Lithium-Ion Battery Charge Control (microcomputer-controlled type) (1 cell)
Monolithic IC MM1475

Outline

This IC is a lithium-ion battery charge control IC. It is a one-chip charge control IC where the protection circuit incorporates constant-current/constant-voltage charge and precharge, precharge timer, and battery temperature detection functions. As opposed to MM1433, the fast-charge timer and full-charge detection function have been eliminated, and charge ON/OFF is controlled externally.

Features

1. Output voltage (Ta = 0°C ~ +50°C)	4.120 ± 30mV
2. Current consumption	3.5mA typ.
3. Precharge function	
4. Adaptor (primary side) abnormality detection function	
5. Timer error time	±10% (not including external deviation)
6. Battery temperature detection function	
7. Precharge timer	

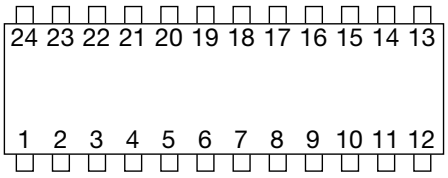
Package

TSOP-24A

Application

Lithium-ion battery charge control (with timer)

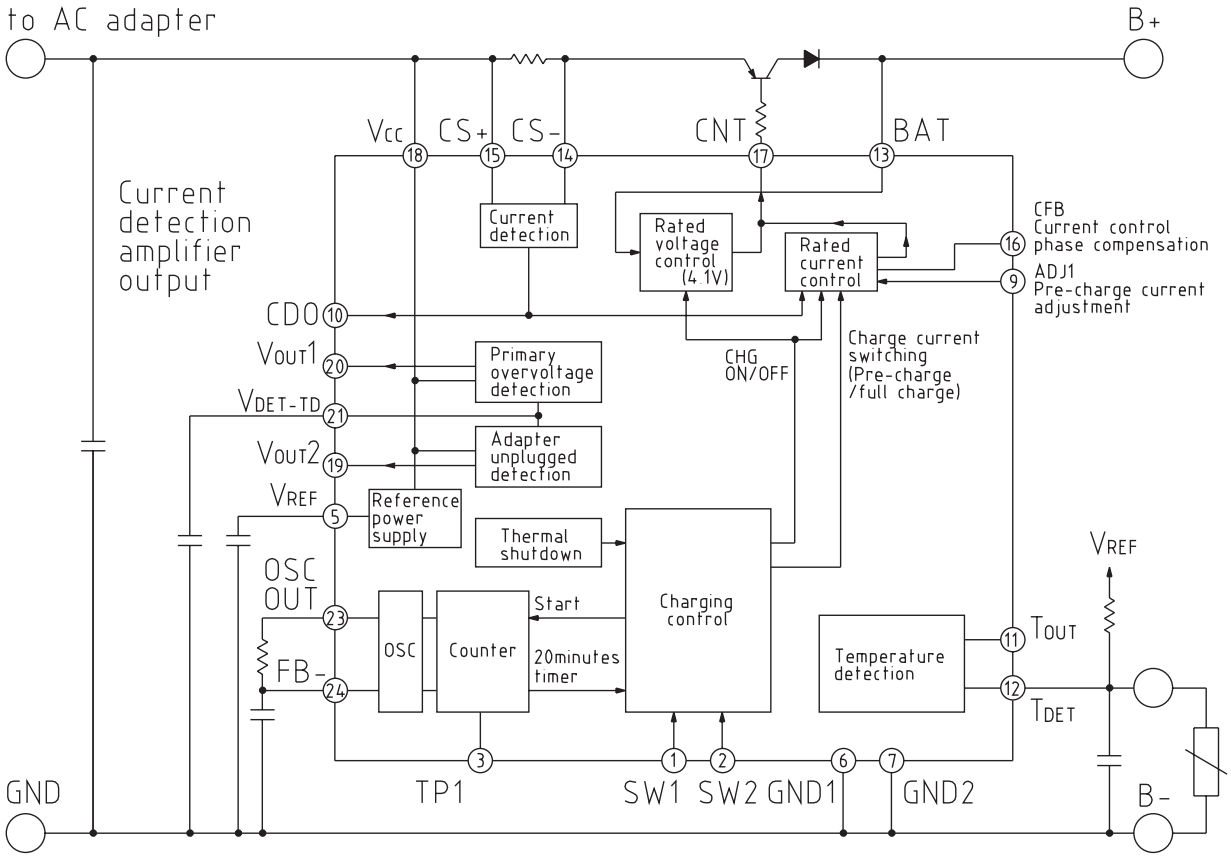
Pin Assignment



TSOP-24A

1	SW1	13	BAT
2	SW2	14	CS–
3	TP1	15	CS+
4	N.C	16	CFB
5	VREF	17	CNT
6	GND1	18	V_{CC}
7	GND2	19	$V_{OUT}2$
8	N.C	20	$V_{OUT}1$
9	ADJ1	21	VDET–TD
10	CDO	22	N.C
11	T_{OUT}	23	OSC OUT
12	TDET	24	OSC FB–

Block Diagram

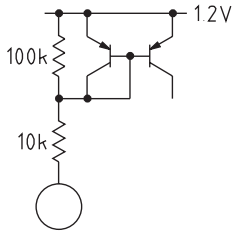
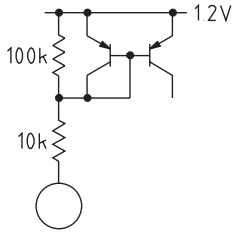
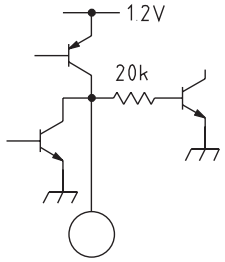
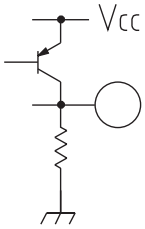
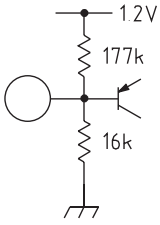
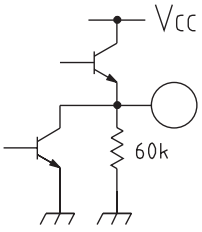


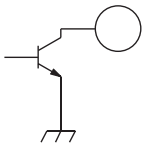
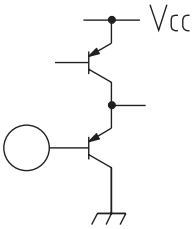
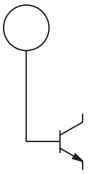
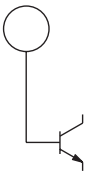
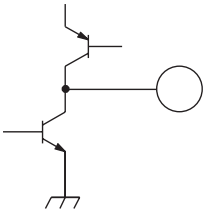
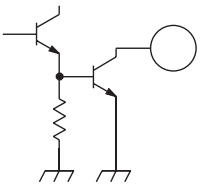
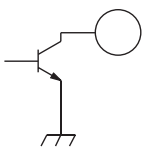
SW1	SW2	Charging	Current limit	Timer
L	H	OFF		OFF
H	H	ON	Controlled by this IC (Current limit 2: 25mV)	ON
L	L	ON	Controlled by adaptor (Current limit 1: 450mV)	OFF
H	L	ON	Controlled by adaptor (Current limit 1: 450mV)	OFF

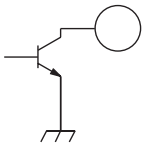
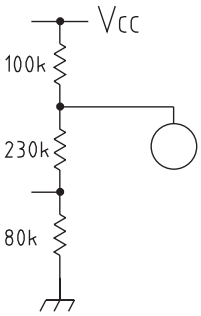
Pin Description

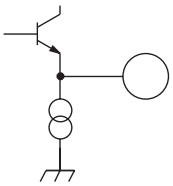
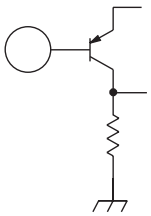
Pin No.	Pin name	I/O Function	Function
1	SW1	Input	Charge control switching pin. Switches charging ON/OFF and switches charging current by combinations of SW1 and SW2 high and low.
2	SW2	Input	
3	TP1	Input/output	Test pin 1. Pre-charge timer test pin. Inverts during counting (from the middle stage of the several-staged FF) and outputs on TP1 for monitoring. Also inverts TP1 output signal again inside the IC and inputs to the next stage FF. (Timer setting done by binary counter.)
5	VREF	Output	Reference power supply output pin. Outputs 1.2V typ. reference voltage.
6	GND1	Input	GND pin.
7	GND2	Input	GND pin.
9	ADJ1	Input	Pre-charge current adjustment pin. Pin voltage is set at 100mV typ.. Pre-charge current can be changed by adjusting pin voltage with an external resistor. Pre-charge current is controlled by comparing ADJ1 pin voltage and the 12dB voltage drop value between CS + and CS –.
10	CDO	Output	Current detection output pin. Outputs voltage difference of 18dB between CS+ and CS –.
11	T_{OUT}	Output	Temperature detection output pin. Normal temperature: Output Tr OFF When high temperature is detected: Output Tr ON
12	TDET	Input	Temperature detection input pin. Be sure to apply the potential obtained by resistance dividing, from reference voltage, with an external resistor and thermistor.
13	BAT	Input	Battery voltage input pin. Detects battery voltage and controls charging.
14	CS–	Input	Current detection pin. Detects current by voltage drop at external resistor between (CS+) and (CS–) and controls charging current.
15	CS+	Input	
16	CFB	Input	Rated current control phase compensation pin. Oscillation is improved by connecting an external capacitor (around 100pF) between CFB and CNT to perform phase compensation.
17	CNT	Output	Charging control output pin. Controls base of external PNP-Tr for rated current rated voltage charging.
18	V_{CC}	Input	Power supply input pin.
19	$V_{OUT}2$	Output	Adapter unplugged detection output pin. V_{CC} low voltage input: Output Tr OFF V_{CC} recommended operating voltage: Output Tr ON
20	$V_{OUT}1$	Output	Overvoltage detection output pin. V_{CC} overvoltage input: Output Tr OFF V_{CC} recommended operating voltage: Output Tr ON
21	VDET–TD	Input	Overvoltage detection delay time setting pin. Delay time is set by connecting an external capacitor.
23	OSC OUT	Output	Oscillator output pin. Timer setting time changes according to oscillation frequency. Oscillation frequency is determined by the external resistor (connected between OSC OUT and OSC FB) and capacitor (connected between OSC FB and GND).
24	OSC FB–	Input	Oscillator inverted input pin.

Pin Description The following valaeis typical

Pin No.	Pin name	Internal equivalent circuit diagram
1	SW1	
2	SW2	
3	TP1	
4	NC	
5	VREF	
8	NC	
9	ADJ1	
10	CDO	

Pin No.	Pin name	Internal equivalent circuit diagram
11	TOUT	
12	TDET	
13	BAT	
14	CS –	
15	CS +	
16	CFB	
17	CNT	
19	VOUT2	

Pin No.	Pin name	Internal Equivalent Circuit Diagram
20	VOUT1	
21	VDET–TD	

Pin No.	Pin name	Internal Equivalent Circuit Diagram
22	NC	
23	OSC OUT	
24	OSC FB –	

Absolute Maximum Ratings (Ta=25°C)

Item	Symbol	Rating	Unit
Storage temperature	TSTG	–40~+125	°C
Operating temperature	TOPR	–20~+70	°C
Power supply voltage	VCCmax.	–0.3~+15	V
Allowable loss	Pd	250	mW

Recommended Operating Conditions

Item	Symbol	Rating	Unit
Operating temperature	TOPR	–20~+70	°C
Charging control operating voltage	VOPR	3.0~5.8	V

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

Item	Symbol	Measurement conditions	Measurement pin	Min.	Typ.	Max.	Unit
Consumption current 1	I_{CC1}	SW1, 2 : H	18		3.5	5.0	mA
Consumption current 2	I_{CC2}	SW1, 2 : L	18		5.5	7.7	mA
Reference voltage	V_{REF}		5		1.207		V
ADP detection voltage L	V_{ADPL}	V_{CC} : H→L	19	2.70	2.80	2.90	V
ADP detection voltage L Hysteresis voltage width	V_{ADPLW}		19	50	100	150	mV
ADP detection voltage H	V_{ADPH}	V_{CC} : L→H	20	5.8	6.0	6.2	V
ADP detection voltage H Hysteresis voltage width	V_{ADPHW}		20	50	100	150	mV
BAT pin leak current	I_{BAT}		13			1	µA
BAT pin output voltage	V_{BAT}	Ta=0~+50°C	13	4.090	4.120	4.150	V
CNT pin output voltage	V_{CNT}	I_{CNT}=20mA	17			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}	Rapid Charging	14, 15	0.35	0.45	0.55	V
Current limit 2	V_{L2}	Preliminary Charging	14, 15	20	25	30	mV
Current detection amp gain	G_I		10	17.5	18.0	18.5	dB
Current detection amp input offset voltage	V_{OFF}		10	–4.5	0	4.5	mV
Current detection amp output current	I_{CDO}		10	0.5	1.0		mA
V_{OUT1} pin output voltage	V_{OUT1}	I_{OUT1}=0.12mA	20		0.2	0.4	V
V_{OUT2} pin output voltage	V_{OUT2}	I_{OUT2}=0.12mA	19		0.2	0.4	V
Battery temperature detection voltage	V_{TDET}	V_{TDET} : H→L	11	0.390	0.413	0.435	V
Battery temperature detection voltage hysteresis voltage width	V_{TDETW}		11	30	60	90	mV
T_{OUT} pin output voltage	V_{TOUT}	I_{TOUT}=0.12mA	11		0.2	0.4	V
TDET input bias current	I_T		12		30	150	nA
Timer error time	⊿T	Excluding Dispersion	17	–10		10	%

*Current limit 1 and 2 are prescribed by the current detection resistor voltage drop range.

*If the control on this IC fails to work, its safety can not be guaranteed. Please protect with something other than this IC.

*Please use a capacitor with good temperature characteristics in the OSC section. Capacitor deviation causes timer error.

Reference Materials on OSC CR Setting

(1) OSC CR – Oscillation cycle T Table

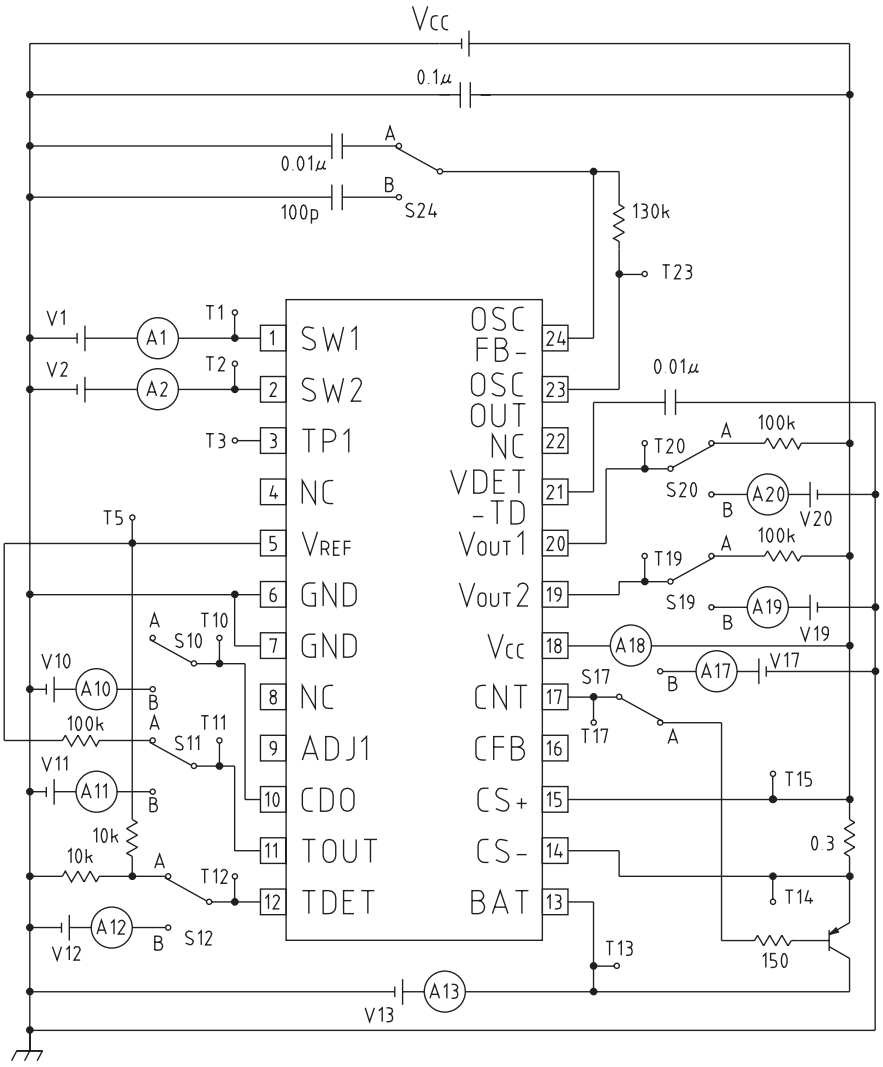
R / C	75k	100k	120k	130k	150k	200k
0.0047µ	0.47ms	0.63ms	0.75ms	0.82ms	0.94ms	1.26ms
0.0082µ	0.83ms	1.10ms	1.32ms	1.43ms	1.65ms	2.20ms
0.01µ	1.03ms	1.37ms	1.63ms	1.77ms	2.04ms	2.73ms
0.015µ	1.48ms	1.98ms	2.38ms	2.58ms	2.97ms	3.95ms
0.022µ	2.16ms	2.87ms	3.44ms	3.73ms	4.30ms	5.76ms

(2) Timer Times

Item	Formula	Example (for C = 0.01µ, R = 130k)
Pre-charge timer	$T \times 2^{19}$	15min. 28s

T: OSC oscillation cycle

Measuring Circuit



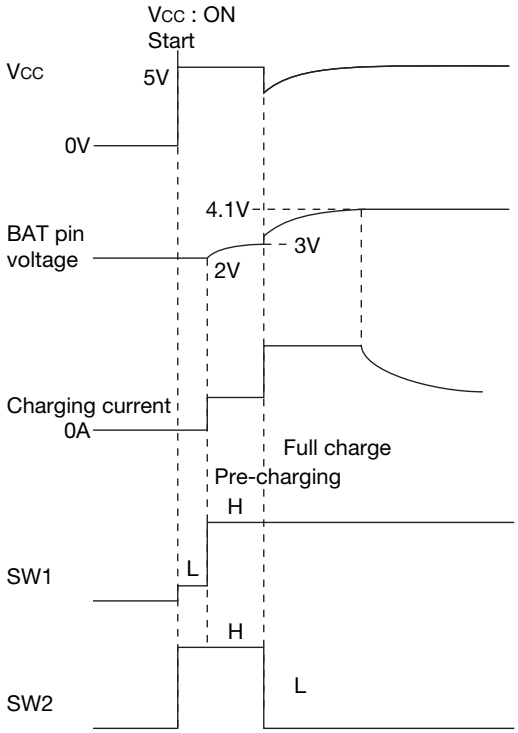
Measurement method

(Except where otherwise indicated, Ta = 25°C, Vcc = 5V, Vcc : current limit 0.5A, V1 = V2 = 0V, V13 = 4.2V, S10, 11, 12, 17, 19, 20, 24:A, timer time is not up)

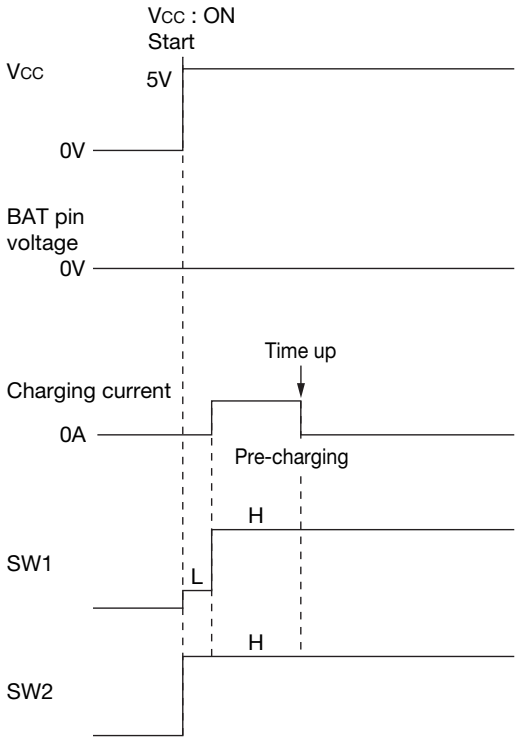
Item	Measurement method
Consumption current 1	Measure A18 current value I_{CC1} when V1 = V2 = 1.2V.
Consumption current 2	Measure A18 current value I_{CC2}.
Reference voltage	Measure T5 potential V_{REF}.
ADP detection voltage L	Gradually lower V_{CC} from 5V. V_{CC} potential when T19 potential goes over V_{CC} – 0.5V is V_{ADPL}.
ADP detection voltage L Hysteresis voltage width	Gradually lower V_{CC} from 2V. V_{CC} potential when T19 potential drops below 0.5V is V_{ADPL2}. $V_{ADPLW}=V_{ADPL2}-V_{ADPL}$
ADP detection voltage H	Gradually raise V_{CC} from 5V. V_{CC} potential when T20 potential goes over V_{CC} – 0.5V is V_{ADPH}.
ADP detection voltage H Hysteresis voltage width	Gradually lower V_{CC} from 7V. V_{CC} potential when T20 potential drops below 0.5V is V_{ADPH2}. $V_{ADPHW}=V_{ADPH}-V_{ADPH2}$
BAT pin leak current	Measure A13 current value I_{BAT} when V_{CC} = 0V, S17: B, V17 = 0V.
BAT pin output voltage	Gradually raise V13 from 3.5V. T13 potential when T15–T14 potential difference is 20mV or less is V_{BAT}.
CNT pin output voltage	Gradually raise V17 from 0V when V13 = 3.5V and S17: B. T17 potential when A17 current value reaches 20mA is V_{CNT}.
SW1 pin input current	Measure A1 current value I_{SW1}.
SW1 pin input voltage H	Change V1 from 0V to 1.2V when V13 = 3.5V and V2 = 1.2V. To identify V_{SW1} H and L, when A13 is over 50mA, charging is ON at current limit 2, and when A13 is 1mA or under, charging is OFF.
SW1 pin input voltage L	
SW2 pin input current	Measure A2 current value I_{SW2}.
SW2 pin input voltage H	Change V2 from 0V to 1.2V when V13 = 3.5V. To identify V_{SW2} H and L, when A13 is over 450mA, charging is ON at current limit 1, and when A13 is 1mA or under, charging is OFF.
SW2 pin input voltage L	
Current limit 1	Gradually raise V_{CC} current limit value when V13 = 3.5V, and measure T15–T14 potential difference VL1.
Current limit 2	V13 = 2.5V, V1 = V2 = 1.2V, and T15-T14 potential difference is V_{L2}.
Current detection amp gain	T15-T14 potential difference fluctuation is ⊿Va and T10 potential fluctuation is ⊿Vb when V13 = 3.5V and V_{CC} current limit value is changed from 100mA to 200mA. $G_I=20\log\lvert\Delta Vb/\Delta Va\rvert$
Current detection amp input offset voltage	T10 potential is Vb2 when V13 = 4.0V and V_{CC} current limit value is 100mA. V_{OFF}=Vb2/8–30mV
Current detection amp output current	Measure A10 current value when V13 = 3.5V, V_{CC} current limit value is 300mA, S10: B and V10 = 0V.
V_{OUT}1 pin output voltage	Gradually raise V20 from 0V when S20: B. T20 potential when A20 current value is 0.12mA is V_{OUT1}.
V_{OUT}2 pin output voltage	Gradually raise V19 from 0V when S19: B. V19 potential when A19 current value is 0.12mA is V_{OUT2}.
Battery temperature detection voltage	At S12:B, lower gradually from V12 = 0V. T12 potential is V_{TDET} when T11 potential falls below 0.3V.
Battery temperature detection voltage hysteresis voltage width	At S12:B, lower gradually from V12 = 0V. T12 potential is V_{TDET2} when T11 potential goes above 0.8V. $V_{TDETW}=V_{TDET2}-V_{TDET}$
T_{OUT} pin output voltage	Raise V11 gradually from 0V when S12:B, V12 = 0V, S11:B. T11 potential is V_{TOUT} when A11 current value is 0.12mA.
TDET input bias current	Measure A12 current value I_T for S12:B, V12 = 0V.

Timing Chart

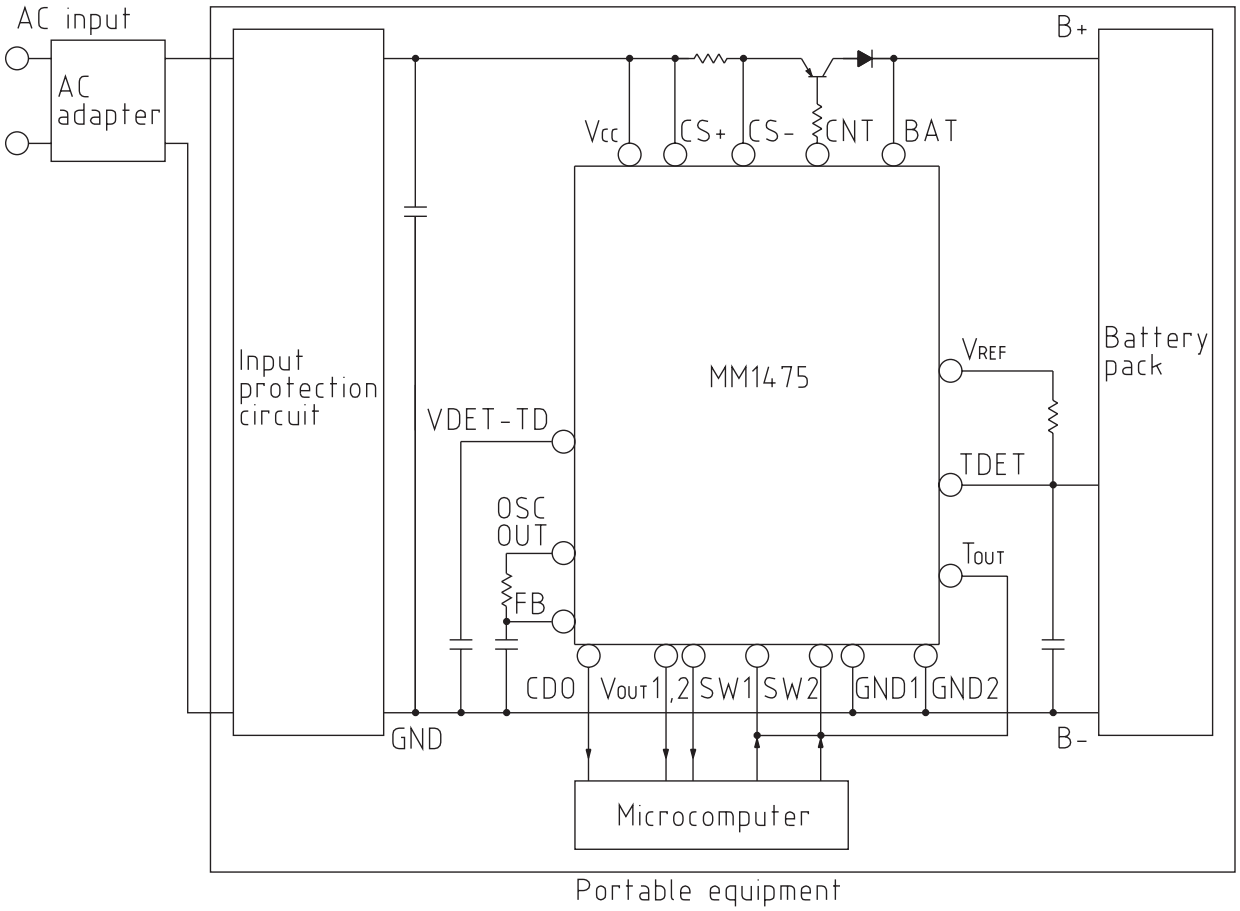
When charging is performed normally



Pre-Charging Time Up

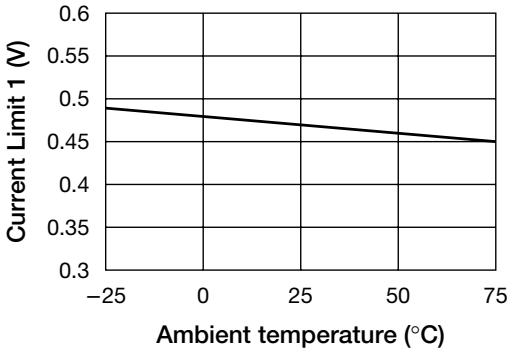


Application Circuit

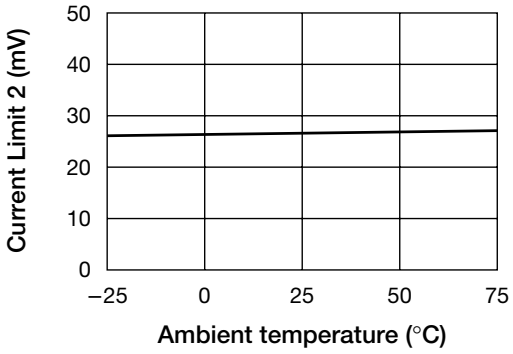


Characteristics

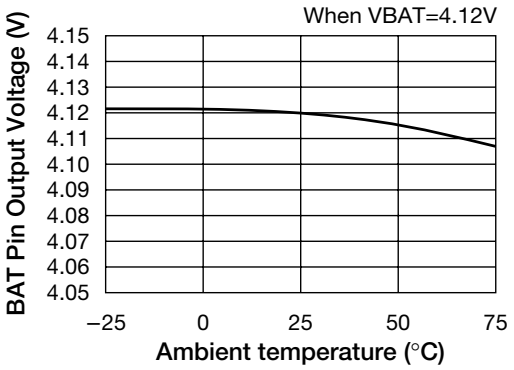
Current Limit 1 vs Ambient temperature



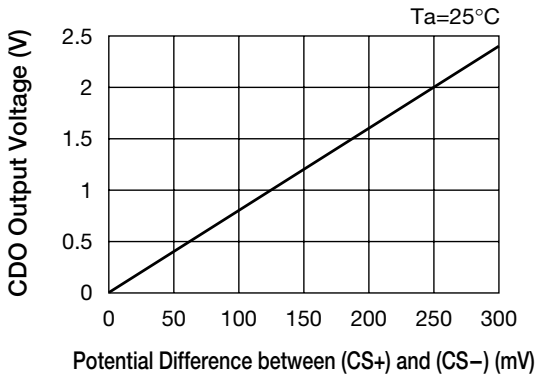
Current Limit 2 vs Ambient temperature



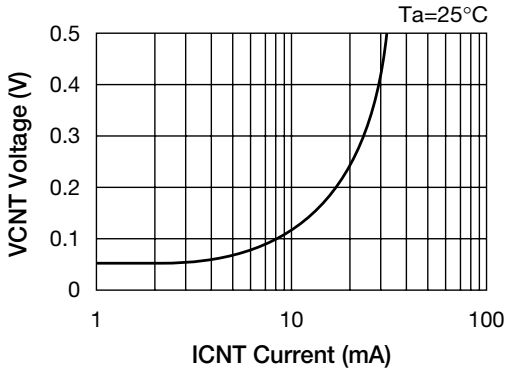
BAT Pin Output Voltage vs Ambient temperature



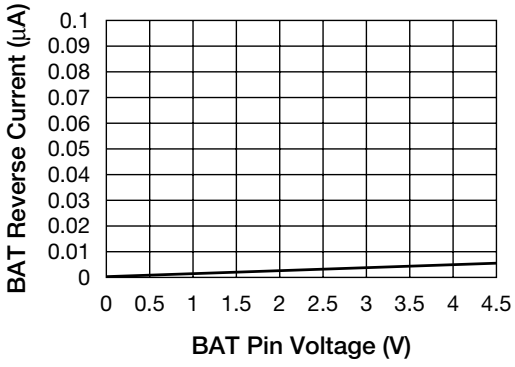
Current Detection Input/Output



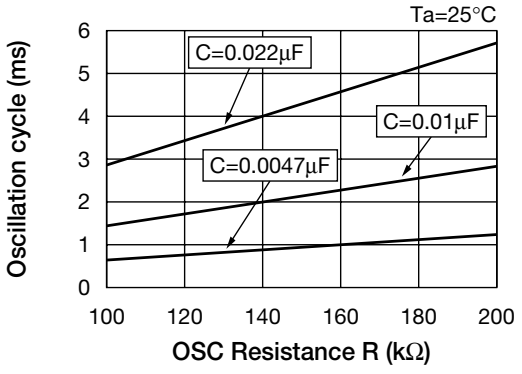
VCNT Voltage vs ICNT Current



BAT Pin Reverse Current vs BAT Pin Voltage



OSC Oscillation Cycle vs CR



ADP Detection H Delay Time