Application Note

Temperature Sensing Without an Adaptor Present on the BQ21040

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ABSTRACT

Temperature sensing is a top priority in many battery charger applications. Oftentimes, accurate temperature monitoring is essential even when an adapter is not present and power is not being supplied to the charger IC. Particularly on the BQ21040, temperature sensing is handled by supplying 50uA current from the TS pin across an NTC thermistor. However, this typical mode of operation is not possible without power being supplied to the BQ21040 via an adapter at the IN pin. This application note serves to outline how TS functions at a high level and how one might use an external MCU to be able to monitor battery temperature even when an adapter is not present

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Trademarks

1 Introduction

This document serves as a guide on how to monitor temperature on the BQ21040 when an adapter is not present at VIN and the device is in battery only mode.

2 How Temperature Sensing Works on the BQ21040

2.1 With Adapter Present

Typically, when monitoring temperature on the BQ21040, a 50uA current is supplied at the TS pin. This current then travels through an NTC thermistor to ground. As the resistance of the NTC varies with temperature, so does the voltage drop across it. This voltage drop is then measured to derive the temperature.

2.2 Without Adapter Present

When an adaptor is not present on the BQ21040, the IC is operating in battery only mode. During this mode of operation, there is no 50-uA current being supplied at TS and therefore essentially 0 voltage drop occurs across the NTC thermistor. Without this voltage drop, the method used to obtain temperature measurements with an adapter present as described above cannot be used. Instead, an external MCU will be used to bias 50uA of current across the thermistor. Voltage will then be measured by the MCU in the same manner that the BQ21040 does when an adapter is connected.

3 Example Application

3.1 Required Devices

1. BQ21040
2. 10k NTC, β = 3370
3. MCU capable of supplying 50 uA and taking voltage measurements.

3.2 Setup

Prior to making any temperature measurements with or without an adapter, the appropriate connections should be made to the NTC from both the BQ21040 and the MCU. The TS pin will connect to one side of the NTC while the other will be grounded as can be seen in the BQ21040 data sheet. Similarly, two GPIO pins from the MCU will be connected to the same side of the NTC as TS. One GPIO pin from the MCU will be used as a current source and the other will be used to monitor the voltage across the NTC. Also ensure that GND from the MCU shares the same GND connection from the BQ21040. A simplified schematic of these connections are shown in Figure 3-1.

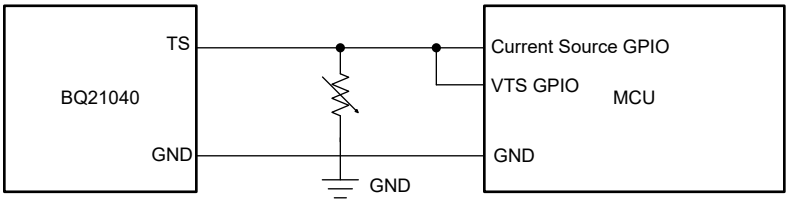

Figure 3-1. Simplified Schematic

4 Procedure

To know when to use this alternative temperature sensing method, one must first know when an adapter is connected or removed from the BQ21040.

4.1 Detecting Adapter Removal

As the 50 uA bias from the TS pin turns off upon adapter removal causing the voltage across the NTC to drop to zero, one pin from the MCU can be used to monitor voltage across the NTC and determine if an adapter is connected. When an adapter is connected and the TS pin is supplying 50 uA, the voltage drop across the thermistor will be non zero. The exact value is dependent on the thermistor being used and it's temperature. For example, assume that the voltage drop of the thermistor is 0.02 V at its max temperature. If the voltage reading across the NTC is ever below 0.02 V it can be assumed that either the temperature has exceeded the max temp supported by that NTC or that the 50uA bias from TS has stopped due to an adapter removal. The adapter removal condition will cause the change in voltage to be near instantaneous so a simple algorithm can be written to the MCU to check for a large jump in VTS.

Once the voltage across the thermistor (VTS) has dropped below this threshold and the 50uA from TS has stopped, the output pin from the MCU will then be used to supply 50 uA. The VTS GPIO pin from the MCU will continue measuring VTS. This 50 uA from the MCU can be constant or in pulses. For example, a pulse of 100 ms may be used, just ensure that the voltage measurement is taking place during that 100ms window. Also, if using pulses, ensure that the device is not configured such that the TS pin is being used to disable charge when pulled low.

Once a voltage measurement has been made across TS, the MCU needs to then use ohm's law to derive the resistance of the NTC and correlate that resistance to a temperature.

4.2 Detecting Adapter Insertion

Once the adapter is re-inserted and the BQ21040 begins to supply 50uA once again, the voltage across the NTC will double as now there is double the current flowing through the thermistor. A simple algorithm that checks for a large change in VTS can be written on the MCU to be able to recognize this condition as the adapter being inserted. Once this adapter insertion condition is met, the MCU should then stop supplying 50uA and let the BQ21040 handle current biasing the NTC until the MCU detects an adapter disconnect once again. It is also important to ensure that the time period when checking for a large change in voltage to detect adapter insertion is not longer than the thermal time constant of the thermistor. This is to prevent a situation where the device actually enters an environment that induces a rapid temperature change and the MCU falsely detects this temp change as an adapter insertion. If the check time is less than the thermal time constant, the MCU will be guaranteed to detect a voltage jump faster than the thermistor would be able to respond to a rapid temperature change, effectively ruling out any situation where a temperature jump would be misinterpreted as adapter insertion.

4.3 Logical Flowchart

Figure 4-1 outlines the basic logical procedure that needs to be implemented on the MCU to properly detect adapter insertion and removal.

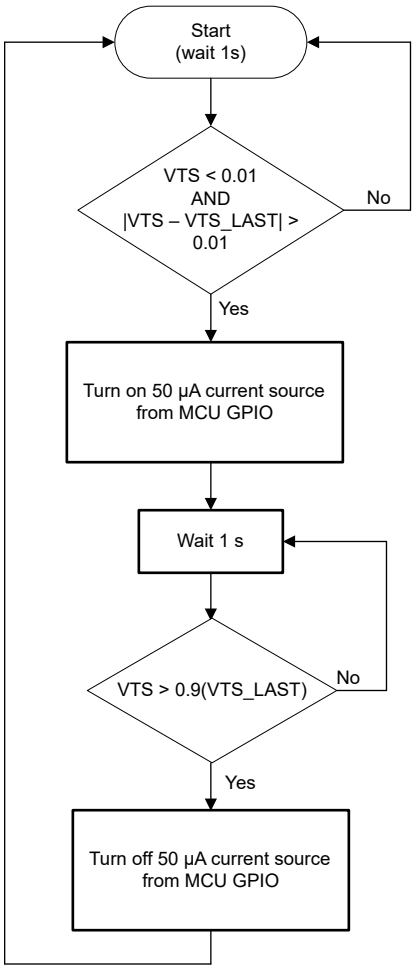

Figure 4-1. Logical Flowchart

5 Summary

Through the use of the BQ21040, an MCU capable of supplying 50 uA current, and an NTC thermistor, the procedure described above can be used to obtain temperature measurements even when an adapter is not present on the BQ21040 and the device is operating in battery only mode.

6 References

- Texas Instruments: bq21040 0.8-A, Single-Input, Single Cell Li-Ion and Li-Pol Battery Charger data sheet
- Texas Instruments: bq21040 0.8-A Single-Input, Single-Cell Li-Ion Battery Charger Evaluation Module

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