

# IC for Control of Lithium-ion Batteries 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°C)      | ±25mV/cell |
| 2. Charging voltage accuracy (Ta=0 to 50°C) | ±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.   |

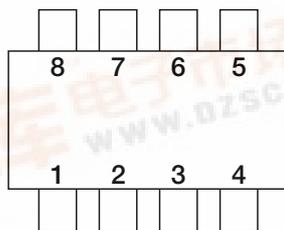
## Package

VSOP-8B

## Applications

IC for control of lithium-ion batteries charging.

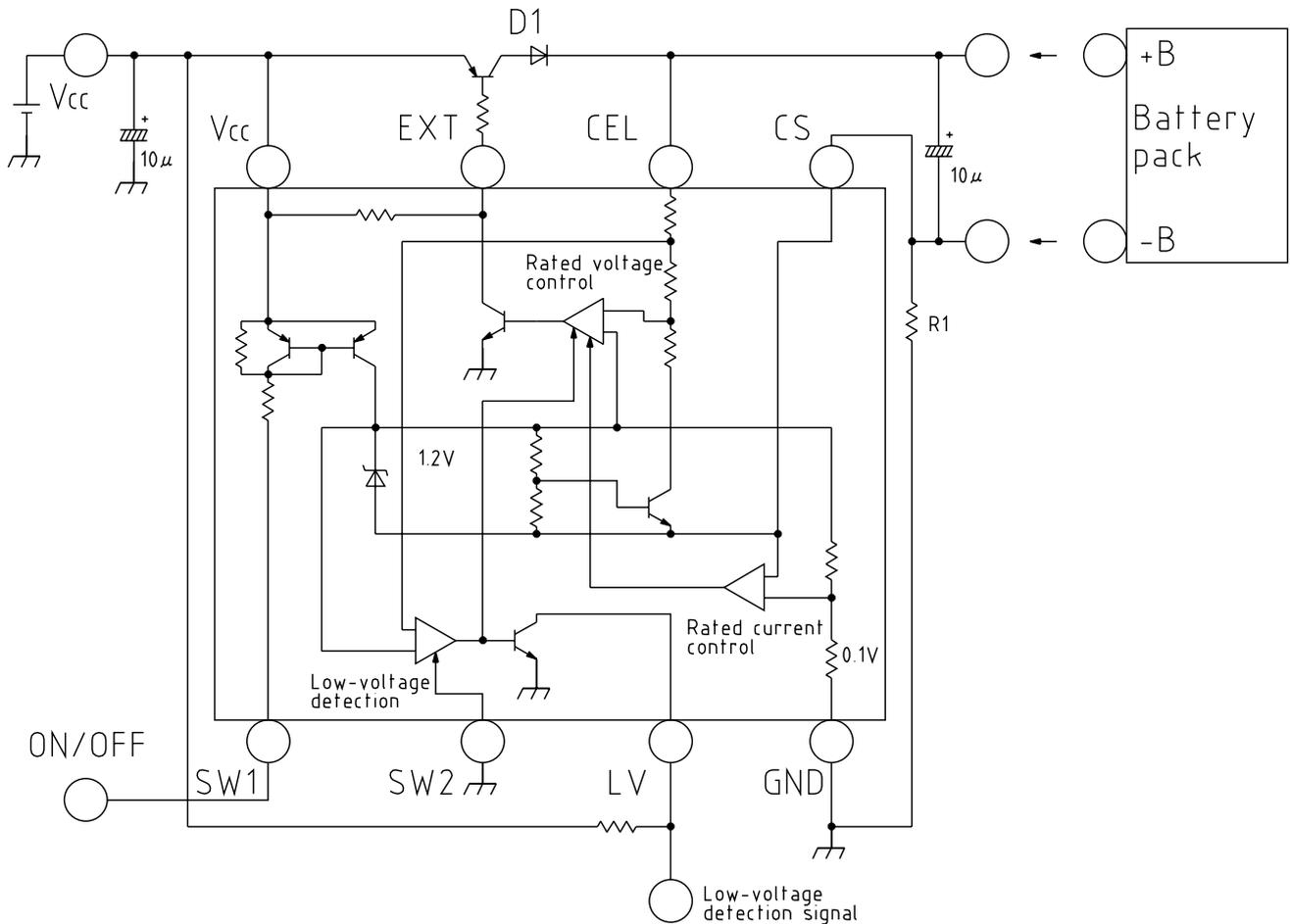
## Pin Assignment



VSOP-8B

1	GND
2	LV
3	SW2
4	SW1
5	V <sub>cc</sub>
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 <sub>STG</sub>	-40~+125	°C
Operating temperature	T <sub>OPR</sub>	-20~+70	°C
Power supply voltage	V <sub>CC</sub> max.	-0.3~+18	V
CFL pin input voltage	V <sub>CEL</sub> max.	-0.3~+13	V
SW input voltage	V <sub>SW</sub>	-0.3~V <sub>CC</sub> +0.3	V
Allowable loss	Pd	300	mW

**Recommended Operating Conditions**

Item	Symbol	Ratings	Unit
Operating temperature	T <sub>OPR</sub>	-20~+70	°C
Charging control operating voltage	V <sub>OPR</sub>	2.5~+17	V

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

**Electrical Characteristics** (Except where noted otherwise, Ta=25°C, V<sub>CC</sub>=5V, SW3 : A, SW6 : A, SW7 : A)

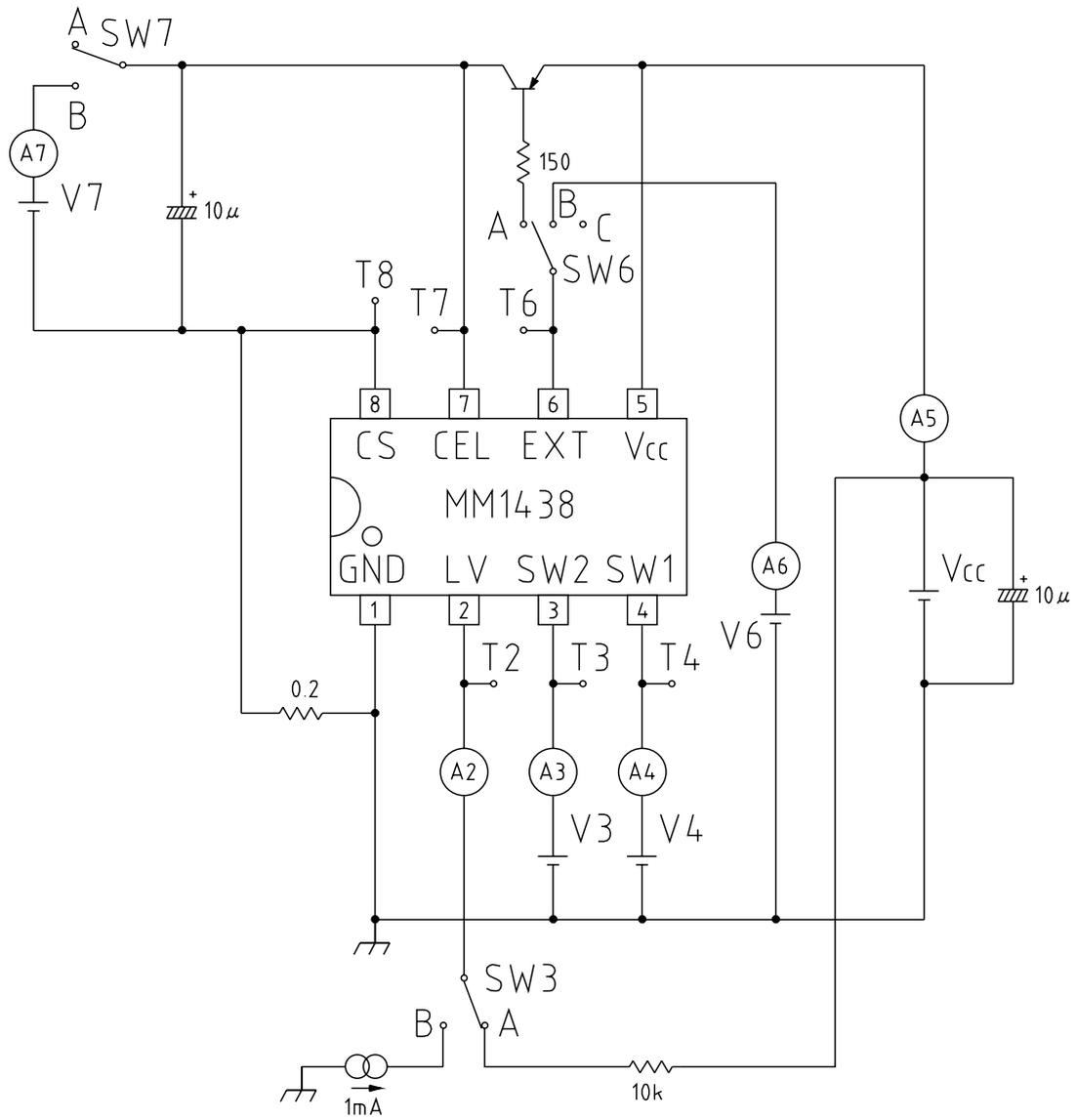
Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Unit
Consumption current 1	I <sub>CC1</sub>	V <sub>SW1</sub> =V <sub>SW2</sub> =0V (Charge : ON)		250	400	μA
Consumption current 2	I <sub>CC2</sub>	V <sub>SW1</sub> =V <sub>SW2</sub> =V <sub>CC</sub> (Charge : OFF)		2	10	μA
Output voltage 1	V <sub>O1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

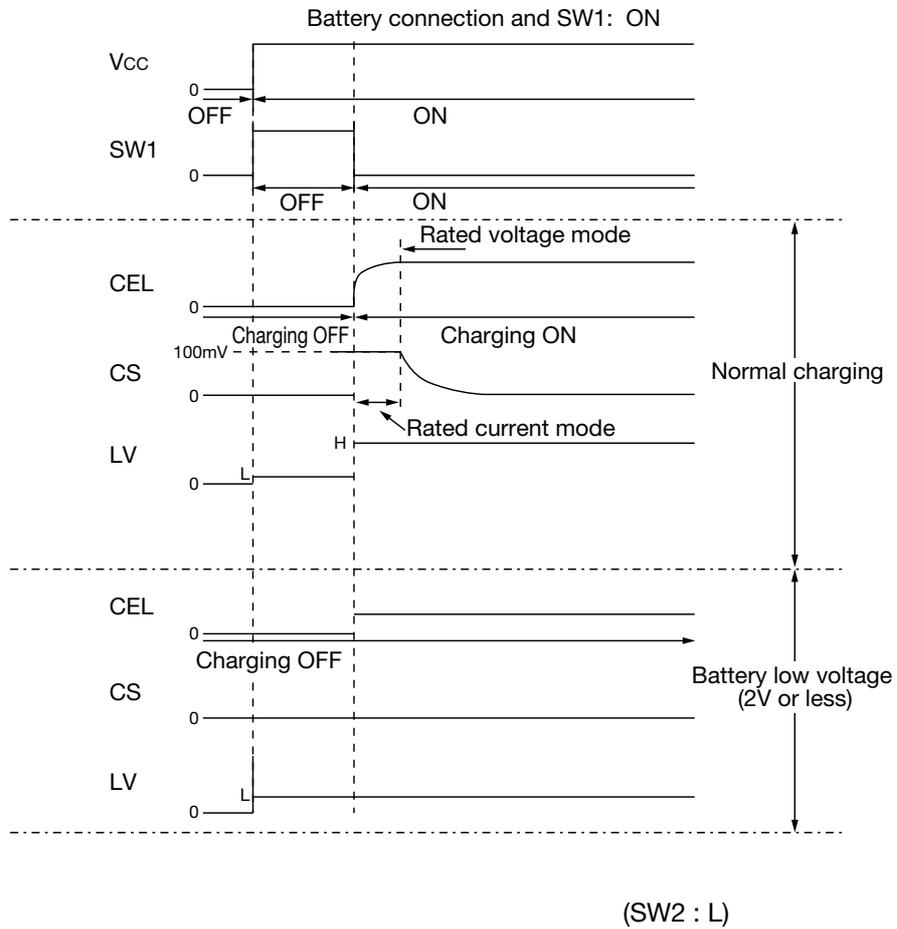
Measuring Circuit



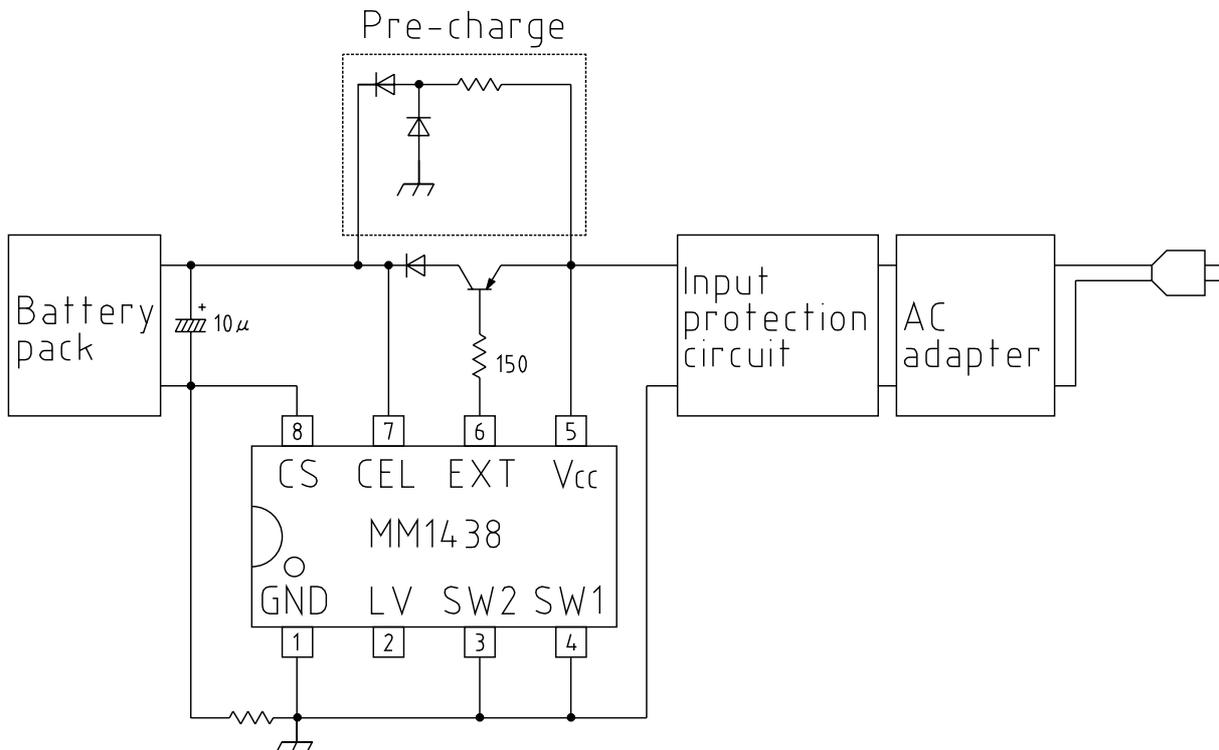
**Measurement Procedures** (Except where noted otherwise,  $T_a=25^{\circ}\text{C}$ ,  $V_{CC}=5\text{V}$ , SW3 : A, SW6 : A, SW7 : A)

Item	Measurement Procedures
Consumption current 1	$V3 = V_{CC}$ , $V4 = 0\text{V}$ . Next, measure A5 current value $I_{CC1}$ when $V3$ is changed from $V_{CC} \rightarrow 0\text{V}$ .
Consumption current 2	$V3 = V_d = V_{CC}$ . Measure A6 current value $I_{CC2}$ at this time.
Output voltage	$V3 = V_{CC}$ , $V4 = 0\text{V}$ . Measure T7 voltage $V_o$ at this time.
Current limit	$V3 = V_{CC}$ , $V4 = 0\text{V}$ . 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	$V3 = V_{CC}$ , $V4 = 0\text{V}$ , SW6: C. $V7 = 4.5\text{V}$ , SW7: B. Measure A7 current value $I_{CEL1}$ at this time.
Leak current between CEL-CS	$V3 = V4 = V_{CC} = 0\text{V}$ , SW6: C. $V7 = 4.5\text{V}$ , SW7: B. Measure A7 current value $I_{CEL2}$ at this time.
SW1 input current	Measure A4 current value $I_{SW1}$ when $V4 = 0\text{V}$ .
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 $0 \sim 0.05\text{V}$ .
Low voltage detection voltage	$V3 = V4 = 0\text{V}$ . Set V7 voltage 1V lower than T7 (output voltage) potential, and SW7: B. Next gradually lower V7 voltage; V7 voltage is $V_L$ when A7 current value is within $\pm 10\mu\text{A}$ .
SW2 input current	Measure A3 current value $I_{SW2}$ when $V3 = 0\text{V}$ .
SW2 input voltage	$V4 = 0\text{V}$ , $V7 = 1\text{V}$ , SW7: B. Low voltage detection circuit: ON ( $V_{L2}$ ) when $V3$ voltage is varied and A7 current value is within $\pm 10\mu\text{A}$ ; low voltage detection circuit: OFF ( $V_{H2}$ ) otherwise.
Low voltage detection output leak current	$V3 = V_{CC}$ , $V4 = 0\text{V}$ . Measure A2 current value $I_{LV}$ when $V3$ is changed from $V_{CC} \rightarrow 0\text{V}$ .
Low voltage detection output saturation voltage	$V3 = V4 = 0\text{V}$ . SW3: B, SW7: B. Measure T2 voltage $V_{LV}$ when V7 voltage is $0\text{V}$ .
EXT pin inflow current	$V3 = V4 = 0\text{V}$ . SW6: B, SW7: B, $V6 = 4\text{V}$ , $V7 = 3\text{V}$ . Measure A6 current value $I_{EXT}$ .
EXT pin output voltage	$V3 = V4 = 0\text{V}$ . SW6: C, SW7: B. T6 voltage when $V7 = 3\text{V}$ and $V7 = 5\text{V}$ is $V_{EXT}$ .

Timing Chart

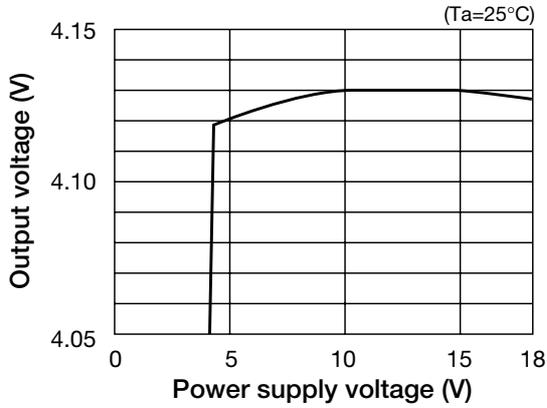


Application Circuit

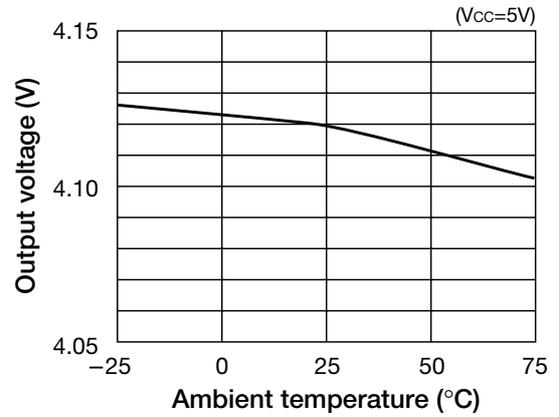


**Characteristics**

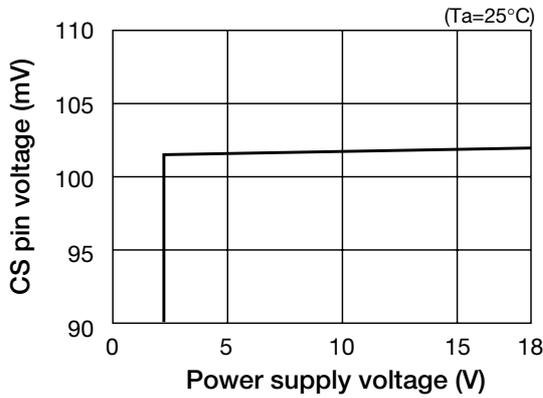
■ Output voltage vs Power supply voltage



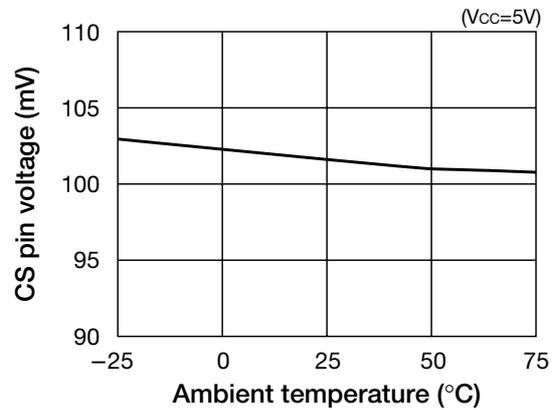
■ Output voltage vs Ambient temperature



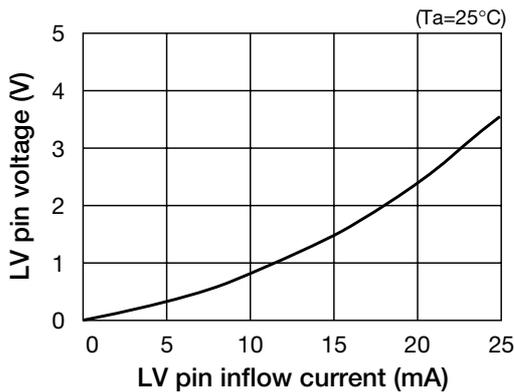
■ CS pin voltage vs Power supply voltage



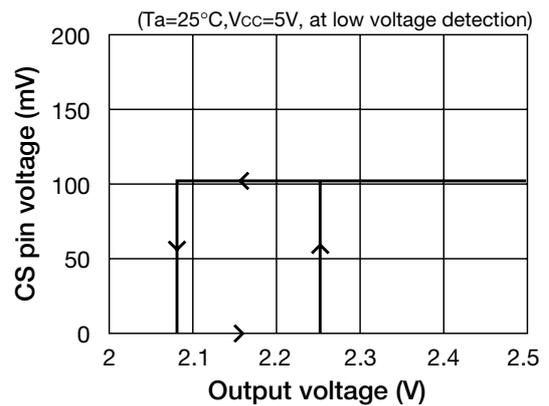
■ CS pin voltage vs Ambient temperature



■ LV pin voltage vs LV pin inflow current



■ CS pin voltage vs Output voltage



■ EXT pin voltage vs EXT pin inflow current

