

# XC6228D/H Series

CTR03060-009

## 300mA High Speed LDO Regulator with ON/OFF Switch

### ■ GENERAL DESCRIPTION

The XC6228D/H series is a high speed LDO regulator that features high accurate, low noise, high ripple rejection, low dropout and low power consumption. The series consists of a voltage reference, an error amplifier, a driver transistor, a current limiter, a phase compensation circuit.

The CE function enables the circuit to be in stand-by mode by inputting low level signal. In the stand-by mode, the series enables the electric charge at the output capacitor  $C_L$  to be discharged via the internal switch, and as a result the  $V_{OUT}$  pin quickly returns to the  $V_{SS}$  level. The output stabilization capacitor  $C_L$  is also compatible with low ESR ceramic capacitors.

The output voltage is selectable from 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 3.0V, 3.1V, 3.3V which fixed by laser trimming technologies. The over current protection circuit is built-in. This protection circuit will operate when the output current reaches current limit level.

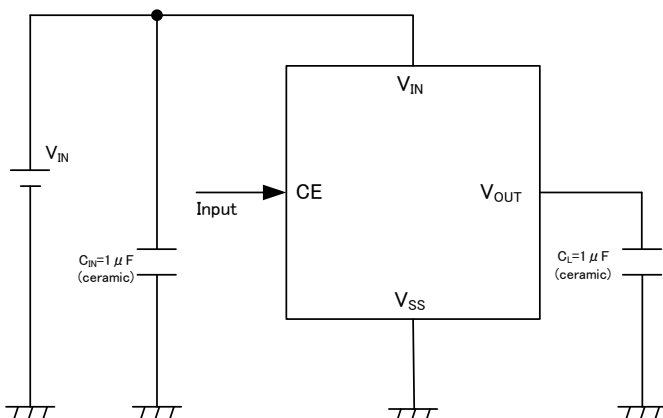
### ■ APPLICATIONS

- Mobile devices
- Wireless communications
- Modules
- Mobile phones

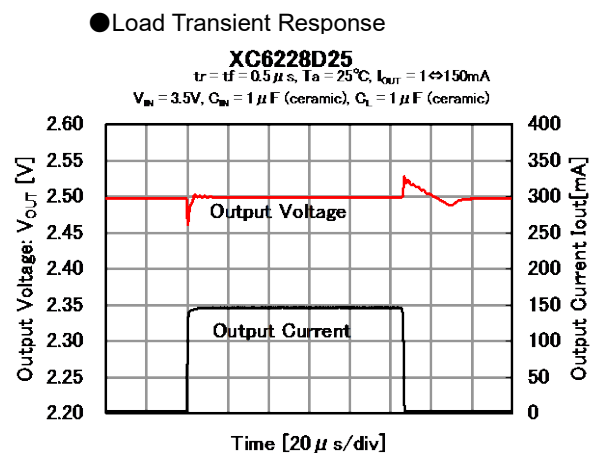
### ■ FEATURES

<b>Maximum Output Current</b>	: 300mA
<b>Input Voltage Range</b>	: 1.6V ~ 5.5V
<b>Output Voltages</b>	: 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 3.0V, 3.1V, 3.3V ( $\pm 1\%$ , $\pm 2\%$ )
<b>Dropout Voltage</b>	: 200mV@300mA ( $V_{OUT}=3.0V$ )
<b>Low Power Consumption</b>	: 100 $\mu$ A
<b>Stand-by Current</b>	: 0.1 $\mu$ A
<b>High Ripple Rejection</b>	: 80dB@1kHz
<b>Protection</b>	: Current Limit (400mA)
<b>Low ESR Capacitors</b>	: $C_{IN}=1\mu F$ , $C_L=1\mu F$
<b>CE Function</b>	: Active High, $C_L$ High Speed Discharge
<b>Operating Ambient Temperature</b>	: $-40^{\circ}C \sim 85^{\circ}C$
<b>Small Package</b>	: SOT-25J USPQ-4B04
<b>Environmentally Friendly</b>	: EU RoHS Compliant, Pb Free

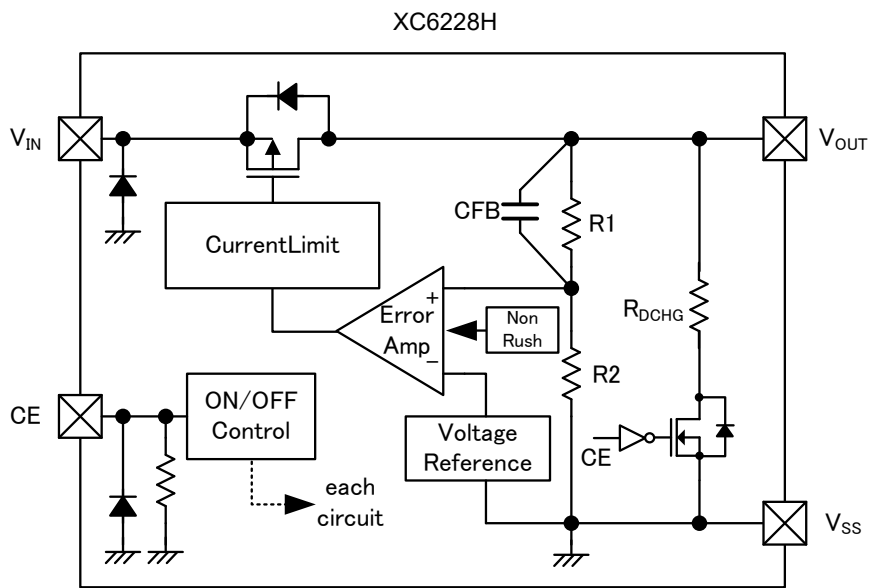
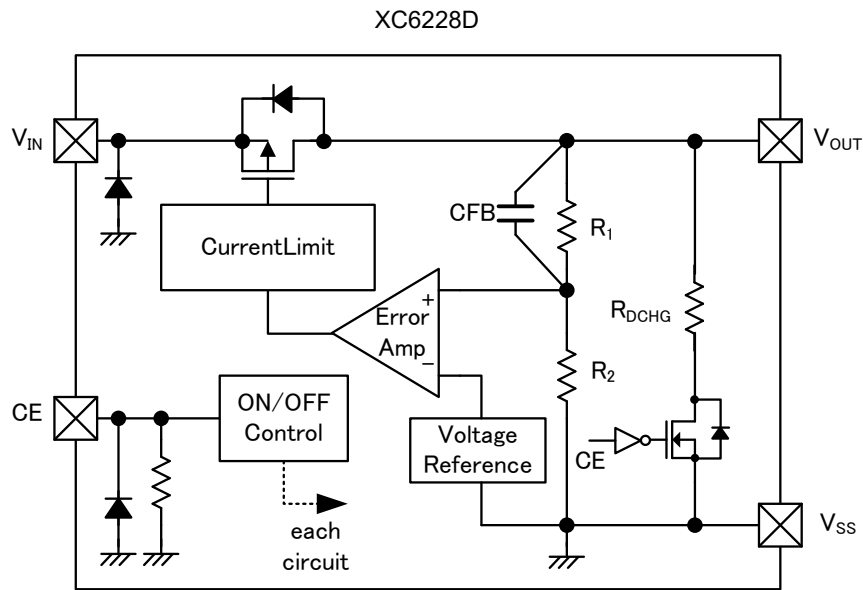
### ■ TYPICAL APPLICATION CIRCUIT



### ■ TYPICAL PERFORMANCE CHARACTERISTICS



## ■ BLOCK DIAGRAMS



\* Diodes inside the circuits are ESD protection diodes and parasitic diodes.

## ■ PRODUCT CLASSIFICATION

### ● Ordering Information

XC6228①②③④⑤⑥-⑦<sup>(\*)</sup>

DESIGNATOR	ITEM	SYMBOL	DESCRIPTION
①	Type	D	Without Inrush Current Prevention
		H	With Inrush Current Prevention
②③	Output Voltage	12	1.2V
		15	1.5V
		18	1.8V
		25	2.5V
		28	2.8V
		30	3.0V
		31	3.1V
		33	3.3V
④	Output Voltage Accuracy	1	±1% <sup>(**)</sup>
		2	±2%
⑤⑥-⑦ <sup>(*)</sup>	Packages (Order Unit)	9R-G	USPQ-4B04 (3,000pcs/Reel)
		VR-G	SOT-25J (3,000pcs/Reel)

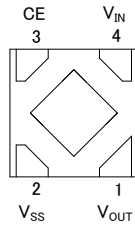
<sup>(\*)</sup> The "-G" suffix denotes Halogen and Antimony free as well as being fully EU RoHS compliant.

<sup>(\*\*)</sup>  $V_{OUT(T)} < 2.0V$ ,  $V_{OUT(T)} \pm 20mV$

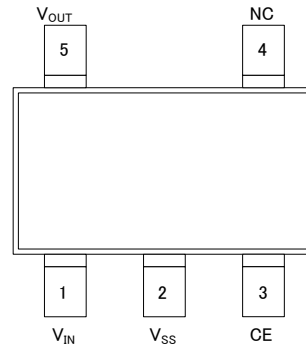
### ● Selection Guide

TYPE	CURRENT LIMIT	CE PULL-DOWN RESISTOR	CL DISCHARGE	INRUSH CURRENT PROTECTION
D	Yes	Yes	Yes	No
H	Yes	Yes	Yes	Yes

## PIN CONFIGURATION



USPQ-4B04  
(BOTTOM VIEW)



SOT-25J  
(TOP VIEW)

\* The dissipation pad for the USPQ-4B04 package should be solder-plated in reference mount pattern and metal masking so as to enhance mounting strength and heat release. If the pad needs to be connected to other pins, it should be connected to the  $V_{SS}$  (No. 2) pin.

## PIN ASSIGNMENT

PIN NUMBER		PIN NAME	FUNCTIONS
USPQ-4B04	SOT-25J		
1	5	$V_{OUT}$	Output
2	2	$V_{SS}$	Ground
3	3	CE	ON/OFF Control
4	1	$V_{IN}$	Power Input
-	4	NC	No Connection

## PIN FUNCTION ASSIGNMENT

PIN NAME	SIGNAL	STATUS
CE	L	Stand-by
	H	Active
	OPEN	Stand-by*

\* An internal pull-down resistor maintains the CE pin voltage to be low.

## ■ ABSOLUTE MAXIMUM RATINGS

PARAMETER		SYMBOL	RATINGS	UNITS
Input Voltage		$V_{IN}$	$V_{SS} - 0.3 \sim V_{SS} + 7.0$	V
Output Current		$I_{OUT}$	500 <sup>(*)1</sup>	mA
Output Voltage		$V_{OUT}$	$V_{SS} - 0.3 \sim V_{IN} + 0.3$	V
CE Input Voltage		$V_{CE}$	$V_{SS} - 0.3 \sim V_{SS} + 7.0$	V
Power Dissipation	SOT-25J	Pd	200 (IC only)	mW
			500 (40mm x 40mm Standard board) <sup>(*)2</sup>	
	USPQ-4B04		100 (IC only)	
			550 (40mm x 40mm Standard board) <sup>(*)2</sup>	
Operating Ambient Temperature		$T_{opr}$	-40 ~ 85	°C
Storage Temperature		$T_{stg}$	-55 ~ 125	°C

<sup>(\*)1</sup>  $I_{OUT} \leq Pd / (V_{IN} - V_{OUT})$

<sup>(\*)2</sup> The power dissipation figure shown is PCB mounted and is for reference only.  
Please refer to PACKAGING INFORMATION for the mounting condition.

## ELECTRICAL CHARACTERISTICS

Ta=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUITS
Output Voltage (±1%)	V <sub>OUT(E)</sub> <sup>(*)</sup>	V <sub>OUT(T)</sub> ≥ 2.0V, V <sub>CE</sub> =V <sub>IN</sub> , I <sub>OUT</sub> =10mA	V <sub>OUT(T)</sub> ×0.99 <sup>(*)</sup>	V <sub>OUT(T)</sub> <sup>(*)</sup>	V <sub>OUT(T)</sub> ×1.01 <sup>(*)</sup>	V	①
		V <sub>OUT(T)</sub> < 2.0V, V <sub>CE</sub> =V <sub>IN</sub> , I <sub>OUT</sub> = 10mA <sup>(*)</sup>	V <sub>OUT(T)</sub> - 20mV <sup>(*)</sup>	V <sub>OUT(T)</sub> <sup>(*)</sup>	V <sub>OUT(T)</sub> +20mV <sup>(*)</sup>	V	
Output Voltage (±2%)	V <sub>OUT(E)</sub> <sup>(*)</sup>	V <sub>CE</sub> =V <sub>IN</sub> , I <sub>OUT</sub> =10mA	V <sub>OUT(T)</sub> ×0.98 <sup>(*)</sup>	V <sub>OUT(T)</sub> <sup>(*)</sup>	V <sub>OUT(T)</sub> ×1.02 <sup>(*)</sup>	V	①
Maximum Output Current	I <sub>OUTMAX</sub>	V <sub>CE</sub> =V <sub>IN</sub>	300	-	-	mA	①
Load Regulation	ΔV <sub>OUT</sub>	V <sub>CE</sub> =V <sub>IN</sub> , 0.1mA ≤ I <sub>OUT</sub> ≤ 300mA	-	25	45	mV	①
Dropout Voltage	V <sub>dif</sub> <sup>(*)</sup>	V <sub>CE</sub> =V <sub>IN</sub> , I <sub>OUT</sub> =300mA	-	E-1		mV	①
Supply Current	I <sub>SS</sub>	V <sub>CE</sub> =V <sub>IN</sub>	-	100	220	μA	②
Stand-by Current	I <sub>STB</sub>	V <sub>CE</sub> =V <sub>SS</sub>	-	0.01	0.4	μA	③
Line Regulation	ΔV <sub>OUT</sub> / (ΔV <sub>IN</sub> · V <sub>OUT</sub> )	V <sub>OUT(T)</sub> +0.5V ≤ V <sub>IN</sub> ≤ 5.5V V <sub>CE</sub> =V <sub>IN</sub> , I <sub>OUT</sub> =50mA	-	0.01	0.1	%/V	①
Input Voltage	V <sub>IN</sub>	-	1.6	-	5.5	V	①
Output Voltage Temperature Characteristics	ΔV <sub>OUT</sub> / (ΔT <sub>opr</sub> · V <sub>OUT</sub> )	V <sub>CE</sub> =V <sub>IN</sub> , I <sub>OUT</sub> =10mA -40°C ≤ Ta ≤ 85°C	-	±100	-	ppm/°C	①
Power Supply Rejection Ratio	PSRR	V <sub>OUT(T)</sub> < 2.5V V <sub>IN</sub> =3.0V <sub>DC</sub> +0.5V <sub>p-pAC</sub> V <sub>CE</sub> =V <sub>OUT(T)</sub> +1.0V I <sub>OUT</sub> =30mA, f=1kHz	-	80	-	dB	③
		V <sub>OUT(T)</sub> ≥ 2.5V V <sub>IN</sub> ={V <sub>OUT(T)</sub> +1.0}V <sub>DC</sub> +0.5V <sub>p-pAC</sub> V <sub>CE</sub> =V <sub>OUT(T)</sub> +1.0V I <sub>OUT</sub> =30mA, f=1kHz					
Current Limit	I <sub>LIM</sub>	V <sub>CE</sub> =V <sub>IN</sub>	310	400	-	mA	①
Short Current	I <sub>SHORT</sub>	V <sub>CE</sub> =V <sub>IN</sub> , V <sub>OUT</sub> =V <sub>SS</sub>	-	50	-	mA	①
CE "H" Voltage	V <sub>CEH</sub>	-	1.0	-	5.5	V	④
CE "L" Voltage	V <sub>CEL</sub>	-	0	-	0.3	V	④
CE "H" Current	I <sub>CEH</sub>	V <sub>CE</sub> =V <sub>IN</sub> =5.5V	3.0	5.5	9.0	μA	④
CE "L" Current	I <sub>CEL</sub>	V <sub>CE</sub> =V <sub>SS</sub>	-0.1	-	0.1	μA	④
C <sub>L</sub> Discharge Resistance	R <sub>DCRG</sub>	V <sub>IN</sub> =5.5V, V <sub>OUT</sub> =2.0V, V <sub>CE</sub> =V <sub>SS</sub>	-	300	-	Ω	①
Inrush Current (Type H)	I <sub>RUSH</sub>	V <sub>IN</sub> =5.5V, V <sub>CE</sub> =0→5.5V	-	150	-	mA	⑤

NOTE:

(\*1)V<sub>OUT(E)</sub>: Effective output voltage

(i.e. the output voltage when "V<sub>OUT(T)</sub>+1.0V" is provided at the V<sub>IN</sub> pin while maintaining a certain I<sub>OUT</sub> value.)

(\*2)V<sub>OUT(T)</sub>: Nominal output voltage

(\*3)V<sub>dif</sub>=V<sub>IN1</sub><sup>(\*)</sup>-V<sub>OUT1</sub><sup>(\*)</sup> (V<sub>IN1</sub> ≥ 1.6V)

(\*4)V<sub>IN1</sub>=The input voltage when V<sub>OUT1</sub> appears as input voltage is gradually decreased.

(\*5)V<sub>OUT1</sub>=A voltage equal to 98% of the output voltage whenever an amply stabilized V<sub>OUT(T)</sub>+1.0V is input for every I<sub>OUT</sub>.

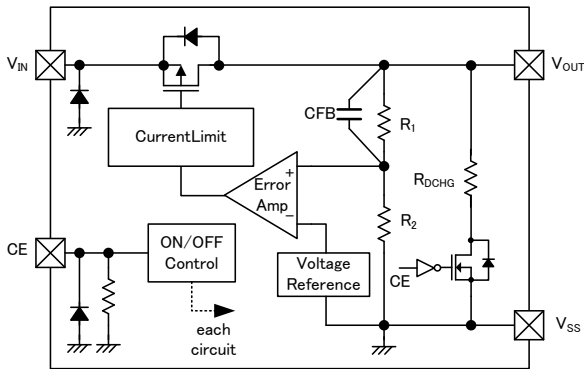
(\*6)Unless otherwise stated regarding input voltage conditions, V<sub>IN</sub>=V<sub>OUT(T)</sub>+1.0V.

## ■ OUTPUT VOLTAGE CHART

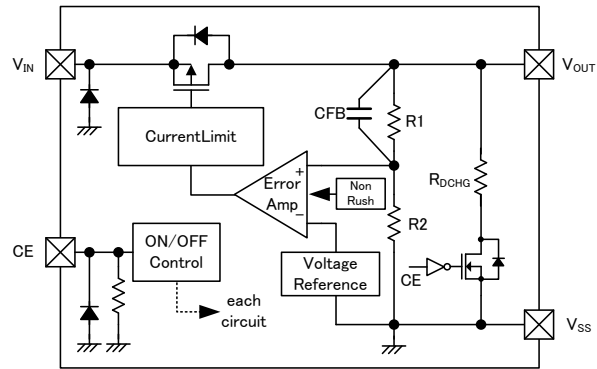
● Voltage Chart 1

NOMINAL OUTPUT VOLTAGE (V)	OUTPUT VOLTAGE(±1%) (V)		OUTPUT VOLTAGE(±2%) (V)		DROPOUT VOLTAGE (mV) E-1	
	$V_{OUT(E)}$		$V_{OUT(E)}$		Vdif	
$V_{OUT(T)}$	MIN.	MAX.	MIN.	MAX.	TYP.	MAX.
1.20	1.180	1.220	1.176	1.224	480	630
1.50	1.480	1.520	1.470	1.530	420	460
1.80	1.780	1.820	1.764	1.836	300	410
2.50	2.475	2.525	2.450	2.550	240	350
2.80	2.772	2.828	2.744	2.856		
3.00	2.970	3.030	2.940	3.060	200	305
3.10	3.069	3.131	3.038	3.162		
3.30	3.267	3.333	3.234	3.366		

## OPERATIONAL EXPLANATION



XC6228D



XC6228H

The voltage divided by resistors R1 & R2 is compared with the internal reference voltage by the error amplifier. The P-channel MOSFET which is connected to the  $V_{OUT}$  pin is then driven by the subsequent output signal. The output voltage at the  $V_{OUT}$  pin is controlled and stabilized by a system of negative feedback. The current limit circuit and short circuit protection operate in relation to the level of output current and heat dissipation. Further, the IC's internal circuitry can be shutdown via the CE pin signal.

### <Low ESR Capacitor>

The XC6228D/H series needs an output capacitor  $C_L$  for phase compensation. Please place an output capacitor ( $C_L$ ) at the output pin ( $V_{OUT}$ ) and the ground pin ( $V_{SS}$ ) as close as possible. Please use the output capacitor ( $C_L$ ) is 1.0 $\mu$ F or larger. For a stable power input, please connect an input capacitor ( $C_{IN}$ ) of 1.0 $\mu$ F between the  $V_{IN}$  pin and the  $V_{SS}$  pin.

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

The XC6228D/H has current limiter and droop shape of fold-back circuit. When the load current reaches the current limit, the droop current limiter circuit operates and the output voltage drops. When the output voltage dropped, the fold-back circuit operates and the output current goes to decrease. The output current finally falls at the level of 50mA when the output pin is short-circuited.

### <CE Pin>

The IC's internal circuitry can be shutdown via the signal from the CE pin. In shutdown mode, the XC6228D/H series enables the electric charge at the output capacitor ( $C_L$ ) to be discharged via the internal switch located between the  $V_{OUT}$  and  $V_{SS}$  pins, and as a result the  $V_{OUT}$  pin quickly returns to the  $V_{SS}$  level. The XC6228D/H series has a pull-down resistor at the CE pin inside, so that the CE pin input current flows.

### <Inrush Current Protection>

The inrush current protection circuit is built in the XC6228H.

When the IC starts to operate, the protection circuit limits the inrush current from input pin ( $V_{IN}$ ) to output pin ( $V_{OUT}$ ) to charge  $C_L$  capacitor.

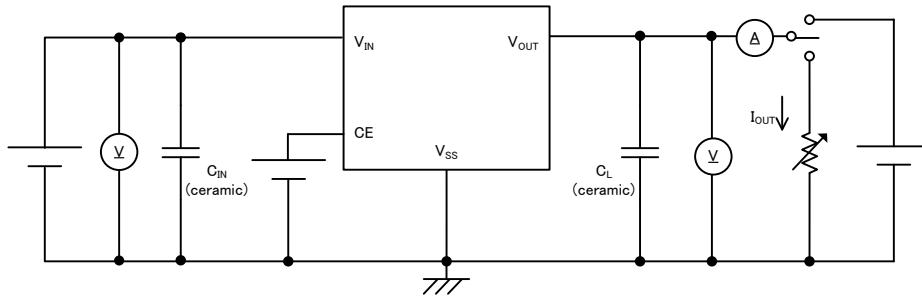


## ■ NOTES ON USE

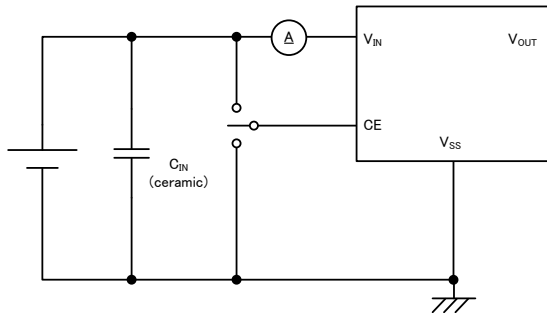
1. For temporary, transitional voltage drop or voltage rising phenomenon, the IC is liable to malfunction should the ratings be exceeded.
2. Where wiring impedance is high, operations may become unstable due to the noise and/or phase lag depending on output current. Please strengthen  $V_{IN}$  and  $V_{SS}$  wiring in particular.
3. The input capacitor  $C_{IN}$  and the output capacitor  $C_L$  should be placed to the as close as possible with a shorter wiring.
4. The IC is controlled with constant current start-up. Start-up sequence control is requested to draw a load current after even nominal output voltage rising up the output voltage.
5. The CE pin current increases to tens of  $\mu A$  when a voltage higher than the  $V_{IN}$  pin voltage is applied to the CE pin. Therefore, if you want to suppress the CE pin current, design the device so that the  $V_{IN}$  pin voltage is higher than the CE pin voltage.
6. Torex places an importance on improving our products and its reliability. However, by any possibility, we would request user fail-safe design and post-aging treatment on system or equipment.

## TEST CIRCUITS

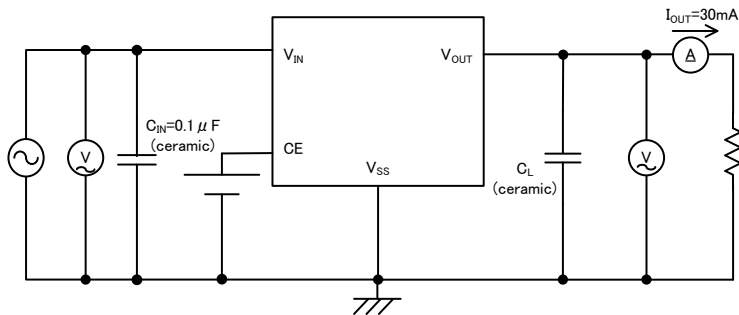
● Circuit ①



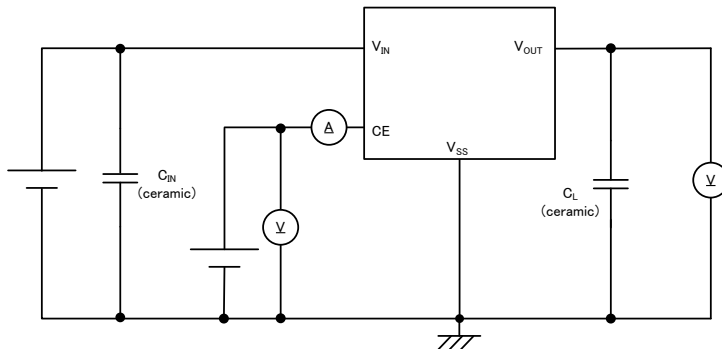
● Circuit ②



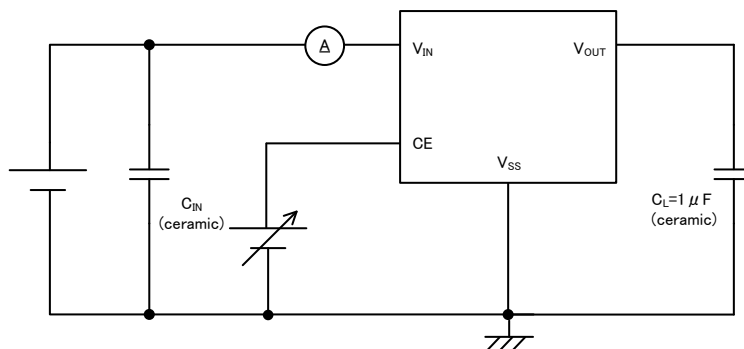
● Circuit ③



● Circuit ④

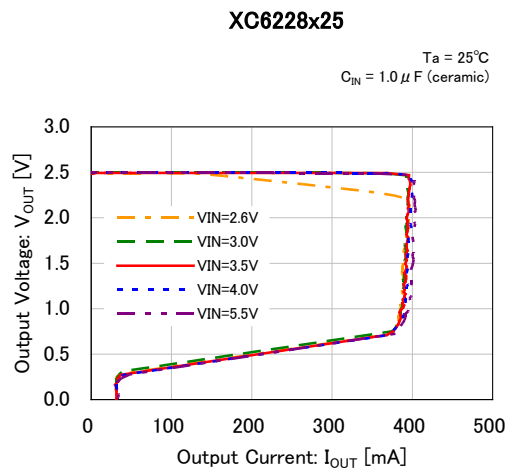
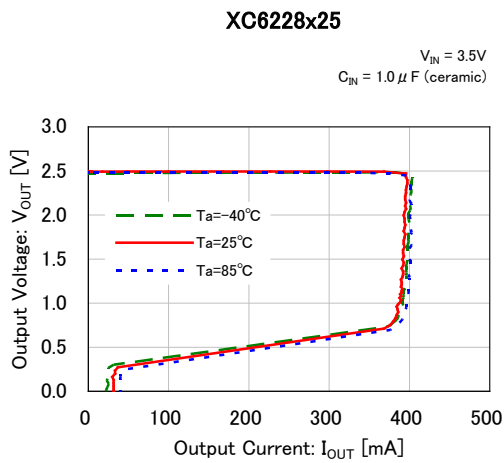
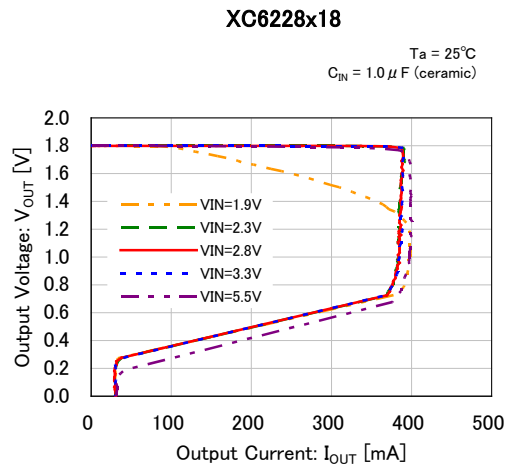
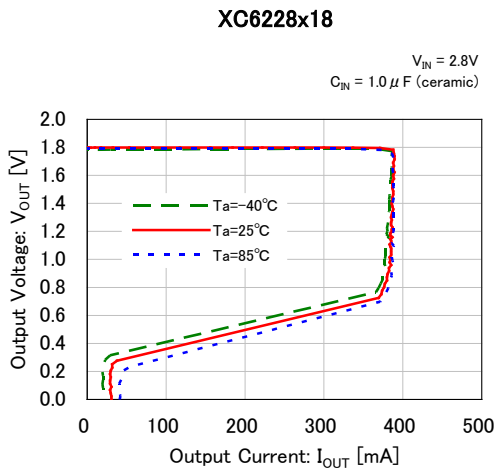
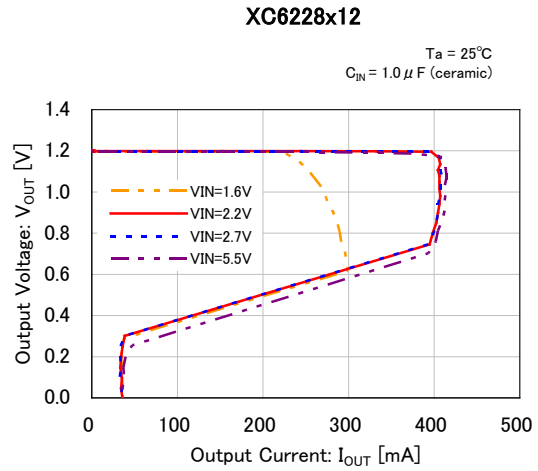
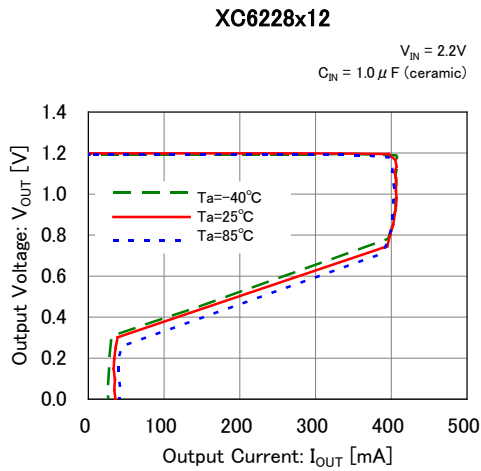


● Circuit ⑤



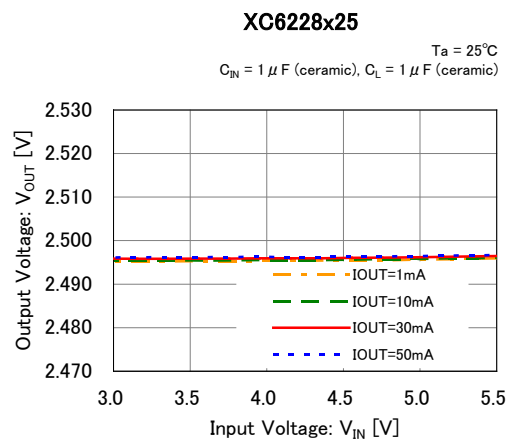
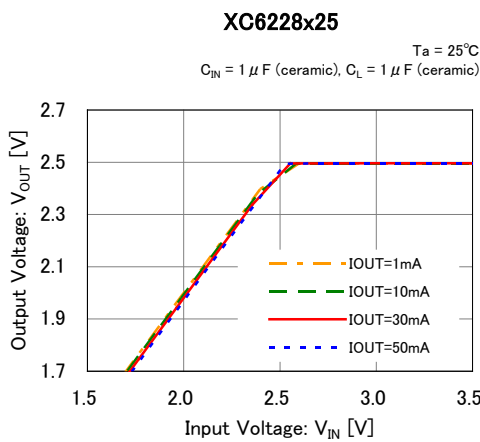
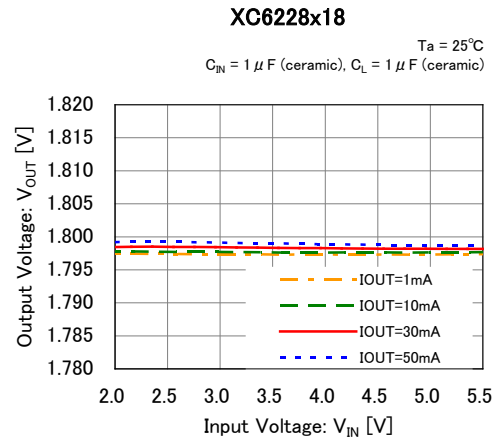
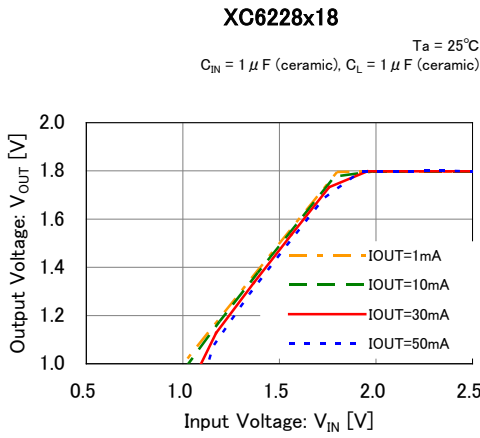
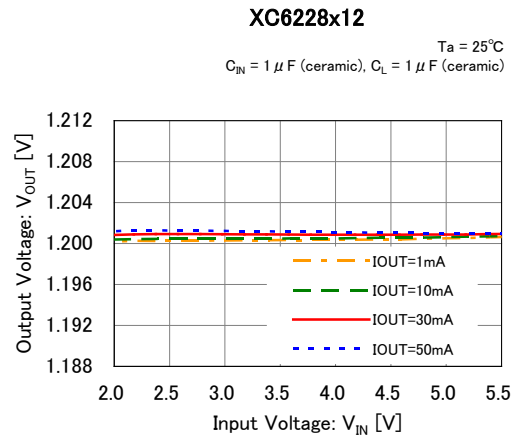
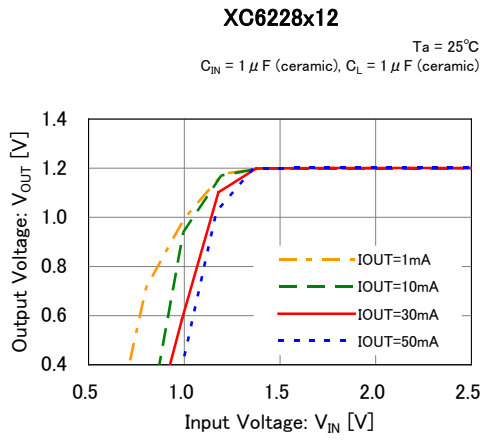
# TYPICAL PERFORMANCE CHARACTERISTICS

(1) Output Voltage vs. Output Current



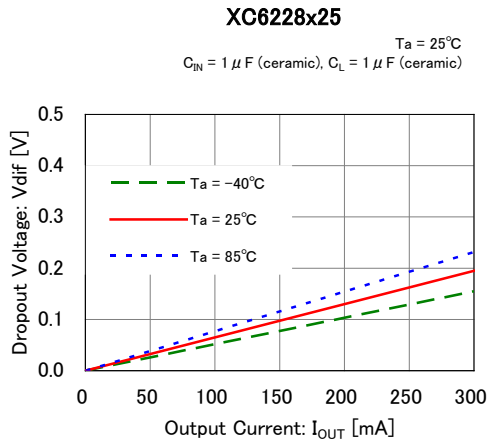
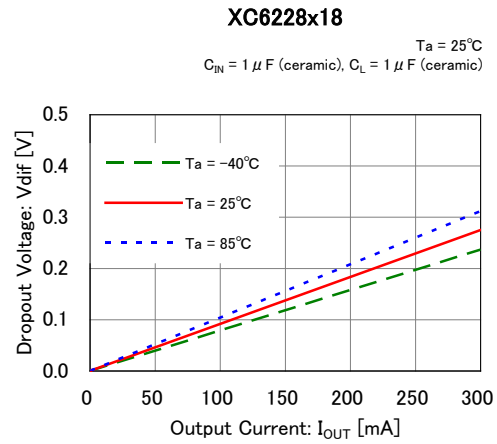
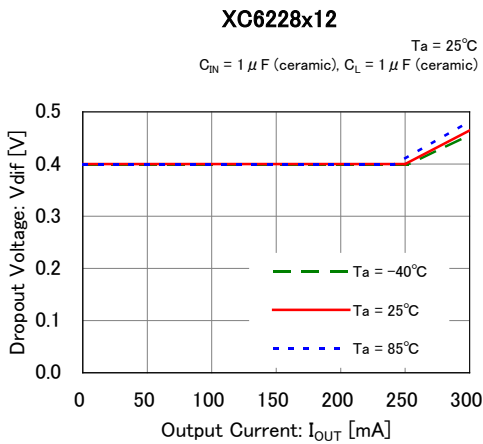
## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2) Output Voltage vs. Input Voltage

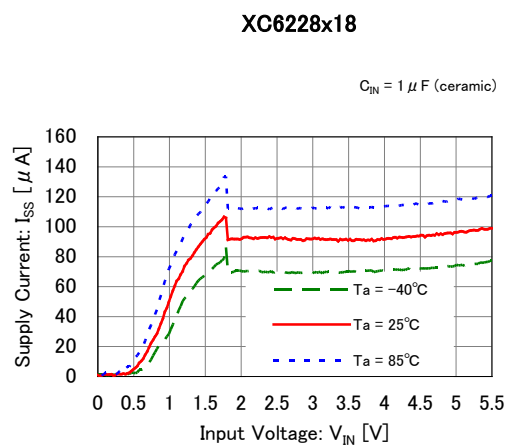
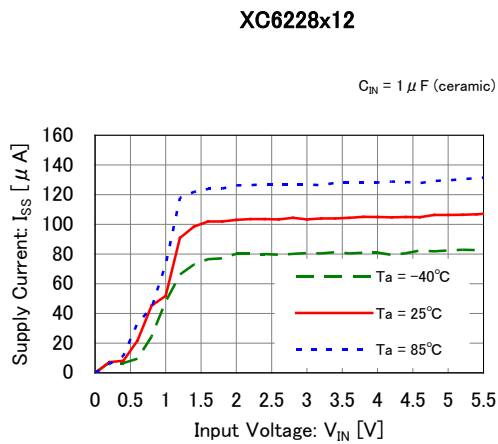


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (3) Dropout Voltage vs. Output Current

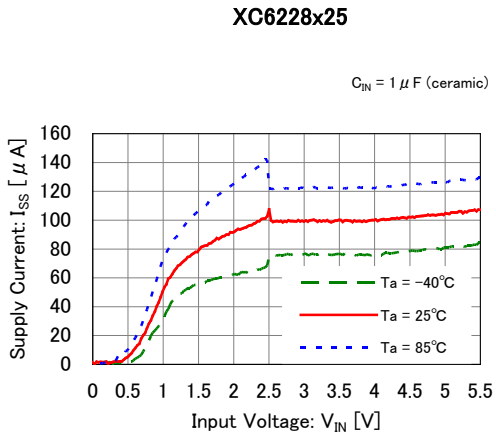


### (4) Supply Current vs. Input Voltage

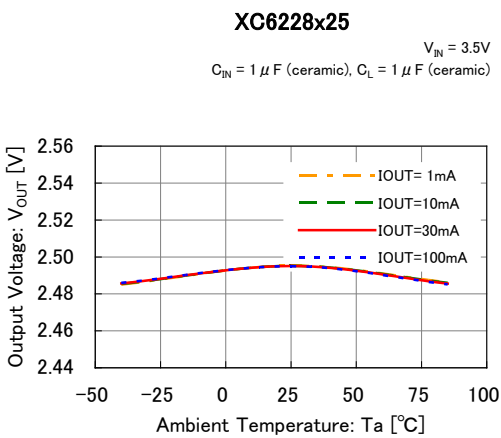
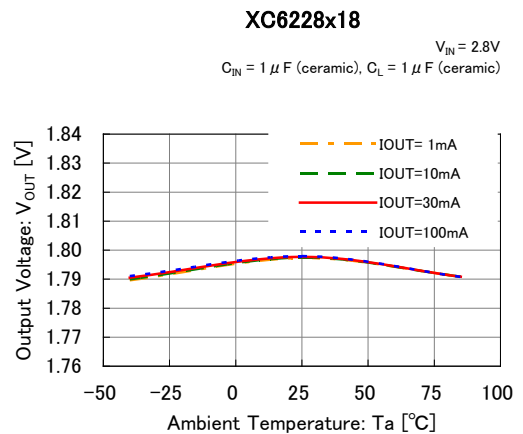
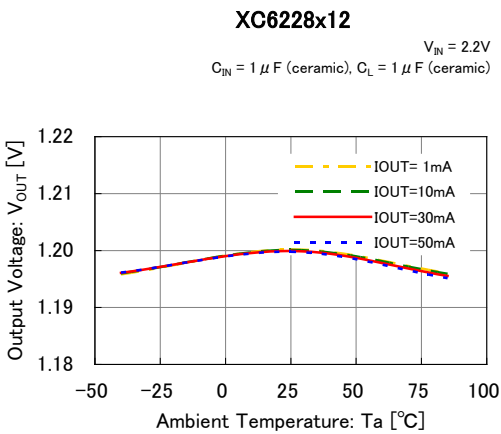


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (4) Supply Current vs. Input Voltage (Continued)

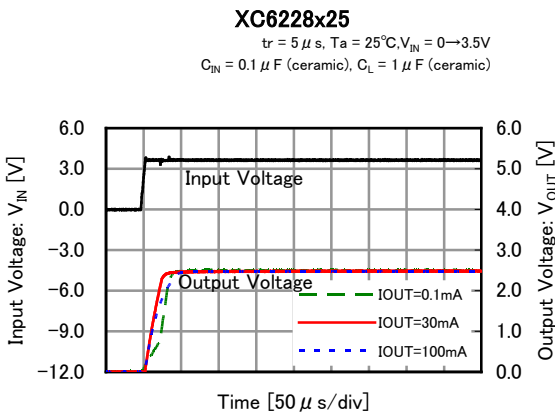
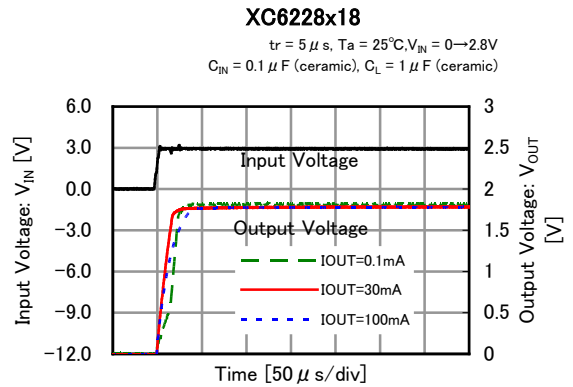
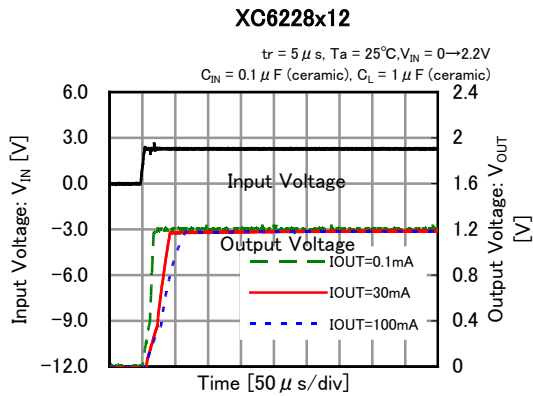


### (5) Output Voltage vs. Ambient Temperature

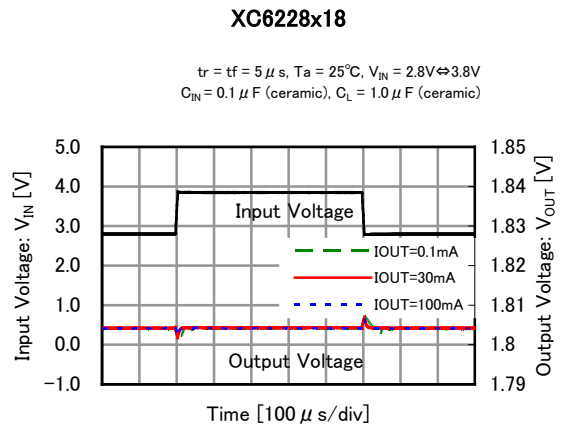
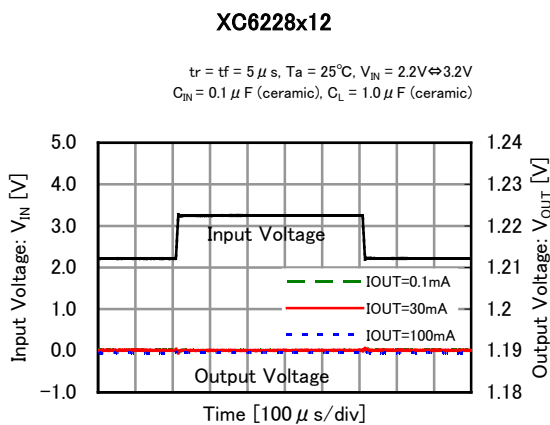


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (6) Rising Response Time

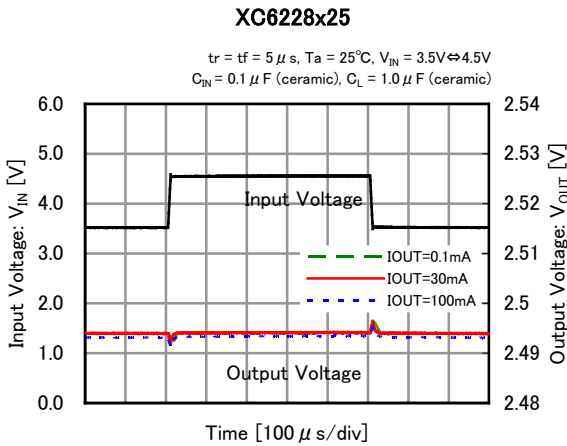


### (7) Input Transient Response

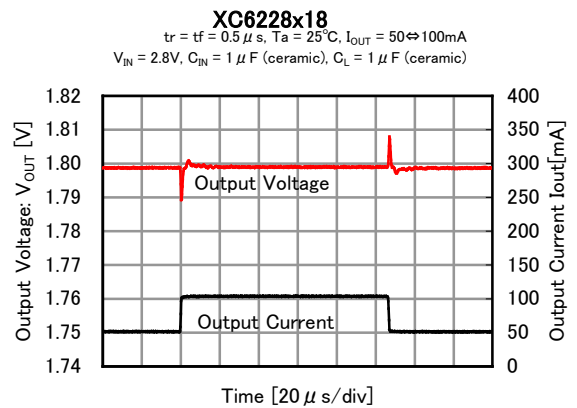
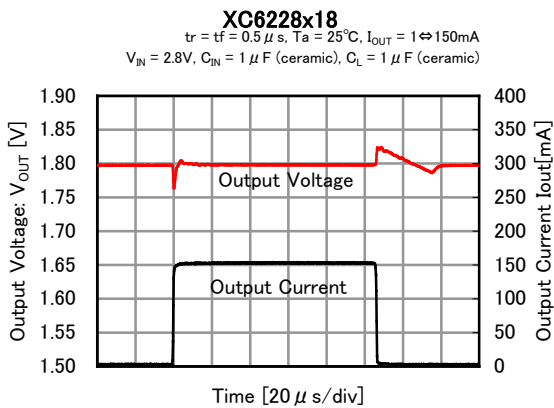
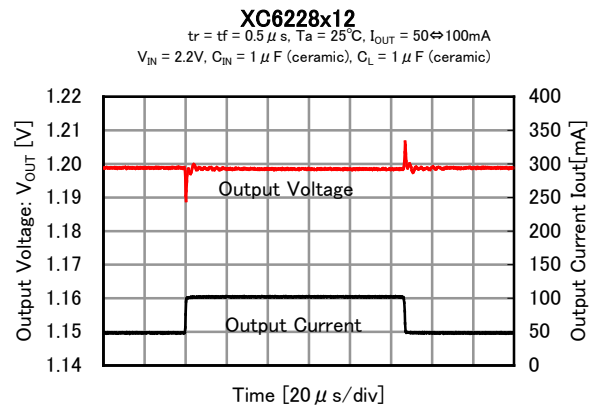
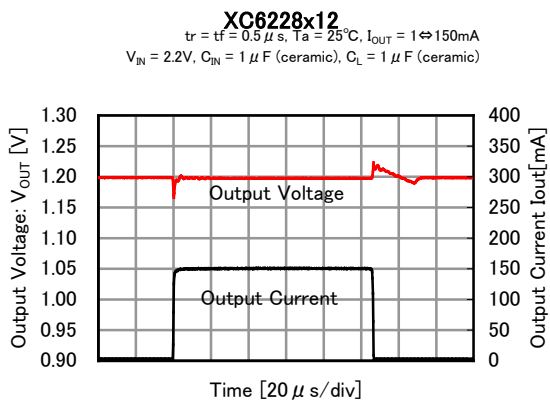


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(7) Input Transient Response (Continued)



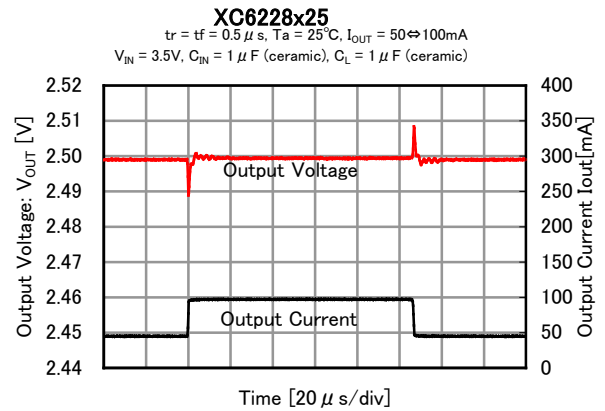
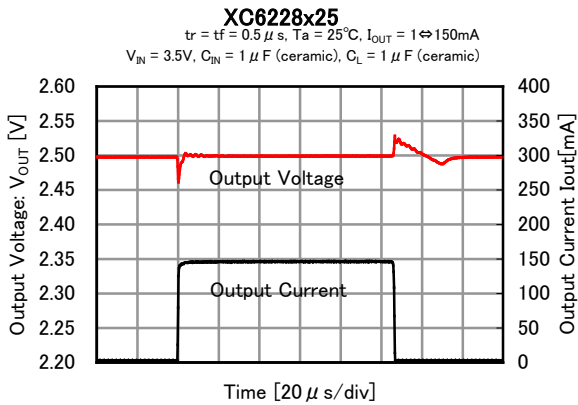
(8) Load Transient Response ( $t_r=t_f=0.5\mu s$ )



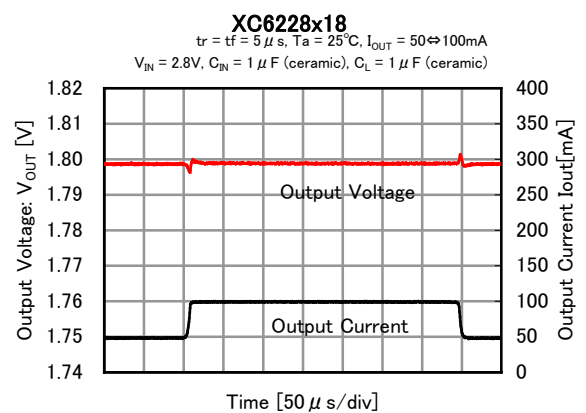
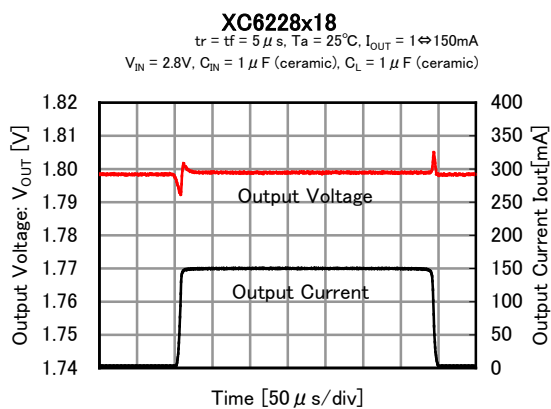
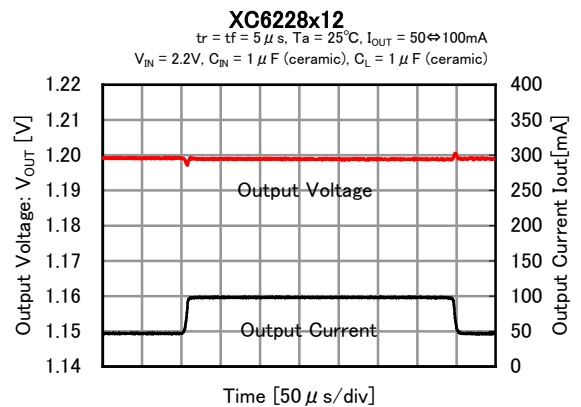
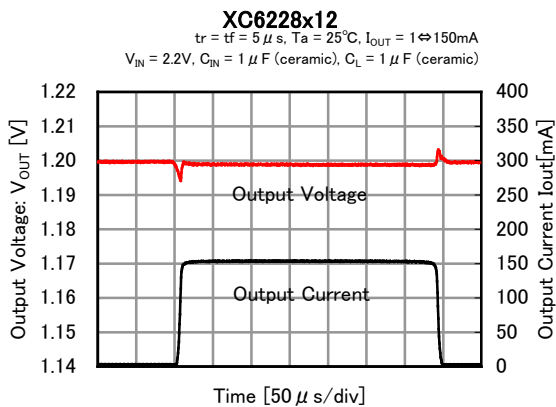


## ■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(8) Load Transient Response ( $t_r=t_f=0.5\mu s$ ) (Continued)

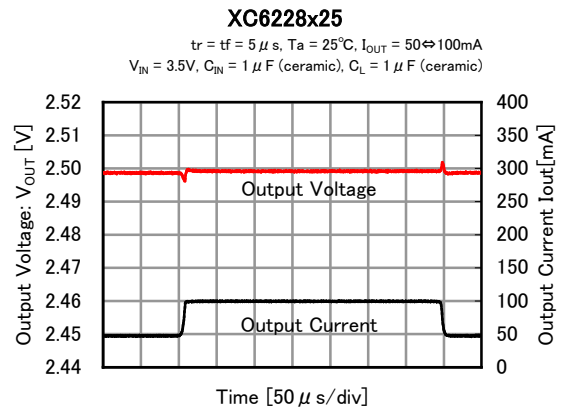
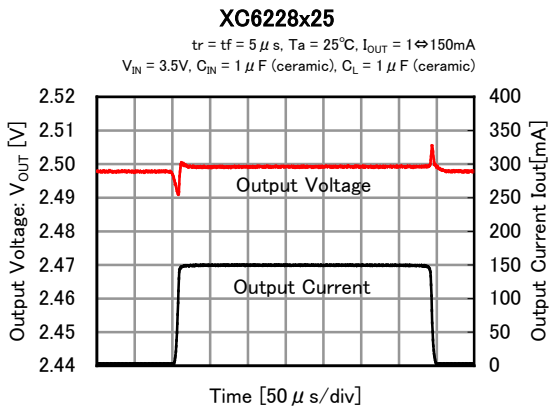


(9) Load Transient Response ( $t_r=t_f=5\mu s$ )

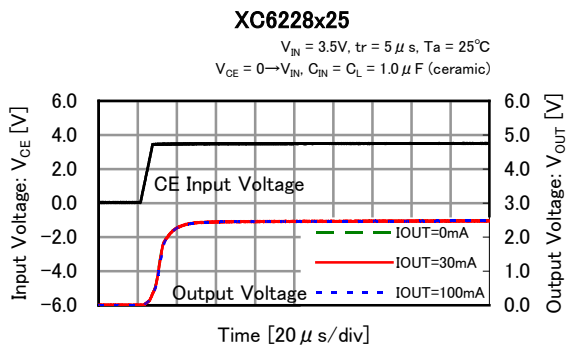
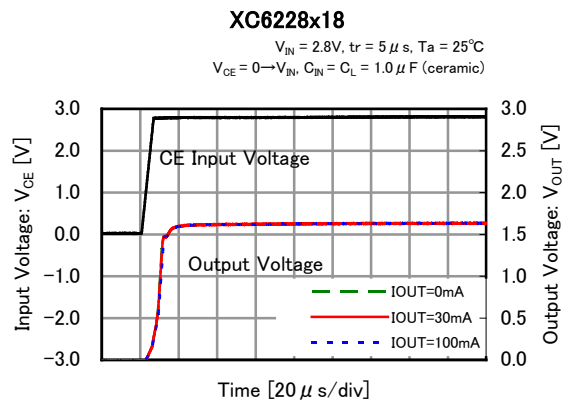
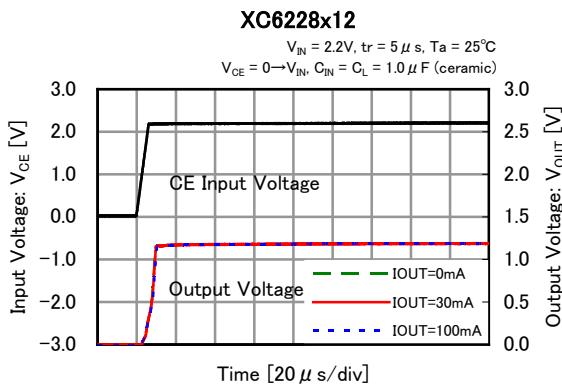


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(9) Load Transient Response ( $t_r=t_f=5\mu s$ ) (Continued)

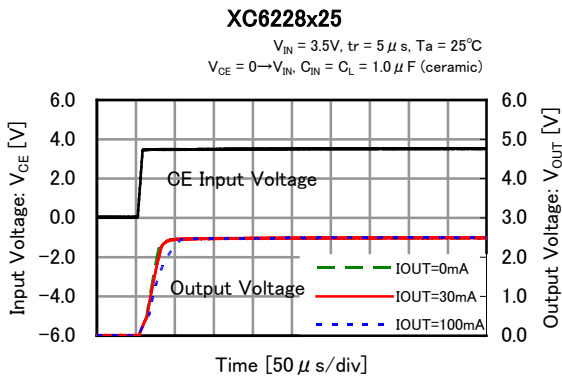
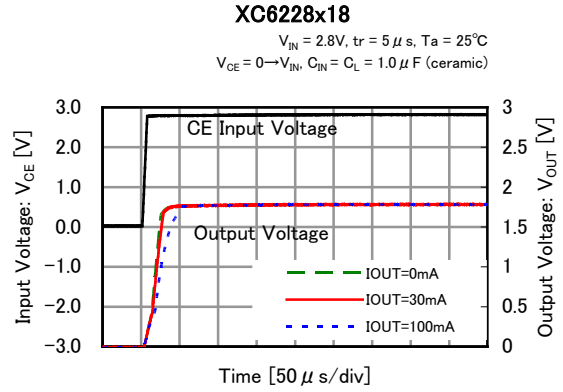
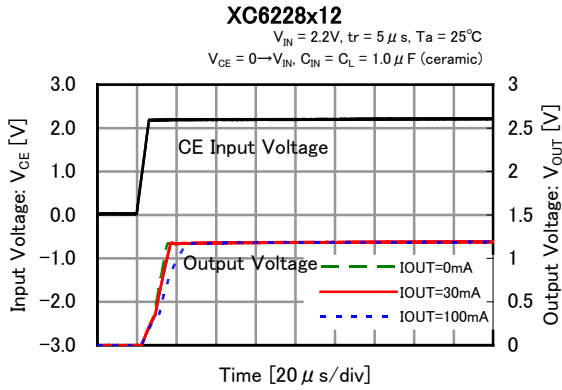


(10) CE Rising Response Time (Type D)

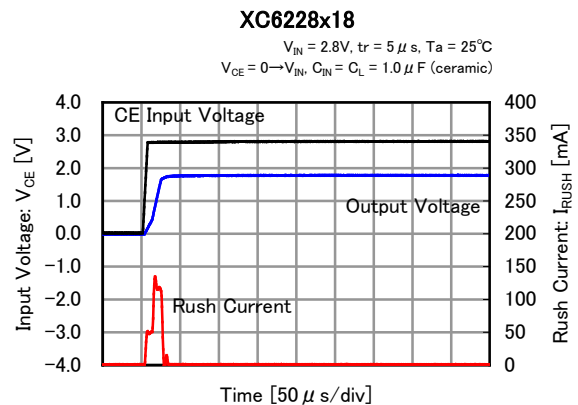
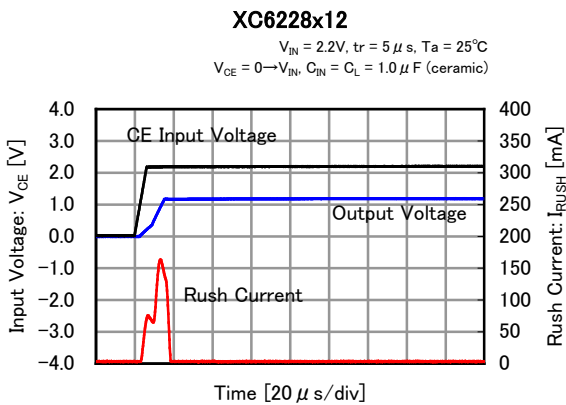


■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(11) CE Rising Response Time (Type H)



(12) Inrush Current Response Time (Type H)

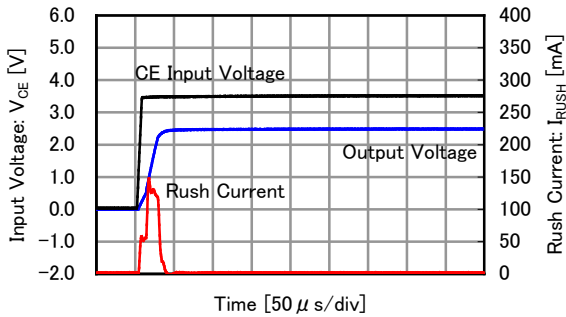


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (12) Inrush Current Response Time (Type H)(Continued)

#### XC6228x25

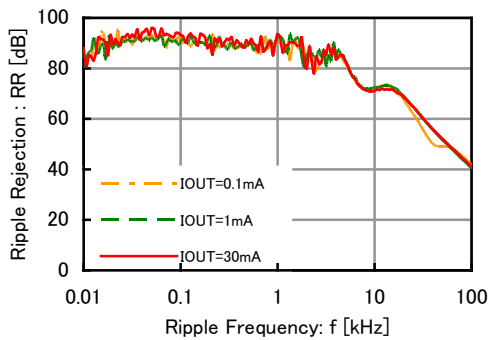
$V_{IN} = 3.5V$ ,  $t_r = 5 \mu s$ ,  $T_a = 25^\circ C$   
 $V_{CE} = 0 \rightarrow V_{IN}$ ,  $C_{IN} = C_L = 1.0 \mu F$  (ceramic)



### (13) Ripple Rejection Rate

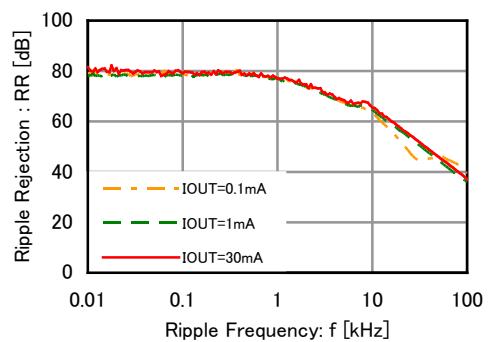
#### XC6228x12

$T_a = 25^\circ C$ ,  $V_{IN} = 3.0VDC + 0.5Vp-pAC$   
 $C_{IN} = 0.1 \mu F$  (ceramic),  $C_L = 1 \mu F$  (ceramic)



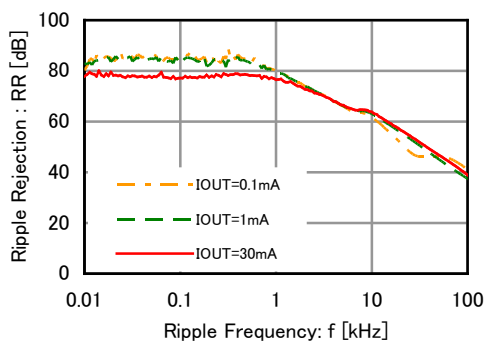
#### XC6228x18

$T_a = 25^\circ C$ ,  $V_{IN} = 3.0VDC + 0.5Vp-pAC$   
 $C_{IN} = 0.1 \mu F$  (ceramic),  $C_L = 1 \mu F$  (ceramic)



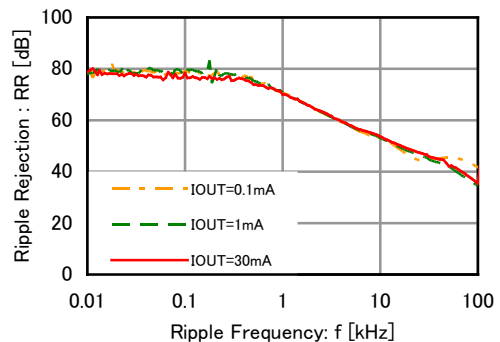
#### XC6228x25

$T_a = 25^\circ C$ ,  $V_{IN} = 3.5VDC + 0.5Vp-pAC$   
 $C_{IN} = 0.1 \mu F$  (ceramic),  $C_L = 1 \mu F$  (ceramic)



#### XC6228x33

$T_a = 25^\circ C$ ,  $V_{IN} = 4.3VDC + 0.5Vp-pAC$   
 $C_{IN} = 0.1 \mu F$  (ceramic),  $C_L = 1 \mu F$  (ceramic)



## ■ PACKAGING INFORMATION

For the latest package information go to, [www.torexsemi.com/technical-support/packages](http://www.torexsemi.com/technical-support/packages)

PACKAGE	OUTLINE / LAND PATTERN	THERMAL CHARACTERISTICS
SOT-25J	<a href="#">SOT-25J PKG</a>	<a href="#">SOT-25J Power Dissipation</a>
USPQ-4B04	<a href="#">USPQ-4B04 PKG</a>	<a href="#">USPQ-4B04 Power Dissipation</a>

## MARKING RULE

### ● USPQ-4B04

① represents product series.

MARK	PRODUCT SERIES
1	XC6228*****-G

② represents products series, type of regulator and output voltage.

MARK	OUTPUT VOLTAGE (V)	PRODUCT SERIES
A	1.2	XC6228D12***-G
B	1.5	XC6228D15***-G
C	1.8	XC6228D18***-G
D	2.5	XC6228D25***-G
E	2.8	XC6228D28***-G
F	3.0	XC6228D30***-G
H	3.1	XC6228D31***-G
K	3.3	XC6228D33***-G
L	1.2	XC6228H12***-G
M	1.5	XC6228H15***-G
N	1.8	XC6228H18***-G
P	2.5	XC6228H25***-G
R	2.8	XC6228H28***-G
S	3.0	XC6228H30***-G
T	3.1	XC6228H31***-G
U	3.3	XC6228H33***-G

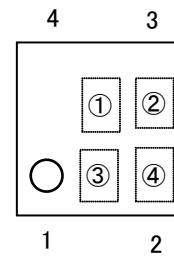
③④ represents production lot number.

01 to 09, 0A to 0Z, 11 to 9Z, A1 to A9, AA to AZ, B1 to ZZ in order.

(G, I, J, O, Q, W excepted)

\*No character inversion used.

### USPQ-4B04



## MARKING RULE (Continued)

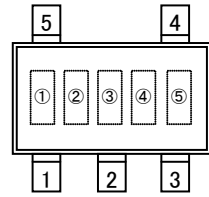
● SOT-25J

① represents product series.

MARK	PRODUCT SERIES
9	XC6228*****-G

② represents type of regulator and combination of output voltage.

MARK	PRODUCT SERIES
P	XC6228D*****-G
3	XC6228H*****-G



SOT-25J  
(TOP VIEW)

MARK	OUTPUT VOLTAGE (V)	PRODUCT SERIES
2	1.2	XC6228*12***-G
5	1.5	XC6228*15***-G
8	1.8	XC6228*18***-G
F	2.5	XC6228*25***-G
L	2.8	XC6228*28***-G
N	3.0	XC6228*30***-G
P	3.1	XC6228*31***-G
S	3.3	XC6228*33***-G

④⑤ represents production lot number.

01 to 09, 0A to 0Z, 11 to 9Z, A1 to A9, AA to AZ, B1 to ZZ in order.

(G, I, J, O, Q, W excepted)

\*No character inversion used.

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