

To all our customers

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

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

MITSUBISHI <STD-Linear ICs>
M62253AGP
 Charge Control IC for Li-Ion Batteries

General Description

The M62253AGP is a charge control IC dedicated to Lithium-Ion batteries.

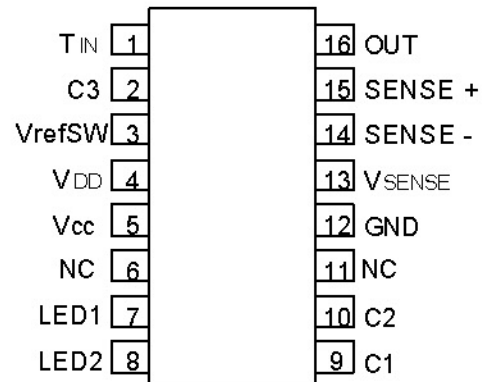
The constant current/voltage charging suitable for Li-Ion batteries are available by utilizing on-chip current/voltage control circuits.

It also includes the charge inhibit function for an over discharged battery and the charge control function detecting battery temperature, enabling easy configuration of a Li-Ion battery charging circuit.

Features

- *Available for 4.1V and 4.2V battery
- *Accurate reference voltage 4.2V ± 30mV
- *Constant current and voltage charging
- *Charging inhibit and protection function for a over discharged battery
- *Charging inhibit and protection function for both a high and low temperature battery
- *Recharging function
- *Dual LED indications monitoring charging states
- *Delay circuit to prevent the erroneous detection

Pin Configuration (Top view)

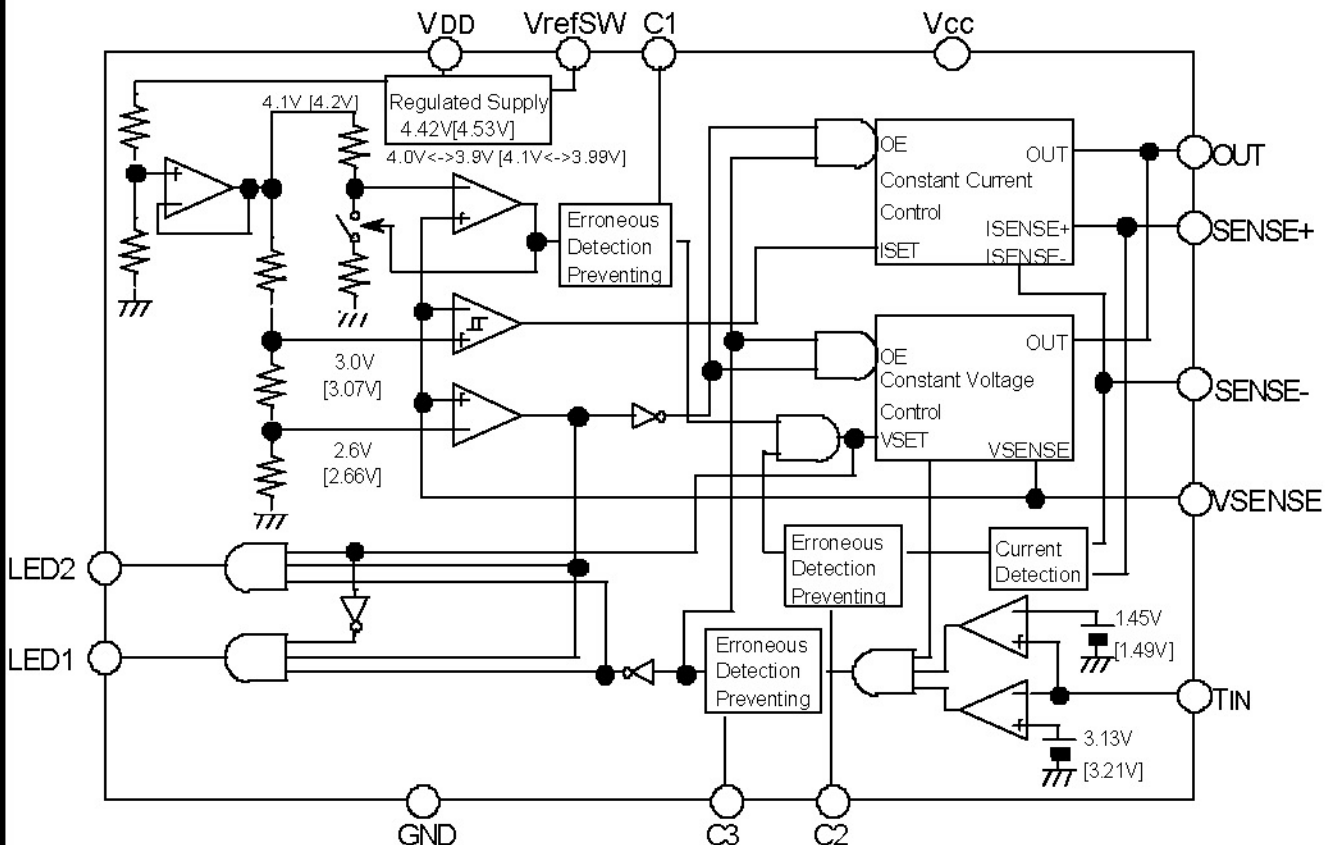


Package Outline : 16P2E

Applications

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

Block Diagram The voltage value within [] is for 4.2V type battery. And the voltage value without [] is for 4.1V type battery or common value for both (4.1V and 4.2V) battery.



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 | VrefSW | Setting 4.1V type battery or 4.2V type battery •For 4.1V type battery, VrefSW pin and VDD pin are shorted. •For 4.2V type battery, VrefSW pin is opened. |
| 4 | VDD | Reference voltage output •For 4.1V type battery <shorted VrefSW pin and VDD pin> : VDD = 4.42V. •For 4.2V type battery <when VrefSW pin is opened> : 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 debating | Ta > 25deg | 3.0 | mW/deg |
| Topr | Operating temperature | | -20 to +85 | deg |
| Tstg | Storage temperature | | -40 to +125 | deg |

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Charge Control IC for Li-Ion Batteries

3. Electrical Characteristics

3-1. For 4.1V type batte

(shorted Vref SW pin and VDD pin)

(Vcc=12.0V, VSENSE=3.6V, Ta=25deg, unless otherwise noted)

| Blocks | Symbol | Parameter | Condition | Limits | | | Unit |
|-------------------|-----------|--------------------------------------|--|--------|------|------|------|
| | | | | Min. | Typ. | Max. | |
| All device | Vcc | Supply voltage | | 5.0 | | 15.0 | V |
| | Icc | Current consumption | LED is off | | 7 | | mA |
| VDD | VDD | VDD output voltage | | 4.20 | 4.42 | 4.64 | V |
| Voltage Detection | VTHchg0n | Charge start voltage | | 2.5 | 2.6 | 2.7 | V |
| | VTHqchg0n | Quick charge start voltage | | 2.9 | 3.0 | 3.1 | V |
| | Vo chg1 | Output voltage setting 1 | during a charge | 4.07 | 4.10 | 4.13 | V |
| | Vo chg2 | Output voltage setting 2 | at charge completion | 2.45 | 2.55 | 2.65 | V |
| | VTHrch0n | Recharge start voltage | at charge completion | 3.8 | 3.9 | 4.0 | V |
| | IinVSENSE | VSENSE terminal input current | | -2.0 | — | 2.0 | uA |
| Current Detection | ISET1 | Charging current setting voltage 1 | 2.6V<battery V.<3.0V | 14 | 25 | 36 | mV |
| | ISET2 | Charging current setting voltage 2 | 5.0V<Vcc<8.0V 3.0V<battery V.<4.1V | 227 | 250 | 273 | mV |
| | | | 8.0V<Vcc<15.0V 3.0V<battery V.<4.1V | 232 | 250 | 268 | mV |
| | ITHchgoff | Charge completion detecting voltage | 4.0V<battery Voltage | 14 | 25 | 36 | mV |
| | IINSENSE+ | Input current into SENSE+ pin | during a charge | — | 60 | 85 | uA |
| | IINSENSE- | Input current into SENSE- pin | during a charge | — | 60 | 85 | uA |
| LED | VOHLED1 | LED1 pin saturation voltage | ILED1=10mA | — | — | 0.4 | V |
| | VOHLED2 | LED2 pin saturation voltage | ILED2=10mA | — | — | 0.4 | V |
| TIN | VTHINTH1 | TIN pin upper threshold voltage 1 | VDD=4.42V | 3.03 | 3.13 | 3.23 | V |
| | VTHINTL1 | TIN pin lower threshold voltage 1 | | 1.35 | 1.45 | 1.55 | V |
| | VTHINTH2 | TIN pin upper threshold voltage 2 | | 3.06 | 3.16 | 3.26 | V |
| | VTHINTL2 | TIN pin lower threshold voltage 2 | | 1.45 | 1.55 | 1.65 | V |
| | Iin TIN | Input current into TIN pin | | | -1.0 | | |
| OUT | VOHOUT | Output pin saturation voltage | IOUT=20mA | | 1.0 | 2.0 | V |
| | ILOUT | Output pin leak current | VOUT=15V | | | 1.0 | uA |
| C1 | td C1 | Delay time for voltage detection | at recharge C1=2.2uF | 0.76 | 1.06 | 1.36 | s |
| C2 | tdBDET1 | Connect/disconnect detection time1 | 4.1V con. voltage output period C2 = 2.2uF | 0.82 | 1.15 | 1.48 | s |
| | tdBDET2 | Connect/disconnect detection time2 | 2.55V con. voltage output period C2 = 2.2uF | 76 | 106 | 136 | ms |
| | tdIDET | Delay time for current detection | C2 = 2.2uF | 0.82 | 1.15 | 1.48 | s |
| | tdILED | Delay time for LED switch over | C2 = 2.2uF | 1.56 | 2.21 | 2.86 | s |
| | td chg | Discharging time | C2=2.2uF (after current detection) | 30 | 90 | — | ms |
| C3 | td C3 | Delay time for temperature detection | C3 = 0.1uF | 34 | 49 | 64 | ms |

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Charge Control IC for Li-Ion Batteries

3-2. For 4.2V type batte

(V_{CC}=12.0V, V_{SENSE}=3.6V, T_a=25deg, unless otherwise noted)

| Blocks | Symbol | Parameter | Condition | Limits | | | Unit |
|-------------------|------------------------------------|---|--|--------|------|------|------|
| | | | | Min. | Typ. | Max. | |
| All device | V _{CC} | Supply voltage | | 5.0 | | 15.0 | V |
| | I _{CC} | Current consumption | LED is off | | 7 | | mA |
| V _{DD} | V _{DD} | V _{DD} output voltage | | 4.30 | 4.53 | 4.76 | V |
| Voltage Detection | V _{THchg} | Charge start voltage | | 2.56 | 2.66 | 2.76 | V |
| | V _{THqchg} | Quick charge start voltage | | 2.97 | 3.07 | 3.17 | V |
| | V _o chg1 | Output voltage setting 1 | during a charge | 4.17 | 4.20 | 4.23 | V |
| | V _o chg2 | Output voltage setting 2 | at charge completion | 2.51 | 2.61 | 2.71 | V |
| | V _{THrchg} | Recharge start voltage | at charge completion | 3.89 | 3.99 | 4.09 | V |
| | I _{in} V _{SENSE} | V _{SENSE} terminal input current | | -2.0 | — | 2.0 | μA |
| Current Detection | I _{SET1} | Charging current setting voltage 1 | 2.66V<battery V.<3.07V | 15 | 26 | 37 | mV |
| | I _{SET2} | Charging current setting voltage 2 | 5.0V<V _{CC} <8.0V 3.07V<battery V.<4.2V | 232 | 256 | 280 | mV |
| | | | 8.0V<V _{CC} <15.0V 3.07V<battery V.<4.2V | 237 | 256 | 275 | mV |
| | I _{THchg} off | Charge completion detecting voltage | 4.1V<battery Voltage | 15 | 26 | 37 | mV |
| | I _{in} SENSE+ | Input current into SENSE+ pin | during a charge | — | 60 | 85 | μA |
| | I _{in} SENSE- | Input current into SENSE- pin | during a charge | — | 60 | 85 | μA |
| LED | V _{OHLED1} | LED1 pin saturation voltage | I _{LED1} =10mA | — | — | 0.4 | V |
| | V _{OHLED2} | LED2 pin saturation voltage | I _{LED2} =10mA | — | — | 0.4 | V |
| T _{IN} | V _{THINTH1} | T _{IN} pin upper threshold voltage 1 | V _{DD} =4.53V | 3.11 | 3.21 | 3.31 | V |
| | V _{THINTL1} | T _{IN} pin lower threshold voltage 1 | | 1.39 | 1.49 | 1.59 | V |
| | V _{THINTH2} | T _{IN} pin upper threshold voltage 2 | | 3.13 | 3.23 | 3.33 | V |
| | V _{THINTL2} | T _{IN} pin lower threshold voltage 2 | | 1.49 | 1.59 | 1.69 | V |
| | I _{in} T _{IN} | Input current into T _{IN} pin | | | -1.0 | | |
| OUT | V _{OHOUT} | Output pin saturation voltage | I _{OUT} =20mA | | 1.0 | 2.0 | V |
| | I _{LOUT} | Output pin leak current | V _{OUT} =15V | | | 1.0 | μA |
| C1 | td _{C1} | Delay time for voltage detection | at recharge C1=2.2μF | 0.76 | 1.06 | 1.36 | s |
| C2 | td _{BDET1} | Conned/disconnect detection time1 | 4.2V con. voltage output period C2 = 2.2μF | 0.82 | 1.15 | 1.48 | s |
| | td _{BDET2} | Conned/disconnect detection time2 | 2.61V con. voltage output period C2 = 2.2μF | 76 | 106 | 136 | ms |
| | td _{IDET} | Delay time for current detection | C2 = 2.2μF | 0.82 | 1.15 | 1.48 | s |
| | td _{ILED} | Delay time for LED switch over | C2 = 2.2μF | 1.56 | 2.21 | 2.86 | s |
| | td _{chg} | Discharging time | C2=2.2μF (after current detection) | 30 | 90 | — | ms |
| C3 | td _{C3} | Delay time for temperature detection | C3 = 0.1μF | 34 | 49 | 64 | ms |

4. Functional Description

Notice: The voltage value within [] is for 4.2V type battery. And the voltage value without [] is for 4.1V type battery or common value for both (4.1V and 4.2V) battery.

(1) Setting 4.1V type or 4.2V type battery

If using 4.1V type battery, make VrefSW pin and VDD pin short. In this case, 4.1V constant charging is performed because internal referential voltage is set at 4.1V.

If using 4.2V type battery, make VrefSW pin open. In this case, 4.2V constant charging is performed because internal referential voltage is set at 4.2V.

The resistance divider between VDD and GND sets internal referential voltage. Changing VDD voltage by switching VDD pin shorted to VrefSW pin or opened sets referential voltage for constant charge 4.1V or 4.2V.

(2) Detection of connecting/disconnecting a battery

The connecting/disconnecting of a battery is detected via the TIN pin. The detection is performed by using an external resistor and thermistor supplied by the regulated 4.42V[4.53V] of the VDD pin.

When the pin TIN voltage is between 1.45V[1.49V] and 3.13V[3.21V], it is confirmed that a battery is connected according to the internal setting.

When the TIN pin voltage is less than 1.45V[1.49V] or more than 3.13V[3.21V], the charge is inhibited owing to possibilities of disconnecting a battery or unusual battery temperature.

The charging start conditions (In a case a battery is connected)

The charging voltage is set to 4.1V[4.2V], when the battery connection is confirmed. 1.15second (C2 = 2.2uF) later, the voltage is changed to 2.55V[2.61V] and then the detection of battery voltage will be started. (The voltage detection is not carried out until the voltage change to 2.55V[2.61V].)

During the 4.1V[4.2V] constant voltage output, the voltage drop caused by the current detecting resistor is limited to 250mV[256mV].

When the battery voltage is between 2.6V[2.66V] and 4.1V[4.2V], the constant current charging starts.

In the case the voltage is more than 4.1V[4.2V], the 4.1V[4.2V] constant voltage charging starts with monitoring the charging current.

(3) The constant current control block and the current detection

The charging current is measured between the SENSE+ and SENSE- pins, so that the constant current control is performed.

The current sensing resistor drop is set as follows;

in a case the battery voltage is between 2.6V[2.66V] / 3.0V[3.07V] or more than 3.0V[3.07V], it is set to 25mV[26mV] or 250mV[256mV], respectively.

When the above voltage drop of less than 25mV[26mV] continues for 1.15sec(C2 =2.2uF) during the constant voltage charging, completion of the charge is confirmed and then the output changes to the constant voltage of 2.55V[2.61V]. (The preventing function of erroneous detection is worked.)

(4) The constant voltage control block

The battery voltage and the output voltage is measured via the VSENSE pin.

When the battery voltage rises to 4.1[4.2V]V or more by the constant current charging, the 4.1V[4.2V] constant voltage control starts alternatively.

When the above voltage drop of less than 25mV[26mV] continues for 1.15sec(C2 = 2.2uF) during the constant voltage charging, completion of the charge is confirmed and then the output changes to the constant voltage of 2.55V[2.61V]. (The preventing function of erroneous detection is worked.)

(5) The voltage detection block

In a case the battery voltage monitoring via the VSENSE pin is less than 2.6V[2.66V], the charge is inhibited because of the following two reasons;

a battery is over discharged or a shorted battery is connected.

In a case the battery voltage is more than 2.6V[2.66V], the following two charging current values are set according to the battery outputs;

the output is between 2.6V[2.66V] and 3.0V[3.07V], resulting in the current measuring resistor drop of 25mV[26mV], the output is more than 3.0V[3.07V], resulting in that of 250mV[256mV].

The battery voltage rises to 4.1V[4.2V] during the constant current charging, which changes the constant current charging to the constant voltage one.

When it continues for 1.06sec($C1 = 2.2\mu F$) that the battery voltage is less than 3.9V[3.99V] after the completion of charging, the recharging will start. (The preventing function of erroneous detection is worked.)

(6) The temperature detecting block

Temperature detection is done through the TIN pin. Detecting battery temperature is accomplished by utilizing an external resistor and thermistor supplied by the regulated 4.42V[4.53V] of the VDD pin.

When the TIN voltage is between 1.45V[1.49V] and 3.13V[3.21V], the measured temperature is regarded as normal according to the internal setting, and then the charging will start. When the voltage of the TIN pin is less than 1.45V[1.49V] or more than 3.13V[3.21V], the charging is inhibited due to the decision of the unusual battery temperature.

In a case the TIN voltage is down to below 1.45V[1.49V] after the charging have started, the charging is stopped until the TIN voltage rises to 1.55V[1.59V] or more. (It has hysteresis corresponding to battery temperature range of 2.5deg.)

The temperature detection is completed after a sensing voltage is halted for 49ms($C3 = 0.1\mu F$). (The preventing function of erroneous detection is worked.)

(7) The regulated power supply block

For 4.1V type battery (shorted VrefSW pin and VDD pin), regulated 4.42V is provided via the VDD pin. For 4.2V type battery (VrefSW pin is opened), regulated 4.53V is provided via the VDD pin.

This regulated voltage is used for detecting battery temperature with the external resistance and thermistor.

(8) The output block

An external PNP transistor should be connected to the OUT pin because of an opened collector output circuit configuration.

The maximum output current is 30mA, which will be multiplied by hFE of an external transistor, thus enabling the high current charging.

(9) The LED driving block

The output configuration of this block is the opened collector by NPN Tr.

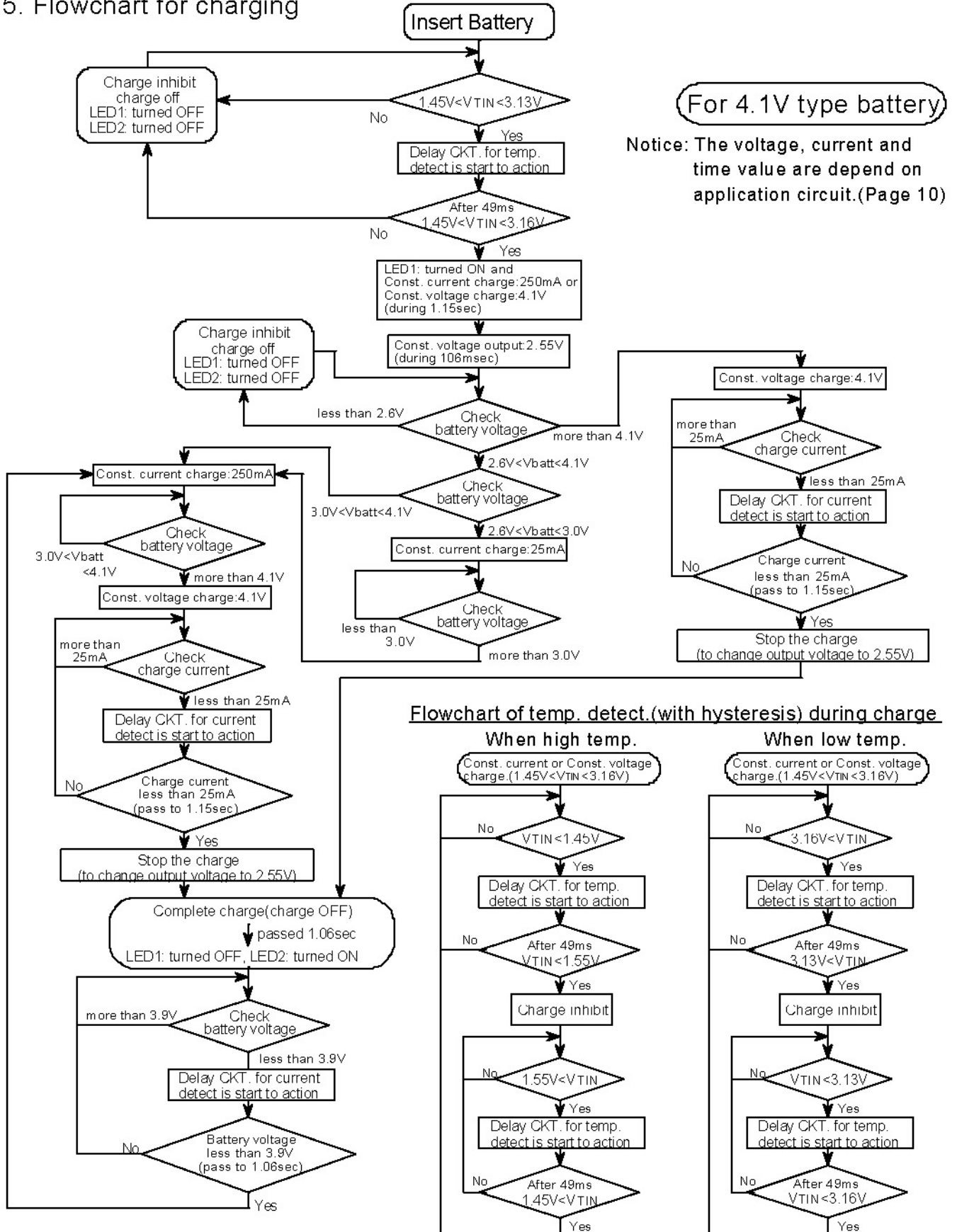
The charging states are indicated by using two LEDs. LED1 or LED2 is on during the charge or at the completion of the charge, respectively. Where "on" is lighting a LED.

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

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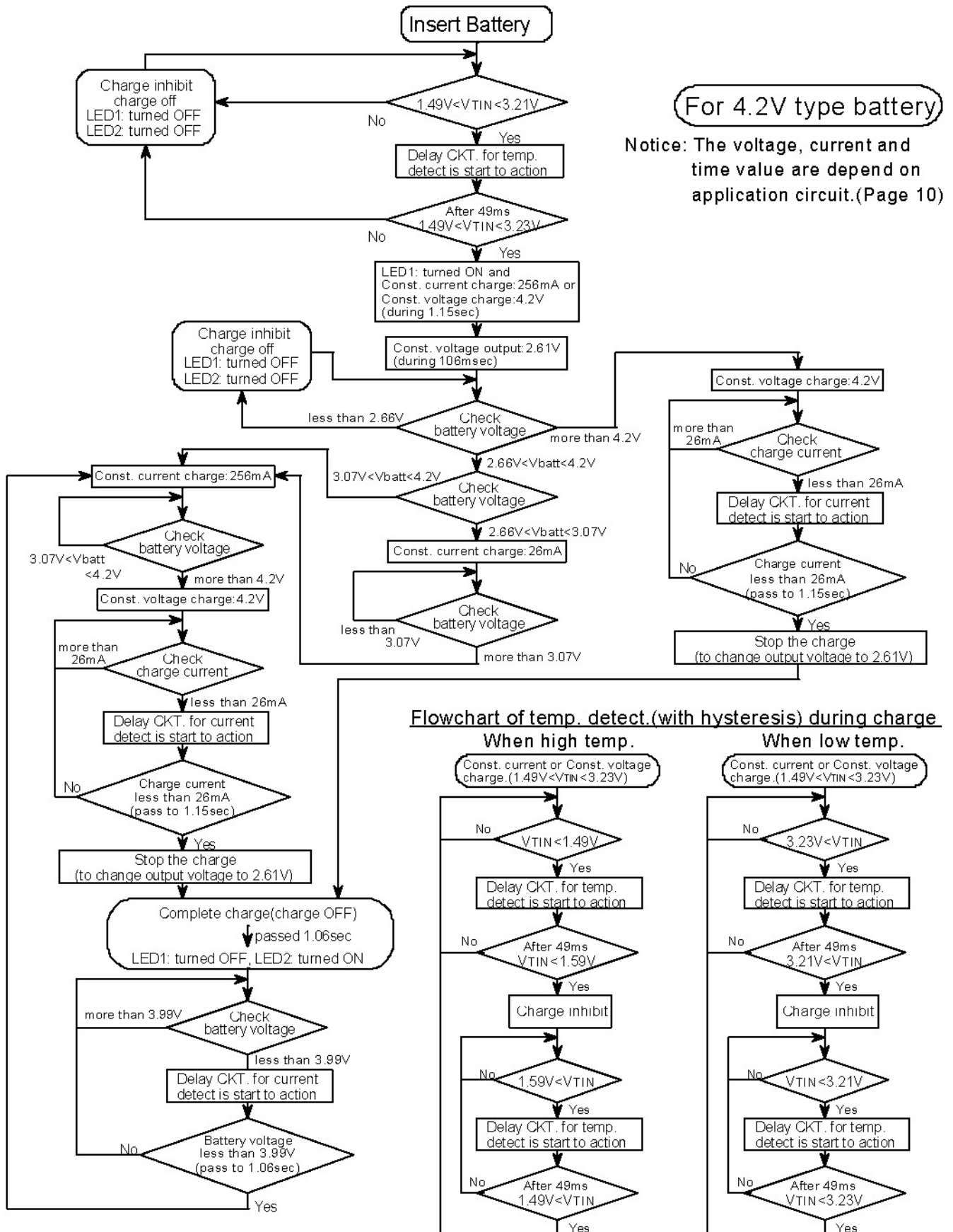
Charge Control IC for Li-Ion Batteries

5. Flowchart for charging



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Charge Control IC for Li-Ion Batteries



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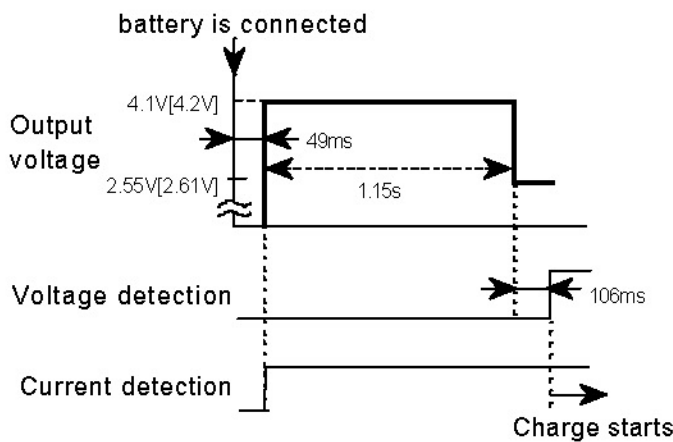
Charge Control IC for Li-Ion Batteries

6. Functional Timing Diagram

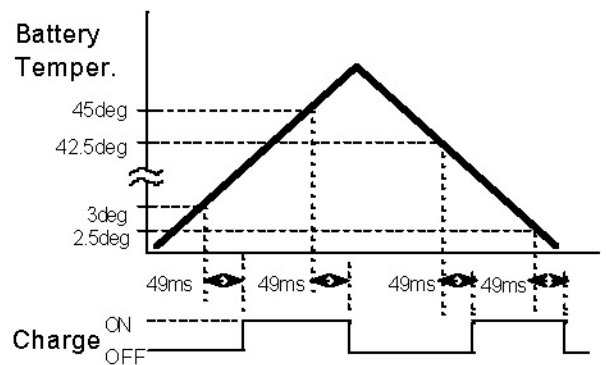
(The component values are the same as those of the application circuits)

Notice: The voltage value within [] is for 4.2V type battery. And the voltage value without [] is for 4.1V type battery or common value for both (4.1V and 4.2V) battery.

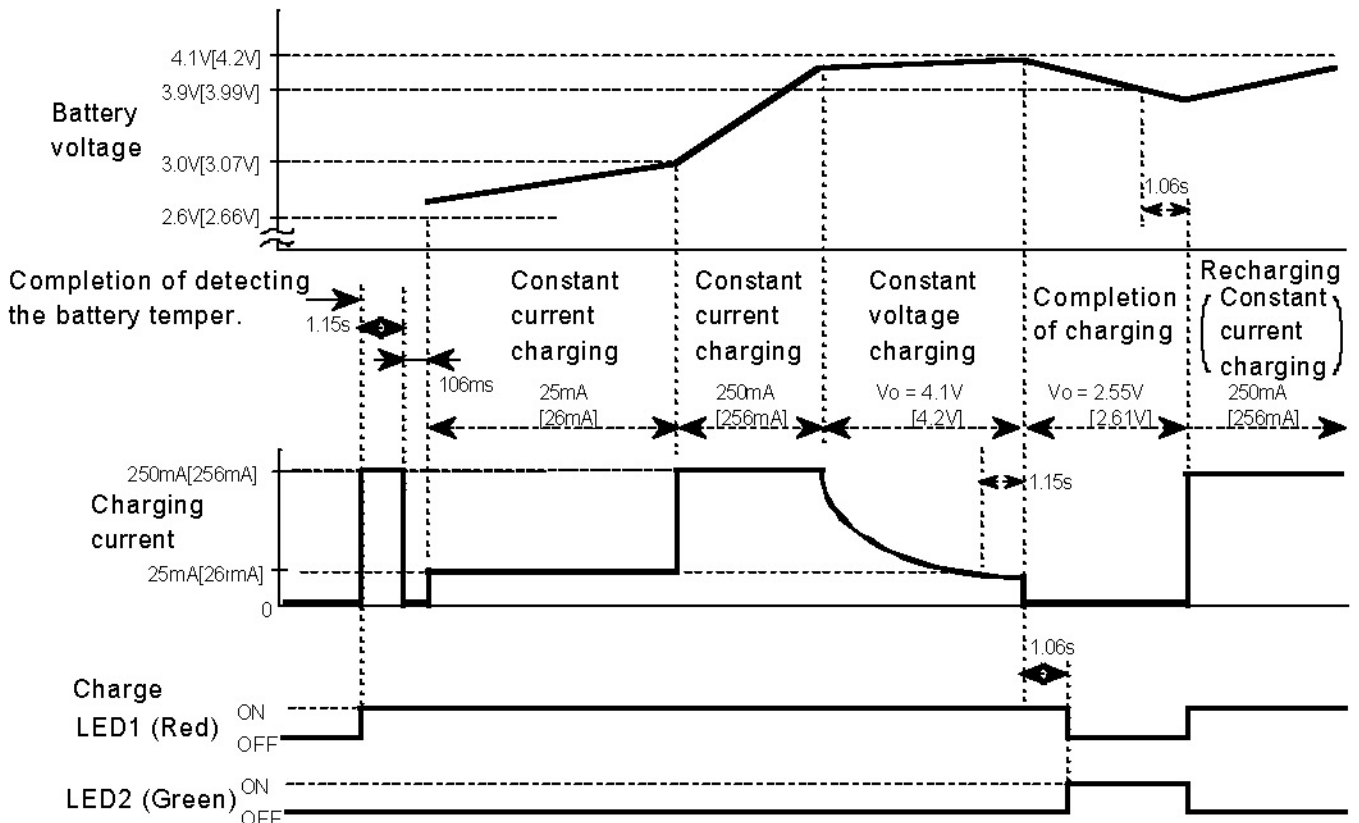
(1) Battery connecting/disconnecting detection timing



(2) Battery temperature detection timing



(3) Timing diagram during a charge

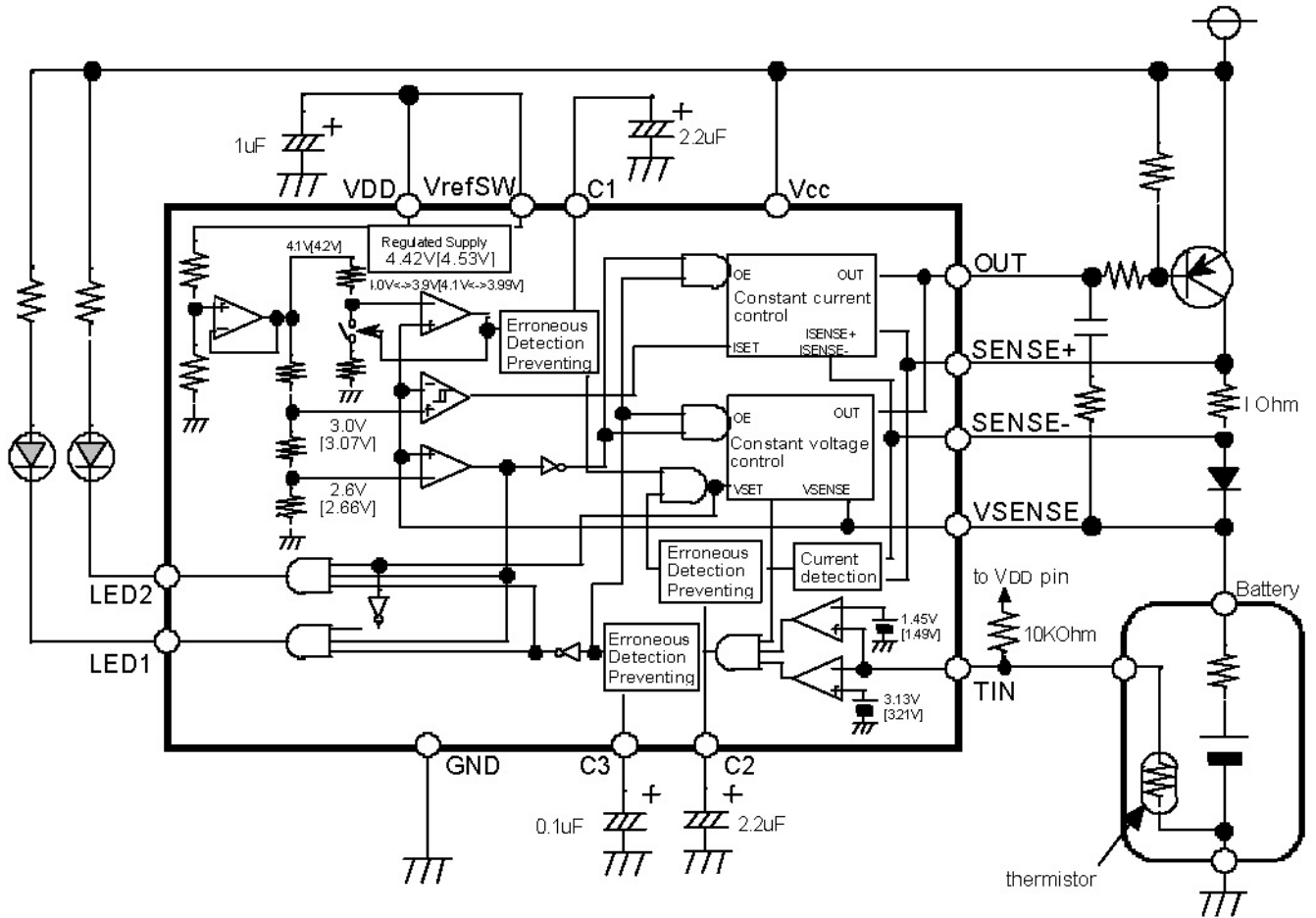


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Charge Control IC for Li-Ion Batteries

7. The Application Circuit

Notice: The voltage value within [] is for 4.2V type battery. And the voltage value without [] is for 4.1V type battery or common value for both (4.1V and 4.2V) battery.



Note : The following thermistor is recommended.

Maker : ISHIZUKA DENSHI

Type :103HT

Characteristic :10kOhm at 25deg

- The above circuit is shown in a case of 4.1V type battery. When using 4.2V type battery, make VrefSW pin open.
- In a case of charging a battery without a thermistor, a mechanical switch should be connected to the TIN pin so that the voltage between 1.45V[1.49V] and 3.13V[3.21V] will be supplied to the pin.