MC13892 Charger Operation

1 Introduction

This document explains the basics of the charger operation of MC13892 (PMIC for i.MX series), and provides a checklist for charger troubleshooting that can be used during the design stage.

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2.1 Charger type

The MC13892 incorporates a classic linear type CCCV charger, with two or three external MOSFETs and two sensing resistors. The charger provides a total current, which is shared between the system and the battery. Higher system consumption current leads to lower battery charging current, hence longer charging completion time. In extreme cases when the system consumption current is larger than the total current, the battery will supply the rest of the current, beyond what the charger can provide. Thus, the battery is actually discharging.

2.2 Charger Circuits

2.2.1 Serial Path Configuration

The connection of serial path configuration looks like the below figure. M1 and M2 control the charger voltage and current, while M3 connects the battery with the system supply voltage (BP). During operation, M1 is the MOSFET which operates as a linear regulator with CC/CV control. M2 is the reverse blocking MOSFET that will disconnect the input node (CHRGRAW) from the battery when there's no input source. During charging operation, M2 is fully conducting by turning CHRGCTRL_2 signal to ground level. M3 is the key to differentiate serial path from single path described later. This MOSFET will conduct during normal charging operation and shut off in no/dead battery power up mode.
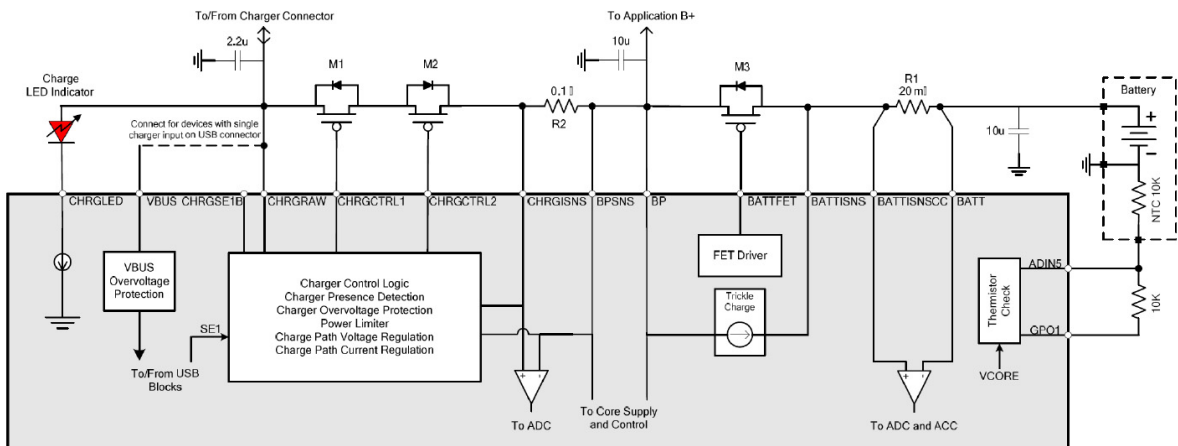
2.2.2 Single Path Configuration

Single path configuration is the same as serial path configuration except M3 is replaced by a direct short, and BATTFET is left open. In this configuration, the system cannot power up in no/dead battery mode as the BP voltage is clamped by the depleted battery. Single path configuration is not as popular as serial path configuration for most of the customers.

2.3 Input Source Differentiation (CHRGSE1B)

The charger of MC13892 differentiates the input source by the state of the CHRGSE1B pin. The pin is internally pulled up. If the state of this pin is high, then the charger recognizes the input source as an USB input with initially 100mA current limit. If this pin is grounded, then it is regarded a wall adapter is connected, so the charging current is raised up to 560mA.

3   Check List for Charger Troubleshooting:

3.1   Charger Does Not Operate (No Charging Current)

3.1.1   Make Sure ADIN5 is Correctly Biased

ADIN5 is an input of the ADC interface, which is used to monitor battery temperature during automatic charging (standalone charging) with no user defined software involvement. The voltage on ADIN5 must be with the range of (10/32)*2.775V to (24/32)*2.775V for the charger to operate. Check if the battery thermistor is correctly connected to ADIN5, or if with no battery the ADIN5 voltage is correctly biased.

3.1.2   Charger current not correct

• Check the status of CHRGSE1B pin

During power up, the initial charging current is decided by the state of CHRGSE1B pin. After system establishes communication, the software can change the charging current through I^2C/SPI commands.

• Check the value of the two sensing resistors

By default, the PMIC regards the sensing resistor between CHRGISNS and BPSNS to be 0.1ohm. The charging current ADC reading is based on this value, so is the automatic controlled constant charging current. If a user uses a 0.05ohm resistor instead, all the actual current will be doubled. Never decrease the sensing resistor value to 0 ohm, as this will make the charger lose constant current control capability.

3.1.3   Charger automatically stops before battery is fully charged

• Reset the SPI register bit CHRTMRRST periodically

There is a 120 minutes time out mechanism for the charging circuit, which cannot be disabled. When the timer expires, the charging process will stop whether the battery is full or not. For most recent designs the capacity of the battery is usually much larger than 2000mAh. In order to delay the time out, the user must reset the timer before the 120min timer expires by software programming.

3.1.4   Charger current not continuous

If the user observes the charging current is not continuous, but rather periodic like a square waveform with a certain duty cycle, this is because the thermal protection on the charging MOSFETs. As a protection mechanism, the PMIC has thermal monitoring on the M1/M2 MOSFETs by multiplying the voltage difference across the MOSFETs with the current flowing through them. The result is compared with the value set in register bit PLIM[1:0]. If the calculated value exceeds the value set in PLIM[1:0], the PMIC will make the charging current discontinuous to relief the MOSFETs from thermal problems. This feature is enabled by default, and can be turned off by setting PLIMDIS=1, which however, is not recommended.

3.1.5   System cannot power up in serial path mode with no/dead battery

This is a very common problem that is encountered by many customers. In fact, this problem is related simultaneously to several points mentioned above. First make sure ADIN5 is correctly biased, and CHRGSE1B is connected to ground. As long as system power up current consumption is less than 560mA, the system should be able to power up with no/dead battery. If, unfortunately, the system power up current consumption is more than 560mA, to power up the system we have to increase the default charging current by reducing the value of the 0.1ohm sensing resistor. However, the system may encounter thermal problem with such modification. So the best way still is to decrease the system power up current consumption.

4 Increasing Charging Current Up to 2A or Higher

In some cases, as 3G or Wi-Fi PA is required in the system, the current consumption will be larger than 2A. But the charger current of the MC13892 can only reach 1.6A theoretically. In fact the charger current will be discontinuous when the charging current is larger than 1.2A, because of the power limitation on the charger MOSFETs. If we increase the charging current by reducing the 0.1ohm sensing resistor, the thermal problem on the MOSFETs will deteriorate. So the practical maximum charging current is only 1.2A. In such case, the battery has to provide current rather than being charged, hence we must find a way to increase the current externally.

A proposal recommended by us is to add another external charger IC, MC34675, to deliver the extra charging current needed when necessary. The MC34675 is disabled by default, and is only enabled when the system determines to operate in high current consumption mode to provide extra current. The power up system current consumption needs to be controlled low than 500mA, by disabling some peripheral devices for example.
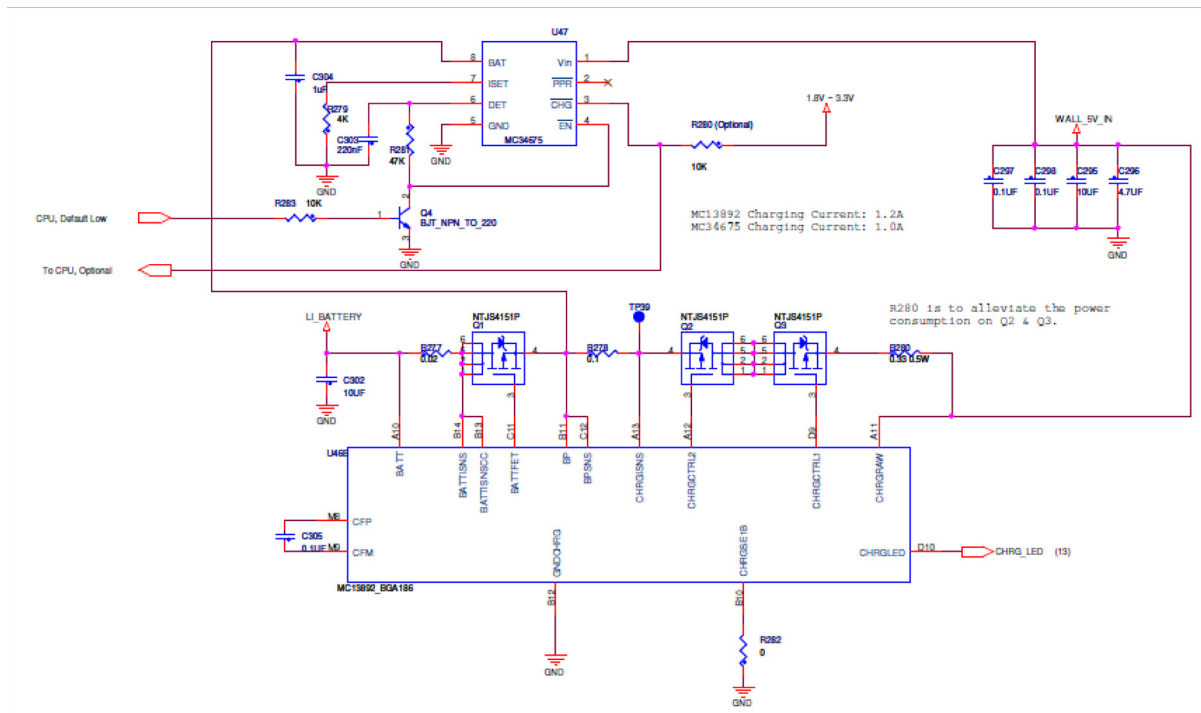
5   References

MC13892 Data sheet for Power Management Integrated Circuit (PMIC) for i.MX35/51

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