MITSUMI

IC for Control of Lithium-ion Betteries Charging
Monolithic IC MM1438

Outline

This IC is used to control charging of lithium-ion batteries consisting of a single cell. It is a modification of the previous MM1332 charging-control IC, with improved charging voltage accuracy and a smaller package.

Features

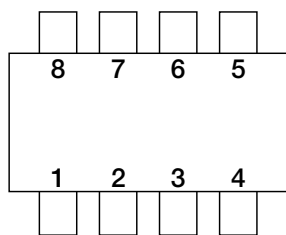|	
1. Charging voltage accuracy (Ta=25℃)	±25mV/cell
2. Charging voltage accuracy (Ta=0 to 50℃)	±30mV/cell
3. Consumption current (charging on)	250μA typ.
4. Consumption current (charging off)	2μA typ.
5. Low-voltage detection	2.15V typ.
6. Leakage current between CEL and CS	1μA max.

Package

VSOP-8B

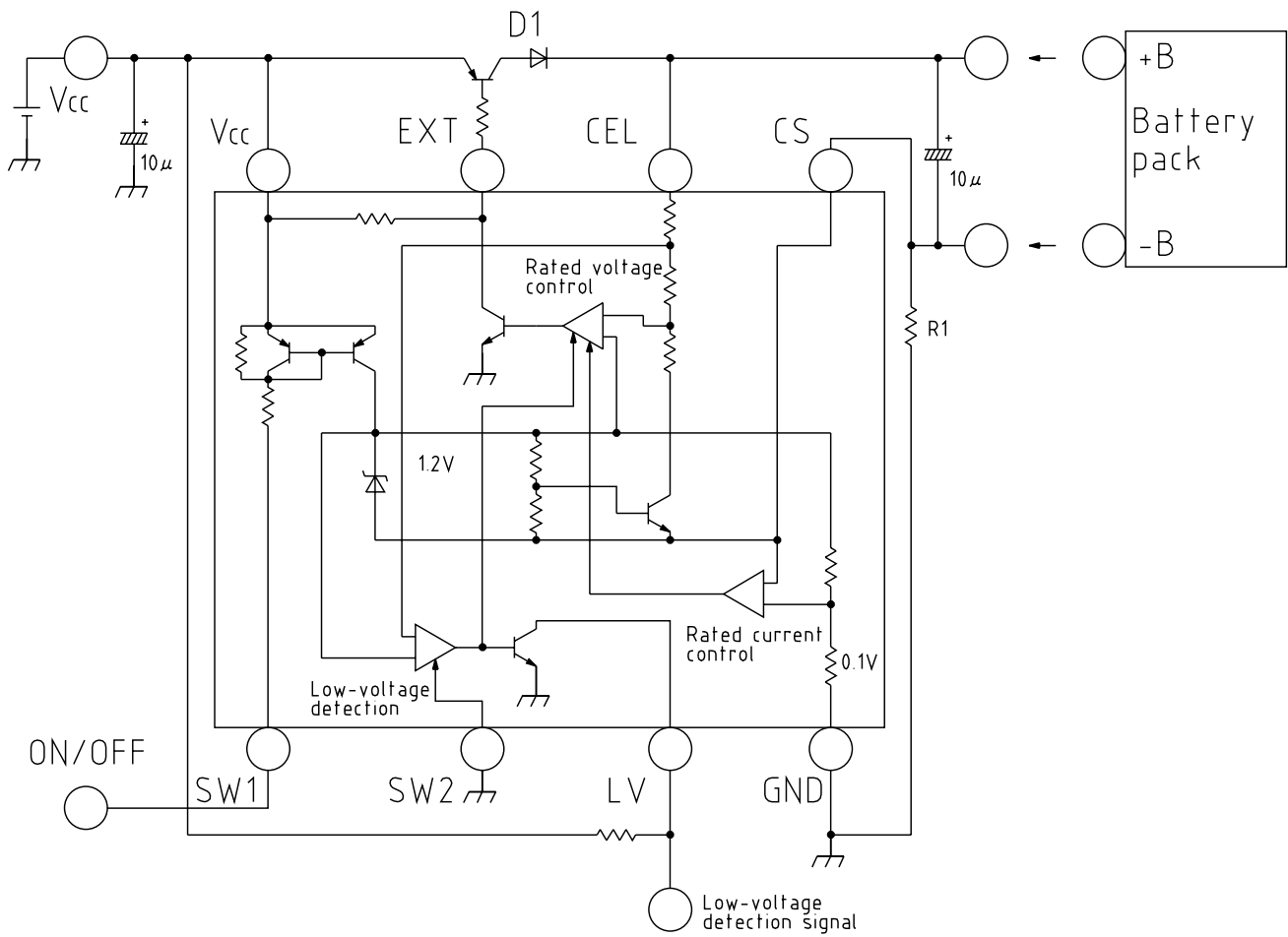## Applications

IC for control of lithium-ion batteries charging.

Pin Assignment

VSOP-8B

1	GND
2	LV
3	SW2
4	SW1
5	V_{CC}
6	EXT
7	CEL
8	CS

Block Diagram

Pin Description

Pin No.	Pin name	I/O	Pin Description
1	GND	Input	Ground pin
2	LV	Output	Low voltage detection circuit output pin ON with NPN-Tr open collector output at low voltage
3	SW2	Input	Low voltage detection circuit ON/OFF control input pin SW2 = Vcc: OFF, SW2 = GND: ON
4	SW1	Input	ON/OFF control input pin for the IC SW1 = Vcc: OFF, SW1 = GND: ON
5	Vcc	Input	Power supply input pin
6	EXT	Output	Charging control output pin Controls external PNP-Tr to control charging.
7	CEL	Input	Battery voltage input pin Detects battery voltage and controls rated Voltage to the prescribed voltage value.
8	CS	Input	Current detection pin Detects current by drop in external resistor voltage and controls rated current. Current value can be set at 0.1V/R1 typ.

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_{CC} max.	−0.3~+18	V
CFL pin input voltage	V_{CEL} max.	−0.3~+13	V
SW input voltage	V_{SW}	−0.3~V_{CC}+0.3	V
Allowable loss	Pd	300	mW

Recommended Operating Conditions

Item	Symbol	Ratings	Unit
Operating temperature	T_{OPR}	−20~+70	°C
Charging control operating voltage	V_{OPR}	2.5~+17	V

Note: Operating voltage minimum value is during rated current control.

Electrical Characteristics (Except where noted otherwise, Ta=25°C, V_{CC}=5V, SW3 : A, SW6 : A, SW7 : A)

Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Unit
Consumption current 1	I_{CC1}	VSW1=VSW2=0V (Charge : ON)		250	400	μA
Consumption current 2	I_{CC2}	VSW1=VSW2=V_{CC} (Charge : OFF)		2	10	μA
Output voltage 1	V_{O1}	Ta=25°C	4.100	4.125	4.150	V
Output voltage 2	V_{O2}	Ta=0~50°C	4.095	4.125	4.155	V
Current limit	V_{CL}		90	100	110	mV
Inflow current between CEL-CS during operation	I_{CEL1}		3.0	5.0	7.0	μA
Leak current between CEL-CS	I_{CEL2}	V_{CC}=0V or OPEN		0.01	1	μA
SW1 input current	I_{SW1}			20	30	μA
SW1 input voltage L	V_{L1}	Charge : ON	−0.3		2.0	V
SW1 input voltage H	V_{H1}	Charge : OFF	V_{CC}−0.1		V_{CC}+0.3	V
Low voltage detection voltage	L_V		2.0	2.15	2.3	V
SW2 input current	I_{SW2}			20	30	μA
SW2 input current L	V_{L2}	Low voltage detection circuit: ON	−0.3		2.0	V
SW2 input current H	V_{H2}	Low voltage detection circuit: OFF	V_{CC}−1.0		V_{CC}+0.3	V
Low voltage detection output leak current	I_{LV}				0.5	μA
Low voltage detection output saturation voltage	V_{LV}	I_{SINK}=1mA			0.2	0.4	V
EXT pin inflow current	I_{EXT}		10	20		mA
EXT pin output voltage	V_{EXT}	For no load	0.3		V_{CC}−0.3	V

Note 1: Please insert a capacitor of several μF between power supply and ground when using.

Note 2: Be sure that CS pin potential does not fall below −0.5V.

Note 3: 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.
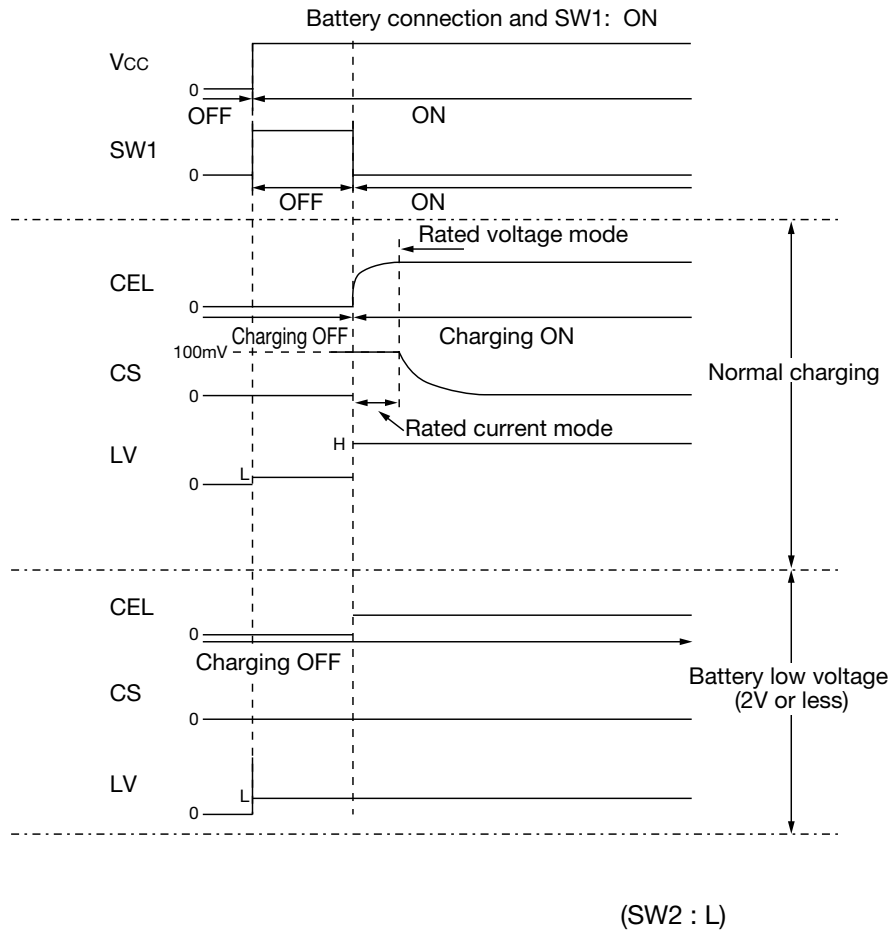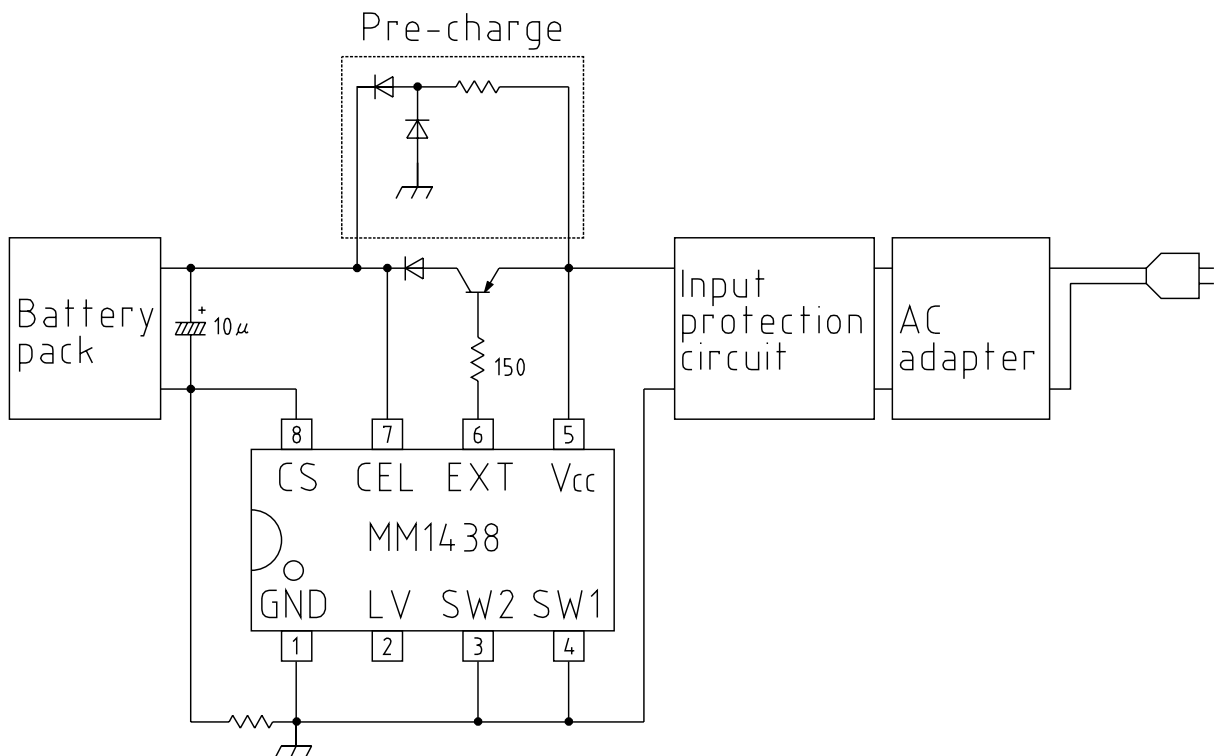
Measuring Circuit
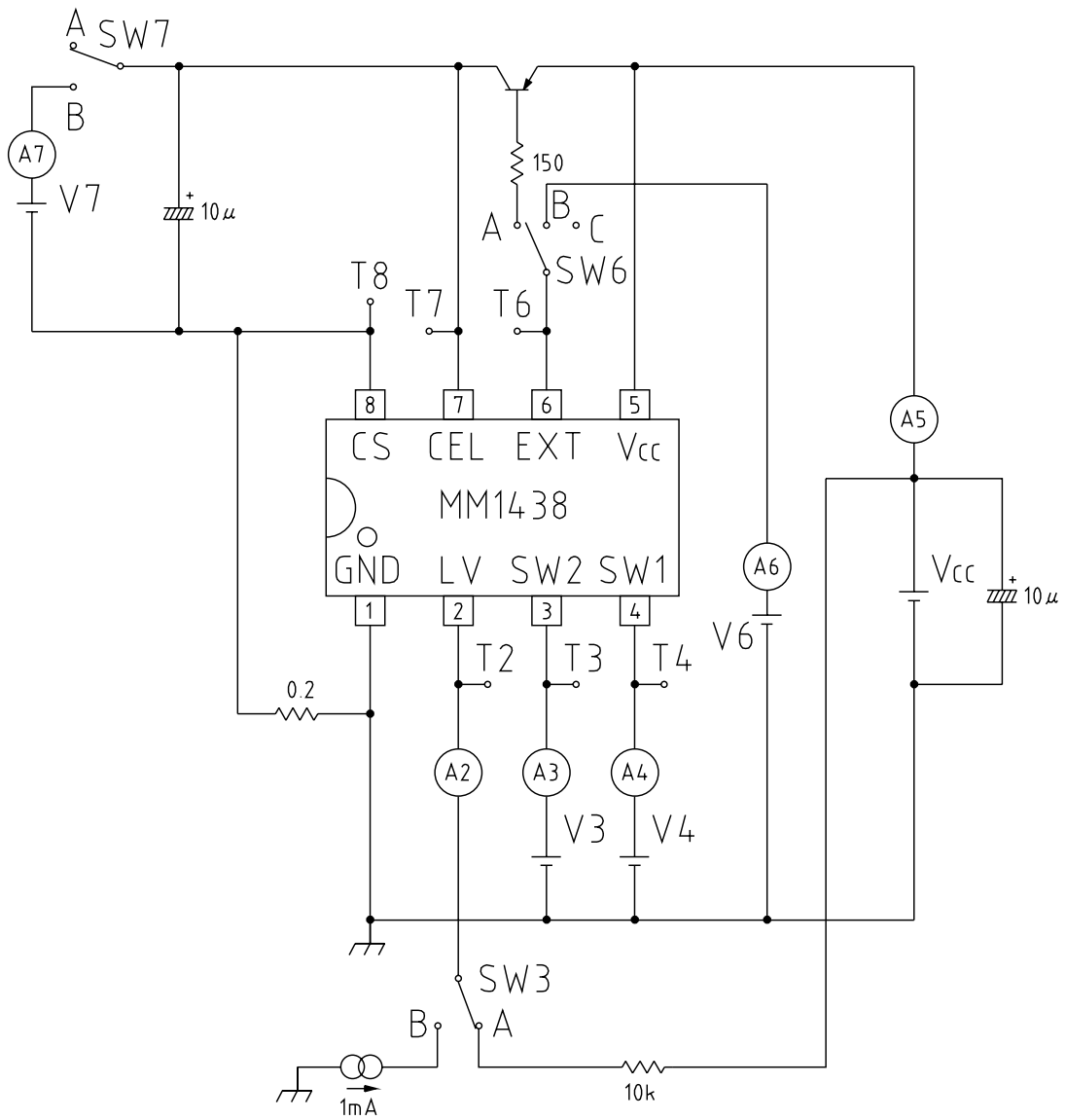
Measurement Procedures (Except where noted otherwise, Ta=25°C, Vcc=5V, SW3 : A, SW6 : A, SW7 : A)

| Item	Measurement Procedures
Consumption current 1	$V3 = V_{CC}$, $V4 = 0V$. Next, measure A5 current value I_{CC1} when V3 is changed from $V_{CC} \rightarrow 0V$.
Consumption current 2	$V3 = Vd = V_{CC}$. Measure A6 current value I_{CC2} at this time.
Output voltage	$V3 = V_{CC}$, $V4 = 0V$. Measure T7 voltage V_O at this time.
Current limit	$V3 = V_{CC}$, $V4 = 0V$. Set V7 voltage 1V lower than T7 (output voltage) potential and set SW7 to B. Measure T8 voltage V_{CL} at this time.
Inflow current between CEL-CS during operation	$V3 = V_{CC}$, $V4 = 0V$, SW6: C. $V7 = 4.5V$, SW7: B. Measure A7 current value I_{CEL1} at this time.
Leak current between CEL-CS	$V3 = V4 = V_{CC} = 0V$, SW6: C. $V7 = 4.5V$, SW7: B. Measure A7 current value I_{CEL2} at this time.
SW1 input current	Measure A4 current value I_{SW1} when $V4 = 0V$.
SW1 input voltage	$V3 = V_{CC}$. Charge: ON (V_{L1}) when V4 potential is varied and T7 voltage is the prescribed output voltage; Charge OFF (V_{H1}) when $0 \sim 0.05V$.
Low voltage detection voltage	$V3 = V4 = 0V$. Set V7 voltage 1V lower than T7 (output voltage) potential, and SW7: B. Next gradually lower V7 voltage; V7 voltage is L_V when A7 current value is within $\pm10\mu A$.
SW2 input current	Measure A3 current value I_{SW2} when $V3 = 0V$.
SW2 input voltage	$V4 = 0V$, $V7 = 1V$, SW7: B. Low voltage detection circuit: ON (V_{L2}) when V3 voltage is varied and A7 current value is within $\pm10\mu A$; low voltage detection circuit: OFF (V_{H2}) otherwise.
Low voltage detection output leak current	$V3 = V_{CC}$, $V4 = 0V$. Measure A2 current value I_{LV} when V3 is changed from Vcc 0V.
Low voltage detection output saturation voltage	$V3 = V4 = 0V$. SW3: B, SW7: B. Measure T2 voltage V_{LV} when V7 voltage is 0V.
EXT pin inflow current	$V3 = V4 = 0V$. SW6: B, SW7: B, $V6 = 4V$, $V7 = 3V$. Measure A6 current value I_{EXT}.
EXT pin output voltage	$V3 = V4 = 0V$. SW6: C, SW7: B. T6 voltage when $V7 = 3V$ and $V7 = 5V$ is V_{EXT}.

Timing Chart

Battery connection and SW1: ON

Vcc

SW1

CEL

Rated voltage mode

CS

Charging OFF   Charging ON

Normal charging

LV

Rated current mode

CEL

Charging OFF

CS

Battery low voltage
(2V or less)

LV

(SW2 : L)

Application Circuit

Pre-charge

Battery pack   10μ

Input protection circuit   AC adapter

| 8 | 7 | 6 | 5 |
| CS | CEL | EXT | Vcc |

MM1438

| GND | LV | SW2 | SW1 |
| 1 | 2 | 3 | 4 |

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Characteristics
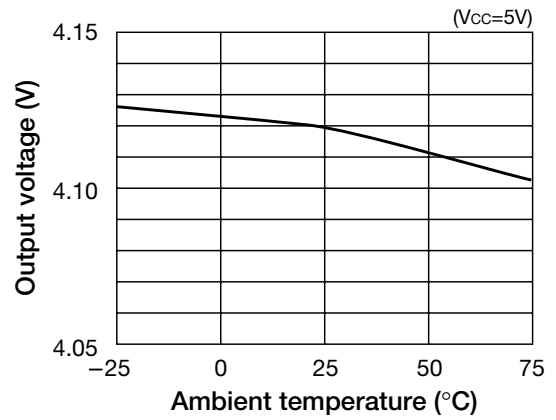
■ Output voltage vs Power supply voltage

(Ta=25°C)

Output voltage (V) vs Power supply voltage (V)
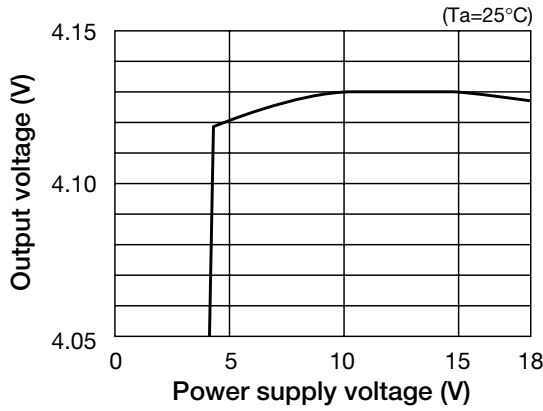
■ Output voltage vs Ambient temperature

(Vcc=5V)

Output voltage (V) vs Ambient temperature (°C)

■ CS pin voltage vs Power supply voltage

(Ta=25°C)

CS pin voltage (mV) vs Power supply voltage (V)

■ CS pin voltage vs Ambient temperature

(Vcc=5V)
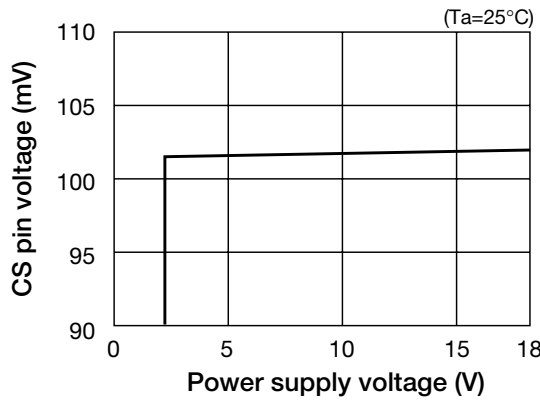
CS pin voltage (mV) vs Ambient temperature (°C)
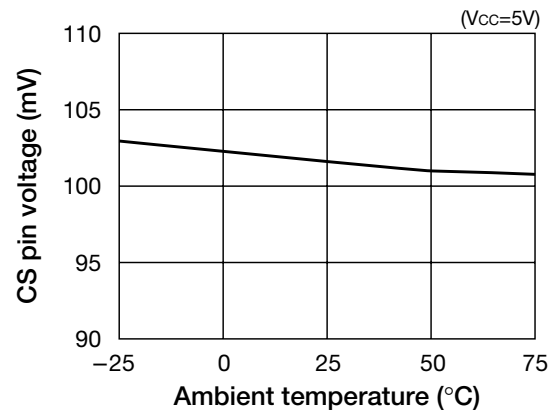
■ LV pin voltage vs LV pin inflow current

(Ta=25°C)

LV pin voltage (V) vs LV pin inflow current (mA)
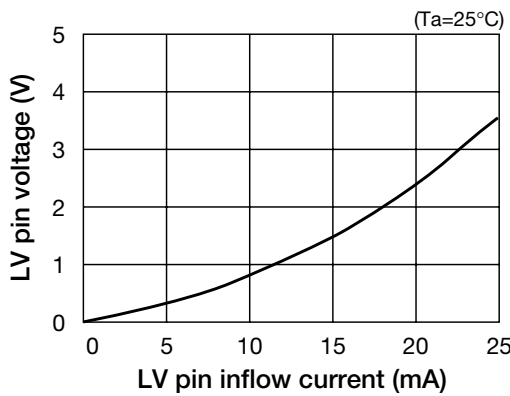
■ CS pin voltage vs Output voltage

(Ta=25°C,Vcc=5V, at low voltage detection)

CS pin voltage (mV) vs Output voltage (V)
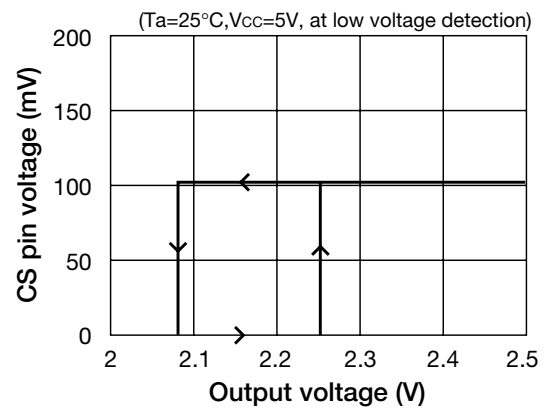
■ EXT pin voltage vs EXT pin inflow current

(Ta=25°C,Vcc=5V)

EXT pin voltage (V) vs EXT pin inflow current (mA)