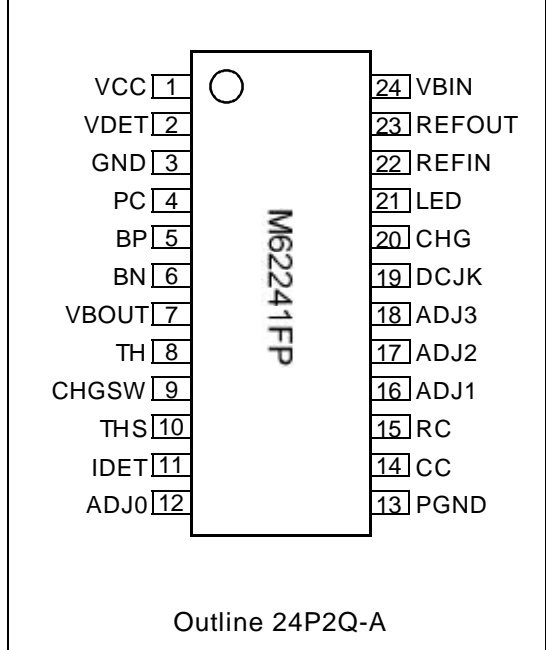## SINGLE CHIP BATTERY CHARGER CONTROL IC

DESCRIPTION

The M62241FP is designed as 1chip Integrated Circuit for controlling battery charger. This IC contains analog circuits needed for controlling charge, and time-sequential-control logic circuits. This IC has various functions such as not only charge-controlling but also battery temperature detection, protection against over-current / over-voltage, and safety timer. The combination with some parts gives a charge circuit for Lithium-ion battery easily.

FEATURE

● Designed to operate at as low as 4V
● CR oscillation circuit for internal logic
● Terminating timer for preventing overcharge
  30min. indicating timer
● Main output switch drive circuit
● LED drive circuit (1 system)to indicate charging status
● System reset circuit for detecting the lowering of supply voltage
● Temperature detection for Lithium-ion battery
● Voltage/current control for feedback to the primary side of switching regulator
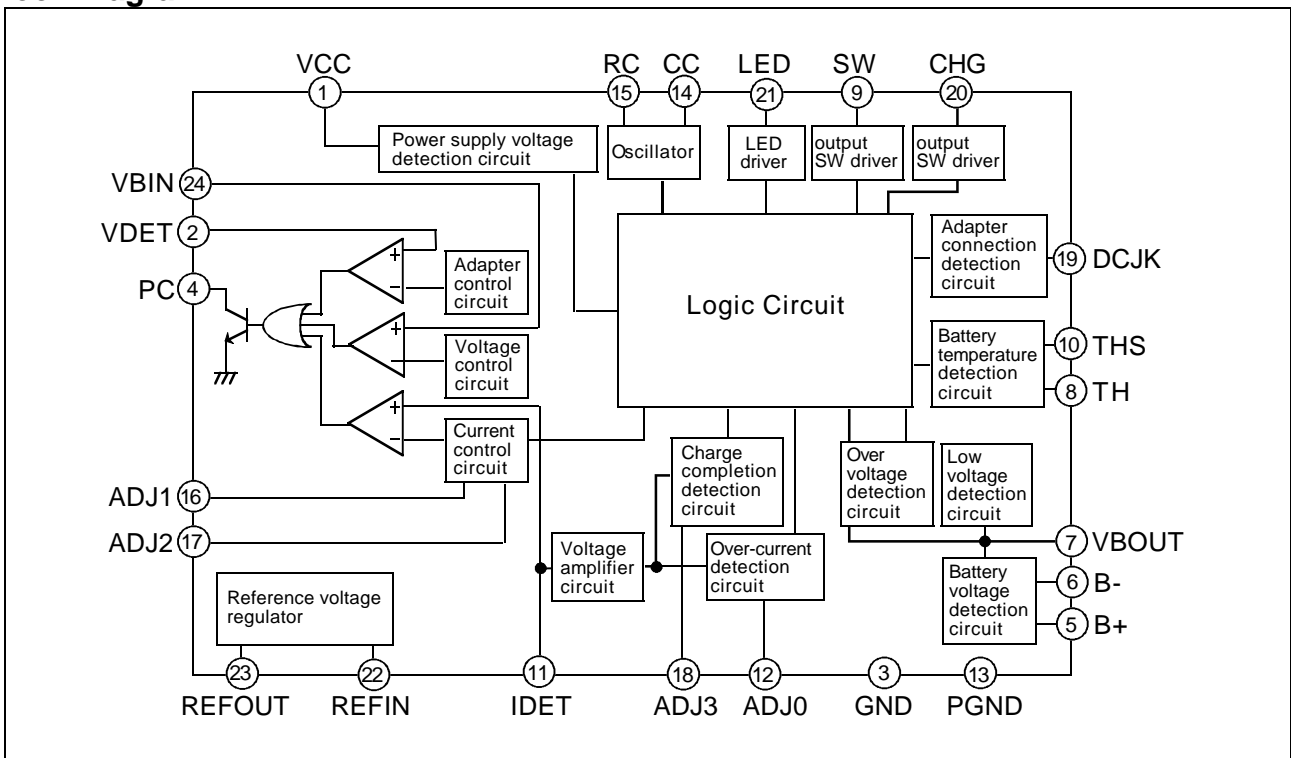● Various protections such as overvoltage detection at charging, overcurrent detection at adaptor connection

PIN configuration (Top view)

VCC	1	
VDET	2	
GND	3	
PC	4	
BP	5	
BN	6	
VBOUT	7	
TH	8	
CHGSW	9	
THS	10	
IDET	11	
ADJ0	12	

M62241FP

24	VBIN	
23	REFOUT	
22	REFIN	
21	LED	
20	CHG	
19	DCJK	
18	ADJ3	
17	ADJ2	
16	ADJ1	
15	RC	
14	CC	
13	PGND	

Outline 24P2Q-A

Application

VCR with camera, cellular phone, battery charger for general electronic equipments.

Block Diagram

DESCRIPTION OF TERMINALS

| Pin No.	Symbol	Input/Output	Functions
1	VCC	-	Power supply
2	VDET	Input	Detecting Adapter output voltage and Connecting capacitor for phase compensation to the charge constant voltage control circuit
3	GND	-	The ground pin for signal unit
4	PC	Output	Driving photo coupler for feedback(opened collector,including resistance for pulled up)
5	BP(B+)	Input	Monitoring the battery voltage.Input the 1/3 battery voltage gained differentially to control charge constant voltage and to detect each voltages.
6	BN(B-)	Input	
7	VBOUT	Output	Outputting the voltage gained differentially from the battery voltage
8	TH	Input	Detecting the battery connection and the battery temperature
9	CHGSW	Output	Driving charge SW transistor(opened collector,including the circuit driving the constant current)
10	THS	-	The ground pin for the circuit generating the referential voltage to compare with TH pin voltage
11	IDET	Input	Detecting output current and Connecting capacitor for phase compensation to the charge constant current control circuit
12	ADJ0	Input	Setting the current of over current.The referential voltage is decided by dividing external resistances.
13	PGND	-	The ground pin for power unit
14	CC	Output	Setting frequency for inside clock by CR oscillator
15	RC	Output	
16	ADJ1	Input	Setting quick charge current.The referential voltage is decided by dividing external resistances.
17	ADJ2	Input	Setting trickle current.The referential voltage is decided by dividing external resistances.
18	ADJ3	Input	Setting the charge completion current.The referential voltage is decided by dividing external resistances.
19	DCJK	Input	Detecting the connection of DC JACK.(including resistance for pulled up)
20	CHG	Output	Switching charge mode
21	LED	Output	Driving LED(opened collector,including the circuit driving constant current)
22	REFIN	Input	Controlling the referential voltage
23	REFOUT	Output	Providing the referential voltage
24	VBIN	Input	For inputting the charge constant voltage Amp. and Connecting capacitor for phase compensation to the charge constant voltage control circuit

Absolute Maximum Ratings

(Ta=25°C,unless otherwise noted)

Parameter	Symbol	Ratings	Unit
Supply voltage	Vccmx	16.0	V
Power dissipation	Pd	1200	mW
Thermal derating	Ktheta	-12.0	mW/°C
Operating temperature	Topr	-20 to +75	°C
Storage temperature	Tstg	-40 to +125	°C
Function Supply voltage range	Vcc	4.0 to 15.0	V
CHGSW pin drive current	Idchgsw	50.0	mA
CHGSW pin low output voltage(Iol=30mA)	Vlchgsw	0.6	V
LED pin driving current	Idled	20.0	mA
LED pin low output voltage(Iol=10mA)	Vlled	0.6	V
PC pin driving current	Idpc	20.0	mA
PC pin low output voltage(Iol=10.0mA)	Vlpc	0.6	V
CHG pin driving current	Idchg	1.0	mA
CHG pin low output voltage(Iol=1.0mA)	Vlchg	0.6	V
Input pin input voltage range	Vin	0 to Vcc	V
Endurable voltage of open output interception	Voc	Vcc	V
REFOUT pin output voltage	Vrefout	1.3 to 3.1	V
REFOUT pin output current(Vrefout=3.1V)	Irefout	2.0	mA
REFOUT input/output voltage gap	Vdrefout	0.9	V

THERMAL DERATING (MAXIMUM RATING)
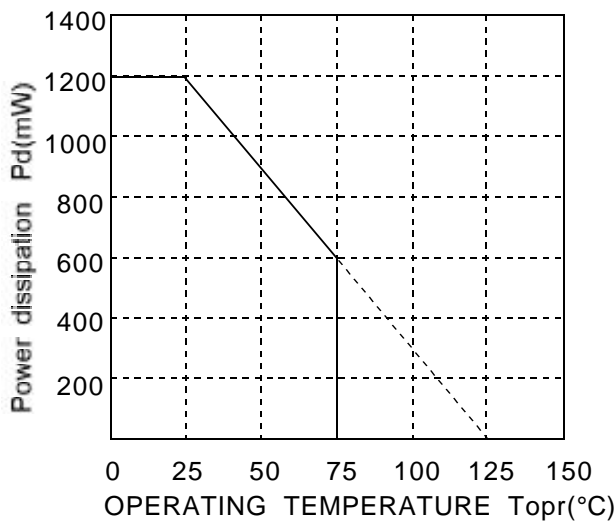
FUNCTION OUTLINE

1)Adapter voltage control
2)Lithium Constant current/voltage charge control
3)Battery connect detection
4)Battery temperature detection
5)Battery voltage detection
6)Charge current detection
7)LED Indication
8)Timer
9)Adapter mode change

M62241FP

SINGLE CHIP BATTERY CHARGER CONTROL IC

ELECTRICAL CHARACTERISTICS

(Vcc=9.0V, Vrefout=2.783V,Ta=25°C)

Block	Parameter	Symbol	Test Conditions	Limits			Unit
				Min.	Typ.	Max.	
Total	Circuit Current	Icc	No Battery connection mode	10.5	14	17.5	mA
Total	Detection voltage of Supply Voltage	Vccrst	Function check after Vcc is beyond Limits Max.	2.8	3.1	3.4	V
Voltage Control/Detection	Adapter Voltage	Vadpt	Function check after Vcc is beyond Limits Max.	7.7	7.9	8.1	V
Voltage Control/Detection	Charge Protection Voltage	Vprot	PC pin output reverses on applying voltage to VDET pin	11.5	12	12.5	V
Voltage Control/Detection	Detection voltage of Over Voltage	Vov	Applying voltage between S+,S-	8.3	8.4	8.5	V
Voltage Control/Detection	Detection voltage of Over Discharge	Vlv	Applying voltage between S+,S-	3.7	4	4.3	V
Voltage Control/Detection	REFIN-pin referential voltage	Vrefin	No connecting load	1.13	1.17	1.21	V
Voltage Control/Detection	Charge Control voltage	Vchg	PC pin output reverses on applying voltage to VDET pin	8.3	8.35	8.4	V
Voltage Control/Detection	Detection voltage of Battery Connection	Vcon	No connecting load	2.454	2.53	2.606	V
Voltage Control/Detection	Detection voltage of temperature protection 1	Vt1	THS=0V	2.081	2.149	2.213	V
Voltage Control/Detection	Hysteresis width of Detection voltage of temperature protection 1	Vt1his	Δt=-5 to -2°C=3°C(±1°C)	45	67	89	mV
Voltage Control/Detection	Detection voltage of temperature protection 2	Vt2	THS=0V	1.708	1.789	1.865	V
Voltage Control/Detection	Hysteresis width of Detection voltage of temperature protection 2	Vt2his	Δt=13 to 10°C=3°C(±1°C)	52	81	106	mV
Voltage Control/Detection	Detection voltage of temperature protection 3	Vt3	THS=0V	0.766	0.823	0.877	V
Voltage Control/Detection	Hysteresis width of Detection voltage of temperature protection 3	Vt3his	Δt=55 to 50°C=5°C(±1°C)	79	101	112	mV
Voltage Control/Detection	Detection voltage of temperature protection 4	Vt4	THS=0V	0.675	0.722	0.781	V
Voltage Control/Detection	Hysteresis width of Detection voltage of temperature protection 4	vt4his	Δt=60 to 55°C=5°C(±1°C)	60	80	91	mV
Current Control/Detection	Quick charge current	Irpd	PC pin output reverses on applying voltage to ADJ1 pin	1.33	1.4	1.47	V
Current Control/Detection	Trickle charge current	Itri	PC pin output reverses on applying voltage to ADJ2 pin	0.4	0.44	0.48	A
Current Control/Detection	Charge Completion current	Ifc	Applying voltage to IDET pin	0.15	0.2	0.25	A
Current Control/Detection	Adapter Over current	Ioc	Applying voltage to IDET pin	1.67	1.81	1.95	A
Adapter Detection	DC JACK-pin H input voltage	Vjkh	Check to be in adapter mode, applying voltage	Vcc-0.7	-	-	V
Adapter Detection	DC JACK-pin L input voltage	Vjkl	(Vcc-2.8 to Vcc-0.7) into DCJK pin	-	-	Vcc-2.8	V
Adapter Detection	Oscillator frequency	Foc	RC=91KΩ,CC=2200pF	3.37	3.64	3.91	KHz
Timer	Charge timer	Tchg	Foc=3.41KHz,Charge mode	1656	1800	1944	min.
Timer	Display timer	Tdisp	Foc=3.41KHz,Charge mode	27.6	30	32.4	min.

FUNCTIONAL DESCRIPTION

<Each voltages written in following are set in standard application circuit.>

1. Adapter Constant Voltage Control

VDET pin supplies this block with voltage to control voltages of both adapter and protection during charge.Control reference voltage ,applied by REFOUT pin , is constant.
Output voltage is generated from dividing the adapter voltage by external two resistors connected to VDET pin and the modification of the dividing ratio of these resistors by CHG pin changes the voltage of Adapter/Charge.

2. Charge Constant Current Control block

IDET pin supplies this block with voltage to control constant current during charge and is controlled directly by the voltage of 0.1Ω resistance ,connected to low side,for the current detection.Control referential voltage is set by ratio between external two resistors connected to REFOUT pin.Buttery temperature detection control performs switching quick and trickle by selecting ADJ pin as follows:.

> Quick charge   : ADJ1pin
> Trickle charge : ADJ2pin

Adapter constant voltage control ,written in 1 clause, is capable of invalidating this control.

3. Charge constant voltage control block

VBIN pin supplies this block with voltage to control constant voltage during charging.
Output voltage of VBOUT pin,gained differentially from battery voltage,supplies to VBIN pin.
Control referential voltage ,applied from REFOUT pin, is constant.

4. Charge SW driving Circuit control block

This block controls SW pin,driving transistor for charging SW.

> Charge off : SW=OPEN
> Charge on : SW=L

5. Battery voltage differential gain block

Battery voltage input from B+/B- pin directly and outputs to VBOUT pin after differential gained.
The gain of Amplifier is 1/3

$$VBOUT=1/3(VB+ - VB-)$$

Input of OPAmp for differential gain or feedback resistance depends on external circuit element.

6. Output current & voltage Amplifier block

The voltage between GND and IDET pin is available to several detector after amplified.
The gain of this amplifier is 13.

> The Gain Range:0 to 2A(Input voltage 0 to 0.2V) ->0.2 to 2.6V

7. Detection of battery connection /battery temperature

This block detects the battery connection and the battery temperature by the input voltage dividing between thermistor inside battery package and resistances outside REFIN pin.

Each referential voltage for detection is set by dividing REFOUT pin voltage by inside resistances.

The dividing circuits are grounded to THS pin connected directly to - terminal of battery to prevent input voltage of TH pin from changing by the current of external circuit.

<1> Battery connection detection

The battery connection is recognized in case the resistance of the thermistor connected to TH pin is less than the following:

Thermistor resistance(Rth): less than approximately 100kΩ

Detecting timing is as follows:

60msec * 2 times =120msec(Foc=3.41KHz)

<2> Battery temperature detection

This block controls to switch charging after detecting the battery temperature by the dividing ratio between resistance pulled up and thermistors.

Detecting timing is as follows:

60msec * 2 times =120msec(Foc=3.41KHz)

For further details, read the 20 clause.

8. Over discharge detection block

In case the voltage majored before starting to charge is less than the detection voltage, the over discharge mode is taken over before waiting. It continues to wait until the battery charges from external circuit and the charge mode is taken over after the voltage becomes more than the detection voltage. The differential gain output voltage of the battery is majored at this block.

The referential voltage for detecting is set by the dividing ratio between resistors connected to the REFOUT pin.

The Over Discharge detection voltage (V Blow) is 4.0V.

This detection is disregarded during charging.

The detection timing is as follows:

300msec *4 times = 1.2sec. (foc=3.41kHz)

9. Over Voltage detection block

NG mode is taken over ,in case the voltage majored before starting to charge is more than the following voltage. The referential voltage for detecting is REFOUT output voltage.

The over detection voltage(Vbhigh) is VREFOUT.

This detection is disregarded during charging.

The detection timing is as follows:

300msec *4 times = 1.2sec. (foc=3.41kHz)

10 The charge completion detection block

The charge completion mode is taken over in case the charge current in charge mode is less than the detection current.

This detection depends on the gained current output.

The referential voltage for detection is set by the dividing ratio between resistors connected to ADJ3 pin. This detection is discharged except during charging.

The detection timings is as follows:

600msec *8 times = 4.8sec. (foc=3.41kHz)

11. The Adapter Over Current mode

The Unusual mode is taken over in case the current majored in the adapter mode is less than the detection current.

The referential voltage for the detection is set by the dividing ratio between the resistors connected to ADJ0 pin.

The detection is disregarded except in adapter mode.

Detection timing is as follows:

3.0sec *4 times = 12sec. (foc=3.41kHz)

12. LED Driving block

This block controls LED driving pin by each mode.

Adapter mode	: off
No Battery Connection mode	: off
Charge mode	: During Display Timer counting ~~~on/off
	After　Display Timer counting ~~~on
Over Discharge mode	: on/off
Temperature Protection mode	: on/off
Charge Completion mode	: off
Charge NG mode	: off
Unusual mode	: off

*LED on/off timing is 1/1.5Hz(0.9sec. on/0.6sec. off) respectively.

13. The regulated referential power supply block

The charge of output REFOUT pin voltage depends on inside bandgap voltage as the reference and the gained voltage of the changeable resistance connected to REFOUT pin.

This block uses REFOUT output voltage as reference and controls the charge constant voltage and every reference both inside and outside.

REFOUT typical voltage : 1/3 of the battery charge constant voltage

14. Adapter detection block

The Adapter connection input switches the mode as follows:

OPEN(H) detection : Adapter connection

GND(L)　detection : No Adapter connection

The detection timing is as follows:

12msec. * 2times = 24msec(Foc=3.41KHz)

15. Adapter mode control block

The detection of adapter connection changes all modes except unusual mode into adapter mode.

The Next mode after adapter mode depends on the previous mode.

Previous mode	->	Next mode
No connection	->	No connection
Charge	->	Charge(after initialization)
Over discharge	->	Charge(after initialization)
Temperature Protection	->	Charge(after initialization)
Charge Completion	->	Charge Completion
Charge NG	->	Charge NG

*The detection of No battery connecting during Adapter mode disregards the previous mode and takes over No battery mode.

16. PC driving block

The control to the PC pin,for driving Photo Coupler, depends on each control of Adapter constant voltage,Charge constant current and Charge constant voltage.

Vcc side   : Photo Coupler off, output voltage rising

GND side : Photo Coupler on, output voltage falling

17.PC short control block

The Unusual mode is taken over in case the over current is detected during the Adapter mode. This block is capable of fixing PC output into Vcc side and shutting down the primary power supply current. All input and detection are disregarded in the Unusual mode. Only reset is capable of returning from Unusual mode.

18.AC check detection block

AC Power off is recognized and Adapter mode is taken over, in case the PC pin voltage continues more than the following voltage in certain period:

AC check voltage (Vacchk: Vcc-0.8V)

The detection timing is as follows:

60 msec. * 16times=960msec.(Foc=3.41KHz)

19. Timer Block

(1) Waiting timer after battery connection

This block pauses for following period from the battery connection detection to starting charge , so that every input is decided.

Waiting time : approximately 3.2 sec(Foc=3.41KHz)

(2) Display Timer

Counting the following time after starting to charge switches display from on/off to on.

Display timer : 30 minutes (Foc=3.41 KHz)

In trickle charge mode,this timer pauses to count. This timer resets counting to initialize before charge restarting,in case the charge as counting or pausing stops because of the charge to the adapter mode or the temperature protection mode.

Example of Display Timer

<1>In case charging starts in quick mode,

Charging		Counting End		Charge Completion
Quick Counting 30min		Counting End		
on/off			on	off
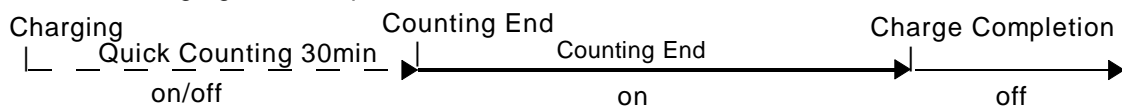
<2> In case quick mode starts ,then trickle mode is taken over after counting is end,

Charging	Counting end	Mode Change	Charge Completion
Quick Counting 30min	Quick Counting end	Trickle Counting end	
on/off		on	off

<3> In case charging starts in trickle mode,

Charging		Charge Completion
	Quick Counting off	
	on/off	off
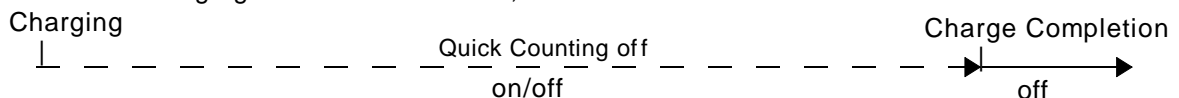
<4> In case it returns quick mode after charging starts in trickle mode,

Charging Mode Change   Counting End   Charge Completion

|̲ Trickle of f ̲▶|̲ _ _ _ Quick Counting 30min _ _ ▶|̲ _ _ Counting End _ _ ▶|̲ _____▶

   on/off   on/off   on   off
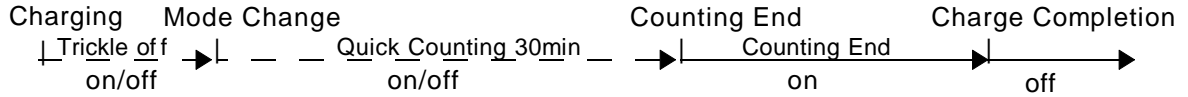
<5> In case quick mode starts, then trickle mode is taken over and then quick mode restarts,

Charging Mode Change Mode Change   Counting End   Charge Completion

|̲ Quick Counting ̲▶|̲ Trickle of f ̲▶|Quick Counting(remaining time) ̲▶|̲ _ Counting End _ ▶|̲ ___▶

   on/off   on/off   on/off   on   off
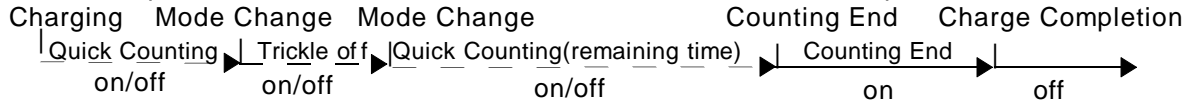
<6> In case quick mode starts, and then charging completes before counter is end,

Charging   Charge Completion

|̲ _ _ Quick Counting _ _ ▶|̲ _____▶

     on/off   off
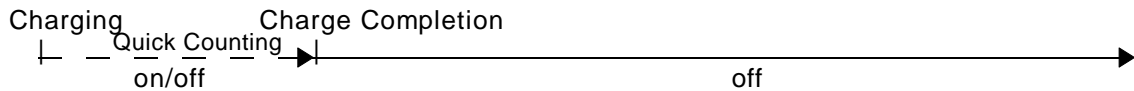
<7> In case trickle mode starts, and then charging completes before counter is end,

Charging   Charge Completion

|̲ _ Quick Counting of f _ ▶|̲ _____▶

    on/off   off
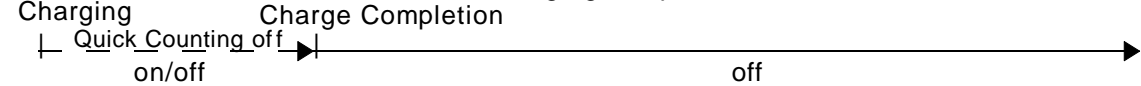
(3) Charge Timer

       Charge NG mode is taken over after counting the following time after charge starts.

           Charge timer : 1800 min.(Foc=3.41KHz)

       Stop of the display timer makes the charge timer stop because the display timer sources
       clock to charge timer as following figure.(In trickle mode, counting is pausing)
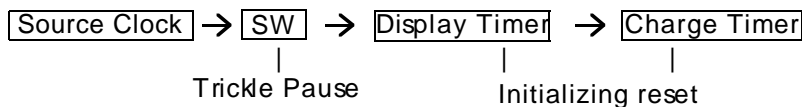
     | Source Clock | → | SW | → | Display Timer | → | Charge Timer |

                | | |

           Trickle Pause   Initializing reset

       This timer resets counting to initialize before charge restarting, in case the charge as
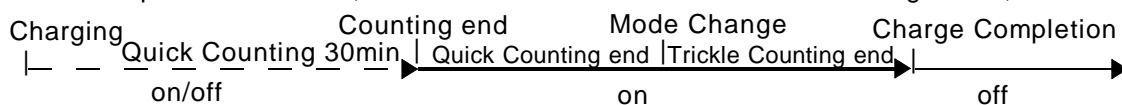   counting or pausing stops because of the change to the adapter mode or the temperature
       protection mode.

20. Control by temperature during charging

    <1> Variety of control

       a . Charge current switch by battery temperature.

          The battery temperature majored before or during charge switches the charge current to
          quick or trickle.

       b . Unusual temperature detection

          The unusual temperature detection (overheat or super cooling) makes charging stop and
          move Temperature protection mode.

       c . No battery unplugging detection

          No battery plugging detection during charging makes charging stop and move no battery
          connection mode.

<2> Each control details

Each temperature controls have hysteresis.

a . Function after the initialization

Immediately battery connection

   less than   -2°C   : Temperature Protection mode(low temperature)

   -2°C to   13°C   : Trickle Charge mode(low temperature)

   13°C to   55°C   : Quick Charge mode

   55°C to   60°C   : Trickle Charge mode(High temperature)

   more than 60°C   : Temperature Protection mode(high temperature)

b. Function after the Temperature Protection mode(low temperature)

   more than -2°C   : Trickle Charge mode(low temperature)

   *Charging starts after the initialization.

c.Function after Trickle Charge mode(low temperature)

   less than   -5°C   : Temperature Protection mode

   more than 13°C   : Quick Charge mode

d.Function after Quick Charge mode

   less than   10°C   : Trickle Charge mode(low temperature)

   more than 55°C   : Trickle Charge mode(high temperature)

e.Function after Trickle Charge mode(high temperature)

   less than   50°C   : Quick Charge mode

   more than 60°C   : Trickle Charge mode(high temperature)

f.Function after Temperature Protection mode(high temperature)

   less than   55°C   : Trickle Charge mode(high temperature)

   *Charging starts after the initialization.

g.Function after all mode

   less than   -28°C   : no battery connection mode

<3>Control Diagram
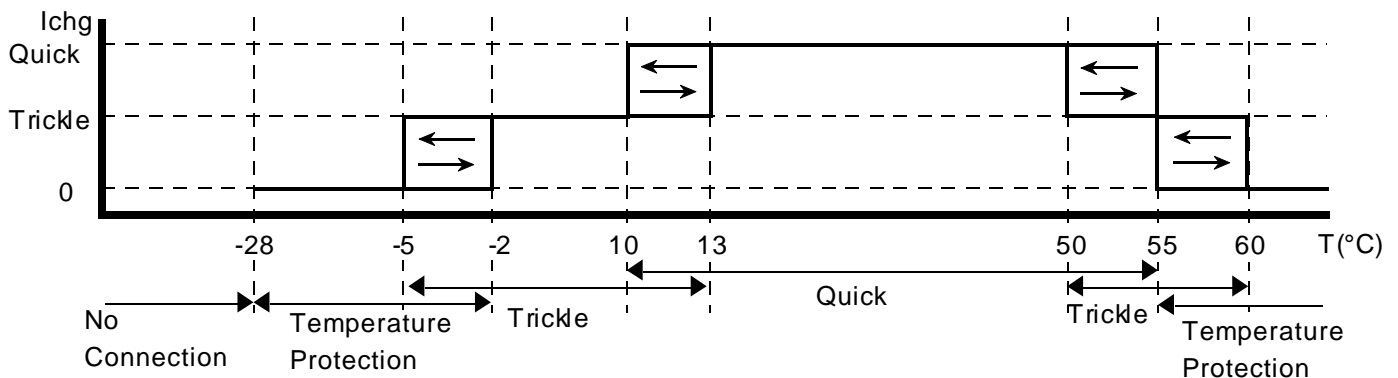
<4> Thermistor Resistance in each threshold level

     -28°C :   100KΩ

      -5°C : 33.9KΩ

      -2°C : 29.7KΩ

      10°C : 18.0KΩ

      13°C : 15.9KΩ

      50°C :   4.2KΩ

      55°C :   3.5KΩ

      60°C :   3.0KΩ

  *Resistance for dividing with thermistor is 10KΩ

Flow chart
(1)Total

```
                                          ┌─────────┐
                                          │  START  │
┌─────────────┐                           └─────────┘
│ AC off      │                              │
│ Return from │─────────────────────►  ┌──────────┐
│ Adapter mode│                         │  Reset   │
└─────────────┘                         └──────────┘
                                              │
                               ┌────────────────────────────┐
                               │ No Battery Connection mode  │
                               └────────────────────────────┘
                                              │
                               ◇ poreset ────"H"────►  [ Reset ]
                                   "L"
                               ◇ AC power ────No────►  [ AC off ]
                                 connection
                                   Yes
                               ◇ Adapter ──DCJK connecting──►  [ Adapter mode ]
                                   │  No
                                 DCJK no connecting
                               ◇ Battery
                                 Connection ── Yes
┌──────────────────┐               │
│ Return from      │           [ Charge from initialization ]
│ Temperature      │───────────────┘
│ protection       │           [ All timer reset ]
│ waiting mode     │               │
└──────────────────┘           ◇ poreset ────"H"────►  [ Reset ]
                                   "L"
                               ◇ AC power ────No────►  [ ACoff ]
                                 connection
                                   Yes
                               ◇ adapter ──DCJK connecting──►  [ Adapter mode ]
                                 DCJK no connecting
                               ◇ Battery ────No────►  [ No Battery Connection mode ]
                                 Connection
                                   Yes
      [ Wait Timer Counting ]   ◇ Over voltage ──Yes──►  [ NG mode ]
                                   No
                               ◇ Over discharge ──VB<4.0V──►  [ waiting mode ]
                                 VB≥4.0V
                               ◇ Temperature Check
                                      Rising :-2°C<T<60°C
                                      Falling :-5°C<T<55°C
                                   [ LED on/off ]
                        L.T. 3.2s.
                               ◇ Wait Timer
                                 over 3.2s
                               ◇ Temperature Check
```

Temperature Check branches:

- Rising :-2°C<T<13°C or 55°C<T<60°C / Falling :-5°C<T<10°C or 50°C<T<55°C → [Trickle charge]
- Rising :13°C<T<55°C / Falling :10°C<T<50°C → [Quick charge]
- Rising :T<-2°C or T>60°C / Falling :T<-5°C or T>55°C → [Temperature Protection mode]

(2)Quick charge

```
                    ┌──────────┐
                    │  START   │
                    └──────────┘
                         │
                         ▼
                      ╱poreset╲      "H"      ┌──────────┐
                      ╲       ╱ ───────────▶  │  Reset   │
                         │                    └──────────┘
                        "L"
                         │
                   ╱AC power ╲       No        ┌──────────┐
                   ╲Connection╱ ───────────▶   │  AC off  │
                         │                     └──────────┘
                        Yes
                         │
                    ╱Adapter ╲     DCJK        ┌──────────────┐
                    ╲Connection╱ connecting ▶  │ Adapter mode │
                         │                     └──────────────┘
              DCJK no connecting
                         │
                    ╱ Battery ╲     No       ┌──────────────────┐
                    ╲Connection╱ ─────────▶  │   No Battery     │
                         │                   │ Connection mode  │
                        Yes                  └──────────────────┘
                         │
```

Temperature — Rising :-2°C<T<60°C / Falling :-5°C<T<55°C → Temperature Protection mode

Rising :-2°C<T<13°C or 55°C<T<60°C / Falling :-5°C<T<10°C or 50°C<T<55°C → Trickle Charge mode

Charging Completion — Yes → Charging Completion mode

30hr. timer — over 30hr → Charge NG mode

L.T. 30hr

30min. timer — over 30min → LED on

L.T. 30min → LED on/off

Timer Counts

	Quick Charge
LED	until 30minutes on/off over 30 minutes on(L)
SW	on("L")
VCC	Vchg
PC	"L"
CCOFF	"H"
CLOCK	work
WAIT TIMER	work
Desplay/Charge Timer	work
Charge Current	adj1
ADPCHGSW	"L"
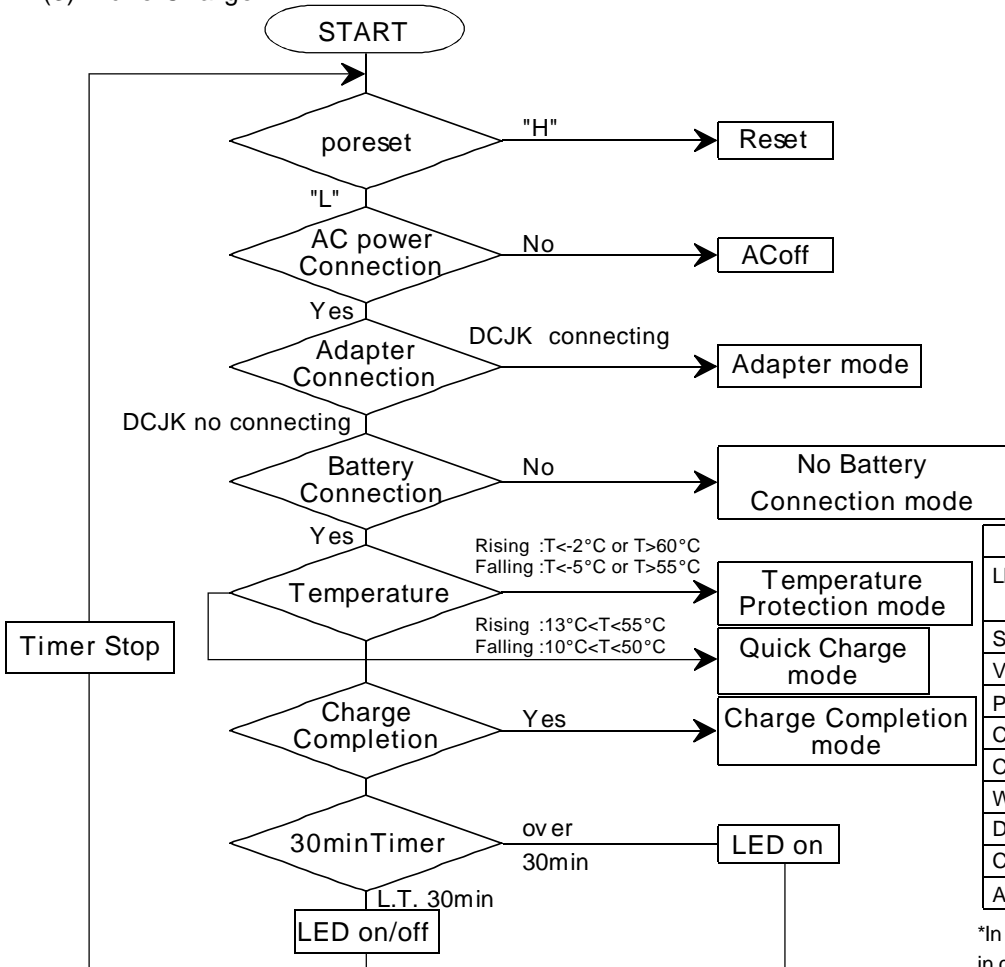
(3)Trickle Charge

	Trickle Charge
LED	on/off
	on("L")*
SW	on("L")
VCC	Vchg
PC	"L"
CCOFF	"H"
CLOCK	work
WAIT Timer	work
Desplay/Charge Timer	stop
Charge Current	adj2
ADPCHGSW	"L"

*In case trickle mode is taken after 30min.
in quick mode, LED continues "on".

(4)Charge Completion mode
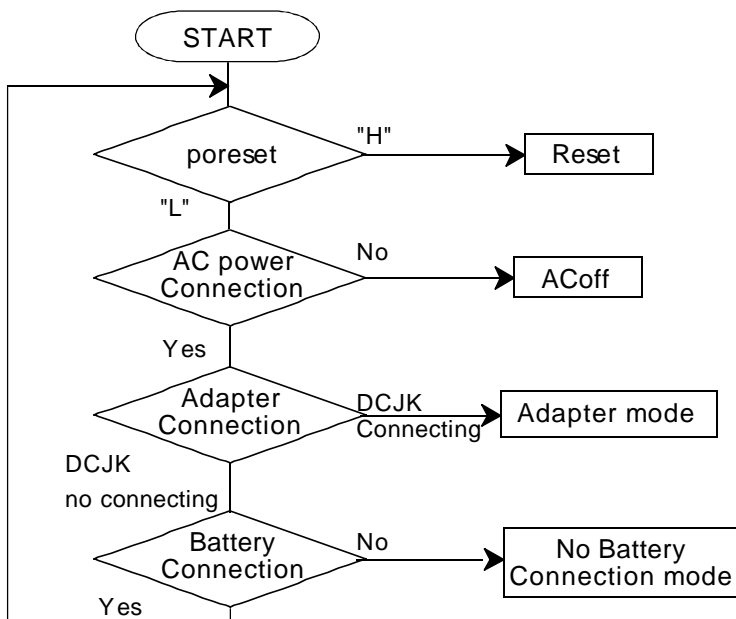
	Charge Completion
LED	off("H")
SW	off("H")
VCC	Vadapt
PC	"L"
CCOFF	"L"
CLOCK	work
Wait Timer	Reset
Display/Charge Timer	Reset
ADPCHGSW	"H"

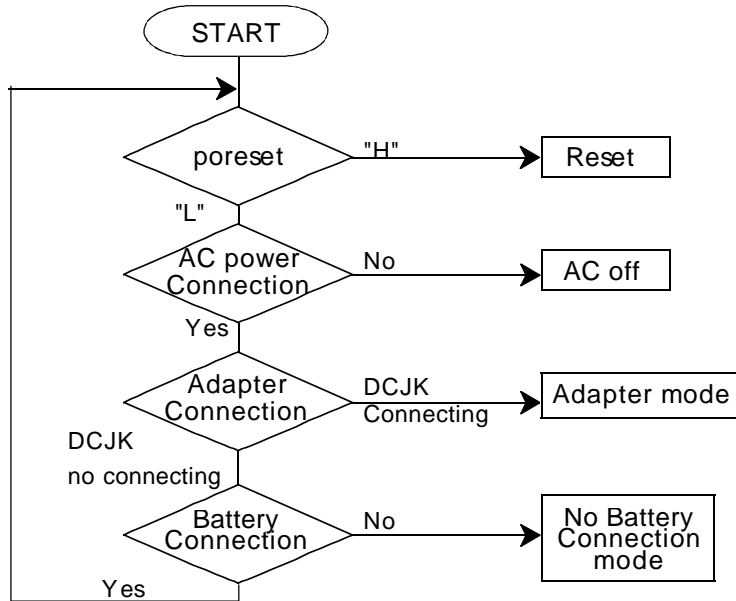## SINGLE CHIP BATTERY CHARGER CONTROL IC

(5)Charge NG mode

START

poreset → "H" → Reset

"L"

AC power Connection → No → AC off

Yes

Adapter Connection → DCJK Connecting → Adapter mode

DCJK no connecting

Battery Connection → No → No Battery Connection mode

Yes

	NG
LED	off("H")
SW	off("H")
VCC	Vadapt
PC	"L"
CCOFF	"L"
CLOCK	work
Wait Timer	Reset
Display/Charge Timer	Reset
ADPCHGSW	"H"

(6)Adapter mode

START

poreset → "H" → Reset

"L"

Battery Connection

Yes | No

Previous mode Reset

ACPower Connection → No → AC off

Yes

Adapter Connection → DCJK No-connecting → Return *

DCJK Connecting

Over Current → Yes → Unusual mode

No

Completion

Battery Connection → No

Yes

Previous mode → other

Completion | NG | Reset

NG
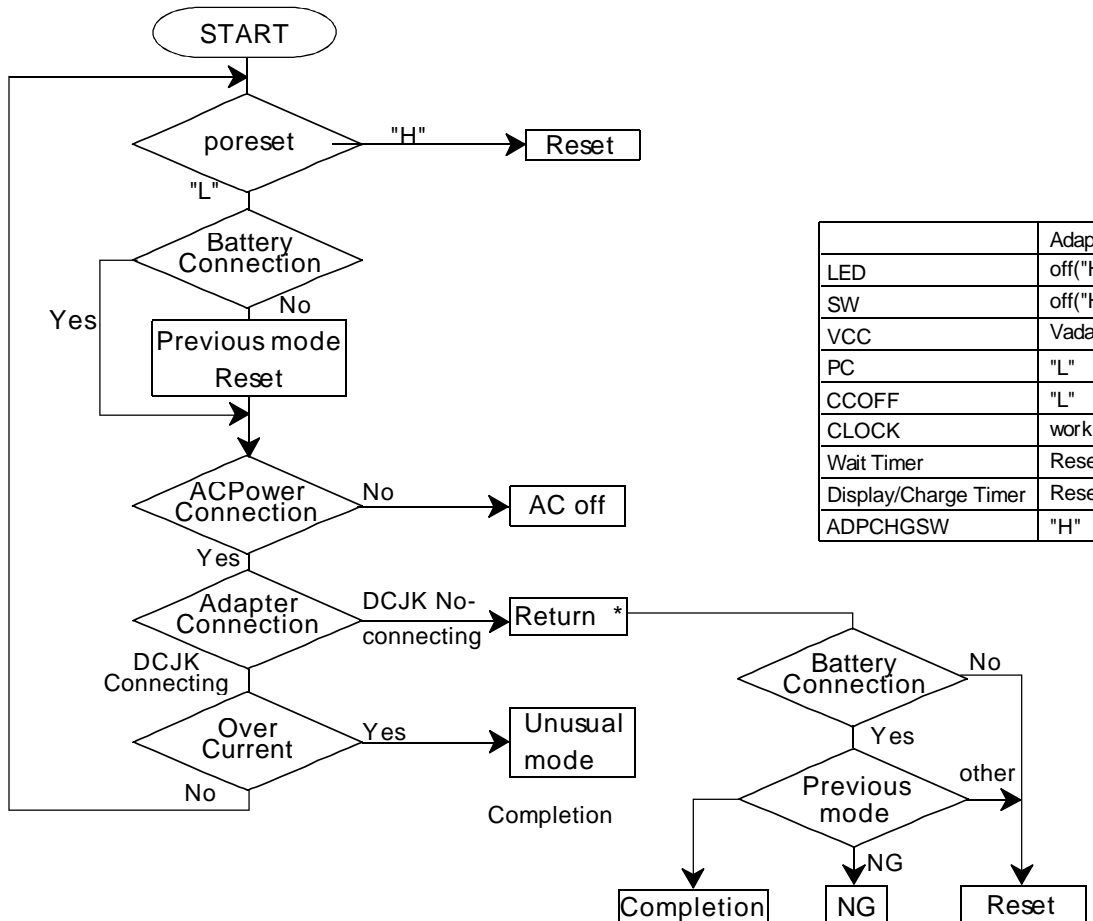
	Adapter
LED	off("H")
SW	off("H")
VCC	Vadapt
PC	"L"
CCOFF	"L"
CLOCK	work
Wait Timer	Reset
Display/Charge Timer	Reset
ADPCHGSW	"H"

* Next mode depends on the previous mode and the input during Adapter mode.

(7) Unusual mode
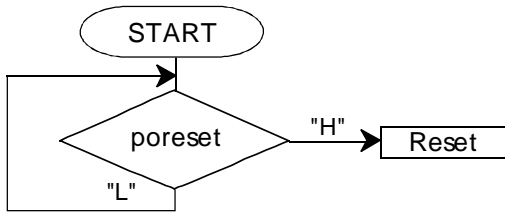
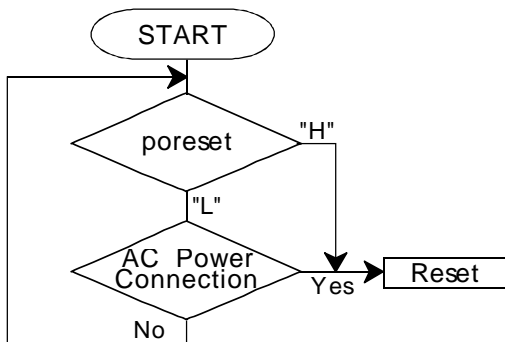|	Unusual
LED	off("H")
SW	off("H")
VCC	Vadapt
PC	"H"
CCOFF	"L"
CLOCK	work
Wait Timer	Reset
Display/Charge Timer	Reset
ADPCHGSW	"H"

(8) AC off

	AC off
LED	off("H")
SW	off("H")
VCC	Vadapt
PC	"H"
CCOFF	"L"
CLOCK	stop
Wait Timer	Reset
Display/Charge Timer	Reset
ADPCHGSW	"H"

(9)Temperature Protection mode
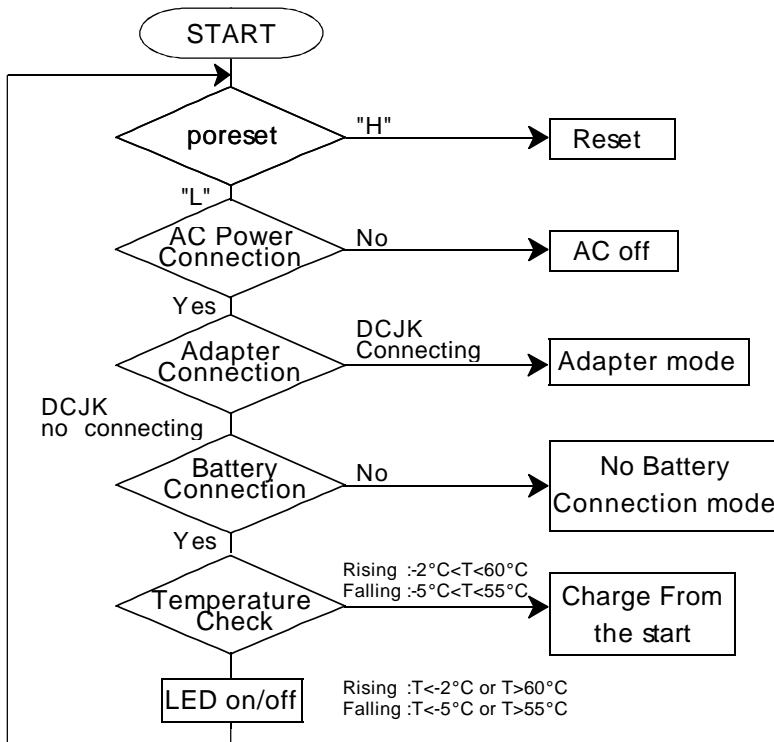
	Temperature Protection
LED	on/off
SW	off("H")
VCC	Vadapt
PC	"L"
CCOFF	"L"
CLOCK	work
Wait Timer	Reset
Display/Charge Timer	Reset
ADPCHGSW	"H"

(10) Waiting mode(Discharge)

```
                    ┌──────────┐
                    │  START   │
                    └────┬─────┘
                         │
        ┌────────────────┤
        │                │
        │            ◇ poreset ◇ ──"H"──▶ ┌────────┐
        │                │                │ Reset  │
        │               "L"               └────────┘
        │                │
        │         ◇ AC Power ◇ ──No──▶ ┌────────┐
        │          Connection          │ AC off │
        │                │             └────────┘
        │               Yes
        │                │
        │         ◇ Adapter ◇ ──DCJK──▶ ┌──────────────┐
        │          Connection Connecting│ Adapter mode │
        │                │              └──────────────┘
        │   DCJK
        │   no Connecting
        │                │
        │         ◇ Battery ◇ ──No──▶ ┌────────────────────┐
        │          Connection         │   No Battery       │
        │                │            │ Connection mode    │
        │               Yes           └────────────────────┘
        │                │
        │         ◇ Battery ◇ ──OK──▶ ┌────────────────────┐
        │          Voltage   VB≧4.0v  │ Charge From the first│
        │                │            └────────────────────┘
        │    Discharge
        │    VB<4.0v
        │           ┌────────────┐
        └───────────│ LED on/off │
                    └────────────┘
```
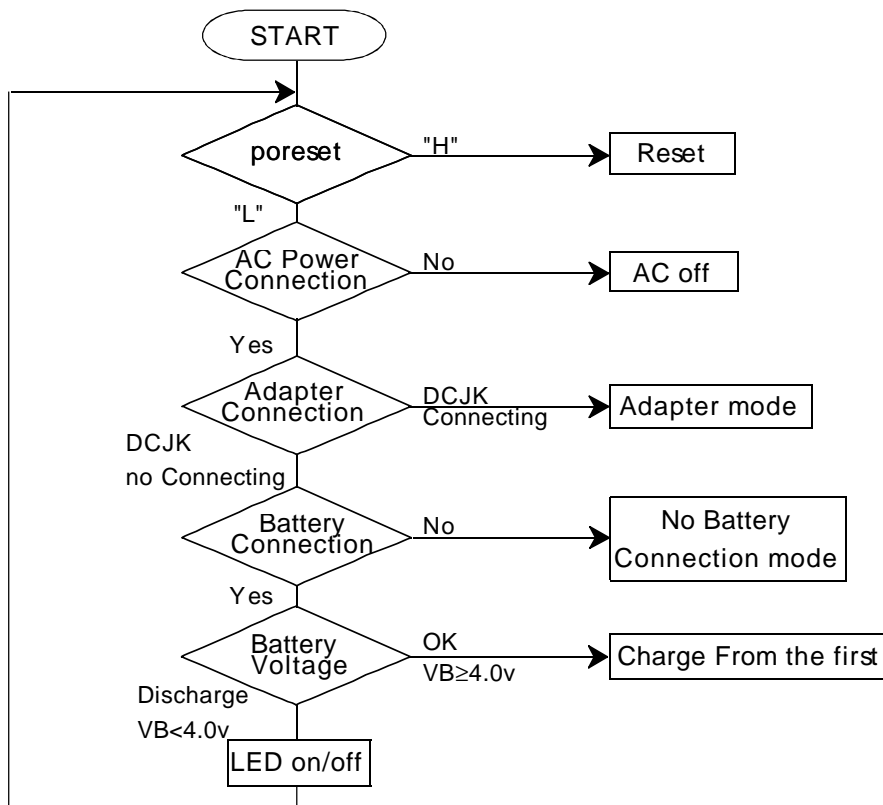
	Waiting
LED	on/off
SW	off("H")
VCC	Vadapt
PC	"L"
CCOFF	"L"
CLOCK	work
Wait Timer	Reset
Display/Charge Timer	Reset
ADPCHGSW	"H"

M62241FP

SINGLE CHIP BATTERY CHARGER CONTROL IC

M62241FP Mode List

	Quick Charge	Trickle Charge	Unusual	Adapter	Charge Completion	NG	Waiting	Temperature Protection	ACOFF	No Battery Connection	Charge Waiting
LED	on/off on("L")*	on/off on("L")**	off("H")	off("H")	off("H")	off("H")	on/off	on/off	off("H")	off("H")	on/off
SW	on("L")	on("L")	off("H")	off("H")	off("H")	off("H")	off("H")	off("H")	off("H")	off("H")	off("H")
VCC	Vchg	Vchg	Vadpt	Vadpt	Vadpt	Vadpt	Vadpt	Vadpt	Vadpt	Vadpt	Vadpt
PC	"L"	"L"	"H"	"L"	"L"	"L"	"L"	"L"	"H"	"L"	"L"
CCOFF	"H"	"H"	"L"	"L"	"L"	"L"	"L"	"L"	"L"	"L"	"L"
ADPCHGSW	"L"	"L"	"H"	"H"	"H"	"H"	"H"	"H"	"H"	"H"	"H"
CLOCK	work	work	work	work	work	work	work	work	stop	work	work
WAITING TIMER	work	work	reset	reset	reset	reset	reset	reset	reset	reset	work
Display & Charge Timer	work	work	reset	reset	reset	reset	reset	reset	reset	reset	reset
Charge Current	adj1	adj2	-	-	-	-	-	-	-	-	-
Adapter Detection	work	work	disregard (work)	work	work	work	work	work	stop	work	work
Battery Connection Detection	work	work	disregard (work)	disregard (work)	work	work	work	work	stop	work	work
Over Current Detection	stop	stop	disregard (work)	work	stop	stop	stop	stop	stop	stop	stop
AC Power off detection	work	work	disregard (work)	work	work	work	work	work	work	work	work
Over Voltage detection	stop	stop	stop	stop	disregard (work)	disregard (work)	disregard (work)	disregard (work)	stop	disregard (work)	work
Over discharge detection	stop	stop	stop	stop	disregard (work)	disregard (work)	work	disregard (work)	stop	disregard (work)	work
Battery temperature detection	work	work	stop	stop	disregard (work)	disregard (work)	disregard (work)	work	stop	disregard (work)	work

*------LED on/off until 30minutes , LED on after 30minutes

**------LED is on in case trickle mode is taken over after 30 minutes of quick charge

Stop------In case detector is reset or Input is fixed

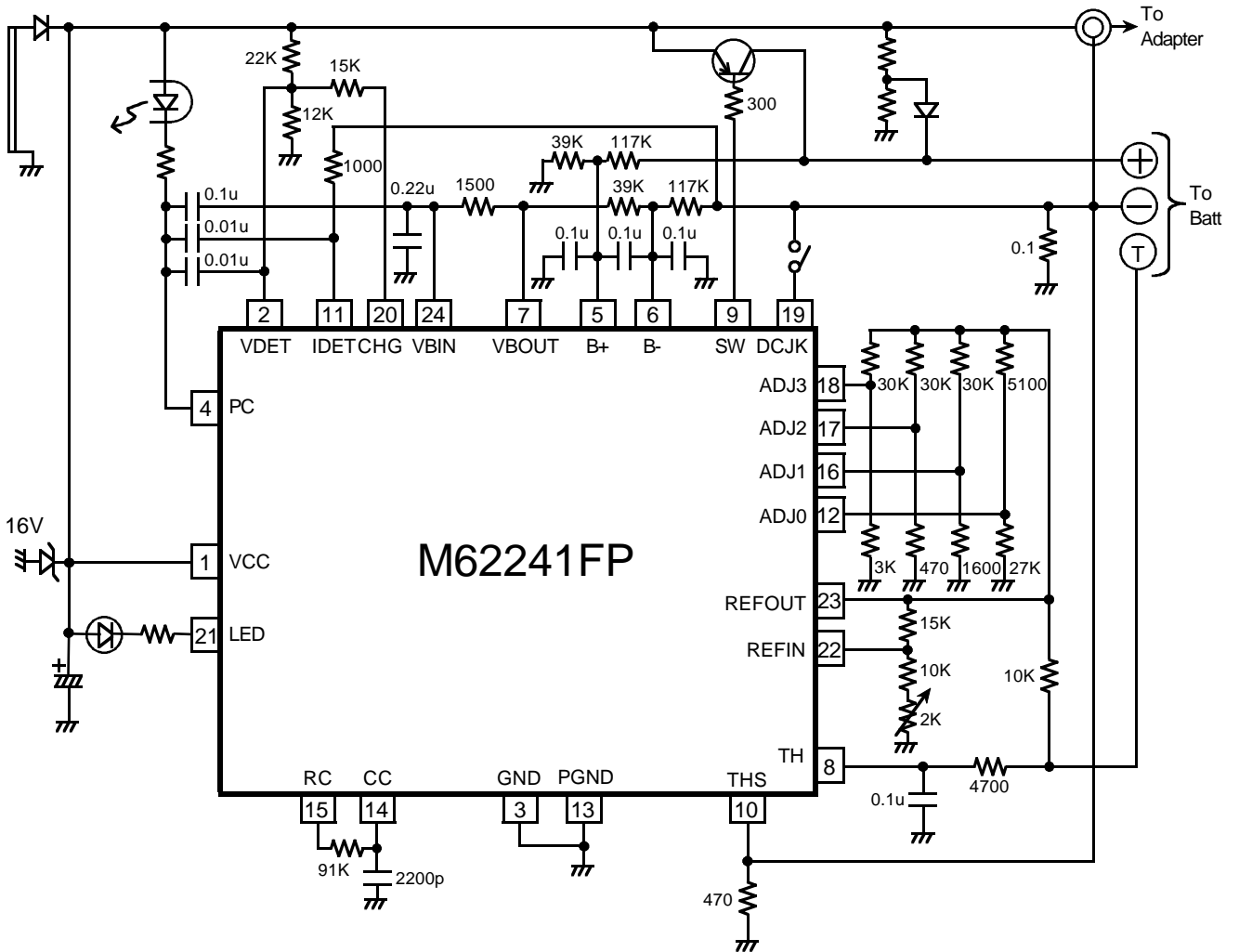disregard(work)------In case detection is discharged except that the function is working.

M62241FP Battery temperature and function relationships

Battery Temperature(Rising)		Function		Battery Temperature(Falling)		Function
t1	tBATT< -2°C	Temperature protection		t1	tBATT< -5°C	Temperature protection
t2	-2°C<tBATT<13°C	Trickle Charge		t2	-5°C<tBATT<10°C	Trickle Charge
t3	13°C<tBATT<55°C	Quick Charge		t3	10°C<tBATT<50°C	Quick Charge
t4	55°C<tBATT<60°C	Trickle Charge		t4	50°C<tBATT<55°C	Trickle Charge
t5	tBATT>60°C	Temperature protection		t5	tBATT>55°C	Temperature protection

SINGLE CHIP BATTERY CHARGER CONTROL IC

EQUIVALENT CIRCUIT

Unit resistance:Ω
capacitor :F