Application Report
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How to Operate Fuel Gauge bq20z7x/8x/9x and the SMBus-Like Smart Chargers bq24747/765 Without a Host Controller

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ABSTRACT

The smart charger bq24747/765 is a high-efficiency, synchronous battery charger with an integrated input current comparator. This charger provides low component count for space constrained, multichemistry battery charging applications. SMBus input current, charge current, and input current digital-to-analog converters allow for very high regulation accuracies that the system power management microcontroller can easily program by using SMBus protocol.

The bq20z7x/8x/9x, SBS-compliant gas gauge integrated circuit (IC), incorporating patented Impedance Track™ technology, is designed for battery-pack or in-system installation. It measures and maintains an accurate record of available charge in Li-ion or Li-polymer batteries using its integrated high-performance analog peripherals. It monitors capacity change, battery impedance, open-circuit voltage, and other critical parameters of the battery pack, and reports the information to the system host controller over a SMBus.

The charger IC (bq24747/765) and gas gauge IC (bq20z7x/8x/9x) are both SBS compliant. The ChargeCurrent() register address is 0x14. The ChargerVoltage() register address is 0x15. The charger IC operates as a slave. Control input is received from the gas gauge IC through the SMBus. The gas gauge IC operates as master with broadcasts enabled. It broadcasts the ChargeCurrent() and ChargeVoltage() command to the charger IC. When the charger IC gets the two commands, it starts the charger. In this system, no extra host controller is required for the charger IC. It saves the total cost or the total system software resource.

Implementations

This application report gives an example of using bq24765 and bq20z80 together as a nonhost control battery charging system solution. The bq24765 evaluation module (HPA349 EVM) and the bq20z80 evaluation module (HPA059) are used for this demonstration. Also, the user's guides of bq25747EVM (HPA272), bq20z7xEVM (HPA140), and bq20z9xEVM (HPA155) are available at www.ti.com.

Figure 1 shows a two-EVM connection for the nonhost control SMBus charger system. The following steps show how the Figure 1 test setup can be constructed.

Step 1.

bq24765EVM setup:

1. Connect VDDSMB to Vref (JP9). This allows the bq24765's internal reference voltage to be the SMBus pullup source.
2. Short the input current sense resistor, R18. This allows bq24765 operation without an extra InputCurrent() command. The default InputCurrent() is 256 mA with a 10-mΩ sense resistor.
3. Solder a BAT54 diode between test point Vddp and the BAT pin. The anode of BAT54 is connected to Vddp.

Step 2.

bq20z80EVM setup:

1. Enable the bcast bit in DF. This bit is in one of the Operation CFG DF locations.
2. Ensure that you do not set the HPE or CPE bits in DF because the charger does not use PEC.

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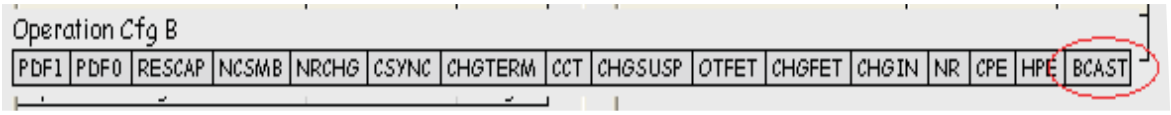


3. Add a short jumper between TB4-Vss and TB1-Sys Pres.
4. Add 3 battery cell series among 1N, 1P, 2P, and 3P. Also add a short jumper between 3P and 4P.

Step 3:

Connect bq24765, bq24747, and power supply together:

1. Connect input power supply only to bq24765EVM J1 (HPA349).
2. Connect SMbus wires between bq24765EVM and bq20z80EVM.

bq24765EVM	bq20z80EVM
J3-GND	J1-Vss
J2-SCL	J1-SMBC
J2-SDA	J1_SMBB

3. Connect the bq24765EVM's BAT output to bq20z80 EVM's pack termination.

bq24765EVM	bq20z80EVM
J10-GND	TB4-PACK–
J10-BAT	TB1-PACK+

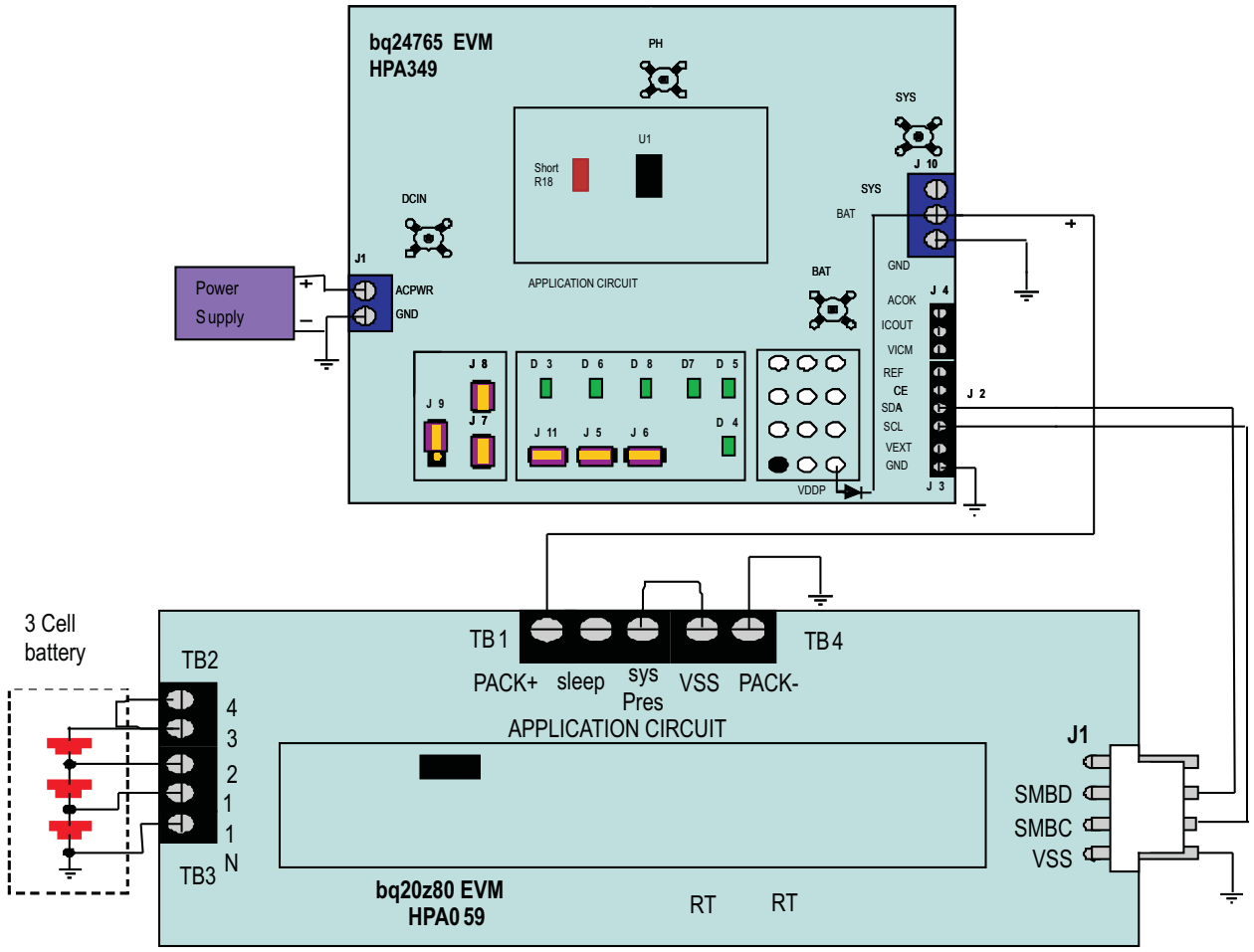
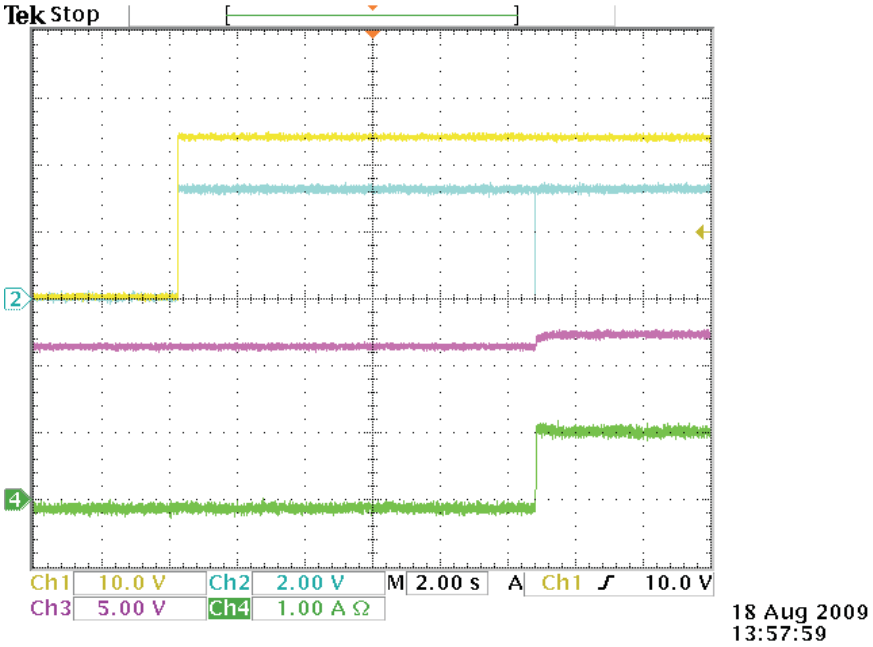


Figure 1. bq24765EVM and bq20z80EVM Constitute a Nonhost Control SMBus Charger System

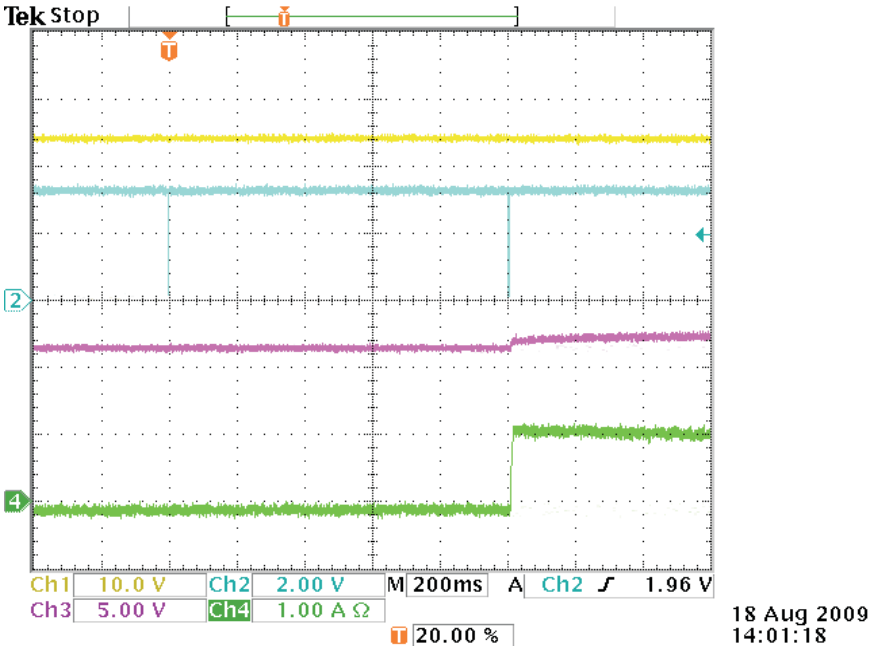
Test Result

Figure 2 shows that after power up, the bq24765EVM input power supply, 3.3V REF, is available as a SMBus pullup source. The bq20z80EVM sends ChargeCurrent and ChargeVoltage commands to the bq24765's 0x14 and 0x15 registers every 45 s through the SMBus. After the bq24765 gets these commands, it starts to charge the battery. Figure 3 zooms in the charger start-up edge. It clearly shows that after two SMBus commands, the charger starts up smoothly.



Ch1: Input; Ch2: SMBus clock; Ch3: Battery pack voltage; Ch4: charge current

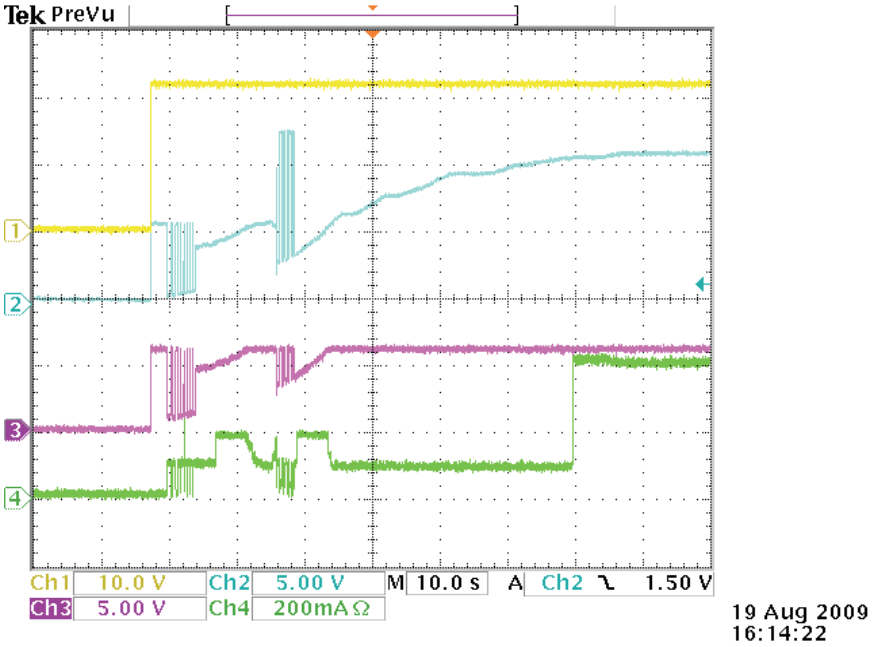
Figure 2. System Power Up and Charger Starts Charging



Ch1: Input; Ch2: SMBus SDA; Ch3: Battery pack voltage; Ch4: charge current

Figure 3. Zoom in Charger Startup Edge

When the battery cell was deeply discharged, the charger's Vddp provided a wake-up current to bring the cell voltage up and power up the bq20z80. First, the bq20z80 sends out ChargeVoltage and Pre-chargeCurrent commands to the bq24765's 0x14 and 0x15 registers. The charger follows these commands and provide the correct charging current. When the battery voltage is higher than a certain threshold, the gas gauge sends out the Fast-chargeCurrent and ChargeVoltage commands to bq24765's 0x14 and 0x15 registers. The charger runs to the fast charge stage. Figure 4 shows that the bq24765EVM charges a deeply discharged battery. (Using a Kepco active load simulates a deeply discharged battery.)



Ch1: Input; Ch2: Battery pack voltage; Ch3: Vddp voltage; Ch4: charge current

Figure 4. bq24765 EVM Charges a Deeply Discharge Battery Over bq20z80

After the battery is fully charged, the gas gauge IC sends zero charging current command to turn off the charger. If the battery voltage is lower than the recharge threshold, the gas gauge IC sends the fast charge current command, and then, the charger recharges again.

Conclusion

The TI smart charger (bq24747/765) and gas gauge IC (bq20z7x/8x/9x) can constitute a nonhost control SMBus charger system.

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