## 200mA High Speed LDO Voltage Regulator with Inrush Current Prevention

## ■GENERAL DESCRIPTION

The XC6233 series is a 200mA high speed LDO regulator that features high accurate high ripple rejection and low dropout. The series consists of a voltage reference, an error amplifier, a driver transistor, a current limiter, a phase compensation circuit and an inrush current prevention circuit.

The output voltage is selectable in 0.05V increments (Accuracy ±1%) within the range of 1.2V to 3.6V.

The CE function enables the circuit to be in stand-by mode as well as the electric charge at the output capacitor $C_L$ to be discharged via the internal switch, and the $V_{OUT}$ pin quickly returns to the Low level.

The series is also compatible with low ESR ceramic capacitors, which provides stable output voltage.  This stability can be maintained even during load fluctuations due to the excellent transient response.

The over current prevention circuit will operate when the output current reaches the current limit.
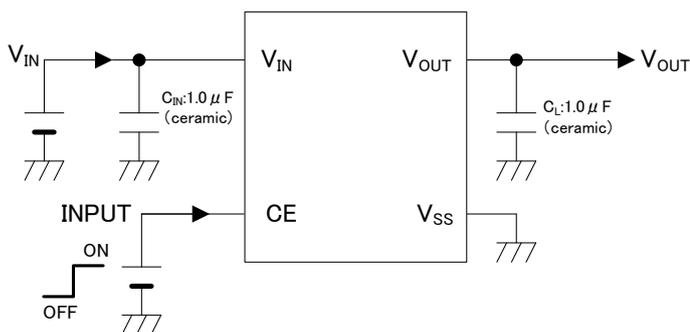
## ■APPLICATIONS

● Mobile devices / terminals

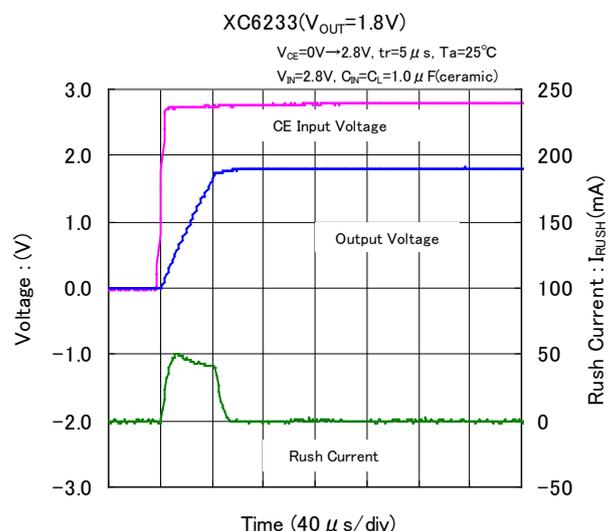● Modules (wireless, cameras, etc.)

● Smart phones / Mobile phones

## ■FEATURES

| | | |
|---|---|---|
| Maximum Output Current | : | 200mA |
| Input Voltage Range | : | 1.7V ~ 5.5V |
| Output Voltage Range | : | 1.2V~3.6V (±1%) 0.05V increments |
| Dropout Voltage | : | 240mV @$I_{OUT}$=200mA ($V_{OUT}$=3.0V) |
| Low Power Consumption | : | 45$\mu$A |
| Stand-by Current | : | 0.01$\mu$A |
| High Ripple Rejection | : | 75dB@1kHz |
| CE Pin Function | : | Active High |
| | | $C_L$ Auto Discharge |
| Protection Circuit | : | Current Limit 255mA |
| | | Short Circuit Protection 60mA |
| External Capacitor | : | Ceramic Capacitor Compatible 1.0$\mu$F |
| Operating Ambient Temperature | : | -40℃ ~ 85℃ |
| Packages | : | USP-4 |
| | | SSOT-24 |
| | | SOT-25 |
| | | USPQ-4B04 |
| Environmentally Friendly | : | EU RoHS Compliant, Pb Free |

## ■TYPICAL APPLICATION CIRCUIT



## ■TYPICAL PERFORMANCE CHARACTERISTICS

XC6233($V_{OUT}$=1.8V)

$V_{CE}$=0V→2.8V, tr=5$\mu$s, Ta=25℃
$V_{IN}$=2.8V, $C_{IN}$=$C_L$=1.0$\mu$F(ceramic)

## ■BLOCK DIAGRAM

XC6233 Series, Type H



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

# ■PRODUCT CLASSIFICATION

●Ordering Information

XC6233①②③④⑤⑥-⑦

| DESIGNATOR | ITEM | SYMBOL | DESCRIPTION |
|---|---|---|---|
| ① | Type of Regulator CE Active High | H | Refer to Function Guide |
| ②③ | Output Voltage | 12~36 | ex.) 2.80V → ②=2, ③=8 ④=please see down below |
| ④ | Output Voltage Accuracy | 1 | 0.10V increments, ±1% ($V_{OUT}$≧2.00V), ±0.02V ($V_{OUT}$＜2.00V) e.g. 2.80V → ④=1 |
| | | B | 0.05V increments, ±1% ($V_{OUT}$≧2.05V), ±0.02V ($V_{OUT}$＜2.05V) e.g. 2.85V → ④=B |
| ⑤⑥-⑦ [*1] | Packages (Order Unit) | 9R-G | USPQ-4B04 (3,000pcs/Reel） |
| | | GR-G | USP-4 (3,000pcs/Reel) |
| | | NR-G | SSOT-24 (3,000pcs/Reel) |
| | | MR-G | SOT-25 (3,000pcs/Reel) |

[*1] The "-G" suffix denotes Halogen and Antimony free as well as being fully EU RoHS compliant.

For another type of regulators, please contact your local Torex sales office or representative.

●Function Guide

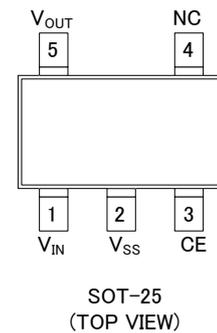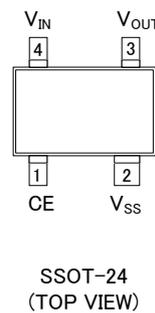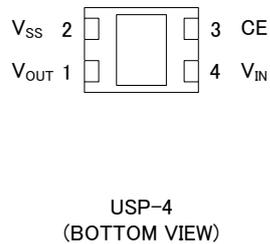| TYPE | CURRENT LIMITTER | CE PULL-DOWN RESISTOR | $C_L$ AUTO-DISCHARGE | INRUSH CURRENT PREVENTION |
|---|---|---|---|---|
| H | Yes | Yes | Yes | Yes |

# ■STANDARD VOLTAGE

●Examples for standard voltage

| $V_{OUT}$ (V) | PACKAGES | | | |
|---|---|---|---|---|
| | USPQ-4B04 | USP-4 | SSOT-24 | SOT-25 |
| 1.20 | XC6233H1219R-G | XC6233H121GR-G | XC6233H121NR-G | XC6233H121MR-G |
| 1.50 | XC6233H1519R-G | XC6233H151GR-G | XC6233H151NR-G | XC6233H151MR-G |
| 1.80 | XC6233H1819R-G | XC6233H181GR-G | XC6233H181NR-G | XC6233H181MR-G |
| 2.80 | XC6233H2819R-G | XC6233H281GR-G | XC6233H281NR-G | XC6233H281MR-G |
| 3.30 | XC6233H3319R-G | XC6233H331GR-G | XC6233H331NR-G | XC6233H331MR-G |

Output voltages can be set internally from 1.2V to 3.6V.   For other voltages, please contact your local Torex sales office or representative.

## ■PIN CONFIGURATION



|  |  |  |  |
|---|---|---|---|
| USPQ-4B04 (BOTTOM VIEW) | USP-4 (BOTTOM VIEW) | SSOT-24 (TOP VIEW) | SOT-25 (TOP VIEW) |
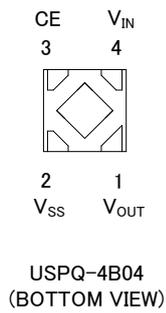
\* The dissipation pad for the USP-4 and USPQ-4B04 packages should be solder-plated in reference mount pattern and metal masking so as to enhance mounting strength and heat release. If the pad needs to be connected to other pins, it should be connected to the $V_{SS}$ (No. 2) pin.

## ■PIN ASSIGNMENT

| PIN NUMBER | | | | PIN NAME | FUNCTIONS |
|---|---|---|---|---|---|
| USPQ-4B04 | USP-4 | SSOT-24 | SOT-25 | | |
| 1 | 1 | 3 | 5 | $V_{OUT}$ | Output |
| 2 | 2 | 2 | 2 | $V_{SS}$ | Ground |
| 3 | 3 | 1 | 3 | CE | ON/OFF Control |
| 4 | 4 | 4 | 1 | $V_{IN}$ | Power Supply Input |
| - | - | - | 4 | NC | No Connection |

## ■PIN FUNCTION ASSIGNMENT

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

\* For type H, CE pin voltage is fixed as L level because of internal pull-down resister.

# ■ABSOLUTE MAXIMUM RATINGS

Ta=25℃

| PARAMETER | | SYMBOL | RATINGS | UNITS |
|---|---|---|---|---|
| Input Voltage | | $V_{IN}$ | -0.3 ~ 6.0 | V |
| Output Current | | $I_{OUT}$ | 275 [*1] | mA |
| Output Voltage | | $V_{OUT}$ | -0.3 ~ $V_{IN}$+0.3 or 6.0 [*2] | V |
| CE Input Voltage | | $V_{CE}$ | -0.3 ~ 6.0 | V |
| Power Dissipation | USPQ-4B04 | Pd | 550 ( PCB mounted) [*3] | mW |
| | USP-4 | | 1000 ( PCB mounted) [*3] | |
| | SSOT-24 | | 500 ( PCB mounted) [*3] | |
| | SOT-25 | | 600 ( PCB mounted) [*3] | |
| Operating Ambient Temperature | | Topr | -40 ~ 85 | ℃ |
| Storage Temperature | | Tstg | -55 ~ 125 | ℃ |

# ■ELECTRICAL CHARACTERISTICS

XC6233 Series  Ta=25℃

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNITS | CIRCUIT |
|---|---|---|---|---|---|---|---|
| Output Voltage | $V_{OUT(E)}$ [*1] | $V_{OUT(T)} \geqq 2.0V$ | $V_{OUT(T)} \times 0.99$ [*2] | $V_{OUT(T)}$ [*2] | $V_{OUT(T)} \times 1.01$ [*2] | V | ① |
| | | | "E-0" [*3] | | | | |
| | | $V_{OUT(T)} < 2.0V$ | $V_{OUT(T)} - 0.02$ [*2] | $V_{OUT(T)}$ [*2] | $V_{OUT(T)} + 0.02$ [*2] | | |
| | | | "E-0" [*3] | | | | |
| Maximum Output Current | $I_{OUTMAX}$ | - | 200 | - | - | mA | ① |
| Load Regulation | $\Delta V_{OUT}$ | $0.1mA \leqq I_{OUT} \leqq 200mA$ | - | 25 | 45 | mV | ① |
| Dropout Voltage | Vdif [*4] | $I_{OUT}=200mA$ | - | "E-1" [*5] | | mV | ① |
| Supply Current | $I_{DD}$ | $I_{OUT}=0mA$ | - | 45 | 87 | μA | ② |
| Stand-by Current | $I_{STB}$ | $V_{CE}=V_{SS}$ | - | 0.01 | 0.10 | μA | ② |
| Line Regulation | $\Delta V_{OUT}/ (\Delta V_{IN} \cdot V_{OUT})$ | $V_{OUT(T)} < 2.0V, I_{OUT}=30mA$ $2.5V \leqq V_{IN} \leqq 5.5V$ | - | 0.02 | 0.10 | %/V | ① |
| | | $V_{OUT(T)} \geqq 2.0V, I_{OUT}=30mA$ $V_{OUT(T)}+0.5V \leqq V_{IN} \leqq 5.5V$ | | | | | |
| Input Voltage | $V_{IN}$ | - | 1.7 | - | 5.5 | V | ① |
| Output Voltage Temperature Characteristics | $\Delta V_{OUT}/ (\Delta Topr \cdot V_{OUT})$ | $I_{OUT}=10mA$ $-40℃ \leqq Topr \leqq 85℃$ | - | ±80 | - | ppm/℃ | ① |
| Power Supply Rejection Ratio | PSRR | $V_{OUT(T)} < 2.5V$ $V_{IN}=3.0V_{DC}+0.5Vp\text{-}p_{AC}$ $V_{CE}=V_{OUT(T)}+1.0V$ $I_{OUT}=30mA, f=1kHz$ | - | 75 | - | dB | ③ |
| | | $V_{OUT(T)} \geqq 2.5V$ $V_{IN}=\{V_{OUT(T)}+1.0V\}+0.5Vp\text{-}p_{AC}$ $V_{CE}=V_{OUT(T)}+1.0V$ $I_{OUT}=30mA, f=1kHz$ | | | | | |
| Current Limit | $I_{LIM}$ | - | 200 | 255 | - | mA | ① |
| Short Current | $I_{SHORT}$ | $V_{OUT}=V_{SS}$ | - | 60 | - | mA | ① |
| CE "H" Level Voltage | $V_{CEH}$ | - | 0.9 | - | 5.5 | V | ① |
| CE "L" Level Voltage | $V_{CEL}$ | - | $V_{SS}$ | - | 0.3 | V | ① |
| CE "H" Level Current (Type H) | $I_{CEH}$ | $V_{CE}=V_{IN}=5.5V$ | 2.5 | 6.0 | 9.5 | μA | ① |
| CE "L" Level Current | $I_{CEL}$ | $V_{CE}=V_{SS}$ | -0.1 | - | 0.1 | μA | ① |
| $C_L$ Auto-Discharge Resistance | $R_{DCHG}$ | $V_{IN}=5.5V, V_{CE}=V_{SS}, V_{OUT}=2.0V$ | - | 270 | - | Ω | ① |
| Inrush Current | $I_{RUSH}$ | $V_{IN}=5.5V, V_{CE}=0 \rightarrow 5.5V$ | - | 95 | - | mA | ④ |

NOTE:

Unless otherwise stated, $V_{IN}=V_{OUT(T)}+1V$, $V_{CE}=V_{IN}$, $I_{OUT}=1mA$

[*1] $V_{OUT(E)}$ is Effective output voltage

[*2] $V_{OUT(T)}$ is Nominal output voltage

[*3] E-0: OUTPUT VOLTAGE (Refer to the Voltage Chart)

[*4] $Vdif=\{V_{IN1} - V_{OUT1}\}$

  $V_{IN1}$ is the input voltage when $V_{OUT1}$ appears at the $V_{OUT}$ pin while input voltage is gradually decreased.

  $V_{OUT1}$ is the voltage equal to 98% of the normal output voltage when amply stabilized $V_{OUT(T)}$ +1.0V is input at the $V_{IN}$ pin.

[*5] E-1: DROPOUT VOLTAGE (Refer to the Voltage Chart)
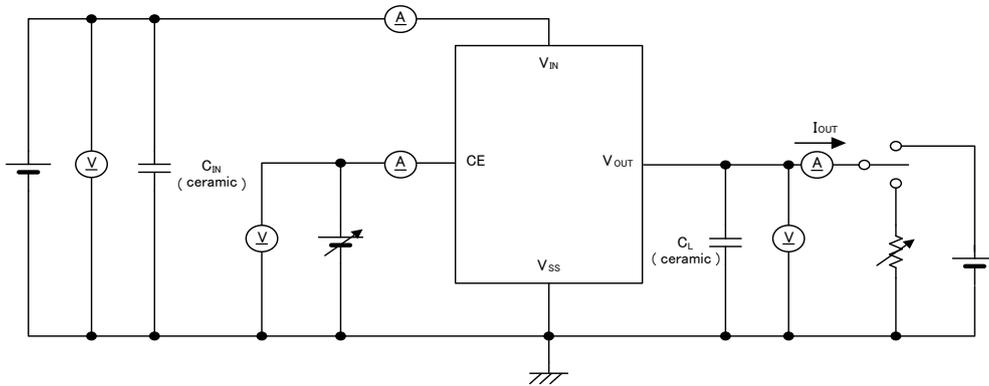
# ■ELECTRICAL CHARACTERISTICS (Continued)

Voltage Chart

| NOMINAL OUTPUT VOLTAGE | E-0 OUTPUT VOLTAGE (V) | | E-1 DROPOUT VOLTAGE (mV) | | NOMINAL OUTPUT VOLTAGE | E-0 OUTPUT VOLTAGE (V) | | E-1 DROPOUT VOLTAGE (mV) | |
|---|---|---|---|---|---|---|---|---|---|
| | $V_{OUT(E)}$ | | Vdif | | | $V_{OUT(E)}$ | | Vdif | |
| $V_{OUT(T)}$ | MIN. | MAX. | TYP. | MAX. | $V_{OUT(T)}$ | MIN. | MAX. | TYP. | MAX. |
| 1.20 | 1.1800 | 1.2200 | 680 | 950 | 2.50 | 2.4750 | 2.5250 | | |
| 1.25 | 1.2300 | 1.2700 | | | 2.55 | 2.5245 | 2.5755 | | |
| 1.30 | 1.2800 | 1.3200 | 640 | 800 | 2.60 | 2.5740 | 2.6260 | | |
| 1.35 | 1.3300 | 1.3700 | | | 2.65 | 2.6235 | 2.6765 | | |
| 1.40 | 1.3800 | 1.4200 | 600 | 695 | 2.70 | 2.6730 | 2.7270 | 310 | 420 |
| 1.45 | 1.4300 | 1.4700 | | | 2.75 | 2.7225 | 2.7775 | | |
| 1.50 | 1.4800 | 1.5200 | | | 2.80 | 2.7720 | 2.8280 | | |
| 1.55 | 1.5300 | 1.5700 | | | 2.85 | 2.8215 | 2.8785 | | |
| 1.60 | 1.5800 | 1.6200 | 510 | 630 | 2.90 | 2.8710 | 2.9290 | | |
| 1.65 | 1.6300 | 1.6700 | | | 2.95 | 2.9205 | 2.9795 | | |
| 1.70 | 1.6800 | 1.7200 | | | 3.00 | 2.9700 | 3.0300 | | |
| 1.75 | 1.7300 | 1.7700 | | | 3.05 | 3.0195 | 3.0805 | | |
| 1.80 | 1.7800 | 1.8200 | 400 | 600 | 3.10 | 3.0690 | 3.1310 | | |
| 1.85 | 1.8300 | 1.8700 | | | 3.15 | 3.1185 | 3.1815 | | |
| 1.90 | 1.8800 | 1.9200 | | | 3.20 | 3.1680 | 3.2320 | | |
| 1.95 | 1.9300 | 1.9700 | | | 3.25 | 3.2175 | 3.2825 | | |
| 2.00 | 1.9800 | 2.0200 | 375 | 520 | 3.30 | 3.2670 | 3.3330 | 240 | 380 |
| 2.05 | 2.0295 | 2.0705 | | | 3.35 | 3.3165 | 3.3835 | | |
| 2.10 | 2.0790 | 2.1210 | | | 3.40 | 3.3660 | 3.4340 | | |
| 2.15 | 2.1285 | 2.1715 | | | 3.45 | 3.4155 | 3.4845 | | |
| 2.20 | 2.1780 | 2.2220 | | | 3.50 | 3.4650 | 3.5350 | | |
| 2.25 | 2.2275 | 2.2725 | | | 3.55 | 3.5145 | 3.5855 | | |
| 2.30 | 2.2770 | 2.3230 | | | 3.60 | 3.5640 | 3.6360 | | |
| 2.35 | 2.3265 | 2.3735 | | | | | | | |
| 2.40 | 2.3760 | 2.4240 | | | | | | | |
| 2.45 | 2.4255 | 2.4745 | | | | | | | |

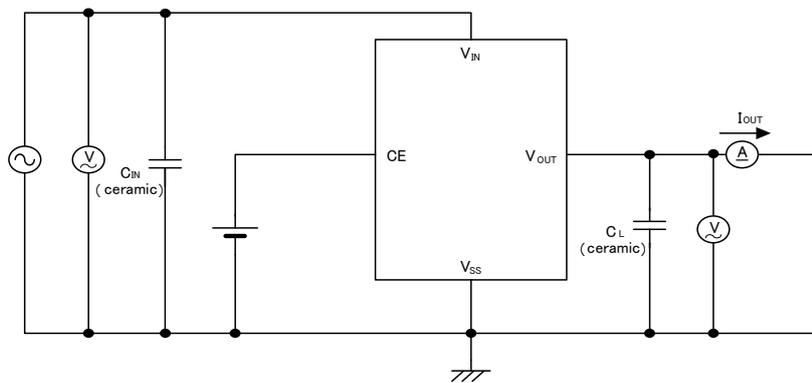## ■TEST CIRCUITS
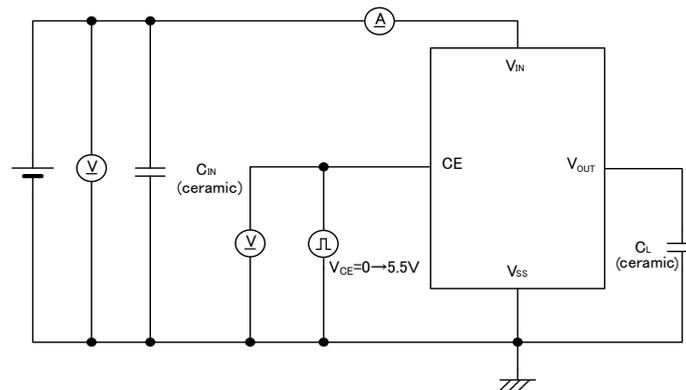
$C_{IN}=1.0\,\mu F$, $C_L=1.0\,\mu F$

Circuit ①



Circuit ②
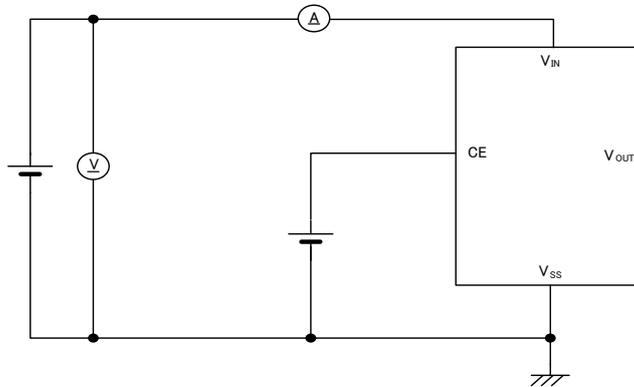


Circuit ③



Circuit ④

# ■OPERATIONAL EXPLANATION

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 control 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 voltage and output current.

XC6233 Series, Type H
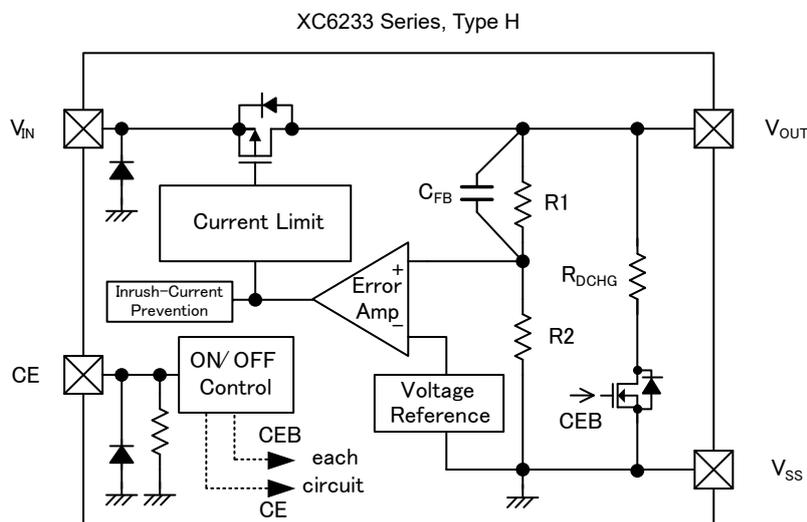


< Low ESR Capacitor>

The XC6233 series needs an output capacitor ($C_L$) for phase compensation. In order to ensure the stable phase compensation, please place an output capacitor of 1.0 $\mu$F at the $V_{OUT}$ pin and $V_{SS}$ pin as close as possible. For a stable power input, please connect an input capacitor ($C_{IN}$) of 1.0 $\mu$F between the input pin ($V_{IN}$) and the ground pin ($V_{SS}$).

<Current Limiter, Short-Circuit Protection >

The XC6233 series 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 with keeping the load current. After that, the output voltage drops to a certain level, the fold-back circuit operates and the output current goes to decrease with a degree of output voltage decreasing. The output current finally reaches at the level of 60mA (TYP.) when the output pin is short-circuited.

<CE Pin>

The IC's internal circuitry can be shutdown via the signal of the CE pin.

The XC6233H series has a pull-down resistor at the CE pin inside. Even the CE pin is left open, the CE pin is fixed as Low level. However, inflow current is generated into the CE pin.

# ■OPERATIONAL EXPLANATION (Continued)

<$C_L$ High-speed Discharge Function>

The N-ch transistor located between the $V_{OUT}$ pin and the $V_{SS}$ pin and the $C_L$ discharge resistance is set to 270Ω (TYP.) when $V_{IN}$ is 5.5V (TYP.) and $V_{OUT}$ is 2.0V (TYP.).

This N-ch transistor can quickly discharge the electric charge at the output capacitor ($C_L$), when a low signal is inputted to the CE pin. Moreover, discharge time of the output capacitor ($C_L$) is set by the $C_L$ auto-discharge resistance ($R_{DCHG}$) and the output capacitance ($C_L$).

By setting time constant of a $C_L$ auto-discharge resistance ($R_{DCHG}$) and an output capacitance ($C_L$) as $\tau$ ($\tau = C_L$ x $R_{DCHG}$), the output voltage after discharge via the N-ch transistor is calculated by the following formula.

$$V = V_{OUT(E)} \times e^{-t/\tau}$$

V: Output voltage after discharge
$V_{OUT(E)}$: Output voltage
t: Discharge time
$\tau$ : $R_{DCHG} \times C_L$
$C_L$: Output capacitance
$R_{DCHG}$: $C_L$ auto-discharge resistance

or discharge time is calculated by the next formula.

$$t = \tau \ln (V_{OUT(E)} / V)$$

< Inrush Current Prevention >

The inrush current prevention circuit is built in the XC6233 series.
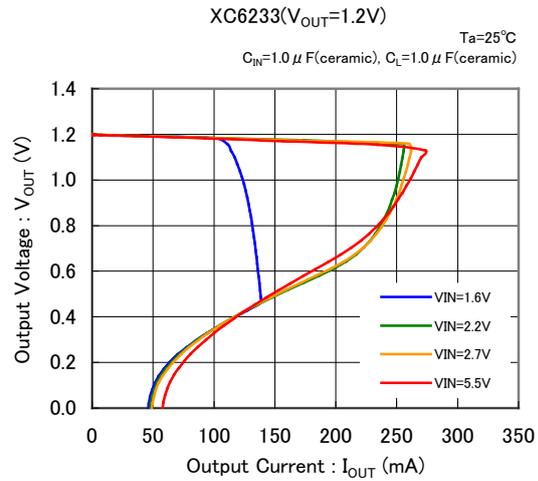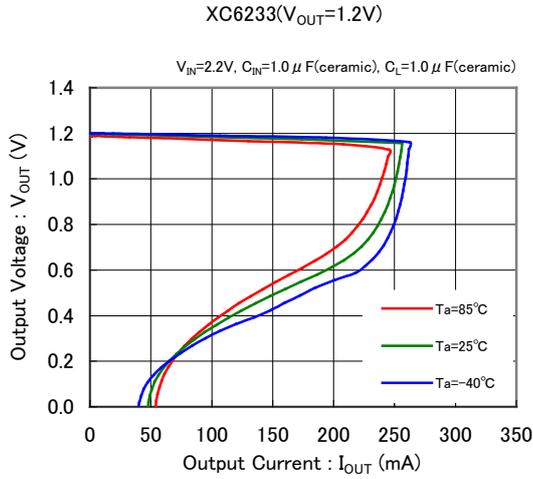
When the IC starts to operate, the prevention circuit limits the inrush current as 95mA (TYP.) from input pin ($V_{IN}$) to output pin ($V_{OUT}$) for charging $C_L$ capacitor. However, the device can not provide the output current beyond 95mA (TYP.) for a period of approximately 100$\mu$s because internal control of the IC.

# ■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 noise and/or phase lag depending on output current. Please strengthen $V_{IN}$ and $V_{SS}$ wiring in particular.

3. Please wire the input capacitor ($C_{IN}$) and the output capacitor ($C_L$) as close to the IC as possible.

4. Torex places an importance on improving our products and their reliability.
   We request that users incorporate fail-safe designs and post-aging prevention treatment when using Torex products in their systems.

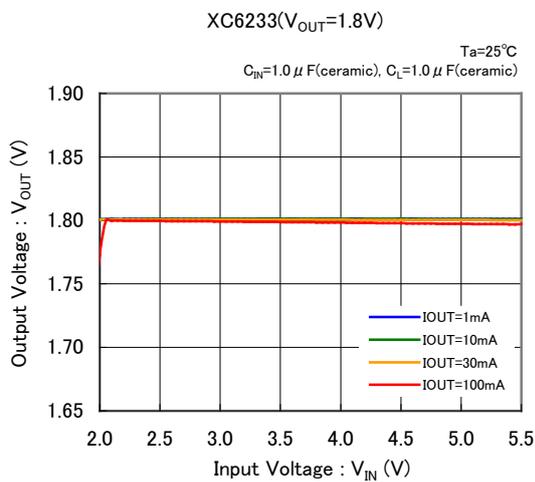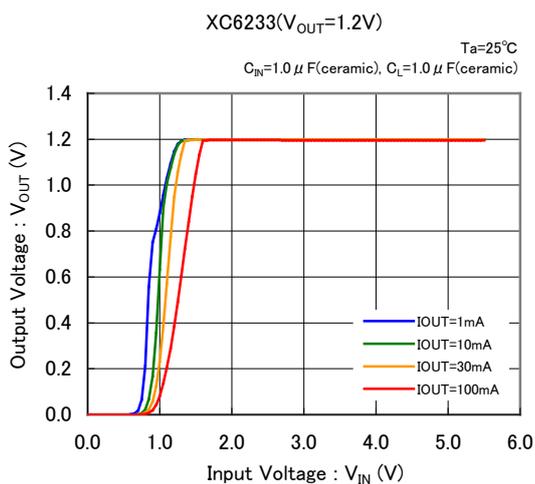## ■TYPICAL PERFORMANCE CHARACTERISTICS

(1) Output Voltage vs. Output Current

XC6233($V_{OUT}$=1.2V)

$V_{IN}$=2.2V, $C_{IN}$=1.0 $\mu$ F(ceramic), $C_L$=1.0 $\mu$ F(ceramic)

Ta=85℃
Ta=25℃
Ta=−40℃

XC6233($V_{OUT}$=1.2V)

Ta=25℃
$C_{IN}$=1.0 $\mu$ F(ceramic), $C_L$=1.0 $\mu$ F(ceramic)

VIN=1.6V
VIN=2.2V
VIN=2.7V
VIN=5.5V

XC6233($V_{OUT}$=1.8V)

$V_{IN}$=2.8V, $C_{IN}$=1.0 $\mu$ F(ceramic), $C_L$=1.0 $\mu$ F(ceramic)

Ta=85℃
Ta=25℃
Ta=−40℃

XC6233($V_{OUT}$=1.8V)

Ta=25℃
$C_{IN}$=1.0 $\mu$ F(ceramic), $C_L$=1.0 $\mu$ F(ceramic)

VIN=1.9V
VIN=2.3V
VIN=2.8V
VIN=3.3V
VIN=5.5V

XC6233($V_{OUT}$=2.5V)

$V_{IN}$=3.5V, $C_{IN}$=1.0 $\mu$ F(ceramic), $C_L$=1.0 $\mu$ F(ceramic)

Ta=85℃
Ta=25℃
Ta=−40℃

XC6233($V_{OUT}$=2.5V)

Ta=25℃
$C_{IN}$=1.0 $\mu$ F(ceramic), $C_L$=1.0 $\mu$ F(ceramic)

VIN=2.6V
VIN=3V
VIN=3.5V
VIN=4V
VIN=5.5V

# ■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

## (1) Output Voltage vs. Output Current (Continued)

XC6233($V_{OUT}$=3.3V)

$V_{IN}$=4.3V, $C_{IN}$=1.0μF(ceramic), $C_L$=1.0μF(ceramic)
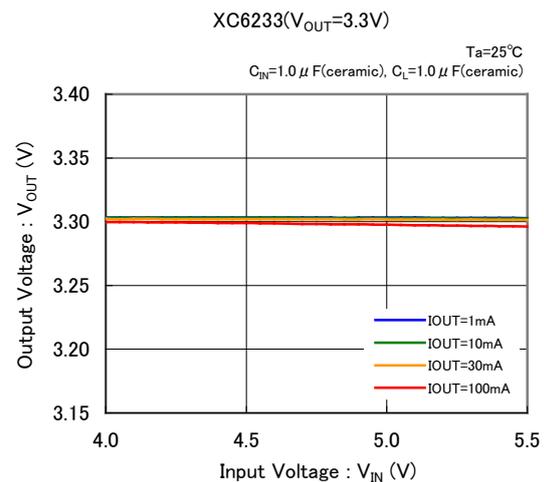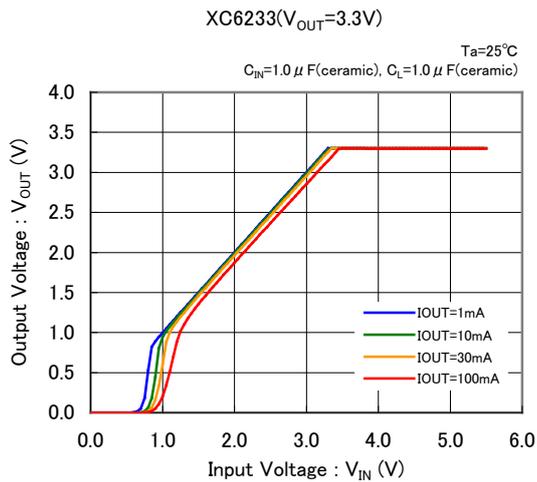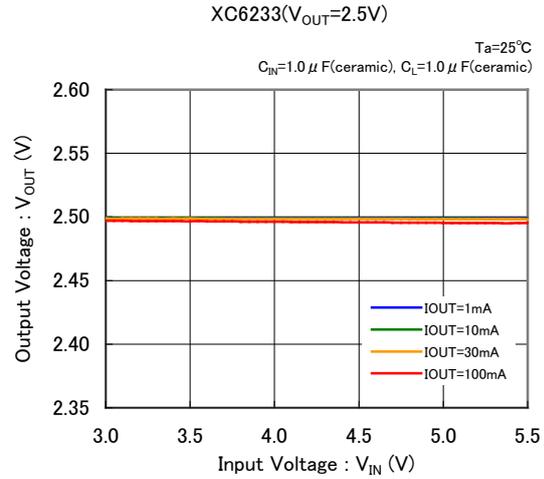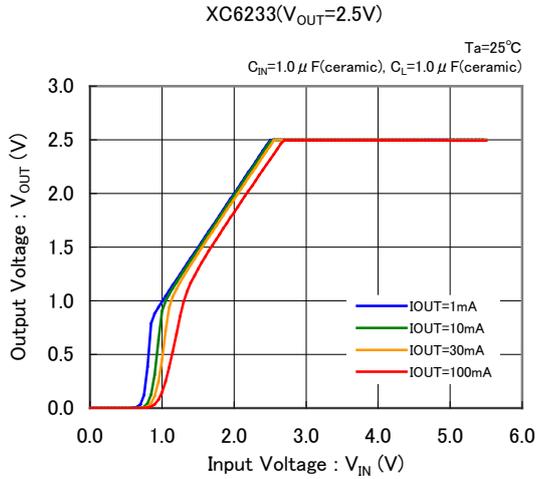


XC6233($V_{OUT}$=3.3V)

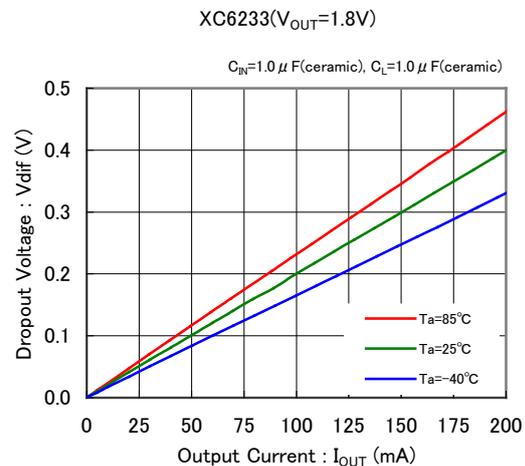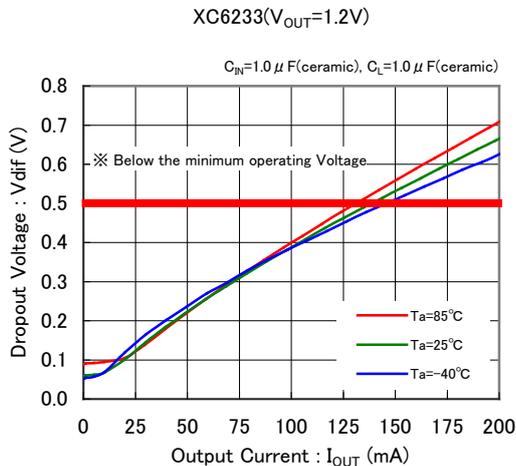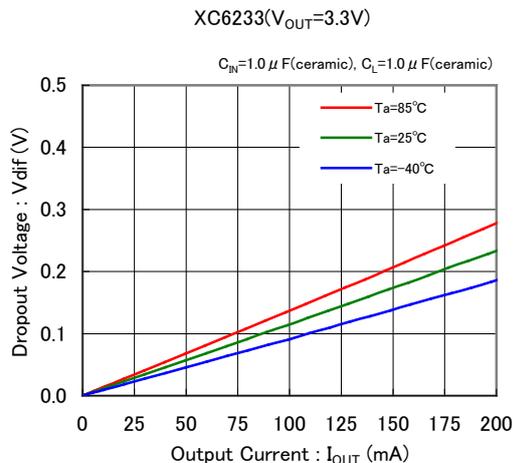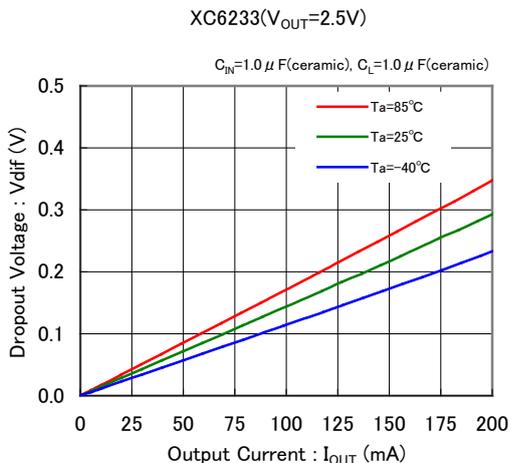Ta=25℃

$C_{IN}$=1.0μF(ceramic), $C_L$=1.0μF(ceramic)



## (2) Output Voltage vs. Input Voltage

XC6233($V_{OUT}$=1.2V)

Ta=25℃

$C_{IN}$=1.0μF(ceramic), $C_L$=1.0μF(ceramic)



XC6233($V_{OUT}$=1.2V)

Ta=25℃

$C_{IN}$=1.0μF(ceramic), $C_L$=1.0μF(ceramic)



XC6233($V_{OUT}$=1.8V)

Ta=25℃

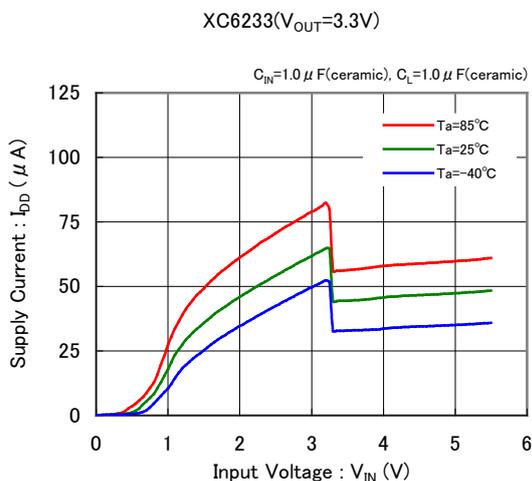$C_{IN}$=1.0μF(ceramic), $C_L$=1.0μF(ceramic)



XC6233($V_{OUT}$=1.8V)

Ta=25℃

$C_{IN}$=1.0μF(ceramic), $C_L$=1.0μF(ceramic)
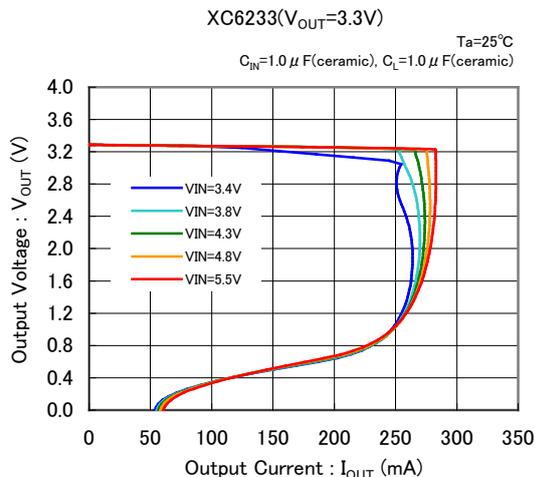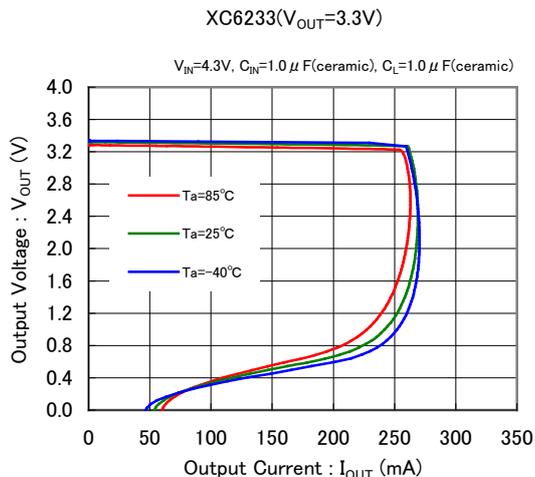
## ■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2)  Output Voltage vs. Input Voltage (Continued)

XC6233($V_{OUT}$=2.5V)

Ta=25℃
$C_{IN}$=1.0μF(ceramic), $C_L$=1.0μF(ceramic)



- IOUT=1mA
- IOUT=10mA
- IOUT=30mA
- IOUT=100mA

XC6233($V_{OUT}$=2.5V)

Ta=25℃
$C_{IN}$=1.0μF(ceramic), $C_L$=1.0μF(ceramic)



- IOUT=1mA
- IOUT=10mA
- IOUT=30mA
- IOUT=100mA

XC6233($V_{OUT}$=3.3V)

Ta=25℃
$C_{IN}$=1.0μF(ceramic), $C_L$=1.0μF(ceramic)



- IOUT=1mA
- IOUT=10mA
- IOUT=30mA
- IOUT=100mA

XC6233($V_{OUT}$=3.3V)

Ta=25℃
$C_{IN}$=1.0μF(ceramic), $C_L$=1.0μF(ceramic)



- IOUT=1mA
- IOUT=10mA
- IOUT=30mA
- IOUT=100mA

(3)  Dropout Voltage vs. Output Current

XC6233($V_{OUT}$=1.2V)

$C_{IN}$=1.0μF(ceramic), $C_L$=1.0μF(ceramic)



※ Below the minimum operating Voltage

- Ta=85℃
- Ta=25℃
- Ta=−40℃

XC6233($V_{OUT}$=1.8V)

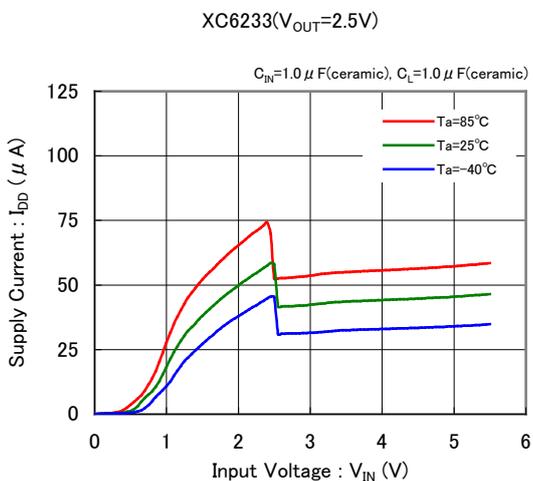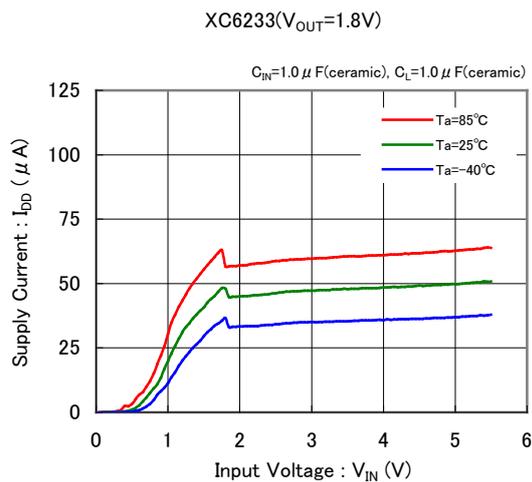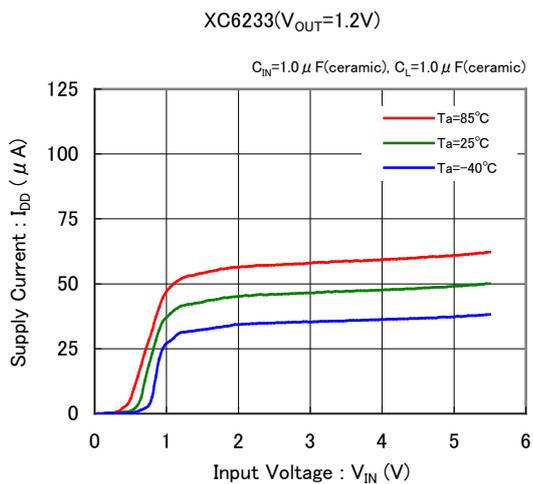$C_{IN}$=1.0μF(ceramic), $C_L$=1.0μF(ceramic)



- Ta=85℃
- Ta=25℃
- Ta=−40℃

# ■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)
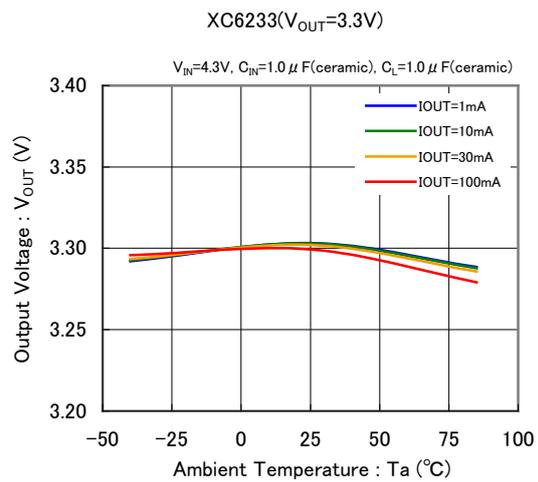
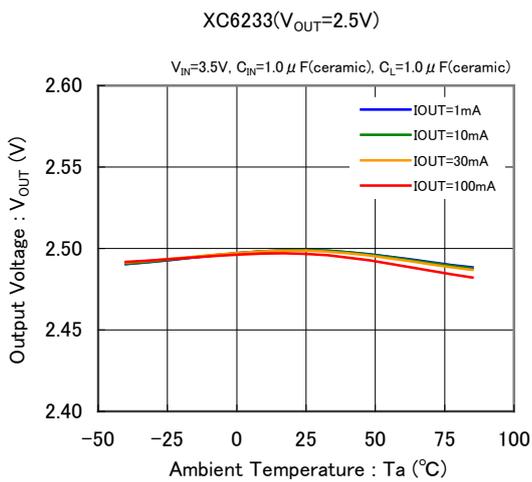## (3) Dropout Voltage vs. Output Current (Continued)

XC6233($V_{OUT}$=2.5V)



XC6233($V_{OUT}$=3.3V)
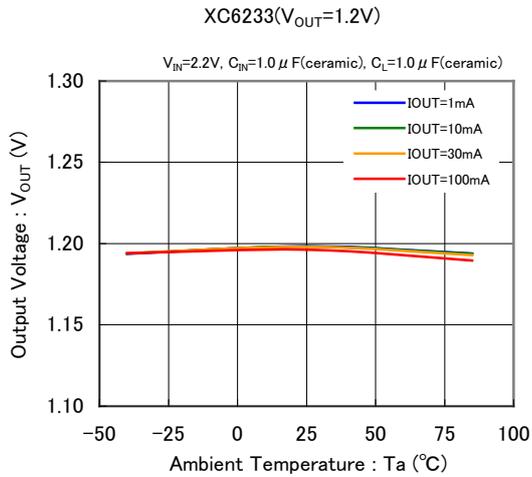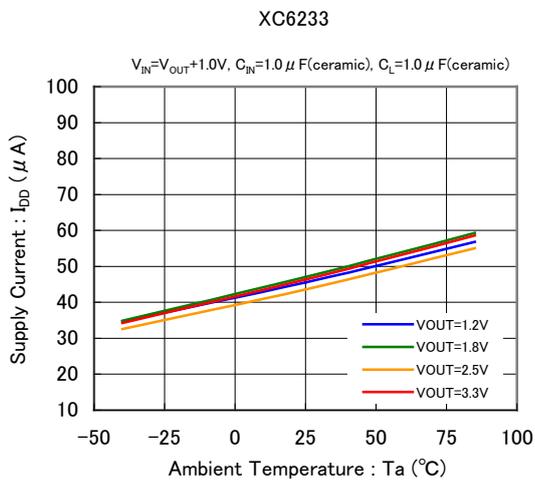


## (4) Supply Current vs. Input Voltage

XC6233($V_{OUT}$=1.2V)



XC6233($V_{OUT}$=1.8V)



XC6233($V_{OUT}$=2.5V)



XC6233($V_{OUT}$=3.3V)

## ■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(5)  Output Voltage vs. Ambient Temperature

XC6233($V_{OUT}$=1.2V)

$V_{IN}$=2.2V, $C_{IN}$=1.0 $\mu$ F(ceramic), $C_L$=1.0 $\mu$ F(ceramic)



XC6233($V_{OUT}$=1.8V)

$V_{IN}$=2.8V, $C_{IN}$=1.0 $\mu$ F(ceramic), $C_L$=1.0 $\mu$ F(ceramic)



XC6233($V_{OUT}$=2.5V)

$V_{IN}$=3.5V, $C_{IN}$=1.0 $\mu$ F(ceramic), $C_L$=1.0 $\mu$ F(ceramic)



XC6233($V_{OUT}$=3.3V)

$V_{IN}$=4.3V, $C_{IN}$=1.0 $\mu$ F(ceramic), $C_L$=1.0 $\mu$ F(ceramic)
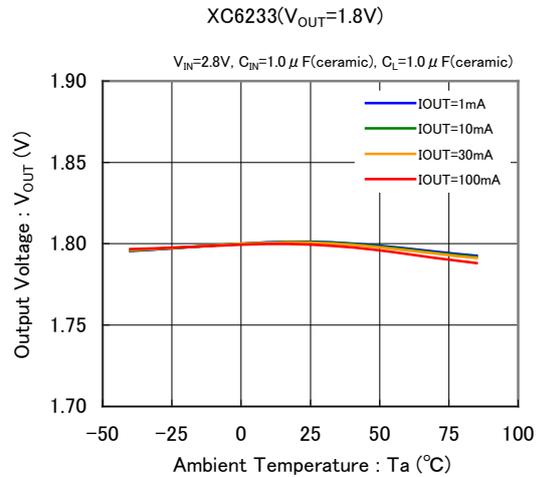


(6)  Supply Current vs. Ambient Temperature
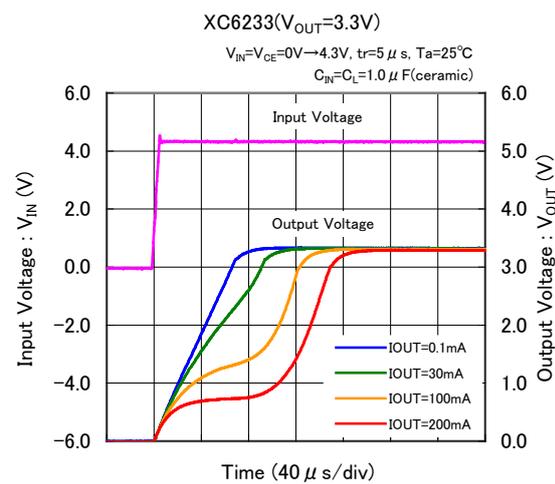
XC6233
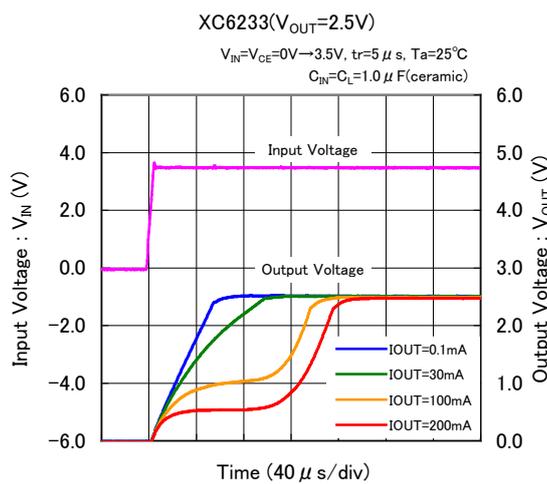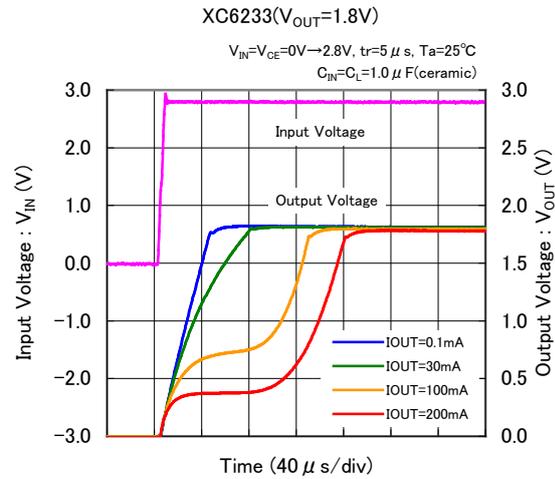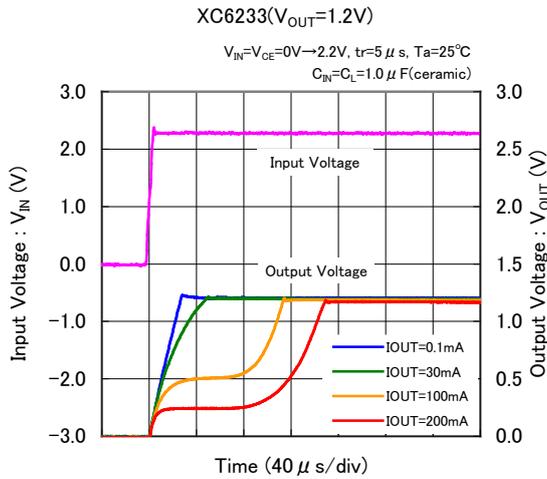
$V_{IN}$=$V_{OUT}$+1.0V, $C_{IN}$=1.0 $\mu$ F(ceramic), $C_L$=1.0 $\mu$ F(ceramic)



(7)  CE Threshold Voltage vs. Ambient Temperature

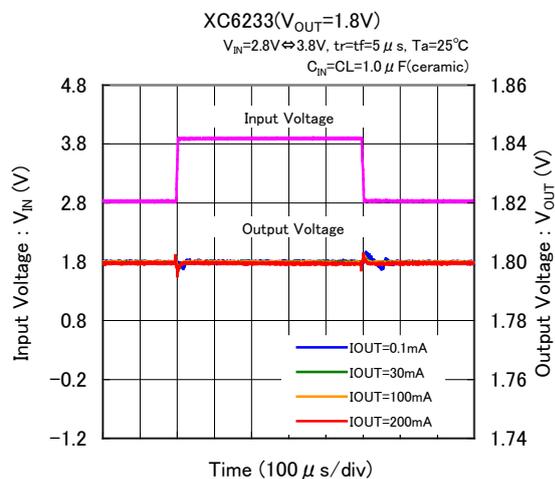XC6233

$C_{IN}$=1.0 $\mu$ F(ceramic), $C_L$=1.0 $\mu$ F(ceramic)
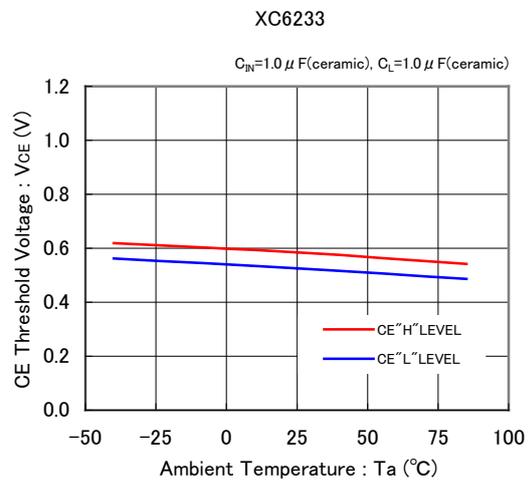
# ■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(8) Rising Response Time

XC6233($V_{OUT}$=1.2V)

$V_{IN}$=$V_{CE}$=0V→2.2V, tr=5$\mu$s, Ta=25℃
$C_{IN}$=$C_L$=1.0$\mu$F(ceramic)



XC6233($V_{OUT}$=1.8V)

$V_{IN}$=$V_{CE}$=0V→2.8V, tr=5$\mu$s, Ta=25℃
$C_{IN}$=$C_L$=1.0$\mu$F(ceramic)



XC6233($V_{OUT}$=2.5V)

$V_{IN}$=$V_{CE}$=0V→3.5V, tr=5$\mu$s, Ta=25℃
$C_{IN}$=$C_L$=1.0$\mu$F(ceramic)



XC6233($V_{OUT}$=3.3V)

$V_{IN}$=$V_{CE}$=0V→4.3V, tr=5$\mu$s, Ta=25℃
$C_{IN}$=$C_L$=1.0$\mu$F(ceramic)



(9) Input Transient Response

XC6233($V_{OUT}$=1.2V)

$V_{IN}$=2.2V⇔3.2V, tr=tf=5$\mu$s, Ta=25℃
$C_{IN}$=CL=1.0$\mu$F(ceramic)



XC6233($V_{OUT}$=1.8V)

$V_{IN}$=2.8V⇔3.8V, tr=tf=5$\mu$s, Ta=25℃
$C_{IN}$=CL=1.0$\mu$F(ceramic)

## ■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)
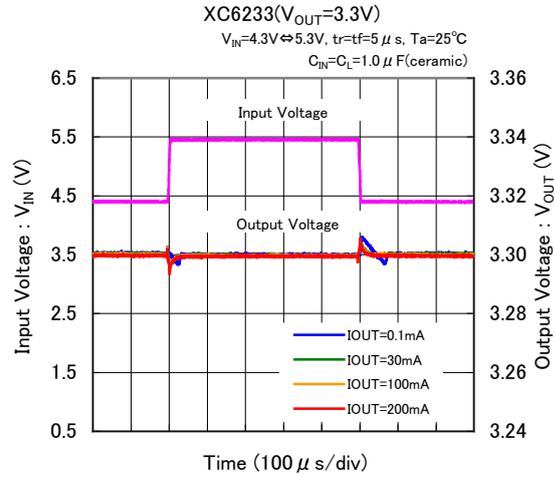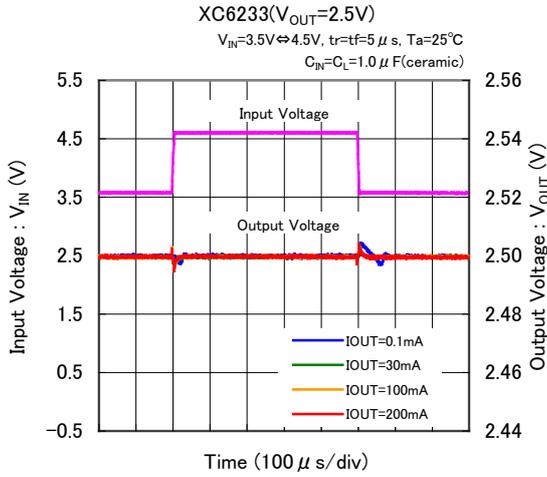
### (9)  Input Transient Response (Continued)

XC6233($V_{OUT}$=2.5V)
$V_{IN}$=3.5V⇔4.5V, tr=tf=5$\mu$s, Ta=25℃
$C_{IN}$=$C_L$=1.0$\mu$F(ceramic)



XC6233($V_{OUT}$=3.3V)
$V_{IN}$=4.3V⇔5.3V, tr=tf=5$\mu$s, Ta=25℃
$C_{IN}$=$C_L$=1.0$\mu$F(ceramic)



### (10)  Load Transient Response

XC6233($V_{OUT}$=1.2V)
$I_{OUT}$=50mA⇔100mA, tr=tf=0.5$\mu$s, Ta=25℃
$V_{IN}$=2.2V, $C_{IN}$=$C_L$=1.0$\mu$F(ceramic)



XC6233($V_{OUT}$=1.2V)
$I_{OUT}$=0.1mA⇔200mA, tr=tf=0.5$\mu$s, Ta=25℃
$V_{IN}$=2.2V, $C_{IN}$=$C_L$=1.0$\mu$F(ceramic)



XC6233($V_{OUT}$=1.8V)
$I_{OUT}$=50mA⇔100mA, tr=tf=0.5$\mu$s, Ta=25℃
$V_{IN}$=2.8V, $C_{IN}$=$C_L$=1.0$\mu$F(ceramic)



XC6233($V_{OUT}$=1.8V)
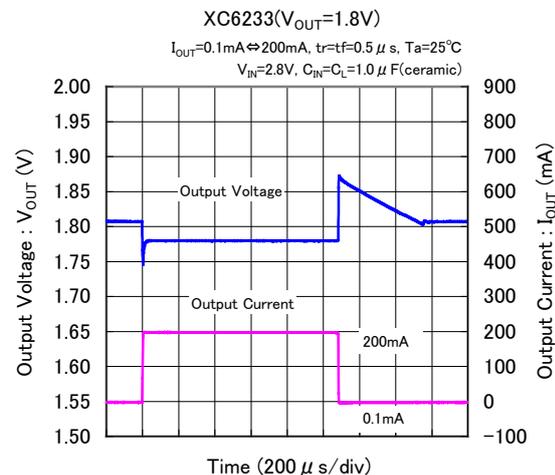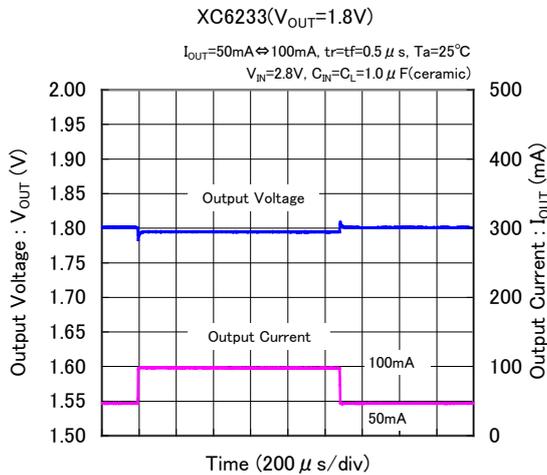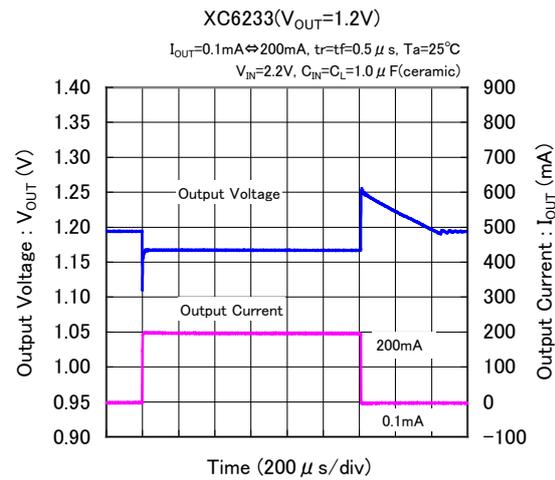$I_{OUT}$=0.1mA⇔200mA, tr=tf=0.5$\mu$s, Ta=25℃
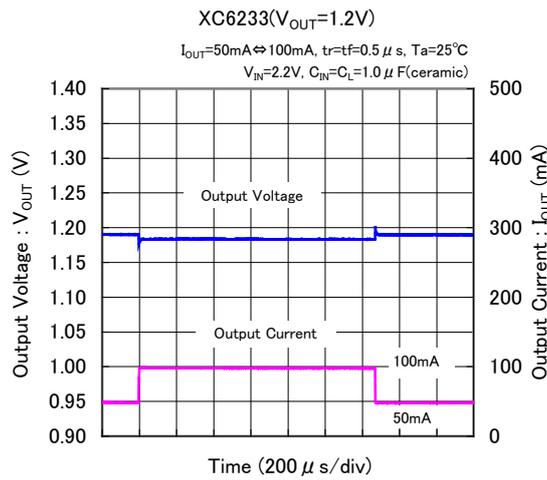$V_{IN}$=2.8V, $C_{IN}$=$C_L$=1.0$\mu$F(ceramic)

# ■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)
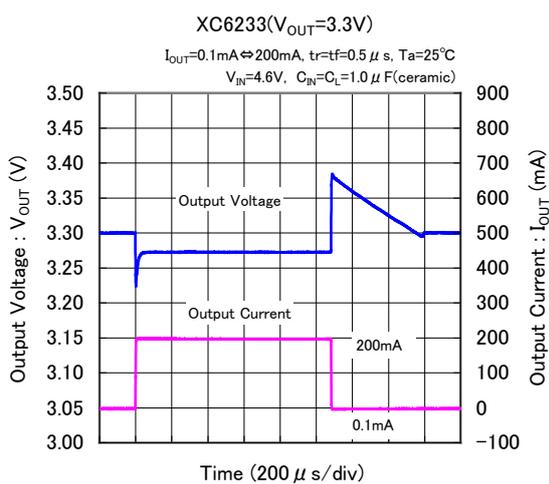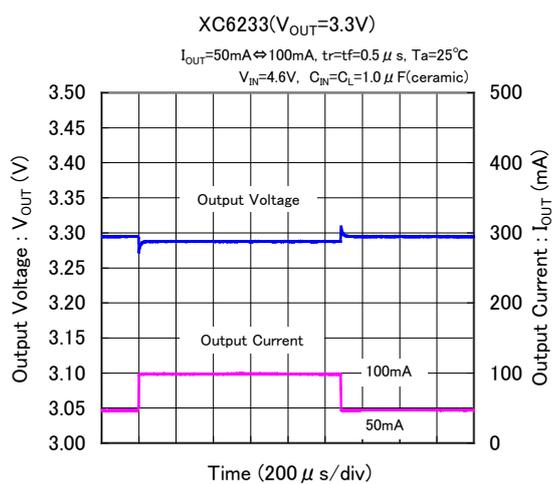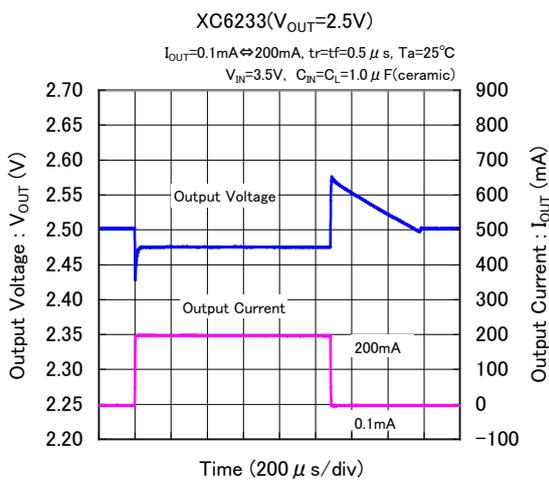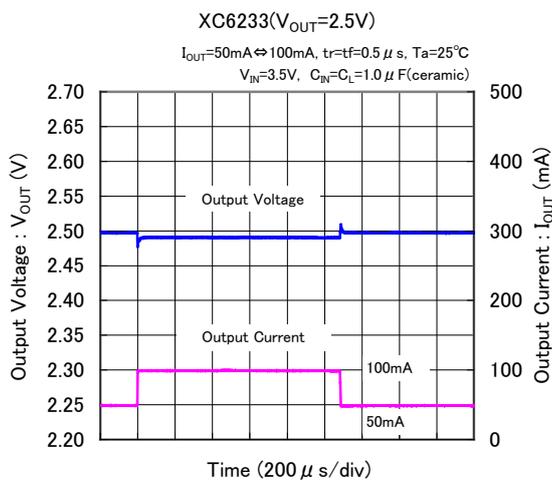
## (10) Load Transient Response (Continued)

XC6233($V_{OUT}$=2.5V)

$I_{OUT}$=50mA⇔100mA, tr=tf=0.5$\mu$ s, Ta=25℃
$V_{IN}$=3.5V, $C_{IN}$=$C_L$=1.0$\mu$ F(ceramic)

XC6233($V_{OUT}$=2.5V)

$I_{OUT}$=0.1mA⇔200mA, tr=tf=0.5$\mu$ s, Ta=25℃
$V_{IN}$=3.5V, $C_{IN}$=$C_L$=1.0$\mu$ F(ceramic)

XC6233($V_{OUT}$=3.3V)

$I_{OUT}$=50mA⇔100mA, tr=tf=0.5$\mu$ s, Ta=25℃
$V_{IN}$=4.6V, $C_{IN}$=$C_L$=1.0$\mu$ F(ceramic)

XC6233($V_{OUT}$=3.3V)

$I_{OUT}$=0.1mA⇔200mA, tr=tf=0.5$\mu$ s, Ta=25℃
$V_{IN}$=4.6V, $C_{IN}$=$C_L$=1.0$\mu$ F(ceramic)

## (11) CE Rising Response Time

XC6233($V_{OUT}$=1.2V)

$V_{CE}$=0V→2.2V, tr=5$\mu$ s, Ta=25℃
$V_{IN}$=2.2V, $C_{IN}$=$C_L$=1.0$\mu$ F(ceramic)

XC6233($V_{OUT}$=1.8V)

$V_{CE}$=0V→2.8V, tr=5$\mu$ s, Ta=25℃
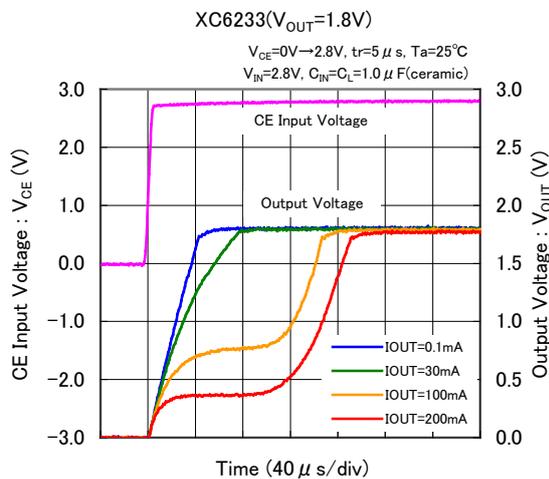$V_{IN}$=2.8V, $C_{IN}$=$C_L$=1.0$\mu$ F(ceramic)

# ■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)
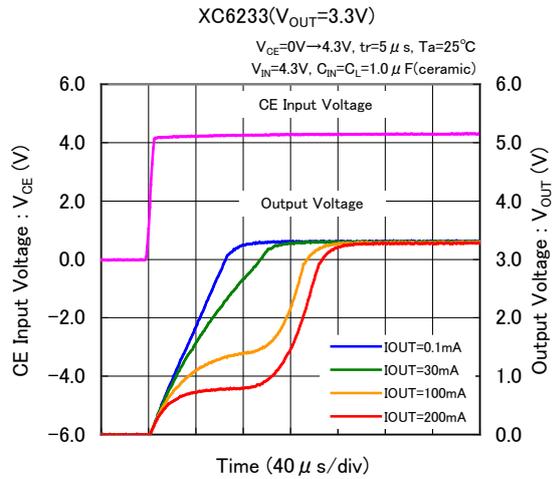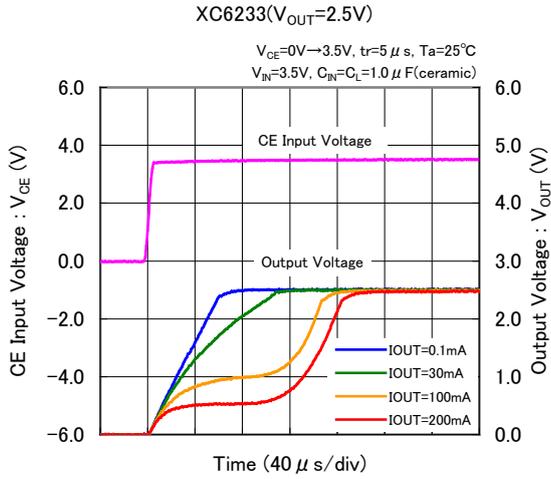
## (11) CE Rising Response Time (Continued)



XC6233($V_{OUT}$=2.5V)

$V_{CE}$=0V→3.5V, tr=5$\mu$s, Ta=25℃
$V_{IN}$=3.5V, $C_{IN}$=$C_L$=1.0$\mu$F(ceramic)

CE Input Voltage

Output Voltage

IOUT=0.1mA
IOUT=30mA
IOUT=100mA
IOUT=200mA

Time (40$\mu$s/div)



XC6233($V_{OUT}$=3.3V)

$V_{CE}$=0V→4.3V, tr=5$\mu$s, Ta=25℃
$V_{IN}$=4.3V, $C_{IN}$=$C_L$=1.0$\mu$F(ceramic)

CE Input Voltage

Output Voltage

IOUT=0.1mA
IOUT=30mA
IOUT=100mA
IOUT=200mA

Time (40$\mu$s/div)

## (12) Power Supply Rejection Ratio



XC6233($V_{OUT}$=1.2V)

$V_{IN}$=3.0V+0.5$V_{p-pAC}$, Ta=25℃
$C_{IN}$=$C_L$=1.0$\mu$F(ceramic)

IOUT=0.1mA
IOUT=1mA
IOUT=30mA
IOUT=100mA

Frequency : f (kHz)



XC6233($V_{OUT}$=1.8V)

$V_{IN}$=3.0V+0.5$V_{p-pAC}$, Ta=25℃
$C_{IN}$=$C_L$=1.0$\mu$F(ceramic)

IOUT=0.1mA
IOUT=1mA
IOUT=30mA
IOUT=100mA

Frequency : f (kHz)



XC6233($V_{OUT}$=2.5V)

$V_{IN}$=3.5V+0.5$V_{p-pAC}$, Ta=25℃
$C_{IN}$=$C_L$=1.0$\mu$F(ceramic)

IOUT=0.1mA
IOUT=1mA
IOUT=30mA
IOUT=100mA

Frequency : f (kHz)



XC6233($V_{OUT}$=3.3V)

$V_{IN}$=4.3V+0.5$V_{p-pAC}$, Ta=25℃
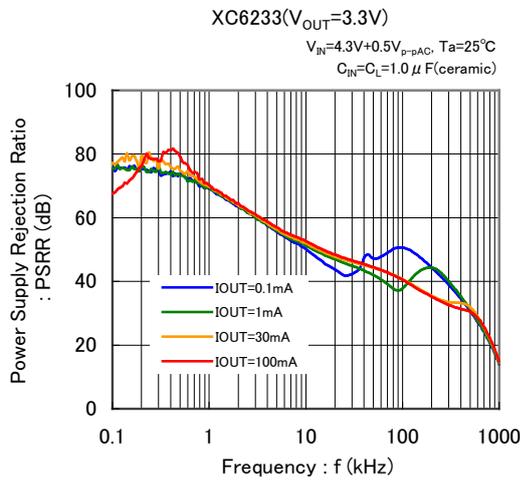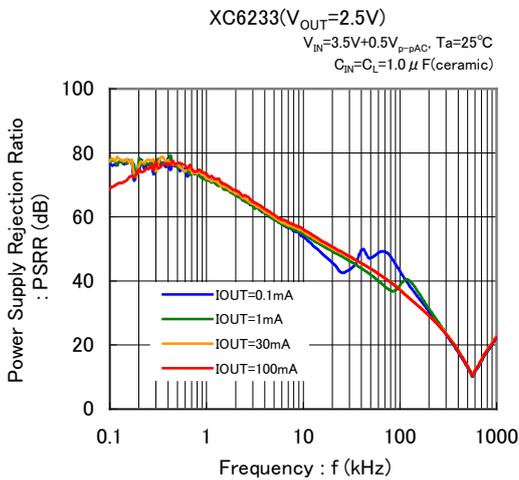$C_{IN}$=$C_L$=1.0$\mu$F(ceramic)

IOUT=0.1mA
IOUT=1mA
IOUT=30mA
IOUT=100mA

Frequency : f (kHz)

# ■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

（13） Inrush Current Response

XC6233(V$_{OUT}$=1.2V)

V$_{CE}$=0V→2.2V, tr=5μs, Ta=25℃
V$_{IN}$=2.2V, C$_{IN}$=C$_{L}$=1.0μF(ceramic)



XC6233(V$_{OUT}$=1.8V)

V$_{CE}$=0V→2.8V, tr=5μs, Ta=25℃
V$_{IN}$=2.8V, C$_{IN}$=C$_{L}$=1.0μF(ceramic)



XC6233(V$_{OUT}$=2.5V)

V$_{CE}$=0V→3.5V, tr=5μs, Ta=25℃
V$_{IN}$=3.5V, C$_{IN}$=C$_{L}$=1.0μF(ceramic)



XC6233(V$_{OUT}$=3.3V)

V$_{CE}$=0V→4.3V, tr=5μs, Ta=25℃
V$_{IN}$=4.3V, C$_{IN}$=C$_{L}$=1.0μF(ceramic)



（14） Output Noise Density

XC6233(V$_{OUT}$=1.2V)

V$_{IN}$=2.2V, Ta=25℃
C$_{IN}$=C$_{L}$=1.0μF(ceramic)

Frequency−Range : 0.1～100kHz
Output Noise : 37.17μVrms

IOUT=30mA



XC6233(V$_{OUT}$=1.8V)

V$_{IN}$=2.8, Ta=25℃
C$_{IN}$=C$_{L}$=1.0μF(ceramic)

Frequency−Range : 0.1～100kHz
Output Noise : 50.33μVrms

IOUT=30mA

# ■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

（14） Output Noise Density（Continued）

XC6233(V$_{OUT}$=3.3V)

V$_{IN}$=5.0V, Ta=25℃
C$_{IN}$=C$_L$=1.0μF(ceramic)



Output Noise Density : (μV/√Hz)

Frequency-Range : 0.1〜100kHz
Output Noise : 90.49μVrms

IOUT=30mA

Frequency : f (kHz)
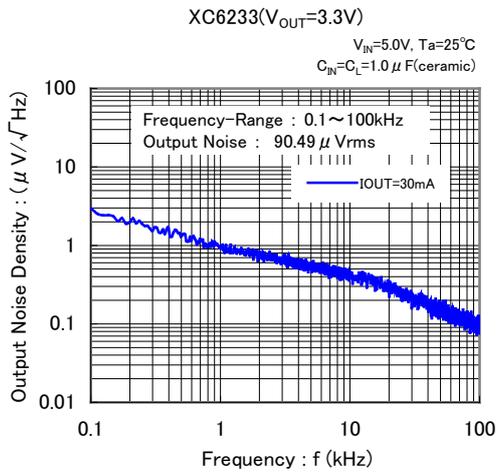
# ■PACKAGING INFORMATION

For the latest package information go to, www.torexsemi.com/technical-support/packages

| PACKAGE | OUTLINE / LAND PATTERN | THERMAL CHARACTERISTICS |
|---|---|---|
| SOT-25 | SOT-25 PKG | SOT-25 Power Dissipation |
| SSOT-24 | SSOT-24 PKG | SSOT-24 Power Dissipation |
| USP-4 | USP-4 PKG | USP-4 Power Dissipation |
| USPQ-4B04 | USPQ-4B04 PKG | USPQ-4B04 Power Dissipation |

## ■ MARKING RULE
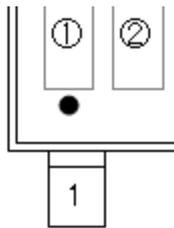
SOT-25 (Under-dot)
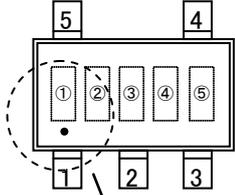


USP-4
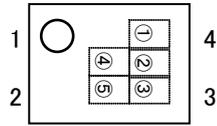


Magnified



\* SOT-25 with the under-dot marking is used.

① represents products series

| MARK | PRODUCT SERIES |
|---|---|
| 1 | XC6233\*\*\*\*\*\*-G |

② represents type of regulator

| MARK | | PRODUCT SERIES |
|---|---|---|
| OUTPUT VOLTAGE 0.1V Increments | OUTPUT VOLTAGE 0.05V Increments | |
| K | M | XC6233H\*\*\*\*\*-G |

③ represents output voltage

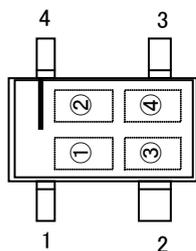| MARK | OUTPUT VOLTAGE (V) | | MARK | OUTPUT VOLTAGE (V) | |
|---|---|---|---|---|---|
| 0 | 1.2 | 1.25 | F | 2.7 | 2.75 |
| 1 | 1.3 | 1.35 | H | 2.8 | 2.85 |
| 2 | 1.4 | 1.45 | K | 2.9 | 2.95 |
| 3 | 1.5 | 1.55 | L | 3.0 | 3.05 |
| 4 | 1.6 | 1.65 | M | 3.1 | 3.15 |
| 5 | 1.7 | 1.75 | N | 3.2 | 3.25 |
| 6 | 1.8 | 1.85 | P | 3.3 | 3.35 |
| 7 | 1.9 | 1.95 | R | 3.4 | 3.45 |
| 8 | 2.0 | 2.05 | S | 3.5 | 3.55 |
| 9 | 2.1 | 2.15 | T | 3.6 | - |
| A | 2.2 | 2.25 | U | - | - |
| B | 2.3 | 2.35 | V | - | - |
| C | 2.4 | 2.45 | X | - | - |
| D | 2.5 | 2.55 | Y | - | - |
| E | 2.6 | 2.65 | Z | - | - |

④,⑤ represents production lot number
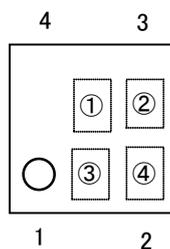01~09, 0A~0Z, 11~9Z, A1~A9, AA~AZ, B1~ZZ in order.
(G, I, J, O, Q, W excluded)
\*No character inversion used.

# ■MARKING RULE (Continued)

SSOT-24 (With the orientation bar at the top)　　USPQ−4B04

(XC6233******-G with the orientation bar at the top is used.)

① represents products series, type of regulator and output voltage

| MARK | OUTPUT VOLTAGE (V) | CURRENT LIMITTER | CE PULL-DOWN RESISTOR | $C_L$ AUTO DISCHARGE | INRUSH CURRENT PREVENTION | PRODUCT SERIES |
|---|---|---|---|---|---|---|
| A | 1.2~2.0 | Yes | Yes | Yes | Yes | XC6233H121**-G~XC6233H201**-G |
| B | 2.1~2.9 | Yes | Yes | Yes | Yes | XC6233H211**-G~XC6233H291**-G |
| C | 3.0~3.6 | Yes | Yes | Yes | Yes | XC6233H301**-G~XC6233H361**-G |
| D | 1.25~2.05 | Yes | Yes | Yes | Yes | XC6233H12B**-G~XC6233H20B**-G |
| E | 2.15~2.95 | Yes | Yes | Yes | Yes | XC6233H21B**-G~XC6233H29B**-G |
| F | 3.05~3.55 | Yes | Yes | Yes | Yes | XC6233H30B**-G~XC6233H35B**-G |

② represents output voltage

| MARK | OUTPUT VOLTAGE (V) | | | | | |
|---|---|---|---|---|---|---|
| 1 | 1.2 | 2.1 | 3.0 | 1.25 | 2.15 | 3.05 |
| 2 | 1.3 | 2.2 | 3.1 | 1.35 | 2.25 | 3.15 |
| 3 | 1.4 | 2.3 | 3.2 | 1.45 | 2.35 | 3.25 |
| 4 | 1.5 | 2.4 | 3.3 | 1.55 | 2.45 | 3.35 |
| 5 | 1.6 | 2.5 | 3.4 | 1.65 | 2.55 | 3.45 |
| 6 | 1.7 | 2.6 | 3.5 | 1.75 | 2.65 | 3.55 |
| 7 | 1.8 | 2.7 | 3.6 | 1.85 | 2.75 | |
| 8 | 1.9 | 2.8 | | 1.95 | 2.85 | |
| 9 | 2.0 | 2.9 | | 2.05 | 2.95 | |

③,④ represents production lot number
01~09, 0A~0Z, 11~9Z, A1~A9, AA~AZ, B1~ZZ in order.
(G, I, J, O, Q, W excluded)
*No character inversion used.

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