Smart Battery
Charging and Discharging
with
GC3001A-10

Content

GC3001A-10

Quick Charge and Discharge Control IC for NiMH/NiCd Battery

1. OVERVIEW

The GC3001A-10 is a quick charge and discharge control IC for Nickel Metal Hydride (NiMH) and Nickel-Cadmium (NiCd) rechargeable batteries. Quick charging ends in response to negative delta voltage detection (–ΔV), max temperature or maximum charging time detection functions. Also, quick charge mode is placed on hold if the battery voltage or temperature becomes abnormal. the charging doesn't start until normal condition is restored. The GC3001A-10 requires few external components to realize a high-stability quick-charging battery charger. It can also control Discharging according to the designed Voltage and Temperature.

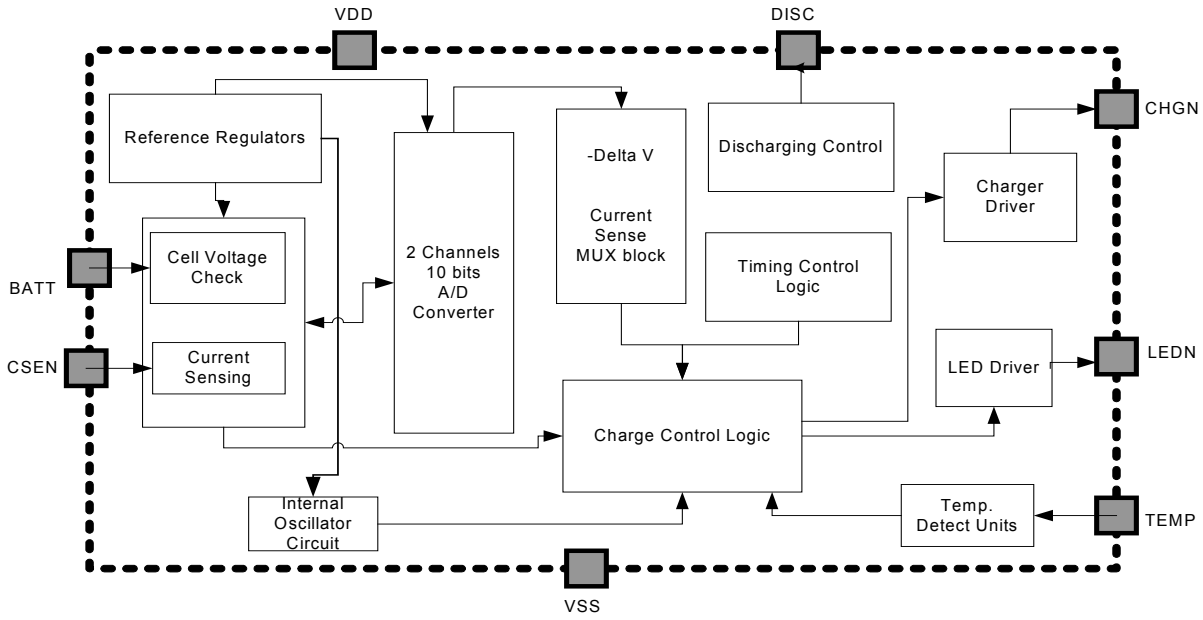
2. FEATURES

- Ni-MH/Ni-Cd battery quick charge control for batteries.
- −ΔV, maximum Temperature and maximum charge time cutoffs
- 6min (typ) −ΔV detection invalid time
- −4mV (typ) −ΔV detection accuracy
- Charge condition LED indicator output (on, pulse, off)
- High PWM Charging Output to simplify the charging circuit with limited components.
- Discharging Control
- 8-pin SOP package

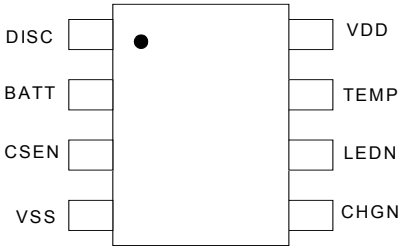
3. APPLICATIONS

- Battery manager for Portable DVD, Digital Camera, Hand-Held home appliance.

4. BLOCK DIAGRAM



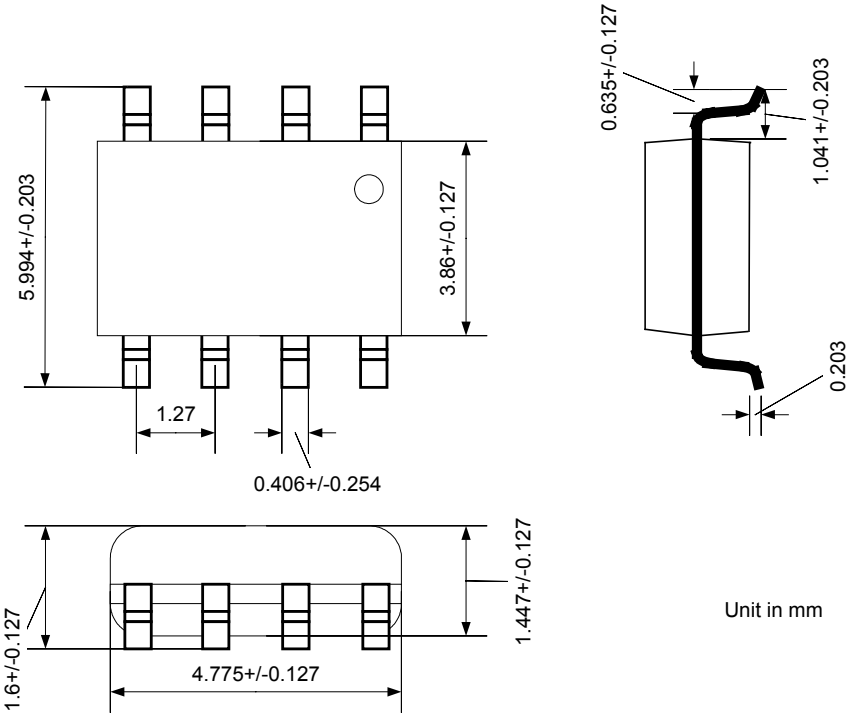
5. PINOUT



6. DESCRIPTION

Number	Name	I/O	Description
1	DISC	O	**Discharging Control Pin** When the battery voltage is lower than Shut Down voltage or the battery temperature is higher than MAXTEMP DISC out high level to cutoff discharging circuit.
2	BATT	I	**Battery voltage detector input.** Connect a high-impedance resistor voltage divider between the poles of the battery for voltage detection.
3	CSEN	I	**Charge current sensing input.**
4	VSS	-	**Ground.**
5	CHGN	O	**Charge control PWM Output** PWM pulse output when charging current is flowing. Low-level output when charging current is stopped or in discharging mode.
6	LEDN	O	**Charge status display LED driver output** High-level output in quick charge or battery wake up mode. 1Hz pulse output when abnormal battery voltage is detected during charging. Low-level output when charging finishes or in discharging mode.
7	TEMP	I	**Temperature detection pin** 1--- Detect the battery temperature during the charging or discharging process. 2----Detect the battery exist or not
8	VDD	-	**Supply**

7. PACKAGE DIMENSIONS



Unit in mm

8. Absolute Maximum Ratings : VSS = 0V

Operating Temperature	:	-55°C to +125°C
Storage Temperature	:	-65°C to +150°C
Voltage on any Pin except TIME with respect to Ground	:	-1.0V to VCC+0.5V
Voltage on TIMER with respect to Ground	:	-1.0V to +10.0V
Maximum Operating Voltage	:	5.5V
DC Current per I/O Pin	:	40.0 mA
DC Current VCC and GND Pins	:	200.0 mA

9. DC Characteristic 1 :

V_{DD} = 2.7 to 5.5V, V_{SS} = 0V, Ta = 25 ° C

Description	INDEX	Min	Typical	Max	Unit	Note
Battery Low Voltage, V_{MNV}	VBATLOW	-	0.3	-	V	V_{BATT}<V_{MNV} quick charge cutoff or prohibition
Maximum Delta Voltage	DVSET		-4		mV	
Maximum Temperature	MAXTEMP		55		° C	1----In charge mode, charging is over and cutoff charge Circuit. 2----In discharge mode , cutoff discharge circuit
Release temperature	RLSTEMP		50		° C	1--In charge mode, after the battery temperature drops from MAXTEMP To RLSTEMP, then IC start trickle charging 2---In discharge mode, after the battery temperature drops from MAXTEMP To RLSTEMP, then IC start discharging
Battery Shut Down Voltage			1.0		V	
Battery Shut Down Current			3.5		A	

10. DC Characteristic 2 :

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
VIL	Input Low Voltage		-0.5		0.2VCC	V
VIH	Input High-voltage		0.6VCC		VCC+0.5	V
VIH2	Input High-voltage		0.9VCC		VCC+0.5	V
VOL	Output Low Voltage Except VDD & VSS	IOL=10mA, VCC=5V;			0.6	V
VOH	Output High-voltage Except VDD & VSS	IOH=-10mA, VCC=5V;	4.3			V
IIL	Input Leakage Current I/O Pin	Vcc=5.5V, pin low (absolute value)			8	µA
IIH	Input Leakage Current I/O Pin	Vcc=5.5V, pin high (absolute value)			8	µA
ICC	Power Supply Current	Active at VCC			12	mA

11. Charging Mode and Detection

11.1. Charging Curve Parameter Setting

Description	INDEX	Min	Typical	Max	Unit	Note
Battery Low Voltage, V_{MNV}	VBATLOW	-	0.3	-	Voltage	V_{BATT}<V_{MNV} trickling charging.
Battery High Voltage, V_{MXV}	VBATHIGH	-	2.0	-	Voltage	V_{BATT}>V_{MXV} quick charge cutoff or prohibition
Battery Quick Charging Current	IQC		1500		mA	
Battery Trickling Charging Current	ITC		75		mA	
Battery Pre-Charging Time	Tdv		6		Minute	Battery Pre-Charging Time

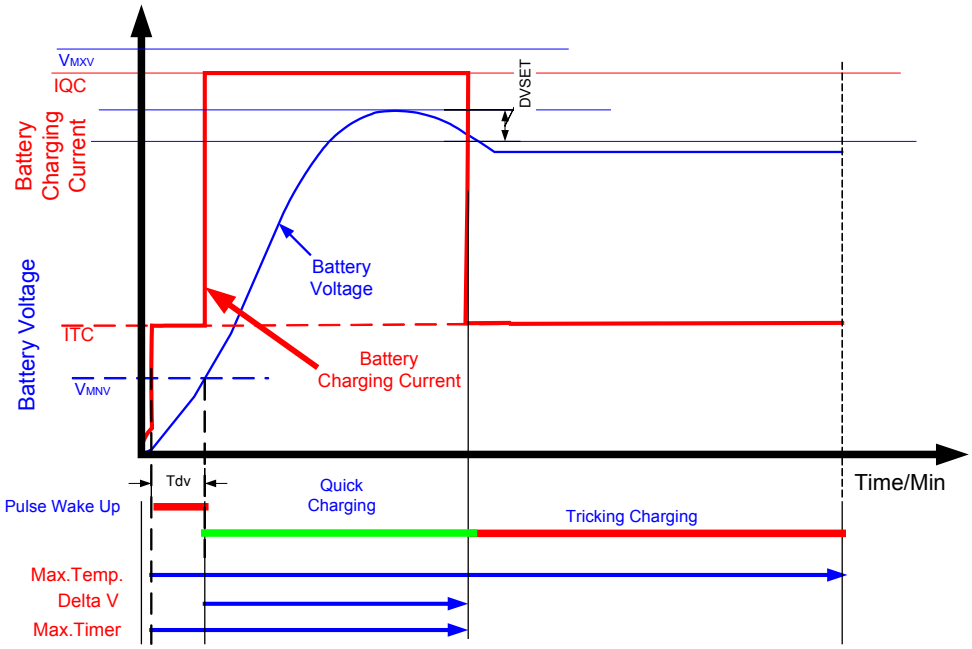


Fig. Charging Mode and Detection Methods.

11.2. Initialization

When the battery is power up, the system will detect the existing of the battery.

11.3. Idle Mode

When battery is not detected, the system will enter the idle mode and keep scanning the battery.

11.3. Pulse Wake Up Mode

When the battery voltage is detected and the V_{BATT} is lower than V_{MNV}, the battery is charged by the pulse wake up with current, ITC, within time, Tdv. The charging during Tdv, is considered as Pulse Wake Up Mode.

After Pulse Wake Up Mode, suppose the battery voltage is still under V_{MNV}, the system will enter the abnormal mode. Otherwise, the system will enter the quick charging mode.

11.3.1. Quick charging

If the battery voltage is between V_{MNV} and V_{MXV}, the quick charging will start. The quick charging will be terminated by either the preset limit of the -△V (-DVSET), max charging time or the battery temperature> MAXTEMP.

11.3.2. Trickling Charging

When the -△V (-DVSET) is detected, the system will enter the trickling charging mode with charging current, ITC, so as to maintain the batteries energy capacity.

11.4. Abnormal Mode

The LED will keep Flash, when the system enters this mode.

NOTE : MAX. TEMP IS MONITORING IN THE WHOLE TRICKLING/QUICK CHARGING AND DISCHARGING MODE. DELTA V DETECTION IS VALID AFTER 6 MINUTES OF THE BATTERY IS INSERTED

12. Functions and Pin Description

12.1. Power Supply

Name	Pin No	I/O	Description
Reset and Power			
VDD	8	-	Supply
VSS	4	-	Ground

The voltage supply of the system is from the external voltage regulator, IC HT7130 with following connection.

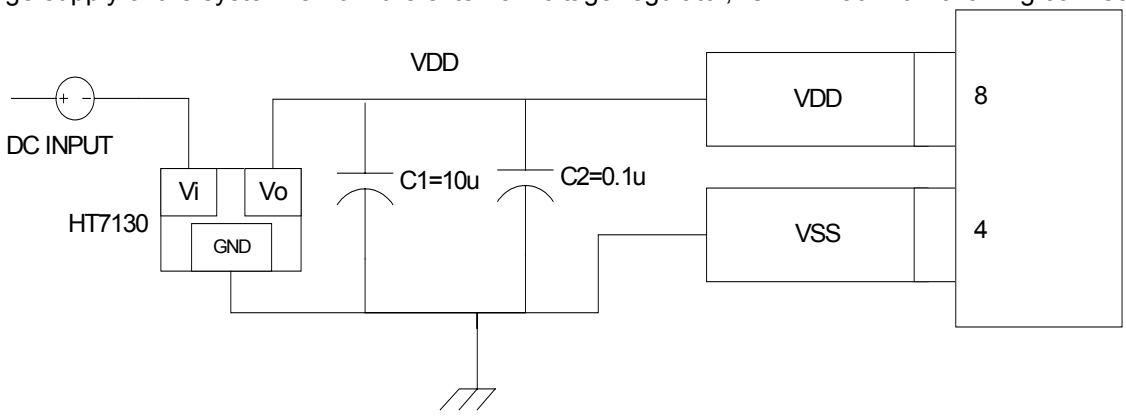


Fig. Power Supply circuit with voltage regulator IC HT7130

12.2. Charging Control

Name	Pin No	I/O	Description
GC3001A-10 Charging Control			
CHGN	5	OUT	Charging current control pin and PWM output pin (HIGH=open the charging FET, LOW=close the charging FET)

CHGN output PWM wave during the charging. CHGN goes LOW when in discharging mode or in abnormal mode. The charging circuit unit is controlled by CHGN

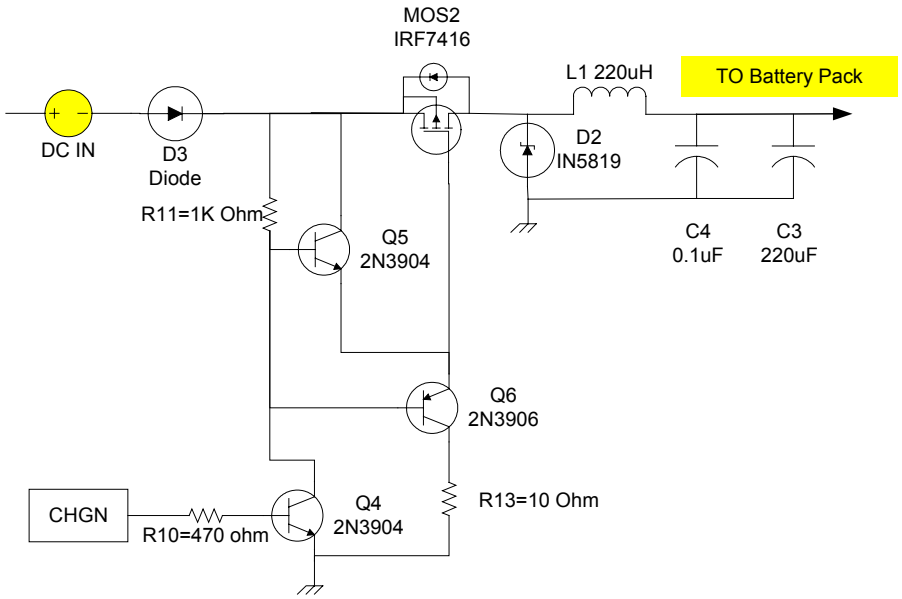


Fig. High Speed PWM charging control circuit.

12.3. LED Display Indication

Name	Pin No	I/O	Description
LED Display			
LEDN	6	OUT	Switch control for LED.

LEDN is high-level during the quick charging or the pulse wake up mode (GREEN is ON). After the charging finishes, LEDN is low-level (RED is ON). When an abnormal battery voltage is detected before the charging finishes, a pulse of 1Hz is output (LED ORGANGE Color flashes).

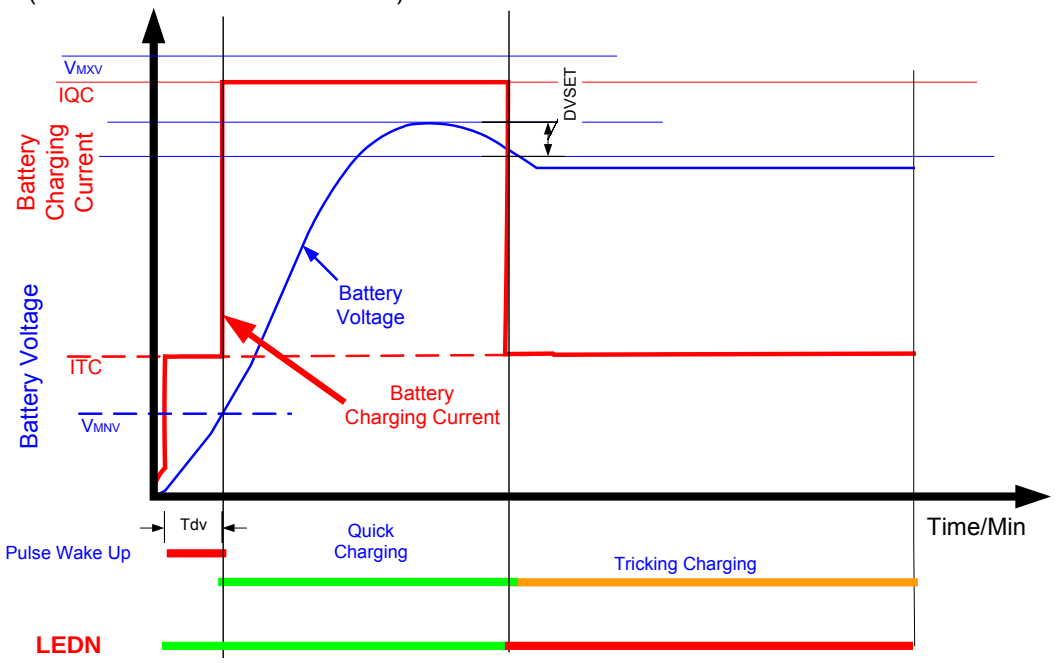


Fig. The LEDN controls the LED output status

LED Output	LED Status		Description
LOW	RED=ON	GREEN=OFF	Charging finishes，discharging or no battery
HIGH	RED=OFF	GREEN=ON	Charging (battery wake up or Quick charging mode)
PULSE (1Hz)	RED=FLASHING	GREEN=FLASHING	Low voltage, the battery voltage is abnormal in charging mode

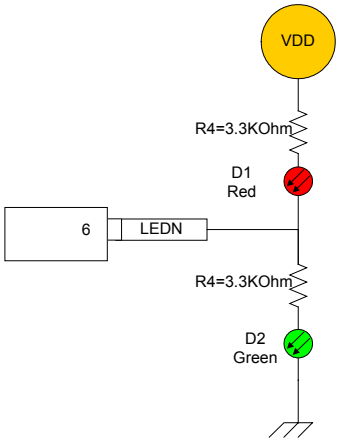


Fig. LEDN circuit control.

12.4. Thermal Sensing

Name	Pin No	I/O	Description
GC3001A-10 Thermal Sensing			
TEMP	7	IN	Temperature Sensing input from the battery cell.

When the battery temperature is higher than the MAXTEMP, the charging or discharging will be stopped. If the battery temperature drops to under RLSTEMP, the charging or discharging will start in normal mode. The battery temperature is detected by the thermal resistor which is closely to the battery pack. NTC resistor, RT1 is used in 104F－AT-2.

In selecting NTC resistor, it must guarantee the following conditions:

Temperature	VRT1
0 ° C	0.78VDD
50 ° C	0.25 VDD
55 ° C	0.20 VDD

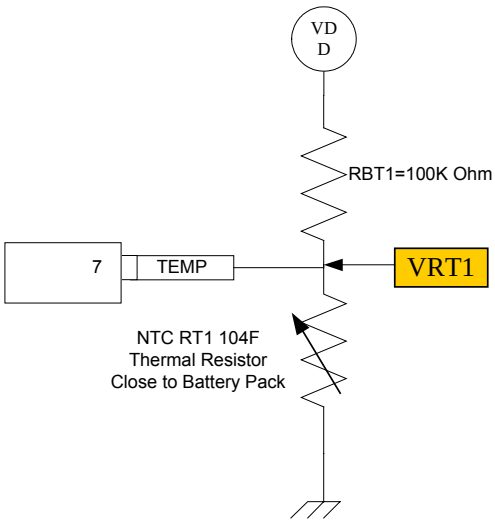


Fig. Thermal Sensing circuit.

12.5. Discharging Control

Name	Pin No	I/O	Description
GC3001A-10 Charging Time Setting			
DISC	1	OUT	Discharging Current Control

When the battery voltage is lower than the shut down voltage for 2S, the battery temperature is higher than the MAXTEMP or the discharging current is higher than 3.5A for 800ms, DISC Pin out HIGH Voltage to cutoff the discharging circuit.

12.6. Battery Voltage and Current Detection

Name	Pin No	I/O	Description
GC3001A-10 Battery Voltage and Current Detection			
BATT	2	IN	Battery Cell voltage detection pin.
CSEN	3	IN	Battery Cell current detection pin.

In the current sensing, the charging current is detected by the sensing resistor, RSNS. By detecting the voltage difference, the charging current value is calculated by V_{CSEN}/RSNS.

Quick Charging Current = 150mV / RSNS ,Trickle charging current =7mV / RSNS.

CSEN Voltage	RSNS Voltage Difference (Unit : mV)		
	Min.	Typical	Max.
Quick charging		150	
Trickle charging		7	

In the application circuit, RSNS is 0.1Ohm, charging current is shown as follows.

Charging current	Detect Current (Unit: mA)		
	Min.	Typical	Max.
Quick charging		1500	
Trickle charging		70	

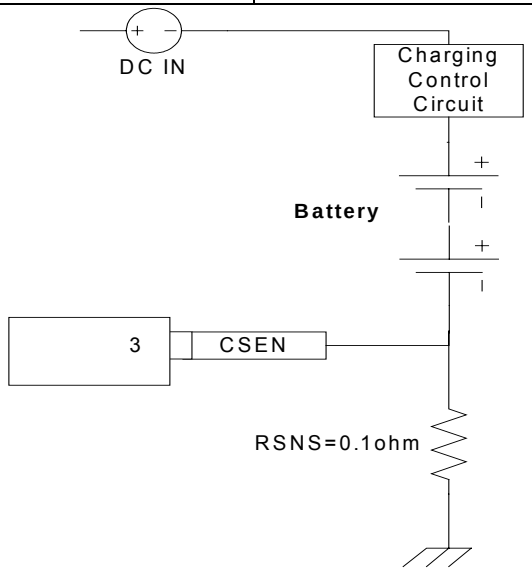


Fig. Current Sensing Circuit Application.

The voltage applied to the BATT input, used for battery voltage detection, is a voltage potential, derived by a voltage divider resistor network (The RB2 should be bigger than 100k ohm) or other means, which represents the voltage of a single battery cell during charging.

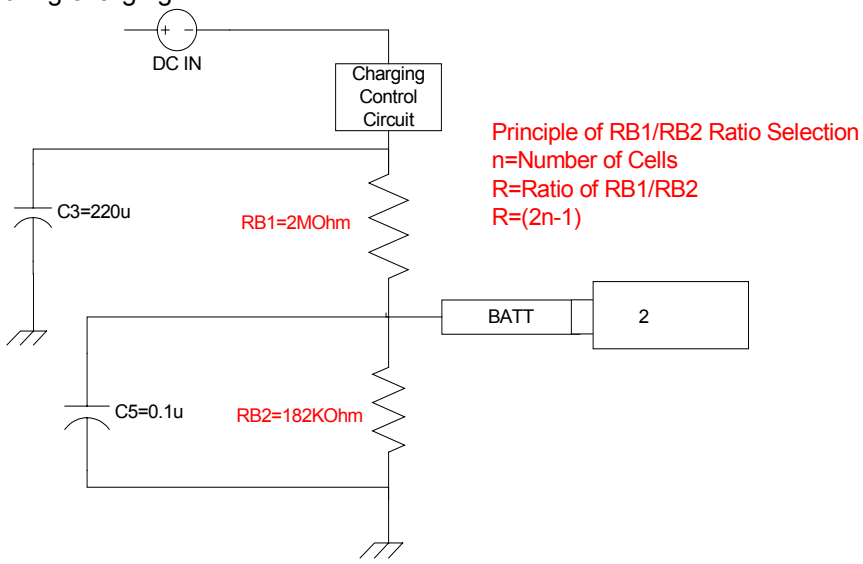
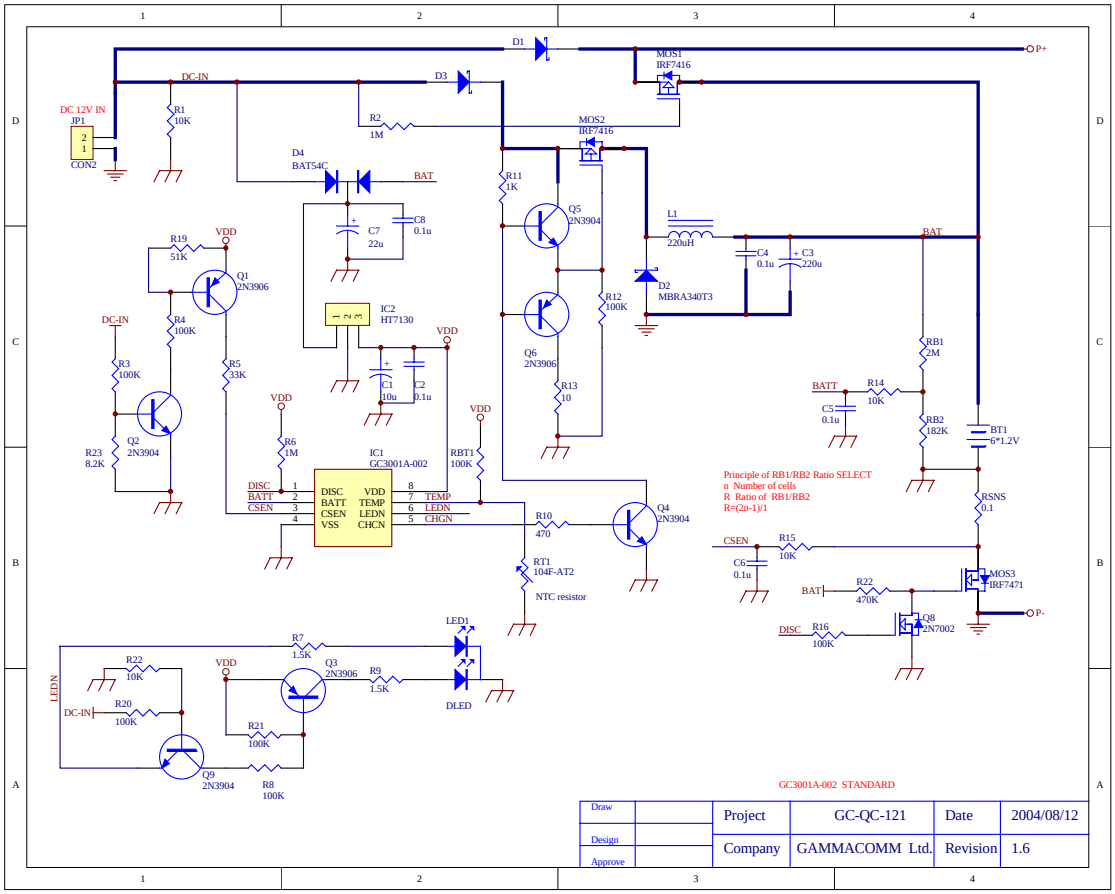


Fig. Battery Voltage Detection Circuit by a voltage divider resistor network.

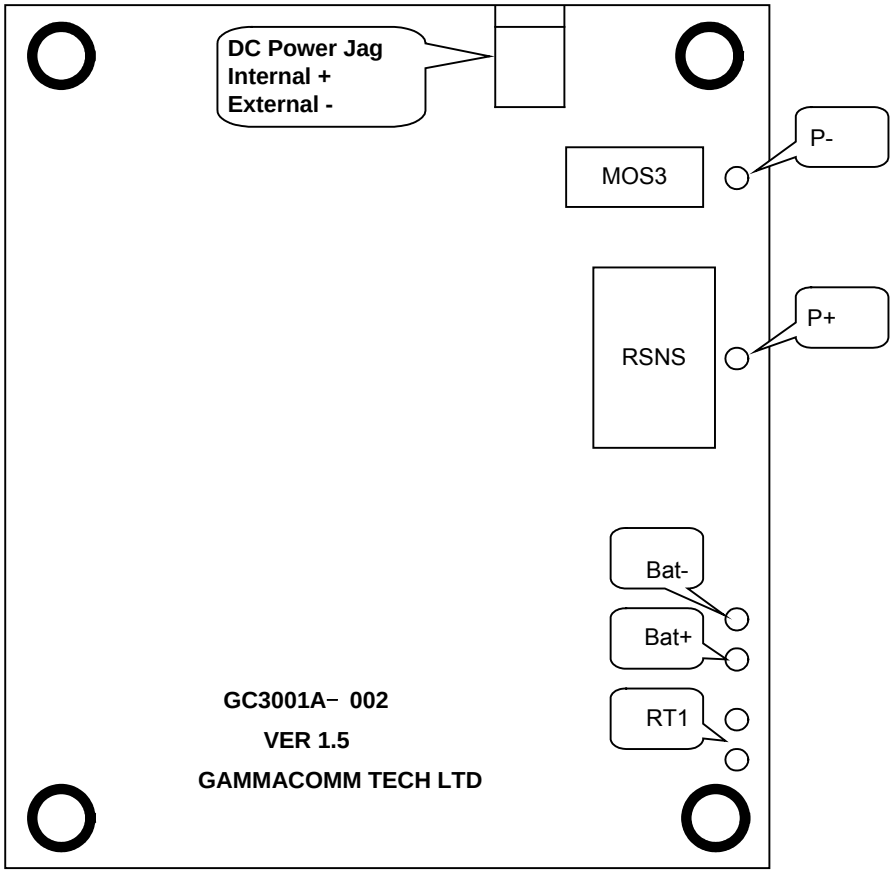
13. Application Circuit



14. GC3001A-10 DEMO 说明

一、版图示意与说明

A、PCB 版图示意



B、主要点说明

1、 bat＋和 bat－分别接串联电池组的正极和负极。

2、 RT1 为热敏电阻接入端，若没有本热敏电阻，则表明没有电池存在。本热敏电阻要与电池包装在一起，以便检测充电和放电时的温度。

3、 p+和 p－为电池的放电负载回路。在充电时不要接放电负载。

4、 充电时先加入电池组，再接入 dc power，注意 dc power 的极性。

二、功能说明：

A、 快速充电电流为：1500ma。

B、涓流充电电流为： 75ma。

C、最大充电时间为： 3.5 hours。

D、 最大放电电流为： 3500ma。

E、放电截止电压为： 1.0V/单节电池。

F、放电电流过流保护时间：800ms，释放时间约为 2000ms。

G、 充电电流过流保护时间为：100ms，释放时间约为 2000ms。

H、 温度保护 55 度，由 55 度恢复到 50 度以下时，解除温度保护。

I、 脉冲唤醒充电方式：当电池电压小于 0.3V,采用脉冲充电方式，充电 6 分钟后，若电池电压仍小于 0.3V,则认为电池出现错误,LED 1HZ 闪烁。

J、 GC3001A-10 放电空载功耗为：200UA 左右。

K、充电结束条件：最大充电时间到、最高温度、Delta－V.

三、指示灯：

A、 在电池充电的过程中，充电指示绿灯亮，红灯灭。

B、若电池加入 6 分钟后，电池电压仍然小于 0.3V/单节电池，则红灯和绿灯以 1hz 进行闪烁。

C、充电结束后或没有电池时，绿灯灭，红灯亮。

D、 在放电时，红灯和绿灯都不亮。

四、分压电阻与串接电池数目的关系：

为了降低系统的功耗，推荐 RB2 应该大于 100k ohm。

串联电池数量	RB1/RB2	RB1 电阻（1%精度）	RB2 电阻（1%精度）
1	1：1	360k ohm	360k ohm
2	3：1	360k ohm	120k ohm
3	5：1	910k ohm	182k ohm
4	7：1	910k ohm	130k ohm
5	9：1	820k ohm	91k ohm
6	11：1	2M ohm	182k ohm
7	13：1	4.7M ohm	360k ohm
8	15：1	2.2M ohm	147k ohm

五、NTC—100K 电阻要求

温度	Temp 端的电压
0°c	0.78vdd
50°c	0.25vdd
55°c	0.20vdd

六、元件规格要求

Part Type	Designator	Footprint
0.1	RSNS	axial0.5
0.1u	C6	0603
0.1u	C5	0603
0.1u	C2	0603
0.1u	C4	0603
0.1u	C8	0603
1K	R9	0603
1K	R11	0603
1K	R1	0805
1K	R7	0603
1M	R2	0603
1M	R6	0603
2N3904	Q4	SOT-23
2N3904	Q9	SOT-23
2N3904	Q2	SOT-23
2N3904	Q8	SOT-23
2N3904	Q5	SOT-23
2N3906	Q3	SOT-23
2N3906	Q6	SOT-23
2N3906	Q1	SOT-23
6*1.2V	BT1	SIP2
10	R13	0603
10K	R24	0603
8.2K	R23	0603
100K	RBT1	0603
10K	R15	0603
10K	R14	0603
10u/16V	C1	RB.1/.2
22u/16V	C7	RB.1/.2
33K	R5	0603
182K	RB2	0603
51K	R19	0603
100K	R21	0603
100K	R20	0603
100K	R8	0603
100K	R3	0603
100K	R12	0603
470K	R22	0603
100K	R4	0603
104F-AT2	RT1	
220u/25V	C3	RB.1/.2
220uH	L1	
470	R10	0603
470K	R16	0603
2M	RB1	0603
BAT54C	D4	SOT-23
CON2	JP1	DCPOWER
MBRA340T3(3A,40V)	D1	
MBRA340T3(3A,40V)	D3	
DLED	LED1	DLED
GC3001A-10	IC1	SO-8
HT7130(3.0V)	IC2	TO-92A
IRF7416	MOS1	SO-8
IRF7416	MOS2	SO-8
IRF7471	MOS3	SO-8
MBRA340T3(3A,40V)	D2	1812

Documents Amended History

Date	Details	By	File Name
Aug. 12, 2004.	Modify the application circuit and the R23 value from 10k ohm to 8.2k ohm	**CF SO**	**GC3001A-10-12**

Contact

GammaComm **Tech. Ltd.**
G1 & G7, 5/F., Phase 2, Yip Fat Industrial Building, 73-75 Hoi Yuen Road, Kwun Tong, Kowloon, Hongkong.
Telephone : (852)-23458116 Fax : (852)-29061003
Web: www.gammacommtech.com Email :info@gammacommtech.com

深圳开发部：中国深圳市人民南路 3002 号国贸大厦 36 楼东座
电话：(86)-755-82213968 传真：(86)-755-82212899
Email : szrd@gammacommtech.com 邮编：518014

济南开发部：中国山东省济南市花园路 4 号 608,610 室.
电话：(86)-531-8062467 传真：(86)-531-8062467
Email : jnrd@gammacommtech.com 邮编：250100