Application Report
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BQ2404x, BQ2405x, and BQ2409x frequently asked questions

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ABSTRACT

This document contains common questions and issues encountered by users when using the BQ2404x, BQ2405x, and BQ2409x families of battery chargers. Interpret the topics separately.

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Trademarks

1 Topic 1: Tips for When There is No Output, Charge Current Low, Early Termination, and Other Unwanted Behaviors

This topic applies to the BQ21040 and the BQ2404x, BQ2405x, and BQ2409x family of devices.

If the device does not start charge or there is no current to battery check:

1. Check that the input voltage is below OVP, or 6.6 V.
2. Check the ISET and PRETERM resistors since the low charge current can cause problems.

The TS pin voltage needs to be between 278 mV and 790 mV to operate normally.

If the charge starts, but battery current does not meet the target:

- The TS pin voltage needs to be in the normal range. At low temperatures, the half charge reduces the current TS between 790 mV and 1230 mV.
- The ISET2 pin and Float limits the current to 100 mA.
- If the input voltage is low, you need a 70 mV–1000 mV drop to get the full output current.
- If the die temperature reaches 125 °C, the output current reduces to control thermal rise.

If the charge terminates early or at a lower voltage:

- If the hot temperature charge voltage reduces to 4.06 V, the TS pin is between 178 mV and 278 mV.
- Resistence between the battery and charge increases voltage at the BAT terminal and appears as a higher battery voltage.
- If the charge terminates early or at a lower voltage, then the battery or battery simulator required for test standard load does not work.
- The $\overline{CHG}$ and PG pin gives some insight into the condition of the device.
- Check the voltage at ISET. It should be proportional to the output current reduced by 400.

- The $\overline{CHG}$ and PG pin gives insight into condition of device.
- Check the voltage at ISET. It needs to be proportional to output current reduced by 400. I_{OUT} / 400 * R-ISET.
- The voltage at ISET represents the output current. The voltage at PRETERM represents the termination point.
- Battery voltage for a normal charge current needs to be 2.5 V–4.1 V. If it is out of the range, the current is reduced.

2 Topic 2: TS Pin Configuration of NTC and TTDM Mode

This topic applies to the BQ21040 and the BQ2404x, BQ2405x, and BQ2409x family of devices. The best arrangement for the TS pin options and configurations depends on the system requirements. The following list provides a summary of the modes and configurations.

- Normal battery charge: This charge is connected to the NTC thermistor in the battery pack to monitor battery temperature. 50 µA current source develops a voltage that is monitored by internal voltage comparators. The charge is suspended above 1230 mV and below 178 mV. A 10-k resistor enables normal operation if a normal battery charge is not used.
- Shutdown: Pull the TS pin to disable the charge.
- Termination and timer disable mode (TTDM): Float or drive high to enter TTDM. The mode is similar to power supply mode. After the charge is complete, the voltage remains applied to the battery.
- TTDM disable: Connect a 237-k resistor to the ground. TTDM disable is used if the battery pack is removed and the TTDM mode is not needed. In this condition, the charge is suspended and no voltage is present.
- Typical configuration: Connect an NTC or 10-k resistor to the TS pin. If the battery pack is removable, then you can use the TTDM mode.

For additional information, see the *TS (bq24040/5)* and *Termination and timer Disable Mode (TTDM) - TS Terminal High* sections in the *BQ24040 Charge Complete Data Sheet*.

3 Topic 3: TTDM Mode Start Up Current Limit

This topic applies to the BQ21040 and the BQ2405x and BQ2404x family of devices. For more information on the termination disable (TTDM) using the TS pin, see the *TS (bq24040/5)* section in the *BQ24040 Charge Complete Data Sheet*. The following list provides information about the information about the TTDM.

- 4.2-V power supply mode when battery is fully charged.
- Start up in this mode requires a light load and must pass Battery Short Protection and Precharge to provide the full current.
- If no battery is present, then you need a load disable or load switch to allow voltage to reach 2.5 V to start up.

Limited output current at low battery voltage:

- Battery Short Protection: When the battery voltage is less than 0.8 V, the output current is limited to 15 mA.
- The battery voltage between the 0.8 V and 2.5 V output current is limited to the precharge current set by the TERM pin, typically 20% of fast charge.
- Battery voltage above the 2.5 V current is the maximum value set by the ISET pin.

4 Topic 4: Charge Complete Pin Behavior, $\overline{CHG}$

This topic applies to the BQ21040, BQ25100, and the BQ2404x, BQ2405x, and BQ2409x family of devices. The $\overline{CHG}$ pin is an open drain output used to indicate that a battery charge cycle is in progress. The pin goes low when the device detects a valid power supply and starts charging the battery. The pin goes high when the device detects that the battery is fully charged (Change Complete or Termination).

To optimize end-user experience, the charger behavior under the particular cases are as follows:

- If the TS (NTC) pin indicates an over temperature condition, the charge is suspended. The $\overline{CHG}$ pin

remains low since termination or charge complete has not been detected. The charge resumes when the temperature reduces and the $\overline{CHG}$ pin remains low.

- The BQ2404x automatically restarts the charge if the battery voltage drops to Recharge (V-RCH). The battery stays fully charged during the restart. The $\overline{CHG}$ pin remains low after termination even if the recharge has started.
- The $\overline{CHG}$ pin is high –Z during the OVP shutdown or charge timer fault.

The charge cycle, but not the First Charge cycle, starts when exiting the TTDM mode or when the battery voltage is below V-RCH. The First Charge cycle starts when any of the following happens:

- Power is applied
- You enable or disable the TS pin
- A battery insertion is detected

For additional information, see the *$\overline{CHG}$ Terminal Indication* and *$\overline{CHG}$ and $\overline{PG}$ Pull-up Source* sections in the *BQ24040 Charge Complete Data Sheet*.

5 Topic 5: V_{IN} to V_{OUT} vs Charge Current Regulation

This topic applies to the BQ21040 and the BQ2404x, BQ2405x, and BQ2409x family of devices.

- The BQ2404x and similar devices are linear chargers similar to a low dropout regulator. These devices require a voltage drop at the input to output.
- V_{IN}–V_{OUT} dropout is typically 325 mV, but has a maximum of 500 mV. The test condition is R-ISET = 540, which is a 1 A output current. The I-out reduced to 0.5 A, which reduces the output current from 1 A to 500 mA. The charging continues and completes without a problem.
- This behavior is most common when the larger charge current near the Constant Voltage phase where the input to output voltage difference is lowest.
- The device needs to be 700 mV–1 V to prevent a current reduction during the charge voltage.

The device also has an IN-DPM feature that reduces the output current when the input voltage drops. The IN-DPM is active when the input voltage drops to 4.4 V.

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