Configuring the bq34100 Data Flash

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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.

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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.

*Italic*: 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 Italic**: 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

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 setting 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 – Qstart. As temperature decreases, Qstart 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 (–)400 mA.
**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.

<table>
<thead>
<tr>
<th>RESCAP</th>
<th>CALEN</th>
<th>RSVD</th>
<th>RSVD</th>
<th>VOLTSEL</th>
<th>IWAKE</th>
<th>RSNS1</th>
<th>RSNS0</th>
</tr>
</thead>
<tbody>
<tr>
<td>X10</td>
<td>RESFACT</td>
<td>SLEEP</td>
<td>RMFCC</td>
<td>RSVD</td>
<td>RSVD</td>
<td>RSVD</td>
<td>TEMPS</td>
</tr>
</tbody>
</table>

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 Configuration C**
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.

\[
\text{Flash Update OK Cell Volt} = \text{Desired Cell mV for no Flash Updates} \times \frac{\text{Number Of Series Cells}}{5000} \times \frac{1}{\text{Voltage Divider}}
\]
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

![System Data Screen](image)

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

4.1 IT Cfg

*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 x Voltage: Based off of Current and Voltage
3 = Average Current x 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 *Remaining Capacity* 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**

**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 Relax Time

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 μV/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 < 1 μV/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.

**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

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% – \[80% + (M – 8) \times 3.3\%\]

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

![Calibration Screen](image)

**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 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

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.
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