Lithium Ion Battery Charging Control
Monolithic IC MM1485

Outline

This IC is a lithium ion battery charging controller, with protection circuits such as constant-current, constant-voltage charging and pre-charge, battery temperature detection function and others all on one chip.
The timer function on charging IC MM1475 has been omitted to achieve a smaller package.

Features

1. Output voltage (Ta = 0 ~ +50°C) 4.120±30mV
2. Consumption current 1 1.5mA typ.
   Pre-charge function
   Adaptor (primary side) abnormality detection function
3. Battery temperature detection function

Package

TSOP-16A

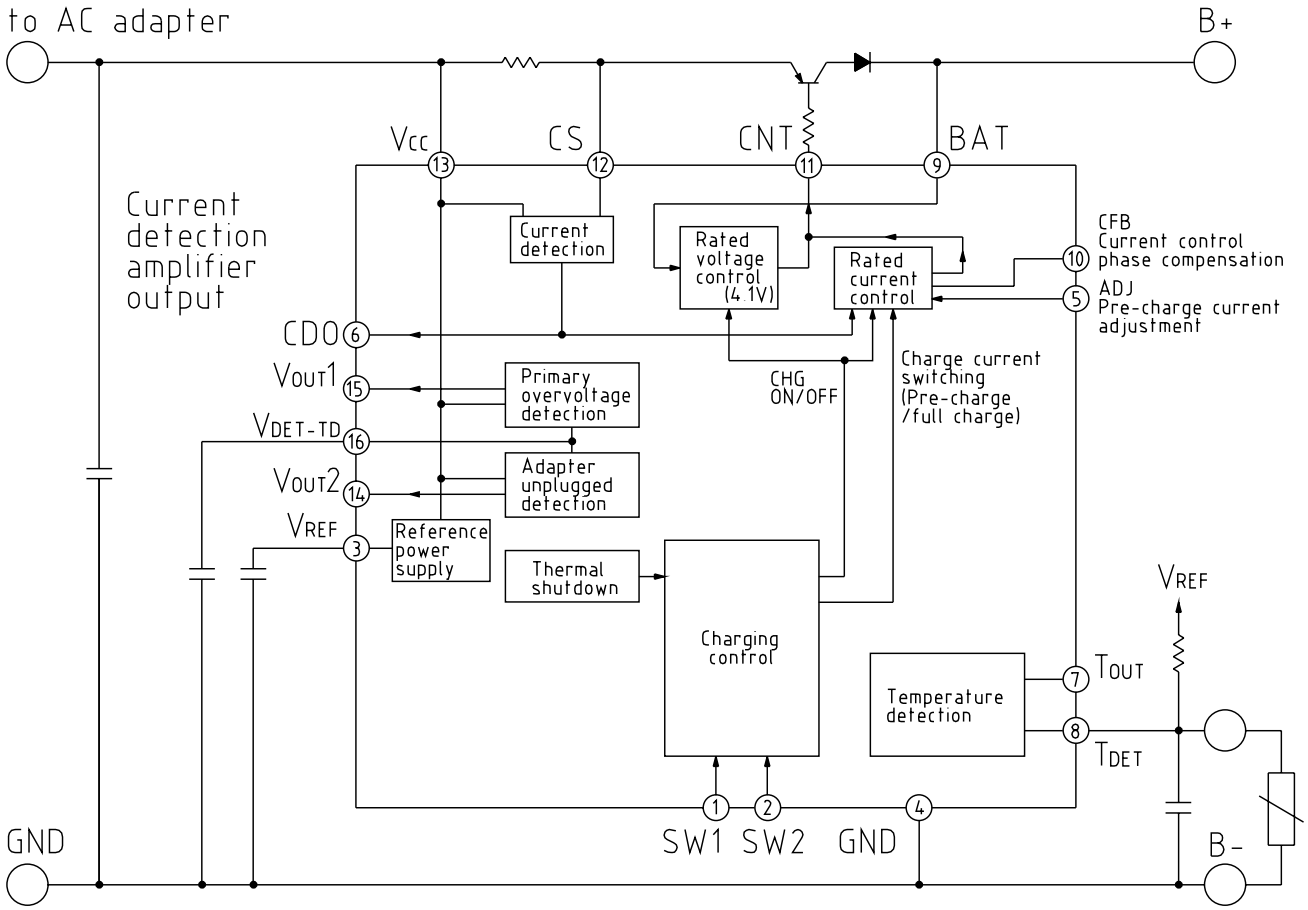
Applications

1. Lithium ion battery charging control

Absolute Maximum Ratings (Ta=25°C)

Item	Symbol	Ratings	Unit
Storage temperature	T_{STG}	–40~+125	°C
Operating temperature	T_{OPR}	–20~+70	°C
Power supply voltage	V_{CCMAX}	–0.3~+15	V
Allowable loss	P_D	250	mW

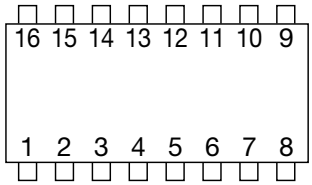
Block Diagram



SW1 and SW2 Specifications

SW1	SW2	Charge	Current Limit
L	H	OFF	
H	H	ON	Controlled by the IC (current limit 2:25mV)
L	L	ON	Controlled by the adaptor (current limit 1:450mV)
H	L	ON	Controlled by the adaptor (current limit 1:450mV)

Pin Assignment



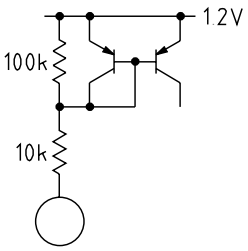
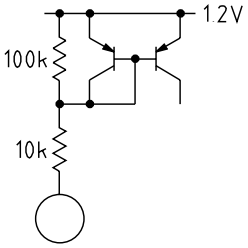
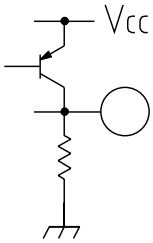
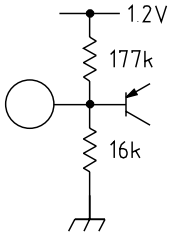
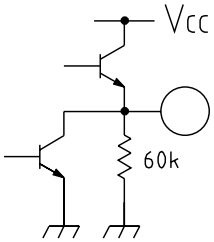
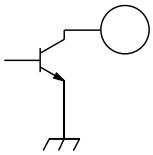
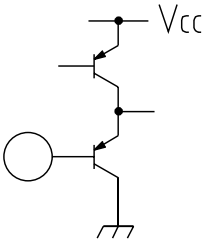
TSOP-16A

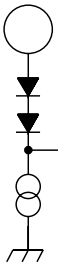
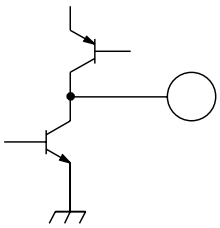
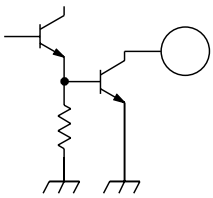
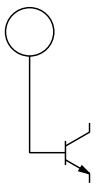
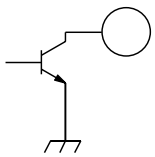
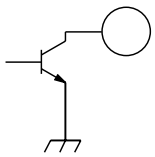
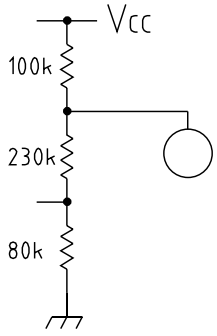
1	SW1	9	BAT
2	SW2	10	CFB
3	V_{REF}	11	CNT
4	GND	12	CS
5	ADJ	13	V_{CC}
6	CDO	14	V_{OUT2}
7	T_{OUT}	15	V_{OUT1}
8	T_{DET}	16	V_{DET-TD}

Pin Description

Pin No.	Pin Name	I/O	Function
1	SW1	Input	Charging control switching pin. Switches charging ON/OFF and charging current by combinations of SW1 and SW2 L and H.
2	SW2	Input	
3	V_{REF}	Output	Reference power supply output pin. Outputs 1.2V typ. reference voltage.
4	GND	Input	GROUND pin.
5	ADJ	Input	Pre-charge current adjustment pin. Pin voltage is set at 100mV typ. Pre-charge current can be adjusted by adjusting the pin voltage with an external resistor, etc. Pre-charge current is controlled by comparing the ADJ pin voltage and voltage drop value of 12dB between V_{CC}-CS.
6	C_{DO}	Output	Current detection output pin. Outputs current difference value of 18dB between V_{CC}-CS.
7	T_{OUT}	Output	Temperature detection output pin. Normal temperature: Output Tr OFF High temperature detection: Output Tr ON
8	T_{DET}	Input	Temperature detection input pin. Use external resistor and thermistor to apply resistance-divided potential from reference voltage.
9	BAT	Input	Battery voltage input pin. Detects battery voltage and controls charging.
10	CFB	Input	Constant-current control phase compensation pin. Connect an external capacitor (around 100pF) between CFB and CNT to perform phase compensation for improved oscillation.
11	CNT	Output	Charging control output pin. Controls external PNP-Tr base and performs constant-current, constant-voltage charging.
12	CS	Input	Current detection pin. Current is detected by voltage drop at external resistor between V_{CC}-CS and charging current is controlled.
13	V_{CC}	Input	Power supply input pin.
14	V_{OUT2}	Output	Adaptor unplugged detection output pin. V_{CC} low voltage input: Output Tr OFF V_{CC} recommended operating voltage: Output Tr ON
15	V_{OUT1}	Output	Overvoltage detection output pin. V_{CC} overvoltage input: Output Tr OFF V_{CC} recommended operating voltage: Output Tr ON
16	V_{DET}-TD	Input	Overvoltage detection delay time setting pin. Delay time can be set by connecting an external capacitor.

Pin Description The following valaeis typical

Pin No.	Pin name	Internal equivalent circuit diagram
1	SW1	
2	SW2	
3	VREF	
5	ADJ	
6	CDO	
7	TOUT	
8	TDET	

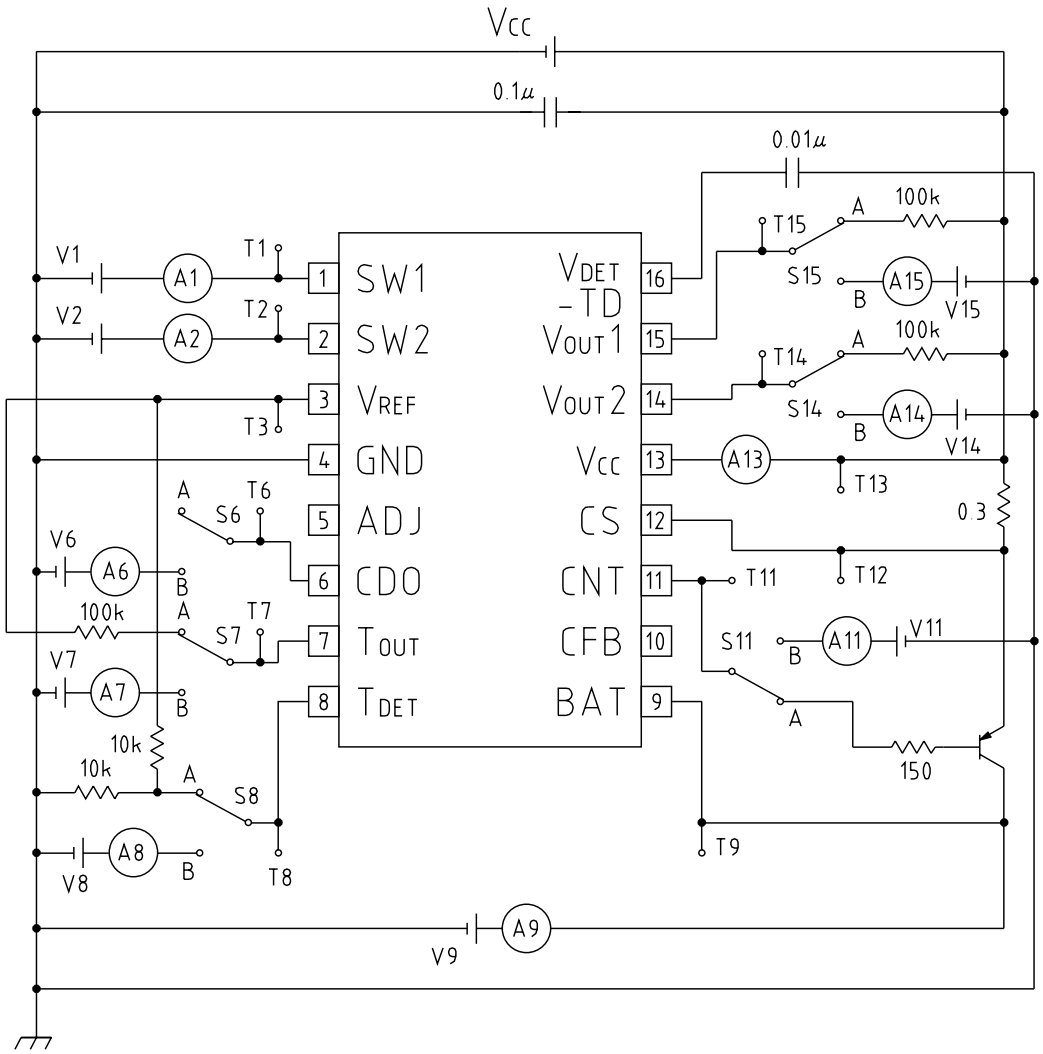
Pin No.	Pin name	Internal equivalent circuit diagram
9	BAT	
10	CFB	
11	CNT	
12	CS	
14	VOUT2	
15	VOUT1	
16	VDET-TD	

Electrical Characteristics (Except where otherwise indicated Ta=25°C, V_{CC}=5V)

Item	Symbol	Conditions	Measurement pin	Min.	Typ.	Max.	Unit
Consumption current 1	I_{CC1}	SW1, 2 : H	13		1.5	2.3	mA
Consumption current 2	I_{CC2}	SW1, 2 : L	13		3.5	5.3	mA
Reference voltage	V_{REF}		3		1.207		V
ADP detection voltage L	V_{ADPL}	V_{CC} : H→L	14	2.70	2.80	2.90	V
ADP detection voltage L hysteresis voltage width	V_{ADPLW}		14	50	100	150	mV
ADP detection voltage H	V_{ADPH}	V_{CC} : L→H	15	5.8	6.0	6.2	V
ADP detection voltage H hysteresis voltage width	V_{ADPHW}		15	50	100	150	mV
BAT pin leak current	I_{BAT}		9			1	µA
BAT pin output voltage	V_{BAT}	Ta=0~+50°C	9	4.090	4.120	4.150	V
CNT pin output voltage	V_{CNT}	I_{CNT}=20mA	11			0.5	V
SW1 pin input current	I_{SW1}		1	40	60	80	µA
SW1 pin input voltage H	V_{SW1H}		1	0.6		1.20	V
SW1 pin input voltage L	V_{SW1L}		1			0.25	V
SW2 pin input current	I_{SW2}		2	40	60	80	µA
SW2 pin input voltage H	V_{SW2H}		2	0.6		1.20	V
SW2 pin input voltage L	V_{SW2L}		2			0.25	V
Current limit 1	V_{L1}	Quick charge	12,13	0.35	0.45	0.55	V
Current limit 2	V_{L2}	Pre-charge	12,13	20	25	30	mV
Current detection amp gain	G_I		6	17.5	18.0	18.5	dB
Current detection amp output offset voltage	V_{OFF}		6	–4.5	0	4.5	mV
Current detection amp output current outflow	I_{CDO}		6	0.5	1.0		mA
V_{OUT1} pin output voltage	V_{OUT1}	I_{OUT1}=0.12mA	15		0.2	0.4	V
V_{OUT2} pin output voltage	V_{OUT2}	I_{OUT2}=0.12mA	14		0.2	0.4	V
Battery temperature detection voltage	V_{TDET}	V_{TDET} : H→L	8	0.390	0.413	0.435	V
Battery temperature detection voltage hysteresis voltage width	V_{TDETW}		8	30	60	90	mV
T_{OUT} pin output voltage	V_{TOUT}	I_{TOUT}=0.12mA	7		0.2	0.4	V
T_{DET} input bias current	I_T		8		30	150	nA

* Current limits 1 and 2 are prescribed by the amount of current detection resistor voltage drop.
* Safety can not be guaranteed if this IC is damaged and control no longer is possible. Please protect with something other than this IC.

Measuring Circuit

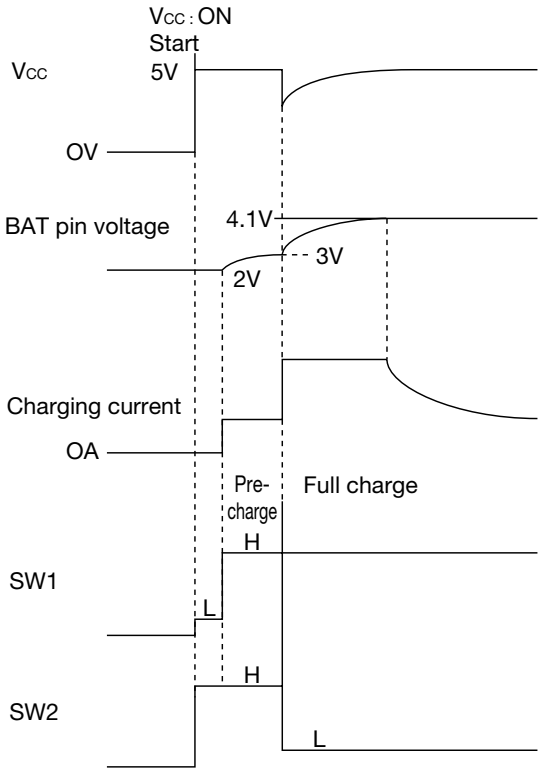


Measurement Procedures

(Except where otherwise indicated Ta = 25°C, V_{CC} = 5V, V_{CC}: current limit 0.5A, V1 = V2 = 0V, V9 = 4.2V, S6, 7, 8, 11, 14, 15: A)

Item	Measurement Procedure
Consumption current 1	Measure A13 current value I_{CC1} at V1 = V2 = 1.2V.
Consumption current 2	Measure A13 current value I_{CC2}.
Reference voltage	Measure T3 potential V_{REF}.
ADP detection voltage L	Gradually lower V_{CC} from 5V. V_{CC} potential is V_{ADPL} when T14 potential goes above V_{CC} – 0.5V.
ADP detection voltage L hysteresis voltage width	Gradually raise V_{CC} from 2V. V_{CC} potential is V_{ADPL2} when T14 potential goes under 0.5V. $V_{ADPLW} = V_{ADPL2} - V_{ADPL}$
ADP detection voltage H	Gradually raise V_{CC} from 5V. V_{CC} potential is V_{ADPH} when T15 potential goes above V_{CC} – 0.5V.
ADP detection voltage H hysteresis voltage width	Gradually lower V_{CC} from 7V. V_{CC} potential is V_{ADPH2} when T15 potential goes under 0.5V. $V_{ADPHW} = V_{ADPH} - V_{ADPH2}$.
BAT pin leak current	V_{CC} = 0V, S11: B, V11 = 0V. Measure A9 current value I_{BAT}.
BAT pin output voltage	Gradually raise V9 from 3.5V. T9 potential is V_{BAT} when the potential difference between T13–T12 is 20mV or less.
CNT pin output voltage	V9 = 3.5V, S11: B. Gradually raise V11 from 0V. T11 potential is V_{CNT} when A11 current value is 20mA.
SW1 pin input current	Measure A1 current value I_{SW1}.
SW1 pin input voltage H	V9 = 3.5V, V2 = 1.2V. Raise V1 from 0V to 1.2V. Identify V_{SW1} H or L; when A9 is 50mA or higher, charging ON at current limit 2, and when A9 is 1mA or lower, charging is OFF.
SW1 pin input voltage L	
SW2 pin input current	Measure A2 current value I_{SW2}.
SW2 pin input voltage H	V9 = 3.5V. Raise V2 from 0V to 1.2V. Identify V_{SW2} H or L; when A9 is 450mA or higher, charging ON at current limit 1, and when A9 is 1mA or lower, charging is OFF.
SW2 pin input voltage L	
Current limit 1	V9 = 3.5V. Gradually raise V_{CC} current limit value and measure the potential difference between T13–T12, V_{L1}.
Current limit 2	V9 = 2.5V, V1 = V2 = 1.2V. Potential difference between T13–T12 is V_{L2}.
Current detection amp gain	V9 = 3.5V. The potential difference fluctuation between T13–T12 when V_{CC} current limit value is changed from 100mA to 200mA is ⊿Va and the T6 potential fluctuation is⊿Vb. $G_1 = 20\log \lvert \Delta Vb / \Delta Va \rvert$
Current detection amp output offset voltage	V9 = 4.0V. T6 potential is Vb2 when V_{CC} current limit is 100mA. V_{OFF} = Vb2/8 – 30mV
Current detection amp output current outflow	V9 = 3.5V, V_{CC} current limit value is 300mA, S6: B, V6 = 0V. Measure A6 current value.
V_{OUT1} pin output voltage	S15: B. Gradually raise V15 from 0V. T15 potential is V_{OUT1} when A15 current value is 0.12mA.
V_{OUT2} pin output voltage	S14: B. Gradually raise V14 from 0V. T14 potential is V_{OUT2} when A14 current value is 0.12mA.
Battery temperature detection voltage hysteresis voltage width	S8: B. Gradually lower V8 from 0.6V. T8 potential is V_{TDET} when T7 potential is 0.3V or under.
Battery temperature detection voltage hysteresis voltage width	S8: B. Gradually raise V8 from 0V. T8 potential is V_{TDET2} when T7 potential is 0.8V or higher. $V_{TDETW} = V_{TDET2} - V_{TDET}$.
T_{OUT} pin output voltage	S8: B, V8 = 0V, S7: B. Gradually raise V7 from 0V. T7 potential is V_{TOUT} when A7 current value is 0.12mA.
T_{DET} input bias current	S8: B, V8 = 0V. Measure A8 potential value I_T.

Timing Chart



Application Circuits