

- ◆ CMOS Low Power Consumption
- ◆ Dropout Voltage :
60mV @ 30mA, 200mV @ 100mA
- ◆ Maximum Output Current : 150mA
- ◆ Highly Accurate : ± 2%
- ◆ Output Voltage Range : 1.8V ~ 6.0V
- ◆ Low ESR capacitor compatible

- Applications
 - Mobile phones
 - Cordless phones
 - Cameras, video recorders
 - Portable games
 - Portable AV equipment
 - Reference voltage
 - Battery powered equipment

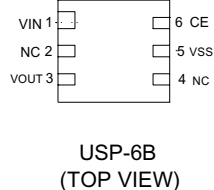
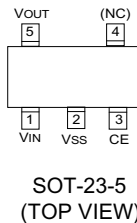
■ General Description

The XC6204 series are highly precise, low noise, positive voltage LDO regulators manufactured using CMOS processes. The series achieves high ripple rejection and low dropout and consists of a standard voltage source, an error correction, current limiter and a phase compensation circuit plus a driver transistor. Output voltage is selectable in 50mV increments within a range of 1.8V ~ 6.0V. The series is also compatible with low ESR ceramic capacitors which give added output stability. This stability can be maintained even during load fluctuations due to the excellent transient response of the series. The current limiter's foldback circuit also operates as a short protect for the output current limiter and the output pin. The CE function enables the output to be turned off, resulting in greatly reduced power consumption.

■ Features

- Maximum Output Current** : 150mA
- Dropout Voltage** : 200mV (I_{OUT} = 100mA)
- Maximum Operating Voltage** : 10V
- Output Voltage Range** : 1.8V ~ 6.0V in 50mV increments
- Highly Accurate** : ± 2%
- Low Power Consumption** : TYP 75µA
- Standby Current** : less than 0.1µA
- High Ripple Rejection** : 70dB (10 kHz)
- Low Output Noise** : 30µVrms
- Operating Temperature Range** : -40°C ~ +85°C
- Low ESR Capacitor Compatible** : Ceramic capacitor

■ Pin Configuration



■ Pin Assignment

| PIN NUMBER | | PIN NAME | FUNCTION |
|------------|--------|----------|----------------|
| SOT-23-5 | USB-6B | | |
| 1 | 1 | VIN | Input |
| 2 | 5 | VSS | Ground |
| 3 | 6 | CE | ON/OFF Control |
| 4 | 2, 4 | NC | No Connection |
| 5 | 3 | VOUT | Output |

■ Selection Guide

The following options for the CE pin logic and internal pull-up/down are available:

- Active 'High' + no pull-down resistor built-in (standard)
- Active 'High' + 300kΩ pull-down resistor built-in <between CE-VSS> (semi-custom)
- Active 'Low' + no pull-up resistor built-in (semi-custom)
- Active 'Low' + 300kΩ pull-up resistor built-in <between CE-VSS> (semi-custom)

Note: *With the pull-up resistor or pull-down resistor built-in types, the supply current during operation will increase by VIN / 300kΩ (TYP.)

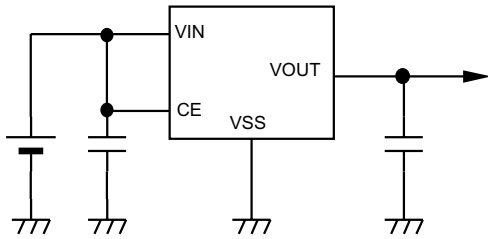
■ Ordering Information

XC6204①②③④⑤⑥

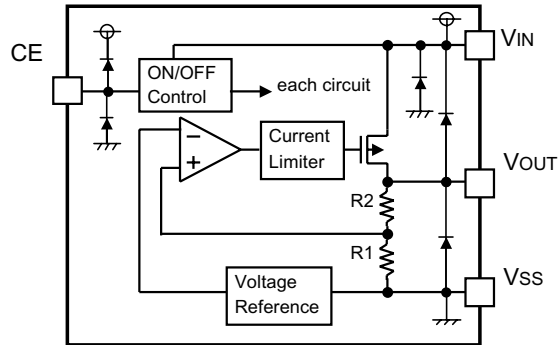
| DESIGNATOR | SYMBOL | DESCRIPTION | DESIGNATOR | SYMBOL | DESCRIPTION | |
|------------|---|--|------------|--------|--|--|
| ① | | CE Pin Logic : | ④ | 2 | Output Voltage : 100mV increments e.g. ②=3, ③=8, ④=2 ⇒ 3.8V | |
| | A | Active 'High' (pull-down resistor built in) | | A | | Output Voltage : 50mV increments e.g. ②=3, ③=8, ④=A ⇒ 3.85V |
| | B | Active 'High' (no pull-down resistor built in) | | | | Package Type : |
| | C | Active 'Low' (pull-up resistor built in) | | | ⑤ | M |
| D | Active 'Low' (no pull-up resistor built in) | | D | | USP - 6B | |
| ② ③ | 18~60 | Output Voltage : | ⑥ | | Device Orientation : | |
| | | e.g. 20 = 2.0V | | R | Embossed Tape : Standard Feed | |
| | | 30 = 3.0V etc. | | L | Embossed Tape : Reverse Feed | |

Please note that the "B" version is the standard part. The A, C, & D versions are semi-custom parts.

■ Typical Application



■ Block Diagram



■ Absolute Maximum Ratings

| PARAMETER | SYMBOL | RATINGS | UNITS |
|-------------------------------|------------------|---|-------|
| Input Voltage | V _{IN} | 12 | V |
| Output Current | I _{OUT} | 500 | mA |
| Output Voltage | V _{OUT} | V _{SS} -0.3~V _{IN} +0.3 | V |
| CE Input Voltage | V _{CE} | V _{SS} -0.3~V _{IN} +0.3 | V |
| Power Dissipation | Pd | SOT-23-5 | 150 |
| | | USP-6B | 100 |
| Operating Ambient Temperature | T _{opr} | -40~+85 | °C |
| Storage Temperature | T _{stg} | -55~+125 | °C |

■ Electrical Characteristics (XC6204Bxx2)

T_a=25°C

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | CIRCUIT |
|--------------------------------------|---|---|---------------------|----------------------|-----------------|-------------------|---------|
| Output Voltage | V _{OUT} (E) | I _{OUT} =30mA | × 0.98 | V _{OUT} (T) | × 1.02 | V | 1 |
| Maximum Output Current | I _{OUTMAX} | | 150 | | | mA | 1 |
| Load Regulation | ΔV _{OUT} | 1mA ≤ I _{OUT} ≤ 100mA | | 15 | 50 | mV | 1 |
| Dropout Voltage | V _{dif1} | I _{OUT} =30mA | see table next page | | | mV | 1 |
| | V _{dif2} | I _{OUT} =100mA | | | | mV | |
| Supply Current | I _{SS} | V _{CE} =V _{IN} | | 75 | | μA | 2 |
| Standby Current | I _{stby} | V _{CE} =V _{SS} | | | 0.3 | μA | 2 |
| Line Regulation | $\frac{\Delta V_{OUT}}{\Delta V_{IN} \cdot V_{OUT}}$ | V _{OUT} (T)+1.0V ≤ V _{IN} ≤ 10V I _{OUT} =30mA | | 0.01 | 0.20 | % / V | 1 |
| Input Voltage | V _{IN} | | 2 | | 10 | V | - |
| Output Voltage Temp. Characteristics | $\frac{\Delta V_{OUT}}{\Delta T_{opr} \cdot V_{OUT}}$ | I _{OUT} =30mA -40°C ≤ T _{opr} ≤ 85°C | | 100 | | ppm / °C | 1 |
| Output Noise | e _n | 300Hz~50kHz | | 30 | | μV _{rms} | 3 |
| Ripple Rejection Rate | PSRR | I _{OUT} =50mA, f=10kHz | | 70 | | dB | 4 |
| Current Limiter | I _{lim} | | | 300 | | mA | 1 |
| Short-circuit Current | I _{short} | | | 50 | | mA | 1 |
| CE "High" Voltage | V _{CEH} | | 1.6 | | V _{IN} | V | 2 |
| CE "Low" Voltage | V _{CEL} | | | | 0.25 | V | 2 |
| CE "High" Current | I _{CEH} | V _{CE} =V _{IN} | -0.1 | | 0.1 | μA | 2 |
| CE "Low" Current | I _{CEL} | V _{CE} =V _{SS} | -0.1 | | 0.1 | μA | 2 |

Note

(NOTE 1) V_{OUT}(T)=Specified Output Voltage

(NOTE 2) V_{OUT}(E)=Effective Output Voltage (I.e. the output voltage when "V_{OUT}(T)+1.0V" is provided at the V_{IN} pin while maintaining a certain I_{OUT} value).

(NOTE 3) V_{dif}={V_{IN1}(NOTE5)-V_{OUT1}(NOTE4)}

(NOTE 4) V_{OUT1}=A voltage equal to 98% of the Output Voltage whenever an amply stabilized I_{OUT} {V_{out}(T)+1.0V} is input.

(NOTE 5) V_{IN1}=The Input Voltage when V_{OUT1} appears as Input Voltage is gradually decreased.

(NOTE 6) V_{IN} is defined as {V_{IN}=V_{OUT}(T)+0.1V} unless specified differently.

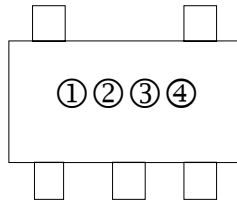
Dropout Voltage

| Voltage (V) | Vdif1 | | | Vdif2 | | |
|-------------|-------|-----|-----|-------|-----|-----|
| | MIN | TYP | MAX | MIN | TYP | MAX |
| 1.80~1.85 | 200 | 200 | 210 | 200 | 300 | 400 |
| 1.90~1.95 | 100 | 120 | 150 | 100 | 280 | 380 |
| 2.00~2.05 | - | 80 | 120 | - | 240 | 350 |
| 2.10~2.25 | - | 80 | 120 | - | 240 | 330 |
| 2.30~2.45 | - | 80 | 120 | - | 240 | 310 |
| 2.50~2.75 | - | 70 | 100 | - | 220 | 290 |
| 2.80~2.95 | - | 70 | 100 | - | 220 | 270 |
| 3.00~3.05 | - | 60 | 90 | - | 200 | 270 |
| 3.10~3.95 | - | 60 | 90 | - | 200 | 250 |
| 4.00~4.95 | - | 60 | 80 | - | 180 | 230 |
| 5.00~6.00 | - | 50 | 70 | - | 160 | 210 |

* Since the operation of this IC is only guaranteed from VIN=2V and above, it is essential that when using with applications where VOUT=2V or less, the difference between VIN and VOUT be at least equal to 2V-VOUT(T).

■ Marking Rule

SOT-25



① Represents the product name

| SYMBOL | PRODUCT NAME |
|--------|--------------|
| 4 | XC6204◆◆◆◆M◆ |

② Represents the type of regulator

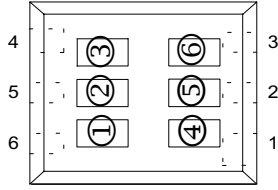
| VOLTAGE(V) | 0.1~3.0 | 3.1~6.0 | 0.15~3.05 | 3.15~6.05 | | |
|------------|---------|---------|-----------|-----------|--------------|---------------|
| SYMBOL | V | A | E | L | Product Name | XC6204A◆◆◆◆M◆ |
| | X | B | F | M | | XC6204B◆◆◆◆M◆ |
| | Y | C | H | N | | XC6204C◆◆◆◆M◆ |
| | Z | D | K | P | | XC6204D◆◆◆◆M◆ |

③ Represents the Output Voltage

| SYMBOL | OUTPUT VOLTAGE (V) | | | | SYMBOL | OUTPUT VOLTAGE (V) | | | |
|--------|--------------------|-----|---|------|--------|--------------------|-----|------|------|
| 0 | - | 3.1 | - | 3.15 | F | - | 4.6 | - | 4.65 |
| 1 | - | 3.2 | - | 3.25 | H | - | 4.7 | - | 4.75 |
| 2 | - | 3.3 | - | 3.35 | K | 1.8 | 4.8 | 1.85 | 4.85 |
| 3 | - | 3.4 | - | 3.45 | L | 1.9 | 4.9 | 1.95 | 4.95 |
| 4 | - | 3.5 | - | 3.55 | M | 2.0 | 5.0 | 2.05 | 5.05 |
| 5 | - | 3.6 | - | 3.65 | N | 2.1 | 5.1 | 2.15 | 5.15 |
| 6 | - | 3.7 | - | 3.75 | P | 2.2 | 5.2 | 2.25 | 5.25 |
| 7 | - | 3.8 | - | 3.85 | R | 2.3 | 5.3 | 2.35 | 5.35 |
| 8 | - | 3.9 | - | 3.95 | S | 2.4 | 5.4 | 2.45 | 5.45 |
| 9 | - | 4.0 | - | 4.05 | T | 2.5 | 5.5 | 2.55 | 5.55 |
| A | - | 4.1 | - | 4.15 | Y | 2.6 | 5.6 | 2.65 | 5.65 |
| B | - | 4.2 | - | 4.25 | V | 2.7 | 5.7 | 2.75 | 5.75 |
| C | - | 4.3 | - | 4.35 | X | 2.8 | 5.8 | 2.85 | 5.85 |
| D | - | 4.4 | - | 4.45 | Y | 2.9 | 5.9 | 2.95 | 5.95 |
| E | - | 4.5 | - | 4.55 | Z | 3.0 | 6.0 | 3.05 | 6.05 |

④ Represents the assembly lot no. 0~9, A~Z repeated (G, I, J, O, Q, W excepted)

USP-6A



① Represents the product name

| SYMBOL | | PRODUCT NAME |
|--------|---|--------------|
| ① | ② | |
| 0 | 4 | XC6204◆◆◆◆D◆ |

③ Represents the type of regulator

| SYMBOL | TYPE | PRODUCT NAME |
|--------|--|---------------|
| A | Active 'High' (pull-down resistor built in) | XC6204A◆◆◆◆D◆ |
| B | Active 'High' (no pull-down resistor built in) | XC6204B◆◆◆◆D◆ |
| C | Active 'Low' (pull-up resistor built in) | XC6204C◆◆◆◆D◆ |
| D | Active 'Low' (no pull-up resistor built in) | XC6204D◆◆◆◆D◆ |

④ Represents the integers of Output Voltage

Example

| SYMBOL | VOLTAGE(V) | PRODUCT NAME |
|--------|------------|---------------|
| 3 | 3.X | XC6204◆3◆◆◆D◆ |
| 5 | 5.X | XC6204◆5◆◆◆D◆ |

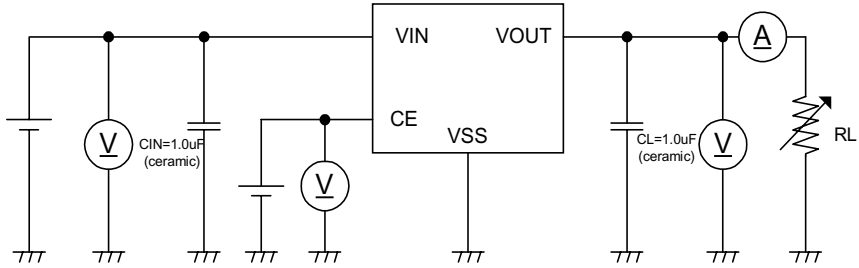
⑤ Represents the decimals of Output Voltage

| SYMBOL | VOLTAGE(V) | PRODUCT NAME | SYMBOL | VOLTAGE(V) | PRODUCT NAME |
|--------|------------|---------------|--------|------------|---------------|
| 0 | X.0 | XC6204◆◆◆0◆D◆ | A | X.05 | XC6204◆◆◆0AD◆ |
| 1 | X.1 | XC6204◆◆◆1◆D◆ | B | X.15 | XC6204◆◆◆1AD◆ |
| 2 | X.2 | XC6204◆◆◆2◆D◆ | C | X.25 | XC6204◆◆◆2AD◆ |
| 3 | X.3 | XC6204◆◆◆3◆D◆ | D | X.35 | XC6204◆◆◆3AD◆ |
| 4 | X.4 | XC6204◆◆◆4◆D◆ | E | X.45 | XC6204◆◆◆4AD◆ |
| 5 | X.5 | XC6204◆◆◆5◆D◆ | F | X.55 | XC6204◆◆◆5AD◆ |
| 6 | X.6 | XC6204◆◆◆6◆D◆ | H | X.65 | XC6204◆◆◆6AD◆ |
| 7 | X.7 | XC6204◆◆◆7◆D◆ | K | X.75 | XC6204◆◆◆7AD◆ |
| 8 | X.8 | XC6204◆◆◆8◆D◆ | L | X.85 | XC6204◆◆◆8AD◆ |
| 9 | X.9 | XC6204◆◆◆9◆D◆ | M | X.95 | XC6204◆◆◆9AD◆ |

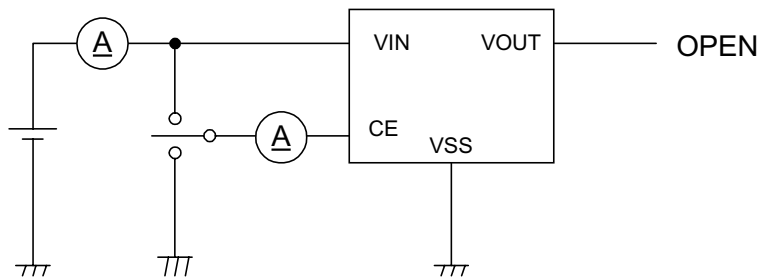
⑥ Represents the assembly lot no. 0~9, A~Z repeated (G, I, J, O, Q, W excepted)

■ Test Circuits

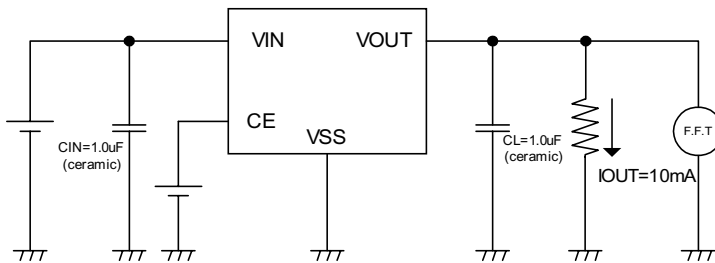
Circuit 1



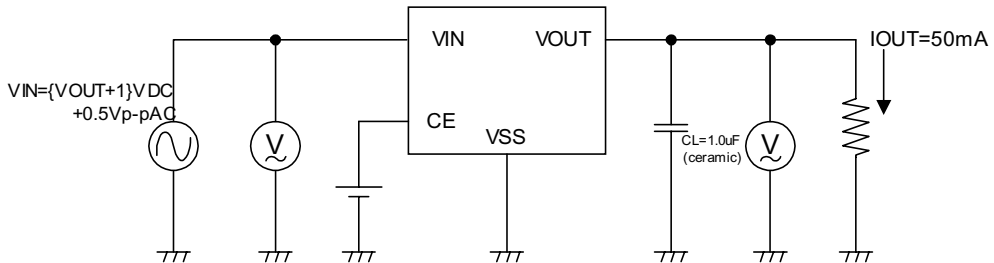
Circuit 2



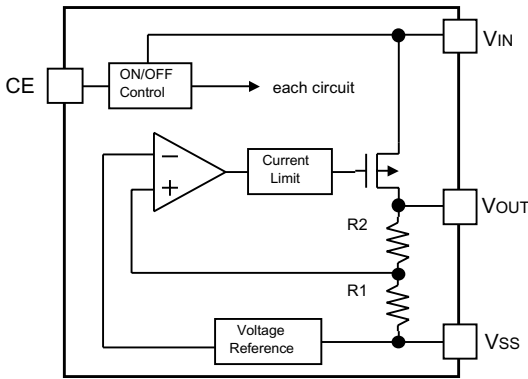
Circuit 3



Circuit 4



■ Operational Explanation



Output voltage control with the XC6204 series :

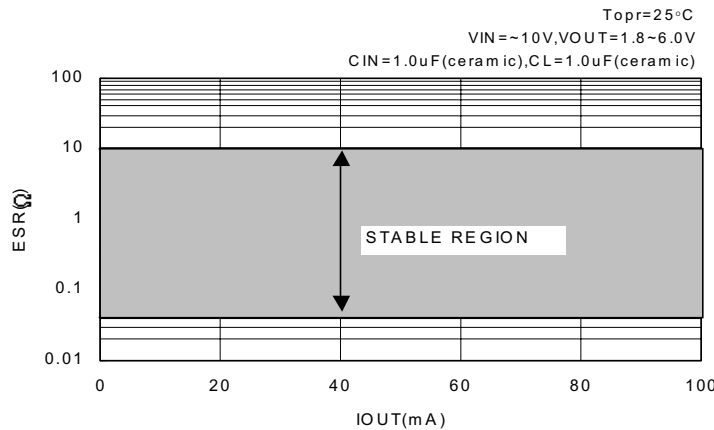
The voltage divided by resistors R1 & R2 is compared with the internal reference voltage by the error amplifier.

The P-Channel MOSFET, which is connected to the VOUT pin, is then driven by the subsequent output signal. The output voltage at the VOUT pin is controlled & stabilised by a system of negative feedback.

The current limit circuit and short protect circuit operate in relation to the level of output current. Further, the IC's internal circuitry can be shutdown via the CE pin's signal.

Low ESR Capacitors

With the XC6204 series, a stable output voltage is achievable even if used with low ESR capacitors as a phase compensation circuit is built-in. In order to ensure the effectiveness of the phase compensation, we suggest that an output capacitor (CL) is connected as close as possible to the output pin (VOUT) and the VSS pin. Please use an output capacitor with a capacitance value of at least 1µF. Also, please connect an input capacitor (CIN) of 0.1µF between the VIN pin and the VSS pin in order to ensure a stable power input.



Current Limiter, Short-Circuit Protection

The XC6204 series includes a combination of a fixed current limiter circuit & a foldback circuit which aid the operations of the current limiter and circuit protection. When the load current reaches the current limit level, the fixed current limiter circuit operates and output voltage drops. As a result of this drop in output voltage, the foldback circuit operates, output voltage drops further and output current decreases (refer to the data on page 5). When the output pin is shorted, a current of about 60mA flows.

CE Pin

The IC's internal circuitry can be shutdown via the signal from the CE pin with the XC6204 series. In shutdown mode, output at the VOUT pin will be pulled down to the VSS level via R1 & R2. The operational logic of the IC's CE pin is selectable (please refer to the selection guide on page 2). Note that as the standard XC6204B type is 'High Active/No Pull Down', operations will become unstable with the CE pin open. Although the CE pin is equal to an inverter input with CMOS hysteresis, with either the pull-up or pull-down options, the CE pin input current will increase when the IC is in operation.

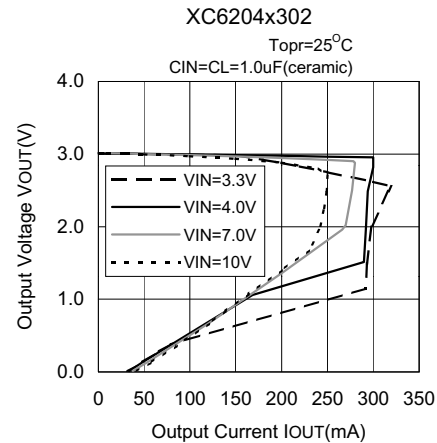
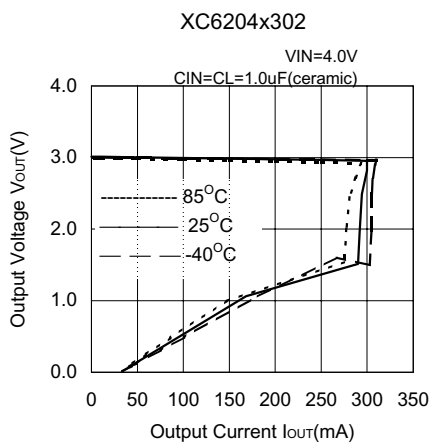
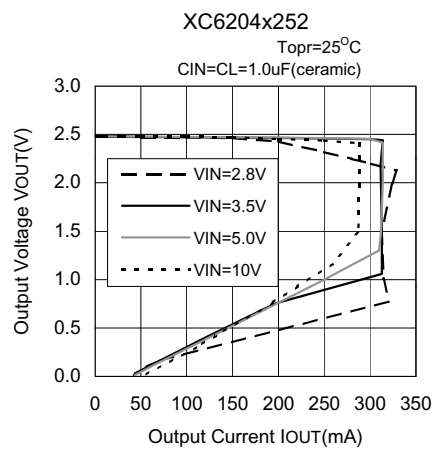
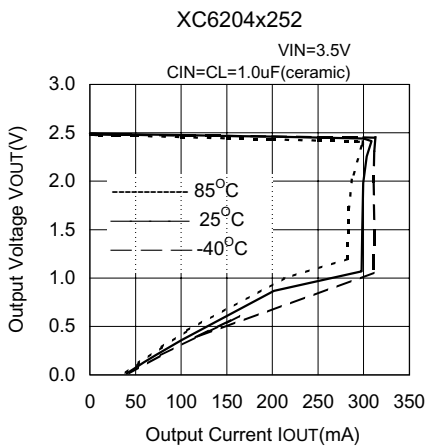
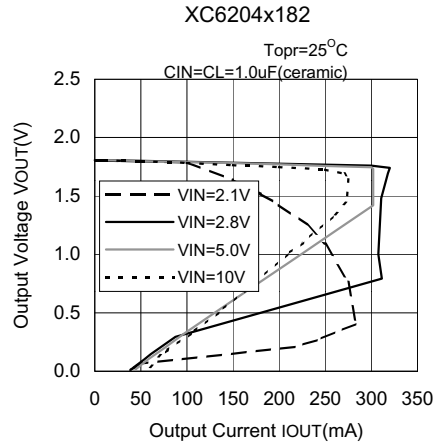
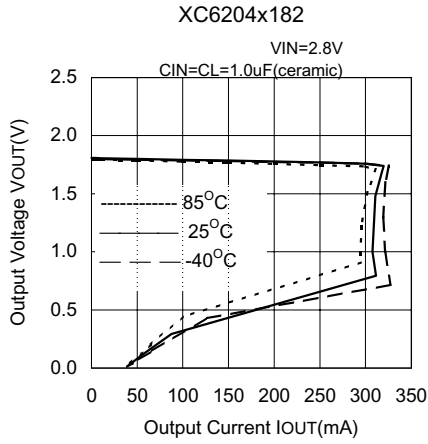
We suggest that you use this IC with either a VIN voltage or a VSS voltage input at the CE pin. If this IC is used with the correct specifications for the CE pin, the IC will operate normally. However, supply current may increase as a result of through current in the IC's internal circuitry if a voltage between 0.25V and 1.5V is input.

■ Notes on Use

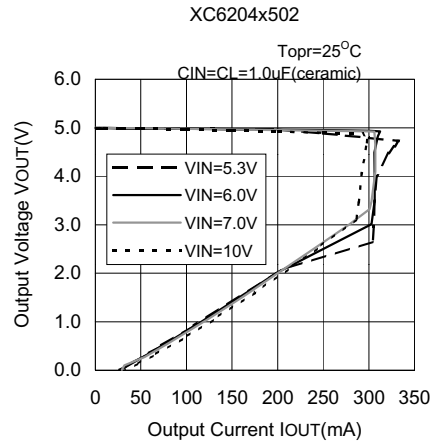
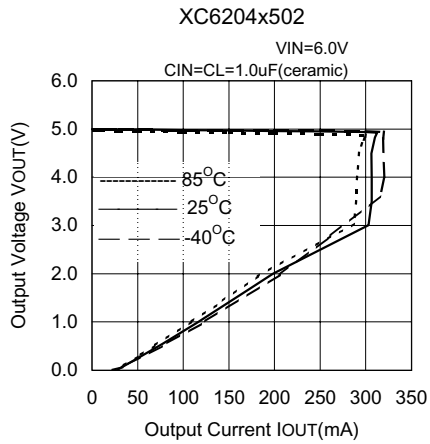
1. Please use this IC within the stated absolute maximum ratings. The IC is liable to malfunction should the ratings be exceeded.
2. Where wiring impedance is high, operations may become unstable due to noise and/or phase lag depending on output current. Please strengthen VIN and VSS wiring in particular.
3. Please wire the input capacitor (CIN) and the output capacitor (CL) as close to the IC as possible.

XC6204

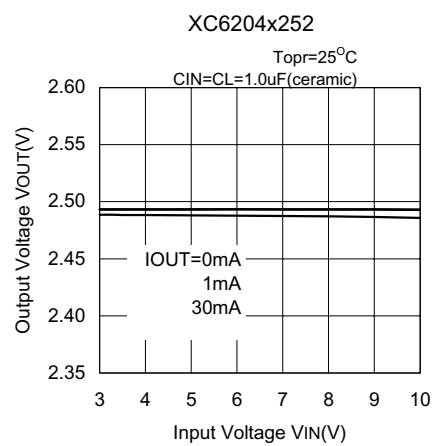
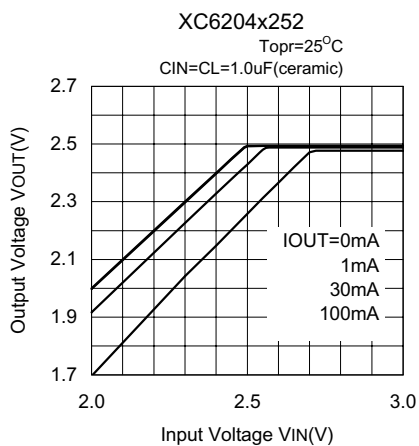
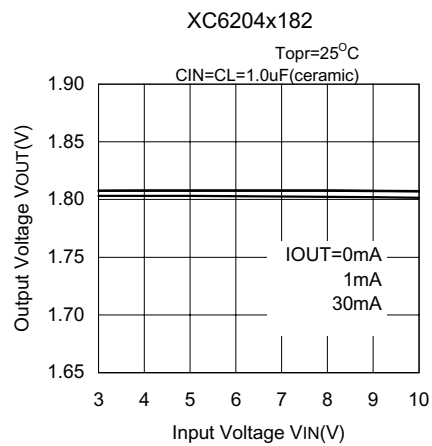
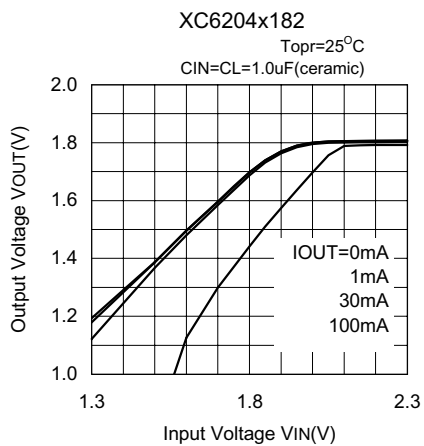
(1) Output Voltage vs. Output Current



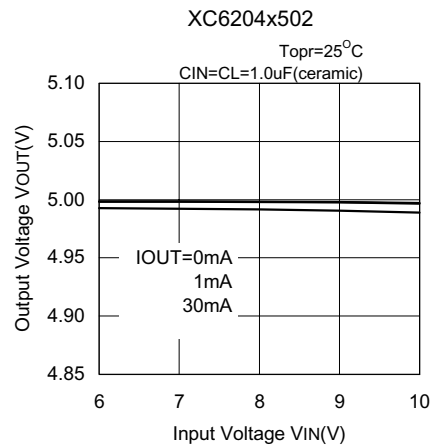
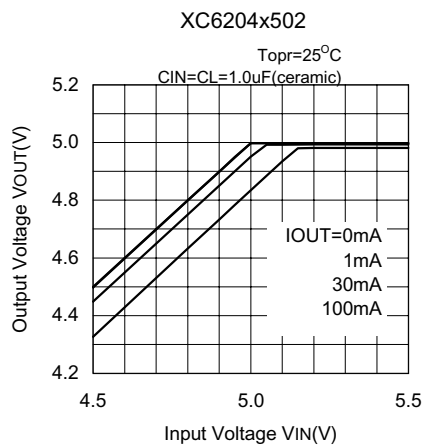
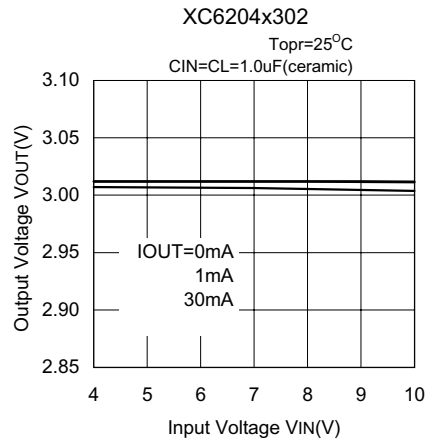
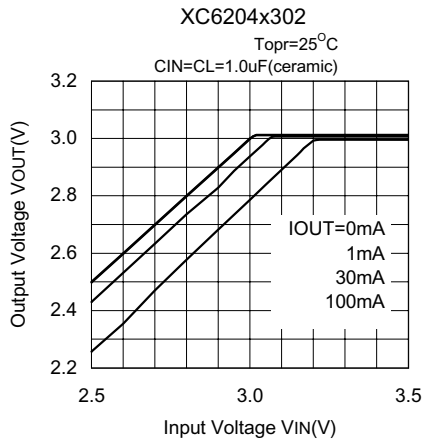
(1) Output Voltage vs. Output Current (Contd.)



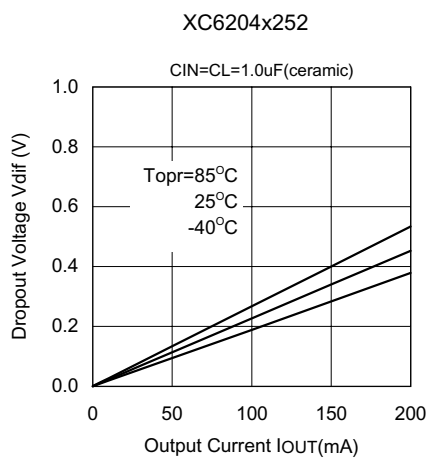
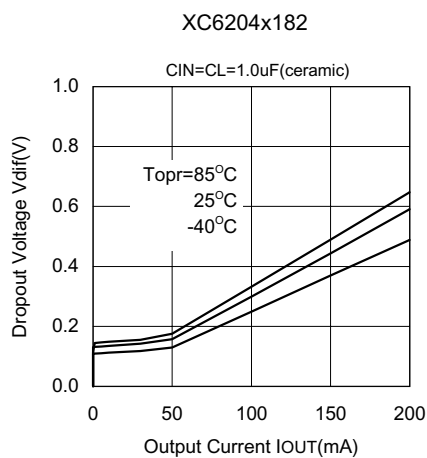
(2) Output Voltage vs. Input Voltage



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

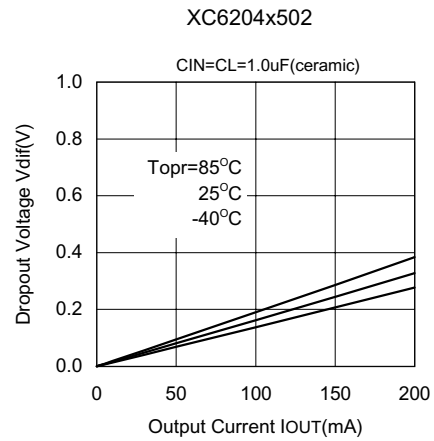
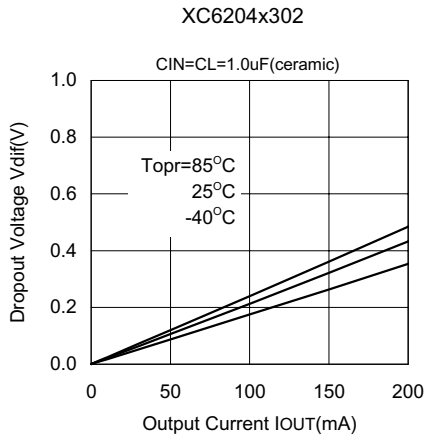


(3) Dropout Voltage vs. Output Current

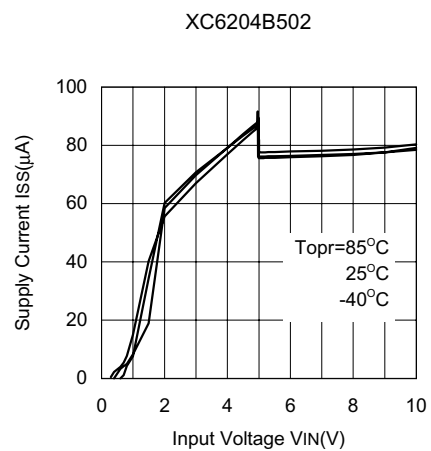
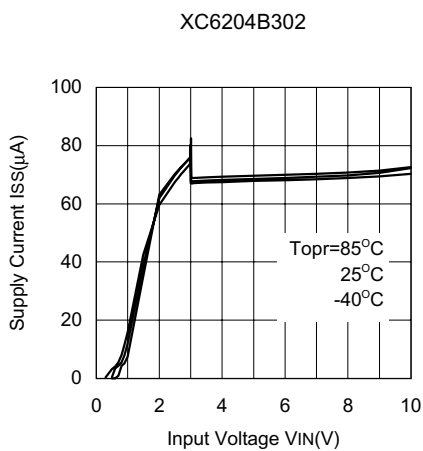
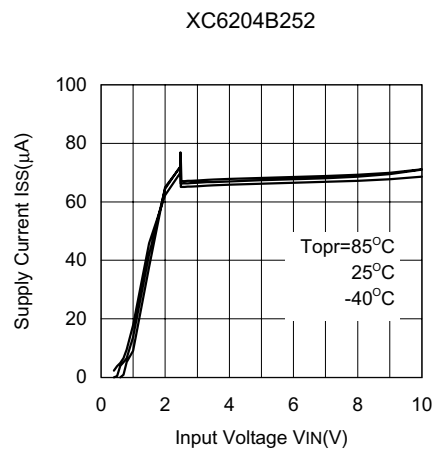
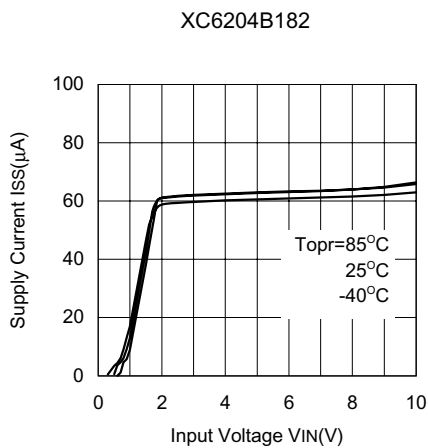


* Since the operation of this IC is only guaranteed from VIN=2V and above, it is essential that when using with applications where VOUT=2V or less, the difference between VIN and VOUT be at least equal to 2V-VOUT(T).

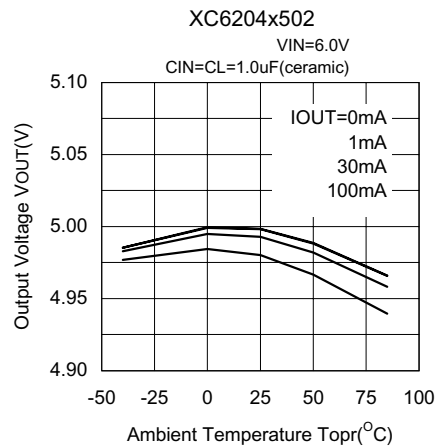
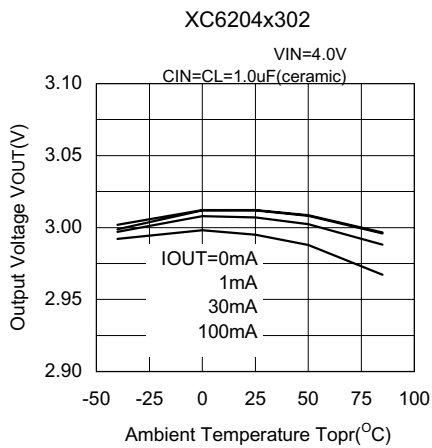
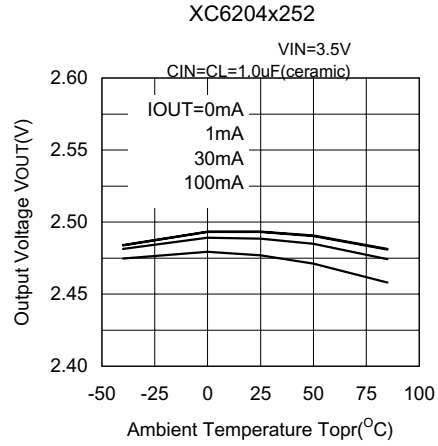
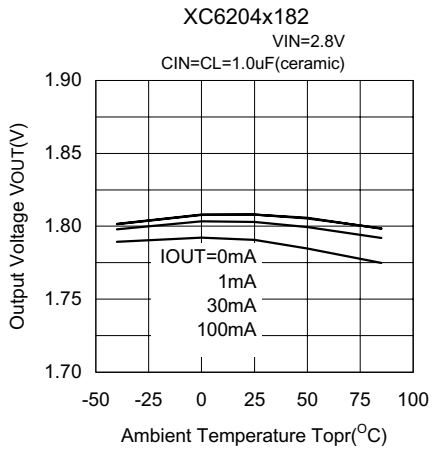
(3) Dropout Voltage vs. Output Current (Contd.)



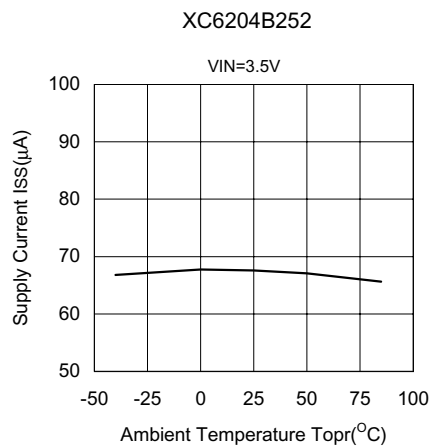
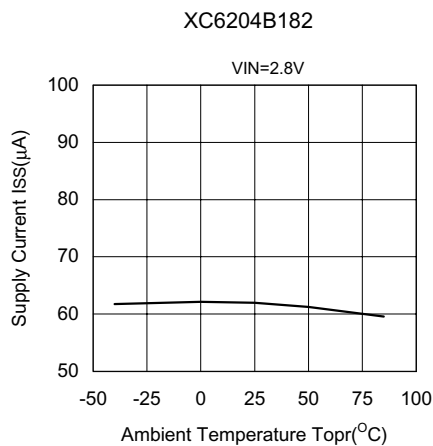
(4) Supply Current vs. Input Voltage



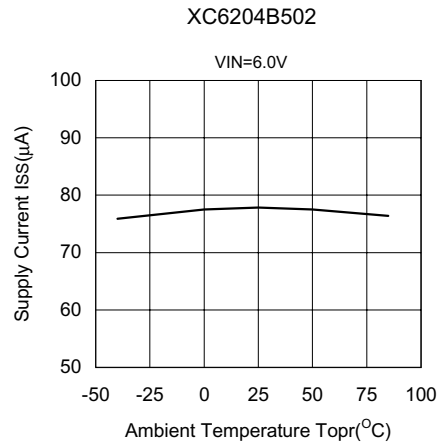
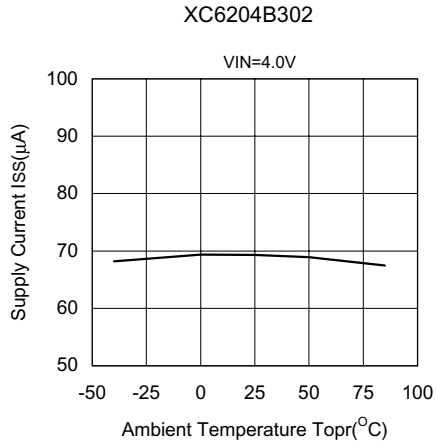
(5) Output Voltage vs. Ambient Temperature



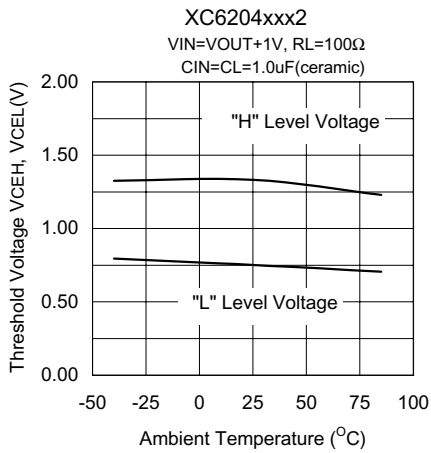
(6) Supply Current vs. Ambient Temperature



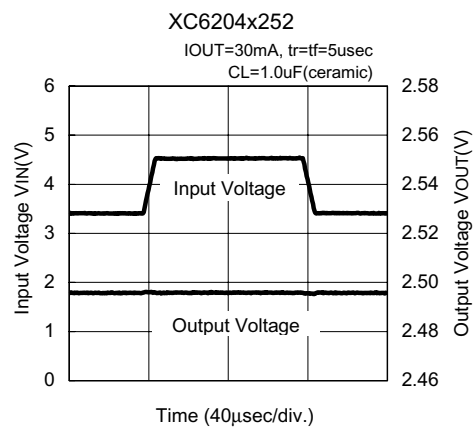
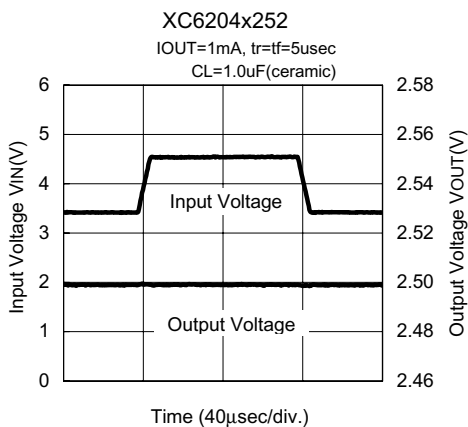
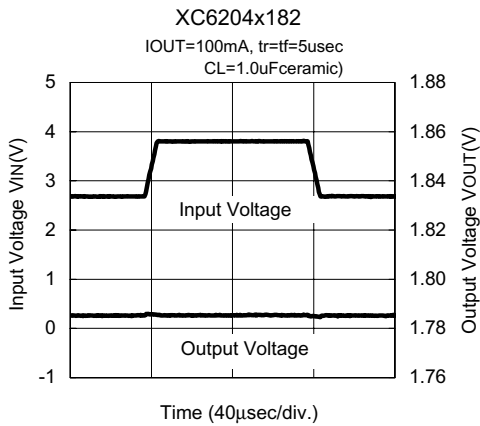
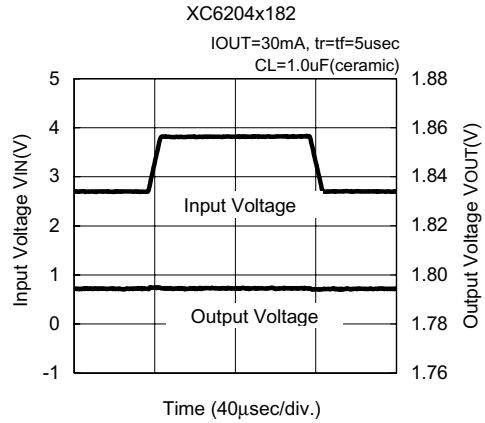
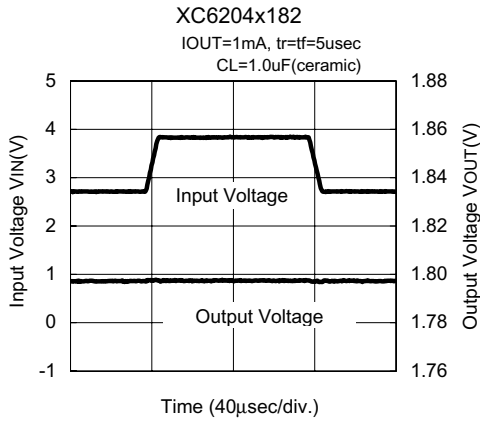
(6) Supply Current vs. Ambient Temperature (Contd.)



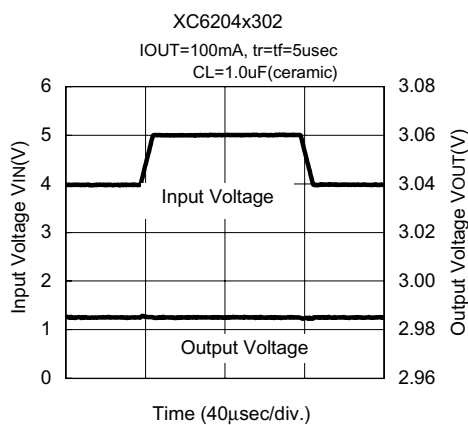
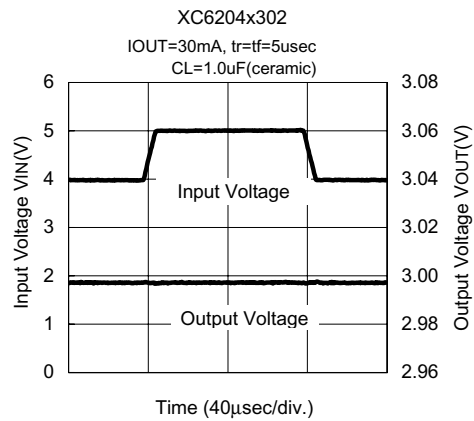
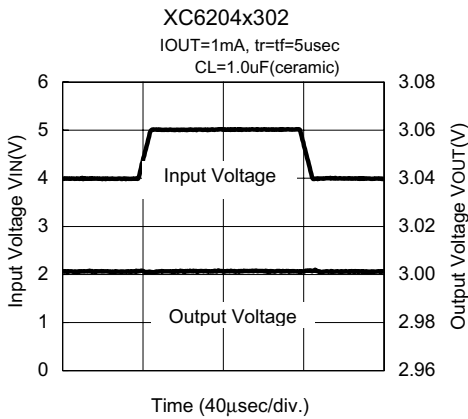
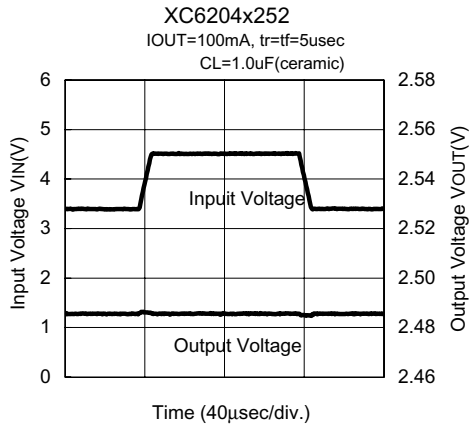
(7) CE Pin Threshold Voltage vs. Ambient Temperature



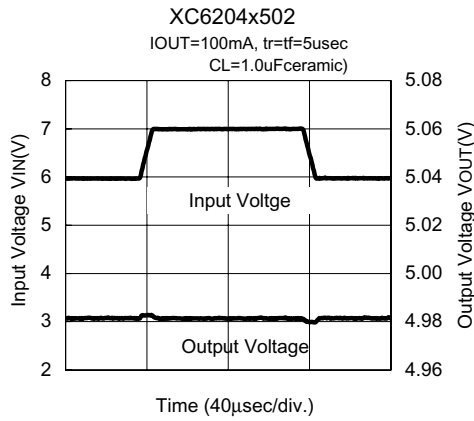
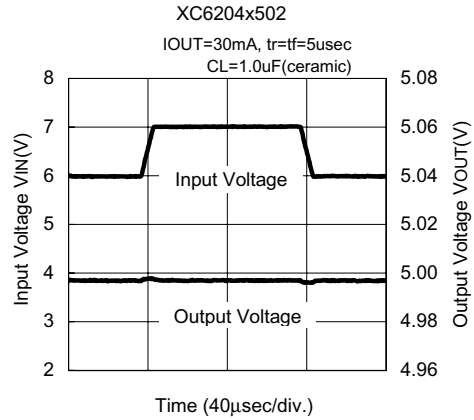
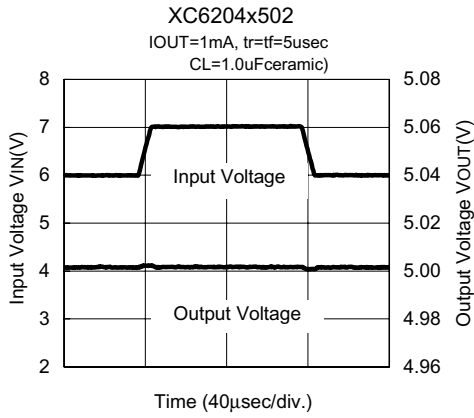
(8) Input Transient Response



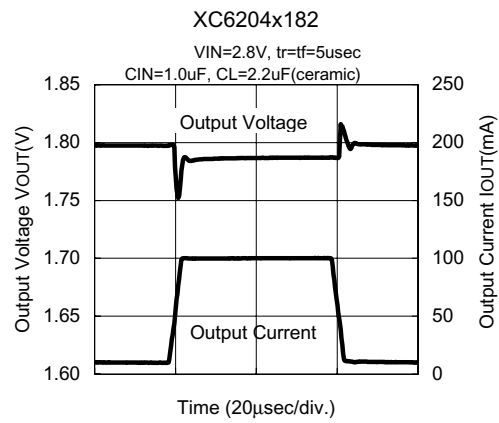
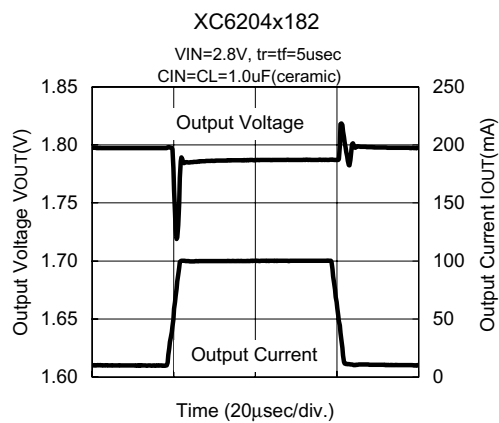
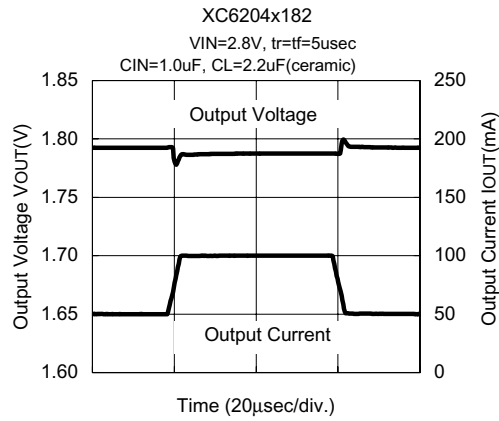
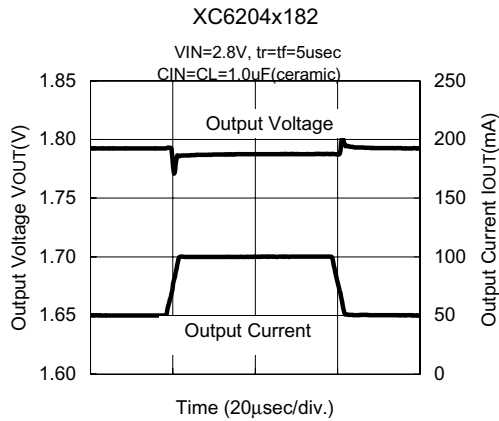
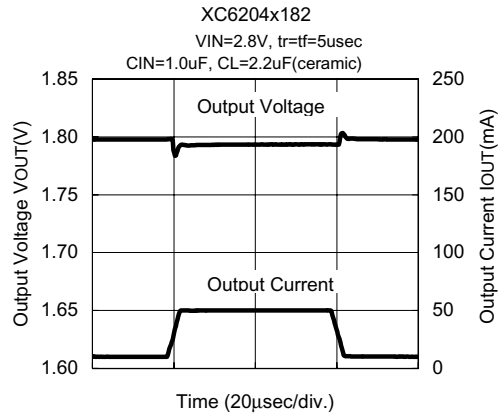
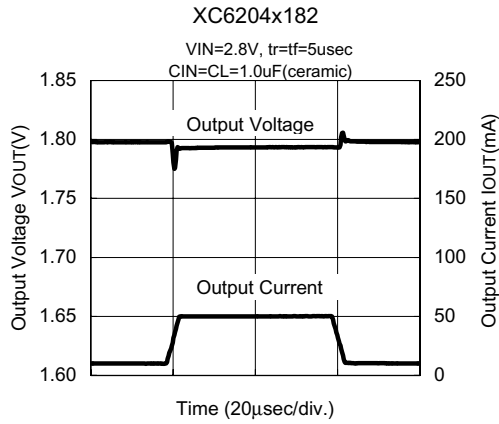
(8) Input Transient Response (Contd.)



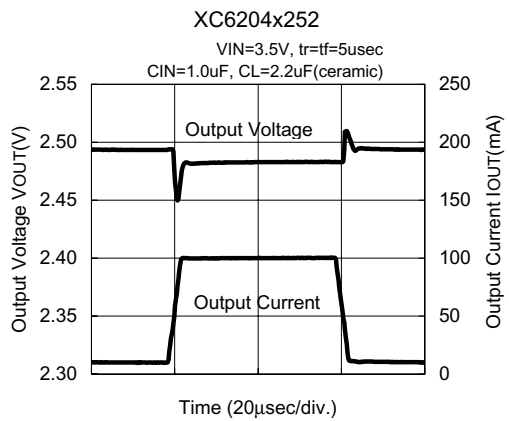
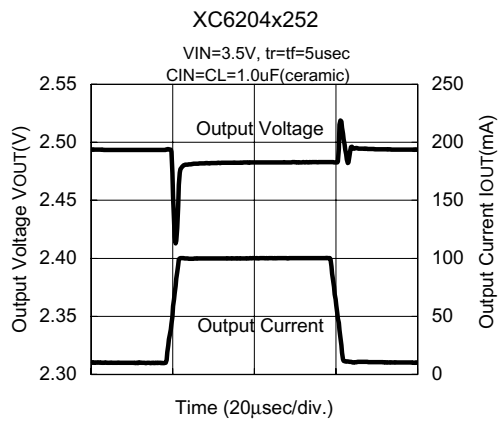
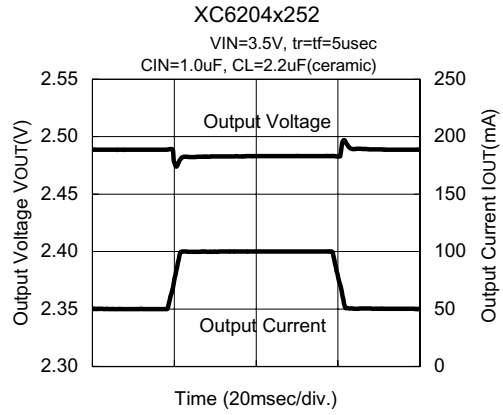
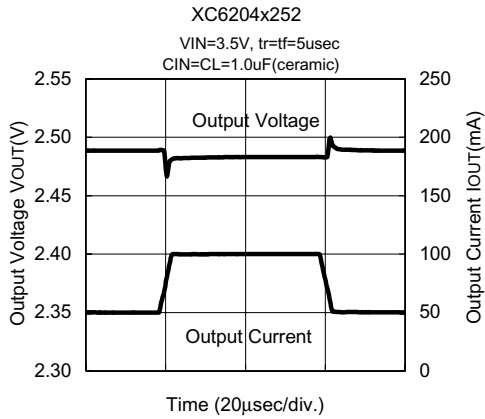
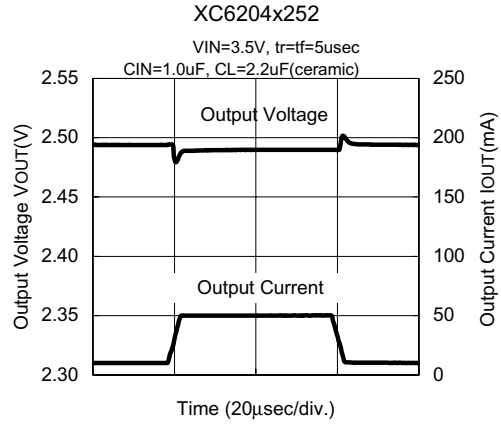
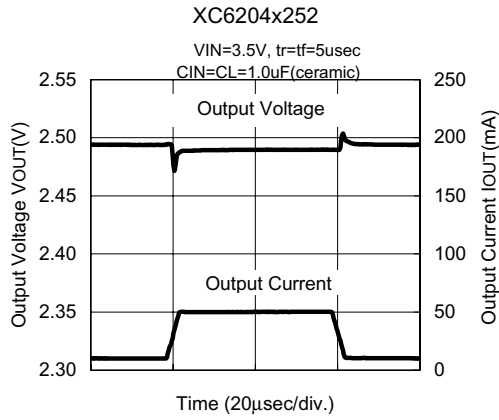
(8) Input Transient Response (Contd.)



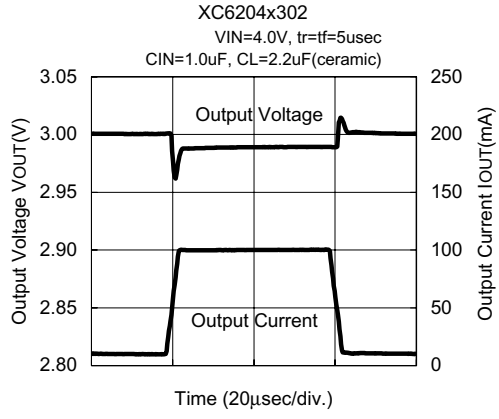
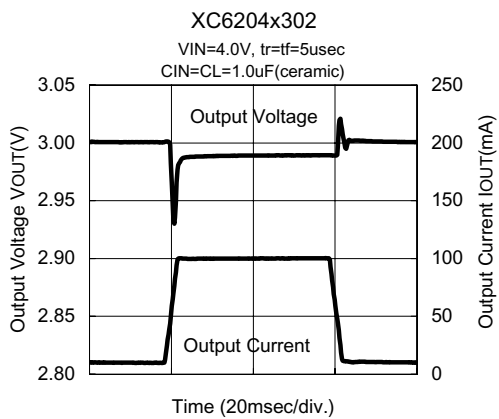
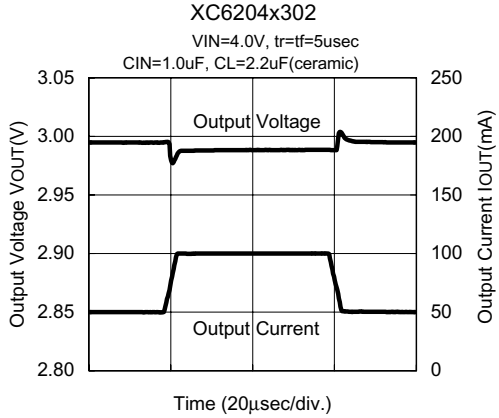
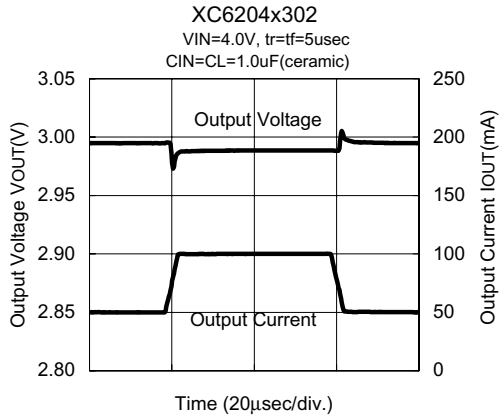
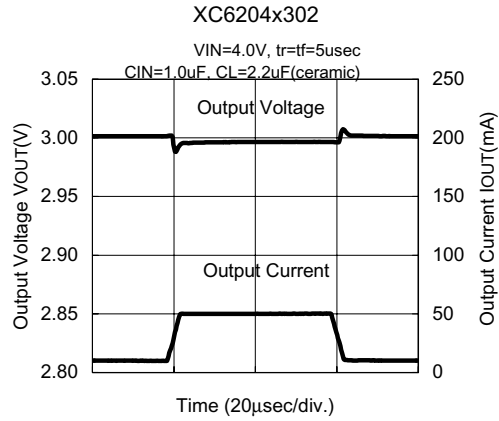
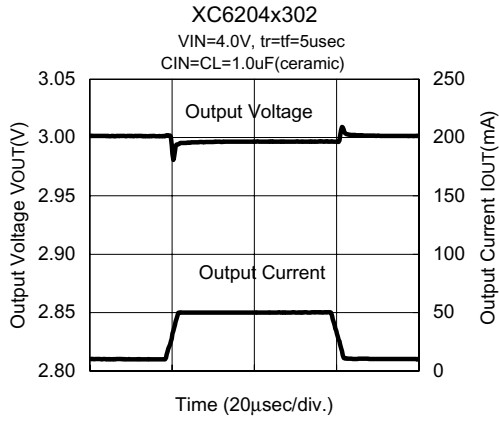
(9) Load Transient Response



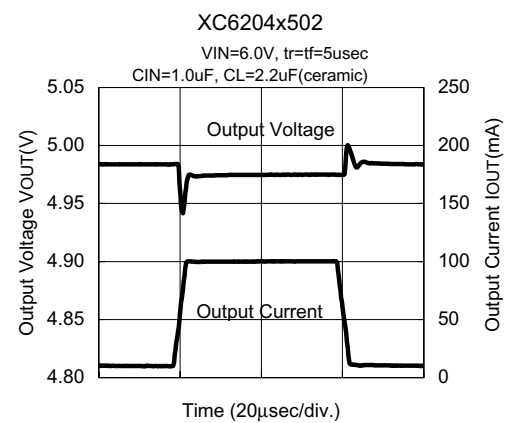
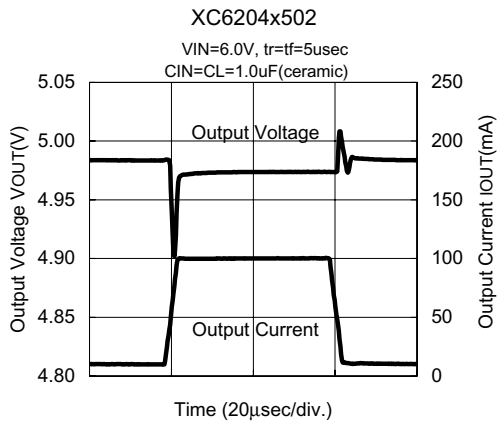
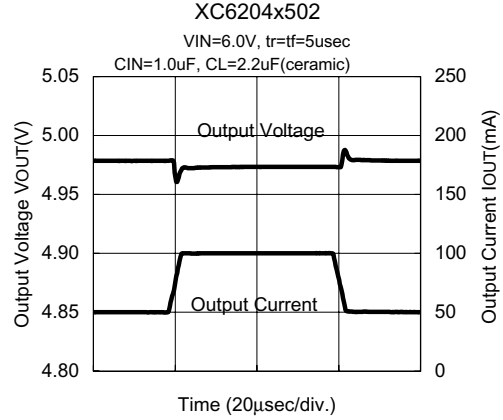
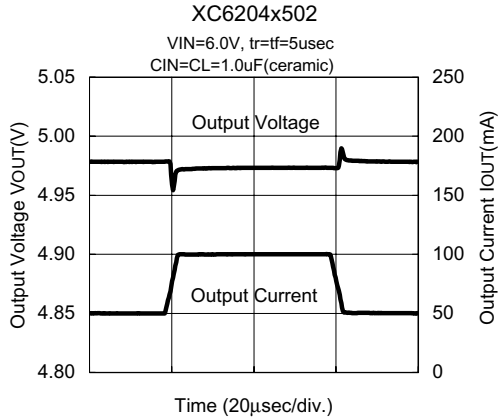
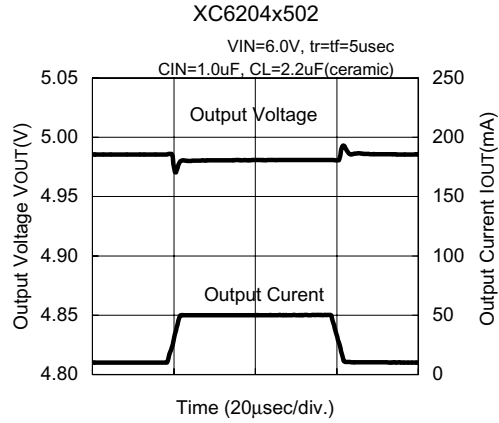
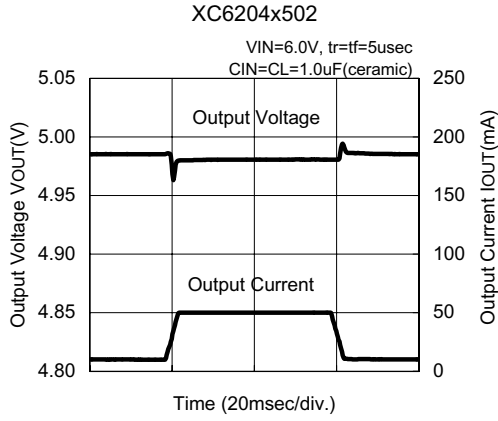
(9) Load Transient Response(Contd.)



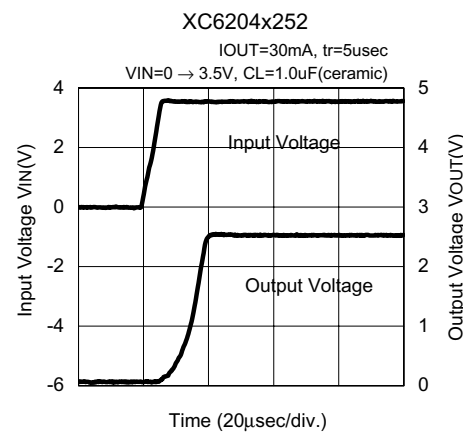
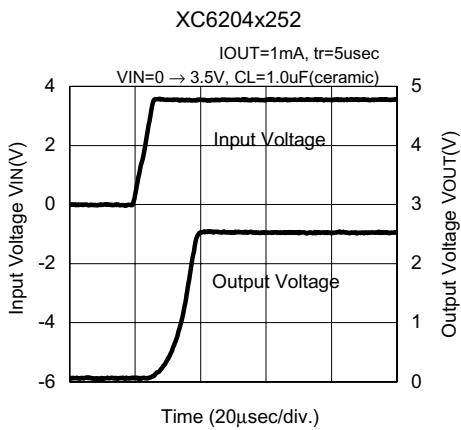
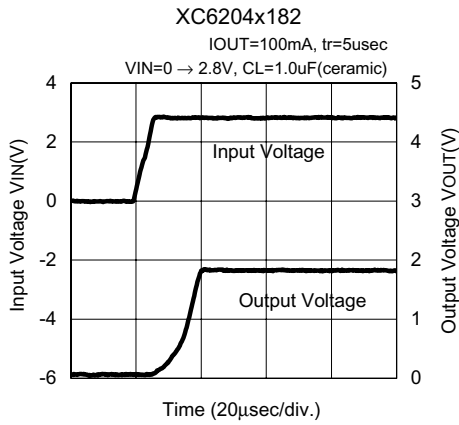
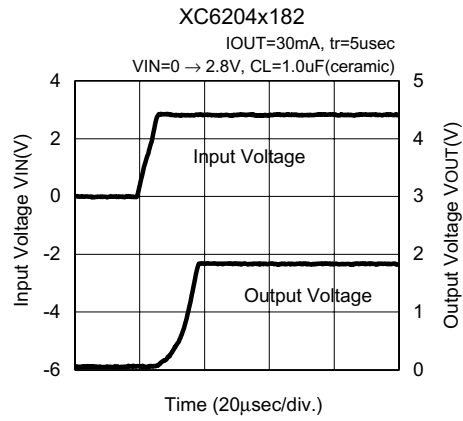
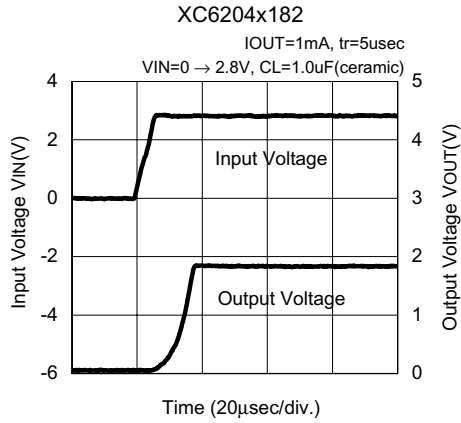
(9) Load Transient Response(Contd.)



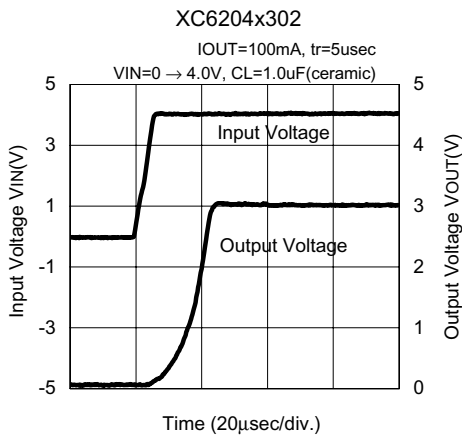
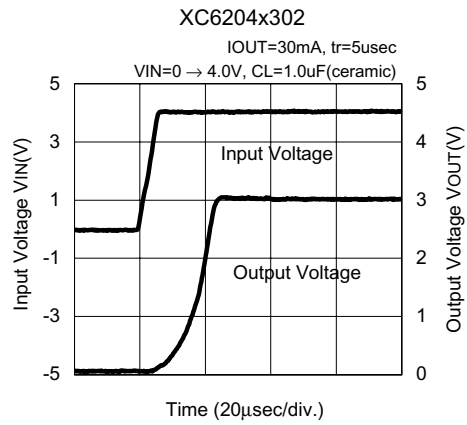
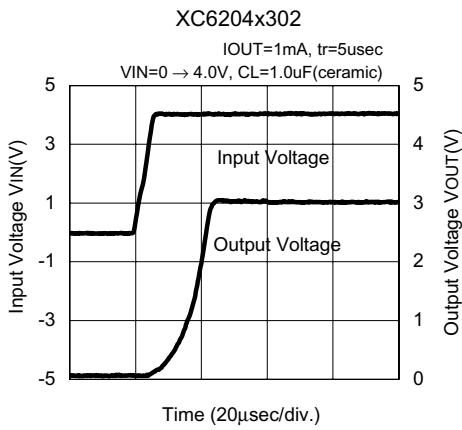
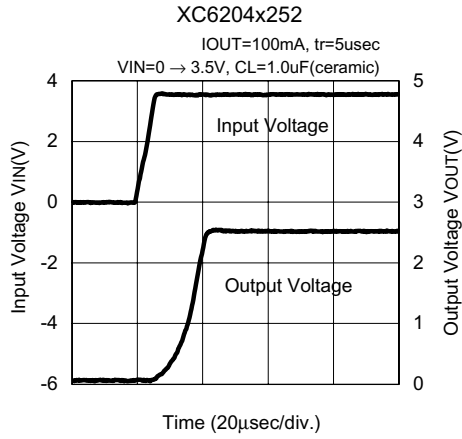
(9) Load Transient Response(Contd.)



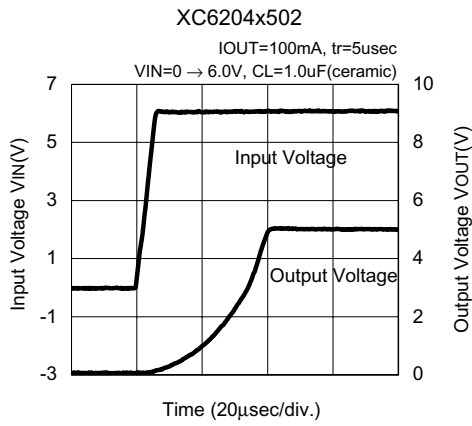
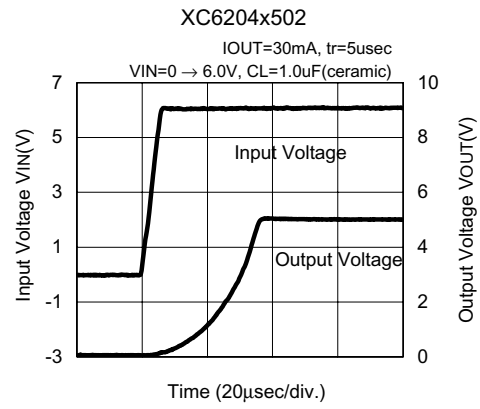
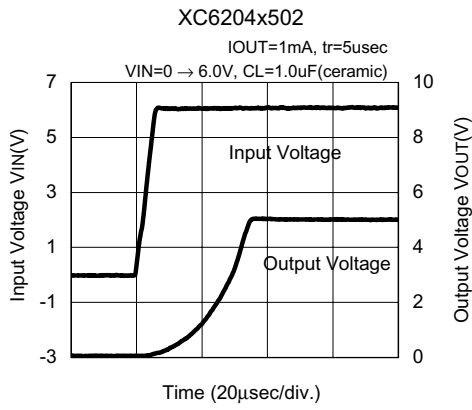
(10) Turn-On Response Time



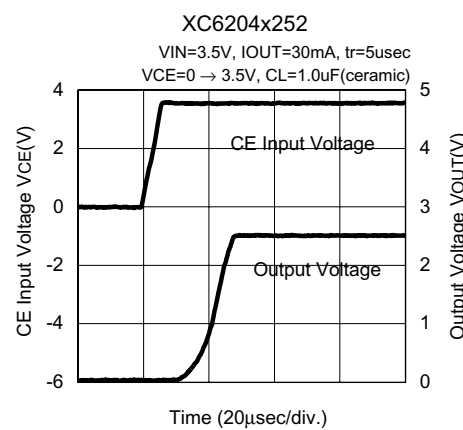
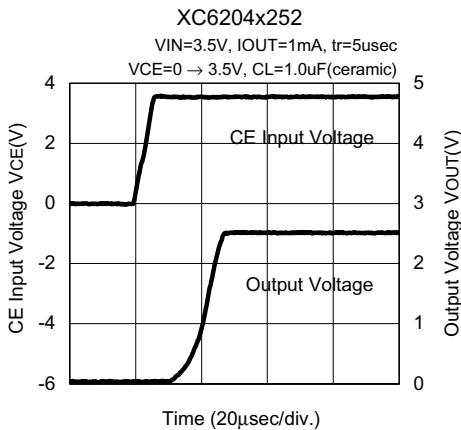
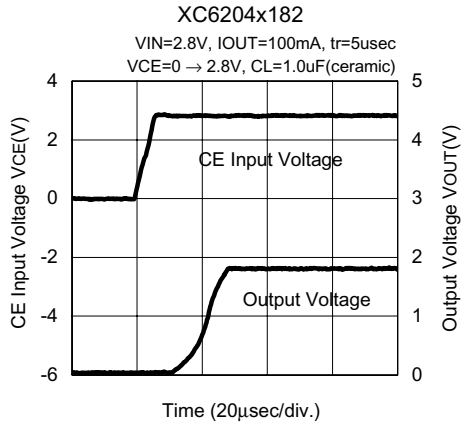
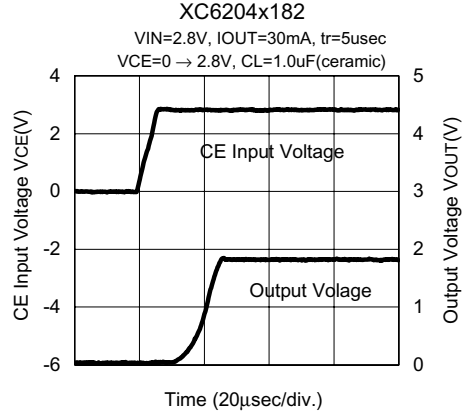
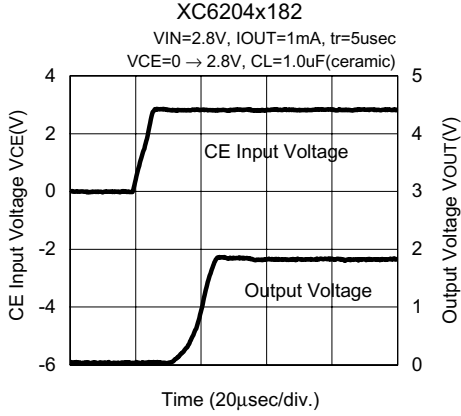
(10) Turn-On Response Time (Contd.)



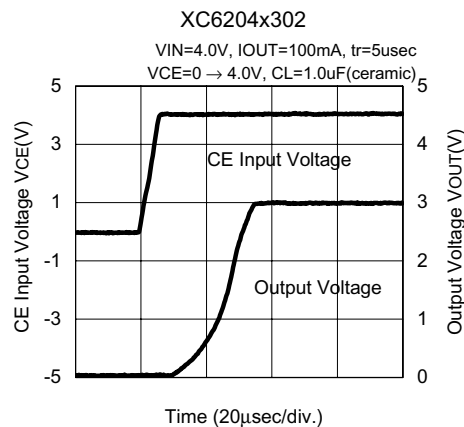
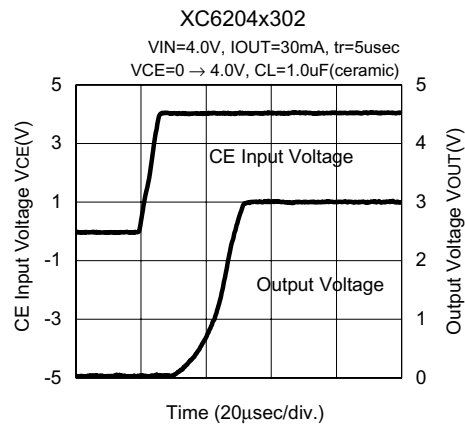
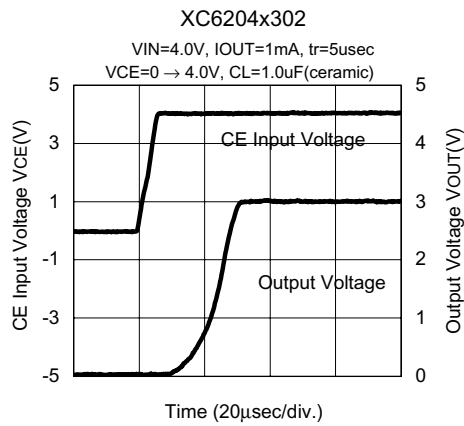
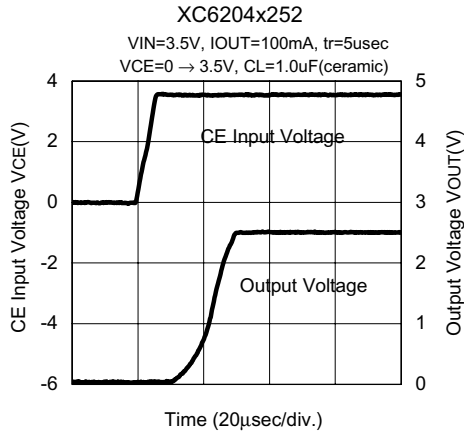
(10) Turn-On Response Time (Contd.)



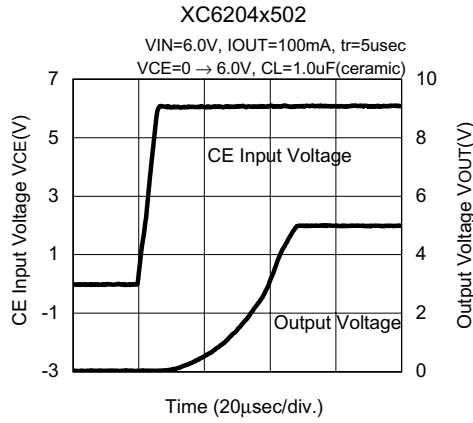
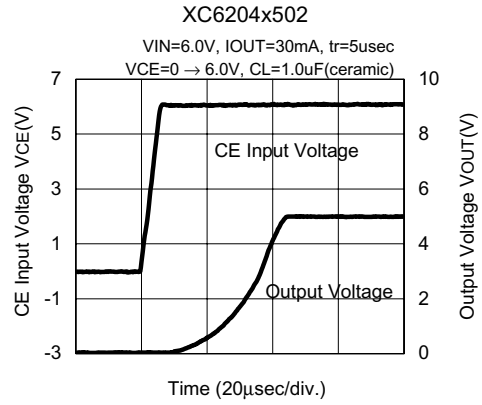
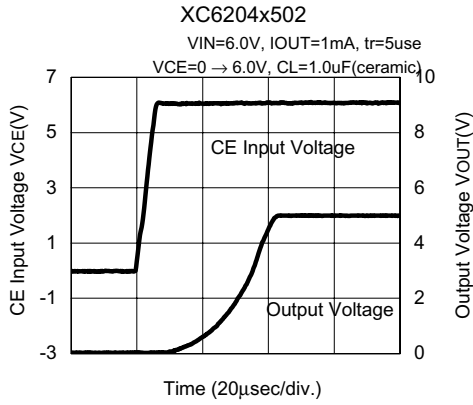
(11) Enable Response Time (These characteristics will not be affected by the nature of the CE pin's logic)



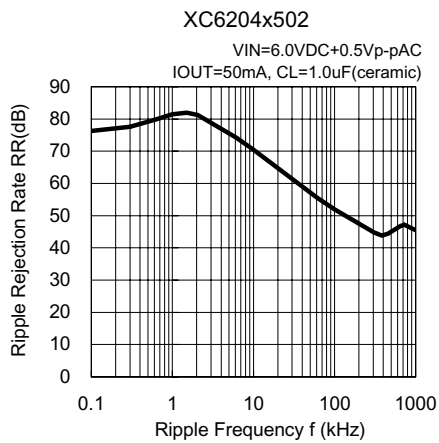
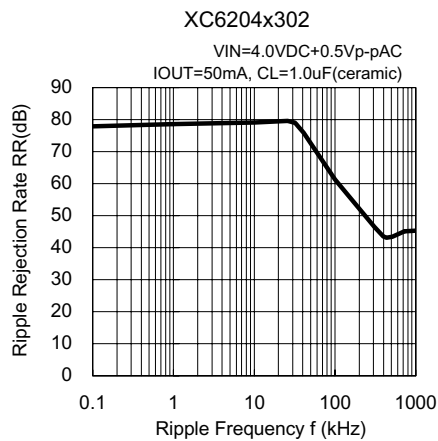
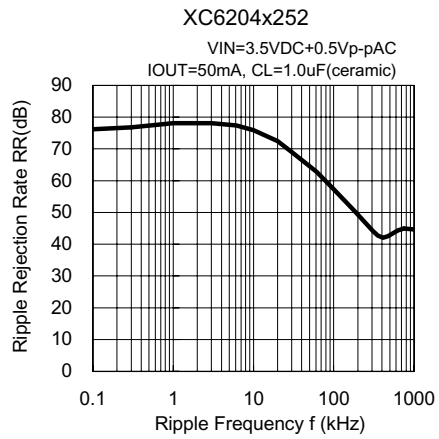
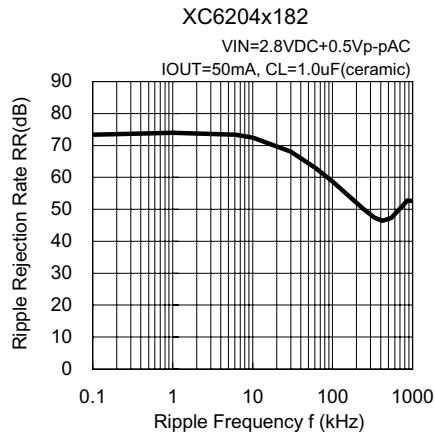
(11) Enable Response Time (Contd.)



(11) Enable Response Time (Contd.)



(12) Ripple Rejection Rate



(13) Output Noise Density

