Lithium-Ion Secondary Battery Charge Control IC for AC Charger
Monolithic IC MM3324

Outline

This charge control IC has characteristics to monitor battery temperature to control the charge current and charge voltage, and it is in compliance with the Safety Standard that will be put in force in 2011.
In addition, this IC has achieved high cost performance in that it has integrated with charge FET and current sensing resistor, which are the external devices in the conventional charge control ICs, and that the reverse current protection function is added.

Features

1. Integrated battery temperature monitor and battery control functions in advance preparation for the Safety Standard slated to be effective in 2011.
   Safety of the battery is secured by changing the full charge voltage and charge current when the battery temperature is low and high.
2. Can reduce parts and its installation costs thanks to the integrated charging FET and current sensing resistor.
3. Because of the control function integrated in the primary side, it is also possible to charge the battery highly efficiently by tracking the battery voltage in addition to the charge control.
   Furthermore, the heat dissipation is minimized.

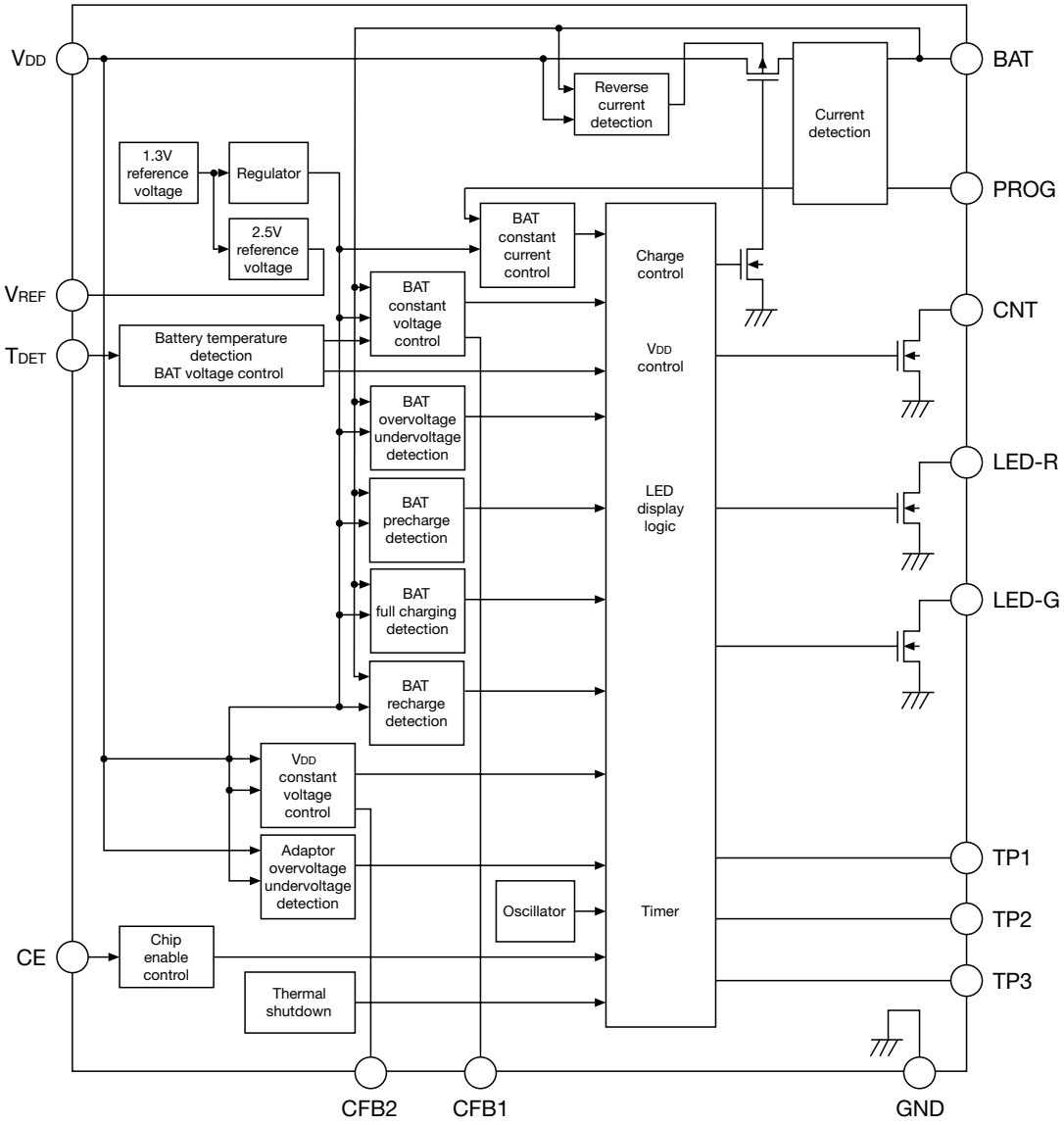
Package

TSOP-16D

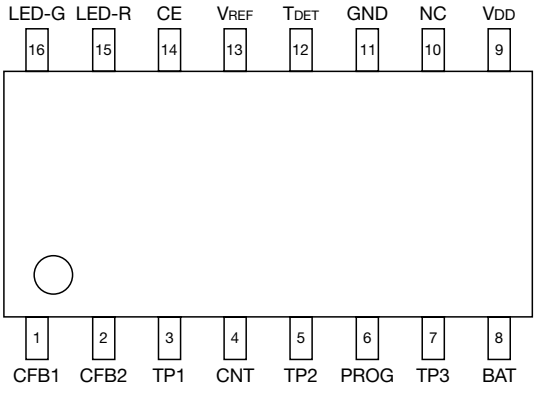
Applications

AC Charger

Block Diagram



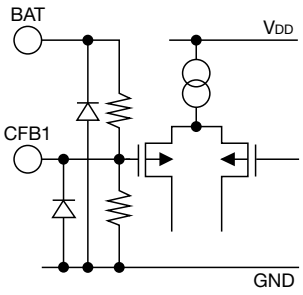
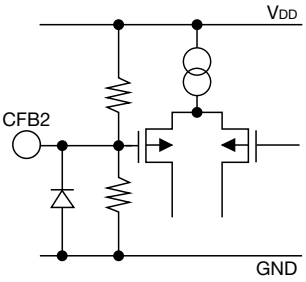
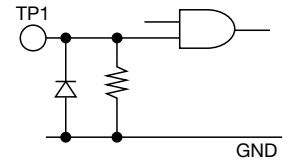
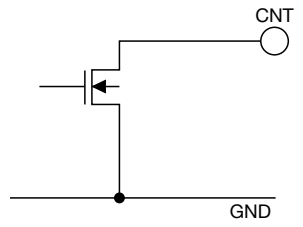
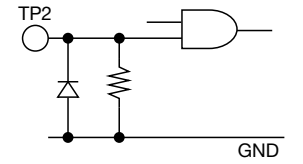
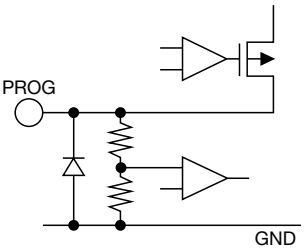
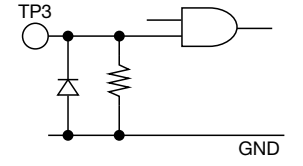
Pin Assignment

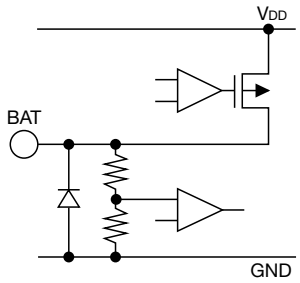
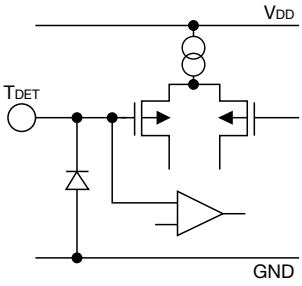
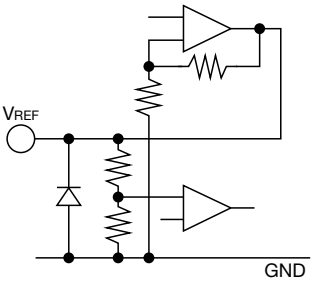
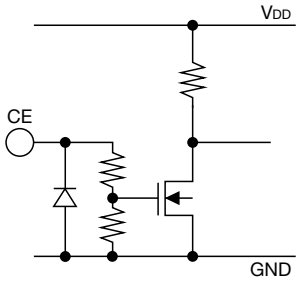
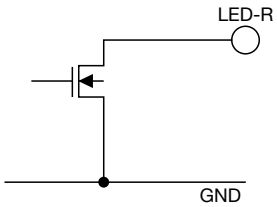
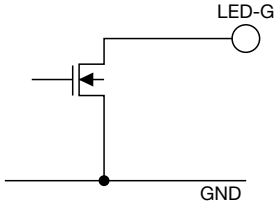


TSOP-16D
(TOP VIEW)

1	CFB1	9	V_{DD}
2	CFB2	10	NC
3	TP1	11	GND
4	CNT	12	T_{DET}
5	TP2	13	V_{REF}
6	PROG	14	CE
7	TP3	15	LED–R
8	BAT	16	LED–G

Pin Description

Pin no.	pin name	I/O	Function	Internal equivalent circuit
1	CFB1	Input	Rated BAT voltage control phase compensation pin. Oscillation is improved by connecting an external capacitor between CFB1 and CNT for phase compensation.	
2	CFB2	Input	Rated V_{DD} voltage control phase compensation pin. Oscillation is improved by connecting an external capacitor between CFB2 and CNT for phase compensation.	
3	TP1	Input	Terminal 1 for test It is a terminal for the timer test. Please connect it with the opening when you use it usually.	
4	CNT	Output	Photo diode drive pin of photo coupler for V_{DD} and BAT constant voltage and constant current control. Connect to cathode of diode.	
5	TP2	Input	Terminal 2 for test It is a terminal for the timer test. Please connect it with the opening when you use it usually.	
6	PROG	Input	It can adjust the charge current for DC input(V_{DD}) with the value of an external resistor. If setting this value smaller, the charge current can be larger.	
7	TP3	Input	Terminal 3 for test It is a terminal for the timer test. Please connect it with the opening when you use it usually.	

Pin no.	pin name	I/O	Function	Internal equivalent circuit
8	BAT	Input	Battery voltage output pin. Detect battery voltage and control charging.	
9	VDD	Input	Power supply input pin.	
10	NC		NC	
11	GND	Input	Ground pin.	
12	TDET	Input	Temperature detection input pin. Apply potential resistance divided by external resistor and thermistor from reference voltage when using. Reset state will exist if TDET pin does not reach the specified potential.	
13	VREF	Output	Reference power supply output pin. Outputs about 2.5Volts typ. reference voltage. Used for temperature detection reference power supply.	
14	CE	Input	Chip enable pin. (active High)	
15	LED–R	Output	LED–R output pin. NMOS–Tr open drain output.	
16	LED–G	Output	LED–G output pin. NMOS–Tr open drain output.	

Absolute Maximum Ratings (Except where noted otherwise Ta=25°C)

Item		Symbol	Ratings	Units
Storage temperature		T_{STG}	−55~+150	°C
Operating temperature		T_{OPR}	−40~+85	°C
Supply voltage		V_{DDMAX}	−0.3~+6	V
Power dissipation	IC unit	Pd1	0.3	W
	Substrate mounting (*1)	Pd2	0.8	

*1 Boardsize : 50×50×1mm Material : Paper phenolic Layer : Single side Wire rate : 70%

Recommended Operating Conditions

Item	Symbol	Ratings	Units
Operating temperature	T_{OPR}	−40~+75	°C
Supply voltage	V_{OPR}	2.7~5.9	V

Electrical Characteristics (Except where noted otherwise Ta=−0~45°C, V_{CC}=5V)

Item	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit.
Consumption current	I_{DD}			1	2	mA
Reference voltage	V_{REF}			2.5		V
V_{DD} detection voltage L	V_{DDL}	V_{DD}=H→L	2.35	2.45	2.55	V
V_{DD} detection voltage L hysteresis voltage width (*1)	V_{DDLW}		50	100	150	mV
V_{DD} detection voltage H	V_{DDH}	V_{DD}=L→H	5.50	5.70	5.90	V
V_{DD} detection voltage H hysteresis voltage width (*1)	V_{DDHW}		50	100	150	mV
V_{DD} control voltage	V_{DD}		4.4	4.5	4.6	V
BAT pin leakage current	I_{BAT}				4	μA
BAT pin output voltage ($V_{BAT}1>V_{BAT}2$)	$V_{BAT}1$	$VT_2<T_{DET}\leqq VT_5$	4.170	4.200	4.230	V
	$V_{BAT}2$	$VT_5<T_{DET}\leqq VT_6$	4.000	4.050	4.100	
Pre-charge current range	I_{PRECHG}	$V_{LV}\leqq BAT<V_P$ $I_{PRECHG}=K_P\times(V_{PRECHG}/R_{PROG})$	30		85	mA
Fast charge current range	$I_{FSTCHG}1$	$V_P\leqq BAT<V_{BAT}$, $VT_2<T_{DET}\leqq VT_3$ $I_{FSTCHG}1=K_P\times(V_{FSTCHG}1/R_{PROG})$	225		640	mA
	$I_{FSTCHG}2$	$V_P\leqq BAT<V_{BAT}$,$VT_3<T_{DET}\leqq VT_6$ $I_{FSTCHG}2=K_P\times(V_{FSTCHG}2/R_{PROG})$	300		850	
Pre-charge PROG pin output voltage	V_{PRECHG}	$V_{LV}\leqq BAT<V_P$		0.20		V
Fast charge PROG output voltage	$V_{FSTCHG}1$	$V_P\leqq BAT<V_{BAT}$,$VT_2<T_{DET}\leqq VT_3$		1.50		V
	$V_{FSTCHG}2$	$V_P\leqq BAT<V_{BAT}$,$VT_3<T_{DET}\leqq VT_6$		2.00		
Charge Current set coefficient K_P	K_P			500		
Full charge PROG output voltage	$V_{DETFULL}$			0.2		V

Note : *1 guaranteed by design

Item	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit.
Pre-charge current accuracy	A_{PRECHG}	I_{PRECHG}=55mA	–35		+35	%
Fast charge current accuracy	A_{FSTCHG}	V_{T2}<T_{DET}≦V_{T3} I_{FSTCHG}1=410mA	–15		+15	%
		V_{T3}<T_{DET}≦V_{T6} I_{FSTCHG}2=550mA	–10		+10	
Detect full charge current accuracy	$A_{DETFULL}$		–35		+35	%
Low voltage detection voltage	V_{LV}	BAT=L→H	1.90	2.00	2.10	V
Low voltage detection voltage hysteresis voltage width (*1)	V_{LVW}		25	50	100	mV
Pre-charge detection voltage	V_P	BAT=L→H	2.80	2.90	3.00	V
Pre-charge detection voltage hysteresis voltage width (*1)	V_{PW}		25	50	100	mV
Re-charge detection voltage	V_R	BAT=H→L	3.85	3.90	3.95	V
Overvoltage detection voltage	V_{OV}	BAT=L→H	4.30	4.35	4.40	V
Battery Temperature detection T_{DET} pin voltage	V_{T1}	T_{DET}=L→H –30°C±6°C detection	V_{REF} ×0.937	V_{REF} ×0.957	V_{REF} ×0.971	V
	V_{T2}	T_{DET}=L→H 0°C±2°C detection	V_{REF} ×0.762	V_{REF} ×0.781	V_{REF} ×0.800	V
	V_{T3}	T_{DET}=L→H 10°C±2.5°C detection	V_{REF} ×0.649	V_{REF} ×0.677	V_{REF} ×0.705	V
	V_{T4}	T_{DET}=H→L 40°C±2.5°C detection	V_{REF} ×0.313	V_{REF} ×0.336	V_{REF} ×0.361	V
	V_{T5}	T_{DET}=H→L 45°C±2.5°C detection	V_{REF} ×0.269	V_{REF} ×0.290	V_{REF} ×0.313	V
	V_{T6}	T_{DET}=H→L 60°C±2.5°C detection	V_{REF} ×0.168	V_{REF} ×0.182	V_{REF} ×0.197	V
	V_{T7}	T_{DET}=H→L 80°C±6°C detection	V_{REF} ×0.079	V_{REF} ×0.096	V_{REF} ×0.116	V
Battery Temperature detection T_{DET} pin voltage hysteresis voltage width (*1)	V_{THW}	V_{T2}, V_{T3}, V_{T4}, V_{T5}, V_{T6}	2	5	8	°C
LED-R pin output voltage	V_{LED-R}	I_{LED-R}=10mA			0.4	V
LED-G pin output voltage	V_{LED-G}	I_{LED-G}=10mA			0.4	V
CNT pin output voltage	V_{CONT}	I_{CONT}=5mA			0.4	V
Output transistor ON resistance	R_{ON}	V_{DD}=4.2V		0.35		Ω
First time charge timer	T_{1STCHG}		119.6	149.5	179.4	s
Pre-charge timer	T_{PRECHG}		959	1199	1439	s
Fast charge timer	T_{FSTCHG}		15354	19193	23032	s
Full charge detection delay time	$T_{DETFULL}$		0.469	0.586	0.703	s
Overvoltage detection delay time	T_{OV}		0.058	0.073	0.088	s
Re-charge detection delay time	T_R		0.058	0.073	0.088	s

Note : *1 guaranteed by design

Item	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit.
First time voltage detection delay time	T_{FTV}		0.117	0.146	0.175	s
LED-R blinking cycle	T_{BL1}	Charge stop $V_{T1}<T_{DET}\leqq V_{T2}$, $V_{T6}<T_{DET}\leqq V_{T7}$	1.874	2.342	2.810	s
	T_{BL2}	Abnormal charge prohibition	0.937	1.171	1.405	
CE Low-Level input voltage	V_{CEL}	Charge OFF threshold	0		0.3	V
CE High-Level input voltage	V_{CEH}	Charge ON threshold	2		V_{DD}	V
CE pin input current	I_{CE}			10	20	μA

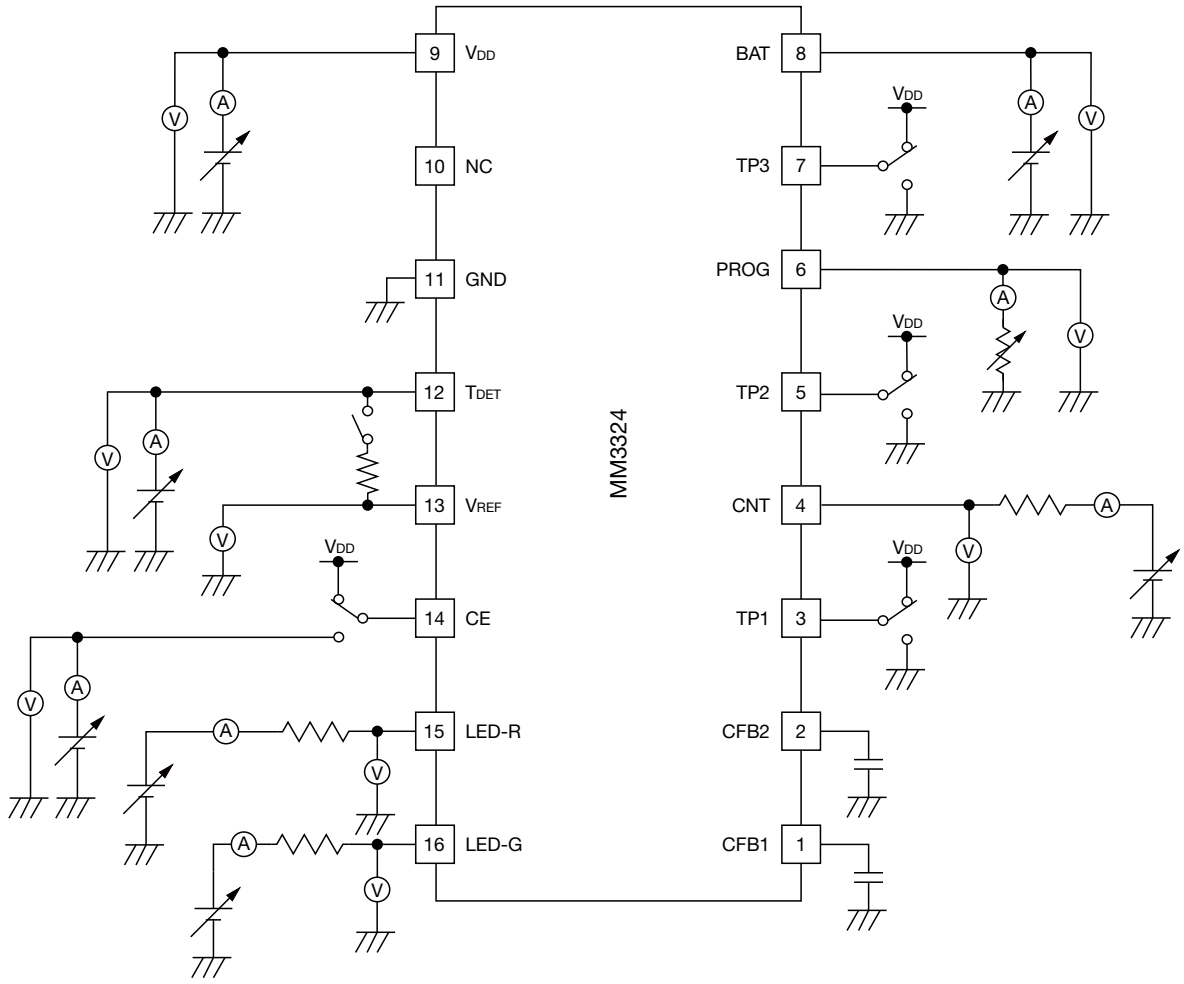
Note : * If the IC is damaged and control is no longer possible, its safety can not be guaranteed. Please protect with something other than this IC.

* Temperature detection is the setting value at B-Value 4250K (25/50°C)(NCP15WF104F03RC made by MURATA MANUFACTURING).

* When the battery overdischarge condition, it fast charge current ($I_{FSTCHG}2$)×1/10 mA charge for 149.5 seconds, and then it does not switch to pre-charging during that interval, it means the IC has identified a battery abnormality.

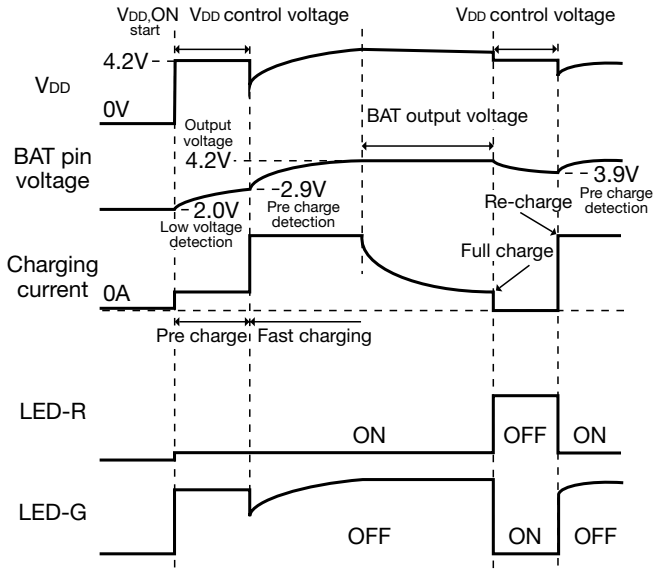
* If adjacent terminals are shorted or each terminal is short with V_{DD} or GND, there is a possibility that the IC malfunctions.

Measuring Circuit

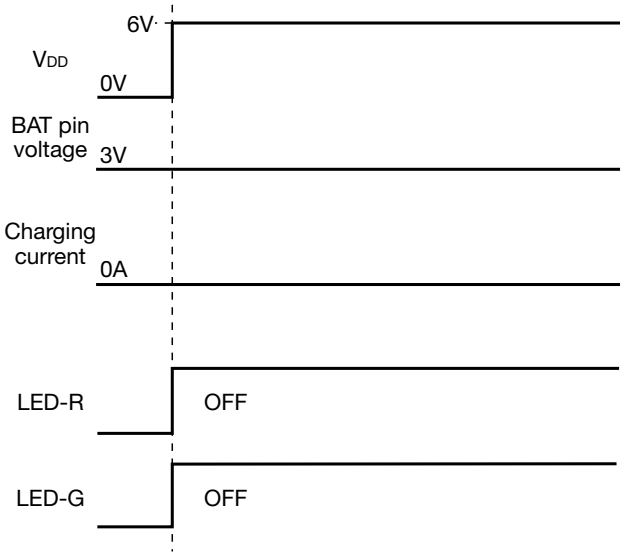


Timing Chart

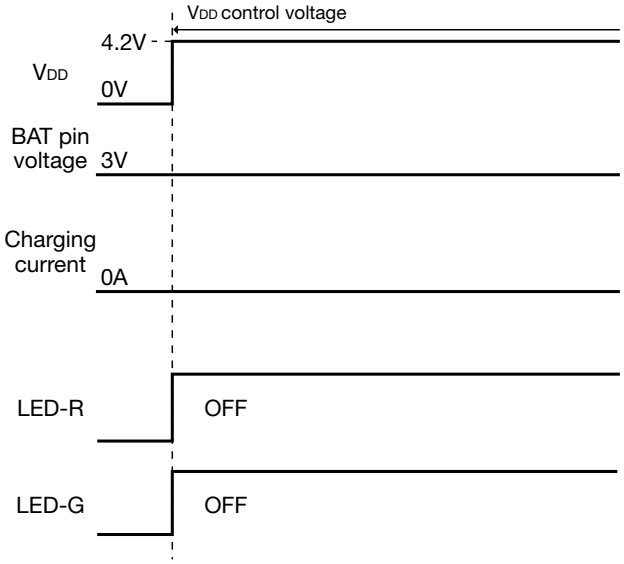
Case of normal charging



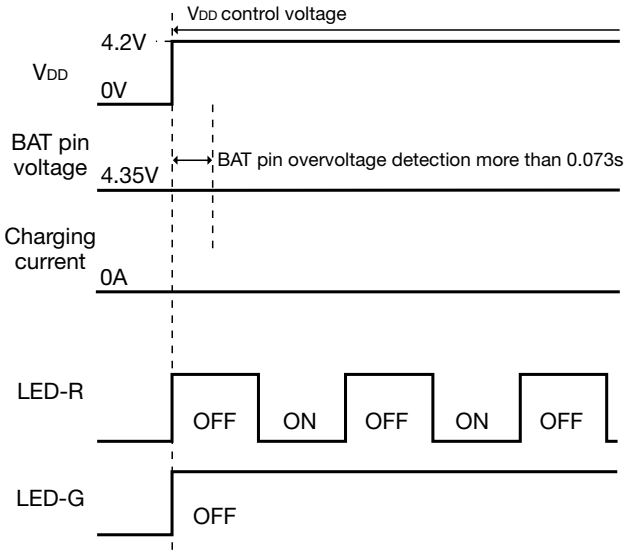
Case of connecting abnormal adapter



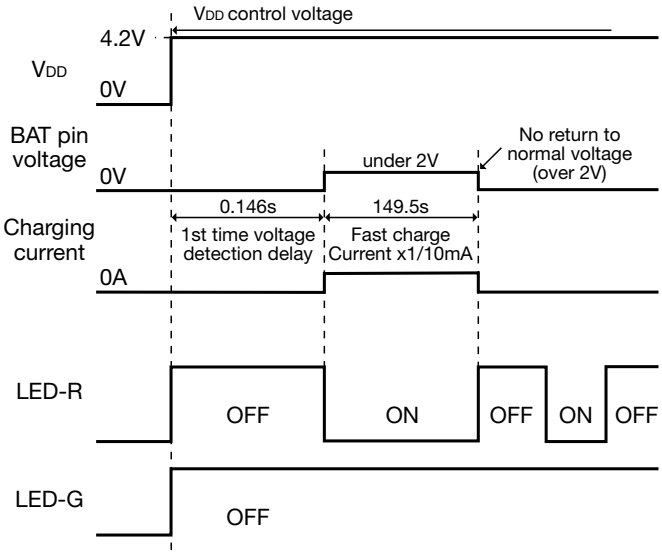
Case of setting battery error (temparature detection pin ; open)



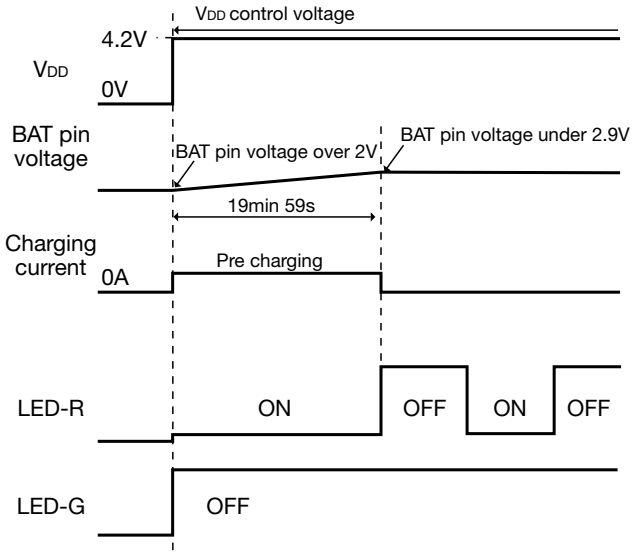
Case of overcharged battery



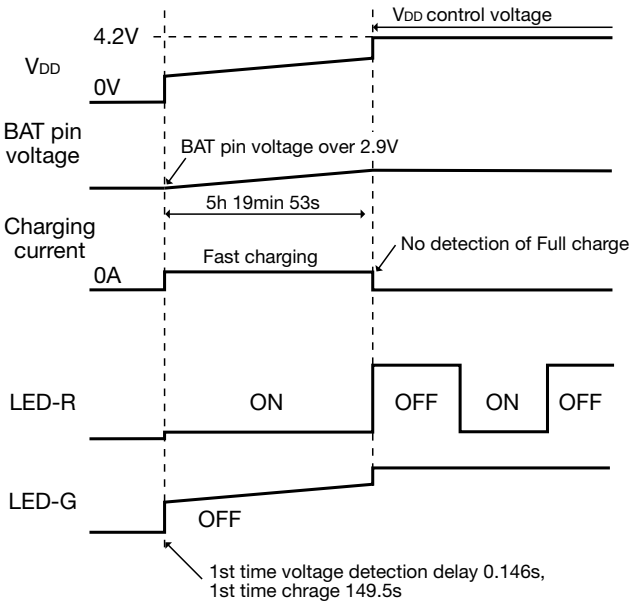
Case of overdischarged battery



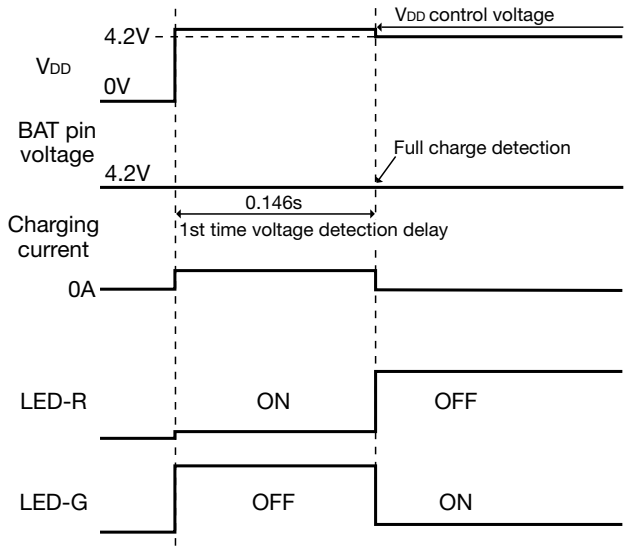
Case of time-up for Pre charging



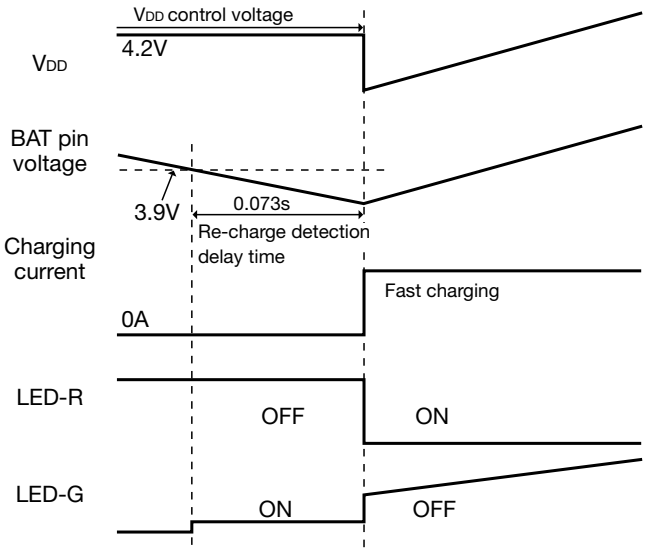
Case of time-up for full charging



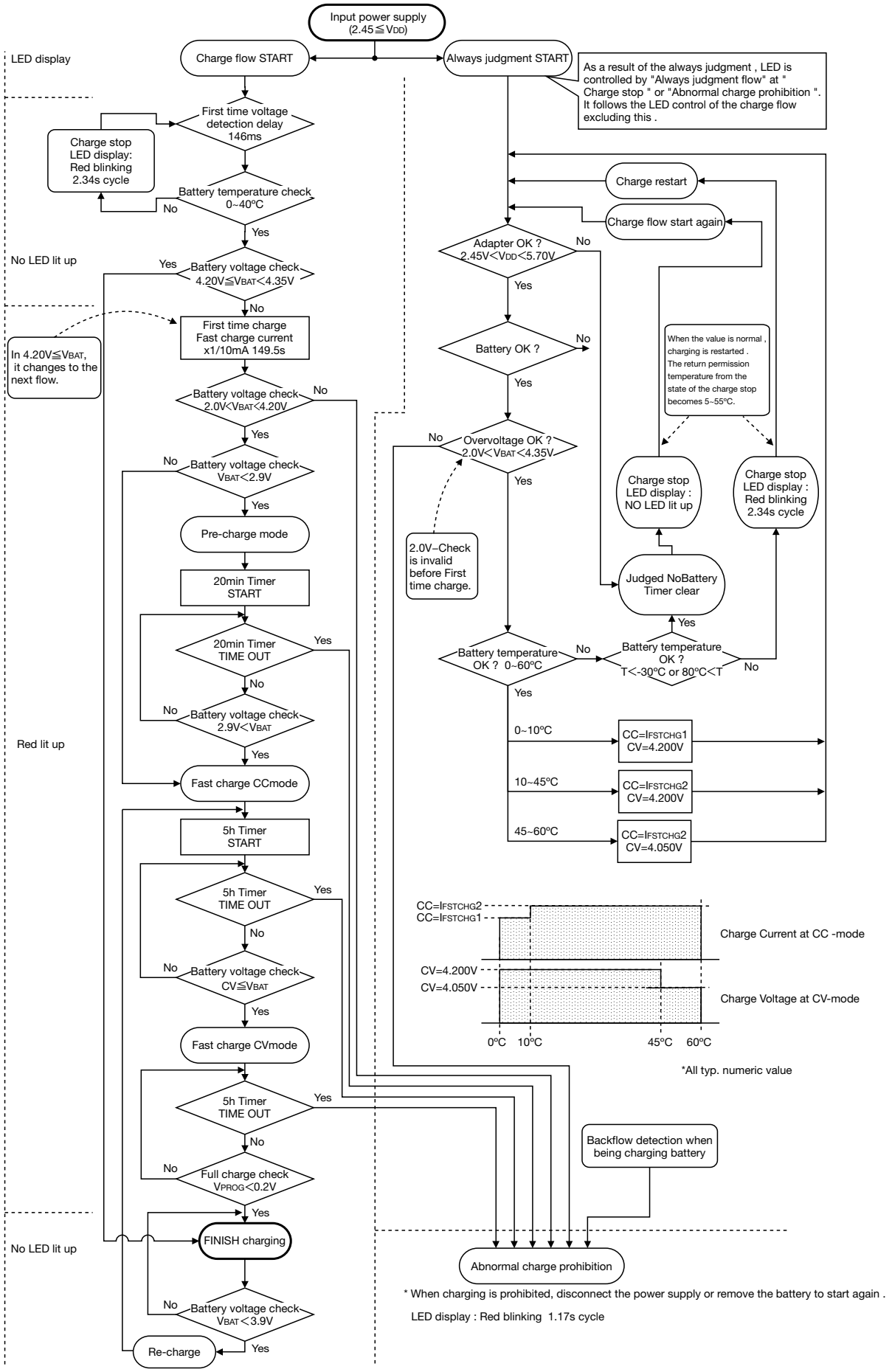
Case of Full charged battery



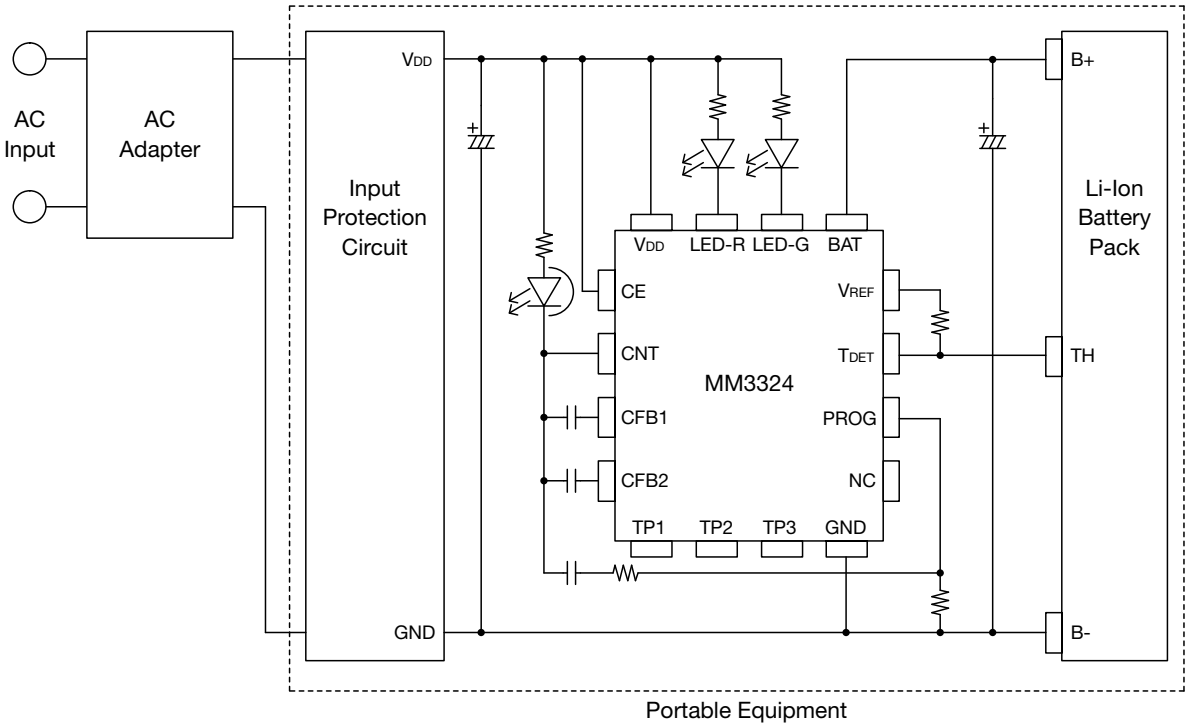
Case of Re-charged battery



Flow Chart


Input power supply (2.45≦VDD)
Charge flow START
Always judgment START
As a result of the always judgment , LED is controlled by "Always judgment flow" at " Charge stop " or "Abnormal charge prohibition ". It follows the LED control of the charge flow excluding this .
LED display
First time voltage detection delay 146ms
Charge stop LED display: Red blinking 2.34s cycle
Battery temperature check 0~40ºC
No
Yes
No LED lit up
Battery voltage check 4.20V≦VBAT<4.35V
Yes
No
First time charge Fast charge current x1/10mA 149.5s
In 4.20V≦VBAT, it changes to the next flow.
Battery voltage check 2.0V<VBAT<4.20V
No
Yes
Battery voltage check VBAT<2.9V
No
Yes
Pre-charge mode
20min Timer START
20min Timer TIME OUT
Yes
No
Battery voltage check 2.9V<VBAT
No
Yes
Red lit up
Fast charge CCmode
5h Timer START
5h Timer TIME OUT
Yes
No
Battery voltage check CV≦VBAT
No
Yes
Fast charge CVmode
5h Timer TIME OUT
Yes
No
Full charge check VPROG<0.2V
No
Yes
No LED lit up
FINISH charging
Battery voltage check VBAT<3.9V
No
Yes
Re-charge
Charge restart
Charge flow start again
Adapter OK ? 2.45V<VDD<5.70V
No
Yes
Battery OK ?
No
Yes
When the value is normal , charging is restarted . The return permission temperature from the state of the charge stop becomes 5~55ºC.
Overvoltage OK ? 2.0V<VBAT<4.35V
No
Yes
2.0V–Check is invalid before First time charge.
Charge stop LED display : NO LED lit up
Charge stop LED display : Red blinking 2.34s cycle
Judged NoBattery Timer clear
Yes
Battery temperature OK ? 0~60ºC
No
Battery temperature OK ? T<-30ºC or 80ºC<T
No
Yes
0~10ºC
CC=IFSTCHG1 CV=4.200V
10~45ºC
CC=IFSTCHG2 CV=4.200V
45~60ºC
CC=IFSTCHG2 CV=4.050V
CC=IFSTCHG2
CC=IFSTCHG1
Charge Current at CC -mode
CV=4.200V
CV=4.050V
Charge Voltage at CV-mode
0ºC 10ºC 45ºC 60ºC
*All typ. numeric value
Backflow detection when being charging battery
Abnormal charge prohibition
* When charging is prohibited, disconnect the power supply or remove the battery to start again .
LED display : Red blinking 1.17s cycle

Application Circuit



- These circuits are typical examples provided for reference purposes, so in actual applications, the circuit constants, conditions and operations should be thoroughly studied.
- Mitsumi Electric Co., Ltd. assumes no responsibility for any trouble or damage as a result of the use of these circuits.
- Mitsumi Electric Co., Ltd. assumes no responsibility for any infringement of industrial property or any other right of a third party or us, as a result of the use of these circuits.
- If terminal CNT(4pin) is short with V_{DD}, V_{DD} voltage keeps rising, and becoming it at risk.
  So in actual applications, the circuit constants, conditions and operations should be thoroughly studied.