CFC and DFC Operation in the bq2060A Gas Gauge IC

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ABSTRACT

The bq2060A gas gauge IC has two pins, CFC (pin 16) and DFC (pin 17), that can be used for secondary override control of a Li-ion protector or for blowing a fuse to disable the battery pack. This application report discusses these pins and their operation in the bq2060A.

1 Introduction

The Charge FET Control (CFC) pin 16 and the Discharge FET Control (DFC) pin 17 of the bq2060A gas gauge IC can be used for secondary override control of a Li-ion protector or for blowing a fuse to disable the battery pack. These pins are not intended for use as primary protection. Use a protector IC like the UCC3957 for primary protection. The CFC pin is for secondary protector control or for blowing a fuse (see Figure 1 and Figure 2) ; the DFC pin is for secondary protector control. Discharge current can cause an override of the CFC control, and charge current can cause an override of the DFC control. The SMBus Pack Status register lower nibble includes the CVOV and CVUV bits which indicate the fault status. The COK and DOK bits in this register indicate the true logic state of the CFC and DFC pins, respectively.

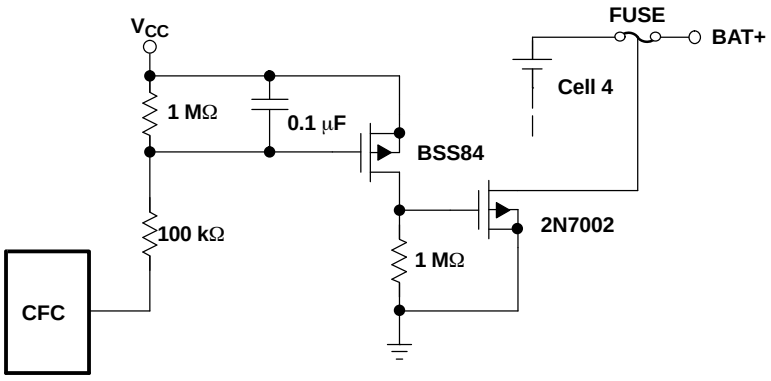

Figure 1. CFC Fuse Blower Circuit Implementation

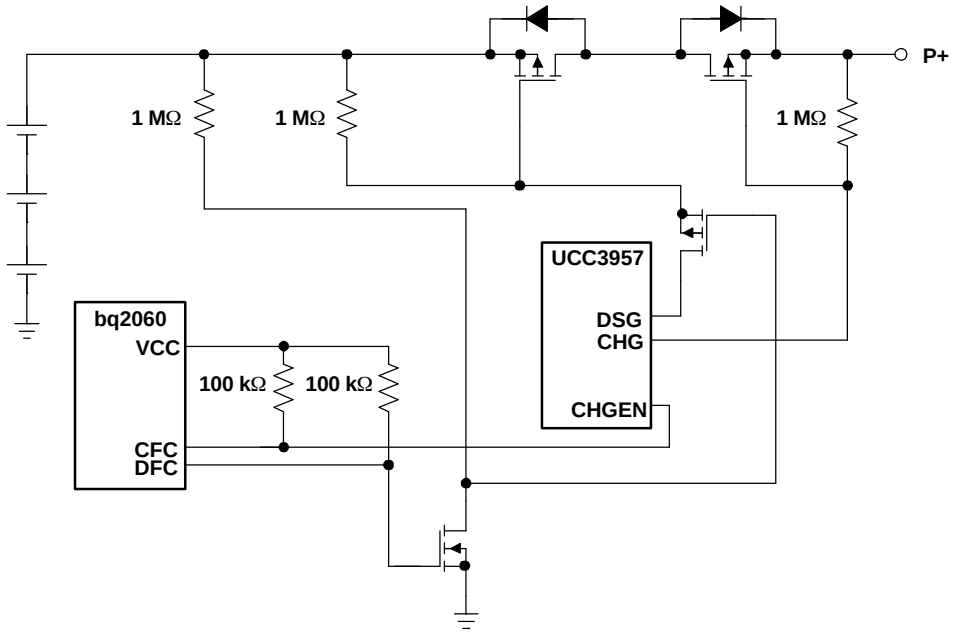

Figure 2. Using the CFC Pin to Control CHGEN on the UCC3957

2 Discussion

The following text describes the conditions that allow the CFC and DFC pins to act as secondary override control of a lithium-ion protector or for blowing a fuse to disable the battery pack.

2.1 CVOV Flag in Pack Status Register

The CVOV flag is set in the Pack Status register if the following conditions occur.

- Voltage ≥ Charging Voltage + Overvoltage Margin
- Any Cell Voltage ≥ Cell Overvoltage Threshold
- Temperature ≥ MaxT

Charging Voltage, Overvoltage Margin, Cell Overvoltage Threshold, and MaxT are all EEPROM-determined values.

CVOV is set regardless of any other controls or conditions. The Safety Overtemperature (SOT) bit and the discharging bit in battery status do not affect this flag. The SOT bit is unused in this equation because MaxT will be exceeded before it is and thus is unnecessary.

2.2 SOT Bit in Miscellaneous Options

Given the preceding information, consider the conditions with the SOT bit in Miscellaneous Options. In the following discussion, *_LOW* indicates that the bit or pin is zero or low. *_HIGH* indicates that the bit or pin is a one or high.

2.2.1 With SOT Bit = 0 (Bit 6 in Miscellaneous Options)

The following conditions cause the CFC bit to go low:

- CFC_LOW = (CVOV_HIGH) and (DSG_LOW) or
- Temperature > Safety OverTemperature

DSG is the Battery Status bit 6 or 0x40 bit. DSG_LOW means that the bit is not set.

This formula can be explained in two ways. First, disregard temperature from the equation. So, if conditions are met for CVOV and the battery is discharging, then the CVOV bit gets set but the CFC does not go low because the DSG bit is high. The part was designed to function this way for two reasons.

- If the CVOV condition was caused by overvoltage, it is undesirable for the CFC pin to blow a fuse in the event that charge is being removed from the battery which will correct the overvoltage condition that caused the CVOV.
- If CFC controls the charge FET, discharging the battery with the charge FET off will cause the current to flow through the body diode and heat the charge FET. The charge FET is not turned off during discharge to prevent thermal damage to the charge FET.

Second, consider the equation with Temperature factored in. If CVOV is high and Temperature is greater than the Safety Overtemperature, then discharging or not is immaterial. CFC needs to be pulled low (blow a fuse or turn off the FET). Remember that if Temperature > Safety Overtemperature, then the temperature is also > MaxT; so, one of the CVOV conditions was met anyway.

2.2.2 With SOT Bit = 1 (Bit 6 in Miscellaneous Options)

The following conditions cause the CFC pin to go low:

- CFC_LOW = CVOV_HIGH and Temperature > Safety Overtemperature

This could also be written another way.

- CFC_LOW = Temperature > Safety OverTemperature

Both of these formulas where the SOF bit = 1 are the same. This is because if the CVOV was caused by Temperature > Safety Overtemperature, then the CFC needs to go low. However, if the CVOV was caused by Overvoltage or Temperature > MaxT, the CFC should not go low. So, the CVOV_HIGH condition in the first (simplified) formula with the SOF bit = 1 can be removed because only the CFC should go low because of Safety Overtemperature. Remember that if Temperature is greater than Safety Overtemperature, then it is also greater than MaxT.

Finally, if Temperature is greater than Safety Overtemperature, it is immaterial whether the system is discharging or not. Therefore, whenever Temperature is greater than Safety Overtemperature, CFC should be pulled low.

2.3 HIT Bit in Miscellaneous Options

The HIT bit in Miscellaneous Options controls the available temperature range for maximum temperature. If this bit is set, it simply adds 16°C to the thresholds of the formulas for MaxT and Safety Overtemperature EEPROM settings. It affects both formulas and, if set, both formulas have an increased threshold.

MaxT formula:

MaxT (EEPROM value) = (69 – MaxTemperature)/1.6

If the HIT bit is set, then this formula becomes:

MaxT (EEPROM value) = (85 – MaxTemperature)/1.6

Safety Overtemperature formula:

SafetyOvertemperature (EEPROM value) = (94.5 – SafetyTemperature) × 10

If HIT bit is set, then this formula becomes:

SafetyOvertemperature(EEPROM value) = (110.5 – SafetyTemperature) × 10

3 References

1. bq2060A, SBS v1.1-Compliant Gas Gauge IC (SLUS500)
2. UCC3957-1, -2, -3, -4, -5, Three- or Four-Cell Lithium-Ion Protector Circuit (SLUS236)

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