LDO with a latchup release function
Monolithic IC MM1897 Series

Outline

This IC is a features a built-in latch-up release function (patent pending) with (1) Latch-up detection ⇒ (2) Power source shut-off ⇒ (3) Latch-up release ⇒ (4) Automatic recovery sequence, which helps to prevent damage to micro-computers caused by latch-up. The use of bi-polar processing and a noise suppression element result in a design that makes it difficult for the IC itself to cause damage due to latch-up or static electricity. Results of static electricity noise/electric field noise/magnetic field noise tests that comply with IEC61000-4-2 (Electrostatic Discharge Immunity Tests) have show a much better ability to withstand noise than Mitsumi's previous products.

Features

1. Latch-up Release Function
   (current detection threshold, detection delay time and recovery delay time can be set)
2. Resilient against noise
   (IEC61000-4-2 Contact Discharge Test immunity 25kV)
3. Wide operating voltage range
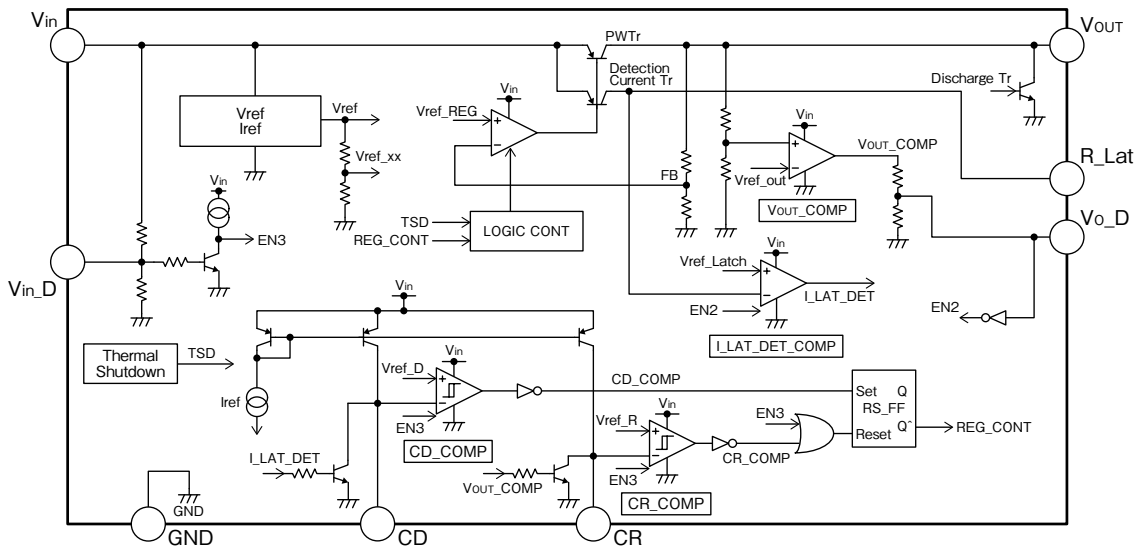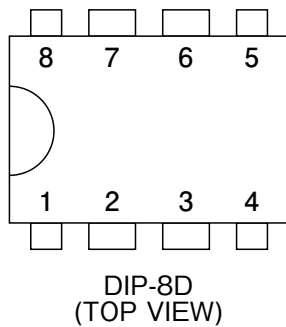   (maximum operating voltage 14V)

Package

DIP-8D

Applications

1. Play equipment
2. Industrial equipment
3. Weather observation equipment
4. Outdoor equipment

Block Diagram

Pin Assignment

DIP-8D
(TOP VIEW)

1	Vo_D
2	CD
3	GND
4	CR
5	Vin
6	Vin_D
7	VOUT
8	R_Lat

Pin Description

Pin No.	Pin name	Functions
1	Vo_D	V_{OUT} Detect pin.
2	CD	Latchup current detect delay time capacitor pin.
3	GND	GND pin
4	CR	Output restart time from latch up current detect capacitor pin.
5	Vin	Voltage-supply pin.
6	Vin_D	Vin detect pin.
7	VOUT	Output pin.
8	R_Lat	Latchup current detect pin.

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

Item	Symbol	Ratings	Units
Supply voltage	V_{in}	−0.3 to+15	V
Output voltage	V_{OUT}	−0.3 to V_{in}+0.3	
Output current	I_{OUT}	0 to 300	mA
Power Dissipation	Pd	850 (Note1)	mW
Storage Temperature	Tstg	−40 to +150	℃
Junction Temperature	T_{jMAX}	150	

Note1：Package only

Recommended Operating Conditions (Except where noted otherwise Ta=25℃)

Item	Symbol	Ratings	Units
Operating Ambient temperature	Topr	−30 to +85	℃
Operating Voltage	Vop	V_{OUT}(typ.)+0.5V to 14	V

Electrical Characteristics (Except where noted otherwise Vin=V_{OUT}(Typ.)+1V, I_{OUT}=1mA, CIN=COUT=1μF, Ta=25℃)

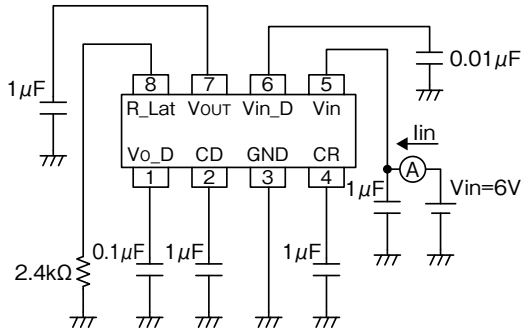| Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Units
No-Load input current consumption	Iin	V_{in}=6V, I_{OUT}=0mA		1.7	2.5	mA
Output voltage	V_{OUT}		4.900	5.000	5.100	V
Dropout voltage	Vio	V_{in}=V_{OUT}−2V, I_{OUT}=50mA		0.1	0.2	
Line regulation	⊿V1	V_{in}=V_{OUT}(Typ.)+1～12V		10	20	mV
Load regulation	⊿V2	I_{OUT}=1～100mA		30	90	mV
V_{OUT} temperature coefficient (Note2)	⊿V_{OUT}/⊿T	Topr=−30～+85℃		100		ppm/℃
Ripple rejection (Note2)	|RR|	f=120Hz, Vripple=1V		60		dB
Latchup current detect current	ILAT	RLATCH=2.4kΩ (注3)	80	100	120	mA
Latchup current detect delay time generation voltage	VL_Delay		0.8	1.0	1.2	V
Latchup current detect delay time generation current	IL_Delay		80	100	120	μA
Output restart time generation voltage	V_REST		0.8	1.0	1.2	V
Output restart time generation current	I_REST		80	100	120	μA
V_{OUT} Current Limit (Note2)	Ilim		170	250		mA
V_{OUT} drop detect voltage	Vodet		3.8	4.0	4.2	V
V_{OUT} Discharge Current (Note2)	Idis	V_{OUT}=0.4V		0.5		mA
Thermal shutdown detect temperature (Note2)	TSD			150		℃
Thermal shutdown release temperature (Note2)	TSD_rel			100		

Note2：The parameter is guaranteed by design.
Note3：External parts should use the thing of predetermined accuracy.
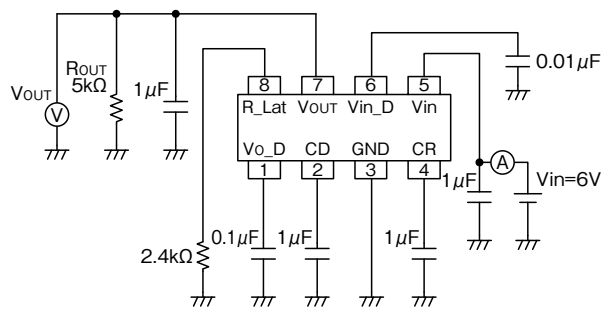　　　　*Resistance：designated value ±2%
　　　　Desired operation may be unable to be satisfied when the parts of accuracy other than a
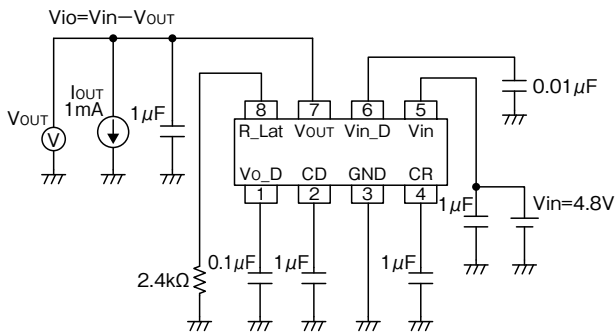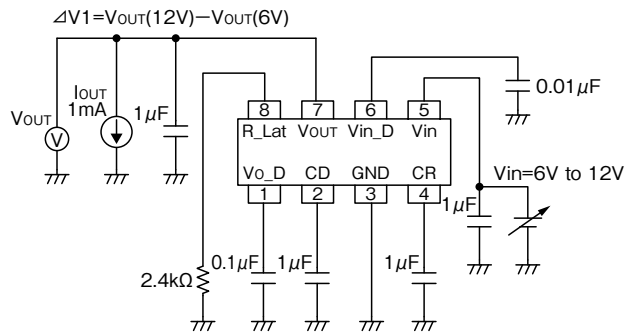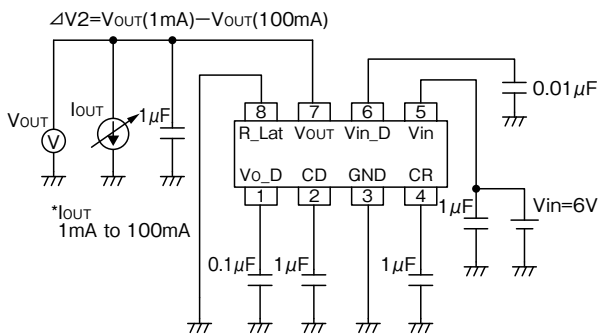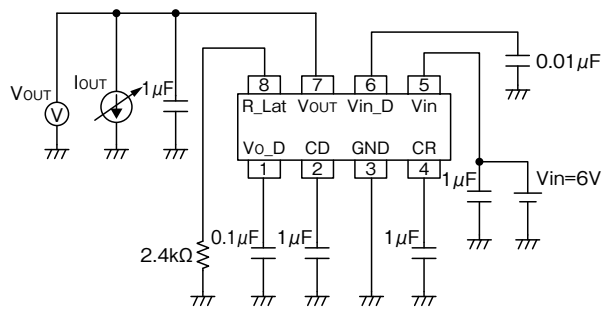　　　　specification value are selected.

Measuring Circuit

A

1μF 2.4kΩ 0.1μF 1μF 1μF 0.01μF

8	7	6	5
R_Lat	VOUT	Vin_D	Vin
Vo_D	CD	GND	CR
1	2	3	4

Iin 1μF (A) Vin=6V

B

VOUT (V) ROUT 5kΩ 1μF 2.4kΩ 0.1μF 1μF 1μF 0.01μF

8	7	6	5
R_Lat	VOUT	Vin_D	Vin
Vo_D	CD	GND	CR
1	2	3	4

1μF (A) Vin=6V

C

Vio=Vin−VOUT

VOUT (V) IOUT 1mA 1μF 2.4kΩ 0.1μF 1μF 1μF 0.01μF

8	7	6	5
R_Lat	VOUT	Vin_D	Vin
Vo_D	CD	GND	CR
1	2	3	4

1μF Vin=4.8V

D

⊿V1=VOUT(12V)−VOUT(6V)

VOUT (V) IOUT 1mA 1μF 2.4kΩ 0.1μF 1μF 1μF 0.01μF

8	7	6	5
R_Lat	VOUT	Vin_D	Vin
Vo_D	CD	GND	CR
1	2	3	4

1μF Vin=6V to 12V

E

⊿V2=VOUT(1mA)−VOUT(100mA)

VOUT (V) IOUT 1μF 0.1μF 1μF 1μF 0.01μF

8	7	6	5
R_Lat	VOUT	Vin_D	Vin
Vo_D	CD	GND	CR
1	2	3	4

*IOUT 1mA to 100mA

1μF Vin=6V

F

VOUT (V) IOUT 1μF 2.4kΩ 0.1μF 1μF 1μF 0.01μF

8	7	6	5
R_Lat	VOUT	Vin_D	Vin
Vo_D	CD	GND	CR
1	2	3	4

1μF Vin=6V

G

H

I

J

K

L

M

Operation flow chart

① Turning ON the Vin.

② Internal circuit is activated.

③ Output Capacitor (COUT) is charged.

④ Regulator Output voltage rises to a predetermined value.

⑤ A load start.

● At the time of Latchup current occurrence.

○ Normal operation.

⑨ Latch-up current flows through the load.

⑥ Turning OFF the Vin.

⑩ Detecting Latchup current, REG_CONT is turn OFF.

⑦ Output drops.

⑪ Output drops.

⑧ Back to ② if ON the Vin again.

⑫ After setting restart time from OFF, REG_CONT is turned ON.

Back to ②.

Timing Chart

Application Circuit

1. Case of the AC input → DC-DC Converter on Vin
   (Recommended Vin conditions : Vin=VOUT (Typ.) +1V)

2. Case of the AC input → DC on Vin
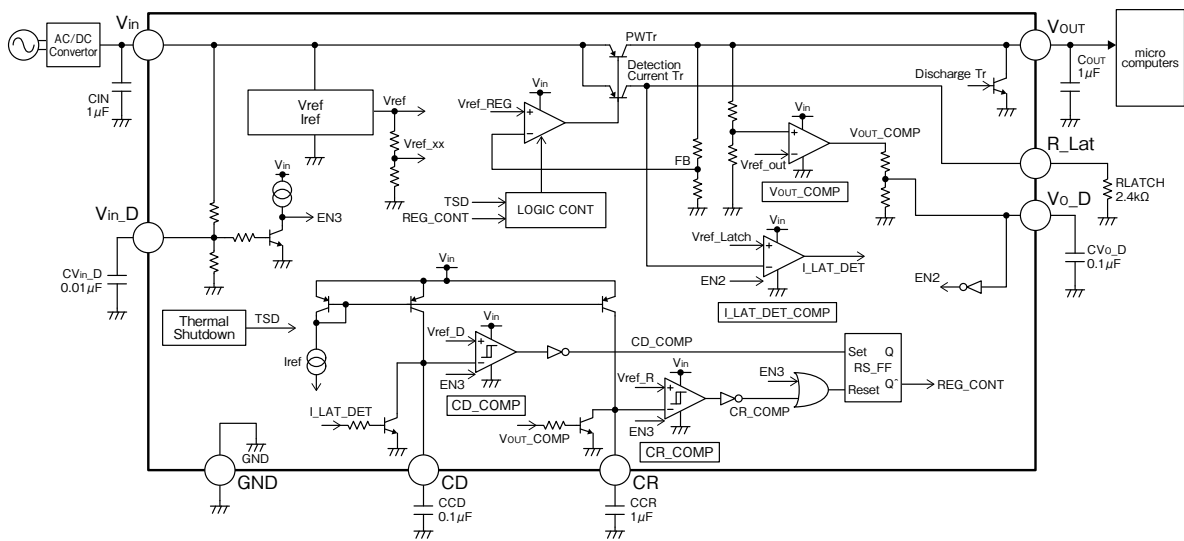   (Recommended Vin conditions : Vin=VOUT (Typ.) +1V)

· Any products mentioned in this catalog are subject to any modification in their appearance and others for improvements without prior notification.
· The details listed here are not a guarantee of the individual products at the time of ordering. When using the products, you will be asked to check their specifications.

External parts setup

1. **About the external components accuracy.**
   External parts should use the thing of predetermined accuracy.
   ※Resistance：designated value ±2%, Capacitor：designed value ±10%
   Desired operation may be unable to be satisfied when the parts of accuracy other than a specification value are selected.

2. **About the recommended value of external parts.**
   Recommended parts to achieve a desired operation, please refer to the following.
   If from the recommended parts that need to be changed, please refer to the various parts setting method described below, check the actual operation, please set.

   *Recommended parts

Parts	Constant
CIN	1μF
C_{OUT}	1μF
CVin_D	0.01μF
CVo_D	0.1μF
RLATCH	2.4kΩ
CCD	0.1μF
CCR	1μF

3. **About the output capacitor (C_{OUT}).**
   If the large output capacitor value, extends the inrush current time at the time of IC start-up, there is a possibility that the erroneous detection Latchup current detection circuit.
   If the output capacitor of the setting of more than 10μF, you will need to adjust the Latchup current delay capacitor CCD.
   Also, if it exceeds 100μF, there is a possibility that the desired operation may not be obtained, so please set it checking the actual operation.

4. **About the Latchup current sense resistor (RLATCH) value.**
   Latchup current detection current can be changed by changing the sense resistor value.
   It should be noted that by the detection resistance settings that you may limit current and the Latchup current detection current will be reversed, please set up your consideration.
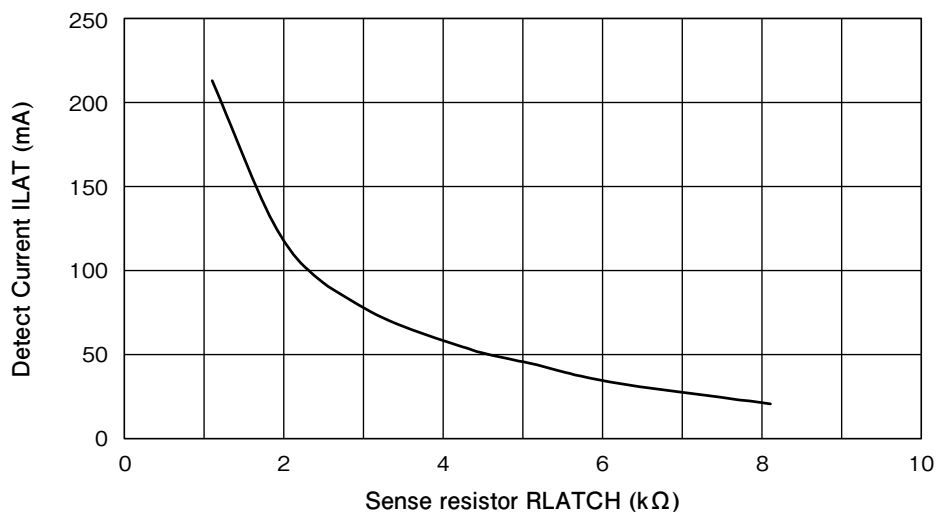
   Detection Current【ILAT】　　= (Vlat ÷ RLATCH) × 245
   Ex. Detection Current　　　　= 1.0V(Vlat) ÷ 2.4kΩ (RLATCH) × 245 ≒ 100mA
   　　　　　　　　　　　　　　　【Vlat】：Latchup current detection voltage (1.0V Typ.)
   　　　　　　　　　　　　　　　【RLATCH】：Latchup current sense resister

   Latchup current sense resistor vs. detect current

5. About the Latchup current detection delay time generation capacitor (CCD)

   In order to create a Latachup current detection delay time, from the internal constant current circuit, and is charging to external capacitor (CCD).

   Since the relationship of the delay time and external capacitor is as shown in the following equation, by any chance, when necessary to change the delay time, please adjust refer to the following formula.

   It should be noted that, if you want to set short detection delay time, inrush current and at the time of start-up, will in response to the instantaneous noise, there is a possibility that not the desired operation is obtained.

   In addition, the case detection delay time is long, the longer it takes to Latchup current is flowing, it will lead to the heating of the set product.

   For this reason, we recommend the settings in the 1ms to 10ms (0.1μF to 1μF).

   Detection delay time【TDELAY】= CCD × VL_Delay ÷ IL_Delay

   Ex. Detection delay time   = 0.1μF (CCD) ×1.0V (VL_Delay)÷100μA (IL_Delay) = 1.0ms

   【CCD】: Detection delay time generation capacitor
   【VL_Delay】: Latchup current detect delay time generation voltage
   【IL_Delay】: Latchup current detect delay time generation current

6. About the output restart time generation capacitor (CCR) after Latchup current detect.

   As well as the Latchup current detection delay time, and the charge from the internal constant current circuit to the external capacitor (CCR).

   In order to return to after the OFF completely the output voltage, sets recommended 10 times the capacitor values for the detection delay time capacitor (CCD).

   Since the relationship of the restart time and the CCR capacitor is as shown in the following formula, by any chance, when the necessary changes of the recovery time, please adjust refer to the following formula.

   output restart time【T_REST】= CCR × V_REST ÷ C_REST

   Ex. output restart time   = 1μF(CCR) × 1.0V (V_REST)÷ 100μA (C_REST) = 10ms

   【CCR】: output restart time generation capacitor
   【V_REST】: Output restart time generation voltage
   【C_REST】: Output restart time generation current

   In addition, Since the CR voltage has also monitor Latchup current at the time of input voltage start-up, you do not get the desired operation in the case of the input start-up time than a short setting.

   Taking into account the start-up time of the input, the restart time setting, please set at 10ms to 50ms (1μF to 5μF).

7. About the input monitoring capacitor (CVin_D).

   Because this is used as a detection prevention erroneous inrush current, please set by 0.01μF.

8. About the output monitoring capacitor (CoD).

   It is associated with a Latchup current detection delay time.

   Until the detection delay time 5ms is 0.1μF, please set by 0.2μF up to 5ms to 10ms.

NOTE

1. There is a possibility with deterioration and destruction of IC when using it exceeding the absolute maximum rating. The absolute maximum rating, Never exceed it.
   The functional operation is not assured.

2. There is a possibility that it becomes impossible to maintain this performance and reliability IC original when using it exceeding recommended operation voltage.
   Please use it in recommended operation voltage.

3. Due to restrictions on the package power dissipation, the output current value may not be satisfied.
   Attention should be paid to the power dissipation of the package when the output current is large or the voltage between Input and Output is high.

4. The output capacitor is required between output and GND to prevent oscillation.

5. The ESR of capacitor must be defined in ESR stability area.
   It is possible to use a ceramic capacitor without ESR resistance for output.
   The ceramic capacitor must be used more than 1.0μF and B temperature characteristics.
   The ceramic capacitor must be used more than 2.2μF and B temperature characteristics for Vo$\geqq$1.1V.

6. The wire of Vin and GND is required to print full ground plane for noise and stability.

7. The input capacitor must be connected a distance of less than 1cm from input pin.

8. In case the output voltage is above the input voltage, the overcurrent flow by internal parasitic diode from output to input.
   In such application, the external bypass diode must be connected between output and input pin.
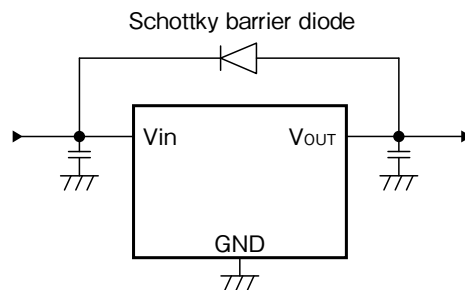
9. There is a possibility of becoming an unstatable operation, when using it with Dropout voltage no margine.

10. The overcurrent protection circuit of the vertical type is built into this IC.

11. There is a possibility that IC generates heat when the output terminal is short-circuited.
    However, the terminal shutdown circuit operates, and it will do operation that protects IC.
    The thermal shutdown circuit is designed only to shut the IC off to prevent thermal runaway.
    Do not continue to use the IC in an environment where the operation of this circuit is assumed.
    The characteristic changes depending on the substate condition.
    Please evaluate IC in the set.

12. External parts should use the thing of predetermined accuracy.
    (Resistance : designated value $\pm$2%, Capacitor : designated value $\pm$10%)
    Desired operation may be unable to be satisfied when the parts of accuracy other than a specification value are selected.
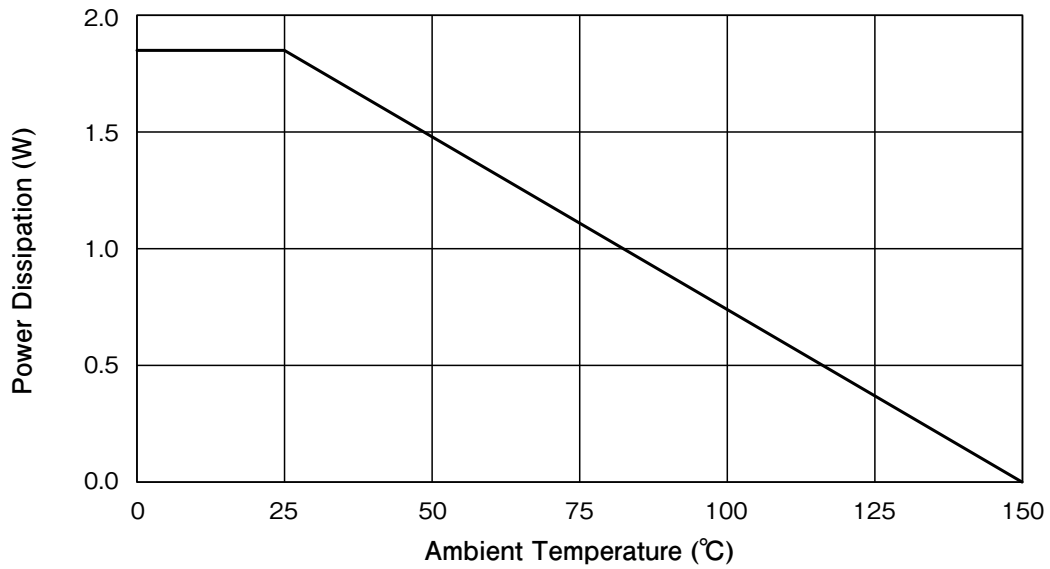
About Power Dissipation

The Power dissipation change if board to mount IC change because radiative heat fix at board.It is reference data below, Evaluate IC in the set.

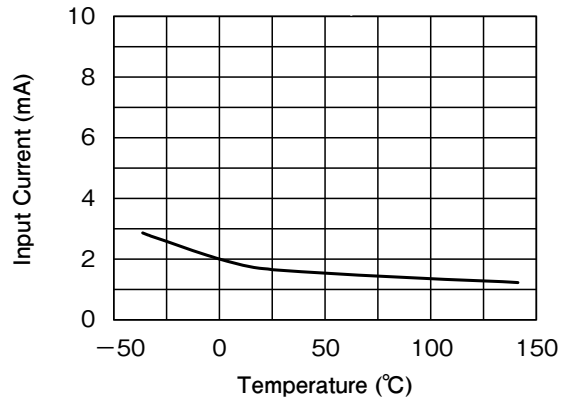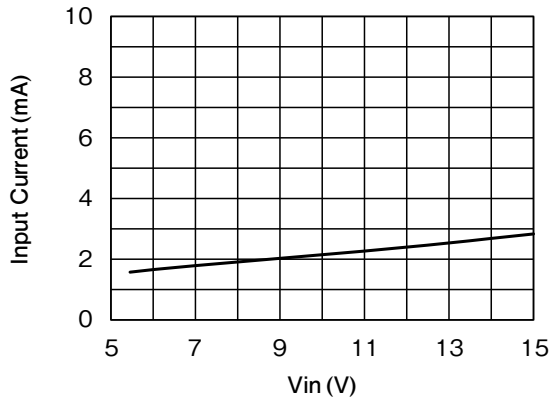1. Polyester HB
   Board size   45mm×45mm t=1.6mm
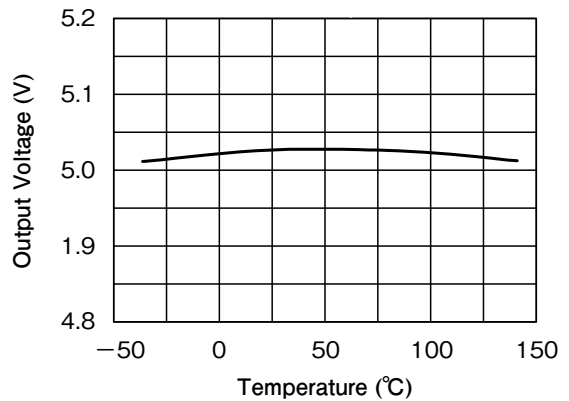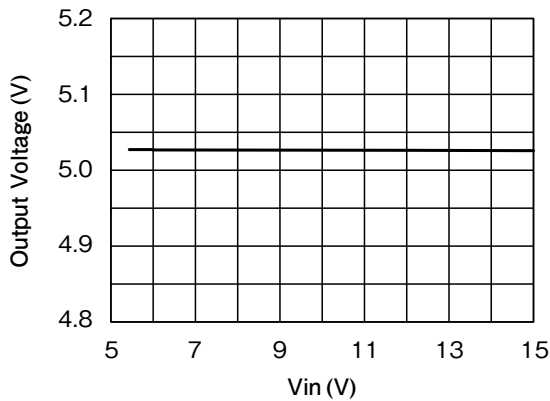   Power dissipation   1.85W Ta=25°C

Characteristics   (Except where noted otherwise Vin=6V, I_OUT=1mA,Ta=25℃)
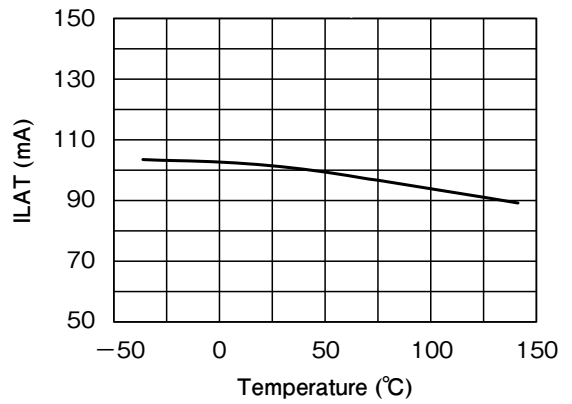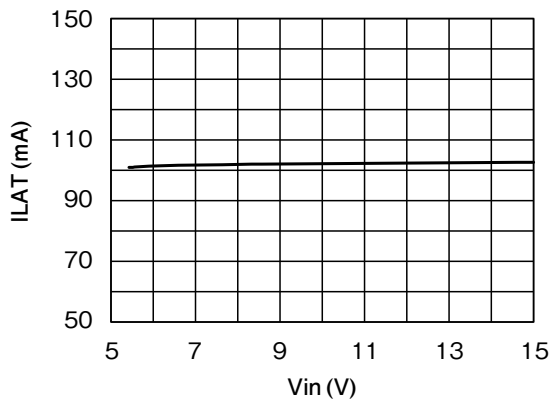
■ No-load input current (Iout=0mA)

■ Output voltage

■ Load regulation
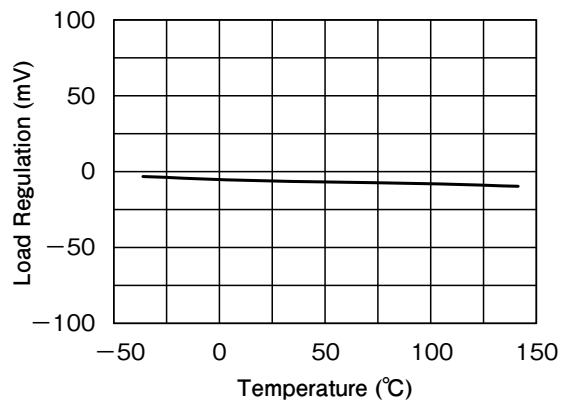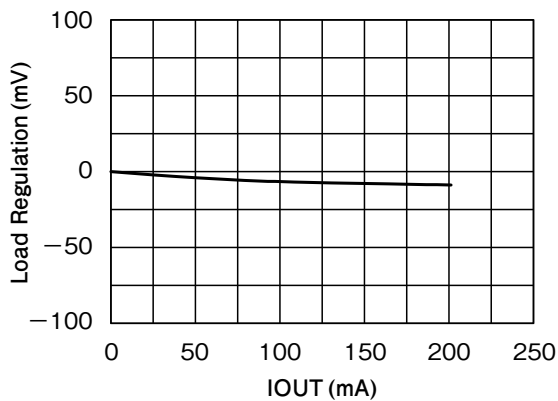
■ V_{OUT} current limit
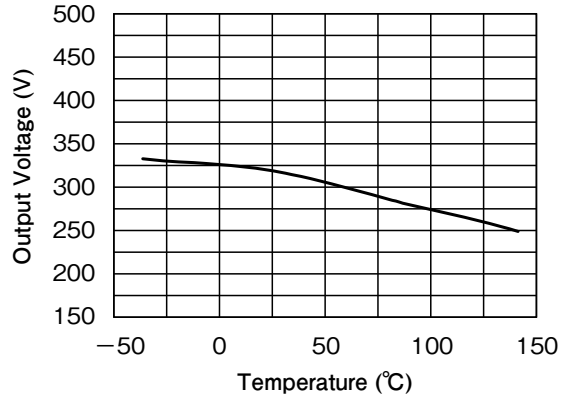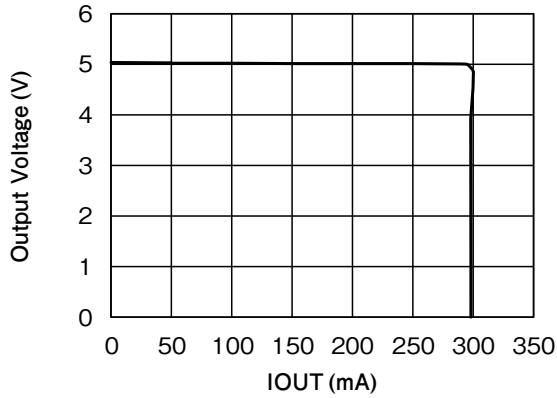
■ Latchup current detect current (RLATCH=2.4kΩ)

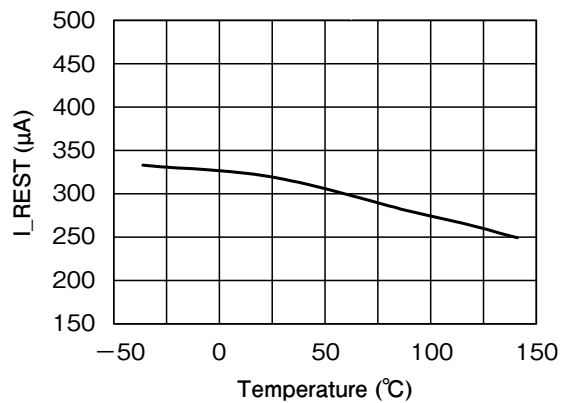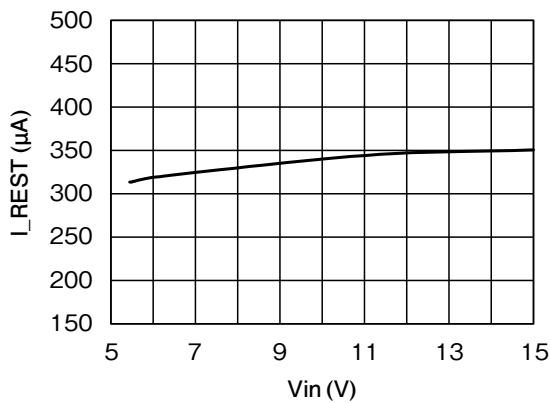■ Latchup current detect delay time generation voltage
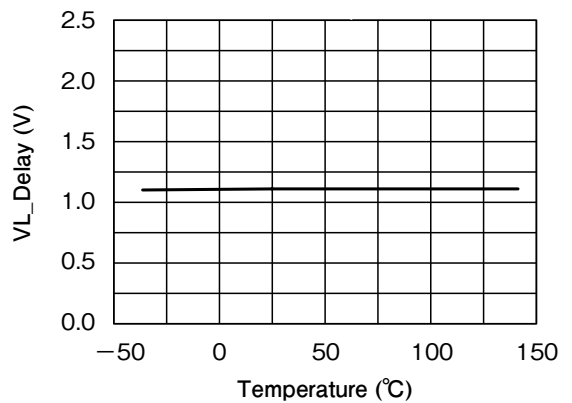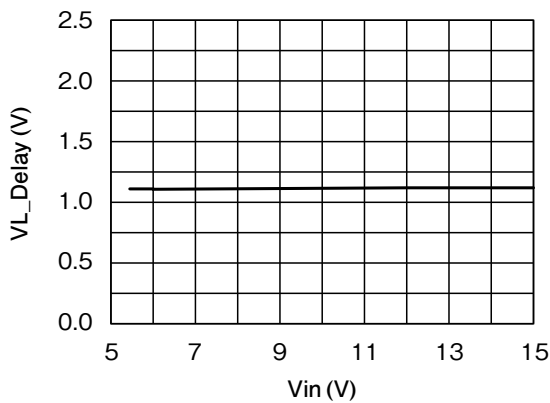
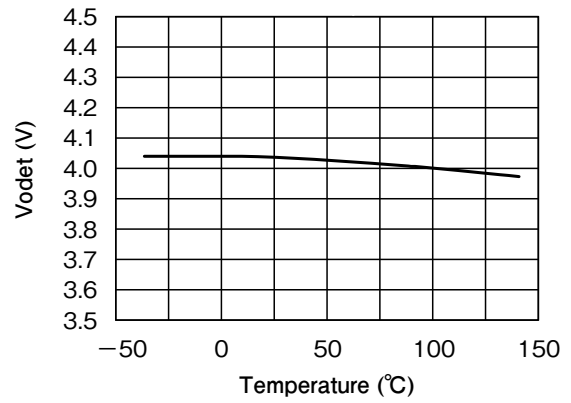■ Latchup current detect delay time generation current
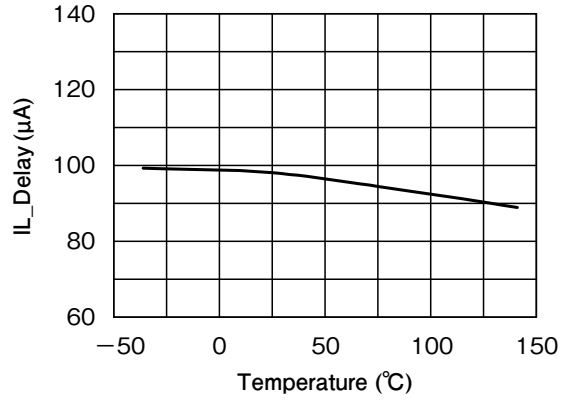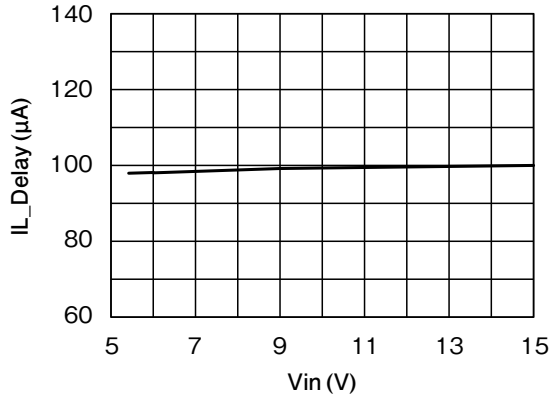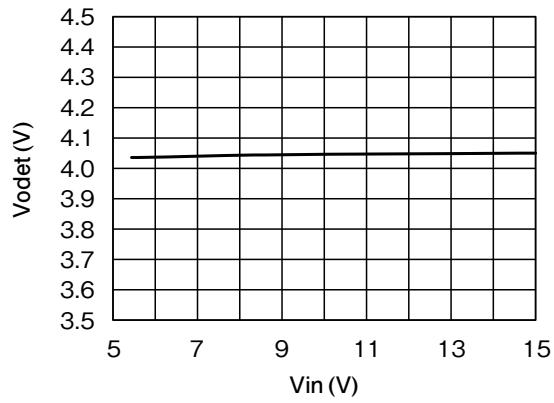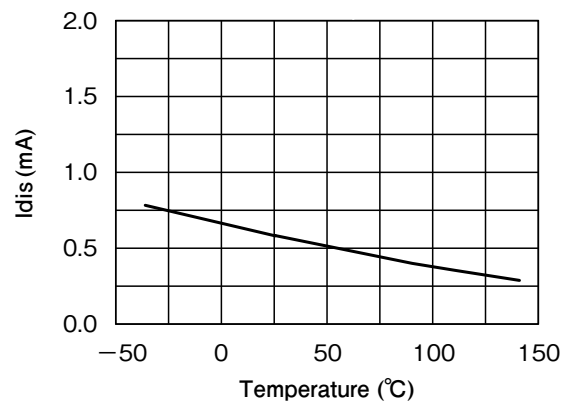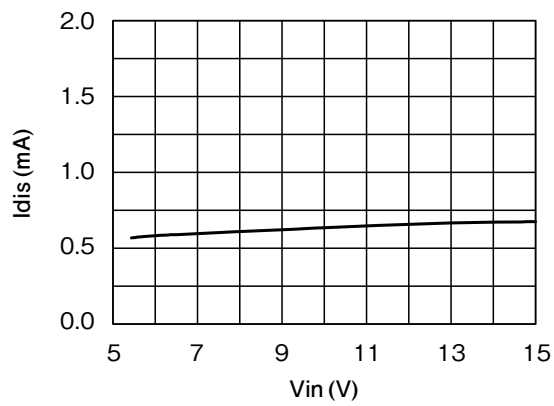

■ Output restart time generation voltage
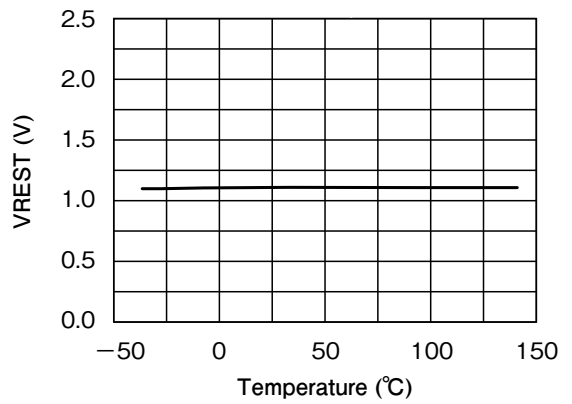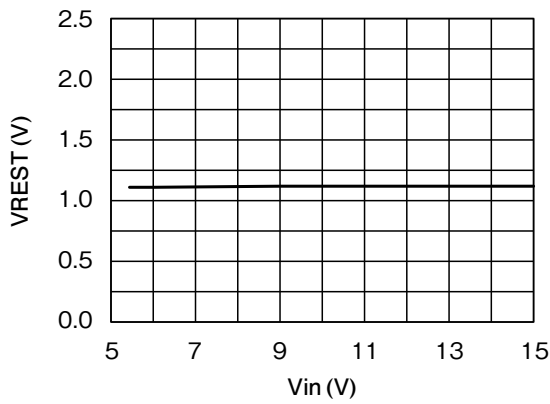
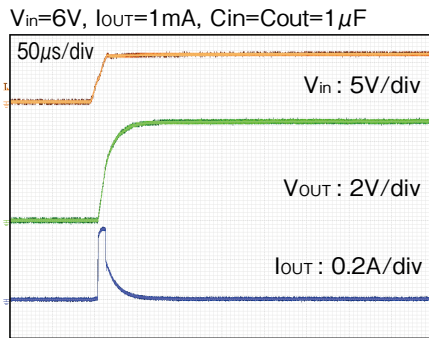

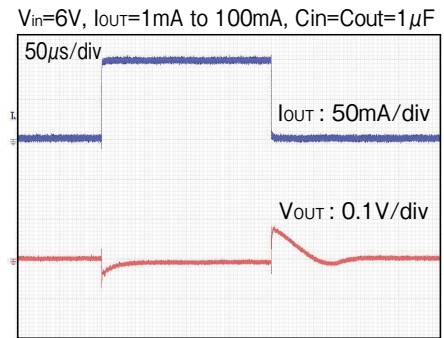■ Output restart time generation current

■ V<small>OUT</small> drop detect voltage

■ V<small>OUT</small> discharge Current

■ Start-up characteristic

V_{in}=6V, I_{OUT}=1mA, Cin=Cout=1μF

50μs/div

V_{in} : 5V/div

V_{OUT} : 2V/div

I_{OUT} : 0.2A/div

■ Transient response characteristic

V_{in}=6V, I_{OUT}=1mA to 100mA, Cin=Cout=1μF

50μs/div

I_{OUT} : 50mA/div

V_{OUT} : 0.1V/div

■ Latchup current detect・restart characteristic

V_{in}=6V, I_{OUT}=1mA, Cin=Cout=1μF

2ms/div

V_{OUT} : 2V/div

CD : 1V/div

CR : 1V/div

I_{OUT} : 0.5A/div