R2A20050ANS

Lithium-ion battery charger control IC

R03DS0071EJ0100
Rev.1.0
May 7 ,2013

Description

R2S20050ANS is a semiconductor integrated circuit designed for Lithium-ion battery charger control IC.
Built-in constant current and constant voltage control circuit allows for charging Lithium-ion battery.

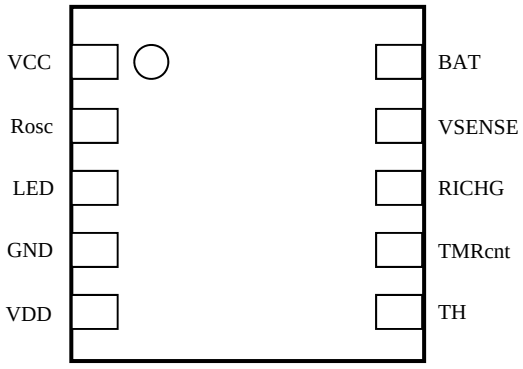
Features

- Available for 4.2V battery
- Built-in high accuracy reference voltage (charge voltage) 4.20V±30mV(at Ta=25degC)
- Constant current and constant voltage control function
- Battery connection detection function
- Built-in adaptor detection function
- Built-in recharge function
- Built-in thermistor interface for battery temperature detection
- Built-in chip temperature detection function
- Substantial protection functions
  - Safety timer
  - Overdischarge protection
  - Overvoltage protection
  - Charge prohibition protection for overvoltage and overdischarge battery.
  - Thermal shutdown function
  - Erroneous detection protection
- Built-in LED display function

Application

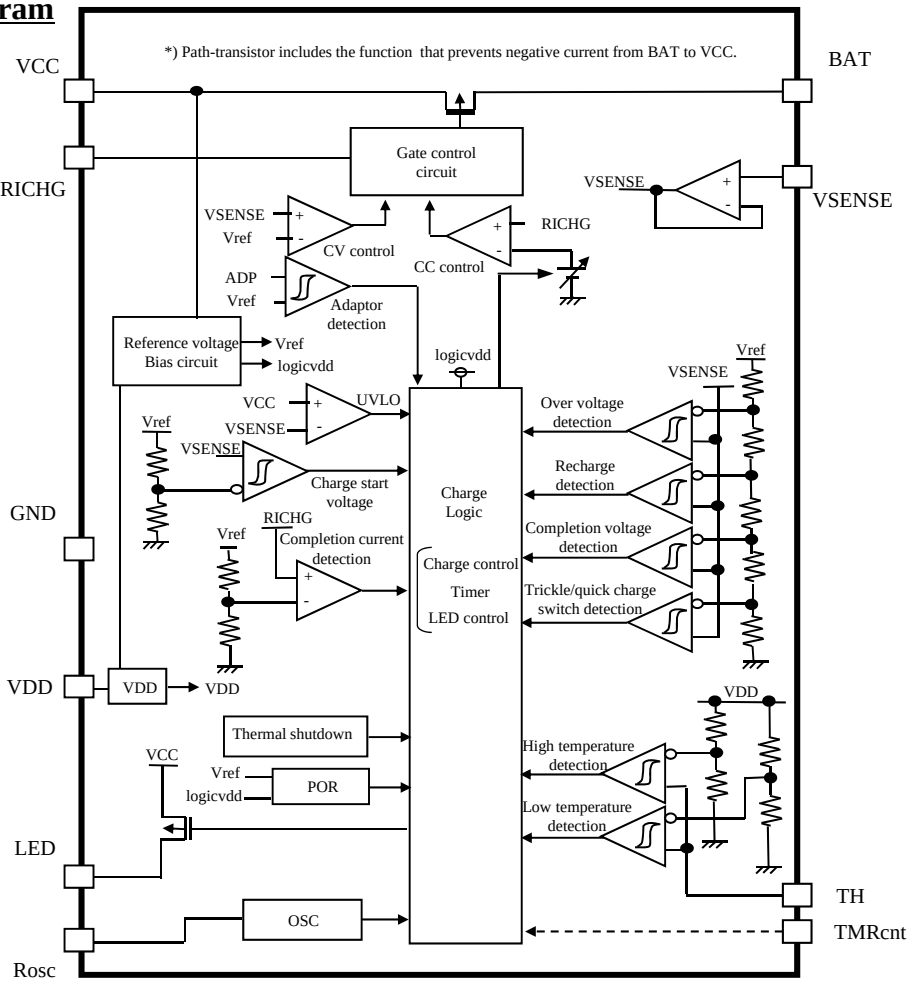
For DSC, cellular phone, PDA, portable memory audio player, handheld game machine, and others.

Pin arrangement



Outline10pin DFN

Block Diagram



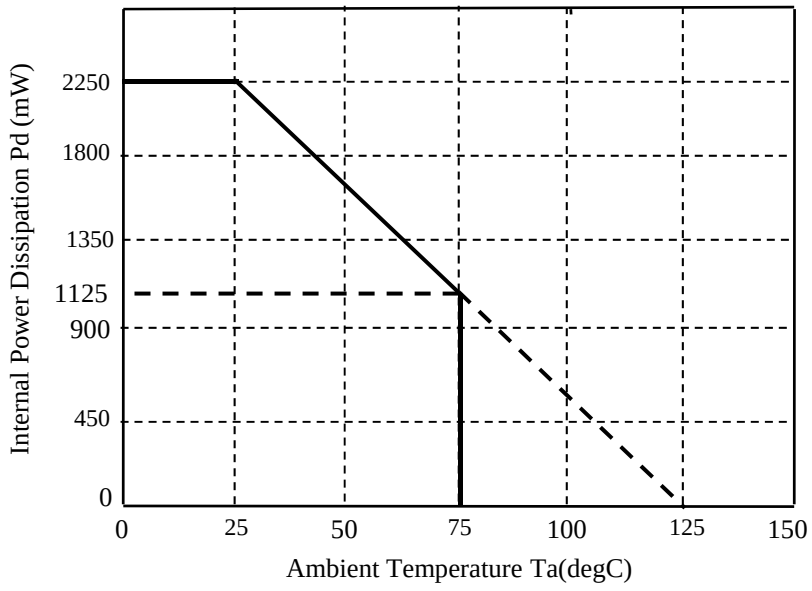
Pin description

No	Pin Name	I/O	Function	Protection Diode	
				Positive	Negative
1	VCC	I	Power supply & charge transistor input	-	GND
2	Rosc	O	Oscillation frequency adjustment	VCC	GND
3	LED	O	LED drive (under charge : ON [H])	VCC	GND
4	GND	O	Ground	-	-
5	VDD	0	Reference voltage terminal for battery temperature detection	VCC	GND
6	TH	I	Battery temperature detection terminal (Thermistor connection terminal)	VCC	GND
7	TMRcnt	I	Timer ON/OFF control H:Timer stop L or OPEN: Timer permission	-	GND
8	RICHG	I	For setting the charge current value	VCC	GND
9	VSENCE	I	Battery voltage detection & constant voltage charge control	-	GND
10	BAT	O	Charge transistor output (charge current output)	-	GND

Absolute Maximum Ratings (Ta=25degC, VCC=5V, unless otherwise specified.)

Item	Symbol	Ratings	Unit	Remark
Maximum applied voltage	Vmax	-0.3~6.5	V	All terminal
Allowable power dissipation *	Pd	2250	mW	When IC is mounted on a board in the conditions below. This value will change depending upon the material of a board, wind speed, etc.
Operating temperature range	Topr	-20~+75	degC	
Storage temperature range	Tstg	-40~+125	degC	
Output current	Iout	1.5	A	
LED input current	Iled	20	mA	

* Board material : FR-4
  Board size : 40 x 40 x 1.6mm
  Cu share : 50%
  Wind velocity : 0m/sec.
  Ambient temperature : 25degC



Thermal Derating Curve

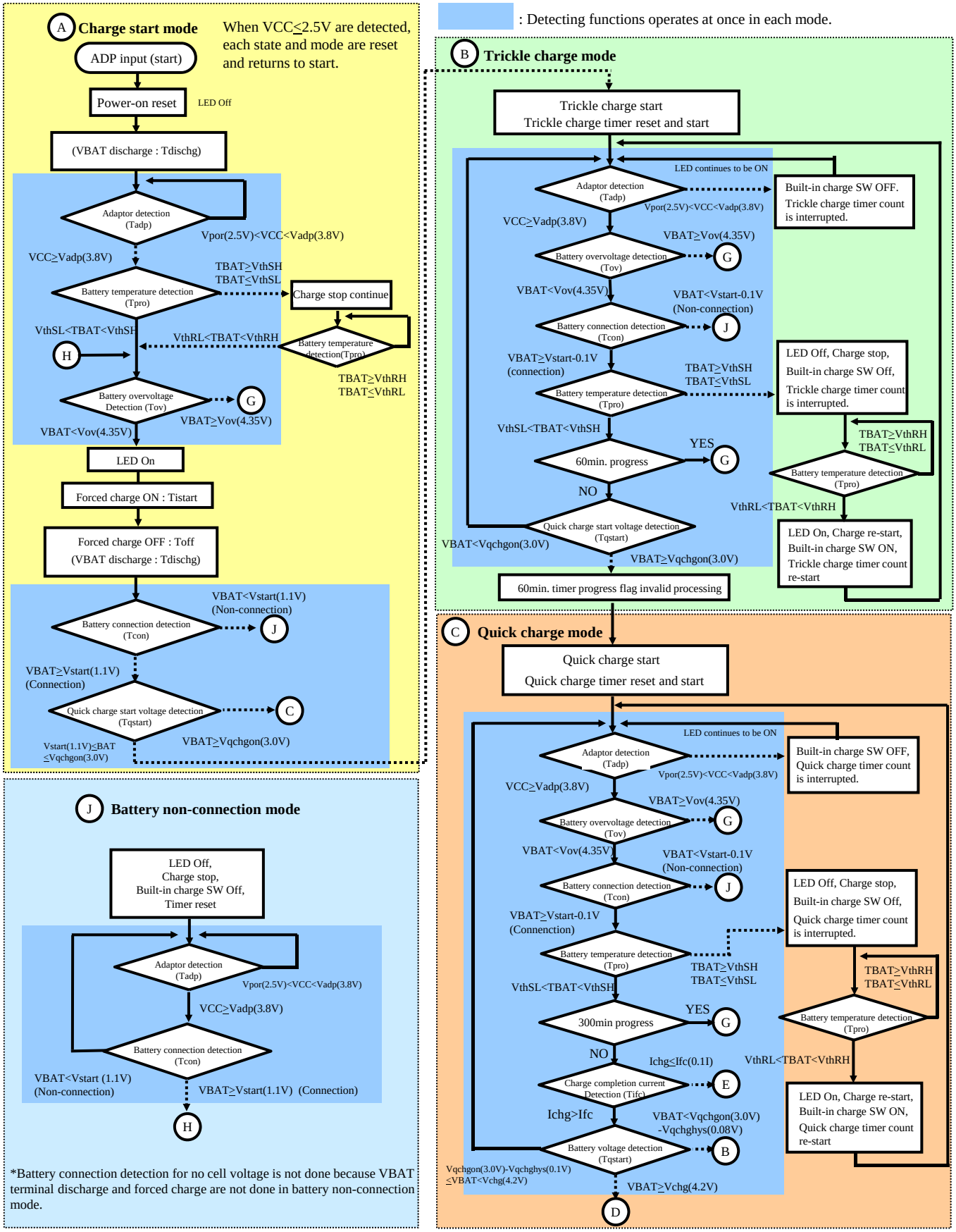
Electrical Characteristics (Ta=25degC, VCC=5V, unless otherwise specified.)

Block	Item	Symbol	Condition	Rated value			Unit
				Min	Typ	Max	
All	Power supply voltage range	Vcc		4.0	5.0	5.8	V
	Circuit current	Icc	Under charge (charge current = 500mA)	-	3.0	4.5	mA
	Adaptor detection voltage	Vadp		3.6	3.8	4.0	V
	Battery discharge current *)	Ibatout	VBAT=1.1~4.2V:When adaptor is not connected or charge is completed(ADP=4.8V).	-	1.0	2.0	uA
	VSENSE discharge current 1	Idischg 1	VBAT=3.2V :In charge error mode	-	10	20	uA
	Reference voltage for battery temperature detection	VDD	VDD terminal voltage	2.4	2.5	2.6	V
Battery voltage detection block	Charge start voltage (Overdischarge protection)	Vstart	Battery connection detection is shared. (Charge is not done to the battery under charge start voltage.)	1.0	1.1	1.2	V
	Charge start voltage hysteresis	Vstarthys	Battery disconnection detection is shared.	50	100	150	mV
	Quick charge start voltage	Vqchgon	Detected voltage at battery voltage rise	2.9	3.0	3.1	V
	Quick charge start voltage hysteresis	Vqchghys	Detected voltage at battery voltage drop	40	80	120	mV
	Recharge start voltage	Vrechg		3.87	3.97	4.07	V
	Charge control voltage	Vchg		4.17	4.20	4.23	V
	Overvoltage detection voltage	Vov	VADP=Vov+70mV	4.27	4.35	4.43	V
Battery Temperature Detection block	Charge stop temperature detection voltage (Low temp.)	VthSL	Detected voltage at battery temperature falling (Lower temp. side) : worth 2 degC.	VDD* 0.6966	VDD* 0.7142	VDD* 0.7313	V
	Charge re-start temperature detection voltage (Low temp.)	VthRL	Detected voltage at battery temperature rising (Lower temp. side) : worth 4 degC.	VDD* 0.6787	VDD* 0.6966	VDD* 0.7141	V
	Charge stop temperature detection voltage (High temp.)	VthSH	Detected voltage at battery temperature rising (Higher temp. side) : worth 43 degC.	VDD* 0.3296	VDD* 0.3448	VDD* 0.3604	V
	Charge re-start temperature detection voltage (High temp.)	VthRH	Detected voltage at battery temperature falling (Higher temp. side) : worth 38 degC.	VDD* 0.3684	VDD* 0.3847	VDD* 0.4014	V
Charge current detection block	Quick charge current 1 (1.0C)	Irapchg1	RICHG=2.32kohm, VBAT=3.6V	520	560	600	mA
	Trickle charge control current 1(0.1C)	Iprechg1	RICHG=2.32kohm, VBAT=2.6V	40	56	72	mA
	Forced charge current (0.3C)	Istart	RICHG=2.32kohm	120	170	220	mA
	Charge completion current	Ifc	RICHG=2.32kohm, VBAT≥4.0V	40	56	72	mA
Timer circuit block	Oscillation frequency	Foc	Rosc=100kohm	57.6	64	70.4	KHz
	LED blinking cycle	Fled	Rosc=100kohm, in charge error mode (design guarantee)	0.922	1.024	1.126	sec
	Quick charge timer	Tchg	Time from quick charge start to charge completion judgment (Rosc=100kohm)	270	300	330	min
	Trickle charge timer	Tdchg	Time from trickle charge start to quick charge start (Rosc=100kohm)	54	60	66	min
LED control Block	LED terminal output"H" voltage	Vledh	Isource=10mA	Vcc-0.6	-	-	V
	LED terminal leakage current	Iledleak	Vled=5V	-1	-	1	uA
Others	TMRcnt terminal "L" voltage	Vtmrl		-	-	0.5	V
	TMRcnt terminal "H" voltage	Vtmrh		2.0	-	-	V
	TMRcnt terminal input current	Itmr	Vin=5.0V	-	-	10	uA
	Chip temperature detection	Ttreg	Chip temperature (design guarantee)	83	93	103	degC
	Chip temperature detection hysteresis	Ttreghys	For releasing the thermal regulation	5	10	15	degC
	Chip temperature reset detection	Ttregrst	Chip temperature (design guarantee)	110	120	130	degC
	Thermal shutdown temperature	Tsd	Chip temperature (design guarantee)		150		degC
	Charge Tr ON resistance	Ron	Contains package lead resistance	-	0.45	0.6	ohm

Flow chart

Battery overvoltage detection and thermal shutdown are always operative after power-on reset.
Adapter detection is always operative after BAT terminal discharge after power-on reset.
Comparison of VCC and BAT is always operative in all state.

: Detecting functions operates at once in each mode.



*Battery connection detection for no cell voltage is not done because VBAT terminal discharge and forced charge are not done in battery non-connection mode.

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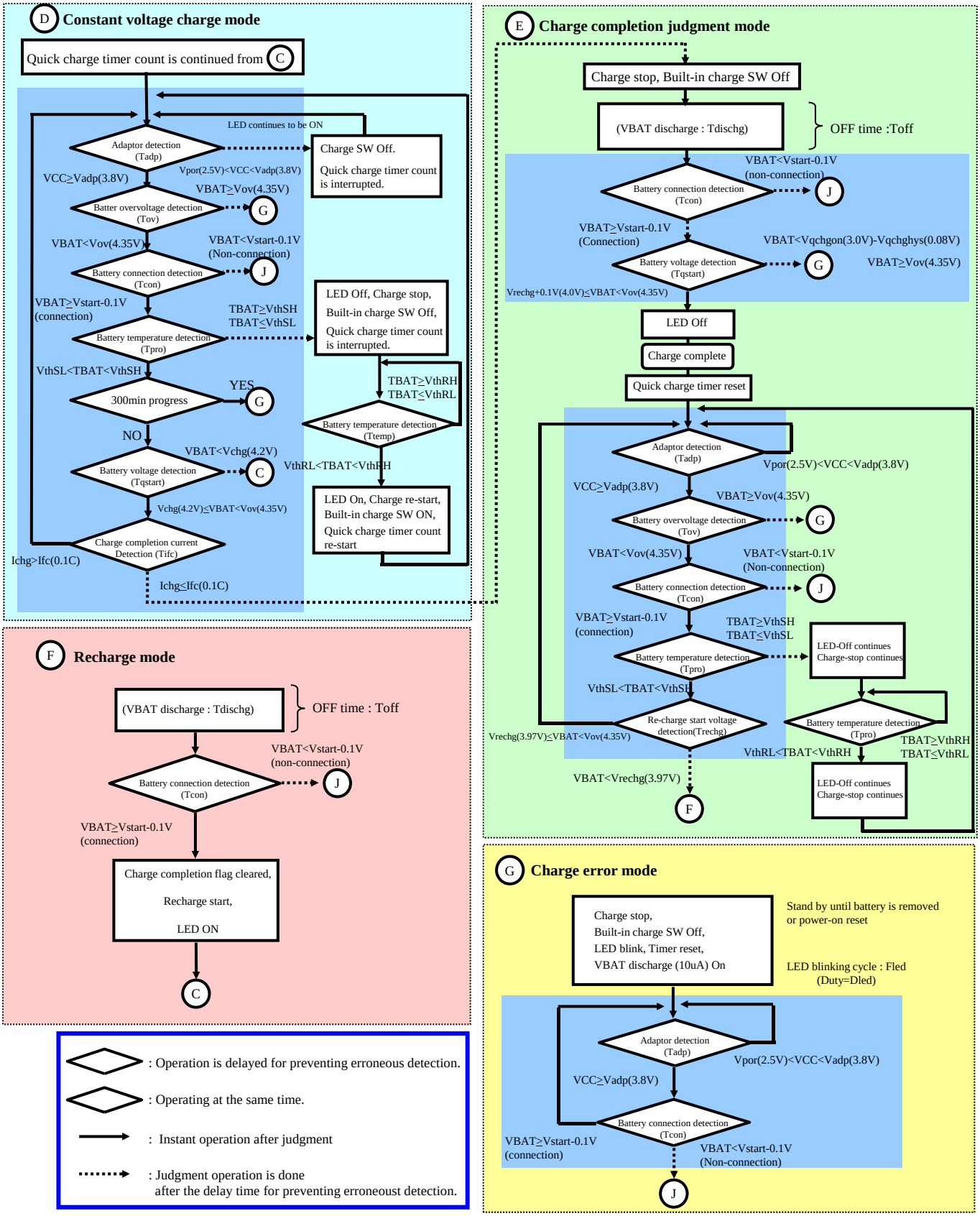
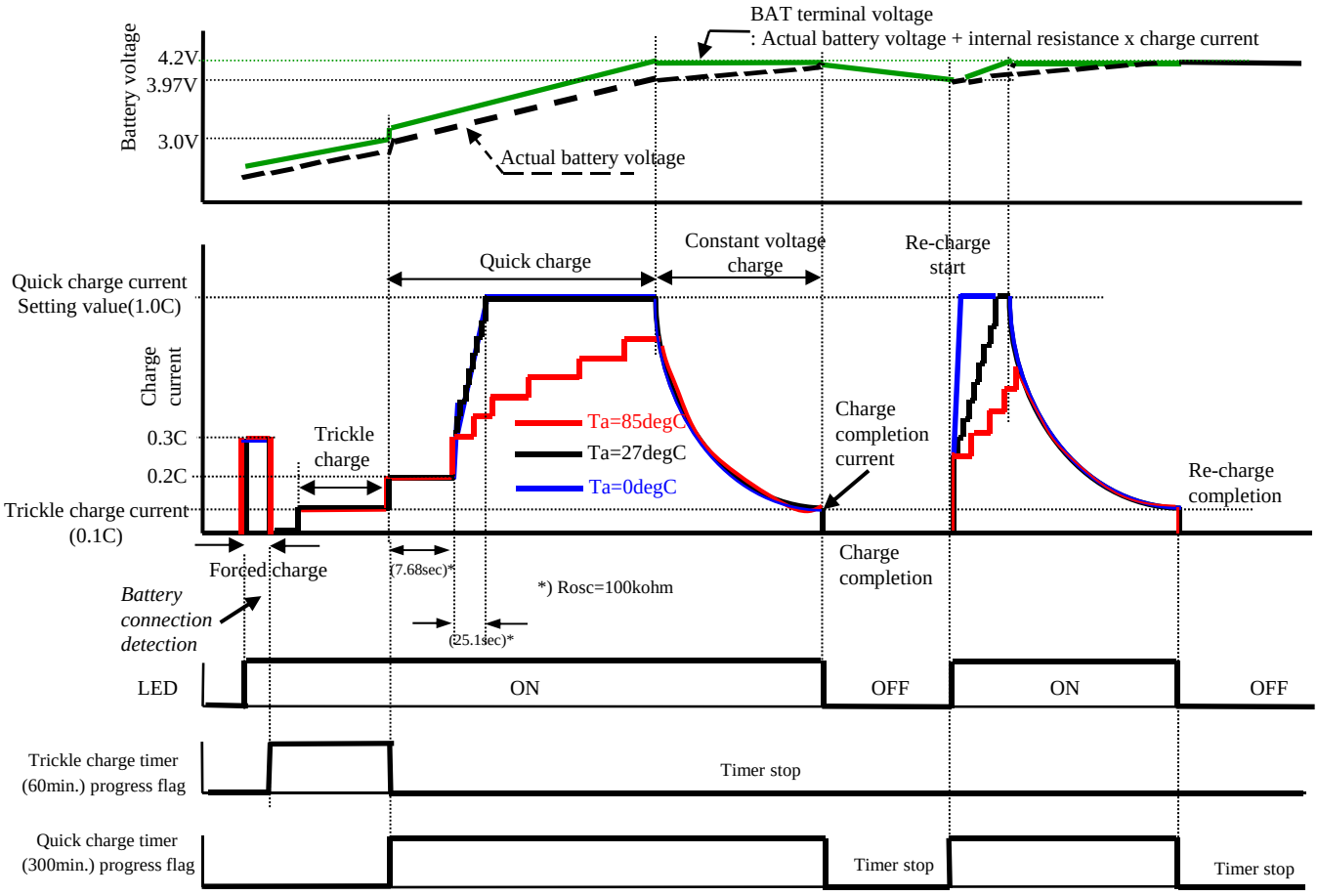
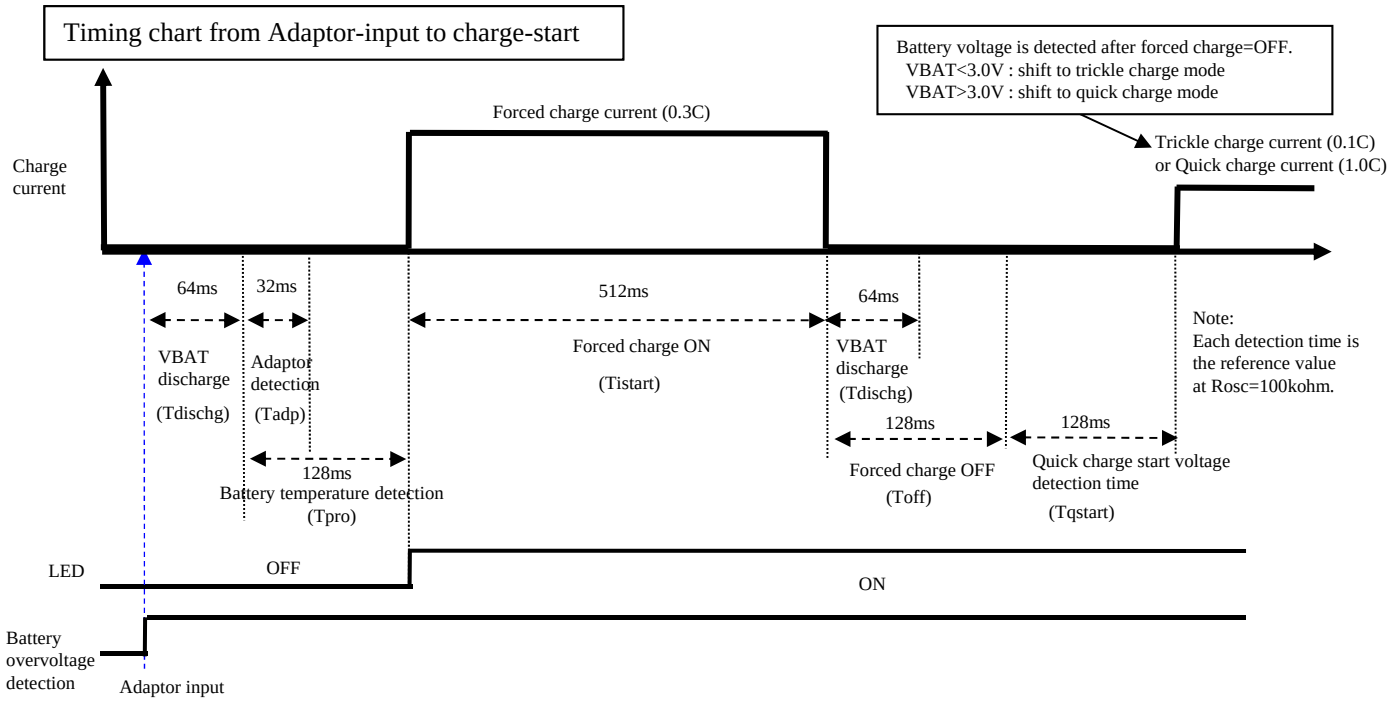


Timing chart





Operational Description

■ Adaptor detection

Adaptor connection is detected.
VCC≥3.8V : Adapter connection is detected to be connected. (charge permission)
VCC≤2.5V : Adapter connection is detected to be disconnected. (mode is reset and returns to start.)

Each detecting operation during adaptor detection is as follows.
- Battery connection/disconnection : count valid (continues to detect without suspending.)
- Quick charge start voltage detection : count suspended
- Charge completion current/voltage detection : count suspended
- Recharge start voltage detection : count suspended
- Chip temperature detection : count reset

(When adaptor is detected in quick charge mode, IC starts to charge at 0.2C.(VCC≥Vadp))

During below charge Off time, IC continues to count even if the adaptor is detected.
- Forced charge Off time after forced charge completed.
- Charge Off time from quick charge to charge completion.
- Charge Off time from charge completion to quick charge.

When adaptor is detected in forced charge mode, forced charge mode is reset and it is restarted after released adaptor detection.

■ Battery connect detection

When adapter is detected, forced charge (0.3C) is started for canceling the cutoff state of battery due to overdischarge protection.
Then, forced charge is stopped and battery connection is detected.
Battery connection detection has a hysteresis characteristic and the battery disconnection judgment voltage after battery connection detection is battery connection detection voltage -100mV.

1) Battery connect detection
- Battery voltage(BAT)≥1.1V : Battery connection is detected to be connected, and charge is started.
- Battery voltage(BAT)≤1.1V : Battery connection is detected to be disconnected (overdischarge protection) ,and charge stops.

2) Battery disconnect detection (under charge)
- When the battery is disconnected under charge, the state shifts to CV control mode (charge current does not flow). Therefore, the state shifts to charge completion judgment mode. In this time, built-in charge transistor is to be OFF, and BAT terminal voltage falls. When BAT terminal < 1.0V, battery connection is detected to be disconnected, and charge stops. ,and the state shifts to battery non-connection mode. (overdischarge protection)

3) Battery disconnect detection (when charge is stopped)
- In this condition, when the battery connection is detected to be disconnected, BAT terminal voltage falls. because built-in charge transistor is already OFF. When BAT terminal < 1.0V, battery connection is detected to be disconnected ,and the state shifts to battery non-connection mode. (overdischarge protection)

■ Trickle charge (0.1C constant current charge)

After adaptor connection judgment and battery connection judgment, trickle charge is started when battery voltage is as follows.

1.1V≤battery voltage≤3.0V

During the trickle charge mode, VSENSE terminal is discharged by 300uA current.
- When battery voltage ≥ 3.0V, the state shifts to quick charge mode.
- Trickle charge timer operates simultaneously with trickle charge start.
- After trickle charge timer expires, when battery voltage < 3.0V, the state shifts to charge error mode.
- When adaptor voltage is battery voltage or less, charge stops.
- When battery voltage ≥4.35V(overvoltage), the state shifts to charge error mode.

■ Quick charge (1.0C constant current charge)

Quick charge is started when battery voltage ≥ 3.0V.
During the quick charge mode, VSENSE terminal is discharged by 300uA current.
- When battery voltage is detected to be 4.2V, the state shifts to CV charge mode.
- Quick charge timer operates simultaneously with quick charge start.
- After quick charge timer expires, when the state is not in charge completion mode , it shifts to a charge error mode.
- When battery voltage is detected to be less than 2.92V, the state shifts to trickle charge mode.
- When adaptor voltage is detected to be battery voltage or less, charge stops.
- When battery voltage is detected to be 4.35V or more, the state shifts to charge error mode.

During quick charge, junction temperature is monitored to limit charge current value between 0.2C-1.0C so that the junction temperature may not exceed Ttreg.

Charge current 1.0C = [Reference voltage(1.495V) / RICHG] x (820~920) * (mA)
* The coefficient changes by the charging current.

Reference : Charge current setting (subject to change)

RICHG resistor(Kohm)	Quick charge current setting(1.0C)(mA)
1.30	1000
1.40	900
1.59	800
1.85	700
2.15	600
2.63	500
3.30	400
4.40	300
6.70	200

■ Constant voltage charge

When battery voltage is detected to be 4.2V under quick charge, constant voltage charge of 4.2V is started.
- If the charge current falls to charge completion current or less under constant voltage charge, the state shifts to charge completion judgment mode.
- When 3.0V ≤ battery voltage < 4.2V is detected, the state shifts to quick charge mode.
- When adapter voltage is detected to be battery voltage or less, charge stops.
- When battery voltage is detected to be 4.35V or more(overvoltage), the state shifts to charge error mode.

■ Charge completion judgment mode

When battery voltage ≥3.0V and charge current ≤ charge completion current
, the state shifts to charge completion judgment mode.
During charge completion judgment mode, charge transistor is turned off and battery voltage is monitored.

Battery voltage after charge transistor is OFF :
- When battery voltage≥2.92V, charge completes.
- When 1.1V≤battery voltage <2.92V, the state shifts to charge error mode.
- When battery voltage < 1.1V, charge stops by battery disconnect detection.

And when the state shifts to charge completion mode, quick charge timer is reset.

■ Recharge function

After charge completion, battery voltage continues to be monitored.
When battery voltage < 3.97V, recharge is started.
Quick charge timer also operates simultaneously with recharge start.

■ Battery temperature detection function

Battery temperature is detected by TH terminal voltage.
- Low temperature side:
  Charge stops when battery temperature(falling) is worth 2 degC.
  Charge restarts when battery temperature(rising) is worth 4 degC.
- High temperature side:
  Charge stops when battery temperature(rising) is worth 43 degC.
  Charge restarts when battery temperature(falling) is worth 38 degC.

During charge stops, LED becomes OFF.(Timer is suspended during charge)
After charge restarts, the state return to the state before it stopped.

■ Timer ON/OFF control function

When “H” signal is input to TMRcnt terminal, timer can be suspended forcefully.
Even under charge, when “H” signal is input to TMRcnt terminal, timer is stopped and reset.
When TMRcnt terminal is "L" or "open", timer is enabled and timer operation is started.

■ Charge error mode

The state shifts to charge error mode and charge stops,
when conditions are as follows,
- Overvoltage detection
- Thermal shutdown detection
- After trickle charge timer or quick charge timer expires.
- When 1.1V ≤ battery voltage < 2.92V is detected.
  (while battery voltage is monitored in charge completion judgment mode.)

When the following conditions are detected, charge error mode is canceled.
- When battery voltage is detected to be less than 1.0V(battery is judged to be disconnected.)
- When battery voltage is detected to be 2.5V or less.(power-on reset)

While charge error mode, the battery discharge current is 10uA.

■ Thermal shutdown

When junction temperature becomes 140degC under charge, the state shifts to charge error mode.

■ Built-in erroneous detection protection

The judgment result is decided delayed by the built-in erroneous detection protection circuit.
Each detection delay time is set by the internal clock.
Refer to Page-5 “Detection time”about each detection time.

Each detection time (Rosc=100kohm)

Item	Symbol	Reference value
Adaptor detection time 1 (when rising)	Tadp1	8msec x 4 times = 32msec
Adaptor detection time 2 (when falling)	Tadp2	8msec x 4 times = 32msec
VCC/BAT voltage comparison	-	Non detection time (judged immediately)
Battery connect detection time	Tcon	32msec x 4 times = 128msec
Quick charge start voltage detection time	Tqstart	32msec x 4 times = 128msec
Charge completion current detection time	Tifc	64msec x 4 times = 256msec
Charge completion voltage detection time *)	Tvfc	32msec x 4 times = 128msec
Recharge start voltage detection time	Trechg	64msec x 4 times = 256msec
Battery overvoltage detection time	Tov	32msec x 4 times = 128msec
Forced charge time	Tistart	512msec
OFF time after forced charge	Toff	128msec
Battery temperature detection time	Tpro	32msec x 4 times = 128msec

*) In the case of Battery voltage $\geq$ 2.9V(completed normally)

Reference: Oscillation frequency setting (subject to change)

Rosc resistor(Kohm)	Oscillation frequency (KHz)
1000	7.5
510	14.1
300	23.5
200	33.9
100	64.0
51	109.3

If the oscillation frequency is changed, each timer and detection time will also change.
（Each time is to change by the change rate of oscillation frequency.)
The precision of each parameter is $\pm$15%(reference value) except when using 100kohm resistor for Rosc.
IC operates at fosc=650kHz when Rosc terminal is shortcircuited to GND.

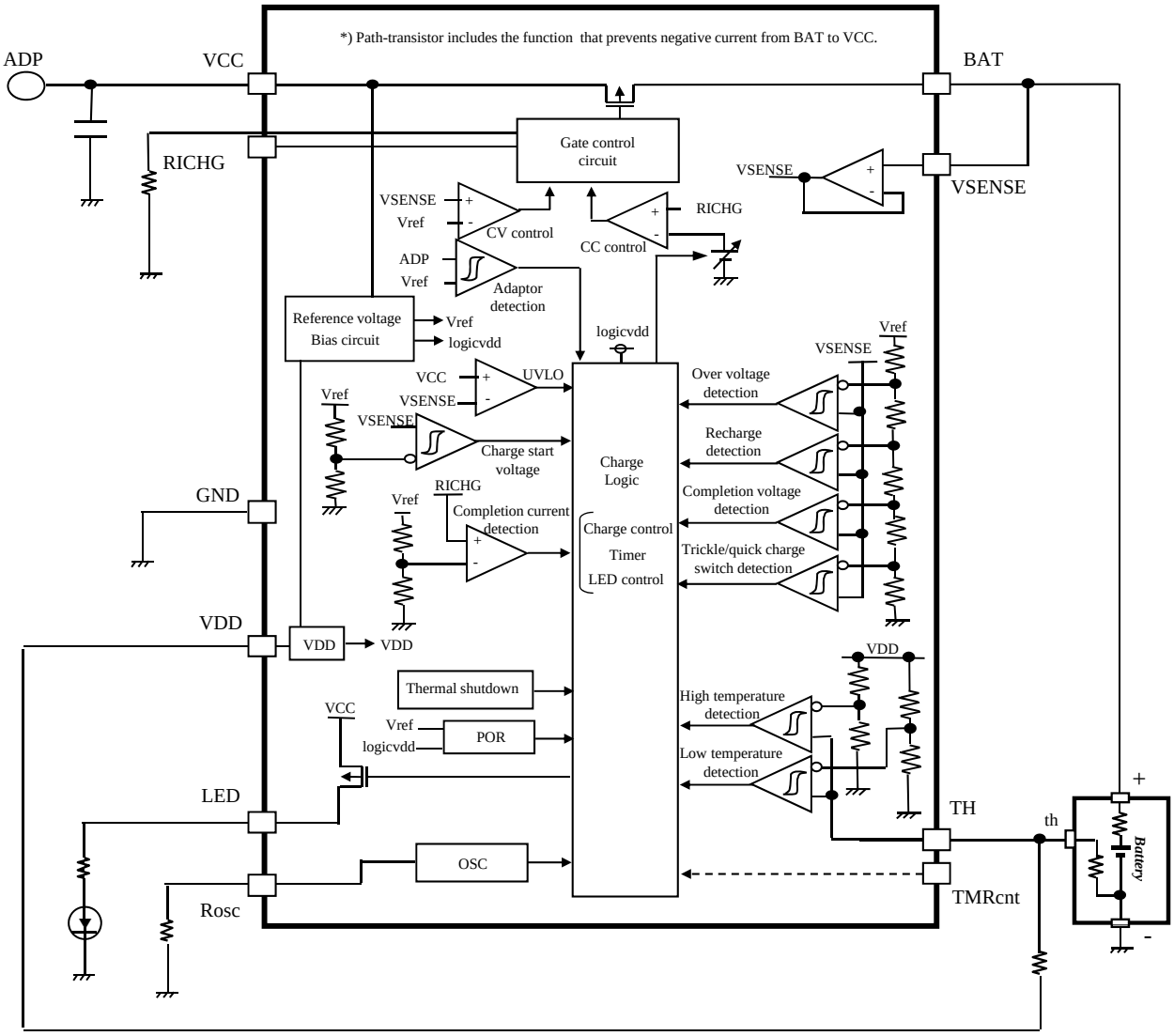
■ LED control block

LED lighting specification is as below.

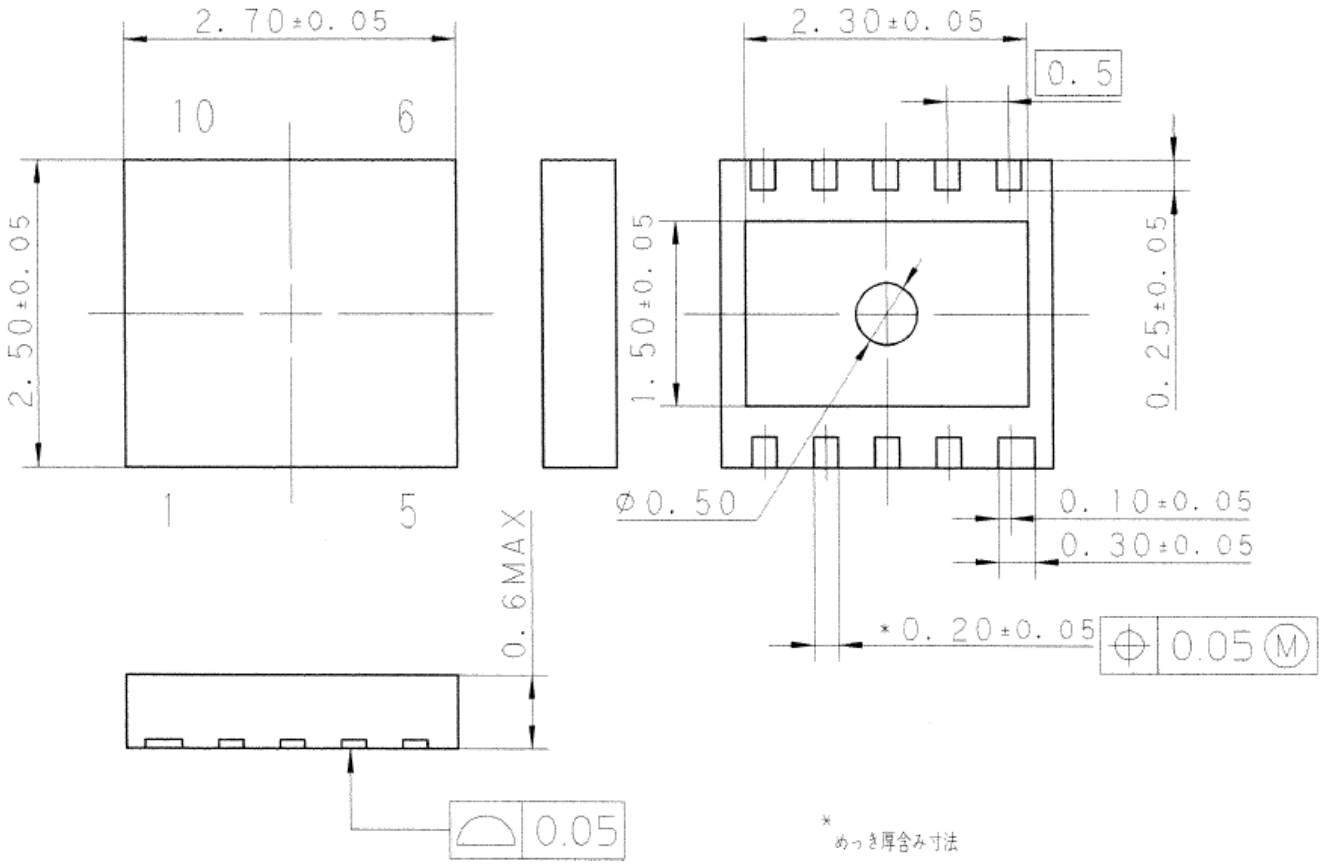
LED lighting table

Mode	LED
Standby	OFF
Under charge	ON
Charge completion	OFF
Recharge	ON
Charge error	Blink
Battery temperature protection	OFF

Application circuit



Package



* めっき厚含み寸法

* Dimension including the plating thickness

(単位 unit : mm)

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