

# Trickle-charge IC for two-cell, lithium-ion batteries

## BA3170

The BA3170 is a trickle-charge IC developed for two-cell, lithium-ion batteries. The IC includes a charge control circuit, a charge output transistor, and an LED driver for showing the charging status.

### ● Applications

Lithium-ion (two cell) battery chargers, and charging circuits

### ● Features

- 1) Output voltage can be varied using an external resistor.
- 2) The output pin is PNP output with low saturation voltage.
- 3) Built-in output current limiting circuit protects batteries from excessive current, and prevents destruction of the IC due to output shorts.  
The initial charge current is set to a low value (the current limit pin voltage can be used to vary the current limit value).
- 4) Pulse charging at over 99% of the final voltage.
- 5) Built-in over-discharge battery return circuit.
- 6) Built-in charge fault protection circuit.
- 7) Built-in over-voltage battery operation circuit.
- 8) Built-in LED output for charge display (two outputs).
- 9) 12-pin power package provides large power dissipation in a compact package.
- 10) Temperature protection circuit prevents thermal destruction of the IC.

### ● Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Applied voltage	Vcc	23	V
Power dissipation	Pd	2200*1	mW
Operating temperature	Topr	-30~+85	°C
Storage temperature	Tstg	-55~+150	°C
Output pin current	Io	400*2	mA
LED output pin current	ILO	20*2	mA
LED output pin voltage	VLO	Vcc	V
Standby pin voltage	VSTB	Vcc	V

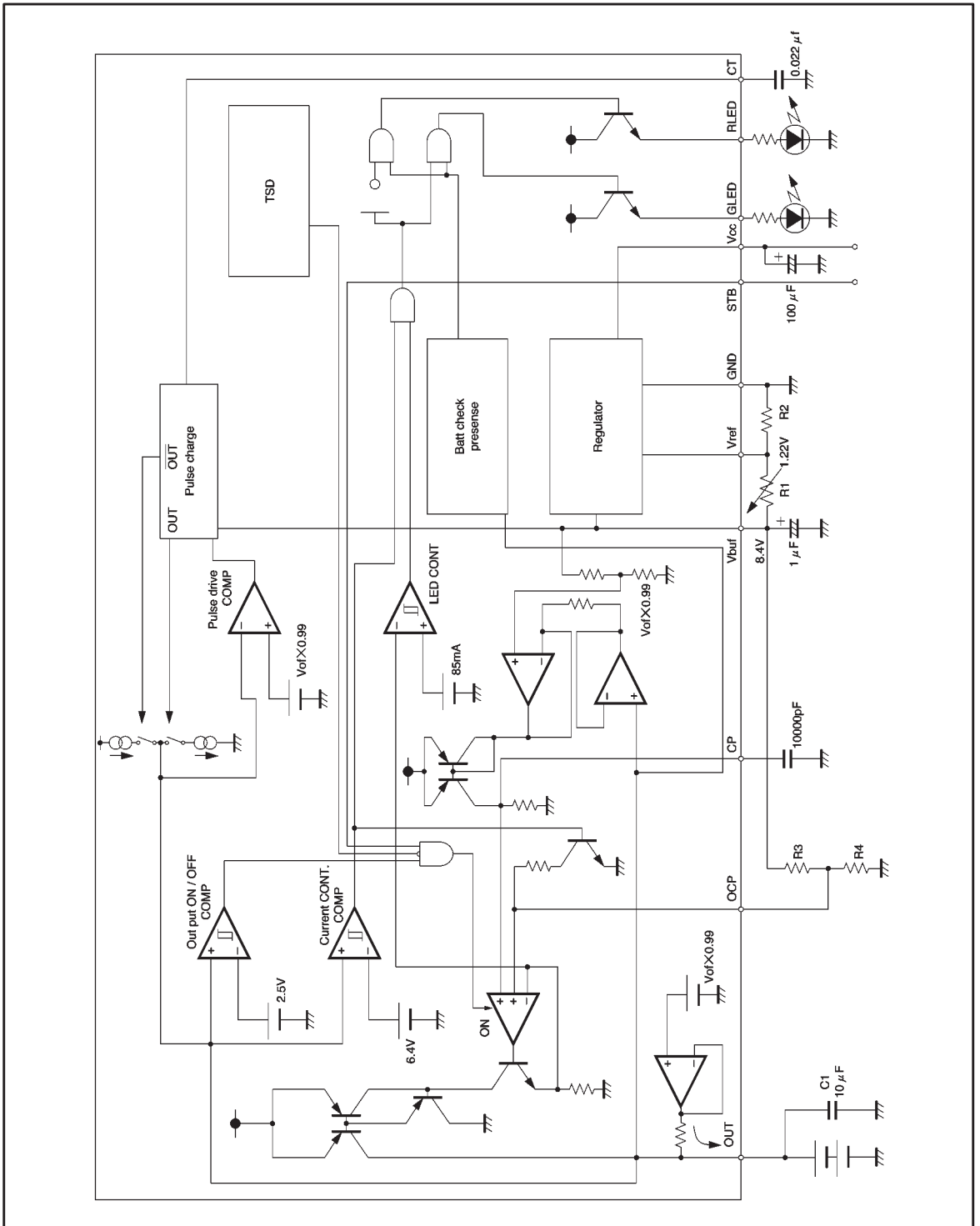
\*1 Reduced by 17.6mW for each increase in Ta of 1°C over 25°C (stand alone IC).

\*2 Should not exceed Pd or ASO values.

### ● Recommended operating conditions (Ta = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage	Vcc	10.0	—	20.0	V

● Block diagram



## ● Pin descriptions

Pin No.	Pin name	Function
1	CT	Pulse charge frequency setting pin
2	CP	For connection of capacitor to prevent oscillation
3	OCP	Output current limit setting pin
4	N.C.	—
5	OUT	Output pin
6	Vcc	Power supply
7	GLED	Charging complete LED output
8	RLED	Charging LED output
9	STB	Standby pin
10	Vbuf	Charging end point voltage output pin
11	Vref	Charging end point voltage setting pin
12	GND	Ground

## ● Electrical characteristics (unless otherwise noted, Ta = 25°C, Vcc = 12V, R1 = 58.7kΩ, R2 = 10kΩ)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
〈Total device〉						
Standby circuit current	I <sub>STB</sub>	—	0.8	1.4	mA	V <sub>stb</sub> =0V
Circuit current (when stopped)	I <sub>o</sub>	—	7.5	11.4	mA	V <sub>stb</sub> =5V
〈Output block〉						
Charging end point voltage	V <sub>of</sub>	8.10	8.40	8.70	V	R <sub>1</sub> =58.7kΩ, R <sub>2</sub> =10kΩ CT=2.2V *1
Charging current	I <sub>o</sub>	200	300	400	mA	R <sub>3</sub> =56kΩ, R <sub>4</sub> =43kΩ, V <sub>o</sub> =7.4V*2
Over-charge battery return current	V <sub>oi</sub>	50	100	150	μA	V <sub>o</sub> =0.2V
Initial charging current	I <sub>so</sub>	50	100	150	mA	R <sub>3</sub> =56kΩ, R <sub>4</sub> =43kΩ, V <sub>o</sub> =4.5V*2
Charging start output voltage	V <sub>sta</sub>	2.3	2.5	2.7	V	—
Charging start detection delay time	T <sub>sta</sub>	3	10	—	ms	—
Charging current switch voltage	V <sub>is</sub>	6.1	6.4	6.7	V	—
Charging current switch detection delay time	T <sub>is</sub>	3	10	—	ms	—
Charging complete current	I <sub>g</sub>	55	85	115	mA	—
Charging complete hysteresis	I <sub>HYS</sub>	10	20	30	mA	—
Load regulation	ΔV <sub>or</sub>	—	50	120	mV	V <sub>of</sub> ×0.99—V <sub>o</sub> , I <sub>o</sub> =0~300mA
Line regulation	ΔV <sub>oi</sub>	—	0	10	mV	V <sub>cc</sub> =10~15V
Pulse charge start voltage	V <sub>p</sub>	8.019	8.316	8.613	V	R <sub>1</sub> =58.7kΩ, R <sub>2</sub> =10kΩ, CT=1.2V
Pulse charge frequency	f <sub>p</sub>	0.60	1.54	2.48	kHz	CT=0.022 μF, C <sub>1</sub> =10 μF
Reverse direction current	I <sub>r</sub>	—	0.1	1.0	μA	V <sub>o</sub> =8.4V
〈Reference voltage block〉						
Reference voltage	V <sub>ref</sub>	1.175	1.22	1.265	V	V <sub>buf</sub> and V <sub>ref</sub> short*1

Parameter	Symbol	Min.	Typ.	Max.	Unit	Coniditions
〈LED output block〉						
LED output voltage	$V_{LED}$	$V_{CC}$ -1.5	$V_{CC}$ -1.0	—	V	$I_{LED}=10\text{mA}$
LED output leak current	$I_{LEDL}$	—	—	50	$\mu\text{A}$	$V_{LED}=0\text{V}$
〈Input block〉						
Input standby voltage	$V_{THOFF}$	—	—	0.8	V	—
Input active voltage	$V_{THON}$	2.0	—	—	V	—
Input high level current	$I_{IN}$	100	175	250	$\mu\text{A}$	$V_{stb}=5\text{V}$

\*1 Refer to the "end point voltage" setting formula.

\*2 Refer to the reference data.

⊙Not designed for radiation resistance.

### ●Operation notes

- (1) Do not use values other than  $C_T = 0.022\mu\text{F}$  for the timing capacitor, and  $C_1 = 10\mu\text{F}$  for the output capacitor.
- (2) For the output capacitor  $C_1$ , use a tantalum capacitor with low capacitance variation with temperature, and a static capacitance tolerance of  $\pm 10\%$  or less.
- (3) For the timing capacitor  $C_T$ , use a film capacitor with low capacitance variation with temperature, a static capacitance tolerance of  $\pm 10\%$  or less, and a temperature variation rate of  $\pm 2\%$  or less.

### ●Measurement circuit

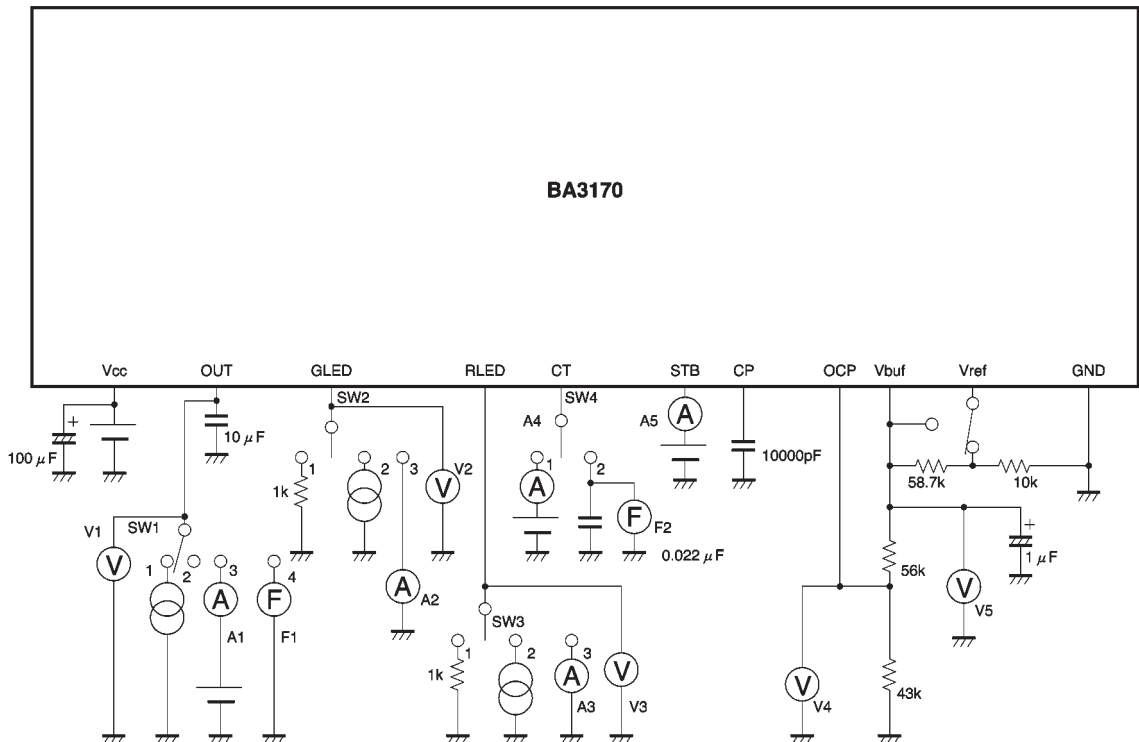


Fig.1

●Timing chart

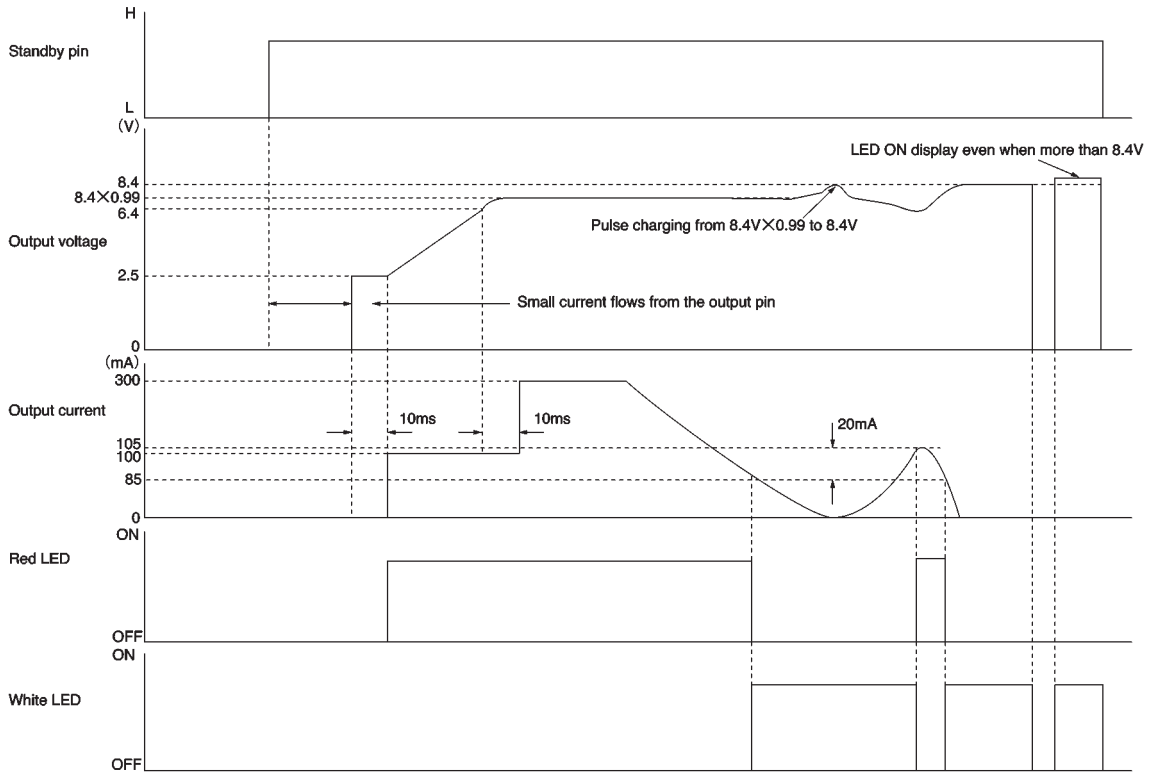


Fig.2

●External components

Setting the "end point voltage"

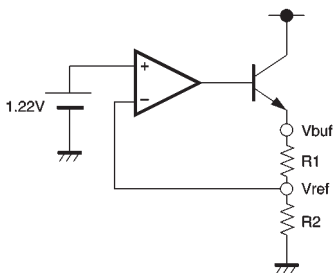


Fig.3

Set the "end point voltage"  $V_{buf}$  using resistors  $R1$  and  $R2$ .

Example:

To set  $V_{buf}$  to 8.4V:

$$1.22 = R2 / (R1 + R2) \times 8.4$$

$$R1 = 5.88 \cdot \cdot \cdot \times R2$$

If  $R2 = 10k\Omega$ , then

$$R1 = 58.7k\Omega$$

\* For measurement of the electrical characteristics,  $V_{ref}$  and  $V_{buf}$  are shorted.

- Reference data
- Output current limit value

Set the value for the OCP voltage using R3 and R4 ( $T_a = 25^\circ\text{C}$ ,  $V_{CC} = 12\text{V}$ ,  $V_{buf} = 8.4\text{V}$ , and  $V_o = 7.4\text{V}$  (Typ.))

Output current	R3	R4	OCP voltage
200mA	56k $\Omega$	20k $\Omega$	2.2V
300mA	56k $\Omega$	43k $\Omega$	3.7V

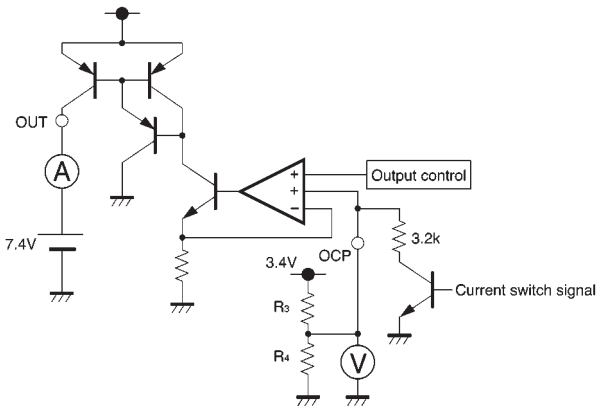


Fig.4

- Charging current and charge complete current for when the “end point voltage” is set to  $8.4\text{V} \pm 50\text{mV}$  ( $T_a = 25^\circ\text{C}$  and  $V_{CC} = 12\text{V}$ )

Parameter	Symbol	Min.	Typ.	Max.	Unit	Coniditions
Charge current	$I_o$	225	300	375	mA	$R_3=56\text{k}\Omega$ , $R_4=43\text{k}\Omega$ , $V_o=7.4\text{V}$
Charge complete current	$I_g$	60	85	110	mA	—

- Charge “end point voltage” temperature characteristic ( $V_{CC} = 12\text{V}$ ,  $R_1 = 58.7\text{k}\Omega$ ,  $R_2 = 10\text{k}\Omega$ , and  $C_T = 2.2\text{V}$ )

Parameter	Symbol	Min.	Typ.	Max.	Unit	Coniditions
Low-temperature variation rate	dVo-C	—	0.17	—	%	With respect to the $25^\circ\text{C}$ value
High-temperature variation rate	dVo-H	—	-0.27	—	%	With respect to the $25^\circ\text{C}$ value

\* However, R1 and R2 have the same temperature characteristic.

### ● Operation notes

#### (1) Application circuit (in the block diagram)

We guarantee the application circuit design, but recommend that you thoroughly check its characteristics in actual use.

If you change any of the external component values, check both the static and transient characteristics of the circuit, and allow sufficient margin in your selections to take into account variations in the components and ICs. Note that Rohm has not fully investigated patent rights regarding this product.

#### (2) Operating voltage range

Provided that the IC is operated within the recommended operating voltage range, the operation of the circuit is guaranteed within the allowed operating temperature range.

With regard to the values for the characteristics, the rating values for electrical characteristics cannot be guaranteed, but within these ranges there will not be a dramatic change in the values for the characteristics.

#### (3) Notes regarding power dissipation (Pd)

A derating characteristic is provided for power dissipation. Your design should not require the component to dissipate more than its maximum allowed power dissipation over the operating temperature range.

## (4) Over-voltage protection circuit

When the voltage between  $V_{CC}$  (pin 6) and GND (pin 12) exceeds about 27V (at normal temperature), the over-voltage protection circuit switches all outputs off. Make sure to use the IC within this voltage limit.

## (5) Capacitors to prevent oscillation of the outputs

Be certain to connect capacitors between OUT (pin 5) and ground, and CP (pin 2) and ground to prevent oscillation. We recommend tantalum capacitors that have low capacitance variation with temperature (particularly for the OUT pin).

## (6) Thermal shutdown circuit

A thermal shutdown circuit is provided on the IC to prevent it from being destroyed by high temperatures. When this circuit operates, all outputs go off, and when the temperature drops to a certain level, operation resumes.

## (7) Output circuit construction

The outputs use PNP power transistors. When the  $V_{CC}$  (pin 6) voltage drops, even if the external capacitor on the output side causes the output-side voltage to exceed the  $V_{CC}$ -side voltage, the IC will not be destroyed.

## (8) Grounding

With regard to the ground connections shown in the application example circuit, make the PCB connections from each earth to the GND pin (pin 12) reasonably short, and design your pattern layout to avoid electrical interference between the pattern lines.

## (9) ASO

This IC includes a variety of protection circuits, but depending on the operation conditions, it may be possible to exceed the ASO.

Exceeding the ASO will result in destruction of the IC, so take due care to ensure that the ASO conditions are never exceeded.

(10) Great care has been paid to the quality of this component. However, due to the nature of lithium-ion batteries, if there is a risk of danger due to failure of this component (e.g. fire or explosion), be certain to take appropriate measures in your design (fuses etc.).

## ● Electrical characteristics curves

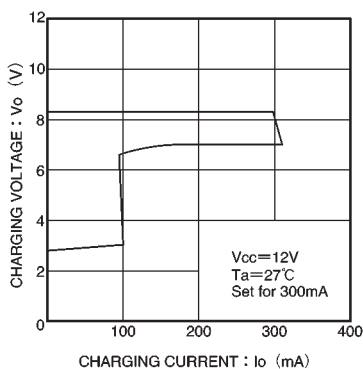


Fig.5 Charging current vs. charging voltage

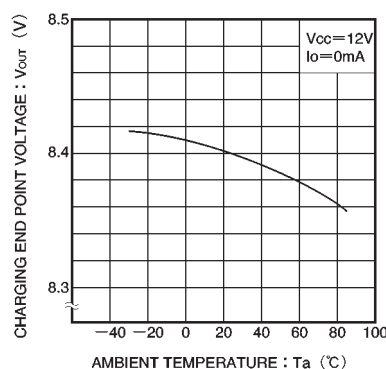


Fig.6 Charging end point voltage vs. ambient temperature

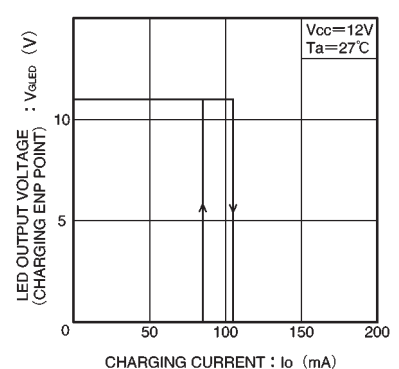


Fig.7 Charging current vs. charging end point LED output voltage

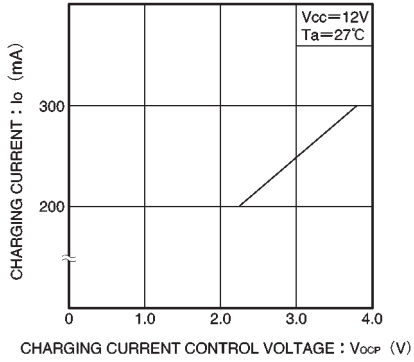


Fig.8 Charging current vs. charging current control voltage

● External dimensions (Units: mm)

