

Configuring Standalone Linear Power Path Chargers

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ABSTRACT

In this application report, proper configuration of standalone power path linear chargers will be discussed as well as the different mode these chargers have. Power Path chargers have an advantage over Non Power Path chargers due to the extra FET between the SYS rail and the BAT pin. This gives priority to the System which allows for system startup with a depleted battery and proper battery termination.

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1 Introduction

The BQ2407X family of devices is a popular Power Path standalone linear charger used in applications that require 1.5A or less charging current. Since these devices are standalone, most of the important parameters like input current limit, charge current and charge timers can be configured using external resistors. The family also has different options depending on the application.

2 Configuring 1.2A Fast Charge

To configure the BQ2407x, a few calculations will need to be done to get the resistors that would be used to program the desired values. Parameters that need to be programmed include the input current limit R_{ILIM} , the fast charge current R_{ISET} , the fast charge timer R_{TMR} , and in some devices like the BQ24074 where the termination current can be programmed, R_{ITERM} . Since the termination current depends on the fast charge current in the BQ24074, R_{ITERM} should be changed when R_{ISET} is changed to have the same termination current.

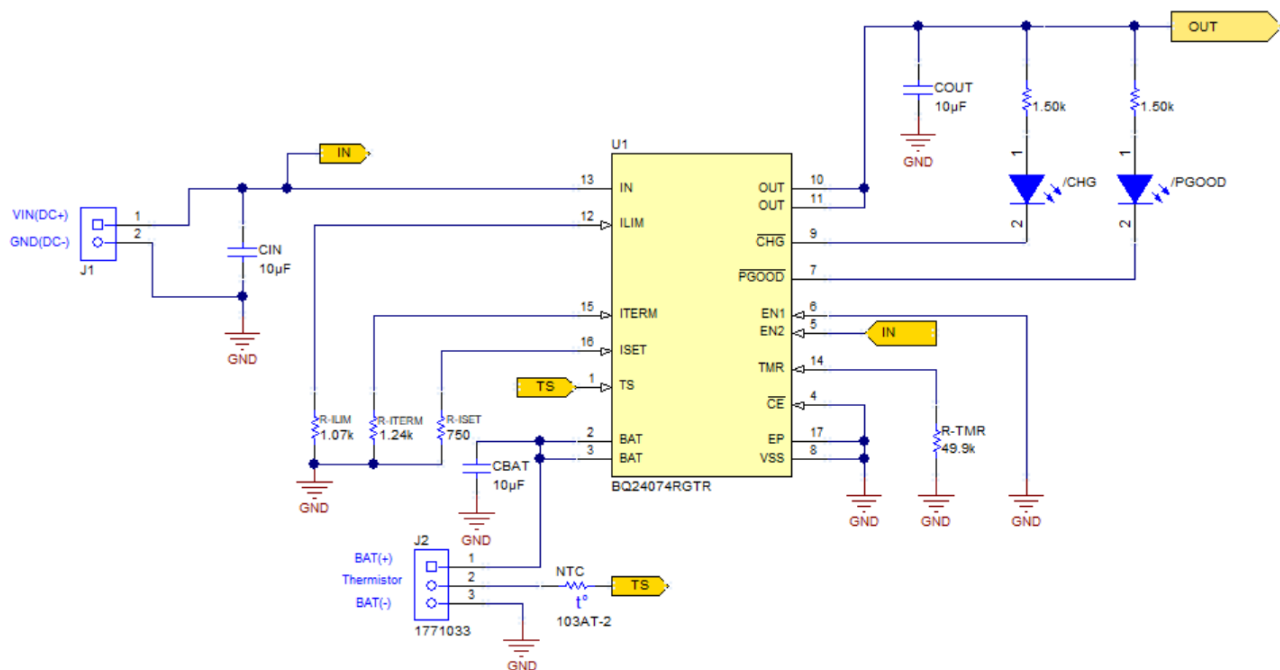


Figure 1. 1.2A Fast Charge Configuration

- **ILIM** set to **1.5A** with $R_{ILIM} = K_{ILIM} / ILIM = 1610 / 1.5A = 1.07k\Omega$
- **ICHG** set to **1.2A** with $R_{ISET} = K_{ISET} / ICHG = 890 / 1.2 = 750\Omega$
- **ITERM** set to **0.05A** with $R_{ITERM} = (ITERM * ISET) / K_{ITERM} = (0.05 * 750) / 0.03 = 1.25k\Omega$
- Charge timer set to **6.65 hours**; $R_{TMR} = (Time * 3600) / (10 * K_{TMR}) = (6.65 * 3600) / (10 * 48) = 49.9k\Omega$
- **EN2** set **High** and **EN1** set **Low** to set input current through **ILIM**
- **KILIM**, **KISET**, **KITERM** and **K_{TMR}** are obtained from the data sheet

3 Configuring USB100 and USB500 Mode

To set the device in USB500 mode, the EN1 pin should be pulled high and the EN2 pin should be pulled low as shown in Figure 2. In this mode, the ILIM setting is ignored with the input current and the charge current limited to 500 mA. In USB100 mode, the input current limit is set to 100 mA. To set the device in USB100 mode, set both EN1 and EN2 low. In USB mode, the input voltage is monitored with the input current being dynamically reduced when the input voltage drops below the VIN-DPM threshold to prevent the input voltage from crashing below the threshold voltage. ITERM can be set with a resistor or left floating to set the termination current to the default of 10% ICHARGE.

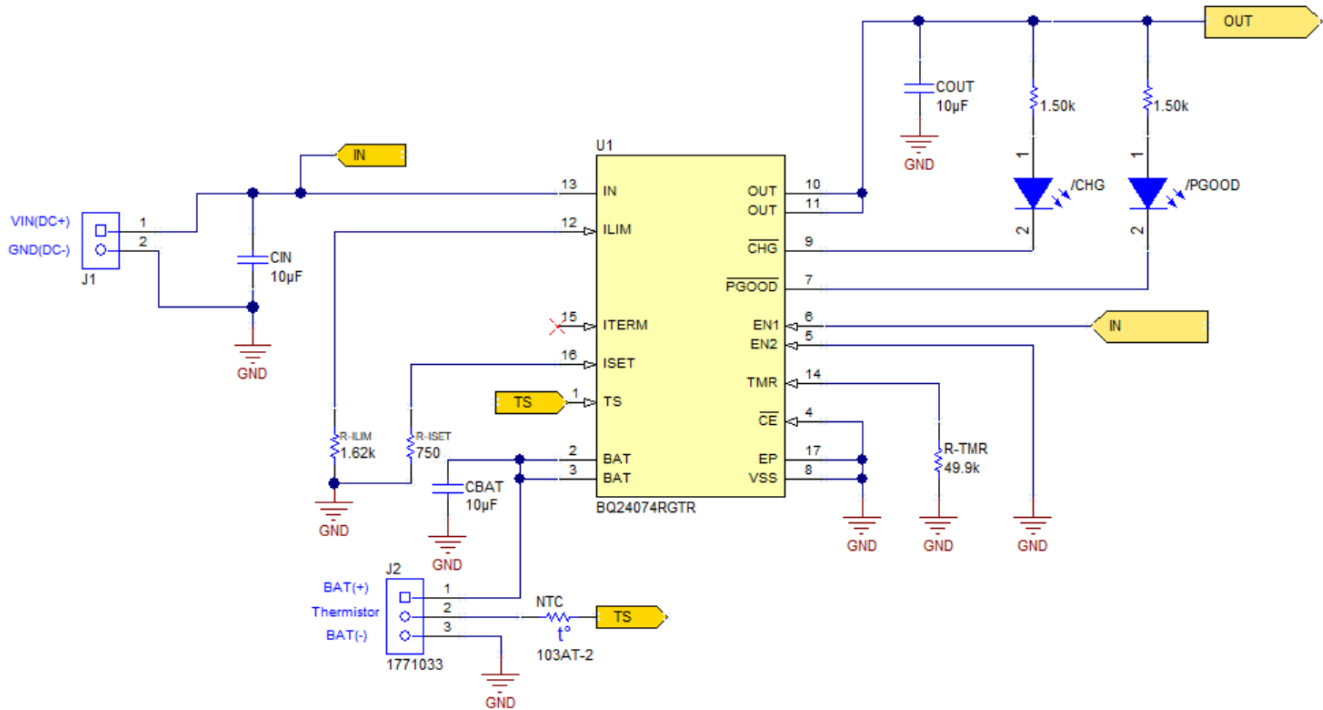


Figure 2. USB500 Mode

4 BQ2407x Optional Functions

The BQ2407x family of devices have optional features on pin 15 of each device. These functions on pin 15 of the device allows the devices to be used in a variety of applications.

| Part Number | Optional Function | Use |
|-------------|-------------------|--|
| BQ24072 | TD | Charge termination can be disabled by pulling the TD pin high. Charge termination is enabled when TD is connected to VSS. Note the TD is internally pulled down with a 285 kΩ resistor |
| BQ24073 | | |
| BQ24074 | ITERM | The ITERM pin can be used to adjust the charge termination current by connecting a 0Ω to 15 kΩ resistor. If ITERM is left unconnected, the termination current is set to 10% of the fast charge current. |
| BQ24075 | SYSOFF | The FET between BAT and the Output can be turned off by setting SYSOFF high. Setting SYSOFF low put the device in normal operation. SYSOFF is internally pulled up to BAT. |
| BQ24076 | | |
| BQ24078 | | |
| BQ24079 | | |

5 Common R_{ILIM} and R_{ISET} Values for BQ2407x

| Input Current Limit | R_{ILIM} | Fast Charge Current | R_{ISET} |
|---------------------|----------------|---------------------|----------------|
| - | - | 100 mA | 8.87k Ω |
| 200 mA | 7.68k Ω | 200 mA | 4.42k Ω |
| 300 mA | 5.11k Ω | 300 mA | 2.94k Ω |
| 400 mA | 3.83k Ω | 400 mA | 2.21k Ω |
| 500 mA | 3.24k Ω | 500 mA | 1.78k Ω |
| 600 mA | 2.67k Ω | 600 mA | 1.47k Ω |
| 700 mA | 2.32k Ω | 700 mA | 1.27k Ω |
| 800 mA | 2k Ω | 800 mA | 1.1k Ω |
| 900 mA | 1.78k Ω | 900 mA | 976 Ω |
| 1000 mA | 1.62k Ω | 1000 mA | 887 Ω |
| 1100 mA | 1.47k Ω | 1100 mA | 806 Ω |
| 1200 mA | 1.33k Ω | 1200 mA | 750 Ω |
| 1300 mA | 1.24k Ω | 1300 mA | 681 Ω |
| 1400 mA | 1.15k Ω | 1400 mA | 634 Ω |
| 1500 mA | 1.07k Ω | 1500 mA | 590 Ω |

6 Common R_{ILIM} and R_{ISET} Values for BQ2423x

| Input Limit Current | R_{ILIM} | Fast Charge Current | R_{ISET} |
|---------------------|------------|---------------------|------------|
| - | - | 100 mA | 8.66k |
| 200 mA | 7.68k | 200 mA | 4.32k |
| 300 mA | 5.11k | 300 mA | 2.87k |
| 400 mA | 3.83k | 400 mA | 2.15k |
| 500 mA | 3.09k | 500 mA | 1.74k |

7 Frequently Asked Questions

Q: Why is my device not charging?

A: Things that could prevent the charger from charging the battery include /CE pin not being low, the TS voltage not being between 0.3 V and 2.1 V, having the load current as high as the input current limit can cause the device to go into supplement mode.

Q: My charging current is lower than expected

A: Ensure the device is not in thermal regulation which will reduce the charge current. Remove the load on the OUT pin to reduce the power dissipated in the IC. Measure the IN and OUT voltage to ensure the device is not in VIN-DPM or DPPM mode respectively. The charge current will be reduced if either of these modes are active. For more details on VIN-DPM and DPPM, see [Dynamic Power Path Management and Dynamic Power Management](#).

Q: Why does my output shutoff when more than 3A from OUT on the BQ2407x?

A: The device has OUT short detection which turns off the FET between BAT and OUT when the short circuit is asserted. This happens when $V_{BAT} - V_{OUT} > V_o(Ssc2)$, which is typically 250 mV. The voltage drop across the FET is due to the $R_{DS(on)}$ which is typically 50 m Ω .

Q: Can I reduce my NTC Hot trip point from 50°C to 45°C

A: Using external resistors and equation 8 in the [BQ2407x Standalone 1-Cell 1.5-A Linear Battery Charger with PowerPath Data Sheet](#), the range can be expanded but not reduced on the BQ2407x devices. The BQ2407xT offers this flexibility.

Q: When is DPPM and VIN-DPM available?

A: VIN-DPM is only available when in either USB-100 or USB-500 mode with the input voltage input being monitored. DPPM is always available with the OUT voltage being monitored. If the input or charge current is being reduced in ILIM mode, this will be due to DPPM mode so the OUT voltage should be checked.

Q: What happens if i set my charge current higher than my input current limit?

A: The battery will be charge at the rate of the input current limit as long as there is no load on OUT.

Q: Why do i see 0V on TS pin with a resistor on TS?

A: Check to make sure there is no short on the pin. After that, check to make sure you have the BQ2407x and BQ2407xT.

Q: What is the difference between the BQ2407x and BQ2407xT family of devices?

A: The BQ2407x devices have a current based NTC monitoring while the BQ2407xT has a voltage based NTC monitoring that requires a pullup to a voltage source.

Q: Does the BQ2407x family have BUVLO?

A: The devices don't have BUVLO. Protection will need to be added to prevent over-discharge of the battery.

Q: Should I be worried about current leaking from BAT or OUT to the IN pin?

A: There are 2 back to back FETs on the input with backgate control to prevent against this.

8 References

- Texas Instruments: [Dynamic Power Path Management and Dynamic Power Management](#)
- Texas Instruments: [BQ2407x Standalone 1-Cell 1.5-A Linear Battery Charger with PowerPath Data Sheet](#)

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Original (March 2019) to A Revision | Page |
|--|------|
| • Updates were made in Section 7 | 4 |

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