Application Report
SLUA955–March 2019

BQ2423x external NTC control reference design

ABSTRACT

The BQ2423x is a family of power path single cell Lithium-Ion / Li-Pol battery chargers that are configured to charge the battery from 0 °C to 60 °C. Typical battery pack temperature monitoring is completed with an external Negative Temperature Coefficient (NTC) resistor. In recent years, there has been more demand for a tighter charging range from 5 °C to 45 °C, which is challenging to achieve with the standard configuration. This application report presents a reference design that can suspend charge accurately at 45 °C.

Contents

List of Figures

List of Tables

Trademarks

1 Typical Circuit

Figure 1 shows the standard configuration for the BQ2423x TS pin. The standard configuration for the BQ2423x TS pin internal current source develops a voltage across the external NTC resistor. Internal voltage comparators are connected to TS pin and sets hot, cold, or other voltage thresholds. The resistance of NTC is adjusted to match the comparator trip point to desired temperature.

2 Standard NTC Circuit

Figure 1 shows the standard NTC circuit designed for 0 °C to 60 °C.

- The TS pin is a 75 µA current source. The current develops a voltage across the NTC resistor proportional to temperature.
- A set of internal voltage comparators are used to set the temperature range.
  - 2.1 V for the cold trip point, above this point, charge is suspended.
  - 0.3 V for the hot trip point, below this point, charge is suspended.
  - Normal operation conditons is between 2.1 V and 0.3 V.
- NTC resistor value changes with the temperature, decreasing when hot and increasing when cold.

This is a good circuit, but the flexibility is limited. The current source and the hot and cold trip point are fixed. The only thing that can change is the external NTC resistor and possibly the resistor network if it is used. To change the temperature range from 0 °C/60 °C to 5 °C/45 °C requires that the NTC change resistance at a faster rate, higher Beta (B). Higher B values with high accuracy are more difficult to find than a standard configuration. It is typically 3450 k +/- 1%. An external resistor network can be used to expand the range or shift it a small amount, but it is not effective in reducing it.

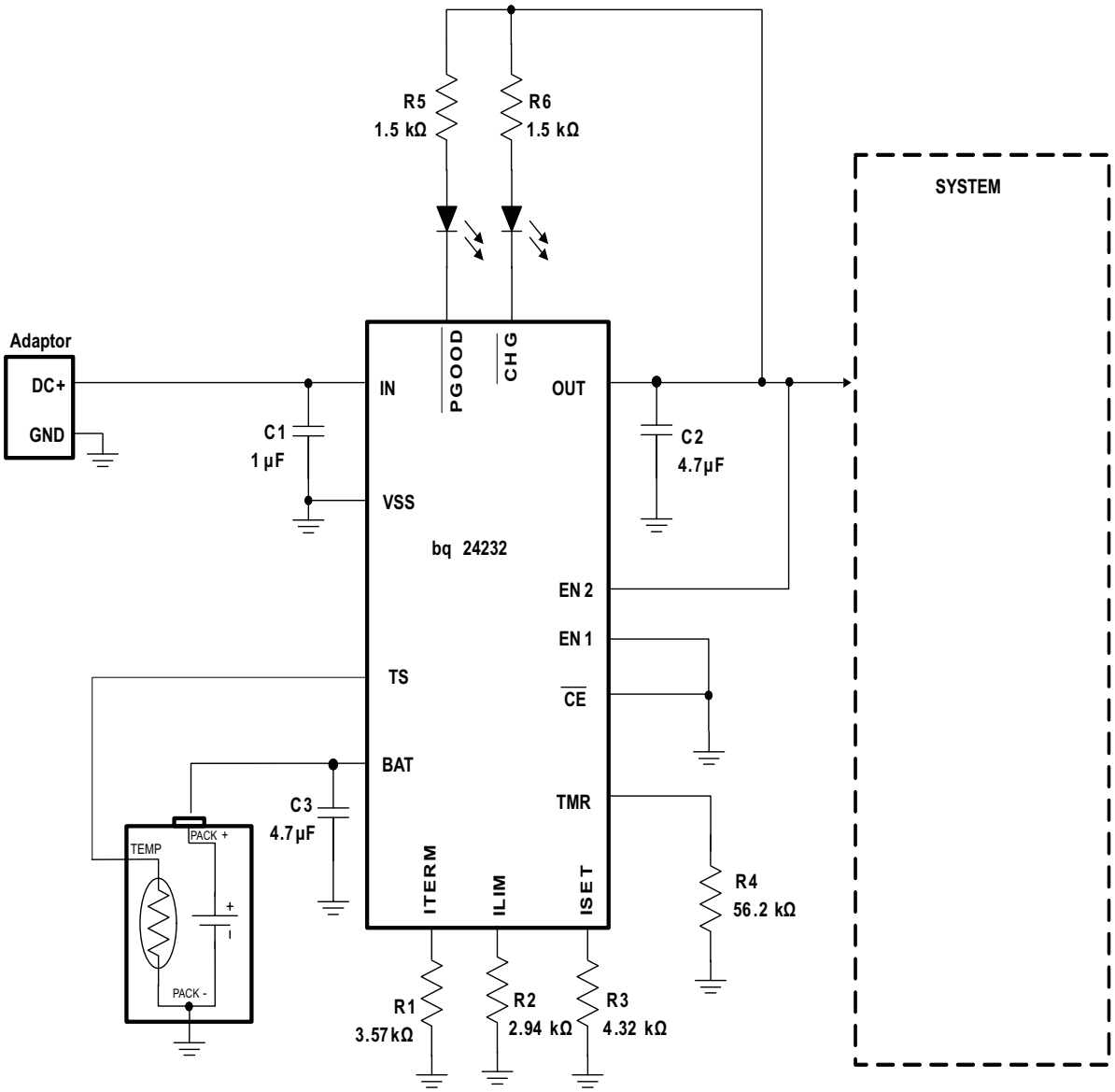

Figure 1. BQ24040 Standard NTC Circuit

3 External Circuit

Figure 2 show the external circuit with a voltage supervisor used to measure hot temperatures while the BQ2423x continues to monitor cold temperatures. The voltage supervisor uses the Charge Enable (CE) pin to disable charging when the hot temperature is reached. The hot temperature window inside the device is not used, only the cold temperature window.

One of the trip points can be adjusted independently from the other using an external voltage supervisor, providing greater flexibility. A typical circuit and the voltage supervisor interact with each other, making adjustment difficult. In this design, the TPS3898 with a 0.5 V reference voltage is used. First, the values for the hot temperature are set, then the values for the cold temperature are set.

This circuit uses the NTC resistor Semtech 103AT-2 (B-3435 k), R-NTC hot = 4.91 k (45 °C) and R-NTC cold = 22.05 k (5 °C).

1. Set the resistor value for hot trip point. This is the R-NTC hot + R-Hot. The current is 75 µA and the trip point is 500 mV.
2. Set R-Hot + R-NTC = R-Total to 500 mV with a 75 µA current source. R-Total is 500 mV / 75 µA for 6.67 kΩ. R-Hot is 1757 Ω.
3. Set the resistor value from the cold trip point. This is the R-NTC Cold + R-Hot + R-Cold. The current is 75 µA and the trip point is 2.1 V. The R-Cold + R-Hot +R-NTC = R-Total to 2.1 V with a 75 µA current source. R-Total is 2.1 V / 75 µA for 28.0 kΩ. R-Cold is 4.19 k.

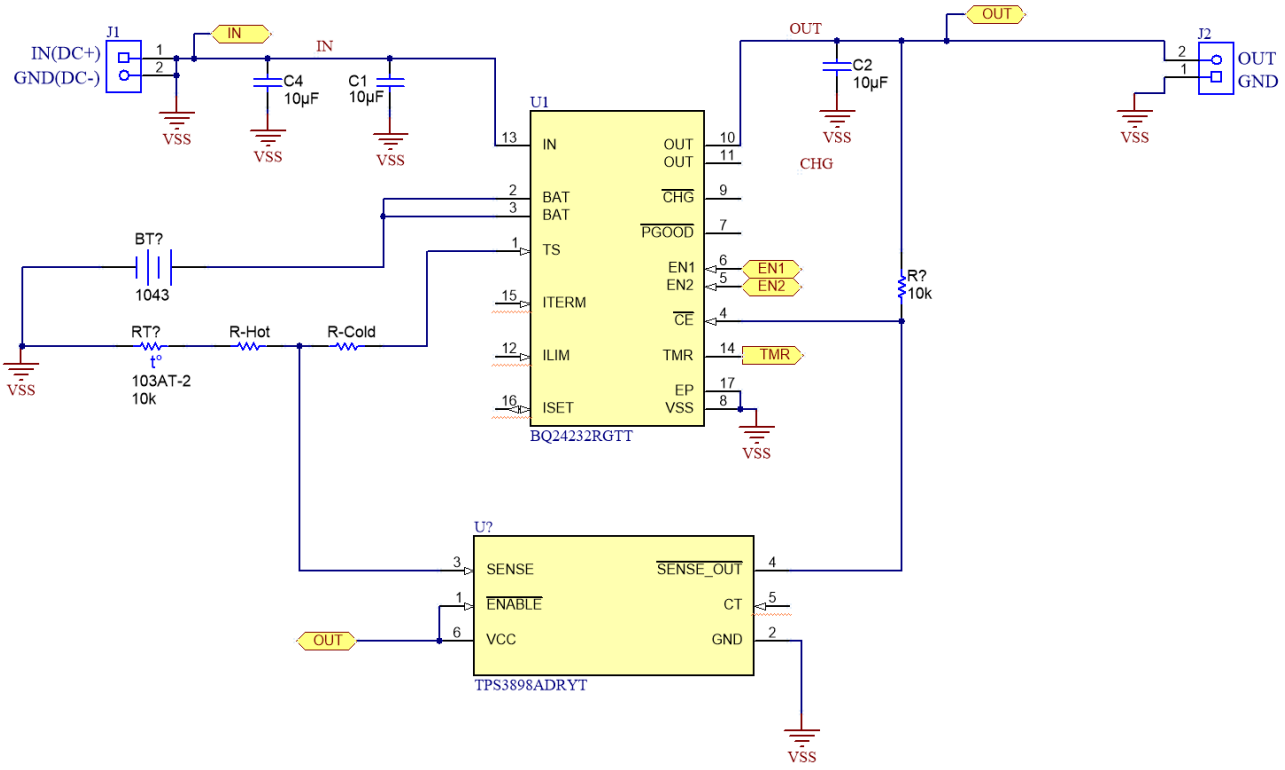

Figure 2. External Voltage Supervisor Solution

4 Typical Values

Table 1 shows R-Hot and R-Cold for some common hot and cold temperatures and is based on the Semtech 103AT-2. Select a hot temperature in the left column with corresponding R-Hot value. Select a R-Cold value for the desired temperature.

Table 1. Typical R-Hot and R-Cold Values

TEMPERATURE	R-HOT	R-COLD (5 °C)	R-COLD (10 °C)	R-COLD (15 °C)
45 °C	1757	4193	8283	11553
50 ° C	2507	3443	7533	10803
55 °C	3127	2823	6913	10183
60 °C	3647	2303	6393	9663

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