JEITA T4	55	degC
ISD Current	10	HourRate
ISD I Filter	127	num
Min ISD Time	7	Hour
Design Energy Scale	1	num
Device Name	bq34z100	
Manufacturer Name	Texas Inst.	
Device Chemistry	LION	
Discharge	-	-
SOC1 Set Threshold	150	mAh
SOC1 Clear Threshold	175	mAh
SOCF Set Threshold	75	mAh
SOCF Clear Threshold	100	mAh
Cell BL Set Volt Threshold	2800	mV
Cell BL Set Volt Time	2	Sec
Cell BL Clear Volt Threshold	2900	mV
Cell BH Set Volt Threshold	4300	mV
Cell BH Volt Time	2	Sec
Cell BH Clear Volt Threshold	4200	mV
Manufacturer Data	-	-
Pack Lot Code	0000	hex
PCB Lot Code	0000	hex

Name	Value	Unit
Firmware Version	0000	hex
Hardware Revision	0000	hex
Cell Revision	0000	
DF Config Version	0000	hex
Integrity Data	-	-
Static Chem DF Checksum	0000	hex
Lifetime Data	-	-
Lifetime Max Temp	30.0	degC
Lifetime Min Temp	20.0	degC
Lifetime Max Chg Current	0	mA
Lifetime Max Dsg Current	0	mA
Lifetime Max Pack Voltage	3200	mV
Lifetime Min Pack Voltage	3500	mV
Lifetime Temp Samples	-	-
LT Flash Cnt	0	num
Registers	-	-
Pack Configuration	0161	flg
Pack Configuration B	FF	flg
Pack Configuration C	30	flg
LED_Comm Configuration	00	flg
Alert Configuration	0000	flg
Number of series cell	1	num
Lifetime Resolution	-	-
LT Temp Res	1.0	degC
LT Cur Res	100	mA
LT V Res	25	mV
LT Update Time	60	Sec
LED Display	-	-
LED Hold Time	4	Sec
Power	-	-
Flash Update OK Cell Volt	2800	mV
Sleep Current	10	mA
FS Wait	0	Sec

Figure 1. Configuration Screen

2.1 Safety

OT Chg

When the pack temperature measured by ***Temperature*** rises to or above the Over Temperature Charge (*OT Chg*) threshold while charging (***Current*** > *Chg Current Threshold*), then the Over Temperature in charge direction [OTC] is set in ***Flags*** after *OT Chg Time*. If the OTC condition clears prior to the expiration of the *OT Chg Time* timer, then no [OTC] is set in ***Flags***.

Normal Setting: This setting depends on the environment temperature and the battery specification. Verify that the battery specification allows temperatures up to this setting while charging, and verify that these setting are sufficient for the application temperature. The default is 55°C, which is sufficient for most Li-ion applications.

OT Chg Time

See *OT Chg*. This is a buffer time allotted for Over Temperature in the charge direction condition. The timer starts every time that ***Temperature*** measured is greater than *OT Chg* and while charging. When the timer expires, the bq34z100 forces an [OTC] in ***Flags***. Setting the *OT Chg Time* to 0 disables this function.

Normal Setting: This is normally set to 2 seconds which is sufficient for most applications. Temperature is normally a slow-acting condition that does not need high-speed triggering. It must be set long enough to prevent false triggering of the [OTC] in ***Flags***, but short enough to prevent damage to the battery pack.

OT Chg Recovery

OT Chg Recovery is the temperature at which the battery recovers from an *OT Chg* fault. This is the only recovery method for an *OT Chg* fault.

Normal Setting: The default is 50°C which is a 5-degree difference from the *OT Chg*.

OT Dsg

When the pack temperature measured by ***Temperature*** rises to or above this threshold while discharging (***Current*** < (–)(*Dsg Current Threshold*)), then the Over Temperature in discharge direction [OTD] is set in ***Flags*** after *OT Dsg Time*. If the OTD condition clears prior to the expiration of the *OT Dsg Time* timer, then no [OTD] is set in ***Flags***. If the condition does not clear, then [OTD] is set in ***Flags.***

Normal Setting: This setting depends on the environment temperature and the battery specification. Verify that the battery specification allows temperatures up to this setting while charging, and verify that these setting are sufficient for the application temperature. The default is 60°C which is sufficient for most Li-ion applications. The default *OT Dsg* setting is higher than the default *OT Chg* because
Li-ion can handle a higher temperature in the discharge direction than in the charge direction.

OT Dsg Time

See *OT Dsg*. This is a buffer time allotted for Over Temperature in the discharge direction condition. The timer starts every time that ***Temperature*** measured is greater than *OT Dsg* and while discharging. When the timer expires, then the bq34z100 forces an [OTD] in ***Flags***. Setting the *OT Dsg Time* to
0 disables this function.

Normal Setting: This is normally set to 2 seconds which is sufficient for most applications. Temperature is normally a slow-acting condition that does not need high-speed triggering. It must be set long enough to prevent false triggering of the [OTD] in ***Flags***, but short enough to prevent damage to the battery pack.

OT Dsg Recovery

OT Dsg Recovery is the temperature at which the battery recovers from an *OT Dsg* fault. This is the only recovery method for an *OT Dsg* fault.

Normal Setting: The default is 55°C which is a 5-degree difference from the *OT Dsg*.

2.2 Charge Inhibit Configuration

Chg Inhibit Temp Low

If pack temperature measured by ***Temperature*** falls to or below the charge inhibit temperature low (*Chg Inhibit Temp Low*) threshold while charging (***Current*** > *Chg Current Threshold*), then the Charge Inhibit [CHG_INH] is set in ***Flags***. The [CHG_INH] is reset to "0" once battery temperature returns to the range [***Chg Inhibit Temp Low + Temp Hys, Chg Inhibit Temp High – Temp Hys***].

Normal Setting: This setting depends on the environment temperature and the battery specification. Verify that the battery specification allows temperatures up to this setting while charging, and verify that these setting are sufficient for the application temperature. The default is 0°C, which is sufficient for most Li-ion applications.

Chg Inhibit Temp High

If the pack temperature measured by ***Temperature*** rises to or above the charge inhibit temperature high (*Chg Inhibit Temp high*) threshold while charging (***Current*** > *Chg Current Threshold*), then the Charge Inhibit [CHG_INH] is set in ***Flags***. The [CHG_INH] is reset to "0" once battery temperature returns to the range [***Chg Inhibit Temp Low + Temp Hys***, ***Chg Inhibit Temp High – Temp Hys***].

Normal Setting: This setting depends on the environment temperature and the battery specification. Verify that the battery specification allows temperatures up to this setting while charging, and verify that these settings are sufficient for the application temperature. The default is 45°C, which is sufficient for most Li-ion applications

Temp Hys

When pack temperature is measured by ***Temperature***, the temperature hysteresis (*Temp Hys*) is defined to prevent false temperature measurement.

Normal Setting: This setting depends on the environment temperature and the battery specification. Verify that the battery specification allows temperatures up to this setting while charging, and verify that these setting are sufficient for the application temperature. The default is 5°C, which is sufficient for most Li-ion applications.

2.3 Charge

Suspend Low Temp

When the pack temperature measured by ***Temperature*** falls to or below the suspend low temperature (*Suspend Low Temp*) threshold while charging (***Current*** > *Chg Current Threshold*), then the Charge Suspend Alert [XCHG] is set in ***Flags***.

Normal Setting: This value depends on the charger that is expected to be used for the battery pack containing the bq34z100. The default is (–)5°C.

Suspend High Temp

When the pack temperature measured by ***Temperature*** rises to or above the suspend high temperature (*Suspend HighTemp*) threshold while charging (***Current*** > *Chg Current Threshold*), then the Charge Suspend Alert [XCHG] is set in ***Flags.***

Normal Setting: This value depends on the charger that is expected to be used for the battery pack containing the bq34z100. The default is 55°C.

2.4 Charge Termination

Taper Current

Taper Current is used in the Primary Charge Termination algorithm. ***Average Current*** is integrated over each of the two *Current Taper Window* periods separately, and then they are averaged separately to give two averages. Both of these averages must be below the *Taper Current* to qualify for a Primary Charge Termination. In total, a primary charge termination has the following requirements:

1. During two consecutive periods of *Current Taper Window*, the ***Average Current*** is < *Taper Current*.
2. During the same periods, the accumulated change in capacity > 0.25 mAh per*Current Taper Window*
3. **Voltage** > Charging Voltage – Taper Voltage.

When this occurs, the [FC] bit of Flags( ) is set and [CHG] bit is cleared. Also, if the [RMFCC] bit of *Operation Config* is set, then ***Remaining Capacity*** is set equal to ***Full Charge Capacity***.

Normal Setting: This register depends on battery cell characteristics and charger specifications, but typical values are C/10 to C/20. ***Average Current*** is not used for this qualification because its time constant is not the same as the *Current Taper Window*. The reason for making two Current Taper qualifications is to prevent false current taper qualifications. False primary terminations happen with pulse charging and with random starting and stopping of the charge current. This is particularly critical at the beginning or end of the qualification period. It is important to note that as the *Current Taper Window* value is increased, the current range in the second requirement for primary charge termination is lowered. If the user increases the *Current Taper Window*, then the current used to integrate to the 0.25 mAh is decreased; so, this threshold becomes more sensitive. Therefore, take care when modifying the *Current Taper Window*. The default is 100 mA.

Min Taper Capacity

During Primary Charge Termination detection, one of the three requirements is that the accumulated change in capacity > 0.25 mAh per*Current Taper Window* for the bq34z100 to start trying to qualify a termination. It must be above this Min Taper Capacity before bq34z100 starts trying to detect a primary charge termination.

Normal Setting: If the value selected is too high, then it can cause no termination or late termination detection. An example value is 0.25 mAh.

Cell Taper Voltage

During Primary Charge Termination detection, one of the three requirements is that ***Voltage*** must be above (***Charge Voltage*** – *Cell Taper Voltage*) for the bq34z100 to start trying to qualify a termination. It must be above this voltage before bq34z100 starts trying to detect a primary charge termination.

Normal Setting: This value depends on charger characteristics. It needs to be set so that ripple voltage, noise, and charger tolerances are taken into account. A high value selected can cause early termination. If the value selected is too low, then it can cause no termination or late termination detection. An example value is 100 mV (see *Taper Current*).

Current Taper Window

During Primary Charge Termination detection, all three requirements as described in *Taper Current* must be valid for two periods of this *Current Taper Window* for the bq34z100 to detect a primary charge termination.

Normal Setting: This register does not need to be modified for most applications. It is important to note that as the *Current Taper Window* value is increased, the current range in the second requirement for primary charge termination is lowered. If the user increases the *Current Taper Window*, then the current used to integrate to the 0.25 mAh is decreased; so, this threshold becomes more sensitive. Therefore, take care when modifying the *Current Taper Window*. The default value is 40 seconds.

TCA Set %

This is the Terminate Charge Alarm Set. It determines the SOC % when the Charge (CHG) bit in Flags register is cleared. . When TCA Set is set to –1, it disables the use of the Charger Alarm threshold. Therefore, Terminate Charge is set when the taper condition is detected.

Normal Setting: The default value is 99%

CA Clear %

This is the Terminate Charge Alarm Clear. It is the SOC % at which the CHG bit in Flags register is set when discharging starts.

Normal Setting: The default value is 95%

FC Set %

This is the Full Charge Set Percentage parameter. If set to –1, the Primary Charge Termination algorithm will be used involving *Taper Current*, *Min Taper Capacity*, *Taper Voltage*, and *Current Taper Window*. If set to –1, the FC (Full Charge) bit will not be set until taper termination is detected using those parameters and conditions. If set to anything besides –1, the Primary Charge Termination algorithm will not be used and instead the FC bit is set when the SOC reported by the gauge reaches this specified percent through coulomb counting or passed charge current.

Normal Setting: The default value is 100%.

FC Clear%

This is the Full Charge Clear. It is the SOC % at which the FC bit is cleared when discharging starts.

Normal Setting: The default value is 98%.

DODatEOC Delta T

This represents the temperature change threshold to update *Qstart* and *Remaining Capacity* due to temperature changes. During relaxation and at the start of charging, the remaining capacity is calculated as *REMCAP = FullChargeCapacity* – Q_{start}. As temperature decreases, Q_{start} can become much smaller than that of the old *FullChargeCapacity* value, resulting in overestimation of *REMCAP*. To improve accuracy, *FullChargeCapacity* is updated whenever the temperature change since the last FullChargeCapacity update is greater than *DODatEOC Delta T* * 0.1°C.

Normal Setting: The default value is 100.

2.5 Data

Rem Cap Alarm

This is the remaining capacity alarm and it is not used in bq34z100.

Initial Standby

This is the first value that is reported in ***Standby Current***. The ***Standby Current*** value is updated every 1 second when the measured current is above the *Deadband* and is less than or equal to 2 × *Initial Standby Current*.

Normal Setting: This value depends on the system. The initial standby current is the current load drawn by the system when in low-power mode. The default value is (–)10 mA.

Initial MaxLoad

This is the first value that is reported in ***MaxLoad Current***. If the measured current is ever greater than *Initial MaxLoad* Current, then ***MaxLoad Current*** updates to the new current. ***MaxLoad Current*** is reduced to the average of the previous value and *Initial MaxLoad Current* whenever the battery is charged to full after a previous discharge to an SOC less than 50%. This prevents the reported value from maintaining an unusually high value.

Normal Setting: This value depends on the system. The default value is (–)500 mA.

Manuf Date

This is the date of manufacture. It is stored in the Data Flash in packed format. All bqEV Software and bqMTester both accept input of this date in standard date format so the packed format does not need to be used in input. It is then translated by the software to packed format. This data does not affect the operation, nor is it used by the part in any way.

Ser. Num.

This is a 16 bit serial number that does not affect the operation nor is it used by the part in any way. It is usually used for battery identification.

Cycle Count

When the bq34z100 accumulates enough discharge capacity equal to the *CC Threshold*, then it increments ***Cycle Count*** by 1. This discharge capacity does not have to be consecutive. The internal register that accumulates the discharge is not cleared at any time except when the internal accumulating register equals the *CC Threshold*, and increments ***Cycle Count***.

Normal Setting: The default is 0.

CC Threshold

This value is always used to increment ***Cycle Count***. When the bq34z100 accumulates enough discharge capacity equal to the *CC Threshold*, then it increments ***Cycle Count*** by 1. This discharge capacity does not have to be consecutive. The internal register that accumulates the discharge is not cleared at any time except when the internal accumulating register equals the *CC Threshold*, and increments ***Cycle Count***.

Normal Setting: This is normally set to about 90% of the *Design Capacity*. The default is 900 mAh.

Design Capacity

This value is used when the compensated battery capacity remaining and capacity when fully charged calculations are performed by the bq34z100. It is also used in the constant-current model when Load Mode is 0 (constant-current) and Load Select is 4 (Design Capacity / 5 for constant discharge).

Normal Setting: This value is set based on the application battery specification. See the battery manufacturer's data sheet. The value chosen may be different from the battery manufacturer’s datasheet if the battery will be charged or discharged to voltages other than those used for the battery datasheet capacity specification. The default is 1000 mAh.

Design Energy

This value is used when the compensated battery capacity remaining and capacity when fully charged calculations are done by the gauge. It is also used in the constant-power model when Load Mode is 1 (constant-power) and Load Select is 4 (Design Energy / 5 for constant discharge).

Normal Setting: This value must be set based on the application battery specification. See the battery manufacturer's data sheet. The default is 1000 mAh.

SOH Load Current

State of Health is calculated using the ratio of Full Charge Capacity and Design Capacity. The FCC depends on temperature and load. The temperature for FCC used in this calculation is 25°C. The load for FCC used is defined by *SOH Load Current*.

Normal Setting: This defaults to (–)400mA.

TDD SOH Percent

When enabled by the pack configuration bit [SE_TDD], the bq34100 can detect a battery tab disconnection as the State of Health will suddenly jump down when this occurs. The value is a percentage of the previous SOH that will trigger the TDD flag.

Normal Setting: This defaults to 90%.

Cell Charge Voltage T1-T2

The bq34z100 sets Charging Voltage to this voltage when Temperature is in the range of JEITA temperatures T1 – T2.

Normal Setting: This defaults to 4200 mV. Charger tolerances and battery specifications should be considered when setting this register.

Cell Charge Voltage T2-T3

The bq34z100 sets Charging Voltage to this voltage when Temperature is in the range of JEITA temperatures T2 – T3.

Normal Setting: This defaults to 4200 mV. Charger tolerances and battery specifications should be considered when setting this register.

Cell Charge Voltage T3-T4

The bq34z100 sets Charging Voltage to this voltage when Temperature is in the range of JEITA temperatures T3 – T4.

Normal Setting: This defaults to 4100 mV. Charger tolerances and battery specifications should be considered when setting this register.

Cell Charge Current T1-T2

The bq34z100 sets Charging Current to this voltage when Temperature is in the range of JEITA temperatures T1 – T2.

Normal Setting: This defaults to 100% of *Design Capacity*. Charger tolerances, circuit characteristics, and battery specifications should be considered when setting this register.

Cell Charge Current T2-T3

The bq34z100 sets Charging Current to this voltage when Temperature is in the range of JEITA temperatures T2 – T3.

Normal Setting: This defaults to 50% of *Design Capacity*. Charger tolerances, circuit characteristics, and battery specifications should be considered when setting this register.

Cell Charge Current T3-T4

The bq34z100 sets Charging Current to this voltage when Temperature is in the range of JEITA temperatures T3 – T4.

Normal Setting: This defaults to 30% of *Design Capacity*. Charger tolerances, circuit characteristics, and battery specifications should be considered when setting this register.

JEITA T1

This is the lower temperature boundary for the JEITA T1-T2 temperature band. See *Cell Charge Current* and *Cell Charge Voltage* parameters above.

Normal Setting: This defaults to 0 deg C. Battery specifications should be considered when setting this register.

JEITA T2

This is the upper temperature boundary for the JEITA T1-T2 temperature band, and lower temperature boundary for the JEITA T2-T3 temperature band. See *Cell Charge Current* and *Cell Charge Voltage* parameters above.

Normal Setting: This defaults to 10 deg C. Battery specifications should be considered when setting this register.

JEITA T3

This is the upper temperature boundary for the JEITA T2-T3 temperature band, and lower temperature boundary for the JEITA T3-T4 temperature band. See *Cell Charge Current* and *Cell Charge Voltage* parameters above.

Normal Setting: This defaults to 45 deg C. Battery specifications should be considered when setting this register.

JEITA T4

This is the upper temperature boundary for the JEITA T3-T4 temperature band. See *Cell Charge Current* and *Cell Charge Voltage* parameters above.

Normal Setting: This defaults to 55 deg C. Battery specifications should be considered when setting this register.

ISD Current, ISD Current Filter, Min ISD Time

These are parameters for the Internal Short Detection method used in the bq34Z100 and should not be modified except in very special circumstance under consultation with the TI application engineers.

Design Energy Scale

This parameter is used to change the power and energy units used throughout the gauge from mW to cW and from mWh to cWh. This does change the behavior of the firmware simulation loop to accommodate the use of 10X larger constant power loads. Note that this is unrelated to the “X10” bit in the *Pack Configuration* register. The bq34z100 datasheet covers this parameter in more detail.

Device Name

This is string data that can be a maximum of 7 characters. This field does not affect the operation, nor is it used by the part in any way. It is returned by reading addresses 0x63 through 0x69. The default is the ASCII values for "bq34z100".

Manufacturer Name

String data that can be a maximum of 11 characters. This field does not affect the operation nor is it used by the part in any way. It is returned by reading addresses 0x6e through 0x78.

Device Chemistry

String data that can be a maximum of 4 characters. This field does not affect the operation nor is it used by the part in any way. It is returned by reading addresses 0x7a through 0x7d.

2.6 Discharge

The bq34z100 has two flags accessed by the ***Flags()*** function that warn when the battery’s SOC has fallen to critical levels.

SOIC Set Threshold

When ***Remaining Capacity*** falls below the first capacity threshold, specified in *SOC1 Set Threshold*, the [SOC1] (*State of Charge Initial*) bit is set in ***Flags***. This bit is cleared once ***Remaining Capacity*** rises above *SOC1 Clear Threshold*.

Normal Setting: This is a user preference. It is normally set at approximately 150 mAh.

SOIC Clear Threshold

When ***Remaining Capacity*** rises to or above this value set by *SOC1 Clear Threshold*, then [SOC1] in ***Flags*** is cleared.

Normal Setting: This is a user preference. If used, it is normally set approximately 10 mAh higher than
SOC1 Set Threshold. In this case, it is set to 175 mAh.

SOCF Set Threshold

When ***Remaining Capacity*** falls below the first capacity threshold, specified in *SOCF Set Threshold*, the [SOCF] (*State of Charge Final*) bit is set in ***Flags*** serving as a final discharge warning. If *SOCF Set Threshold* = (–)1, the flag is inoperative during discharge. This bit is cleared once ***Remaining Capacity*** rises above *SOCF Clear Threshold*.

Normal Setting: This is a user preference. It is normally set at approximately 75 mAh.

SOCF Clear Threshold

When ***Remaining Capacity*** rises to or above this value set *by SOCF Clear Threshold*, then [SOCF] in ***Flags*** is cleared.

Normal Setting: This is a user preference. If used, it is normally set approximately 30 mAh higher than *SOC1 Set Threshold*. In this case, it is set to 100 mAh.

Cell BL Set Volt Threshold

Battery Low Threshold setting for cell voltage. A measured cell voltage (pack voltage / number of series cells) below this level will activate the BatLow flag in the Flags 0x0e/0x0f register, following expiration of the time parameter below.

Normal Setting: This is a user preference. Default value is 2800 mV.

Cell BL Set Volt Time

Battery Low Threshold timer setting. A measured cell voltage (pack voltage / number of series cells) below the *Cell BL Set Volt Threshold* will activate the BatLow flag in the Flags 0x0e/0x0f register following the expiration of a timer.

Normal Setting: This is a user preference. Default value is 2 seconds.

Cell BL Clear Volt Threshold

Battery Low clear threshold for cell voltage. A measured cell voltage (pack voltage / number of series cells) above this level will clear the BatLow flag in the Flags 0x0e/0x0f register immediately.

Normal Setting: This is a user preference. Default value is 2900 mV.

Cell BH Set Volt Threshold

Battery High Threshold setting for cell voltage. A measured cell voltage (pack voltage / number of series cells) above this level will activate the BatHigh flag in the Flags 0x0e/0x0f register, following expiration of the time parameter below.

Normal Setting: This is a user preference. Default value is 4300 mV.

Cell BH Set Volt Time

Battery High Threshold timer setting. A measured cell voltage (pack voltage / number of series cells) above the *Cell BH Set Volt Threshold* will activate the BatHigh flag in the Flags 0x0e/0x0f register following the expiration of a timer.

Normal Setting: This is a user preference. Default value is 2 seconds.

Cell BH Clear Volt Threshold

Battery High clear threshold for cell voltage. A measured cell voltage (pack voltage / number of series cells) below this level will clear the BatHigh flag in the Flags 0x0e/0x0f register immediately.

Normal Setting: This is a user preference. Default value is 4200 mV.

2.7 Manufacturer Data

The bq34z100 has added this new section of data flash for a pack manufacturer to have a dedicated area to store lot codes and version information. All fields in this section are blank (zeros) by default. Their use is optional and they are not used by the fuel gauge algorithm in any way.

Pack Lot Code

The pack manufacturer can use this location to store the pack lot code.

PCB Lot Code

The pack manufacturer can use this location to store the PCB lot code.

Firmware Version

The pack manufacturer can use this location to store a firmware version number for their system or pack. This value is user defined and is not related to the gauge's *Control(FW_VERSION)*.

Hardware Revision

The pack manufacturer can use this location to store a hardware version number for their system or pack. This value is user defined and is not related to the gauge's *Control(HW_VERSION)*

Cell Revision

The pack manufacturer can use this location to store the version of their cell.

DF Config Version

The pack manufacturer can use this location to store the data flash configuration version. Version control of DFI files used in production is recommended.

Static Chem DF Checksum

After issuing the MAC 0x17 command to calculate the checksum of the Rb and OCV tables, the returned value may be placed in this location for future reference. This may be useful for mass production to assure that the correct chemistry has been loaded.

2.8 Lifetime Data

The bq34z100 has added this new datalogging section of data flash for recording lifetime minimum and maximum temperatures, voltages, and currents experienced by the pack. The data sheet contains more details about this feature. Also see section 2.11 where the Lifetime Resolution settings must be configured by the user.

Lifetime Max Temp

Maximum temperature observed by the gauge. It is initialized to 300. The unit is 0.1°C.

Lifetime Min Temp

Minimum temperature observed by the gauge. It is initialized to 200. The unit is 0.1°C.

Lifetime Max Chg Current
Maximum charge current observed by the gauge. It is initialized to 0. The unit is mA.

Lifetime Max Dsg Current
Maximum discharge current observed by the gauge. It is initialized to 0. The unit is mA.

Lifetime Max Pack Voltage
Maximum battery voltage observed by the gauge. It is initialized to 3200. The unit is mV.

Lifetime Min Pack Voltage
Minimum battery voltage observed by the gauge. It is initialized to 4200. The unit is mV.

2.9 Lifetime Temp Samples

LT Flash Count
Lifetime flash page update counter. It is initialized to 0. The unit is counts.

2.10 Registers

Pack Configuration

This register is used to enable or disable various functions of the bq34z100.

RESCAP	CALEN	RSVD	RSVD	VOLTSEL	IWAKE	RSNS1	RSNS0
X10	RESFACT STEP	SLEEP	RMFCC	RSVD	RSVD	RSVD	TEMPS

Refer to table 12 in the bq34z100 data sheet for setting details.

Pack Configuration B
Refer to table 17 in the bq34z100 datasheet for setting details.

Pack ConfigurationC
Refer to table 18 in the bq34z100 datasheet for setting details.

LED_Comm Configuration
Refer to table 13 in the bq34z100 datasheet for setting details.

Alert Configuration
Refer to tables 14 and 15 in the bq34z100 datasheet for setting details.

Number of Series Cells
Since the chemical ID tables are based on a single cell, it is vital to program this parameter correctly for proper operation of the fuel gauge. Note that the VOLTSEL bit in *Pack Configuration* will normally be cleared for single-cell operation and set for multi-cell operation.

Normal Setting: This is application dependent. Default setting is 1.

2.11 Lifetime Resolution

LT Temp Res

This parameter sets the minimum temperature change that will be recorded by the gauge over the lifetime.
Normal Setting: The default for this register is 10 deg C.

LT Cur Res

This parameter sets the minimum current change that will be recorded by the gauge over the lifetime.
Normal Setting: The default for this register is 100 mA.

LT V Res

This parameter sets the minimum voltage change that will be recorded by the gauge over the lifetime.
Normal Setting: The default for this register is 25 mV.

LT Update Time

This parameter sets the minimum time between data flash writes to update the Lifetime Parameters.
Normal Setting: The default for this register is 60 seconds.

2.12 LED Display

LED Hold Time

This parameter sets the number of seconds for the LED display to be active following activation of the LED push button. Note that there is an LED_ON bit in the LED configuration register, which can be used to keep the LED display always active.

Normal Setting: The default for this register is 4 seconds.

2.13 Power

Flash Update OK Cell Voltage

This register controls one of several data flash protection features. It is critical that data flash is not updated when the battery voltage is too low. Data flash programming takes much more current than normal operation of the bq34z100. With a depleted battery this current can cause the battery voltage to drop dramatically, forcing the bq34z100 into reset before completing a data flash write. The effects of an incomplete data flash write can corrupt the memory, resulting in unpredictable and extremely undesirable results. The voltage setting in *Flash Update OK Cell Voltage* is used to prevent any writes to the data flash below this value. If a charging condition is detected, then this register is ignored.

Normal Setting: The default for this register is 2800 mV. Ensure that this register is set to a voltage where the battery has plenty of capacity to support data flash writes but below any normal battery operation conditions. The actual value used is for this setting is based on the formula below, rather than the actual desired millivolts per cell. Since it is a function of ***Voltage Divider***, it should only be determined following voltage calibration.

Flash Update OK Cell Volt =

Desired Cell mV for no Flash Updates * ***Number Of Series Cells*** * 5000 / ***Voltage Divider***

Sleep Current

When ***Average Current*** is less than *Sleep Current* or greater than (–)*Sleep Current* in mA, the bq34z100 enters SLEEP mode if the feature is enabled (*Op Config* [SLEEP] = 1). The bq34z100 does an analog-to-digital converter (ADC) calibration and then goes to sleep.

Normal Setting: This setting must be below any normal application currents. The default is 10 mA, which is sufficient for most applications.

Full Sleep Wait Time (FS Wait)

This is the Full Sleep Wait time and represents a delay in seconds. When in SLEEP mode, the gauge will count down from this value before entering FULLSLEEP mode. If set to 0, the function is disabled and the gauge will never go to FULLSLEEP mode.

Normal Setting: The default setting is 0 second, which disables the FS Wait function.

3 System Data

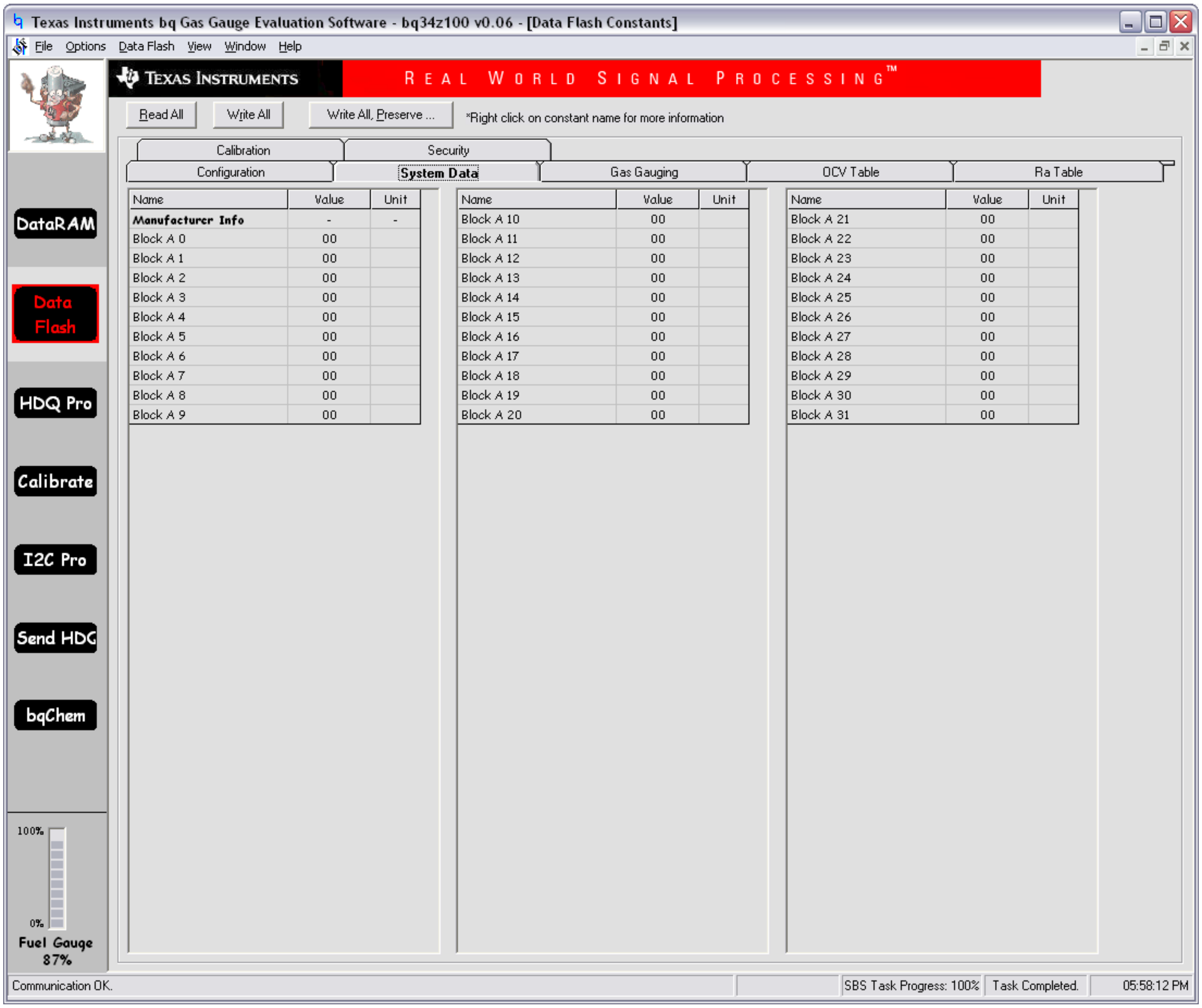


Figure 2. System Data Screen

3.1 Manufacturer Info

Block A

This is string data that can be any user data. It can be a maximum of 32 bytes.

Normal Setting: Can be used for any user data. The default is all data 0.

4 Gas Gauging

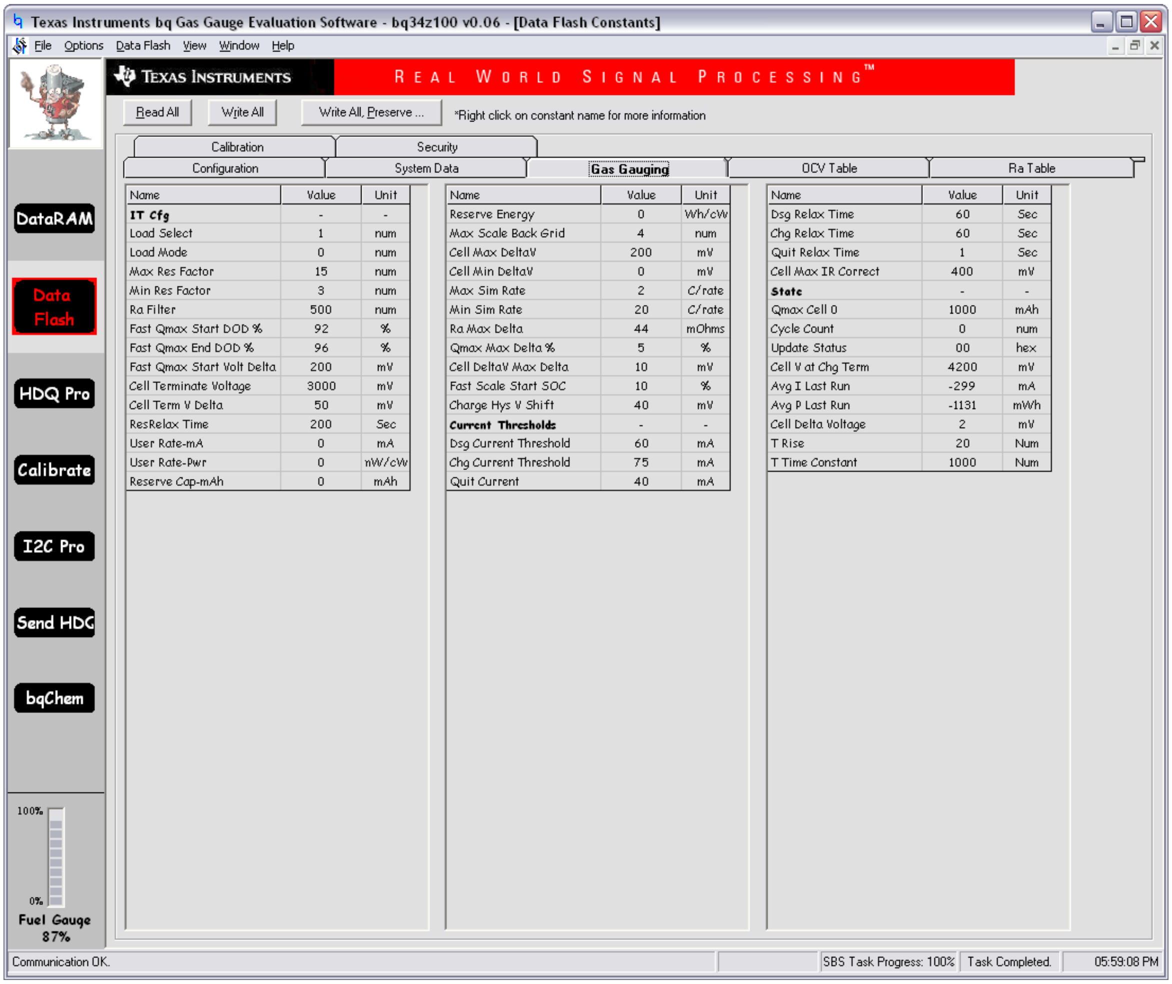


Figure 3. Gas Gauging Screen

4.1 IT Cfg

Load Select

Load Select defines the type of power or current model to be used for ***Remaining Capacity*** computation in the Impedance Track™ algorithm.

If *Load Mode* = Constant Current, then the following options are available:

0 = Average discharge current from previous cycle: An internal register records the average discharge current through each entire discharge cycle. The previous average is stored in this register.

1 = Present average discharge current (default): This is the average discharge current from the beginning of this discharge cycle until present time.

2 = *Current:* Based off of instantaneous ***Current***

3 = ***Average Current:*** Based off of ***Average Current***

4 = ***Design Capacity***/5: C Rate based off of ***Design Capacity***/5 or a C/5 rate in mA.

5 = ***At Rate*** (mA): Use whatever current is in ***At Rate*** register.

6 = *User Rate-mA:* Use the value in *User Rate-mA*. This gives a completely user-configurable method.

If *Load Mode* = Constant Power, then the following options are available:

0 = Average discharge power from previous cycle: An internal register records the average discharge power through each entire discharge cycle. The previous average is stored in this register.

1 = Present average discharge power (default): This is the average discharge power from the beginning of this discharge cycle until present time.

2 = ***Current × Voltage:*** Based off of ***Current*** and ***Voltage***

3 = ***Average Current × Voltage :*** Based off of ***Average Current*** and ***Voltage***

4 = ***Design Energy***/5: C Rate based off of ***Design Energy***/5 or a C/5 rate in mA

5 = ***At Rate*** (10 mW): Use whatever value is in ***At Rate*** register.

6 = *User Rate-mW*: Use the value in *User Rate-mW*. This gives a completely user-configurable method.

Normal Setting: The default for this register is 1. This is application dependent.

Load Mode

Load Mode is used to select either the constant current or constant power model for the Impedance Track™ algorithm as used in *Load Select*. (See *Load Select*.)

0: Constant Current Mode

1: Constant Power Mode

Normal Setting: This is normally set to 0 (Constant Current Mode) but it is application specific. If the application load profile more closely matches a constant power mode, then set to 1. This provides a better estimation of remaining run time, especially close to the end of discharge where current increases to compensate for decreasing battery voltage.

Max Res Factor

Max percentage (ratio) that an impedance value stored in the Ra table is allowed to change in a single update in the positive direction.

Normal Setting: It is normally set to 30.

Min Res Factor

Min percentage (ratio) that an impedance value stored in the Ra table is allowed to change in a single update in the negative direction.

Normal Setting: It is normally set to 3.

Ra Filter

Ra table updates are filtered. This is the weight factor. It takes certain percentage of previous Ra value and the remaining percentage comes from the newest learned Ra value.

Normal Setting: It is normally set to 800 (80% previous Ra value plus 20% learned Ra value to form new Ra value)

Fast Qmax Start DOD%, Fast Qmax End DOD%, Fast Qmax Start Volt Delta

These parameters are used for special applications to configure the Fast Qmax Update algorithm, which can be enabled by setting the FastQmax bit in Pack Configuration C. The default values should be used. Changes to the default values should only be made after consultation with a TI applications engineer.

Cell Terminate Voltage

Terminate Voltage is used in the Impedance Track™ algorithm to help compute ***Remaining Capacity***. This is the absolute minimum voltage for end of discharge, where the remaining chemical capacity is assumed to be zero.

Normal Setting: This register is application dependent. It must be set based on battery cell specifications to prevent damage to the cells or the absolute minimum system input voltage, taking into account impedance drop from the PCB traces, FETs, and wires. The default is 3000 mV.

Cell Term V Delta

This parameter is used for special applications only. It is recommended to use the default value and only make changes after consulting with the appropriate TI applications engineer.

User Rate-mA

User *Rate-mA* is only used if *Load Select* is set to 6 and *Load Mode* = 0. If these criteria are met, then the current stored in this register is used for the ***Remaining Capacity*** computation in the Impedance Track™ algorithm. This is the only function that uses this register.

Normal Setting: It is unlikely that this register is used. An example application that would require this register is one that has increased predefined power at the end of discharge. With this application, it is logical to adjust the rate compensation to this period because the IR drop during this end period is affected the moment *Terminate Voltage* is reached. The default is 0 mA units.

User Rate-Pwr

User *Rate-Pwr* is only used if Load Select is set to 6 and *Load Mode* = 1. If these criteria are met, then the power stored in this register is used for the ***Remaining Capacity*** computation in the Impedance Track™ algorithm. This is the only function that uses this register.

Normal Setting: It is unlikely that this register is used. An example application that requires this register is one that has increased predefined power at the end of discharge. With this application, it is logical to adjust the rate compensation to this period because the IR drop during this end period is affected the moment *Cell Terminate Voltage* is reached. The default is 0 cW units.

Reserve Cap-mAh

Reserve Cap-mAh determines how much actual remaining capacity exists after reaching 0 ***RemainingCapacity*** before *Terminate Voltage* is reached. This register is only used if *Load Mode* is set to 0.

Normal Setting: This register defaults to 0, which disables this function. This is the most common setting for this register. This register is application dependent. This is a specialized function for allowing time for a controlled shutdown after 0 reported ***Remaining Capacity*** is reached.

Reserve Energy

Reserve Energy determines how much actual remaining capacity exists after reaching 0 ***Remaining Capacity*** before *Terminate Voltage* is reached. This register is only used if *Load Mode* is set to 1.

Normal Setting: This register defaults to 0, which basically disables this function. This is the most common setting for this register. This register is application dependent. This is a specialized function for allowing time for a controlled shutdown after 0 reported ***Remaining Capacity*** is reached.

Max Scale Back Grid

During the R table update, the R value that has been learned through previous grid points will be scaled up or down depending on the new R leaned at current grid point. This is the maximum grid point that allows scaling back when doing R update.

Normal Setting: this defaults to grid point 4

Cell Max DeltaV

This is the maximum delta V allowed during discharge cycle.

Normal Setting: it defaults to 200mV

Cell Min DeltaV

This is the minimum delta V allowed during discharge cycle.

Normal Setting: it defaults to 0mV

Max Sim Rate

Maximum IT simulation rate (reversed). 2 means C/2.

Normal Setting: This register defaults to 2.

The gauge will never run a simulation for predictions at a rate higher / lower than Max Sim Rate.

Min Sim Rate

Minimum IT simulation rate (reversed). 20 means C/20.

Normal Setting: This register defaults to 20.

The gauge will never run a simulation for predictions at a rate higher / lower than Min Sim Rate.

Ra Max Delta

Maximum jump allowed during updates of a Ra table grid point. It must be manually changed to 15% of the grid point 4 Ra value after an optimization cycle has been completed.

Normal Setting: This register defaults to 44 but must be calculated and changed for the golden DFI file to be 20% of the Ra 4 grid point after an optimization cycle has been completed.

Qmax Max Delta %

This is the percent of design capacity to limit how much Qmax may grow or shrink during any one Qmax update.

Normal Setting: it defaults to 5%.

Cell DeltaV Max Delta

Limits on how far Delta V can grow or shrink on one grid update (in mV).

Normal Setting: This register defaults to 10.

Fast Scale Start SOC

This parameter is used for special applications only. It is recommended to use the default value and only make changes after consulting with the appropriate TI applications engineer.

Charge Hys Voltage Shift

This parameter is used for special applications only. It is recommended to use the default value and only make changes after consulting with the appropriate TI applications engineer.

4.2 Current Thresholds

Dsg Current Threshold

This register is used as a threshold by many functions in the bq34z100 to determine if actual discharge current is flowing out of the battery. This is independent from [DSG] in ***Flags***, which indicates whether the bq34z100 is in discharge mode or charge mode.

Normal Setting: The [DSG] flag in ***Flags*** is the method for determining charging or discharging. If the bq34z100 detects charging or relaxation, then [DSG] is 0 and any other time (***Average Current*** less than or equal to Dsg Current Threshold) the [DSG] flag is set equal to 1. Many algorithms in the bq34z100 require more definitive information about whether current is flowing in either the charge or discharge direction. *Dsg Current Threshold* is used for this purpose. The default for this register is
60 mA which is sufficient for most applications. This threshold must be set low enough to be below any normal application load current but high enough to prevent noise or drift from affecting the measurement.

Chg Current Threshold

This register is used as a threshold by many functions in the bq34z100 to determine if actual charge current is flowing into the battery. This is independent from [DSG] in Battery Status which indicates whether the bq34z100 is in discharge mode or not. It is also independent from the [CHG] bit which indicates whether charging is allowed.

Normal Setting: Many algorithms in the bq34z100 require more definitive information about whether current is flowing in either the charge or discharge direction. This is what *Chg Current Threshold* is used for. The default for this register is 75 mA which is sufficient for most applications. This threshold must be set low enough to be below any normal application load current but high enough to prevent noise or drift from affecting the measurement.

Quit Current

The *Quit Current* is used as part of the Impedance Track™ algorithm to determine when the bq34z100 goes into relaxation mode from a current-flowing mode in either the charge direction or the discharge direction. Either of the following criteria must be met to enter relaxation mode:

1. ***Average Current*** is greater than (–)*Quit Current* and then goes within (±)*Quit Current* for *Dsg Relax Time*.
2. ***Average Current*** is less than *Quit Current* and then goes within (±)*Quit Current* for *Chg RelaxTime*

After 30 minutes in relaxation mode, bq34z100 starts checking if the dV/dt requirement for OCV readings is satisfied. When the battery relaxes sufficiently to satisfy this criteria, bq34z100 takes OCV reading for updating Qmax and for accounting for self-discharge. These updates are used in the Impedance Track™ algorithms.

Normal Setting: It is critical that the battery voltage be relaxed during OCV readings to get the most accurate results. This current must not be higher than C/20 when attempting to go into relaxation mode; however, it must not be so low as to prevent going into relaxation mode due to noise. This must always be less than *Chg Current Threshold* or *Dsg Current Threshold*. Default is 40 mA.

Dsg Relax Time

The *Dsg Relax Time* is used in the function to determine when to go into relaxation mode. When ***Current*** is greater than (–)*Quit Current* and then goes within (±)*Quit Current* the *Dsg Relax Time*, the timer is initiated. If the current stays within (±)*Quit Current* until the *Dsg Relax Time* timer expires, then the bq34z100 goes into relaxation mode. After 30 minutes in relaxation mode, the bq34z100 starts checking if the dV/dt < 1 uV/s requirement for OCV readings is satisfied. When the battery relaxes sufficiently to satisfy these criteria, the bq34z100 takes OCV reading for updating Qmax and for accounting for self-discharge. These updates are used in the Impedance Track™ algorithms.

Normal Setting: Care must be taken when interpreting discharge descriptions in this document while determining the direction and magnitude of the currents because they are in the negative direction. This is application specific. Default is 60 seconds.

Chg Relax Time

The *Chg Relax Time* is used in the function to determine when to go into relaxation mode. When ***Current*** is greater than *Quit Current* and then goes within (±)*Quit Current* the *Chg Relax Time*, the timer is initiated. If the current stays within (±)*Quit Current* until the *Chg Relax Time* timer expires, then the bq34z100 goes into relaxation mode. After approximately 30 minutes in relaxation mode, the bq34z100 attempts to take accurate OCV readings. An additional requirement of dV/dt < 1µV/s (delta voltage over delta time) is required for the bq34z100 to perform Qmax updates. These updates are used in the Impedance Track™ algorithms.

Normal Setting: This is application specific. Default is 60 seconds.

Quit Relax Time

The *Quit Relax Time* is a delay time to exit relaxation. If current is greater than *Chg Current Threshold* or less than *Dsg Current Threshold* and this condition is maintained during *Quit Relax Time*, then exiting relaxation is permitted.

Normal Setting: This is particular to handheld applications in which low duty cycle dynamic loads are possible. Default is 1 second.

Cell Max IR Correct

If current is flowing during voltage measurement that is used for finding initial DOD, IR correction will be used to eliminate the effect of IR drop across cell impedance and obtain true OCV. Max IR Correct is the maximal value of IR correction that will be used. It is to avoid artifacts due to high resistance at low DOD values during charge.

Normal Setting: This is particular to handheld applications. Default is 400 mV.

4.3 State

Qmax Cell 0

These are the maximum chemical capacity of the battery cell. The bq34z100 has only one cell profile stored. It also corresponds to capacity at a low rate of discharge such as a C/20 rate. This value is updated continuously by the bq34z100 during use to keep capacity measuring as accurate as possible.

Normal Setting: Before an optimization cycle is run, this value initially must be set to the battery cell data-sheet capacity. After the optimization cycle is run and for creation of the golden settings, it must be set to the learned value. Default is 1000 mAh.

Cycle Count

These are the numbers of Qmax update the battery has experienced. This is not the same as Cycle Count in the Configuration:Data subclass.

Normal Setting: Initially must be set to 0 for fresh battery cell. The default is 0.

Update Status

Three bits in this register are important:

- Bit 2 (0x04) indicates whether the Impedance Track™ algorithm is enabled.
- Bit 1 (0x02) indicates that the bq34z100 has learned optimized values for Qmax and the Ra tables during a learning cycle.
- Bit 0 (0x01) indicates that the bq34z100 has learned an initial value for Qmax after the charging portion of a learning cycle.

At the beginning of a learning cycle when creating a golden DFI file in bqEASY™, Update Status will start at 0x00. When IT is enabled with the IT_ENABLE subcommand being sent to Control(), Update Status will automatically be changed to 0x04. After the charge and relaxation portion of the learning cycle are complete, Update Status should have become 0x05. Finally, after the discharge and relaxation portion of the learning cycle, Update Status will become 0x06 if the learning cycle was successfully completed. A golden DFI file can then be generated in the final step of bqEASY if Update Status was successfully set to 0x06 by the gauge.

When the golden DFI file is created by bqEASY, bit 2 will be cleared, leaving Update Status = 0x02. Note that none of these bits should be manually changed. IT must be enabled only by sending the
IT_ENABLE subcommand to the Control() register.

Normal Setting: Bit 1 and bit 2 are user configurable; however, bit 1 is also a status flag that can be set by the bq34z100. This bit must never be modified except when creating a golden image file. Bit 1 is updated as needed by the bq34z100.

Cell V at Chg Term

This is the gauge recorded voltage at charge termination

Normal Setting: This defaults to 4200 mV.

Avg I Last Run

The bq34z100 logs the ***Average Current*** averaged from the beginning to the end of each discharge cycle. It stores this average current from the previous discharge cycle in this register.

Normal Setting: This register never needs to be modified. It is only updated by the bq34z100 when required.

This will be used by the IT algorithm if Load Select = Constant Current and Load Mode = 0.

Avg P Last Run

The bq34z100 logs the power averaged from the beginning to the end of each discharge cycle. It stores this average power from the previous discharge cycle in this register. To get a correct average power reading, the bq34z100 continuously multiplies instantaneous Current to ***Voltage*** to get power. It then logs this data to derive the average power.

Normal Setting: This register never needs to be modified. It is only updated by the bq34z100 when required.

This will be used by the IT algorithm if Load Select = Constant Power and Load Mode = 0.

Avg P Last Run

The bq34z100 logs the power averaged from the beginning to the end of each discharge cycle. It stores this average power from the previous discharge cycle in this register. To get a correct average power reading, the bq34z100 continuously multiplies instantaneous Current to ***Voltage*** to get power. It then logs this data to derive the average power.

Normal Setting: This register never needs to be modified. It is only updated by the bq34z100 when required.

This will be used by the IT algorithm if Load Select = Constant Power and Load Mode = 0.

Cell Delta Voltage

The maximum difference of ***Voltage( )*** during short load spikes and normal load, so the Impedance Track algorithm can calculate remaining capacity for pulse loads.

The Delta Voltage value will be automatically updated by the gauge during operation as voltage spikes are detected. It can be initialized to a higher value if large spikes are typical for the system. Allowable values are limited by Max DeltaV and Min DeltaV.

Normal Setting: It defaults to 2mV.

T Rise

This is the thermal rise factor that is used in the single time constant heating-cooling thermal modeling. If set to 0, this feature is disabled and simulations in the IT algorithm will not account for self-heating of the battery cell.

Normal Setting: It defaults to 0.

T Time Constant

This is the thermal time constant that is used in single time constant heating-cooling thermal modeling. If set to 32767, this feature is disabled and simulations in the IT algorithm will assume no self-heating of the battery cell.

Normal Setting: It defaults to 32767.

5. Ra Table

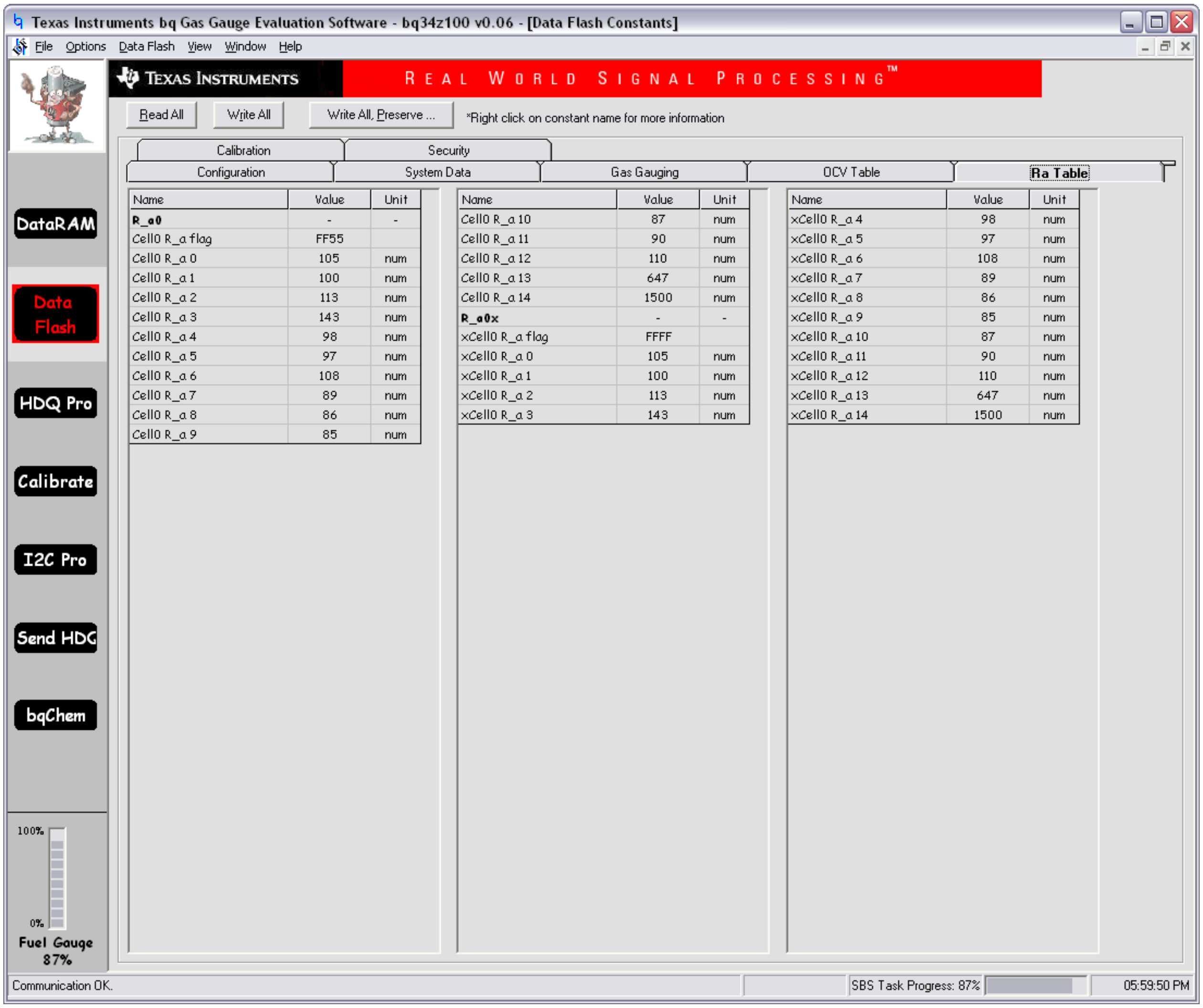


Figure 4. Ra Table Screen

This data is automatically updated during device operation. No user changes need to be made except for reading the values from another pre-learned pack for creating "Golden Image Files". See the application report *Going to Production With the* *bq34z100*. Profiles have format *Cell0 R_a* M where M is the number indicating state of charge to which the value corresponds.

Each subclass (R_a0 and R_a0x) in the Ra Table class is a separate profile of resistance values normalized at 0 degrees for the cell in a design. The cell has two profiles. They are denoted by the x or absence of the x at the end of the subclass.

Cell0 R_a flag, xCell0 R_a flag

The purpose for two profiles for the cell is to ensure that at any given time at least one profile is enabled and is being used while attempts can be made to update the alternate profile without interference. Having two profiles also helps reduce stress on the flash memory. At the beginning of each of the two subclasses (profiles) is a flag called *Cell0 R_a flag* or *xCell0 R_a flag*. This flag is a status flag that indicates the validity of the table data associated with this flag and whether this particular table is enabled or disabled.

Each flag has two bytes:

1. The LSB (least-significant byte) indicates whether the table is currently enabled or disabled. It has the following options:
   (a) 0x00: means the table has had a resistance update in the past; however, it is not the currently enabled table for the cell. (The alternate table for the cell must be enabled at this time.)
   (b) 0xff: This means that the values in this table are default values. These table resistance values have never been updated, and this table is not the currently enabled table for the cell. (The alternate table for the indicated cell must be enabled at this time.)
   (c) 0x55: This means that this table is enabled for the indicated cell. (The alternate table must be disabled at this time.)
2. The MSB (most-significant byte) indicates the status of the data in this particular table. The possible values for this byte are:
   (a) 0x00: The data associated with this flag has had a resistance update, and the *QMax Pack* has been updated.
   (b) 0x05: The resistance data associated with this flag has been updated, and the pack is no longer discharging (this is prior to a *Qmax Pack* update).
   (c) 0x55: The resistance data associated with this flag has been updated, and the pack is still discharging. (Qmax update attempt not possible until discharging stops.)
   (d) 0xff: The resistance data associated with this flag is all default data.

This data is used by the bq34z100 to determine which tables need updating and which tables are being used for the Impedance Track™ algorithm.

Normal Setting: This data is used by the bq34z100 Impedance Track™ algorithm. The only reason this data is displayed and accessible is to give the user the ability to update the resistance data on golden image files. This description of the *xCell0 R_a flags* is intended for information purposes only. It is not intended to give a detailed functional description for the bq34z100 resistance algorithms.

Cell0 R_a0 – Cell0 R_a14, xCell0 R_a0 – xCell0 R_a14

The **Ra Table** class has 15 values for each R_a subclass. Each of these values represent a resistance value normalized at 25°C for the associated *Qmax Pack*-based SOC grid point as found by the following rules:

For *Cell0 R_aM* where:

1. If 0 ≤ M ≤ 8: The data is the resistance normalized at 0° for: SOC = 100% – (M × 10%)
2. If 9 ≤ M ≤ 14 : The data is the resistance normalized at 0° for: SOC = 100% – [80% + (M – 8) × 3.3%]

This gives a profile of resistance throughout the entire SOC profile of the battery cells concentrating more on the values closer to 0%.

Normal Setting: SOC as stated in this description is based on *Qmax Pack*. It is not derived as a function of SOC. These resistance profiles are used by the bq34z100 for the Impedance Track™ algorithm. The only reason this data is displayed and accessible is to give the user the ability to update the resistance data on golden image files. This resistance profile description is for information
purposes only. It is not intended to give a detailed functional description for the bq34z100 resistance algorithms. It is important to note that this data is in mΩ units and is normalized to 25°C. The following are useful observations to note with this data throughout the application development cycle:

1. Watch for negative values in the **Ra Table** class. Negative numbers in profiles must never be anywhere in this class.
2. Watch for smooth consistent transitions from one profile grid point value to the next throughout each profile. As the bq34z100 does resistance profile updates, these values are roughly consistent from one learned update to another without huge jumps in consecutive grid points.

6 Calibration

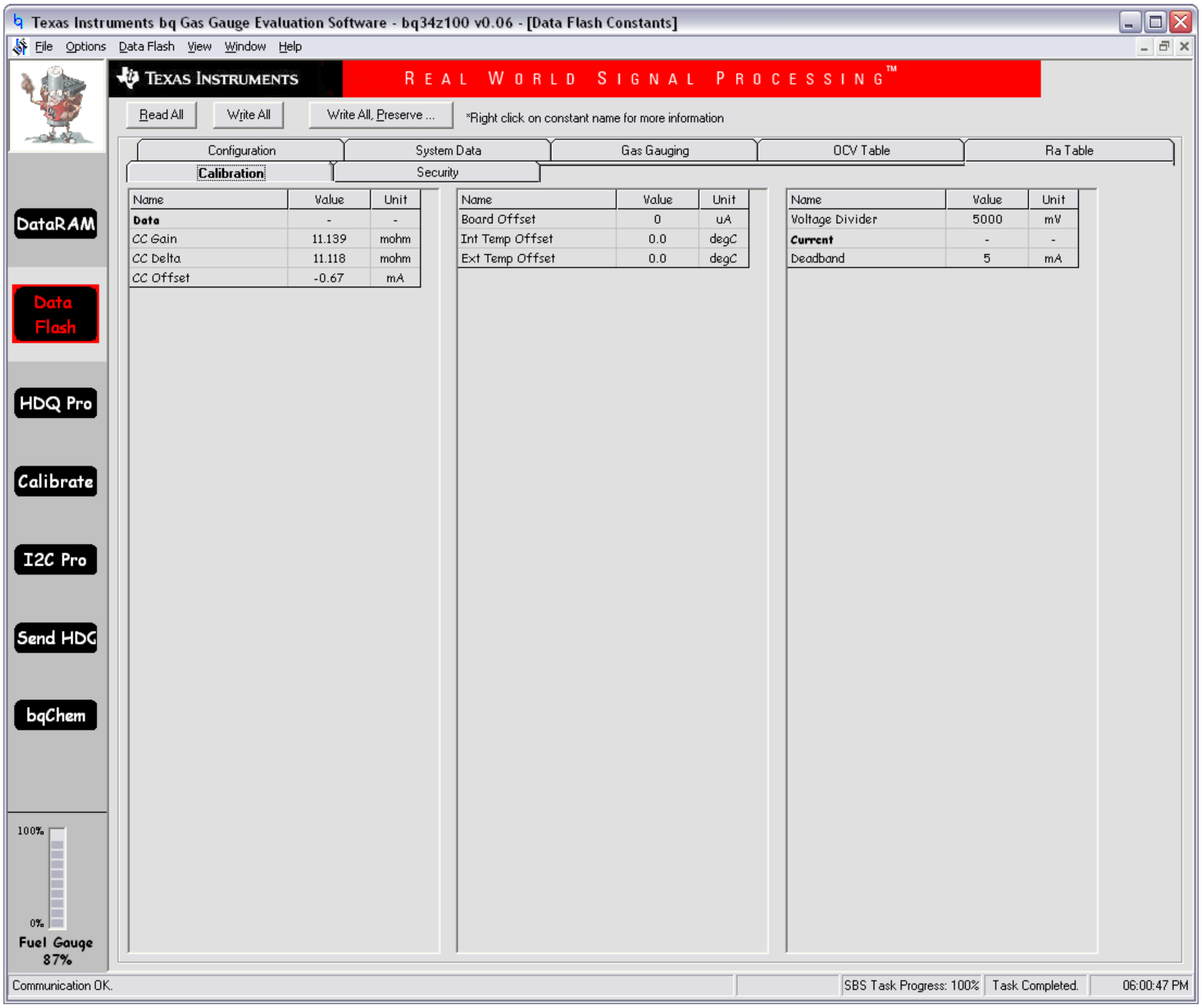


Figure 5. Calibration Screen

6.1 Data

Most of these values never require modification by the user. They are only modified by the Calibration commands in Calibration mode as explained in the application report *Going to Production with the bq34z100*.

CC Gain

This is the gain factor for calibrating Sense Resistor, Trace, and internal Coulomb Counter (integrating ADC delta sigma) errors. It is used in the algorithm that reports ***Average Current***. The difference between *CC Gain* and *CC Delta* is that the algorithm that reports Current cancels out the time base because ***Average Current*** does not have a time component (it reports in mA) and CC Delta requires a time base for reporting ***Remaining Capacity*** (it reports in mAh).

Normal Setting: *CC Gain* never needs to be modified directly by the user. It is modified by the current calibration function from Calibration mode. See the application report *Going to Production with the bq34z100* for more information.

CC Delta

This is the gain factor for calibrating Sense Resistor, Trace, and internal Coulomb Counter (integrating ADC delta sigma) errors. It is used in the algorithm that reports charge and discharge in and out of the battery through the ***Remaining Capacity*** register. The difference between *CC Gain* and *CC Delta* is that the algorithm that reports ***Average Current*** cancels out the time base because ***Average Current*** does not have a time component (it reports in mA) and *CC Delta* requires a time base for reporting ***Remaining Capacity*** (it reports in mAh).

Normal Setting: *CC Delta* never needs to be modified directly by the user. It is modified by the current calibration function from Calibration mode. See the application report *Going to Production with the bq34z100* for more information.

CC Offset

Two offsets are used for calibrating the offset of the internal Coulomb Counter, board layout, sense resistor, copper traces, and other offsets from the Coulomb Counter readings. *CC Offset* is the calibration value that primarily corrects for the offset error of the bq34z100 Coulomb Counter circuitry. The other offset calibration is *Board Offset* and is described next. To minimize external influences when doing *CC Offset* calibration either by automatic *CC Offset* calibration or by the *CC Offset* calibration function in Calibration Mode, an internal short is placed across the SRP and SRN pins inside the bq34z100. *CC Offset* is a correction for small noise/errors; therefore, to maximize accuracy, it takes about 20 seconds to calibrate the offset. Because it is impractical to do a 20-s offset during production, two different methods for calibrating *CC Offset* were developed.

(A) The first method is to calibrate *CC Offset* by the putting the bq34z100 in Calibration mode and initiating the *CC Offset* function as part of the entire bq34z100 calibration suite. See the application report *Going to Production with the bq34z100* information on the Calibration mode. This is a short calibration that is not as accurate as the second method, *Board Offset*. Its primary purpose is to calibrate *CC Offset* enough so that it does not affect any other Coulomb Counter calibrations. This is only intended as a temporary calibration because the automatic calibration, *Board Offset*, is done the first time the I2C Data and Clock is low for more than 20 seconds, which is a much more accurate calibration.

(B) During normal Gas Gauge Operation when the I2C clock and data lines are low for more than 5 seconds and ***Average Current*** is less than *Sleep Current* in mA, then an automatic *CC Offset* calibration is performed. This takes approximately 16 seconds and is much more accurate than the method in Calibration mode.

Normal Setting: *CC Offset* must never be modified directly by the user. It is modified by the current calibration function from Calibration mode or by Automatic Calibration. See the application report *Going to Production with the bq34z100* for more information on calibration.

Board Offset

Board Offset is the second offset register. Its primary purpose is to calibrate all that the *CC Offset* does not calibrate out. This includes board layout, sense resistor and copper trace, and other offsets that are external to the bq34z100 integrated circuit (IC). The simplified ground circuit design in the bq34z100 requires a separate board offset for each tested device.

Normal Setting: This value must only be set one time when all the other data flash constants are modified during the pack production process.

Int Temp Offset

The bq34z100 has a temperature sensor built into the IC. The *Int Temp Offset* is used for calibrating offset errors in the measurement of the reported ***Temperature*** if the internal temperature sensor is used. The gain of the internal temperature sensor is accurate enough that a calibration for gain is not required.

Normal Setting: *Int Temp Offset* never needs to be modified by the user. It is modified by the internal temperature sensor calibration command in Calibration mode. *Int Temp Offset* must only be calibrated if the internal temperature sensor is used. See the application report *Going to Production with the bq34z100* for more information on calibration

Ext Temp Offset

Ext Temp Offset is for calibrating the offset of the thermistor connected to the TS1 pin of the bq34z100 as reported by Temperature. The gain of the thermistor is accurate enough that a calibration for gain is not required.

Normal Setting: *Ext Temp Offset* never needs to be modified by the user. It is modified by the external temperature sensor calibration command in Calibration Mode. *Ext Temp Offset* must only be calibrated if a thermistor is connected to the TS pin of the bq34z100. See the application report *Going to Production with the bq34z100* for more information on calibration.

Voltage Divider

This is the calibration constant to calibrate the bq34z100 analog-to-digital converter for single-cell or multi-cell voltage measurement.

Normal Setting: For single-cell operation, with [VOLTSEL] in *Pack Configuration* cleared, the default value of 5000 will usually never need modification, since single-cell calibration is performed during TI assembly and test.

For multi-cell applications, with [VOLTSEL] in *Pack Configuration* set, the initial value will depend on the ratio of the external voltage divider. Following voltage calibration, the value will change to the exact value required to maintain best accuracy. With the voltage divider designed as per the bq34z100 datasheet, the initial value for *Voltage Divider* will be approximately equal to the maximum expected pack voltage in millivolts.

6.2 Current

Deadband

The purpose of the *Deadband* is to create a filter window to the reported ***Average Current*** register where the current is reported as 0. Any negative current above this value or any positive current below this value is displayed as 0.

Normal Setting: This defaults to 5 mA. Only a few reasons may require changing this value:

1. If the bq34z100 is not calibrated.
2. *Board Offset* has not been characterized.
3. If the PCB layout has issues that cause inconsistent board offsets from board to board.
4. An extra noisy environment along with reason 3.

7 Security

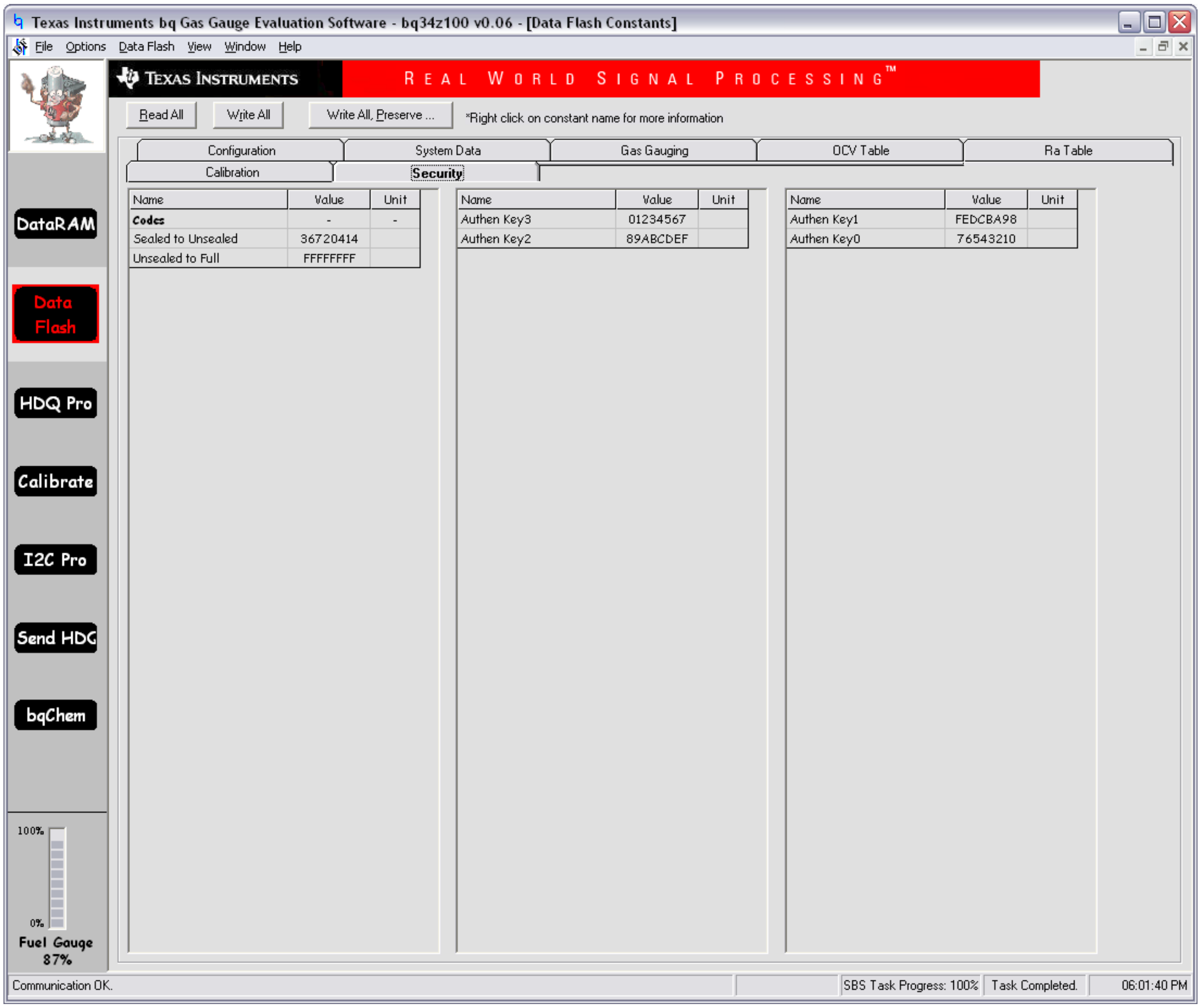


Figure 6. Security Screen

7.1 Codes

Sealed to Unsealed

This is the register to store the security code to set the device from sealed mode to unsealed mode.

Normal Setting: The default code is set to 0x36720414.

Unsealed to Full

This is the register to store the security code to set the device from unsealed mode to full access mode.

Normal Setting: The default code is set to 0xFFFFFFFF.

Authen Key0–Key3

This is the register to store the SHA-1 authentication key to allow system to authenticate the battery pack.

Normal Setting: The default key is set to 0x0123456789ABCDEFFEDCBA9876543210.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265