

## Load Switch with Low On-Resistance

### GENERAL DESCRIPTION

The XC8102 series is a low ON resistance load switch IC with ON/OFF control and output current protection which integrates a P-channel MOSFET.

By connecting the XC8102 to the output pin of a step-down DC/DC converter, the CE pin controls ON/OFF for each distribution switch to deliver power per requirements and maximize total power efficiency. As a result, the XC8102 helps to extend battery life and product operation time.

The series contains a current limit and protection circuit so these are not required externally unlike discrete circuit solutions where MOSFETs and resistors are used.

When a low signal is input to the CE pin, the series enters stand-by mode. Even where a load capacitor is connected to the output pin during stand-by, the electric charge stored at the load capacitor is discharged through the internal switch. As a result, the  $V_{OUT}$  pin voltage falls quickly to the  $V_{SS}$  level.

The series contains over current protection with fold-back current circuitry which operates as over current protection and short circuit protection for the output pin.

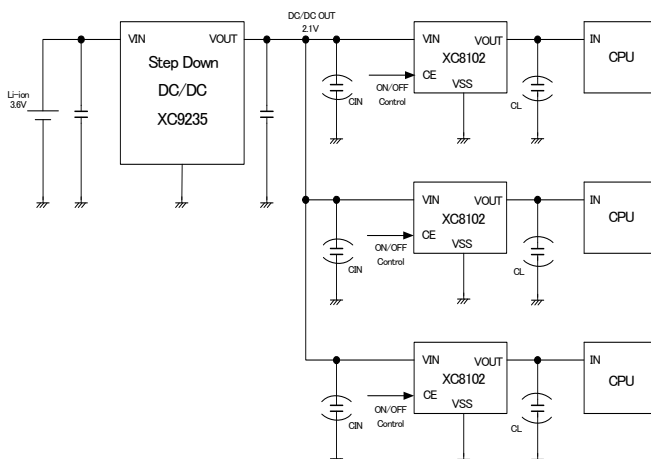
### APPLICATIONS

- Mobile phones, Smart phones
- Digital still cameras, Digital video cameras
- Portable game consoles
- Portable equipment

### FEATURES

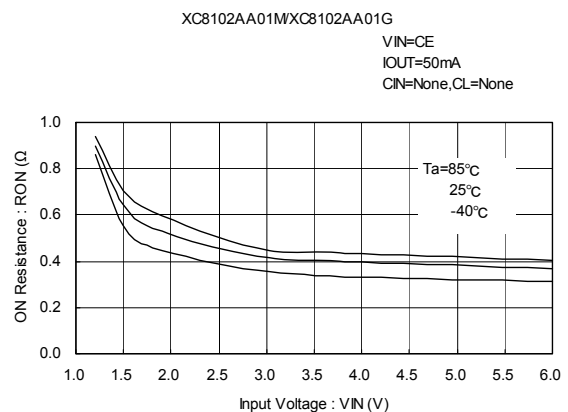
- On Resistance : 0.28Ω@  $V_{IN}=6.0V$  (TYP.)  
: 0.31Ω@  $V_{IN}=4.0V$  (TYP.)  
: 0.35Ω@  $V_{IN}=2.9V$  (TYP.)  
: 0.52Ω@  $V_{IN}=1.8V$  (TYP.)  
: 0.60Ω@  $V_{IN}=1.5V$  (TYP.)  
: 0.80Ω@  $V_{IN}=1.2V$  (TYP.)
- Input Voltage Range : 1.2V ~ 6.0V
- Power Consumption : 3.0 μA@  $V_{IN}=1.2V$   
: 3.6 μA@  $V_{IN}=2.9V$   
: 4.0 μA@  $V_{IN}=6.0V$
- Stand-by Current : 0.1 μA
- Protection Circuit : Current limit(Output Current)  
480mA (TYP.) (1.8  $V_{IN}$  6.0V)  
: Short-circuit Protection,  
Short current= 30mA (TYP.)
- ON/OFF Function : High Active Enable
- High-Speed Discharge Function
- Operating Temperature Range : -40 ~ +85
- Packages : USP-4,SSOT-24, SOT-25  
USPN-4
- Environmentally Friendly : EU RoHS Compliant, Pb Free

### TYPICAL APPLICATION CIRCUIT

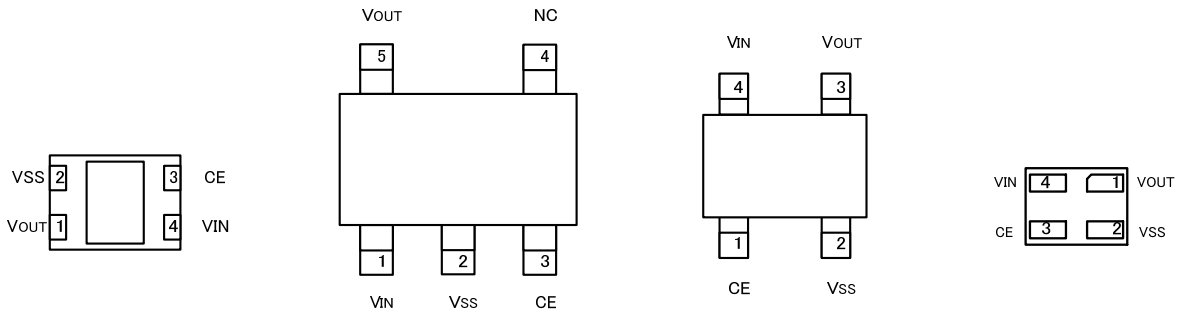


### TYPICAL PERFORMANCE CHARACTERISTICS

On Resistance vs. Input Voltage



## PIN CONFIGURATION



USP-4  
(BOTTOM VIEW)

SOT-25  
(TOP VIEW)

SSOT-24  
(TOP VIEW)

USPN-4  
(BOTTOM VIEW)

\*The heat dissipation pad of the USP-4 package is recommended to solder as shown in the recommended mount pattern and metal mask pattern for mounting strength. The heat dissipation pad should be electrically opened or connected to the  $V_{SS}$  (No. 2) pin.

## PIN ASSIGNMENT

PIN NUMBER				PIN NAME	FUNCTIONS
USP-4	SOT-25	SSOT-24	USPN-4		
4	1	4	4	$V_{IN}$	Power Input
1	5	3	1	$V_{OUT}$	Output
2	2	2	2	$V_{SS}$	Ground
3	3	1	3	CE	ON/OFF Control
-	4	-	-	NC	No Connection

## PRODUCT CLASSIFICATION

Ordering Information

XC8102 \_\_\_\_\_ - <sup>(\*)</sup>

DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
	CE pin logic	A	CE High active
	$C_L$ Discharge Function	A	Output capacitor ( $C_L$ ) auto-discharge function integrated
	Internal Standard Number	01	Fixed
-	Packages Taping Type <sup>(*)</sup>	GR-G	USP-4
		MR-G	SOT-25
		NR-G	SSOT-24
		7R-G	USPN-4

<sup>(\*)</sup> The "-G" suffix indicates that the products are Halogen and Antimony free as well as being fully RoHS compliant.

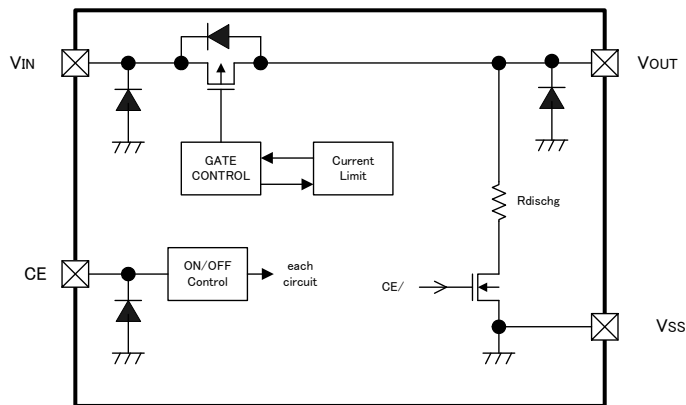
<sup>(\*)</sup> The device orientation is fixed in its embossed tape pocket. For reverse orientation, please contact your local Torex sales office or representative. (Standard orientation: R- , Reverse orientation: L- )

## FUNCTION CHART

SERIES	CE	IC OPERATIONAL STATUS ON/OFF
XC8102AA01	High	ON
	Low	OFF

## BLOCK DIAGRAM

XC8102AA Series



\* Diodes inside the circuit are an ESD protection diode and a parasitic diode.

## ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATINGS	UNITS
Input Voltage	$V_{IN}$	$V_{SS}-0.3 \sim +6.5$	V
Output Current	$I_{OUT}$	850*	mA
Output Voltage	$V_{OUT}$	$V_{SS}-0.3 \sim V_{IN}$	V
CE Input Voltage	$V_{CE}$	$V_{SS}-0.3 \sim +6.5$	V
Power Dissipation	USP-4	120	mW
	SSOT-24	150	
	SOT-25	250	
	USPN-4	100	
Operating Temperature Range	$T_{opr}$	$-40 \sim +85$	$^{\circ}C$
Storage Temperature Range	$T_{stg}$	$-55 \sim +125$	$^{\circ}C$

\* Please make sure that  $I_{OUT}$  is less than  $Pd / (V_{IN} - V_{OUT})$

## ELECTRICAL CHARACTERISTICS

XC8102AA Series

Ta=25

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUITS
Input Voltage	$V_{IN}$		1.2	-	6.0	V	-
On Resistance (SSOT-24/USPN-4)	$R_{ON}$	$V_{IN}=6.0V, V_{CE}=V_{IN}$	-	0.28	0.425	$\Omega$	①
		$V_{IN}=4.0V, V_{CE}=V_{IN}$	-	0.31	0.475		
		$V_{IN}=2.9V, V_{CE}=V_{IN}$	-	0.35	0.475		
		$V_{IN}=1.8V, V_{CE}=V_{IN}$	-	0.52	0.625		
		$V_{IN}=1.5V, V_{CE}=V_{IN}$	-	0.60	0.80		
On Resistance (SOT-25/USP-4)	$R_{ON}$	$V_{IN}=6.0V, V_{CE}=V_{IN}$	-	0.35	0.475	$\Omega$	
		$V_{IN}=4.0V, V_{CE}=V_{IN}$	-	0.38	0.525		
		$V_{IN}=2.9V, V_{CE}=V_{IN}$	-	0.43	0.525		
		$V_{IN}=1.8V, V_{CE}=V_{IN}$	-	0.59	0.675		
		$V_{IN}=1.5V, V_{CE}=V_{IN}$	-	0.67	0.85		
Supply Current	$I_{DD}$	$V_{IN}=6.0V, V_{CE}=V_{IN}, V_{OUT}=OPEN$	-	4.0	7.0	$\mu A$	②
		$V_{IN}=4.0V, V_{CE}=V_{IN}, V_{OUT}=OPEN$	-	3.8	6.5		
		$V_{IN}=2.9V, V_{CE}=V_{IN}, V_{OUT}=OPEN$	-	3.6	6.3		
		$V_{IN}=1.8V, V_{CE}=V_{IN}, V_{OUT}=OPEN$	-	3.4	5.7		
		$V_{IN}=1.5V, V_{CE}=V_{IN}, V_{OUT}=OPEN$	-	3.2	5.5		
Stand-by Current	$I_{STBY}$	$V_{IN}=6.0V, V_{CE}=V_{SS}, V_{OUT}=OPEN$	-	0.01	0.10	$\mu A$	②
Switch Leakage Current	$I_{LEAK}$	$V_{IN}=6.0V, V_{CE}=V_{SS}, V_{OUT}=0V$	-	0.01	0.10	$\mu A$	②
Current Limit	$I_{LIM}$	$V_{IN} \geq 2.9V, V_{OUT} = V_{IN} - 0.8V$	400	480	-	mA	①
		$1.8V \leq V_{IN} < 2.9V, V_{OUT} = V_{IN} - 0.6V$	400	480	-		
		$1.5V \leq V_{IN} < 1.8V, V_{OUT} = 1.2V$	200	-	-		
		$1.2V \leq V_{IN} < 1.5V, V_{OUT} = 1.0V$	90	-	-		
Short Circuit Current	$I_{SHORT}$	$V_{CE}=V_{IN}, V_{OUT}=0V$	-	30	75	mA	①
CE High Level Voltage	$V_{CEH}$		1.1	-	6.0	V	③
CE Low Level Voltage	$V_{CEL}$		-	-	0.3	V	③
CE High Level Current	$I_{CEH}$	$V_{CE}=V_{IN}$	-0.1	-	0.1	$\mu A$	③
CE Low Level Current	$I_{CEL}$	$V_{CE}=V_{SS}$	-0.1	-	0.1	$\mu A$	③
$C_L$ Auto-Discharge Resistance	$R_{DCHG}$	$V_{IN}=4.0V, V_{OUT}=4.0V, V_{CE}=V_{SS}$	380	480	570	$\Omega$	④
Turn On Time <sup>(1)</sup>	$t_{DLY(ON)}$	$V_{IN}=4.0V, V_{CE}=0.3V \rightarrow 1.2V, R_L=80\Omega$ , without $C_{IN}, C_L$	-	8.5	18	$\mu s$	⑤
Turn Off Time <sup>(2)</sup>	$t_{DLY(OFF)}$	$V_{IN}=4.0V, V_{CE}=1.2V \rightarrow 0.3V, R_L=80\Omega$ , without $C_{IN}, C_L$	-	3.0	7.5	$\mu s$	⑤

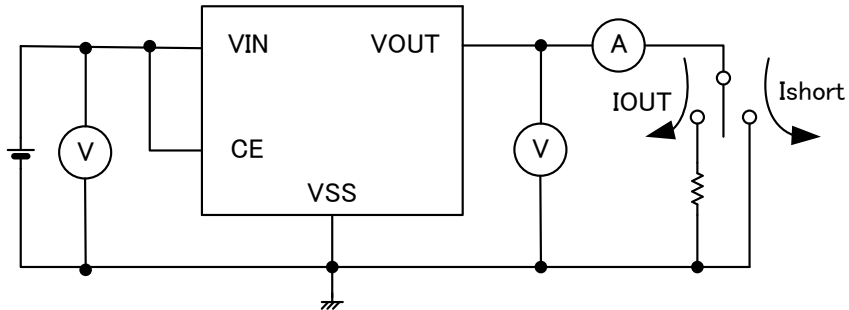
NOTE:

 \*1: Time to reach 90% of  $V_{OUT}$  after  $V_{CE}$  entering the  $V_{CEH}$  threshold.

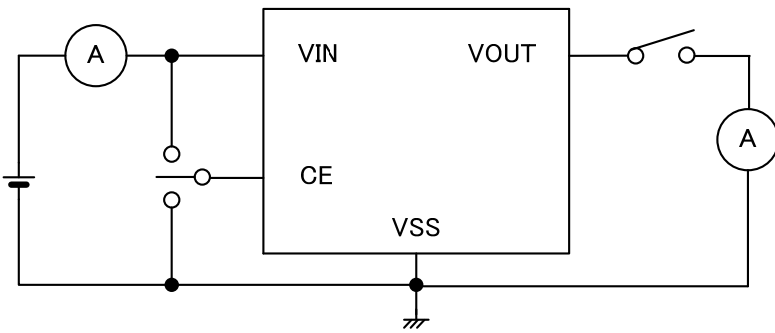
 \*2: Time to fall to 10% of  $V_{OUT}$  after  $V_{CE}$  entering the  $V_{CEL}$  threshold.

## TEST CIRCUITS

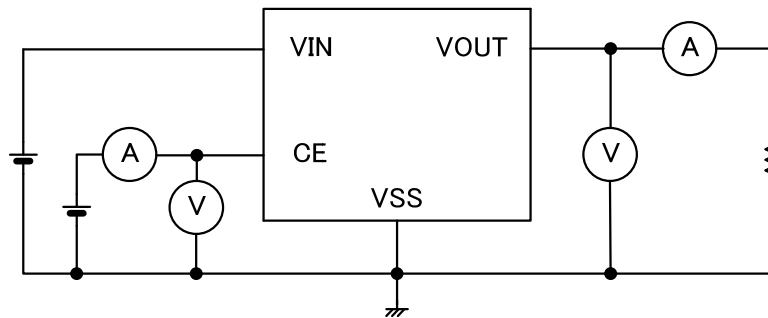
Circuit



Circuit

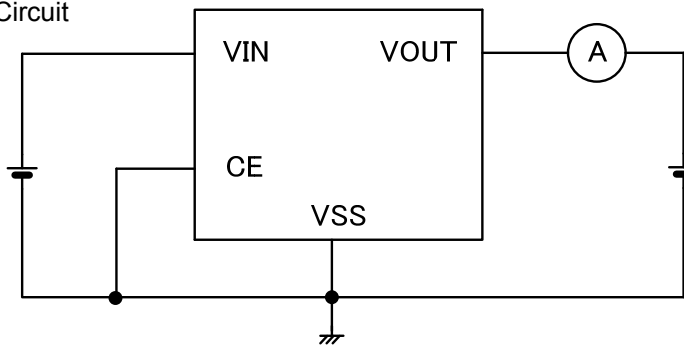


Circuit

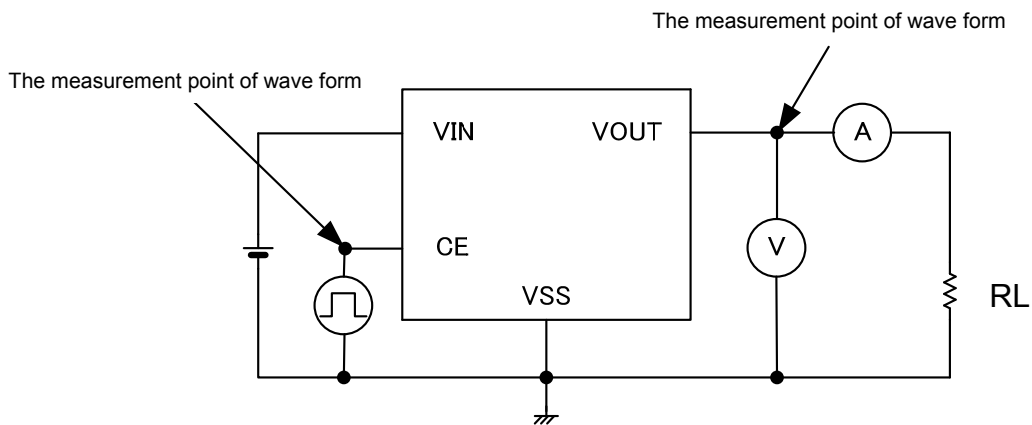


## TEST CIRCUITS (Continued)

Circuit



Circuit



## OPERATIONAL EXPLANATION

### <CE Pin>

The XC8102 enables an output P-channel MOSFET switch and the IC internal circuitry to turn off by the signal to the CE pin. In the shutdown mode, the  $V_{OUT}$  pin will be pulled down to the  $V_{SS}$  by the  $C_L$  auto-discharge function.

The output voltage becomes unstable when the CE pin is opened. If the input voltage to the CE pin is within the specified threshold voltages, the logic is fixed and the XC8102 will operate normally. However, supply current may increase as a result of the shoot-through current of internal circuitry when the medium level voltage is input to the CE pin.

### <Input/Output Capacitor>

The XC8102 works well without an input and output capacitors. Also, an output capacitor of the power source can be used as an input capacitor of the XC8102 and a bypass capacitor of the driving IC can be used as an output capacitor of the XC8102.

### <CL Auto-Discharge Function>

The XC8102AA contains a  $C_L$  auto-discharge resistor and an N-channel transistor between the  $V_{OUT}$  pin and the  $V_{SS}$  pin. The device quickly discharge the electric charge in the output capacitor ( $C_L$ ) when a low signal to the CE pin is input to turn off a whole IC circuit. The  $C_L$  auto-discharge resistance is set at  $480\ \Omega$  ( $V_{OUT}=4.0V$  TYP. @  $V_{IN}=4.0$ ). Discharge time of the output capacitor ( $C_L$ ) is determined by a  $C_L$  auto-discharge resistor value ( $R_{dischg}$ ) and an output capacitor value. Time constant  $\tau$  is defined as ( $\tau = C \times R_{dischg}$ ). Output voltage after starting discharge can be calculated by the following formula.

$$V = V_{OUT} \times e^{-t/\tau}, \text{ or } t = \tau \ln(V_{OUT} / V)$$

V: Output voltage after starting discharge,

$V_{OUT}$ : Output voltage,

t : Discharge time,

$\tau$  : Output discharge resistor value  $R_{dischg}$  x Output capacitor ( $C_L$ ) value C

### <Current Limiter, Short-Circuit Protection>

The XC8102 series contains a constant current limiter and fold-back current circuitry. The constant current limiter operates to limit output current and the fold-back current circuitry operates as short circuit protection for the output pin.

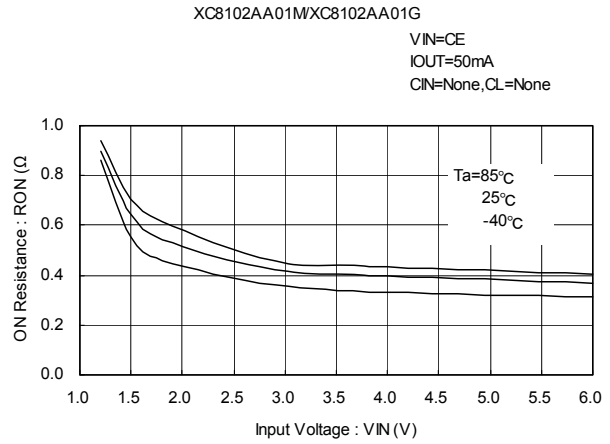
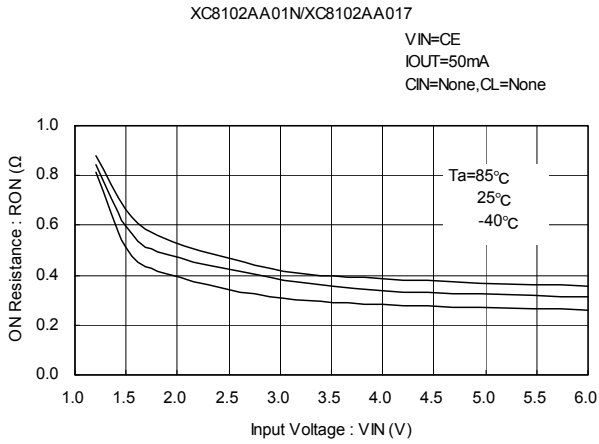
When the load current reaches the limit current, the constant current limiter operates and the output voltage drops. The output voltage further, then the fold-back current circuitry operates to decrease the output current. When the output pin is short-circuited to the ground, the output current drops and maintains a flow about 30mA.

## NOTES ON USE

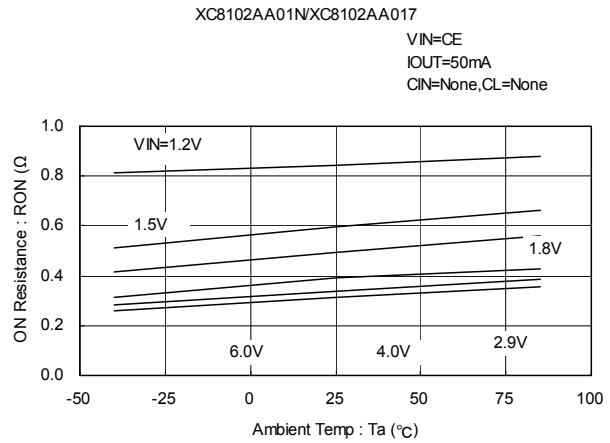
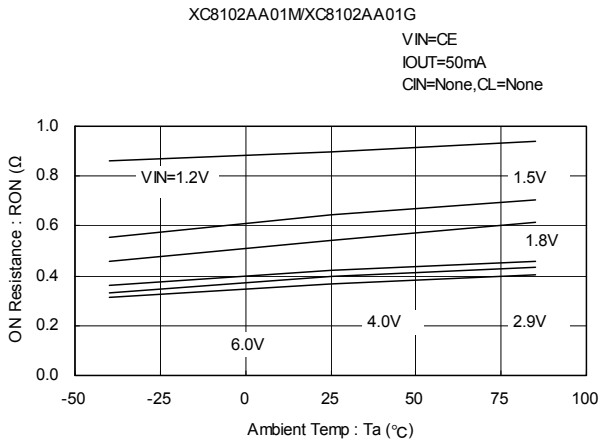
1. Please use this IC within the stated absolute maximum ratings. Operation beyond these limits may cause degrading or permanent damage to the device.
2. The X8102 goes into an undefined operation when the CE pin is left open. The CE pin shall be tied to low or high level.
3.  $V_{OUT}$  pin voltage should not be applied beyond the  $V_{IN}$  pin voltage.  
The IC may get damage due to the reverse current toward the  $V_{IN}$  pin.
4. Current limit function is integrated. However, power dissipation may be beyond the limit before starting a fold-back current protection when used in high temperature. For the power dissipation of each package, please refer to the graphs of Package Power vs. Operating Temperature in page 15 to 18.

## TYPICAL PERFORMANCE CHARACTERISTICS

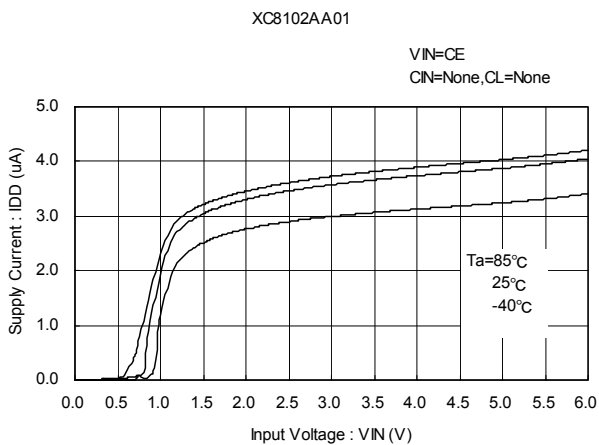
### (1) ON Resistance vs. Input Voltage



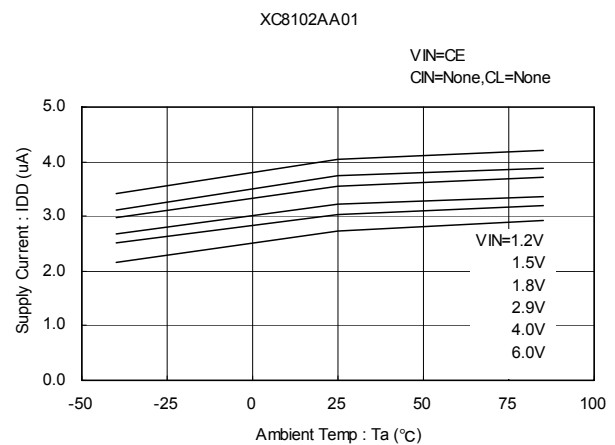
### (2) ON Resistance vs. Ambient Temperature



### (3) Supply Current vs. Input Voltage



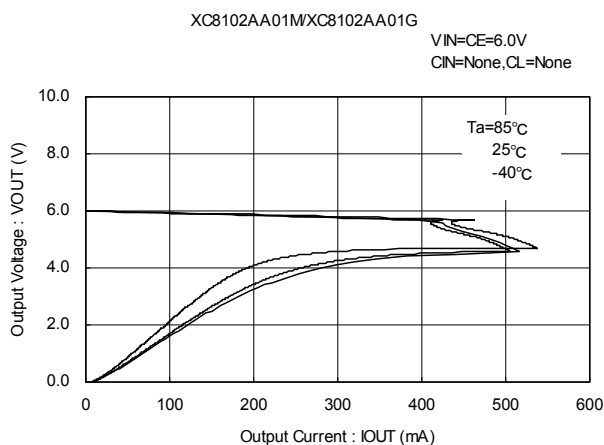
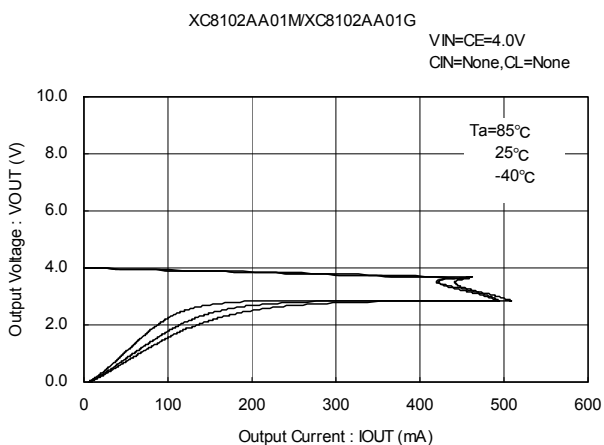
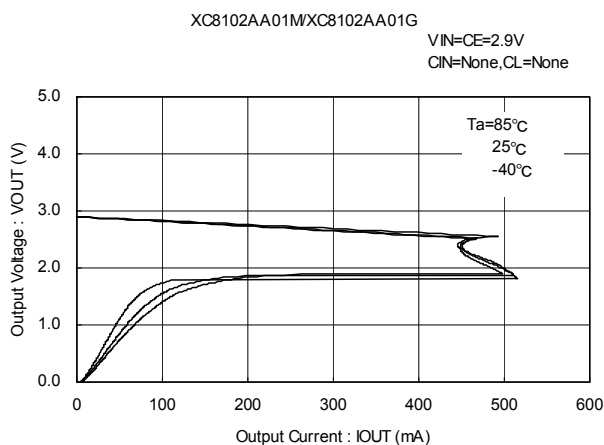
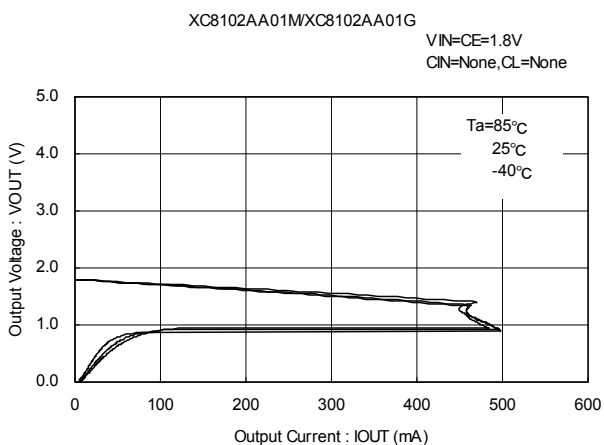
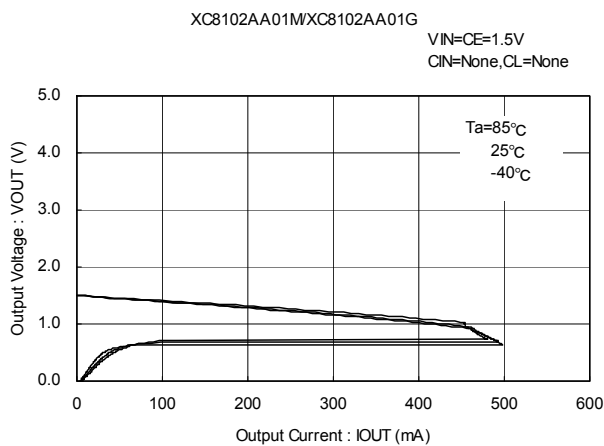
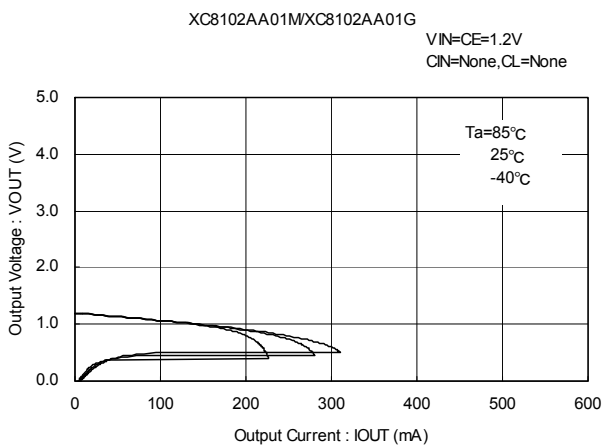
### (4) Supply Current vs. Ambient Temperature





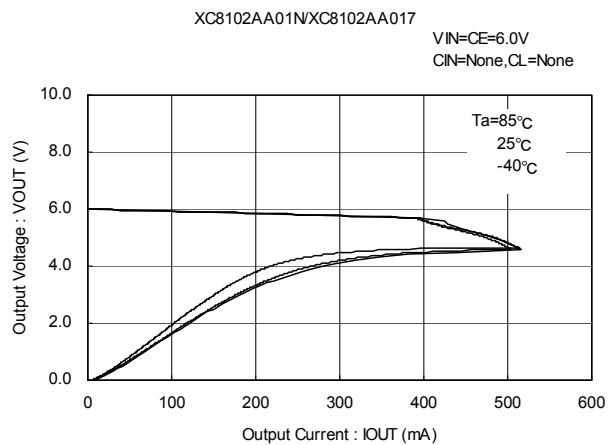
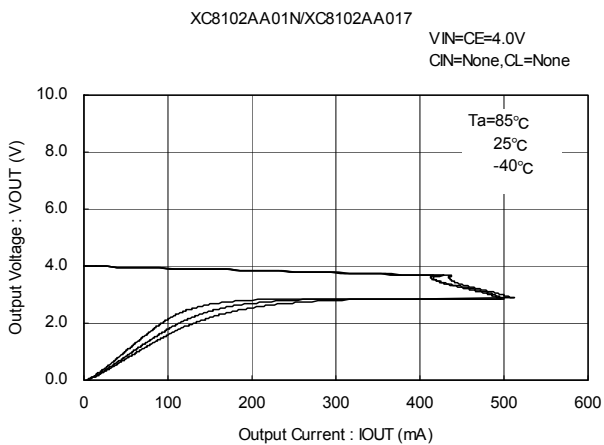
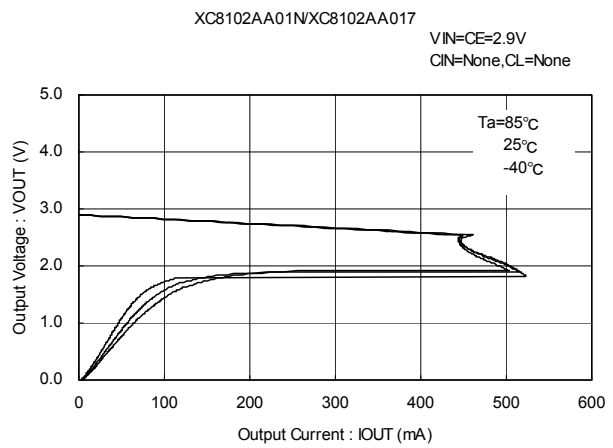
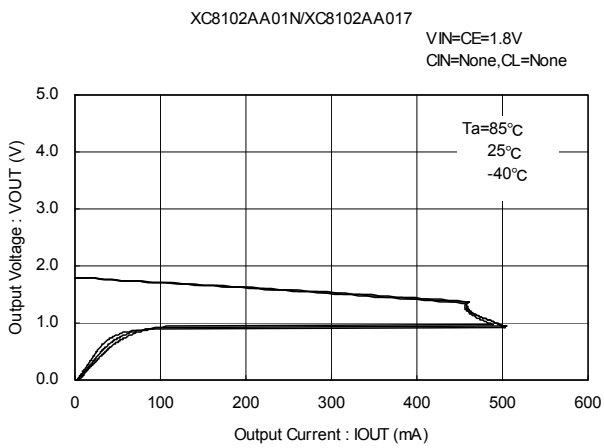
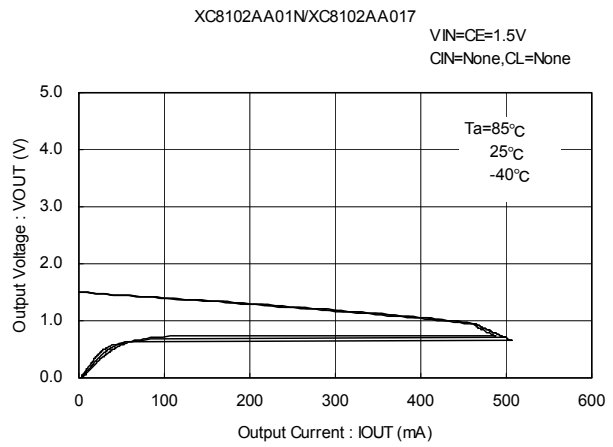
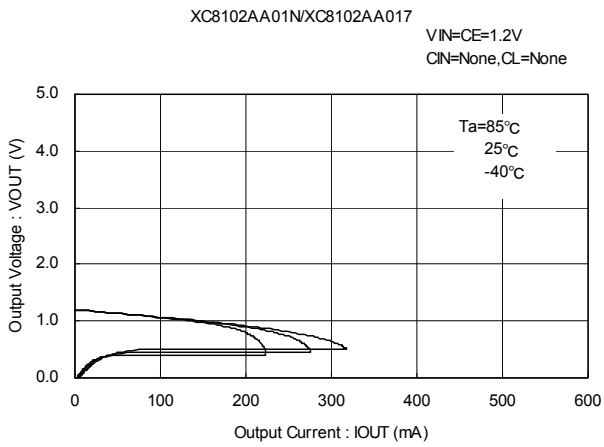
## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (5) Output Voltage vs. Output Current



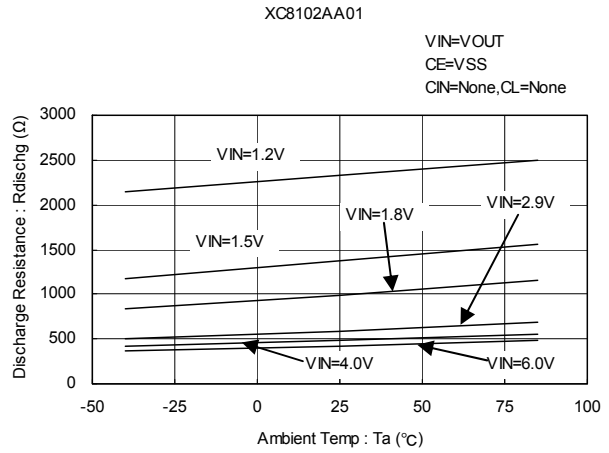
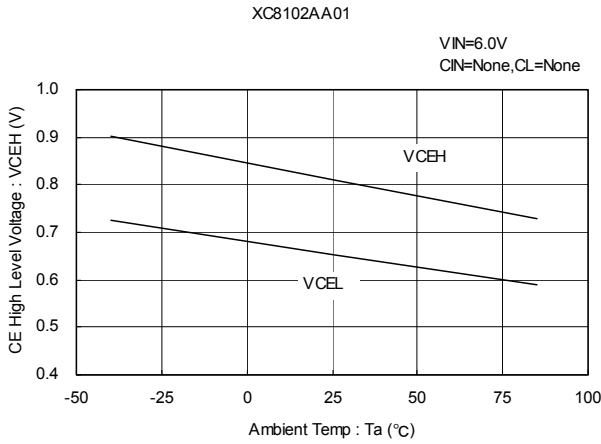
## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (5) Output Voltage vs. Output Current

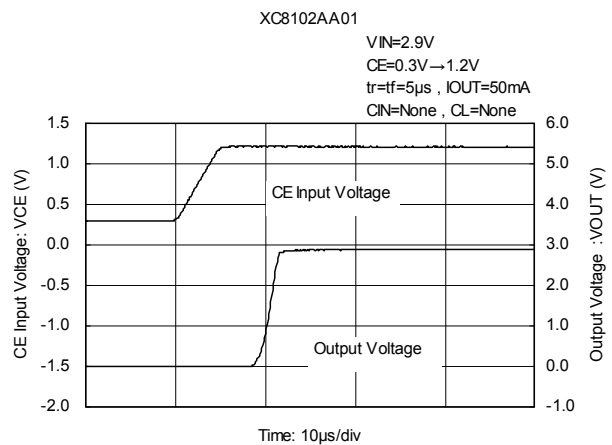
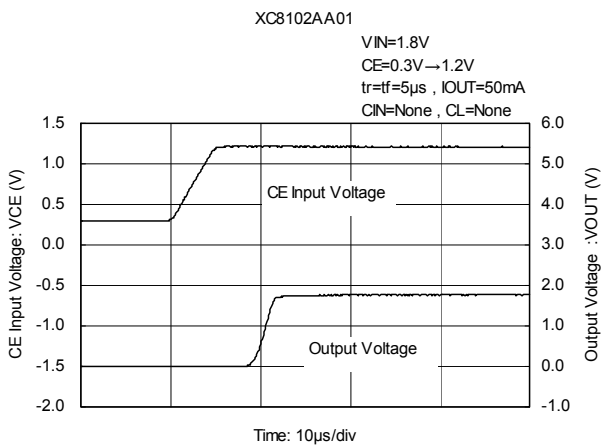
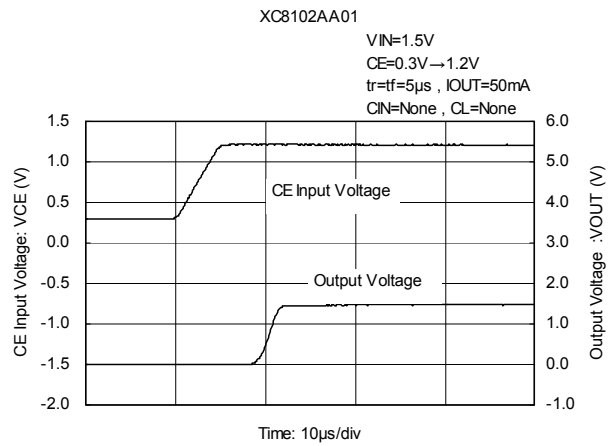
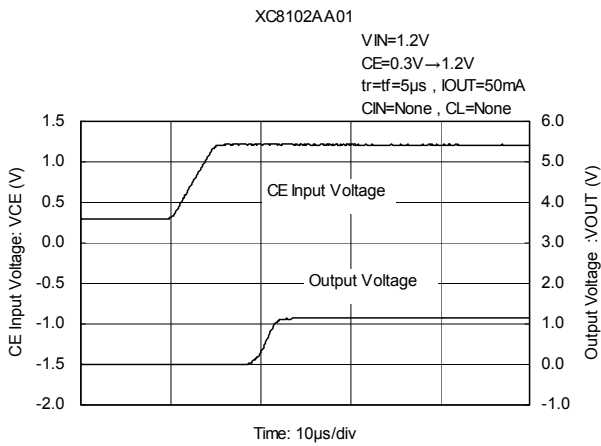


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(6) CE Threshold Voltage vs. Ambient Temperature (7) CL Discharge Resistance vs. Ambient Temperature

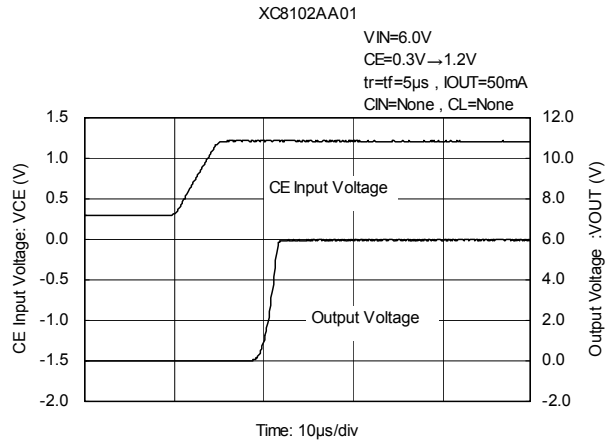
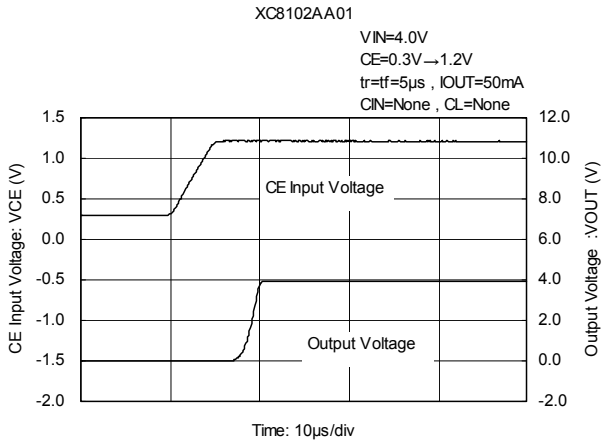


(8) Output Turn-on Time with CE

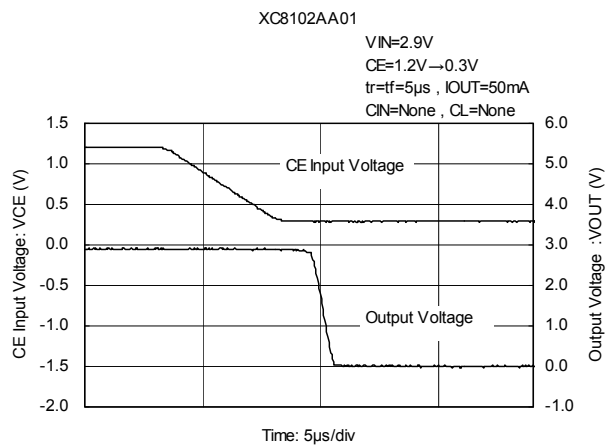
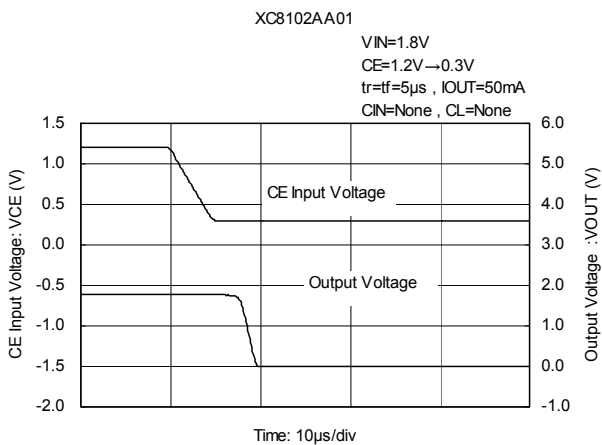
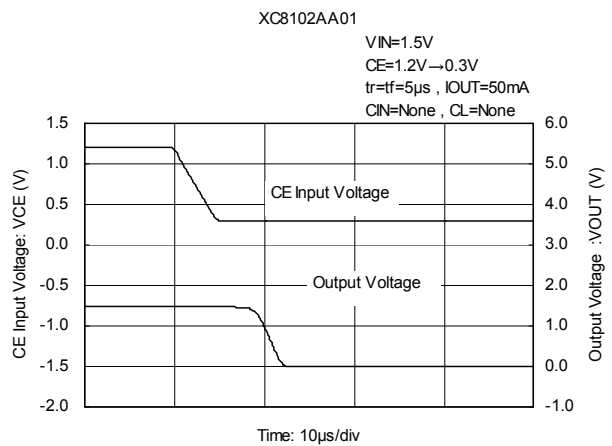
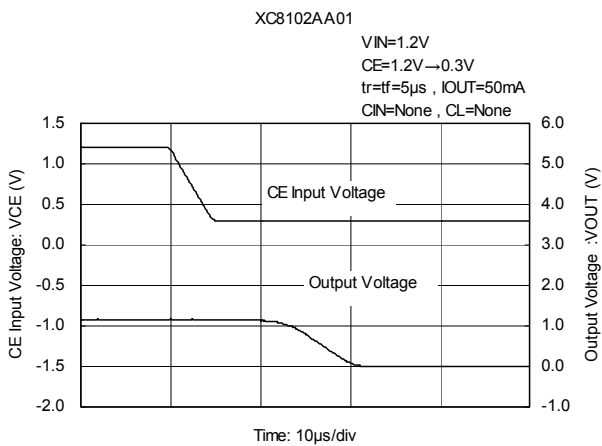


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (8) Output Turn-on Time with CE (Continued)

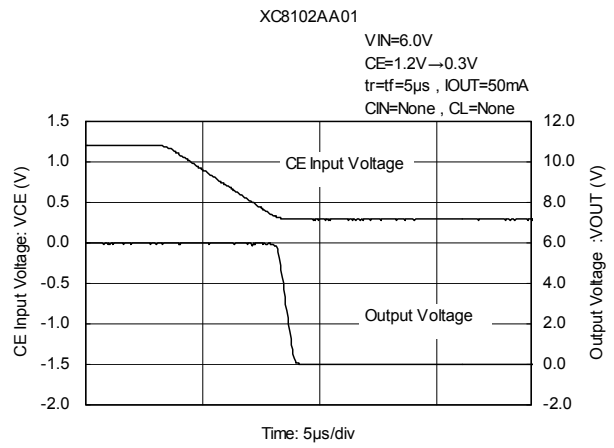
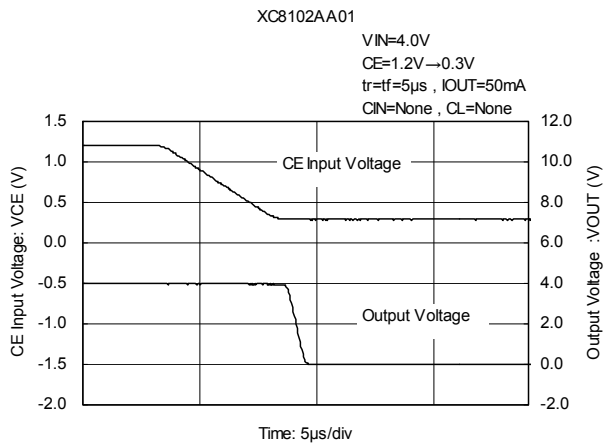


### (9) Output Turn-off Time with CE



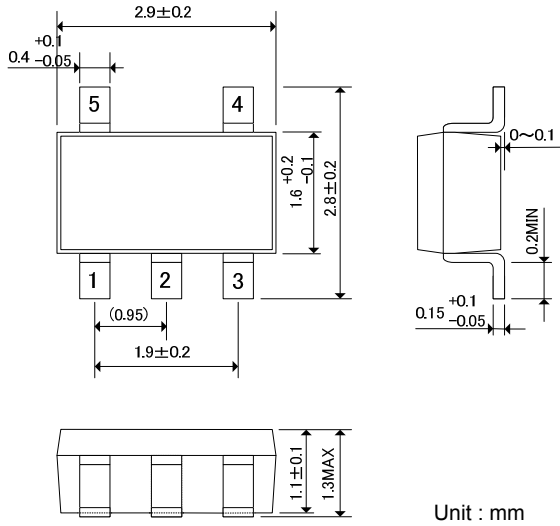
## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (9) Output Turn-off Time with CE (Continued)

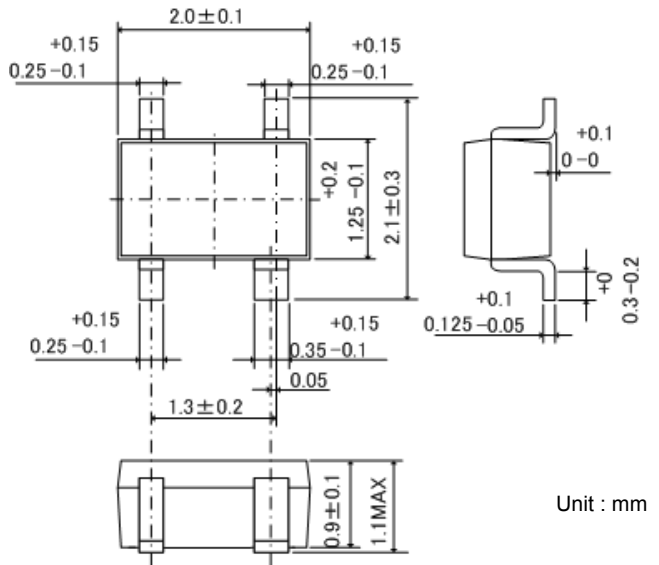


## PACKAGING INFORMATION

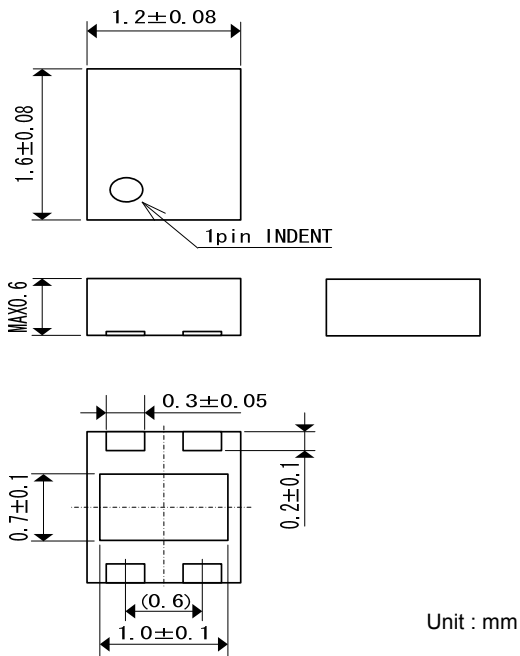
SOT-25



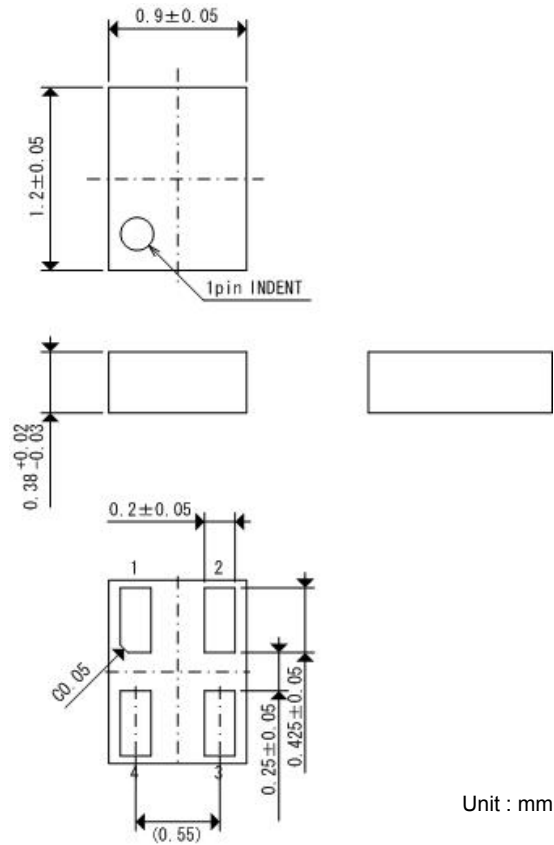
SSOT-24



USP-4



USPN-4



## PACKAGING INFORMATION (Continued)

### SOT-25 Power Dissipation

Power dissipation data for the SOT-25 is shown in this page.

The value of power dissipation varies with the mount board conditions.

Please use this data as one of reference data taken in the described condition.

#### 1. Measurement Condition (Reference data)

Condition: Mount on a board

Ambient: Natural convection

Soldering: Lead (Pb) free

Board: Dimensions 40 x 40 mm (1600 mm<sup>2</sup> in one side)

Copper (Cu) traces occupy 50% of the board area

In top and back faces

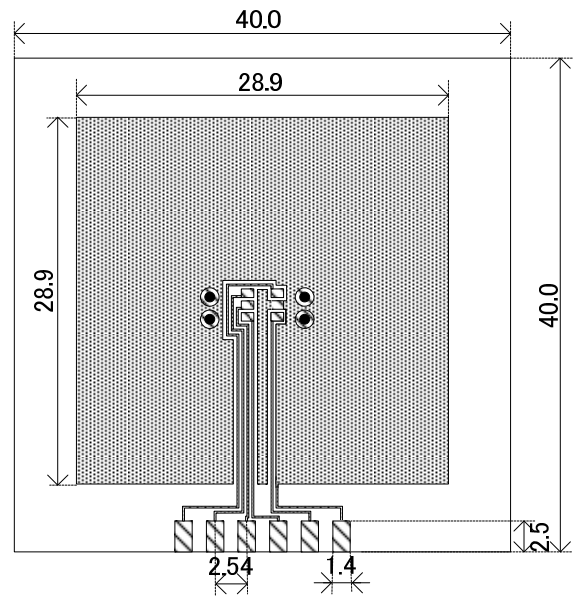
Package heat-sink is tied to the copper traces

(Board of SOT-26 is used)

Material: Glass Epoxy (FR-4)

Thickness: 1.6 mm

Through-hole: 4 x 0.8 Diameter

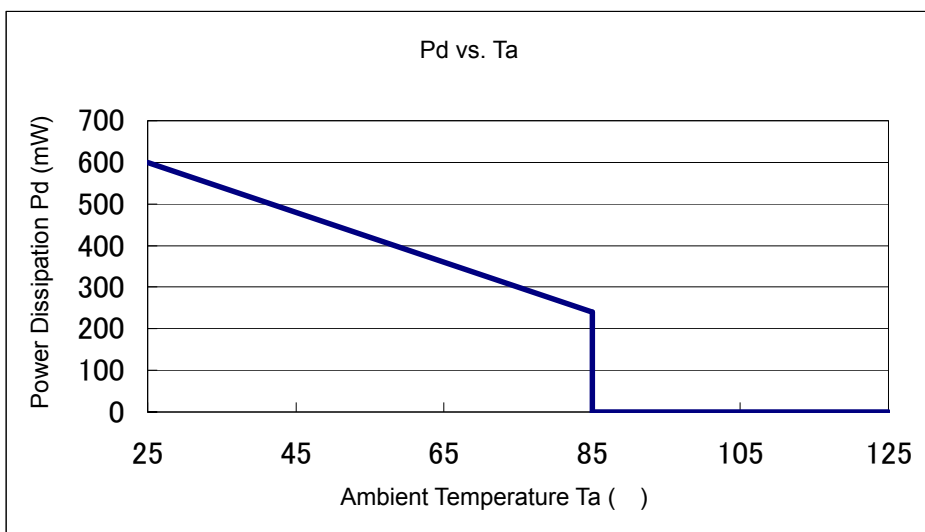


Evaluation Board (Unit: mm)

#### 2. Power Dissipation vs. Ambient Temperature

Board Mount (T<sub>j</sub> max = 125 °C)

Ambient Temperature (°C)	Power Dissipation Pd (mW)	Thermal Resistance (°C/W)
25	600	166.67
85	240	



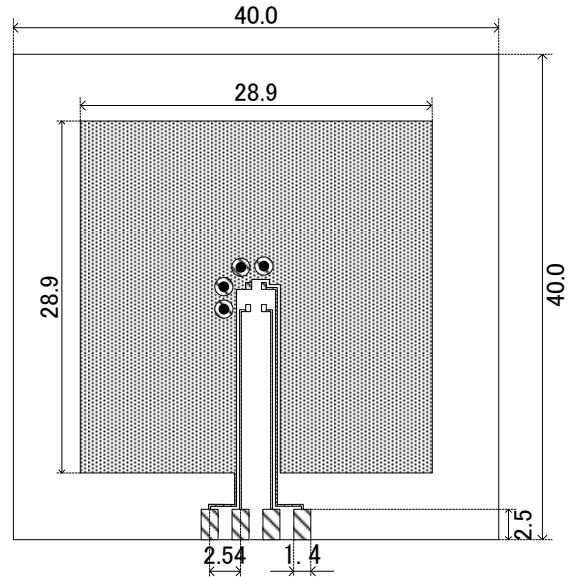
## PACKAGING INFORMATION (Continued)

### SSOT-24 Power Dissipation

Power dissipation data for the SSOT-24 is shown in this page.  
 The value of power dissipation varies with the mount board conditions.  
 Please use this data as one of reference data taken in the described condition.

#### 2. Measurement Condition (Reference data)

- Condition: Mount on a board
- Ambient: Natural convection
- Soldering: Lead (Pb) free
- Board: Dimensions 40 x 40 mm (1600 mm<sup>2</sup> in one side)
- Copper (Cu) traces occupy 50% of the board area
- In top and back faces
- Package heat-sink is tied to the copper traces
- Material: Glass Epoxy (FR-4)
- Thickness: 1.6 mm
- Through-hole: 4 x 0.8 Diameter

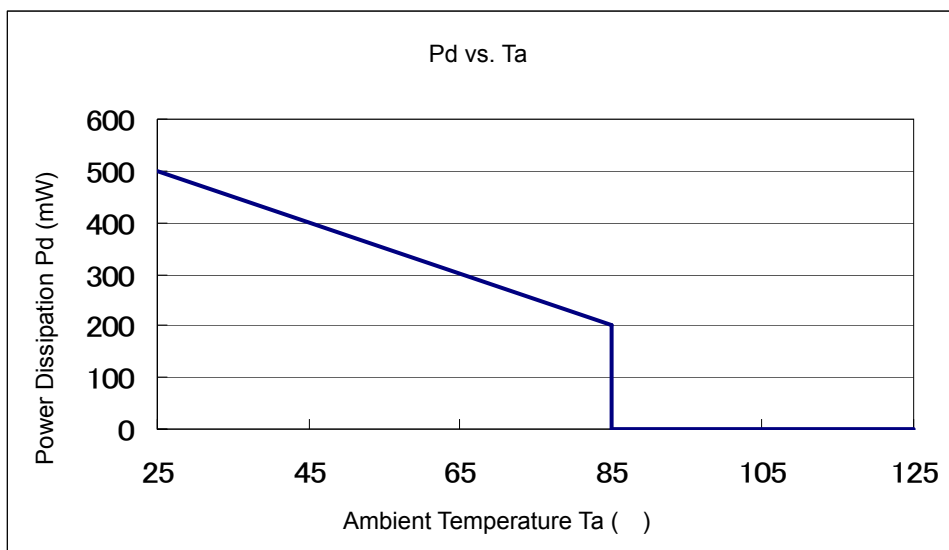


Evaluation Board (Unit: mm)

#### 2. Power Dissipation vs. Ambient Temperature

Board Mount ( $T_j \text{ max} = 125$  )

Ambient Temperature (°C)	Power Dissipation Pd (mW)	Thermal Resistance (°C/W)
25	500	200.00
85	200	





## PACKAGING INFORMATION (Continued)

### USP-4 Power Dissipation

Power dissipation data for the USP-4 is shown in this page.

The value of power dissipation varies with the mount board conditions.

Please use this data as one of reference data taken in the described condition.

#### 1. Measurement Condition (Reference data)

Condition: Mount on a board

Ambient: Natural convection

Soldering: Lead (Pb) free

Board: Dimensions 40 x 40 mm (1600 mm<sup>2</sup> in one side)

Copper (Cu) traces occupy 50% of the board area

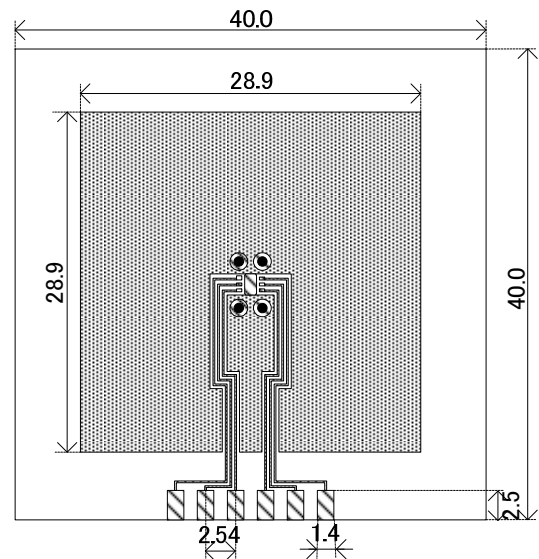
In top and back faces

Package heat-sink is tied to the copper traces

Material: Glass Epoxy (FR-4)

Thickness: 1.6 mm

Through-hole: 4 x 0.8 Diameter

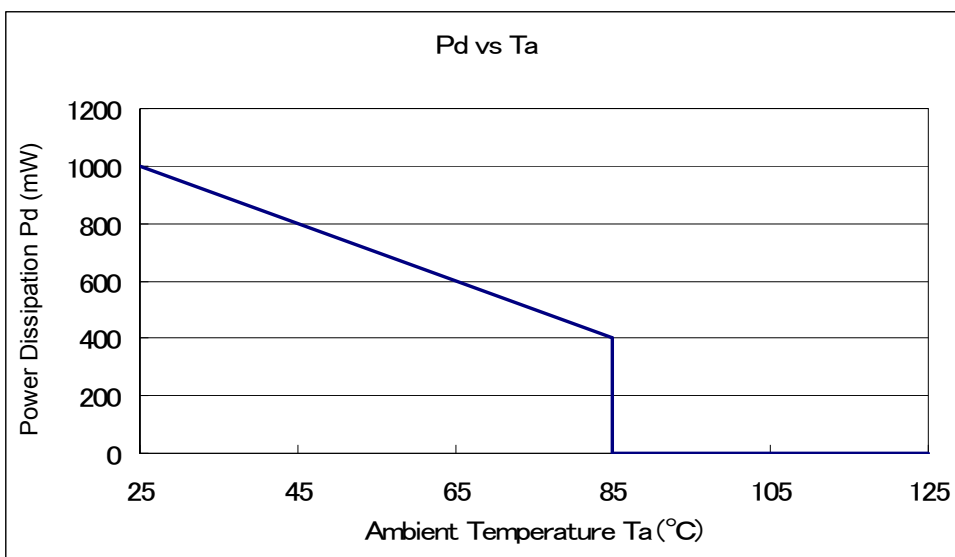


Evaluation Board (Unit: mm)

#### 2. Power Dissipation vs. Ambient Temperature

Board Mount ( $T_j \text{ max} = 125$  )

Ambient Temperature (°C)	Power Dissipation Pd (mW)	Thermal Resistance (°C/W)
25	1000	100.00
85	400	



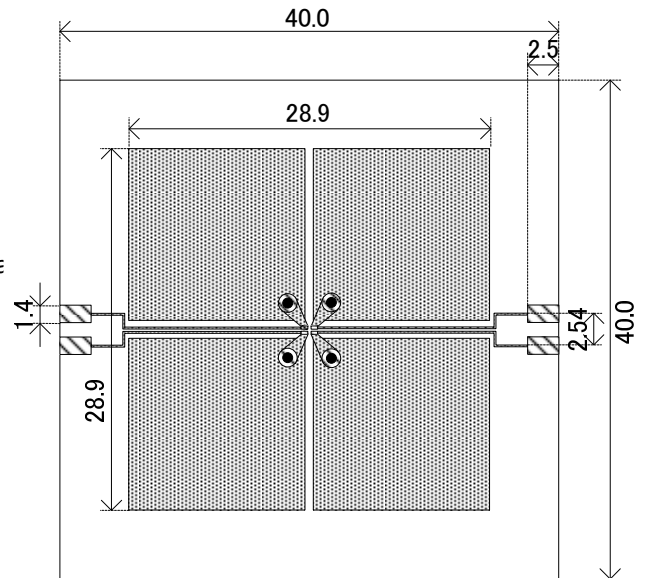
## PACKAGING INFORMATION (Continued)

### USPN-4 Power Dissipation

Power dissipation data for the USPN-4 is shown in this page.  
 The value of power dissipation varies with the mount board conditions.  
 Please use this data as one of reference data taken in the described condition.

#### 2. Measurement Condition (Reference data)

- Condition: Mount on a board
- Ambient: Natural convection
- Soldering: Lead (Pb) free
- Board: Dimensions 40 x 40 mm (1600 mm<sup>2</sup> in one side)
- Copper (Cu) traces occupy 50% of the board area
- In top and back faces
- Package heat-sink is tied to the copper traces
- Material: Glass Epoxy (FR-4)
- Thickness: 1.6 mm
- Through-hole: 4 x 0.8 Diameter

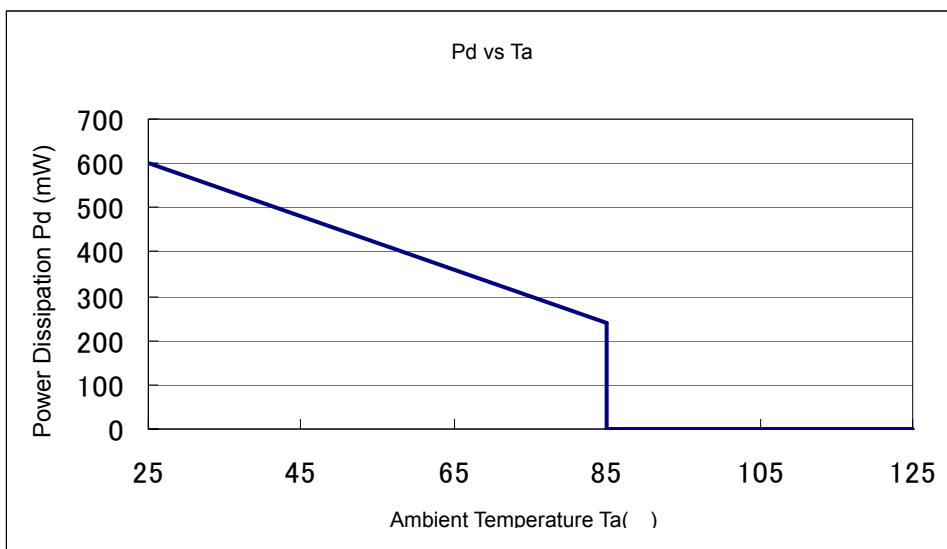


Evaluation Board (Unit: mm)

#### 2. Power Dissipation vs. Ambient Temperature

Board Mount ( $T_j \text{ max} = 125$  )

Ambient Temperature (°C)	Power Dissipation Pd (mW)	Thermal Resistance (°C/W)
25	640	166.67
85	240	



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