M62253BGP

Charge Control IC for Li-Ion Batteries

REJ03F0243-0200
Rev.2.00
Sep 14, 2007

Not recommend for new design

Description

M62253BGP 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.

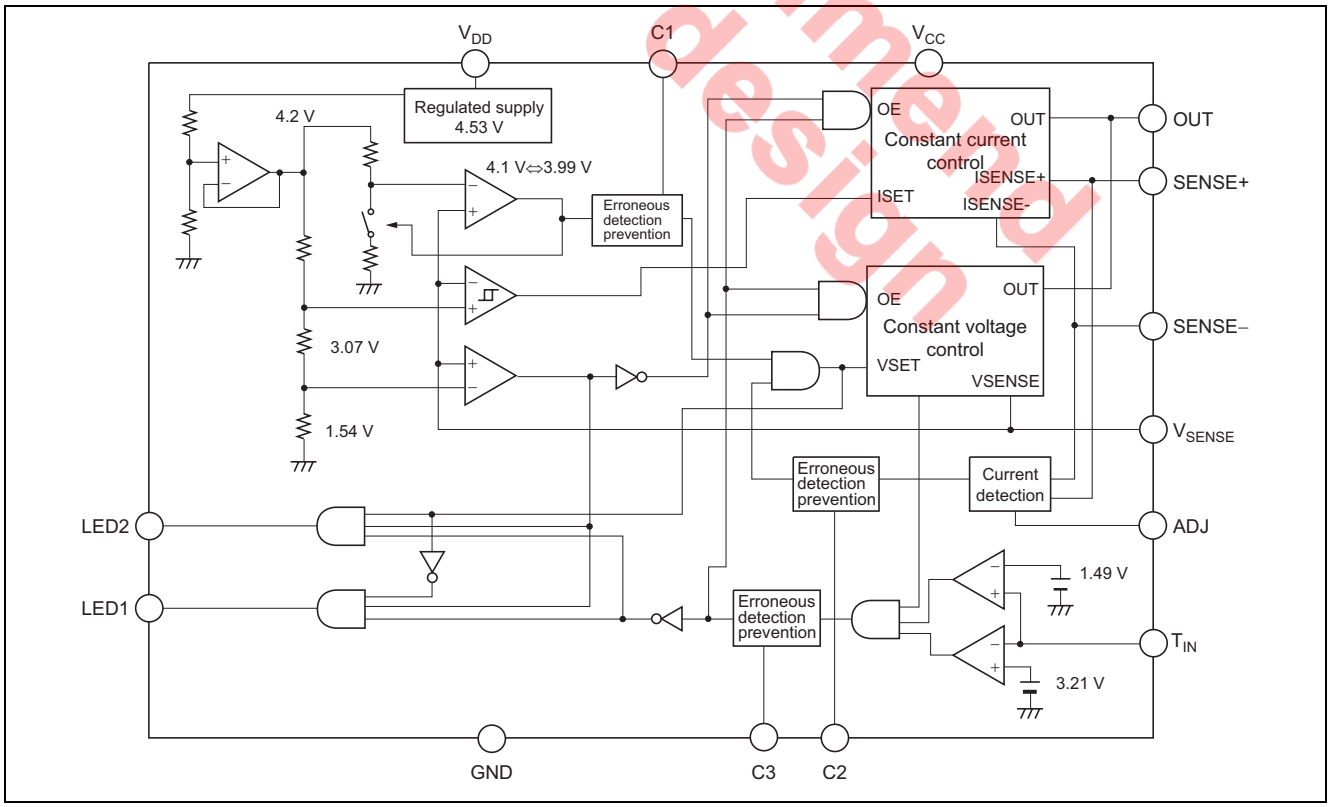
Features

- Available for 4.2 V battery
- High precision reference voltage 4.2 V ± 30 mV
- 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

Applications

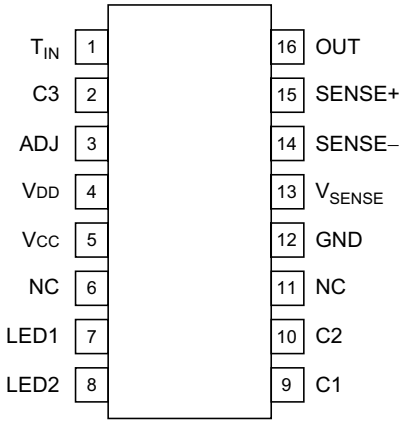
Li-Ion battery charger for hand-held instruments such as cellular phones and notebook computers

Block Diagram



Pin Arrangement

M62253BGP



(Top view)

Outline: PLSP0016JA-A (16P2E-A)

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Pin Description

Pin No.	Pin Name	Function
1	T_{IN}	Temperature sensing input (also battery connecting detection input)
2	C3	Delay time setting for temperature sensing (Tpd = 49 ms @ 0.1μF)
3	ADJ	Charge completion detection voltage setting (One fifth of ADJ terminal voltage is equal to charge completion detection voltage.)
4	V_{DD}	Reference voltage output V_{DD} = 4.53 V
5	V_{CC}	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 = 1.06 s @ 2.2 μF)
10	C2	Delay time setting for current sensing (Tpd = 1.15 s @ 2.2 μF)
12	GND	Ground
13	V_{SENSE}	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)

Absolute Maximum Ratings

(Ta = 25°C, unless otherwise noted)

Item	Symbol	Ratings	Unit	Condition
Supply voltage	V_{CC}	16	V	
Output current	I_{OUT}	30	mA	
Applying voltage to SENSE pin	V_{SENSE}	V_{CC}	V	
Applying voltage to T_{IN} pin	VT_{IN}	V_{CC}	V	
Power dissipation	Pd	300	mW	Ta = 25°C
Thermal derating	Kθ	3.0	mW/°C	Ta > 25°C
Operating temperature	Topr	–20 to +85	°C	
Storage temperature	Tstg	–40 to +125	°C	

Electrical Characteristics

(V_{CC} = 12.0 V, V_{SENSE} = 3.6 V, Ta = 25°C, unless otherwise noted)

Blocks	Item	Symbol	Min	Typ	Max	Unit	Condition
All device	Supply voltage	V_{CC}	5.0	—	15.0	V	
	Current consumption	I_{CC}	—	7	—	mA	LED is off
V_{DD}	V_{DD} output voltage	V_{DD}	4.30	4.53	4.76	V	
Voltage detection	Charge start voltage	$V_{THchgon}$	1.44	1.54	1.64	V	
	Quick charge start voltage	$V_{THqchgon}$	2.97	3.07	3.17	V	
	Output voltage setting	Vo_{chg}	4.17	4.20	4.23	V	During a charge
	Recharge start voltage	$V_{THrchgon}$	3.89	3.99	4.09	V	At charge completion
	V_{SENSE} terminal input current	linVSENSE	–2.0	—	2.0	µA	
Current detection	Charging current setting voltage 1	I_{SET1}	15	26	37	mV	1.56 V < battery V. < 3.07 V
	Charging current setting voltage 2	I_{SET2}	232	256	280	mV	5.0 V < V_{CC} < 8.0 V 3.07 V < battery V. < 4.2 V
			237	256	275	mV	8.0 V < V_{CC} < 15.0 V 3.07 V < battery V. < 4.2 V
	Charge completion detecting voltage	$I_{THchgoff}$	15	26	37	mV	Vadj = 0.13 V
	Charge completion detecting voltage	$I_{THchgoff}$	75	100	125	mV	Vadj = 0.5 V
	Input current into SENSE+ pin	$I_{INSENSE+}$	—	60	85	µA	During a charge
	Input current into SENSE– pin	$I_{INSENSE–}$	—	60	85	µA	During a charge
LED	LED1 pin saturation voltage	V_{OHLED1}	—	—	0.4	V	ILED1 = 10 mA
	LED2 pin saturation voltage	V_{OHLED2}	—	—	0.4	V	ILED2 = 10 mA
T_{IN}	T_{IN} pin upper threshold voltage 1	$V_{THINTH1}$	3.11	3.21	3.31	V	V_{DD} = 4.53 V
	T_{IN} pin lower threshold voltage 1	$V_{THINTL1}$	1.39	1.49	1.59	V	
	T_{IN} pin upper threshold voltage 2	$V_{THINTH2}$	3.13	3.23	3.33	V	
	T_{IN} pin lower threshold voltage 2	$V_{THINTL2}$	1.49	1.59	1.69	V	
	Input current into T_{IN} pin	Iin_{TIN}	–1.0	—	—	µA	
OUT	Output pin saturation voltage	V_{OHOUT}	—	1.0	2.0	V	I_{OUT} = 20 mA
	Output pin leak current	I_{LOUT}	—	—	1.0	µA	V_{OUT} = 15 V
C1	Delay time for voltage detection	td_{C1}	0.76	1.06	1.36	s	At recharge C1 = 2.2 µF
C2	Connect/disconnect detection time1	td_{BDET1}	0.82	1.15	1.48	s	4.2 V con. voltage output period C2 = 2.2 µF
	Delay time for current detection	td_{IDET}	0.82	1.15	1.48	s	C2 = 2.2 µF
	Delay time for LED switch over	td_{ILED}	1.56	2.21	2.86	s	C2 = 2.2 µF
	Discharging time	td_{chg}	30	90	—	ms	C2 = 2.2 µF (after current detection)
C3	Delay time for temperature detection	td_{C3}	34	49	64	ms	C3 = 0.1 µF

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Functional Description

(1) Detection of connection/disconnection of battery

Connection/disconnection of battery is detected via T_{IN} pin. The detection is performed by external resistor and thermistor using the regulated 4.53 V of V_{DD} terminal.

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

When T_{IN} terminal voltage is 1.49 V or less, or 3.21 V or more, charge is inhibited owing to possibilities of battery din connection or unusual battery temperature.

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

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

1.15 second (C2 = 2.2 μF) later, the voltage is changed to 1.46 V to detect battery voltage. (Voltage detection is not done until the voltage is changed to 1.46 V.)

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

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

In the case the voltage is 4.2 V or more, 4.2 V 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 1.54 V and 3.07 V, voltage drop is set to 26 mV.

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

When charge current is detected and battery voltage is 4.1 V or more, and the above voltage drop of less than one fifth of ADJ terminal voltage continues for 1.15 second (C2 = 2.2 μF) during constant voltage charging, completion of charge is confirmed and then output changes to constant voltage of 1.46 V.

(Preventing function of erroneous detection works.)

(3) Constant voltage control block

Battery voltage and output voltage is measured via V_{SENSE} terminal.

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

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

(4) Voltage detection block

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

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

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

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

When battery voltage is 3.99 V or less for 1.06 second (C1 = 2.2 μF) after charge completion, recharging will start.

(Prevention function of erroneous detection works.)

(5) Temperature detecting block

Temperature detection is done through T_{IN} terminal. Detecting battery temperature is accomplished by external resistor and thermistor using the regulated 4.53 V of the V_{DD} terminal.

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

When T_{IN} voltage goes down to 1.49 V or less after charging starts, charging stops until T_{IN} voltage rises up to 1.59 V or more. (It has hysteresis corresponding to battery temperature range of 2.5°C.)

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

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(6) Regulated power supply block

Regulated 4.53 V is provided at V_{DD} 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 30 mA, so charging can be done with charging current up to 30 mA 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" 2.21 second (C2 = 2.2 μF) 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 T_{IN} terminal. Such is also the case with the period for recharging.

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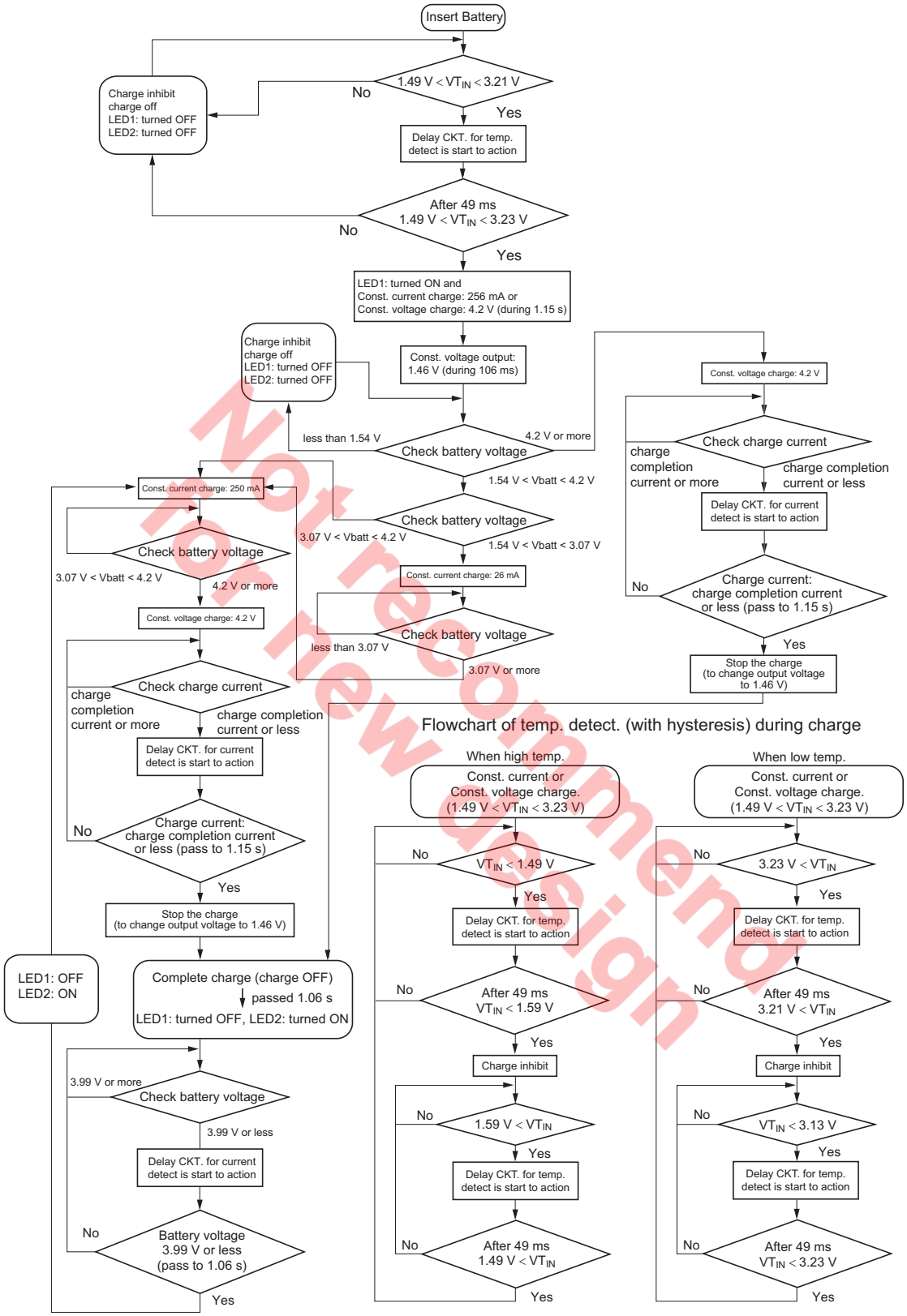
Flowchart for Charging



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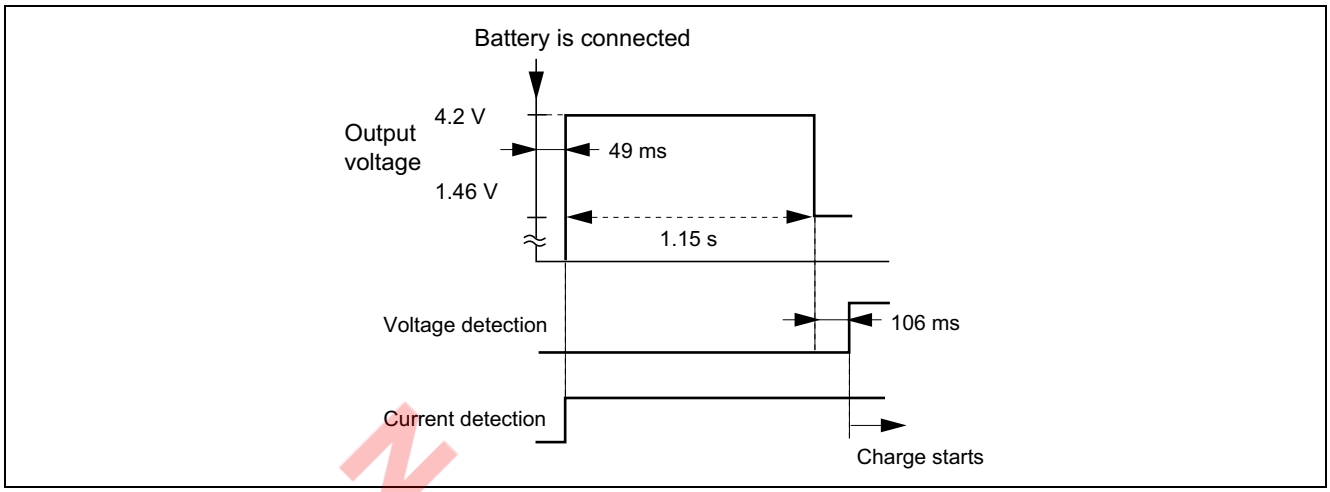
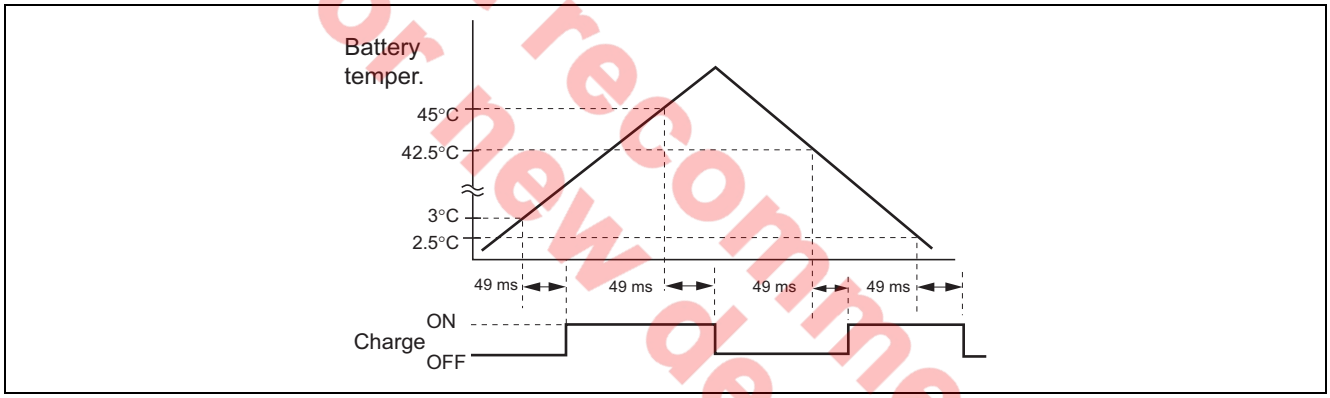
Notes: 1. The voltage, current, and time values depend on application circuit.
2. Chage completion current = one fifth ADJ voltage/Rsense

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



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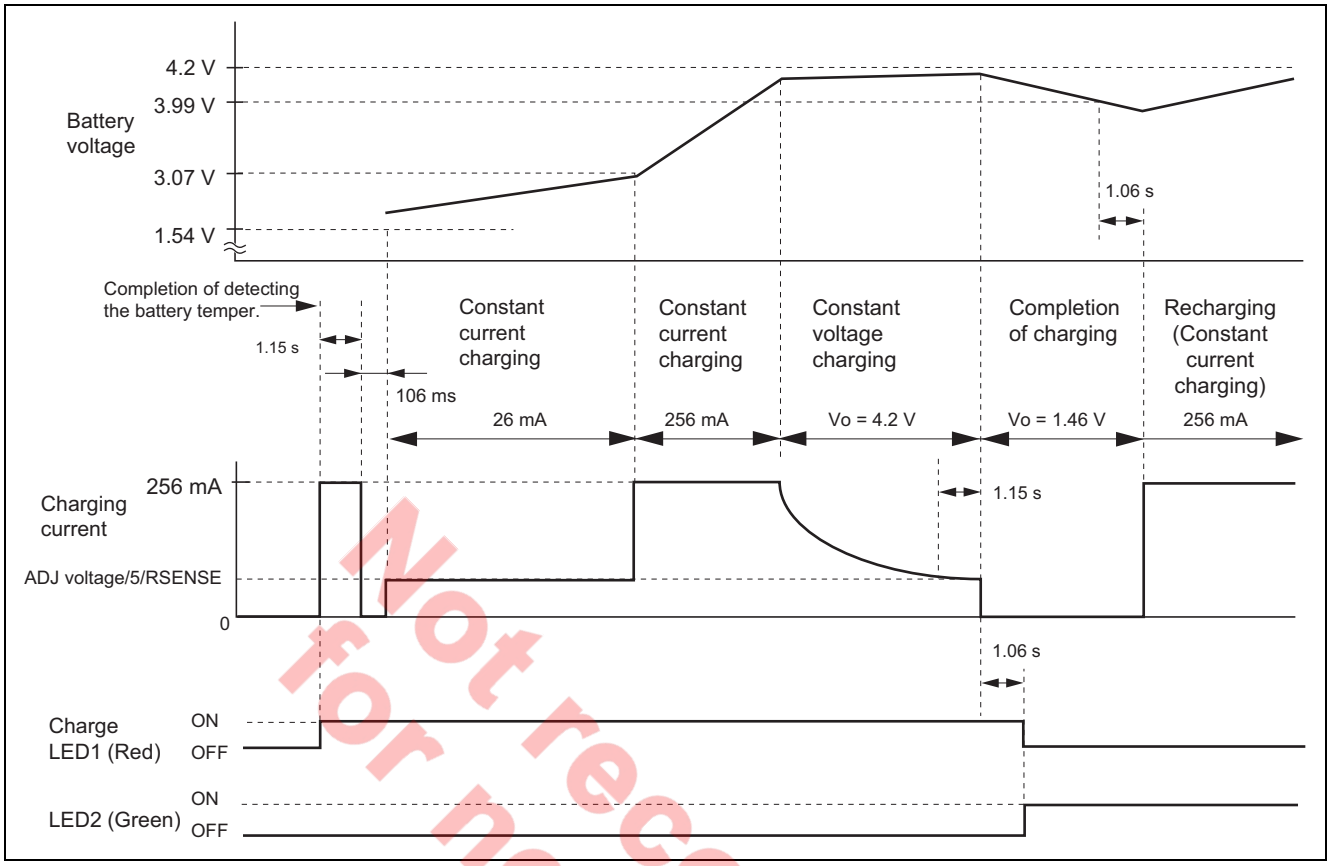
(3) Timing Diagram During a Charge



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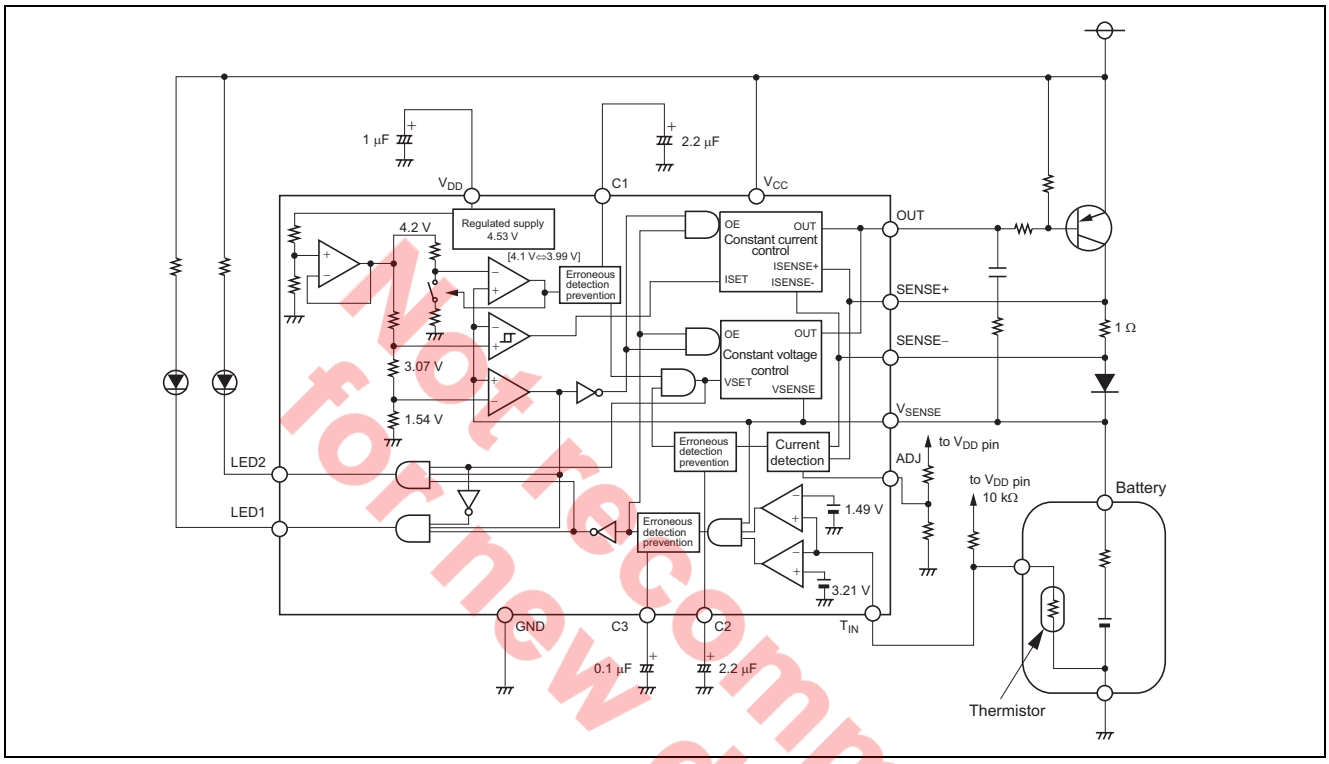
The Application Circuit

Note: The following thermistor is recommended.
Maker: ISHIZUKA DENSHI
Type: 103HT
Characteristic: 10 kΩ at 25°C

(1) When Thermistor is Located in Battery Pack



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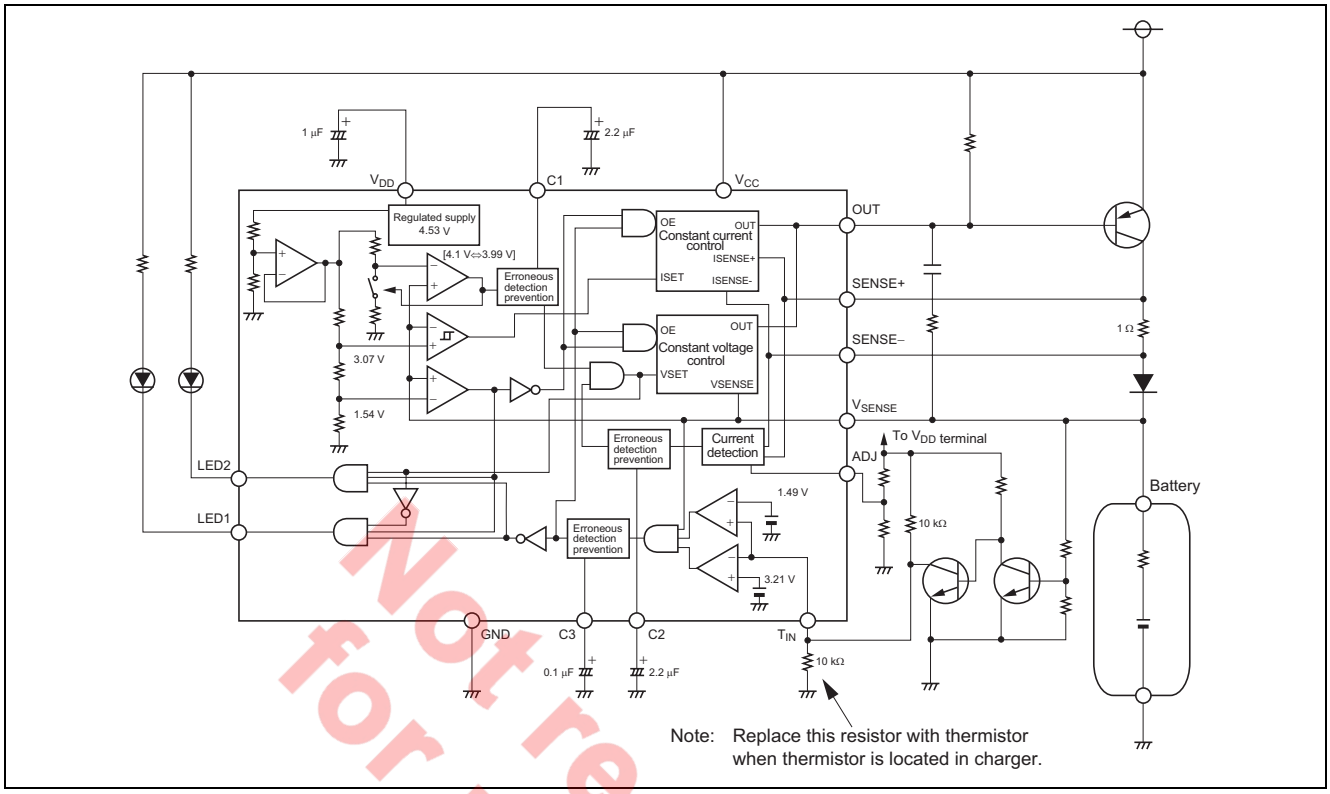
(2) When Thermistor is Located in Charger or Thermistor is not Used (For Your Reference)



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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 [Ω] = charge current setting voltage 2 / Iqchg [mA] =256 mA / Iqchg [mA]

, where pre-charge current is given by:

Pre-charge current = charge current setting voltage 1 / RSENSE = 26 mV / 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 × RSENSE [Ω] × Icomp [A]

, where the constant 5 is internally fixed.

Note: 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).)

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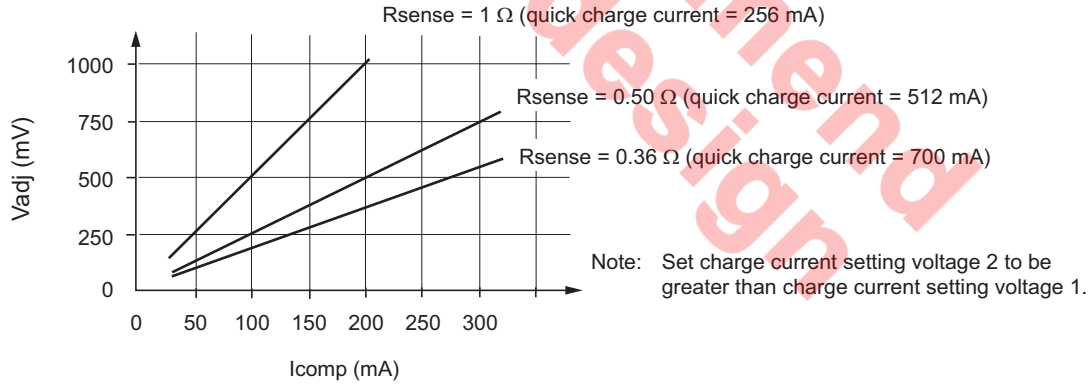
ADJ Term. Volt. Setting

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

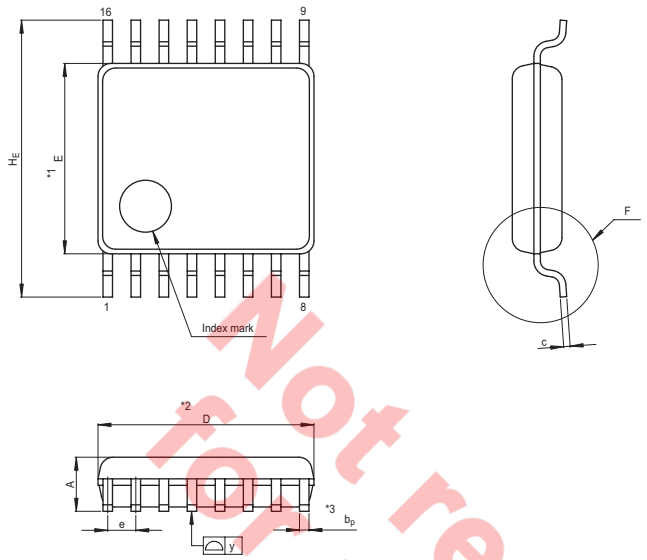
Note: Several 10 kΩ or around is recommended for the total resistor value R1 and R2 for ADJ.

How Icomp Relates itself to Vadj



Package Dimensions

JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-LSSOP16-4.4x5-0.65	PLSP0016JA-A	16P2E-A	0.06g



NOTE)
1. DIMENSIONS "*1" AND "*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION "*3" DOES NOT INCLUDE TRIM OFFSET.

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	4.9	5.0	5.1
E	4.3	4.4	4.5
A_2	—	1.15	—
A	—	—	1.45
A_1	0	0.1	0.2
b_p	0.17	0.22	0.32
c	0.13	0.15	0.2
θ	0°	—	10°
H_E	6.2	6.4	6.6
e	0.53	0.65	0.77
y	—	—	0.10
L	0.3	0.5	0.7

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