

To all our customers

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**Regarding the change of names mentioned in the document, such as Mitsubishi Electric and Mitsubishi XX, to Renesas Technology Corp.**

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The semiconductor operations of Hitachi and Mitsubishi Electric were transferred to Renesas Technology Corporation on April 1st 2003. These operations include microcomputer, logic, analog and discrete devices, and memory chips other than DRAMs (flash memory, SRAMs etc.) Accordingly, although Mitsubishi Electric, Mitsubishi Electric Corporation, Mitsubishi Semiconductors, and other Mitsubishi brand names are mentioned in the document, these names have in fact all been changed to Renesas Technology Corp. Thank you for your understanding. Except for our corporate trademark, logo and corporate statement, no changes whatsoever have been made to the contents of the document, and these changes do not constitute any alteration to the contents of the document itself.

Note : Mitsubishi Electric will continue the business operations of high frequency & optical devices and power devices.

Renesas Technology Corp.  
Customer Support Dept.  
April 1, 2003

# M62253BGP

Charge Control IC for Li-Ion Batteries

## General Description

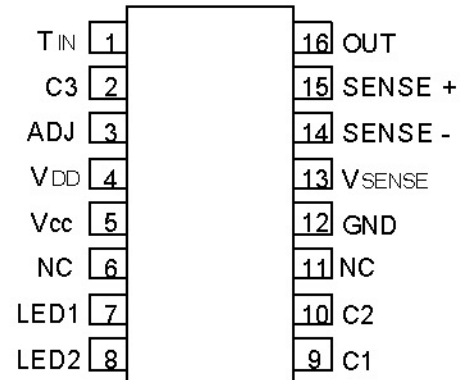
M62253AGP is a charge control IC dedicated to Lithium-ion batteries. Constant current/voltage charging suitable for Li-Ion batteries are available by utilizing on-chip current/voltage control circuits. It also includes charge inhibit function for over discharged battery and charge control function detecting battery temperature, allowing for easy configuration of Li-ion battery charging circuit.

Specs. are subject to change without notice.

## Features

- \*Available for 4.2V battery
- \*High precision reference voltage  $4.2V \pm 30mV$
- \*Constant current and constant voltage charging
- \*Charge completion detection voltage settable by external resistors
- \*Charging inhibit and protection function for over discharged battery
- \*Charging inhibit and protection function for both high and low temperature battery
- \*Dual LED indications monitoring charging status
- \*Recharging function (LED2 remains turned on after recharging)
- \*Delay circuit to prevent erroneous detection

## Pin Configuration (Top view)

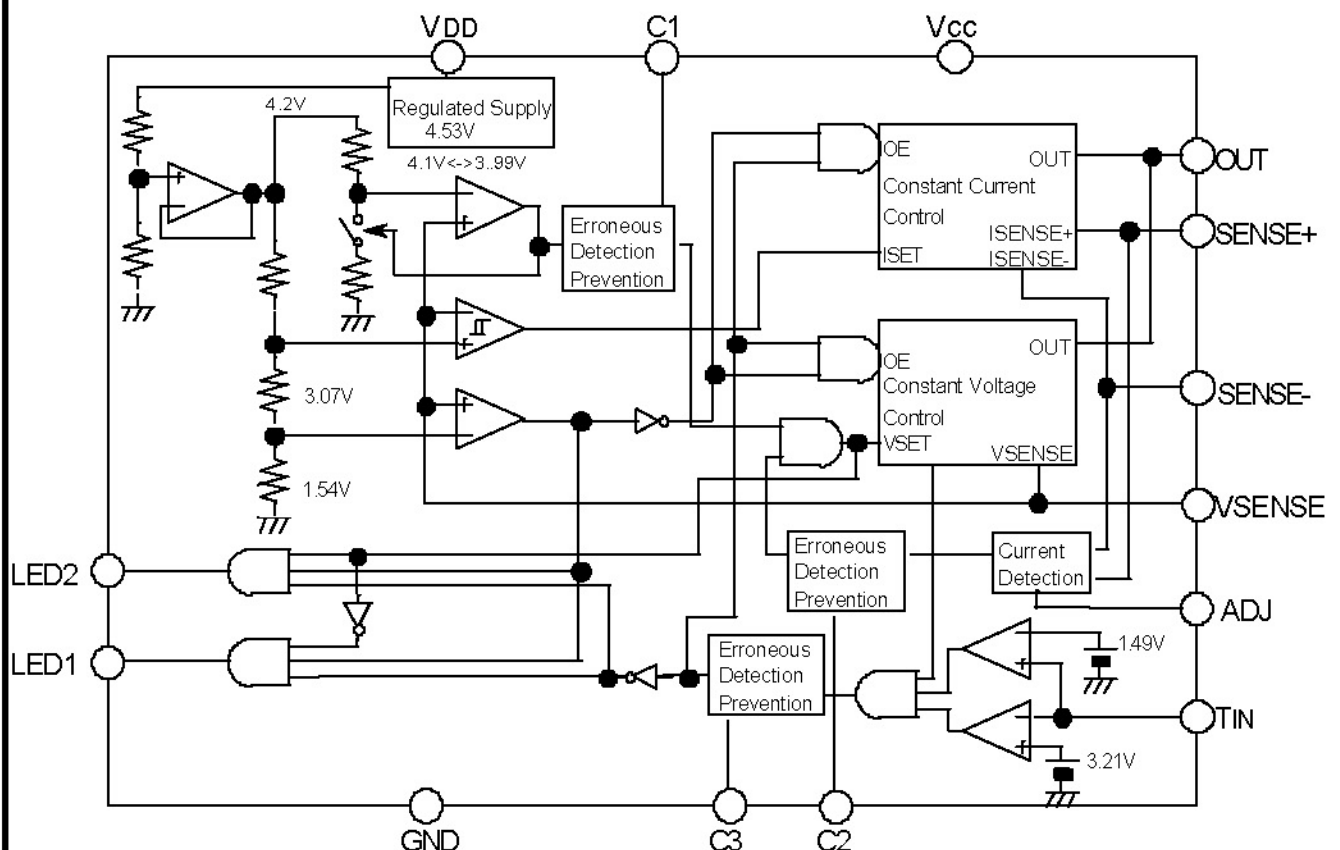


Package Outline : 16P2E

## Applications

Li-ion Battery Charger for hand-held instruments such as cellular phones and notebook computers

## Block Diagram



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## 1. Pin Description

Pin No.	Symbol	Function
1	TIN	Temperature sensing input(also battery connecting detection input)
2	C3	Delay time setting for temperature sensing (Tpd = 49ms @ 0.1uF)
3	ADJ	Charge completion detection voltage setting (one fifth of ADJ terminal voltage is equal to charge completion detection voltage.)
4	VDD	Reference voltage output VDD = 4.53V
5	Vcc	Power supply
7, 8	LED1,2	LED driver outputs (opened collector) LED1 for during charge, LED2 for completion of charge
9	C1	Delay time setting for voltage sensing (Tpd = 1.06s @ 2.2uF)
10	C2	Delay time setting for current sensing (Tpd = 1.15s @ 2.2uF)
12	GND	Ground
13	VSENSE	Battery output voltage sensing input
14	SENSE-	Charging current sensing input (connect to lower voltage node)
15	SENSE+	Charging current sensing input (connect to higher voltage node)
16	OUT	Charger output (opened collector)

## 2. Absolute Maximum Ratings (Ta=25deg, unless otherwise noted)

Symbol	Parameter	Condition	Ratings	Unit
Vcc	Supply voltage		16	V
IOUT	Output current		30	mA
VSENSE	Applying voltage to SENSE pin		Vcc	V
VTIN	Applying voltage to TIN pin		Vcc	V
Pd	Power dissipation	Ta = 25deg	300	mW
Ktheta	Thermal derating	Ta > 25deg	3.0	mW/deg
Topr	Operating temperature		-20 to +85	deg
Tstg	Storage temperature		-40 to +125	deg

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## 3. Electrical characteristics

(V<sub>CC</sub>=12.0V, V<sub>SENSE</sub>=3.6V, T<sub>a</sub>=25deg, unless otherwise noted)

Blocks	Symbol	Parameter	Condition	Limits			Unit
				Min.	Typ.	Max.	
All device	V <sub>CC</sub>	Supply voltage		5.0		15.0	V
	I <sub>CC</sub>	Current consumption	LED is off		7		mA
V <sub>DD</sub>	V <sub>DD</sub>	VDD output voltage		4.30	4.53	4.76	V
Voltage Detection	V <sub>THchg</sub>	Charge start voltage		1.44	1.54	1.64	V
	V <sub>THqchg</sub>	Quick charge start voltage		2.97	3.07	3.17	V
	V <sub>o chg</sub>	Output voltage setting	during a charge	4.17	4.20	4.23	V
	V <sub>THrchg</sub>	Recharge start voltage	at charge completion	3.89	3.99	4.09	V
	I <sub>inVSENSE</sub>	VSENSE terminal input current		-2.0	—	2.0	μA
Current Detection	I <sub>SET1</sub>	Charging current setting voltage 1	1.56V < battery V. < 3.07V	15	26	37	mV
	I <sub>SET2</sub>	Charging current setting voltage 2	5.0V < V <sub>CC</sub> < 8.0V	232	256	280	mV
			3.07V < battery V. < 4.2V				
			8.0V < V <sub>CC</sub> < 15.0V	237	256	275	mV
	I <sub>THchgoff</sub>	Charge completion detecting voltage	V <sub>adj</sub> =0.13V	15	26	37	mV
	I <sub>THchgoff</sub>	Charge completion detecting voltage	V <sub>adj</sub> =0.5V	75	100	125	mV
	I <sub>inSENSE+</sub>	Input current into SENSE+ pin	during a charge	—	60	85	μA
	I <sub>inSENSE-</sub>	Input current into SENSE- pin	during a charge	—	60	85	μA
LED	V <sub>OHLED1</sub>	LED1 pin saturation voltage	I <sub>LED1</sub> =10mA	—	—	0.4	V
	V <sub>OHLED2</sub>	LED2 pin saturation voltage	I <sub>LED2</sub> =10mA	—	—	0.4	V
T <sub>IN</sub>	V <sub>THINTH1</sub>	T <sub>IN</sub> pin upper threshold voltage 1	V <sub>DD</sub> =4.53V	3.11	3.21	3.31	V
	V <sub>THINTL1</sub>	T <sub>IN</sub> pin lower threshold voltage 1		1.39	1.49	1.59	V
	V <sub>THINTH2</sub>	T <sub>IN</sub> pin upper threshold voltage 2		3.13	3.23	3.33	V
	V <sub>THINTL2</sub>	T <sub>IN</sub> pin lower threshold voltage 2		1.49	1.59	1.69	V
	I <sub>inTIN</sub>	Input current into T <sub>IN</sub> pin		-1.0			μA
OUT	V <sub>OHOUT</sub>	Output pin saturation voltage	I <sub>OUT</sub> =20mA		1.0	2.0	V
	I <sub>LOUT</sub>	Output pin leak current	V <sub>OUT</sub> =15V			1.0	μA
C1	t <sub>dC1</sub>	Delay time for voltage detection	at recharge C1=2.2μF	0.76	1.06	1.36	s
C2	t <sub>dBDET1</sub>	Connect/disconnect detection time1	4.2V con. voltage output period C2 = 2.2μF	0.82	1.15	1.48	s
	t <sub>dIDET</sub>	Delay time for current detection	C2 = 2.2μF	0.82	1.15	1.48	s
	t <sub>dILED</sub>	Delay time for LED switch over	C2 = 2.2μF	1.56	2.21	2.86	s
	t <sub>dchg</sub>	Discharging time	C2=2.2μF (after current detection)	30	90		ms
C3	t <sub>dC3</sub>	Delay time for temperature detection	C3 = 0.1μF	34	49	64	ms

## 4. Functional Description

### (1) Detection of connection/disconnection of battery

Connection/disconnection of battery is detected via TIN pin. The detection is performed by external resistor and thermistor using the regulated 4.53V of VDD terminal.

When TIN terminal voltage is between 1.49V and 3.21V, battery is confirmed to be connected according to the internal setting.

When TIN terminal voltage is 1.49V or less, or 3.21V or more, charge is inhibited owing to possibilities of battery disconnection or unusual battery temperature.

#### Charging start conditions (when battery is confirmed to be connected)

Charging voltage is set to 4.2V when battery connection is confirmed.

1.15second ( $C2 = 2.2\mu\text{F}$ ) later, the voltage is changed to 1.46V to detect battery voltage will be (Voltage detection is not done until the voltage is changed to 1.46V.)

During 4.2V constant voltage output, the voltage drop by current detecting resistor is limited to 256mV.

When battery voltage is between 1.54V and 4.2V, constant current charge gets started.

In the case the voltage is 4.2V or more, 4.2V constant voltage charging starts to monitor charging current.

### (2) Constant current control block and current detection

Charging current is measured between SENSE+ and SENSE- terminals so that constant current control is performed.

Current sensing resistor voltage drop is set as follows:

When battery voltage is between 1.54V and 3.07V, voltage drop is set to 26mV.

When battery voltage is 3.07V or more, voltage drop is set to 256mV.

When charge current is detected and battery voltage is 4.1V or more, and the above voltage drop of less than one fifth of ADJ terminal voltage continues for 1.15sec( $C2 = 2.2\mu\text{F}$ ) during constant voltage charging, completion of charge is confirmed and then output changes to constant voltage of 1.46V. (Preventing function of erroneous detection works.)

### (3) Constant voltage control block

Battery voltage and output voltage is measured via VSENSE terminal.

When battery voltage rises up to 4.2V or more by constant current charging, 4.2V constant voltage control starts instead.

When the above voltage drop of less than one fifth of ADJ terminal voltage continues for 1.15sec( $C2 = 2.2\mu\text{F}$ ) during constant voltage charging, charge completion is confirmed and then output changes to constant voltage of 1.46V. (The preventing function of erroneous detection works.)



**(4) Voltage detection block**

When battery voltage monitored via the VSENSE terminal is 1.54V or less, charging is inhibited by confirming that battery is over discharged or shorted battery is connected.

When battery voltage is 1.54V or more, following two charging current values are to be set according to the battery outputs:

When battery voltage is between 1.54V and 3.07V, current measuring resistor voltage drop is set to 26mV. When battery voltage is 3.07V or more, above voltage drop is set to 256mV.

When battery voltage rises up to 4.2V during the constant current charging, constant voltage charging gets started.

When battery voltage is 3.99V or less for 1.06sec( $C1 = 2.2\mu F$ ) after charge completion, recharging will start. (Prevention function of erroneous detection works.)

**(5) Temperature detecting block**

Temperature detection is done through TIN terminal. Detecting battery temperature is accomplished by external resistor and thermistor using the regulated 4.53V of the VDD terminal.

When TIN voltage is between 1.49V and 3.21V, measured temperature is regarded as normal according to internal setting, then charging will start. When TIN voltage is 1.49V or less, or 3.21V or more, charging is inhibited due to the decision of the unusual battery temperature.

When TIN voltage goes down to 1.49V or less after charging starts, charging stops until TIN voltage rises up to 1.59V or more. (It has hysteresis corresponding to battery temperature range of 2.5deg.)

Temperature detection is completed after 49ms( $C3 = 0.1\mu F$ ) halt of detection voltage. Preventing function of erroneous detection works.)

**(6) Regulated power supply block**

Regulated 4.53V is provided at VDD terminal. Detecting battery temperature is done by this regulated voltage together with external resistor and thermistor.

**(7) Output block**

External PNP transistor should be connected to OUT terminal because of an opened collector output circuit configuration.

Maximum output current is 30mA, so charging can be done with charging current up to 30mA multiplied by hFE of external transistor.

**(8) LED driving block**

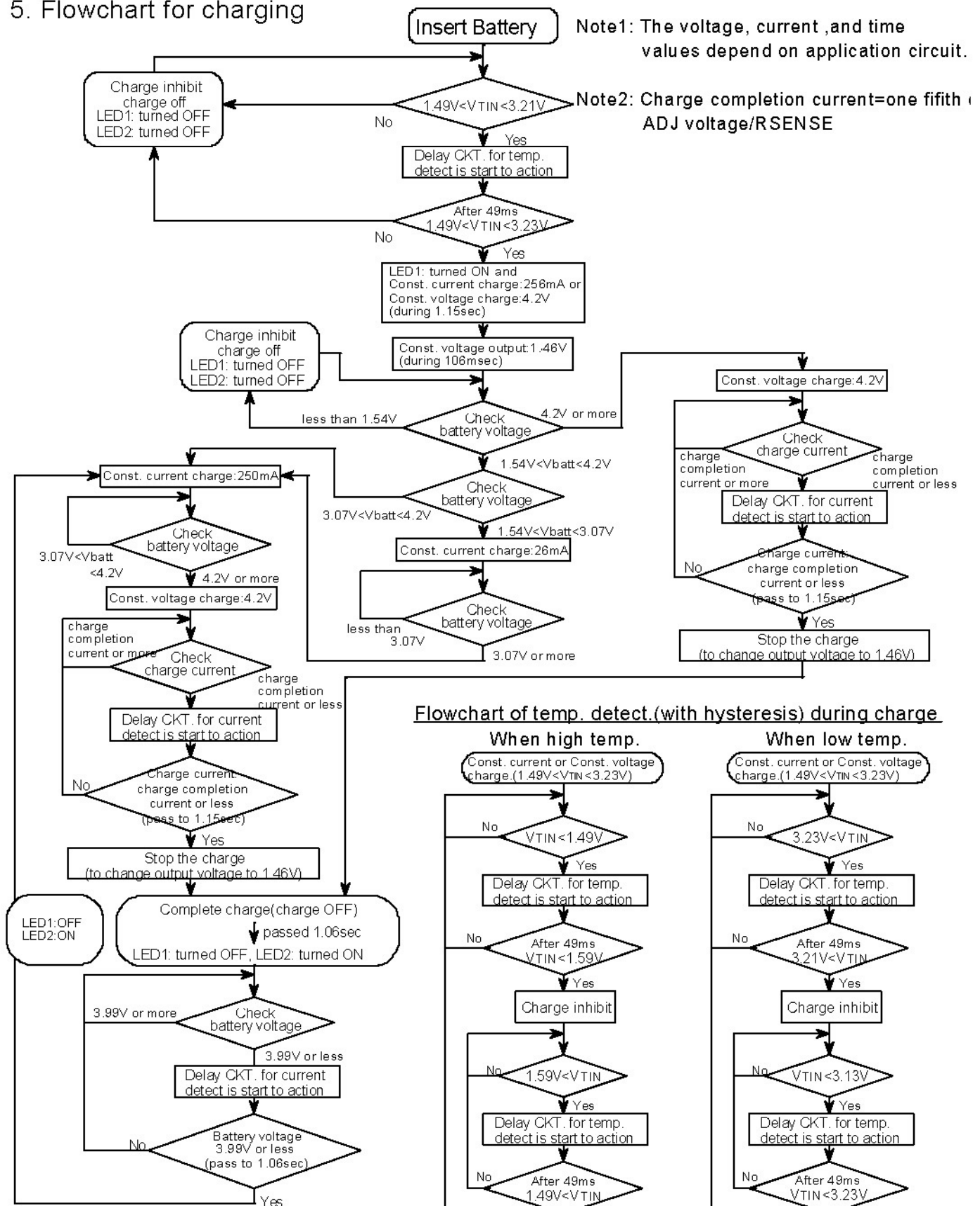
Output configuration of this block is opened collector by NPN Tr.

Charging states are indicated by using two LEDs. LED1 is on during charge, LED2 is on at the completion of charge, where "on" refers to turning on of LED, "off" turning off of LED.

LED indication changes from "charge" to "completion of charge" 2.21sec ( $C2 = 2.2\mu F$ ) after the completion is confirmed by monitoring the charging current.

Once charge completion is indicated(LED1=OFF, LED2=ON), LED1 continues to be OFF, and LED2 continues to be ON until non-connection of battery is confirmed at TIN terminal. Such is also the case with the period for recharging.

### 5. Flowchart for charging



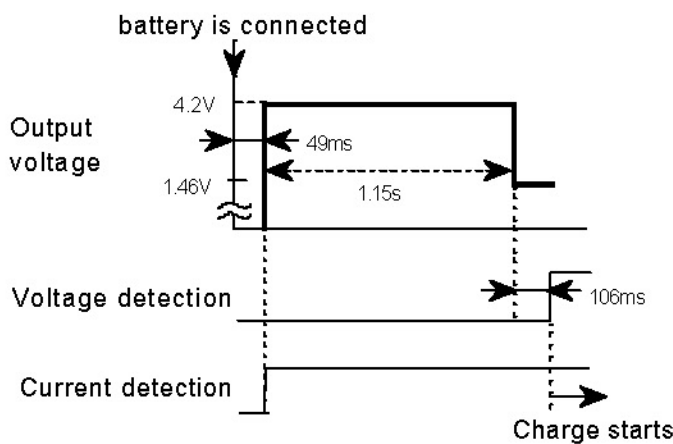
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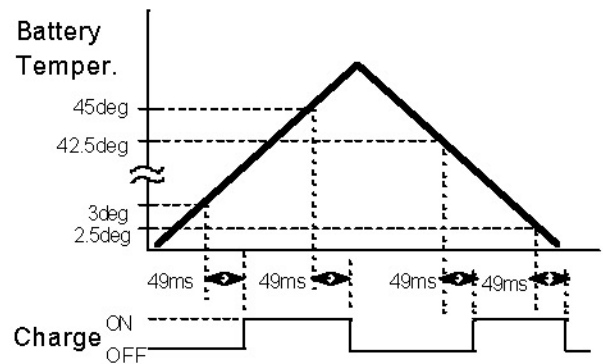
## 6. Functional Timing Diagram

(The component values are the same as those of the application circuits)

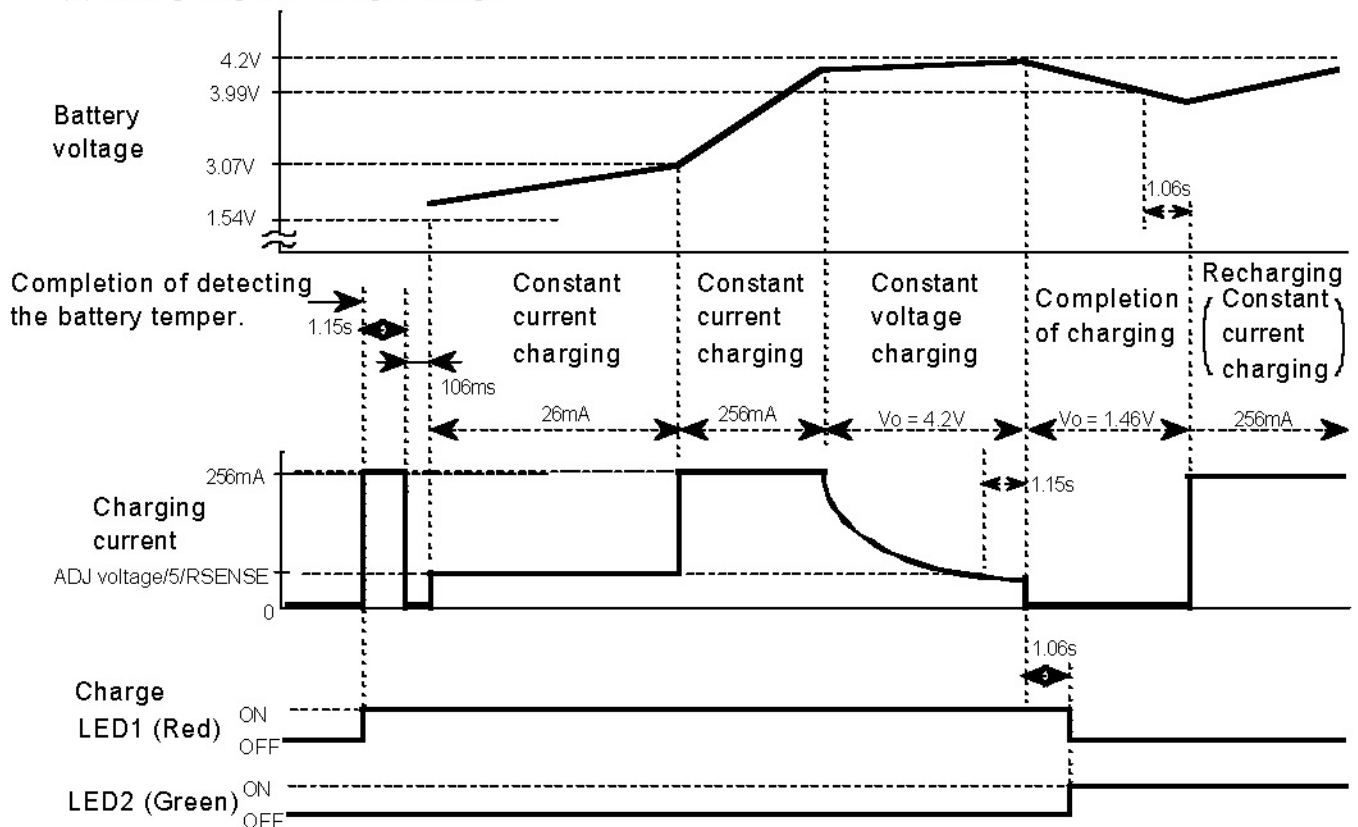
(1) Battery connecting/disconnecting detection timing



(2) Battery temperature detection timing



(3) Timing diagram during a charge





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## 7. The Application Circuit

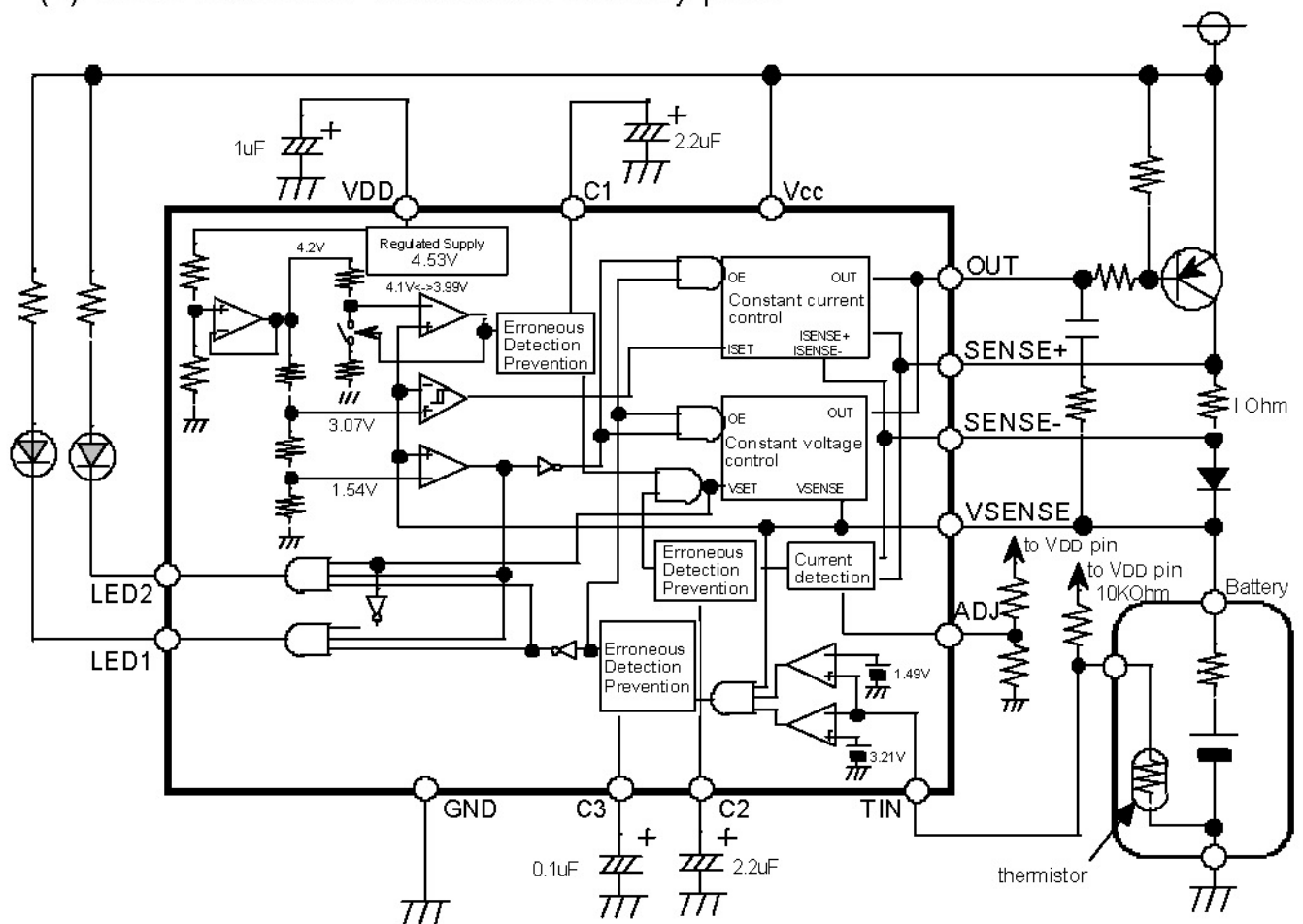
Note : The following thermistor is recommended.

Maker : ISHIZUKA DENSHI

Type :103HT

Characteristic :10kOhm at 25deg

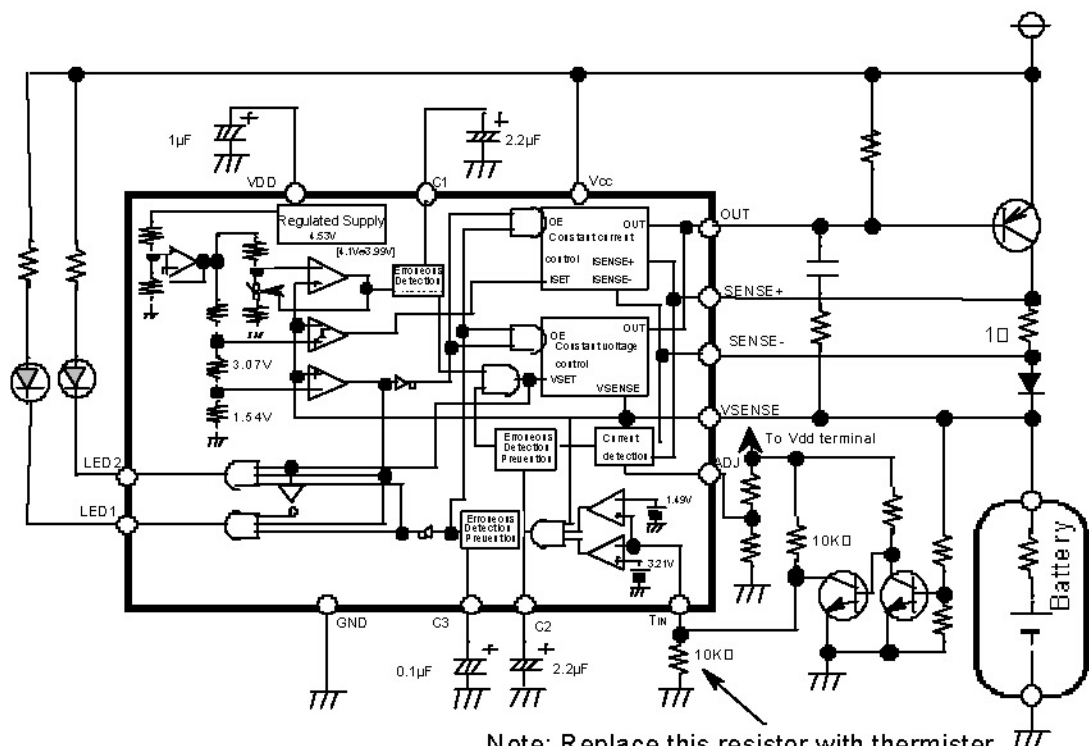
(1) When thermistor is located in battery pack



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- (1) When thermister is located in charger or thermister is not used  
(For your reference)



Note: Replace this resistor with thermister when thermister is located in charger.

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## 8. How to set quick charge current and charge completion detection current

### (1) How to set quick charge current (Iqchg)

Quick charge current (Iqchg) depends upon RSENSE.

Set the value of RSENSE by putting Iqchg required into the formula below.

$$RSENSE[ohm] = \text{charge current setting voltage2} / Iqchg[mA] = 256mA / Iqchg[mA]$$

,where pre-charge current is given by:

$$\text{Pre-charge current} = \text{charge current setting voltage1} / RSENSE = 26mV / RSENSE$$

### (2) How to set charge completion detection current(Icomp)

Charge completion detection current(Icomp) depends upon RSENSE and ADJ terminal voltage(Vadj).

Set ADJ terminal voltage by putting charge completion detection current required and RSENSE given by (1) into the formula below.

$$Vadj[V] = 5 \times RSENSE[ohm] \times Icomp[A], \text{ where the constant 5 is internally fixed.}$$

\* Refer to the chart below for setting RSENSE and ADJ terminal voltage.

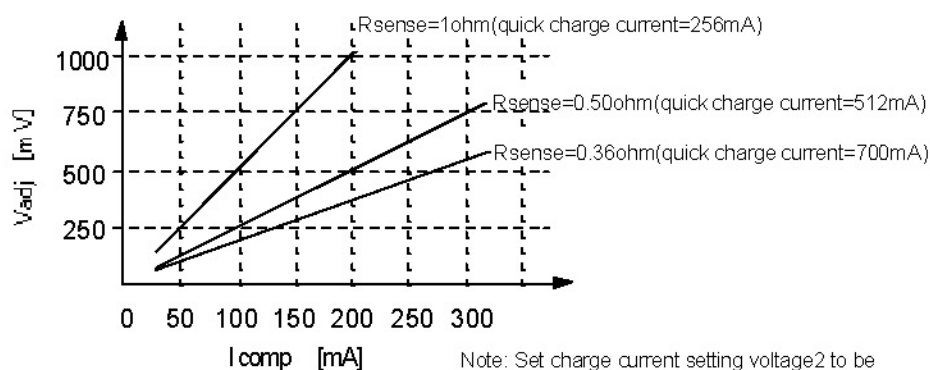
(Chart below shows the relationship between ADJ terminal voltage(Vadj) and charge completion detection current(Icomp).

ADJterm. volt. setting

Quick charge	256mA	450mA		512mA		700mA	
Rsense	1ohm	0.56ohm		0.50ohm		0.36ohm	
Charge comp. current Icomp	26mA	100mA	130mA	100mA	130mA	100mA	130mA
ADJ term. voltage Vadj = 5 x Rs x Icomp	125mV	280mV	364mV	250mV	325mV	180mV	234mV

Several 10Kohm or around is recommended for the total resistor value R1 and R2 for ADJ.

How Icomp relates itself to Vadj



Note: Set charge current setting voltage2 to be greater than charge current setting voltage1.