BlueCore®

CSR8600 ROM Charger Configuration

Application Note

Issue 1

Document History

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Contents

Tables, Figures and Equations

1. Introduction

This document describes how to configure the battery charger on CSR8600 ROM devices using the Headset Configuration Tool.

Detailed descriptions of the PS Key format used in the Headset can be found in the *Headset ADK 1 Configuration PS Key Bit Fields Application Note*.

Further details regarding power management and charger setup in CSR8600 devices can be found in *Power Management Application Note* and *Lithium Polymer Battery Charger Calibration and Operation for CSR8670 Application Note*.

2. Thermistor Configuration

This section describes how to configure the CSR8600 ROM device for temperature readings from a thermistor used for battery temperature measurement during charge control. Up to 7 battery temperature thresholds can be set for use with different temperature dependent charger configurations.
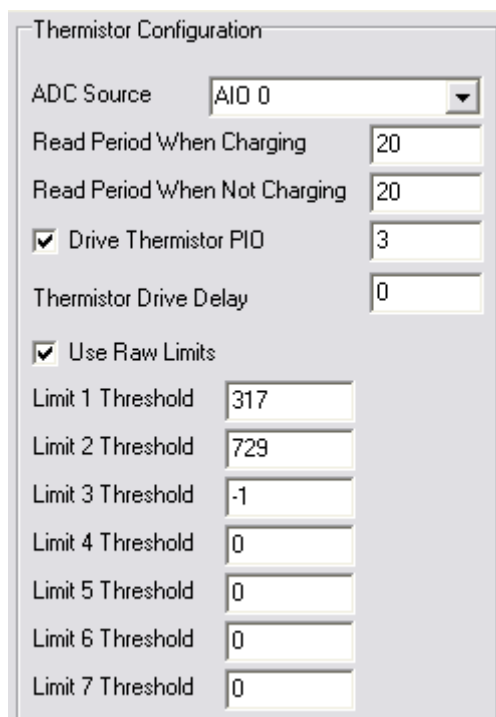

Figure 2.1: Thermistor Configuration

2.1. Configuration with Thermistor

See the *Lithium Polymer Battery Charger Calibration and Operation for CSR8670 Application Note* for example battery temperature monitoring circuits.

Description of Thermistor Configuration Fields

ADC Source: The thermistor input should be configured to use one of the available AIOs.

Read Period When Charging: This configures the time interval between thermistor updates in seconds while charging. 0 disables this timer.

Read Period When Not Charging: This configures the time interval between thermistor updates in seconds while not charging. 0 disables this timer.

Drive Thermistor PIO: When set, the PIO specified will be used to provide drive to the thermistor. If this is not set an alternative drive source is required.

Thermistor Drive Delay: This configures a delay in milliseconds between driving the thermistor and taking a reading of up to 15 ms. This may be used to allow the voltage to settle before taking a temperature reading.

Use Raw Limits: When set, the limit thresholds are entered as raw ADC counts rather than mV. When the thermistor drive source is the same as the ADC source, the option of using raw limits is available as the thermistor voltage is always proportional to the common drive source V_{SRC} for given temperatures. This is more accurate than a voltage reading as it eliminates any error from the tolerance of Vref which is used in voltage calculations.

The CSR8600 ROM devices have 10 bit ADCs giving a range of 0 to 1023. V_{SRC} should be 1.35 V.

ADC count for a specific voltage across the thermistor can be calculated using the following formula:

$$ADC\ counts = 1024\ \times\ \frac{V_{THM}}{V_{SRC}}$$

V_{THM} is the voltage measured on the thermistor and V_{SRC} is the voltage source for the ADC and thermistor.

Limit Thresholds: Up to 7 limit thresholds, increasing down the list, can be configured to provide a greater degree of temperature monitoring control. If fewer than 7 limits are set, then the list must finish with "-1". The list values are set in counts or mV depending on how **Use Raw Limits** is set. See section 5 for charger options.

2.2. Configuration without Thermistor

Using and charging batteries outside of their operating temperature range may damage the battery, reducing the life of battery and/or damaging the device leading to consumer safety issues.

CSR recommends using a thermistor to monitor battery temperature to reduce the risk of battery malfunction.

To use CSR8600 ROM devices without a thermistor, use the following settings:

ADC Source: ADC source will be ignored so this may be set as any source.

Read Period When Charging: Set to 0.

Read Period When Not Charging: Set to 0.

Drive Thermistor PIO: Not selected
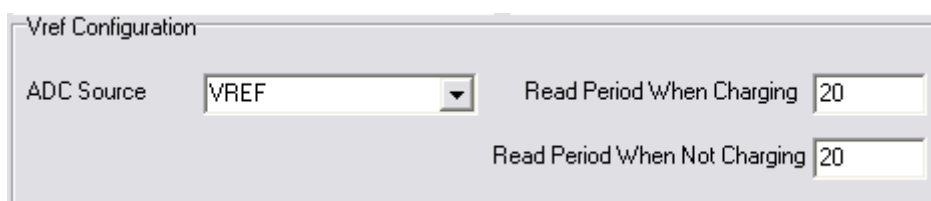
Thermistor Drive Delay: Set to 0.

Use Raw Limits: Selected.

Limit Thresholds: Set the first limit threshold to -1.

With the above settings the first (top) charger configuration option shall be used. Other charger configurations shall be ignored. See section 5 for charger options.

3.   Vref Configuration

This section describes how to configure the CSR8600 ROM device reference voltage, Vref, which is used by the on-chip application when thermistor limit thresholds are provided in mV.

Figure 3.1: Vref Configuration

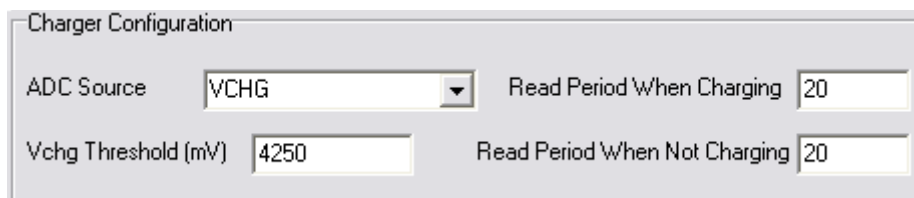**Description of Vref Configuration Fields**

ADC Source: The ADC Source for the reference voltage should be configured to use VREF for CSR8600 ROM devices. The VREF source uses the on chip reference. Customers should only change this on advice from CSR.

Read Period When Charging: This configures the time interval between Vref updates in seconds while charging. 0 disables this timer.

Read Period When Not Charging: This configures the time interval between Vref updates in seconds while not charging. 0 disables this timer.

4.   Charger Configuration

This section describes how to configure the CSR8600 ROM device charger readings.

Figure 4.1: Charger Configuration

Description of Charger Configuration Fields

ADC Source: The ADC Source for the charger should be configured to use VCHG for CSR8600 ROM devices. Customers should only change this on advice from CSR.

Vchg Threshold (mV): This configures the threshold under which charging can be limited. This is only applicable if the device is configured to support USB battery charging. See section 7 for further USB charging configuration options.

Read Period When Charging: This configures the time interval between the charger voltage reading updates in seconds while charging. 0 disables this timer.

Read Period When Not Charging: This configures the time interval between charger voltage reading updates in seconds while not charging. 0 disables this timer.

5.   Charger Settings

This section describes how to configure the CSR8600 ROM device charge configuration settings which are used at different battery temperatures.

5.1.   Charge Configuration Selection

The charger can be configured to use up to eight possible charge configurations. The charge configurations correspond to the seven thermistor limit thresholds, see section 2.

Figure 5.1 shows the method used for determining the charge configuration settings to be used for a given temperature.

The on-chip application compares the thermistor level, in millivolts or ADC counts, to the thermistor limit thresholds.

If the thermistor level is less than the 1st threshold, the 1st charge configuration is used. If the thermistor level is less than the 2nd threshold, but greater or equal to the 1st threshold, the 2nd charge configuration is used. This continues for each of the 7 thresholds. If the thermistor level is greater than the 7th threshold, the 8th charge configuration is used.

For the case where n thresholds are set and $n < 7$, the $(n + 1)$ threshold will be "-1" signifying the limit end. In this case the $(n + 1)$ charge configuration shall be used for any thermistor level greater than largest threshold.

Increasing or decreasing ADC count or V_{THM}, crossing a limit threshold, changes the charger configuration to the next/previous configuration listed accordingly.
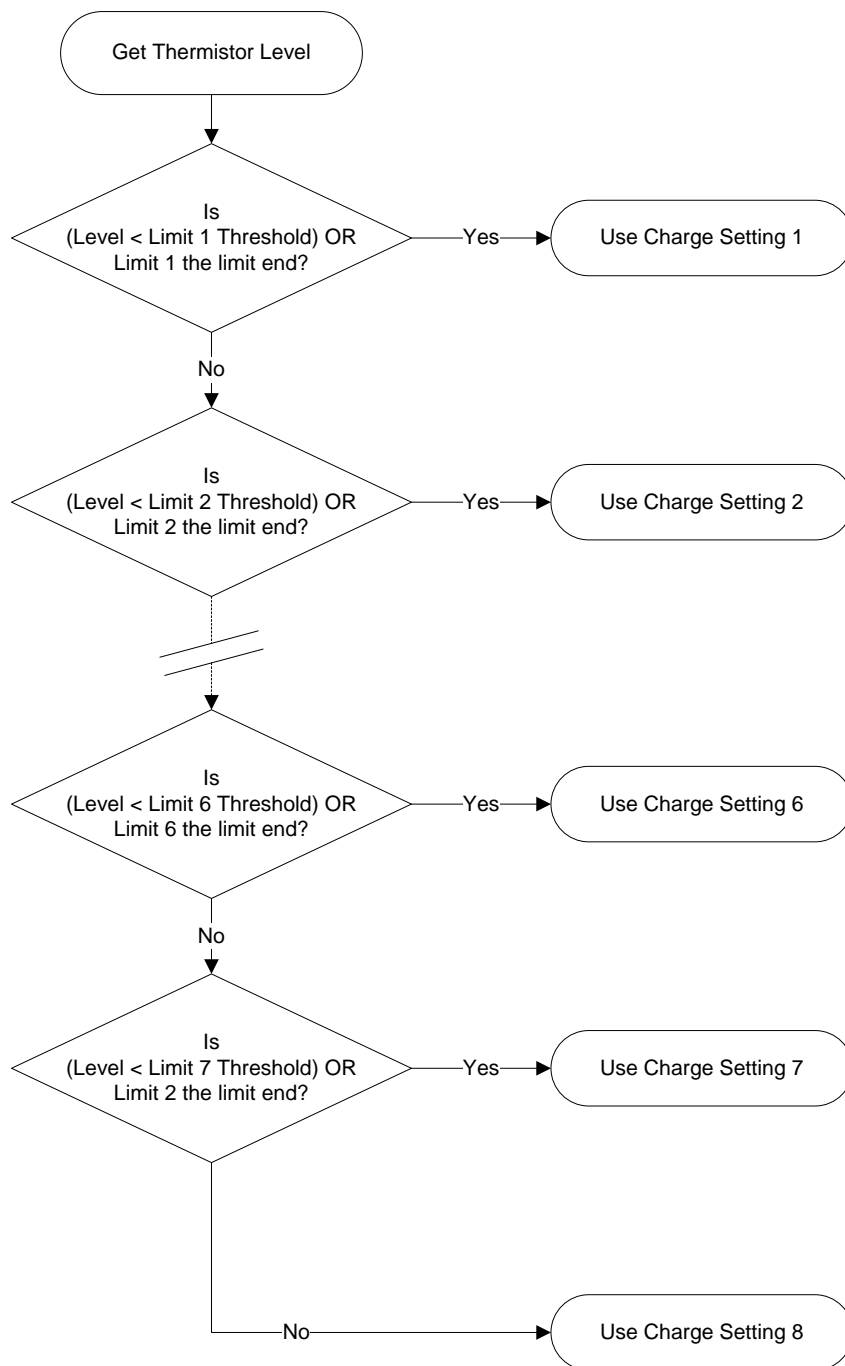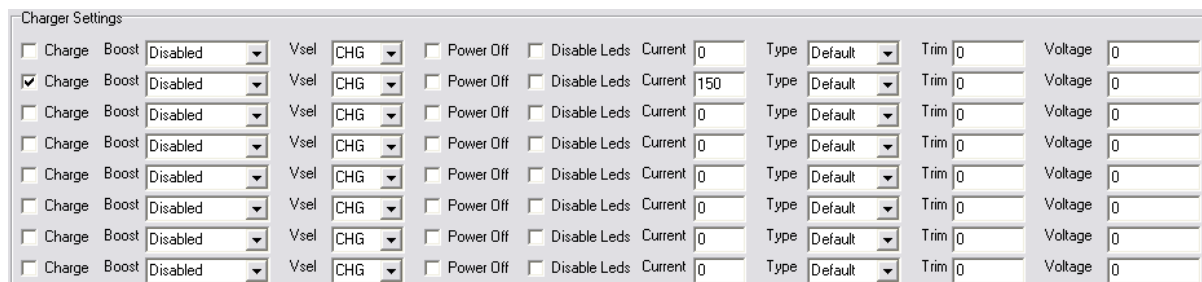
Figure 5.1: Flow Diagram for Temperature Based Charge Configuration Selection

5.2. Charge Configuration Settings

Each charge setting is made up of a charger current and charger termination setting.

Figure 5.2: Charger Settings

Description of Charger Configuration Settings Fields

Charge: When selected, the charger will be active in the charger configuration.

Boost: Boost charging can be disabled or set to enable externally controlled boost if the there is an external pass device available for CSR8600 ROM devices.

Vsel: The IC supply can be set to either the charger (**CHG**) or the battery (**BAT**).

Power Off: When set, the device will power off if it had been turned on, reducing to the minimum power consumption possible. The IC supply will also be set to the charger. This is useful if the battery is outside its operating temperature range.

Disable LEDs: When set, the LEDs are disabled while charging.

Current: The charger current specified in mA.
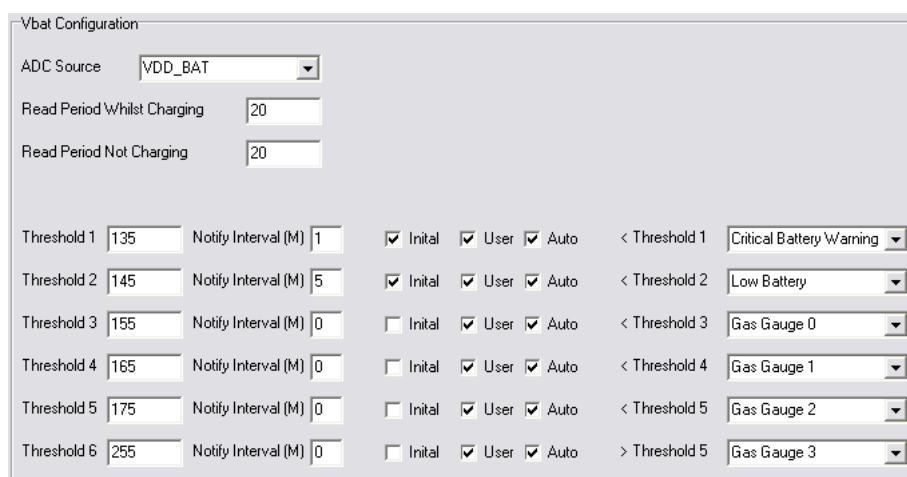
Type: The charger voltage termination type. CSR8600 devices can either use **Default** or **Voltage**. **Default** uses the charger termination settings as they were previously set either from PS Keys or by the previously used charger configuration. **Voltage** overrides the current settings. Selecting **Default** does not override any previously set termination voltage.

Trim: This is not applicable for CSR8600 ROM devices.

Voltage: The end of charging termination voltage value for CSR8600 ROM devices may be used if **Type** is set to **Voltage**. Termination threshold should be entered as (value * 20 mV).

6. Vbat Configuration

This section describes how to set the battery voltage levels used for providing battery level notifications and the configuration options for the notifications.

Figure 6.1: Vbat Configuration

Description of Vbat Configuration Fields

ADC Source: The ADC source for the battery voltage should be configured to use VDD_BAT for CSR8600 ROM devices.

Read Period When Charging: This configures the time interval between the battery voltage reading updates in seconds while charging. 0 disables this timer.

Read Period When Not Charging: This configures the time interval between the battery voltage reading updates in seconds while not charging. 0 disables this timer.

Threshold: These configure the battery voltage level thresholds used by the on-chip application. They can be configured to generate events when the threshold of Vbat is reached and are used to report battery voltage level on request. Threshold 1-5 (if all thresholds are used) should be set up as (value * 20mV). Threshold 6 should be set as 255 to signify the highest level. If fewer events are required, higher numbered thresholds not required should also be set to 255.

Notify Interval: This is a repeat timer interval used to re-send events generated by the voltage threshold. A value of 0 results in a single event being generated when the threshold is initially crossed. The interval time is specified in minutes.

Initial: When set the event is generated for the initial reading after headset power on.

User: When set the event is generated for user initiated readings.

Auto: When set the event is generated for automatic readings.

Event: The events should be selected from those listed in Table 6.1.

Event	Description
Critical Battery Warning	Should be generated when the voltage drops to the point the headset needs to power off to preserve remaining power. This causes the headset to power off, unless the charger is connected.
Low Battery	Should be generated when the voltage drops to the point that low power notifications for the user should be generated. This generates a low battery warning tone / LED indication if configured to do so, unless the charger is connected.
Gas Gauge 0	Should be generated when the voltage drops to the point the headset needs to activate low battery intelligent power management. Sends CSR battery level = 2
Gas Gauge 1	Sends CSR battery level = 4
Gas Gauge 2	Sends CSR battery level = 7
Gas Gauge 3	Sends CSR battery level = 9

Table 6.1: Battery Level Events

7. USB Charger Configuration

This section describes how to set the USB charger configuration. CSR8600 ROM devices can be configured to be compliant with the USB battery charging specification.
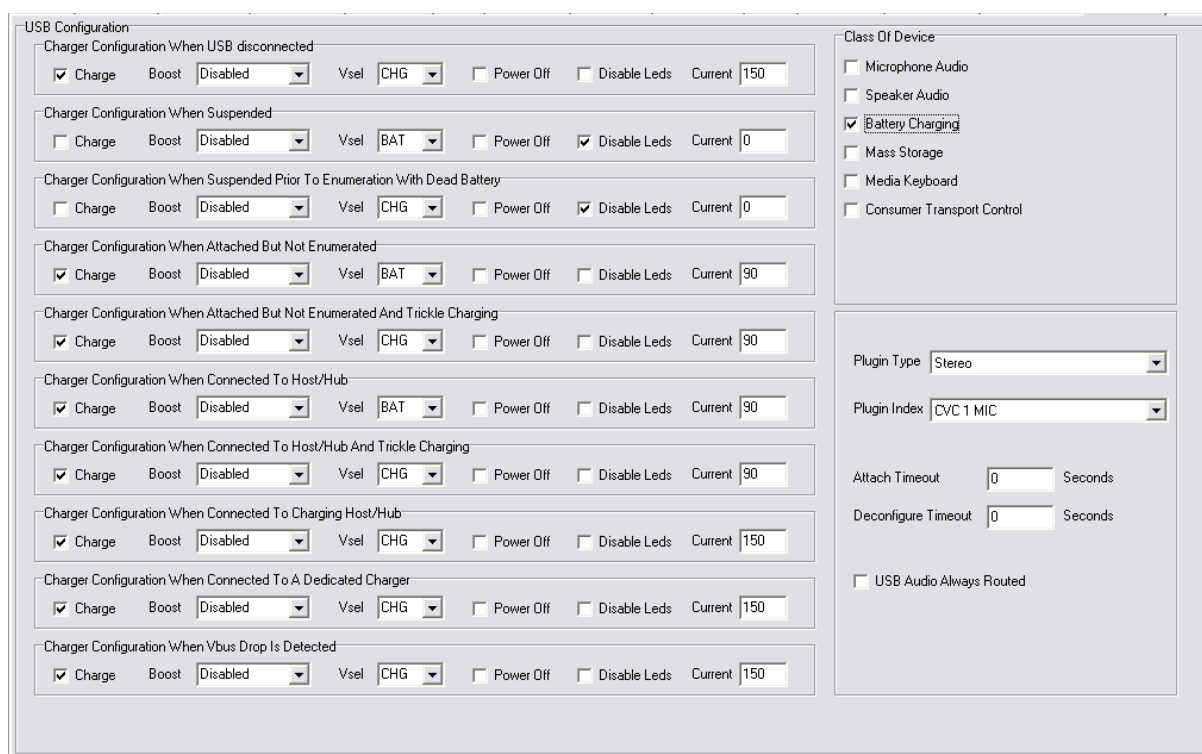

Figure 7.1: USB Configuration

To enable USB battery charging set the Class Of Device to use Battery Charging.

Due to the interaction between the USB interfaces and the charger control it is necessary to configure the charger to work differently in different USB operating states, therefore there are charger configuration modes available for the following USB operating states:

- Current when USB disconnected but charger connected
- Current when suspended
- Current when suspended prior to enumeration with dead battery
- Current when attached but not enumerated
- Current when attached but not enumerated and trickle charging
- Current when connected to host/hub
- Current when connected to host/hub and trickle charging
- Current when connected to a charging host/hub
- Current when connected to a dedicated charger
- Current when vbus drop is detected

The charger configuration mode for each of the above operating states has the configuration items as in Figure 7.2.
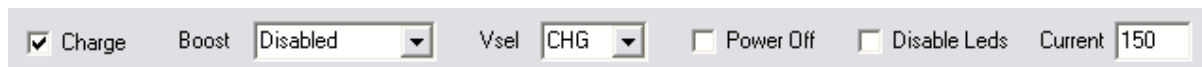
Figure 7.2: USB Charger configuration items

Description of Fields

Charge: When selected the charger is enabled in this state.

Boost: Boost charging can be disabled or set to enable externally controlled boost if the there is an external pass device available for CSR8600 ROM devices.

Vsel: The IC supply can be set to either the charger (**CHG**) or the battery (**BAT**).

Power Off: This is not applicable for CSR8600 ROM devices.

Disable LEDs: When set the LEDs are disabled while charging.

Current: The charger current specified in mA.

8.   Configuration resolution with USB Charging Enabled

With USB Battery Charging enabled, it is possible to have a conflict between the active temperature controlled charger configuration and the active USB operating state controlled charger configuration.

The following scheme is used in CSR8600 ROM Devices to resolve the configurations.

8.1.   Charge Enable/Disabled

The charger will only be enabled if it is set to be enabled by both configurations.

8.2.   Boost Charge Enable/Disabled

External boost charge is only enabled if it is set to be enabled by both configurations.

8.3.   IC Power Supply

The IC supply (Vsel) for the IC will be the battery (**BAT**) if the battery is selected by either configuration. The voltage source will only be the charger if selected by both configurations.

8.4.   Disable LEDs

The LEDs are disabled if **Disable LEDs** is set in either configuration.

8.5.   Current

The lower value from the two active configurations is used as the charger current.

Document References

Document	Reference
Headset ADK 1 Configuration PS Key Bit Fields Application Note	CS-212778-AN
Power Management Application Note	CS-217437-AN
Lithium Polymer Battery Charger Calibration and Operation for CSR8670 Application Note	CS-204572-AN
Headset Configuration Tool User Guide	CS-207370-UG

Terms and Definitions

ADC	Analogue-to-Digital Converter
ADK	Audio Development Kit
AIO	Asynchronous Input/Output
BAT	Battery
BlueCore®	Group term for CSR's range of Bluetooth wireless technology chips
Bluetooth®	Set of technologies providing audio and data transfer over short-range radio connections
CHG	Charger
CSR	Cambridge Silicon Radio
IC	Integrated Circuit
LED	Light Emitting Diode
PIO	Programmable Input/Output
PS Key	Persistent Store Key
ROM	Read Only Memory
USB	Universal Serial Bus