Application Note for GC-QC-368

GCQC368 E-bike Li-ion Battery Management

1. 说明 Description

GCQC368 锂电池保护方案，包括 GC1318 和两片 X3100/01,可以管理 6/7/8/9/10 节锂电池，智能实现锂电池的测量、保护、平衡等管理功能。

通过测量电池的电压、电流和温度，准确计算电池电量，控制平衡电路的平衡动作，执行电压、电流和温度的保护。

各种工作和保护的参数可以进行灵活设定，并在内部保存于 GC1318 的 EEPROM 中。

系统自动进行电量智能调整、记录充放电循环次数(cycle)和电量自学习等功能，实现系统参数数据的自动管理。

Solution GCQC368 is using 1 GC1318 and 2 X3100/01 to manage 6/7/8/9/10 Li-ion battery in series. The solution provides smart battery control function such as battery voltage/current/capacity measurement, battery over/under voltage, over current short circuit protection, battery cell-balancing management.

Every parameter of the protection such as voltage, current, temperature, can be stored in the EEPROM of GC1318 with the GC-SmartLoader and GC-PackManager.

The solution, can smartly calculate the battery capacity, record the charging/discharging cycle, and provide the FCC capacity re-learning function.

2. 特性 Characteristic,

- 使用 GC1318 集中管理
- GC1318 centrally control the smart battery management.
- 支持多种锂电池电芯(cells)连接方式。
- Provide multi-cell pack connect such as 2Px6/7/8/9/10S.
- 强大、完善的双重保护功能。对过压、欠压、过流具有硬件和软件的双重保护。
- Provide the second protection for over/under voltage, over current with software and hardware mechanism.
- 系统电量通过电流测量获得，高精确度。
- System capacity is calculated by the accurate current detection.
- 各种参数可以进行设定并保存在 GC1318 的 EEPROM 中。
- All the protection and battery parameters, are set and protected in the EEPROM of GC1318.
- 系统对各种过程数据进行保存。
- All the real-time data is stored and protected in the EEPROM of GC1318.
- 可以通过接口读出系统的一些参数和过程、状态参数。
- All the real-time parameters such as temperature, current, voltage, capacity and the battery status, can be read through the SMBus.
- 高精度的电压、电流测量。
- High precision detection in voltage and current.
- 控制软件可以实现在线更新。
- The GC1318 can provide the In-Application-Programming(IAP). This will provide a good inventory control for different kind of product.
- GC1318 智能控制平衡电路，实现有效电池平衡。
- GC1318, can smartly control the cell-balancing circuit.
- GC1318 具有多种休眠(sleep)模式，降低系统电力消耗。
- GC1318 has several kind of sleep mode to achieve system in the low power consumption.
- 具有可靠的短路、反接保护功能。
- Short-circuit and reverse connection of the battery power terminal, will be protected.

3. 功能 Function

- 连接方式 Connection method.

X3100 可以管理 4 节锂电池，X3101 可以管理 3 节，另外 GC1318 管理 2 节。本系统根据使用的芯片可以管理 6/7/8/9/10 节锂电池。

X3100/X3101 provides 4/3 cell management. GC1318 manages 2 cells. Hence, the current system, can smartly, manage 6/7/8/9/10 Li-ion cell in series.

- 电源 Power

X3100/01 有电源整流部分，输出＋5V 电源。A 片的电源同时供给 GC1318 使用，B 片的电源提供给电平转换部分使用。

X3100/X3101 has built-in the voltage regulator, which can provide 5V voltage. The X3100/01(A)'s regulated voltage provides to GC1318 and X3100/01(B)'s regulated voltage provides to the level shift circuit.

- LED 电量指示 LEDs Battery Capacity Indicatoin.

系统可以选择使用 4 或 5LEDs 进行电量指示。

System, provides the 4 or 5 LEDs for the battery capacity indications.

4 LEDS Indications	5 LEDS Indications	Estimated Battery Capacity
4 LEDS	5 LEDS	>75%
3 LEDS	4 LEDS	>50%
2 LEDS	3 LEDS	>25%
1 LEDS	2 LEDS	<25%
0 LEDS	1 LEDS	<6%

- 电压测量 Voltage detection.

系统电压测量精确到 mV。The accuracy of the voltage detection is 1mV.

X3100/01(A) detects the battery voltage and passes to GC1318.

X3100/01(B) detects the battery voltage and passes to GC1318 through the level shift circuit.

- 电流测量 Current Detection

电流的测量通过 A 片向 X100/01 实现。通过测量电流检测电阻的电压，获得电流值。测量精度可以达到 16BITS。

X3100/01A detects the current through the sensing resistor and passed to GC1318. The accuracy can be 16 Bits.

- 电量计算 Gas Gauge Function

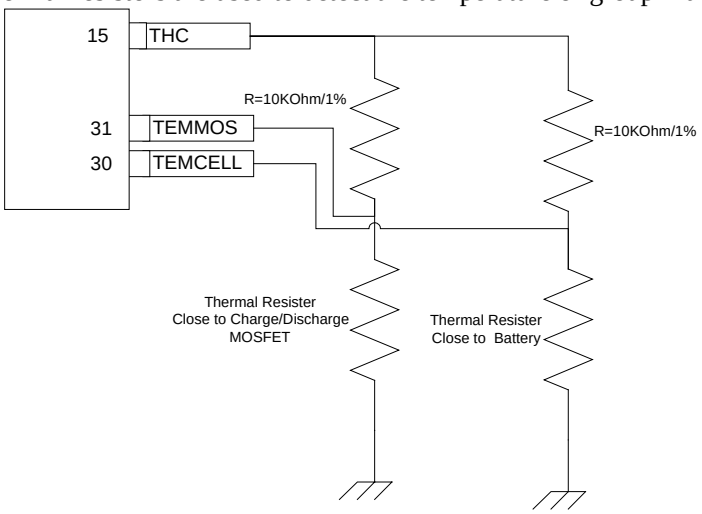
软件通过电流值，计算获得电量的值。具有高精确度。

GC1318 by using the current detection from GC3100/01(A) to calculate the battery capacity.

- 温度测量 Temperature Detection.

两路温度传感器分别测量 A、B 组电芯的温度。

2 thermal resistors are used to detect the temperature of group A and B battery.



- SPI 通信电路 SPI Port Communication.

GC1318 对 X3100/01 参数的设定、FET 的控制指令及状态的读取都通过 SPI 接口完成。

对应的 CS 线选取 A 片或 B 片。B 片的 SPI 接口经过电平转换电路的转换。

The communication between GC1318 and X3100/01 is SPI protocol. This allows GC1318 to set X3100/01, control

the MOSFET and read those battery status. The chip selection of GC1318 will separately control the SPI to communicate with X3100/01(A) or (B). The SPI port of X3100/01(B) is through the level shift circuit.

- 电平转换电路 Level Shift Circuit.

本部分电路是 B 片 X3100/01 与 GC1318 之间的电平转换电路。包括 SPI 口线、AS0-2 的选择线和 AO 线。AO 输出经比较器实现电平搬移。

由于两部分的工作电压不同，须经本电路的转换事项通信和测量。

本部分电路由 VDD2C 控制，周期性的工作，即只在需要时打开以节省电耗。

Since the working voltage is different for X3100/01(B) and GC1318, the circuit provide the level shift function between the X3100/01(B) and GC1318 in the SPI port, AS0-2 and AO.

The level shift circuit's voltage is provided by X3100/01(B). In order to save the power, the level shift circuit will be open in need.

- FETS 电路 FET Circuit.

A 片 X3100/01 的 OVP 和 UVP 脚分别控制充电和放电的 FETs。其本身在有硬件保护动作时，可以控制 FETs 的关断。软件通过 SPI 接口，实现对 FETs 的控制。

X3100/01(A)'s OVP and UVP control the charging FET(CFET) and discharging FET(DFET) respectively. X3100/01(A) can control the CFET and DFET with the internal hardware control. Meanwhile, GC1318 can also control CFET and DFET through the SPI port of X3100/01(A).

- 平衡电路 Cell Balance Circuit.

本系统的每节 cell 都可以带平衡电路，包括一个电阻和一个 MOSFET。GC1318 通过 SPI 指令，通过 X3100/01 控制平衡电路的 MOSFET。通过对电压高的电芯的旁路执行平衡动作，达到平衡的目的。

The system can provide the cell balancing control to each cell and the circuit just contains 1 resistor and 2N7002 Balancing MOSFET(BFET). The BFET is open/off by X3100/01(A)/(B) with the control of GC1318 through the SPI port.

The by-pass current flows through the BFET for the high-voltage cell so as to slow down the over-voltage of cell with the capacity adjustment.

- 电量的智能调整和自学习 Battery Capacity Smart Adjustment and Re-learning.

系统会根据电压，智能调整电量值。根据内在的算法完成系统 FCC（完全充满电量）的自学习和更新。

System will adjust the battery capacity with battery voltage. With the smart gas gauging algorithm, system provide accurate Full-Charge-Capacity re-learning and renew.

- 按键功能 Key Control

系统带有一个按键，当按键按下时，会通过 LEDs 指示剩余电量，并持续 3s。

此按键还用于程序在线更新。

System has one key control for the Remain-Capacity indication by LEDs with 3 second light-on.

The key also help in the GC1318 programming download.

- 双重保护 Second Protection

X3100/01 本身具有过压、欠压、过流、短路等保护功能。当参数超过设定的值，其自动提供保护。

同时可以设定软件的保护门限，有软件实现过压、欠压、过流和温度的第一级保护。

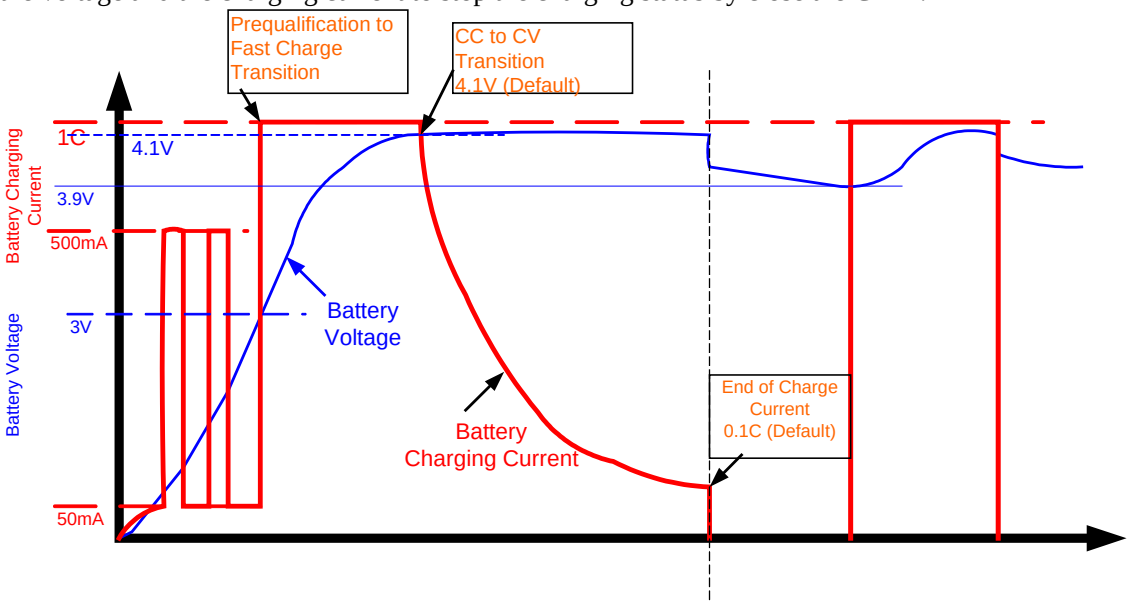
By setting the parameter to X3100/0, X3100/01 has automatically hardware control for the over/under voltage, over current and short circuit protection.

Meanwhile, in the first protection, GC1318 can provide the over/under voltage, over current and over temperature protection.

- 充电方式 Charging Mode

系统支持脉冲－恒流－恒压的充电方式。并依据电压和电流判断充电结束。在充电结束后，关闭 CFET.

System provides the pulse charging, constant current and constant voltage charging mechanism. The system will detect the voltage and the charging current to stop the charging status by close the CFET.



- SMBus 接口 SMBus Port

系统带有 SMBus 接口，用于参数的写入和数据的读取。

System has the SMBus which is used for the parameter read/write process

时钟 CLOCK	数据 Data	地 Ground
SCK	SDA	GND

- 在线更新接口 In-Application-Programming(IAP) Port

本接口用于配合专用的接口设备，实现程序的在线更新。

By using GC-SmartLoader, GC1318 can be programmed with the IAP port.

地 Ground	复位信号 Reset Pin	RXD	TXD
GND	RESET	RXD	TXD

4. 测试软件，工具，测试板 Testing Software, Tools and Testing board.

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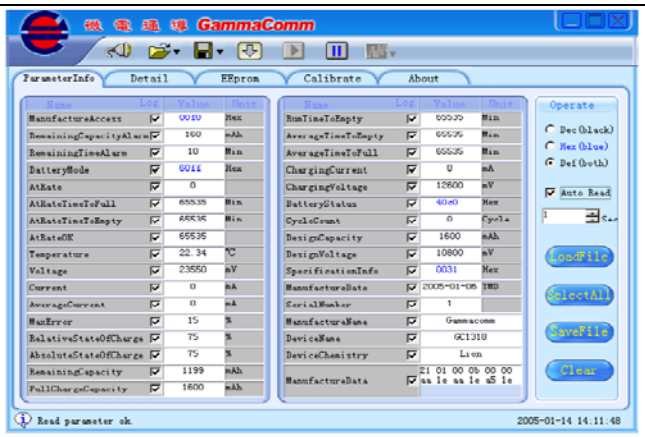
<td> 
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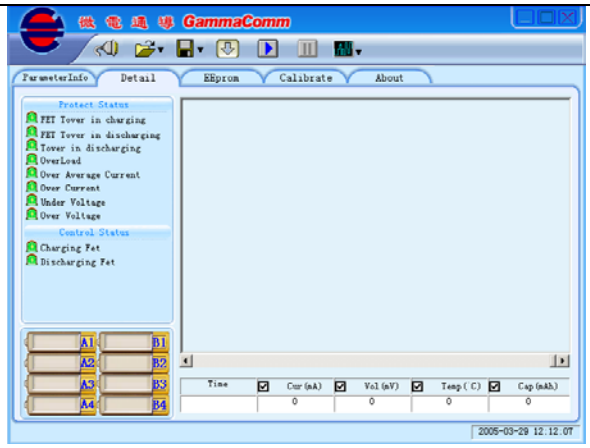
<td> 
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<td colspan="2">程序，电池参数下载，测试（电流，温度，电池容量，电压），各种保护（过/欠压，过流，电池平衡）控制
GC-PackManager provides the programming download, battery parameter download, data-logging for current, temperature, capacity and voltage and report the status of every single protection such as over/under voltage, over current, cell-balance of each cell.</td>
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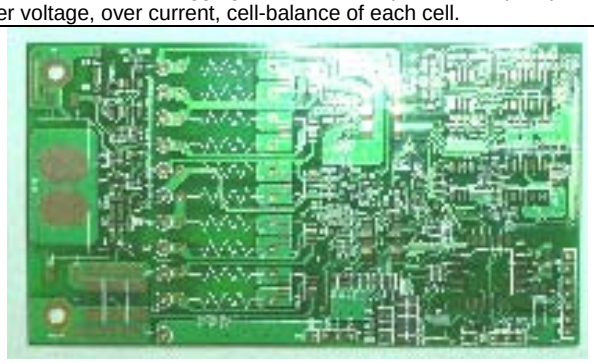
<td>  </td>
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