

# Application Report

## BQ40Z50-R3 to BQ40Z50-R4 Change List



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### ABSTRACT

This document describes the changes made from the BQ40Z50-R3 device to the BQ40Z50-R4 firmware. The latest ordering information and the [BQ40Z50-R4 Technical Reference Manual](#) are available on [TI.com](#).

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### 1 Introduction

The BQ40Z50-R4 firmware is released to enable several feature additions and performance improvements.

To work with BQ40Z50-R4, download the latest version of the [Battery Management Studio](#) (BQSTUDIO) evaluation software from [TI.com](#).

The existing BQ40Z50, BQ40Z50-R1, BQ40Z50-R2, and BQ40Z50-R3 integrated circuits and evaluation modules (EVMs) can be upgraded to BQ40Z50-R4 firmware by downloading the .srec firmware file from [TI.com](#).

### 2 Change Details

Table 2-1. Change Details

Change Description	BQ40Z50-R4	BQ40Z50-R3	Comments
Add support for a single <a href="#">TMP468</a> multi-channel remote temperature sensor	New Feature	Feature does not exist.	Extends temperature sensing capability. TMP468 data is accessible via MAC commands 0x0081 through 0x0087.
Expanded Lifetime Data Collection	New Feature	Feature does not exist.	Adds separate thermistor and TMP468 temperature data tracking for each gauging mode: RELAX, CHARGE and DISCHARGE. Added <b>Temperature Hold-off Time</b> to define the minimum time spent in a gauging mode to begin data tracking. New Lifetime MAC commands 0x006c to 0x006e returns 30 bytes of temperature data for RELAX, CHARGE and DISCHARGE modes respectively. Added 10-hour data flash archive interval of Lifetime data in SLEEP mode.
Separate power/reset event counters from Lifetime Data Collection	Modified Feature	Reset counters are only associated with Lifetime data block.	The following Lifetime Data power events: <b>No Of Shutdowns</b> , <b>No Of Partial Resets</b> , <b>No Of Full Resets</b> and <b>No Of Wdt Resets</b> are tracked all the time even if Lifetime Data logging is not enabled. These events can be read via the MAC 0x006F <i>PowerEvents()</i> command and available in as individual data flash parameters. Note: These parameters have been moved from Lifetime Data Block 2 to the individually accessible Lifetimes:Power Events subclass. New data flash added (defaults): <b>No Of Shutdowns</b> (0 events) <b>No Of Partial Resets</b> (0 events) <b>No Of Full Resets</b> (0 events) <b>No Of Wdt Resets</b> (0 events)
Automatic Coulomb Counter offset calibration improvements	Modified Feature	Calibration may continue when unnecessary.	Terminates automatic coulomb counter offset calibration to avoid potential current measurement errors. Under all conditions, clear <i>OperationStatus()[SMBLICAL]</i> status bit after 10 hour timer has expired.
Add additional SEALED mode override commands with new override keys	New Feature	Only supports <i>ChargingVoltageOverride</i> (0x00B0) command	Adds new Override security key at block locations 20-23 via MAC 0x0035 <i>SecurityKeys()</i> . Also adds Override support for commands such as MAC 0x00B2 <i>ChargingCurrentOverride()</i> and MAC 0x3008 <i>WriteTemp()</i> .
Add controls and limits for override commands	New Feature	Feature does not exist	Adds min/max limits and enable/disable controls for SEALED mode <i>ChargingVoltageOverride()</i> MAC 0x00B0 and <i>ChargingCurrentOverride()</i> MAC 0x00B2 commands. New data flash parameters added: <b>CHGV Override Max</b> , <b>CHGV Override Min</b> (2000 mV), <b>CHGI Override Max</b> , and <b>CHGI Override Min</b> . Adds <b>Charging Configuration[CC_SEALED_EN]</b> , <b>[CV_SEALED_EN]</b> (bits 14,13) to enable/disable overrides of the charging voltage and charging current.
Configurable ChargingVoltage() determination	New Feature	Feature does not exist	Supports configurability via <b>Charging Configuration Ext [CELL_VAL1:0]</b> for the Advanced Charging Algorithm's determination of <i>ChargingVoltage()</i> based on average, minimum or maximum of all <i>CellVoltageN()</i> values.
Add optional data flash read-only mode when gauge is SEALED	New Feature	Feature does not exist	Enabled via <b>Auth Config[DF_READ_EN]</b> . Data flash in SEALED mode is accessible only for <b>DF Read Only Timeout</b> seconds after the DF Read Only security keys are successfully received via MAC command 0x0035.

**Table 2-1. Change Details (continued)**

Change Description	BQ40Z50-R4	BQ40Z50-R3	Comments
Additional configurability in host reported temperature	New Feature	Feature does not exist	Change <code>[SMB_CELL_TEMP]</code> to <code>[RSVD]</code> (bit 6) in <i>SBS Configuration</i> . Adds <i>Temperature Enable[USER_TS]</i> (bit 5) and <i>Temperature Mode [USER_TS Mode]</i> (bit 5).
Add smart temperature selectivity of min/max of cell temperature for charging	New Feature	Feature does not exist	Adds an option to <i>Settings:DA Configuration[CTEMP1:0]</i> to select smart temperature sensing in addition to average, max and min options.
Add Fast OCV feature	New Feature	Feature does not exist	OCV is updated faster in relax mode by a prediction function enabled <code>[FOCV_EN]</code> (bit 8) in <i>IT Gauging Ext</i> . Upon Fast OCV prediction, <code>IT Status[OCVPRED]</code> and <code>GaugingStatus()[OCVPRED]</code> bits are set.
State of Health (SOH) improvements	Expanded Feature	SOH calculations are less adaptive.	Adds <i>IT Gauging Ext[SOH_LEARN_EN]</i> , <i>FCC Max mAh</i> and <i>SOH FCC Max cWh</i> to support SOH learning where the learned capacity of the pack is used for SOH determination rather than the <i>Design Capacity</i> . Thermal modeling parameters <i>SOH Temp k</i> and <i>SOH Temp a</i> are added to support the SOH calculation based on room temperature (RT) and taper current rather than previous method. New Lifetime Data Block 2 parameters, <i>Minimum SOH-FCC mAh</i> and <i>Minimum SOH-FCC cWh</i> , are maintained data flash and used to initialize <code>StateOfHealth()</code> up gauge reset. This implementation avoids a temporary 0% value of <code>StateOfHealth()</code> prior to the initial SOH computation.
Add separate temperature hysteresis values for individual JEITA thresholds	Expanded Feature	A single hysteresis value is used for all temperature ranges	The Advanced Charge Algorithm now supports individual temperature hysteresis values for each JEITA threshold as <i>Hysteresis Temp T1</i> through <i>Hysteresis Temp T6</i> .
Safety fault check at initialization	New Feature	Feature does not exist.	Adds <i>Protection Configuration[CHECK_FAULT_WAKE]</i> (bit 3). If any protection (ignoring the time delay) is active at POR/initialization, the corresponding FET's are prevented to close.
Configurable debounce on PRES/SHUTDOWN pin	Expanded Feature	Debounce is not configurable.	Adds configurable detection debounce timing via <i>SYS_PRES Delay</i> for the PRES/SHUTDOWN pin. Valid range is 1 to 8 samples (250 to 2000 ms). Depending on device configuration, this pin is used for System Present detection, Emergency Shutdown activation and as an exit from SLEEP mode.
Separate Safety Over-Temperature (SOT) triggers based on gauging mode	Expanded Feature	Safety Over-Temperature does not consider battery operating mode.	Adds separate <i>SOTC Threshold / SOTC Delay</i> and <i>SOTD Threshold / SOTD Delay</i> thresholds / delays to trigger SOT events in CHARGE and DISCHARGE/RELAX modes respectively.
Modify CUV_RECOV_CHG to use charger detection	Modified Feature	Charger detection method only considers current flow.	Charger detection is changed to use PACK pin voltage instead of charge current when <i>Protection Configuration[CUV_RECOV_CHG]</i> option is enabled. Gauge recovers from <code>SafetyStatus()[CUV]</code> if pack voltage is greater than <i>Charger Present Voltage</i> for more than <i>Recovery Charger Present Time</i> .
Initialize <code>ChargingVoltage()</code> to non-zero value at initialization	Modified Feature	<code>ChargingVoltage()</code> register is 0 mV at initialization	<code>ChargingVoltage()</code> register is set to <i>Low Temp Charging: Voltage</i> at initialization.
Fixed override condition of OCC/OCC2 faults in PCHG mode	Modified Feature	OCC/OCC2 dependent on PCHG mode	OCC/OCC2 now triggers independently even during PCHG mode with separate PCHG safety protection.
Add SOC based BTP option	Modified Feature	BTP supports only RemCap	Battery Trip Point (BTP) can now be triggered based on either RemCap or RSOC. <i>IO Config[BTP_MODE]</i> selects the option: <code>[BTP_MODE] = 1</code> , based on RSOC <code>[BTP_MODE] = 0</code> , based on RemCap New data flash parameters added (defaults): <i>Init Charge SoC Set</i> (10%) <i>Init Discharge SoC Set</i> (5%) <i>IO Config[BTP_MODE]</i> (0)
Adds charge degradation mode indicator	New Feature	Feature does not exist	Gauge now reports degradation in charging voltage and charging current in <code>ChargingStatus()[DEG1:0]</code> bits 23:22. [0, 0] - No Degradation applied [0, 1] - Cycle Threshold Degradation [1, 0] - SOH Threshold [1, 1] - Runtime Threshold Degradation
Expand Black Box timers to 2 bytes	Expanded Feature	Supports only 1-byte timers	The following <i>Black Box:Safety Status</i> and <i>PF Status</i> timers are expanded from 1-bytes to 2-bytes to support over 18 hours of time in data flash: <i>1st Time to Next Event</i> , <i>2nd Time to Next Event</i> , and <i>3rd Time to Next Event</i> .
Extended Manufacturer Info Block data size and accessibility.	Expanded Feature	Block B is smaller and Block C added as writable in SEALED mode.	<i>Manufacturer Info Block B</i> length is extended from 4 to 32 bytes. A new 32 byte <i>Manufacturer Info Block C</i> is added along with the associated MAC command <code>0x007B ManufacturerInfoC()</code> which is read/write in all access modes including SEALED.
Add optional Very Low Battery indicator with a configurable hold of remaining capacity	New Feature	Feature does not exist	A Very Low Battery indicator as <code>OperationStatus()[VLB]</code> bit 26 replaces the <code>[SLPAD]</code> Sleep ADC indicator. <i>SBS Gauging Configuration [VLB]</i> bit 5 is added to enable the option. Adds following data flash parameters: <i>VLB Remaining Cap. mAh</i> , <i>VLB Remaining Cap cWH</i> , <i>VLB Voltage</i> , <i>VLB Hold Time</i> , and <i>VLB Timeout</i>
Improved gauge time accuracy in SLEEP mode	Expanded Feature	SLEEP time keeping is less accurate.	Gauge AFE timer is aligned more closely with the coulomb counter measurement time in order to improve timing accuracy in SLEEP mode.
<i>Res Relax Time</i> parameter is exposed	Modified Feature	Parameter is not modifiable and has different default value.	For additional configurability the <i>Res Relax Time</i> parameter is exposed for possible modification. For potentially improved gauging performance under certain conditions, the default value is changed from 50 to 200 seconds.
Reset CTO timer when battery is fully charged.	New Feature	Feature does not exist	Charge Timeout (CTO) is cleared upon detection of a fully charged battery, <code>BatteryStatus()[FC] = 1</code> . This prevents disabling of charging in some rarely discharged systems like battery back-up (BBU) units.
Enable SMBus Auto NACK only for initial command phase	Modified Feature	Auto NACK remains enabled after initial command byte.	For proper SMBus protocol without the optional PEC byte, Auto NACK is now disabled after the initial command byte and re-enabled for the next transaction.
Remove explicit checks for load voltages from Turbo Mode calculations.	Expanded Feature	Explicit load voltage checks exist.	This change avoids a condition where Turbo Mode <code>SusTurboCurr()</code> and <code>MaxTurboCurr()</code> calculations may jump to and from 0 near the end of discharge.

**Table 2-1. Change Details (continued)**

Change Description	BQ40Z50-R4	BQ40Z50-R3	Comments
Add voltage-based cell balancing capability	Expanded Feature	Cell balancing based on state of charge only	Gauge may be configured for voltage-based cell balancing by setting the new <b>Balancing Configuration[CBV]</b> bit 6. If [CBV] bit is cleared, cell balancing is based on state of charge as before. New data flash parameters added (defaults): <b>Voltage Cell Balance Threshold</b> (3900 mV) <b>Voltage Cell Balance Window</b> (100 mV) <b>Voltage Cell Balance Min</b> (40 mV) <b>Voltage Cell Balance Interval</b> (20 s) Adds Bit 6 of <b>Balancing Configuration[CBV]</b> (0)
Improved host watchdog recovery	Expanded Feature	Host may have to communicate again to clear watchdog fault	Change avoids potential race condition on host watchdog recovery.

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