

1.2V Low Voltage Operation, 150mA High Speed LDO Voltage Regulator

GENERAL DESCRIPTION

The XC6224 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, and a phase compensation circuit.

This IC is suitable for a local power supply placed in adjacent to the system logic LSI or others, because of low input voltage operation, using an ultra small package USPN-4B02 (0.75mm x 0.95mm) and stable operation with a small phase compensation capacitor (C_L) 0.47 μ F.

Also, this IC has fast transient response and high ripple rejection (70dB @ 1kHz).

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 over current protection circuit is integrated and operates when the output current reaches current limit level.

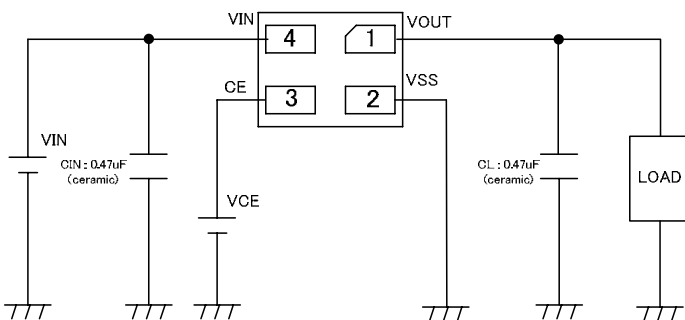
APPLICATIONS

Smart phones / Mobile phones
 Digital still cameras
 Mobile devices / terminals
 Bluetooth
 Wireless LAN
 Digital TV tuners

FEATURES

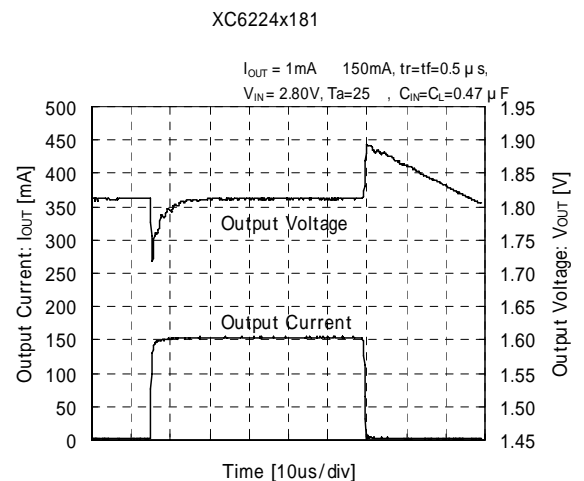
| | |
|--------------------------------------|---|
| Maximum Output Current | : 150mA |
| Operating Voltage Range | : 1.2V ~ 3.6V |
| High Accuracy | : $\pm 1.5\%$ ($V_{OUT} = 1.25V \sim 3.0V$) $\pm 20mV$ ($V_{OUT} = 0.8V \sim 1.20V$) |
| Low Power Consumption | : 33 μ A (TYP.) |
| Stand-by Current | : 0.1 μ A |
| High Ripple Rejection | : 70dB@1kHz |
| Dropout Voltage | : 210mV@150mA ($V_{OUT}=2.8V$) |
| Protection Circuits | : Current Limiter Short Circuit Protection |
| ON/OFF Control | : Active High C_L Auto Discharge Function |
| Output Capacitor | : Low ESR Capacitor |
| Operating Ambient Temperature | : -40 ~ +85 |
| Packages | : USPN-4B02 SSOT-24 SOT-25 |
| Environmentally Friendly | : EU RoHS Compliant, Pb Free |

TYPICAL APPLICATION CIRCUIT

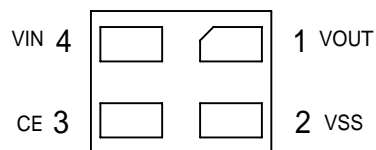


USPN-4B02 0.75mm x 0.95mm size
(BOTTOM VIEW)

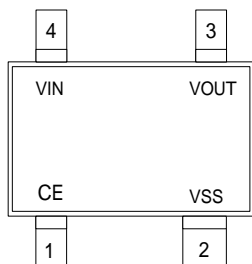
TYPICAL PERFORMANCE CHARACTERISTICS



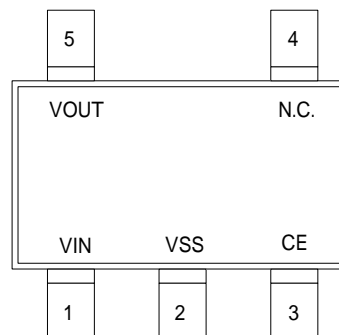
PIN CONFIGURATION



USPN-4B02
(BOTTOM VIEW)



SSOT-24
(TOP VIEW)



SOT-25
(TOP VIEW)

PIN ASSIGNMENT

| PIN NUMBER | | | PIN NAME | FUNCTIONS |
|------------|---------|--------|------------------|----------------|
| USPN-4B02 | SSOT-24 | SOT-25 | | |
| 4 | 4 | 1 | V _{IN} | Power Input |
| 1 | 3 | 5 | V _{OUT} | Output |
| 2 | 2 | 2 | V _{SS} | Ground |
| 3 | 1 | 3 | CE | ON/OFF Control |
| - | - | 4 | NC | No Connection |

PIN LOGIC CONDITION

| PIN NAME | DESIGNATOR | CONDITIONS |
|----------|------------|---------------------------|
| CE | L | 0V V _{CE} 0.3V |
| | H | 1.0V V _{CE} 3.6V |
| | OPEN | V _{CE} =OPEN |

FUNCTION CHART FOR CE PIN

| DESIGNATOR | IC OPERATION |
|------------|----------------------------|
| H | ON |
| L | OFF (Stand-by) |
| OPEN | Undefined state in XC6224A |
| | OFF(Stand-by) in XC6224B* |

H=High Level

L=Low Level

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

PRODUCT CLASSIFICATION

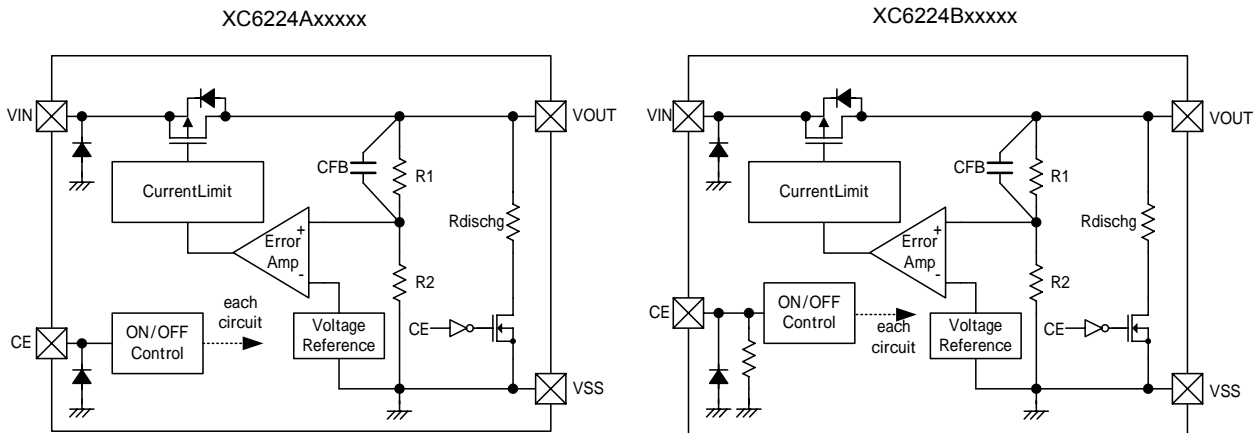
Ordering Information

XC6224 - (*)

| DESIGNATOR | ITEM | SYMBOL | DESCRIPTION |
|------------|---|---------|---|
| | Type of Regulator | A | CE Active High, Without CE pull-down, with C _L Discharge |
| | | B | CE Active High, With CE pull-down, with C _L Discharge |
| | Output Voltage | 08 ~ 30 | ex.) 2.5V =2, =5 |
| | Output Voltage (The 2 nd Decimal Place) | 1 | {x.x0V} (the 2 nd decimal place is "0") |
| | | B | {x.x5V} (the 2 nd decimal place is "5") |
| - | Packages (Order Unit) | 7R-G | USPN-4B02 (5,000/Reel) |
| | | MR-G | SOT-25 (3,000/Reel) |
| | | NR-G | SSOT-24 (3,000/Reel) |

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

BLOCK DIAGRAMS



ABSOLUTE MAXIMUM RATINGS

| PARAMETER | SYMBOL | RATINGS | UNITS | |
|-----------------------------------|-----------|-----------------------------------|-------|-----------------------------------|
| Input Voltage | V_{IN} | $V_{SS}-0.3 \sim +4.6$ | V | |
| Output Current | I_{OUT} | 180 ^(*1) | mA | |
| Output Voltage | V_{OUT} | $V_{SS}-0.3 \sim V_{IN}+0.3$ | V | |
| CE Input Voltage | V_{CE} | $V_{SS}-0.3 \sim 4.6$ | V | |
| Power Dissipation | USPN-4B02 | 100 | mW | |
| | | 550 (PCB mounted) ^(*2) | | |
| | | SSOT24 | | 150 |
| | | | | 500 (PCB mounted) ^(*2) |
| | | SOT-25 | | 250 |
| 600 (PCB mounted) ^(*2) | | | | |
| Operating Ambient Temperature | T_{opr} | $-40 \sim +85$ | | |
| Storage Temperature | T_{stg} | $-55 \sim +125$ | | |

*1: Please use within the range of $I_{OUT} \cdot Pd / (V_{IN} - V_{OUT})$

*2: This is a reference data taken by using the test board. Please refer to page 21 ~ 23 for details.

ELECTRICAL CHARACTERISTICS

XC6224Axxxxx

Ta=25

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNITS | CURCUITS |
|--|--|--|---|------------------------------------|---|-------|----------|
| Output Voltage | V _{OUT(E)} ⁽³⁾ | V _{OUT(T)} 1.25V V _{CE} =V _{IN} , I _{OUT} =10mA | V _{OUT(T)} ×0.985 ⁽²⁾ | V _{OUT(T)} ⁽²⁾ | V _{OUT(T)} ×1.015 ⁽²⁾ | V | |
| | | V _{OUT(T)} 1.2V V _{CE} =V _{IN} , I _{OUT} =10mA | -20mV ⁽⁷⁾ | V _{OUT(T)} ⁽²⁾ | +20mV ⁽⁷⁾ | | |
| Maximum Output Current | I _{OUTMAX} | V _{CE} =V _{IN} | 150 | - | - | mA | |
| Load Regulation | ΔV _{OUT} | V _{CE} =V _{IN} 0.1mA I _{OUT} 150mA | - | 5 | 20 | mV | |
| Dropout Voltage ⁽⁴⁾ | V _{dif} | I _{OUT} =150mA V _{CE} =V _{IN} , V _{IN} =V _{OUT(E)} ×0.98 ⁽³⁾ | E-1 | | | mV | |
| Supply Current | I _{DD} | V _{CE} =V _{IN} , I _{OUT} =0mA | - | 33 | 77 | μA | |
| Stand-by Current | I _{STBY} | V _{CE} =V _{SS} | - | 0.01 | 0.4 | μA | |
| Line Regulation | ΔV _{OUT} / (ΔV _{IN} ·V _{OUT}) | V _{OUT(T)} 1.10V V _{OUT(T)} +0.5V V _{IN} 3.6V V _{CE} =V _{IN} , I _{OUT} =10mA ⁽²⁾ | - | 0.04 | 0.37 | %V | |
| | | V _{OUT(T)} 1.05V 1.6V V _{IN} 3.6V V _{CE} =V _{IN} , I _{OUT} =10mA ⁽²⁾ | | | | | |
| Input Voltage | V _{IN} | | 1.2 | - | 3.6 | V | |
| Output Voltage Temperature Characteristics | ΔV _{OUT} / (ΔTa·V _{OUT}) | V _{CE} =V _{IN} , I _{OUT} =30mA ⁽¹⁾ -40 Ta 85 | - | ± 100 | - | ppm/ | |
| Power Supply Rejection Ratio | PSRR | V _{CE} =V _{IN} · When 0.80V V _{OUT(T)} 2.60V, V _{IN} =3.0V + 0.5Vp-pAC · 2.65V V _{OUT(T)} 3.00V V _{IN} =3.3V+0.25Vp-pAC I _{OUT} =30mA, f=1kHz ⁽²⁾ | - | 70 | - | dB | |
| Current Limit | I _{LIM} | V _{CE} =V _{IN} | 150 | 250 | - | mA | |
| Short Current | I _{SHORT} | V _{CE} =V _{IN} , V _{OUT} is connected to V _{SS} | - | 35 | - | mA | |
| CE High Level Voltage | V _{CEH} | | 1.0 | - | 3.6 | V | |
| CE Low Level Voltage | V _{CEL} | | - | - | 0.3 | V | |
| CE High Level Current | I _{CEH} | V _{CE} =V _{IN} A Type | -0.1 | 0 | 0.1 | μA | |
| CE High Level Current | I _{CEL} | V _{CE} =V _{SS} | -0.1 | 0 | 0.1 | μA | |
| C _L Discharge Resistance | R _{DCHG} | V _{IN} =3.6V, V _{CE} =V _{SS} | - | 450 | - | Ω | |

NOTE:

*1: Unless otherwise specified, input voltage conditions are;

0.80V V_{OUT(T)} 2.60V : {V_{IN}=V_{OUT(T)}+1.0V}

2.65V V_{OUT(T)} 2.80V : {V_{IN}=3.3V}

2.85V V_{OUT(T)} 3.00V : {V_{IN}=3.5V}

*2: V_{OUT(T)}: Nominal output voltage

*3: V_{OUT(E)}: Effective output voltage

This output voltages are measured at the constant current when the input voltages are stable as Note 1.

*4: V_{dif} = {V_{IN1}⁽⁵⁾ - V_{OUT1}⁽⁶⁾}

*5: V_{IN1}=The input voltage when V_{OUT1} appears as input voltage is gradually decreased.

*6: V_{OUT1}=A voltage equal to 98% of the output voltage whenever an amply stabilized I_{OUT} {V_{OUT(T)}+1.0V} is input

*7: V_{OUT(T)}±20mV is the specification value of output voltage where V_{OUT(T)} 1.20V

ELECTRICAL CHARACTERISTICS (Continued)

XC6224Bxxxxx

Ta=25

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNITS | CIRCUITS |
|--|--|---|---|------------------------------------|---|-------|----------|
| Output Voltage | V _{OUT(E)} ⁽³⁾ | V _{OUT(T)} 1.25V V _{CE} =V _{IN} , I _{OUT} =10mA | V _{OUT(T)} ×0.985 ⁽²⁾ | V _{OUT(T)} ⁽²⁾ | V _{OUT(T)} ×1.015 ⁽²⁾ | V | |
| | | V _{OUT(T)} 1.2V, V _{IN} =2.5V V _{CE} =V _{IN} , I _{OUT} =10mA | -20mV ⁽⁷⁾ | V _{OUT(T)} ⁽²⁾ | +20mV ⁽⁷⁾ | | |
| Maximum Output Current | I _{OUTMAX} | V _{CE} =V _{IN} ⁽¹⁾ | 150 | - | - | mA | |
| Load Regulation | ΔV _{OUT} | V _{CE} =V _{IN} ⁽¹⁾ 0.1mA I _{OUT} 150mA | - | 5 | 20 | mV | |
| Dropout Voltage ⁽⁴⁾ | V _{dif} | I _{OUT} =150mA, V _{CE} =V _{IN} V _{IN} =V _{OUT(E)} ×0.98 ⁽³⁾ | E-1 | | | mV | |
| Supply Current | I _{DD} | V _{CE} =V _{IN} ⁽¹⁾ I _{OUT} =0mA | - | 33 | 77 | μA | |
| Stand-by Current | I _{STBY} | V _{CE} =V _{SS} | - | 0.01 | 0.4 | μA | |
| Line Regulation | ΔV _{OUT} / (ΔV _{IN} ·V _{OUT}) | V _{OUT(T)} 1.10V V _{OUT(T)} +0.5V V _{IN} 3.6V V _{CE} =V _{IN} , I _{OUT} =10mA ⁽²⁾ | - | 0.04 | 0.37 | %V | |
| | | V _{OUT(T)} 1.05V 1.6V V _{IN} 3.6V V _{CE} =V _{IN} , I _{OUT} =10mA ⁽²⁾ | | | | | |
| Input Voltage | V _{IN} | | 1.2 | - | 3.6 | V | |
| Output Voltage Temperature Characteristics | ΔV _{OUT} / (ΔTa·V _{OUT}) | V _{CE} =V _{IN} , I _{OUT} =30mA ⁽¹⁾ -40 Ta 85 | - | ± 100 | - | ppm/ | |
| Power Supply Rejection Ratio | PSRR | V _{CE} =V _{IN} ·When 0.80V V _{OUT(T)} 2.60V V _{IN} =3.0V + 0.5Vp-pAC ·2.65V V _{OUT(T)} 3.00V V _{IN} =3.3V+0.25Vp-pAC I _{OUT} =30mA, f=1kHz ⁽²⁾ | - | 70 | - | dB | |
| Current Limit | I _{LIM} | V _{CE} =V _{IN} | 150 | 250 | - | mA | |
| Short Current | I _{SHORT} | V _{CE} =V _{IN} , V _{OUT} is connected to V _{SS} | - | 35 | - | mA | |
| CE High Level Voltage | V _{CEH} | | 1.0 | - | 3.6 | V | |
| CE Low Level Voltage | V _{CEL} | | - | - | 0.3 | V | |
| CE High Level Current | I _{CEH} | V _{CE} =V _{IN} B Type | - | 5.5 | 13.0 | μA | |
| CE High Level Current | I _{CEL} | V _{CE} =V _{SS} | -0.1 | 0 | 0.1 | μA | |
| C _L Discharge Resistance | R _{DCHG} | V _{IN} =3.6V, V _{CE} =V _{SS} | - | 450 | - | Ω | |

NOTE:

*1: Unless otherwise specified, input voltage conditions are;

0.80V V_{OUT(T)} 2.60V : {V_{IN}=V_{OUT(T)}+1.0V}

2.65V V_{OUT(T)} 2.80V : {V_{IN}=3.3V}

2.85V V_{OUT(T)} 3.00V : {V_{IN}=3.5V}

*2: V_{OUT(T)}: Nominal output voltage

*3: V_{OUT(E)}: Effective output voltage

This output voltages are measured at the constant current when the input voltages are stable as Note 1.

*4: V_{dif} = {V_{IN1}⁽⁵⁾ - V_{OUT1}⁽⁶⁾}

*5: V_{IN1}=The input voltage when V_{OUT1} appears as input voltage is gradually decreased.

*6: V_{OUT1}=A voltage equal to 98% of the output voltage whenever an amply stabilized I_{OUT} {V_{OUT(T)}+1.0V} is input

*7: V_{OUT(T)}±20mV is the specification value of output voltage where V_{OUT(T)} 1.20V.

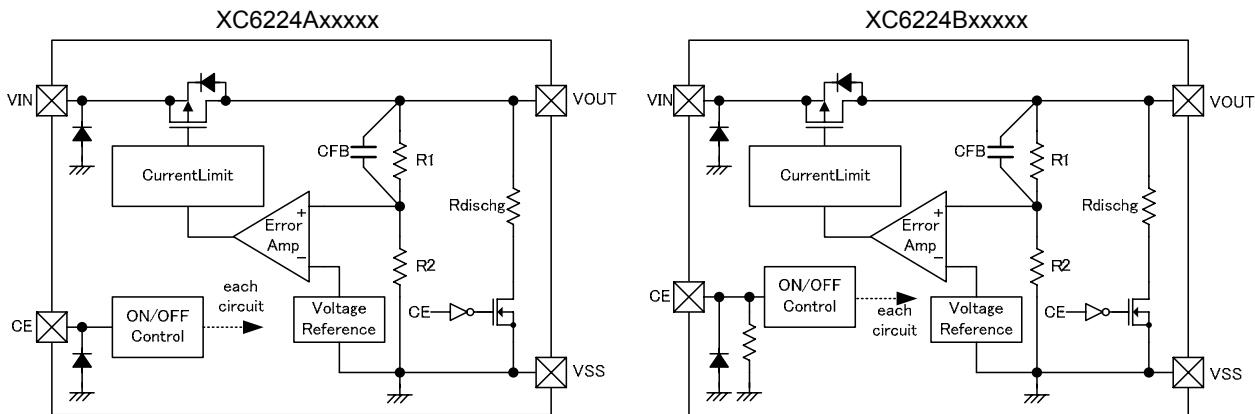
ELECTRICAL CHARACTERISTICS (Continued)

Voltage Table

| NOMINAL OUTPUT VOLTAGE (V) | OUTPUT VOLTAGE ^(*) (V) | | DROPOUT VOLTAGE (E-1) (mV) | |
|----------------------------------|--------------------------------------|--------|-------------------------------|------|
| | V _{OUT(E)} | | V _{dif} | |
| V _{OUT(T)} | MIN. | MAX. | TYP. | MAX. |
| 0.80 | 0.7800 | 0.8200 | - | - |
| 0.85 | 0.8300 | 0.8700 | - | - |
| 0.90 | 0.8800 | 0.9200 | - | - |
| 0.95 | 0.9300 | 0.9700 | - | - |
| 1.00 | 0.9800 | 1.0200 | - | - |
| 1.05 | 1.0300 | 1.0700 | - | - |
| 1.10 | 1.0800 | 1.1200 | - | - |
| 1.15 | 1.1300 | 1.1700 | - | - |
| 1.20 | 1.1800 | 1.2200 | 400 | 500 |
| 1.25 | 1.2313 | 1.2687 | | |
| 1.30 | 1.2805 | 1.3195 | | |
| 1.35 | 1.3298 | 1.3702 | | |
| 1.40 | 1.3790 | 1.4210 | | |
| 1.45 | 1.4283 | 1.4717 | | |
| 1.50 | 1.4775 | 1.5225 | | |
| 1.55 | 1.5268 | 1.5732 | | |
| 1.60 | 1.5760 | 1.6240 | | |
| 1.65 | 1.6253 | 1.6747 | | |
| 1.70 | 1.6745 | 1.7255 | | |
| 1.75 | 1.7238 | 1.7762 | | |
| 1.80 | 1.7730 | 1.8270 | 300 | 430 |
| 1.85 | 1.8223 | 1.8777 | | |
| 1.90 | 1.8715 | 1.9285 | | |
| 1.95 | 1.9208 | 1.9792 | | |
| 2.00 | 1.9700 | 2.0300 | | |
| 2.05 | 2.0193 | 2.0807 | | |
| 2.10 | 2.0685 | 2.1315 | | |
| 2.15 | 2.1178 | 2.1822 | | |
| 2.20 | 2.1670 | 2.2330 | | |
| 2.25 | 2.2163 | 2.2837 | | |
| 2.30 | 2.2655 | 2.3345 | | |
| 2.35 | 2.3148 | 2.3852 | | |
| 2.40 | 2.3640 | 2.4360 | | |
| 2.45 | 2.4133 | 2.4867 | | |
| 2.50 | 2.4625 | 2.5375 | 210 | 410 |
| 2.55 | 2.5118 | 2.5882 | | |
| 2.60 | 2.5610 | 2.6390 | | |
| 2.65 | 2.6103 | 2.6897 | | |
| 2.70 | 2.6595 | 2.7405 | | |
| 2.75 | 2.7088 | 2.7912 | | |
| 2.80 | 2.7580 | 2.8420 | | |
| 2.85 | 2.8073 | 2.8927 | | |
| 2.90 | 2.8565 | 2.9435 | | |
| 2.95 | 2.9058 | 2.9942 | | |
| 3.00 | 2.9550 | 3.0450 | | |

(*1) When V_{OUT(T)} 1.20V, the output voltage accuracy is ±20mV.
When V_{OUT(T)} 1.25V, the output voltage accuracy is ±1.5%.

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 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. Further, the IC's internal circuitry can be shutdown via the CE pin signal.

<Low ESR Capacitor>

The XC6224 needs an output capacitor C_L and a built-in phase compensation circuit for phase compensation. In order to ensure the stable phase compensation, please place an output capacitor C_L of 0.47 μF or bigger at the V_{OUT} pin as close as possible. For a stable power input, please connect an input capacitor C_{IN} of 0.47 μF between the V_{IN} pin and the V_{SS} pin.

<Current Limiter, Short-Circuit Protection>

The protection circuit operates as a combination of an output current limiter and fold-back short circuit protection. When load current reaches the current limit level, the output voltage drops. As a result, the load current starts to reduce with showing fold-back curve. The output current finally falls at the level of 35mA when the output pin is short-circuited.

<CE Pin>

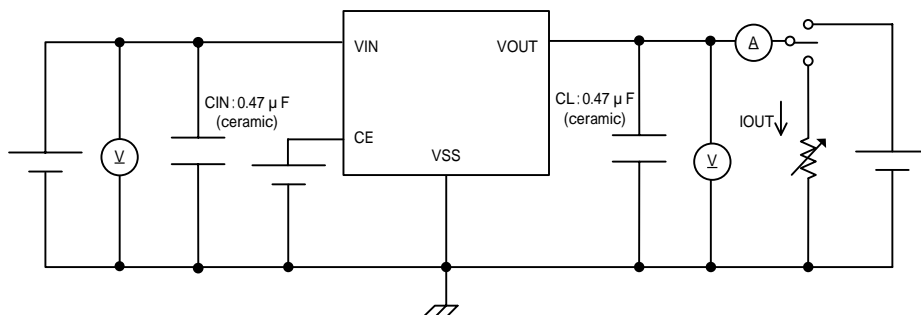
The IC's internal circuitry can be shutdown via the signal from the CE pin. In shutdown mode, output at the V_{OUT} pin will be pulled down to the V_{SS} level in the XC6224B series. When the CE pin is open, the output voltage becomes undefined state in the XC6224A series because of a high active and no pull-down. Although the CE pin is equal to CMOS input configuration, the CE pin input current which flows into a pull-down resistor will increase in the XC6224B series

NOTES ON USE

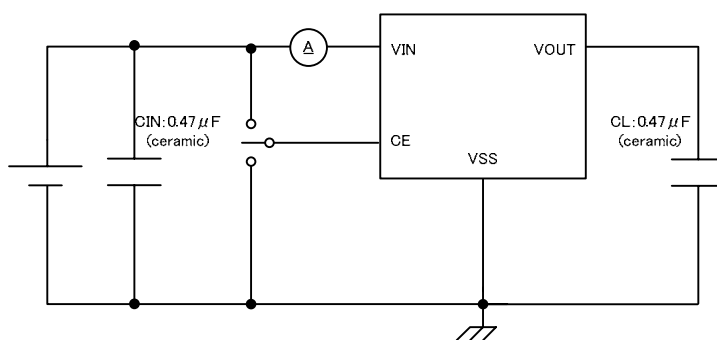
1. For temporary, transitional voltage drop or voltage rising phenomenon, the IC is liable to malfunction should the ratings be exceeded.
2. Torex places an importance on improving our products and its reliability. However, by any possibility, we would request user fail-safe design and post-aging treatment on system or equipment.
3. 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.
4. The input capacitor C_{IN} and the output capacitor C_L should be placed to the IC as close as possible with a shorter wiring.

TEST CIRCUITS

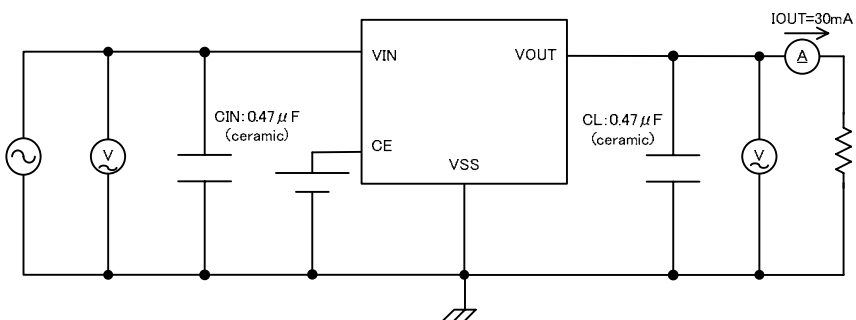
Circuit



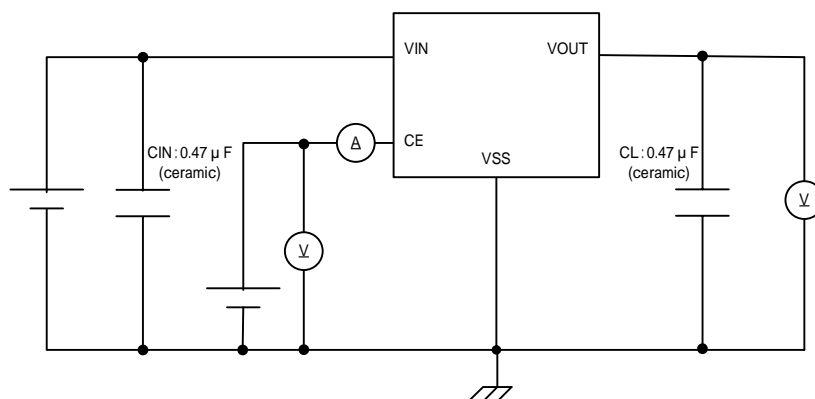
Circuit



Circuit

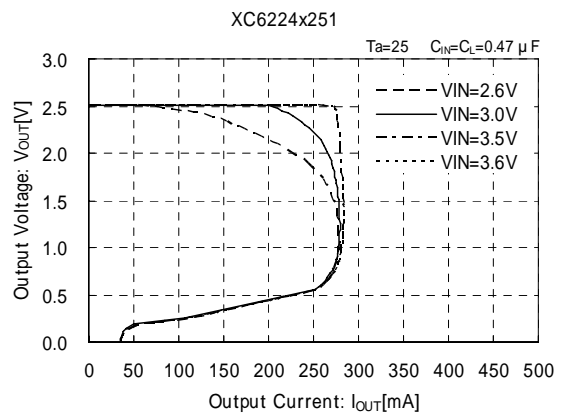
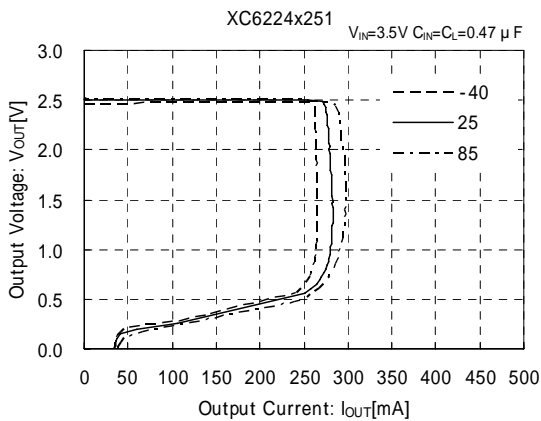
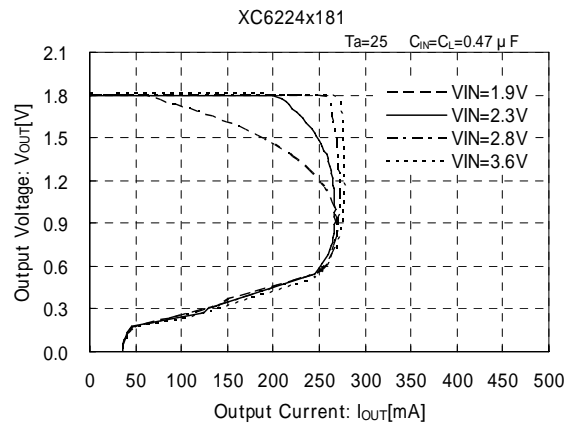
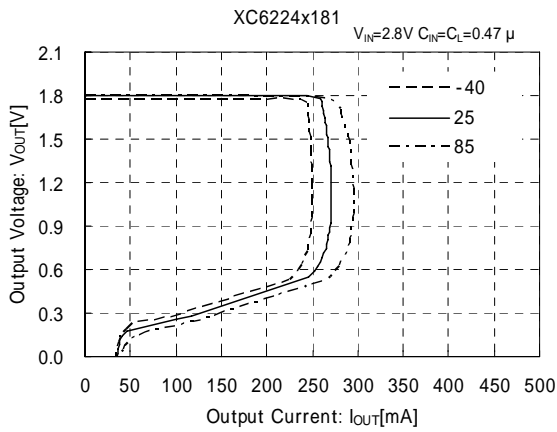
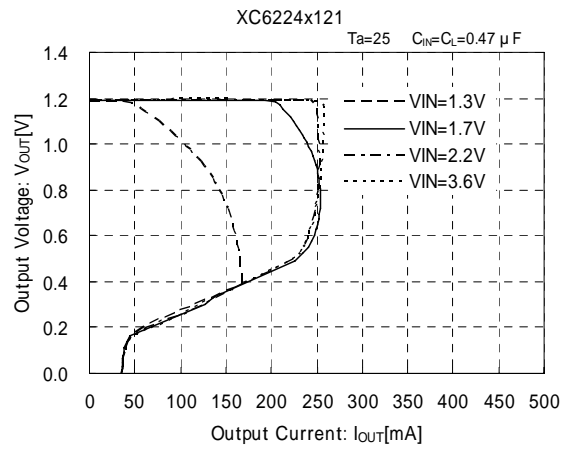
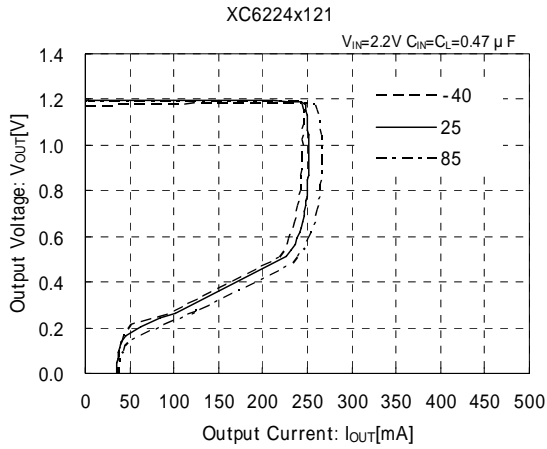


Circuit



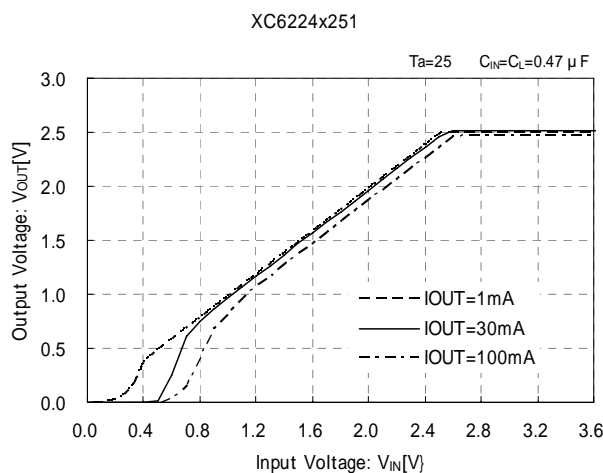
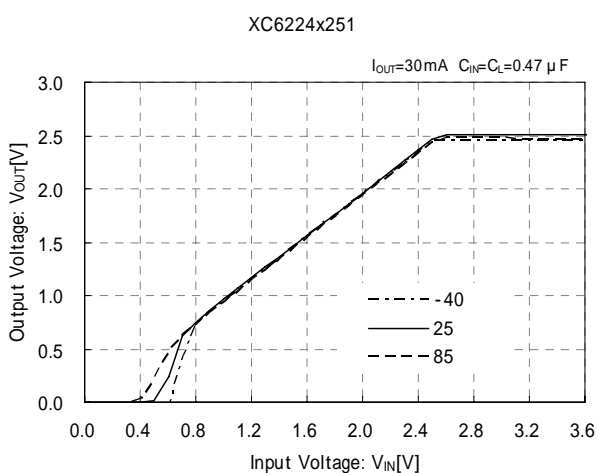
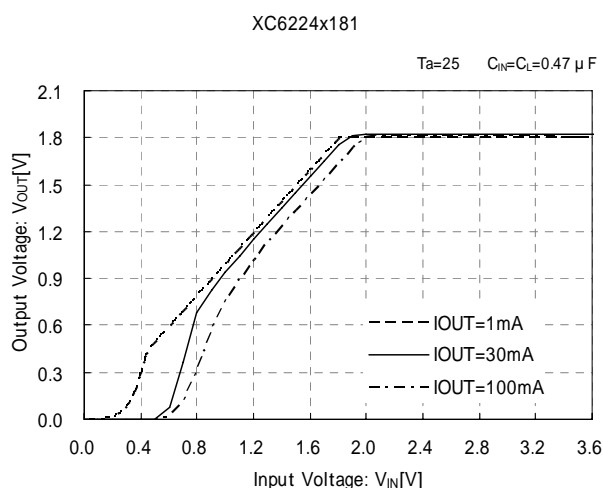
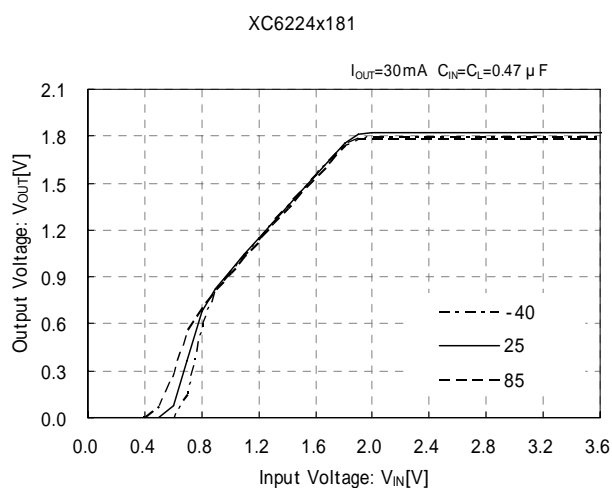
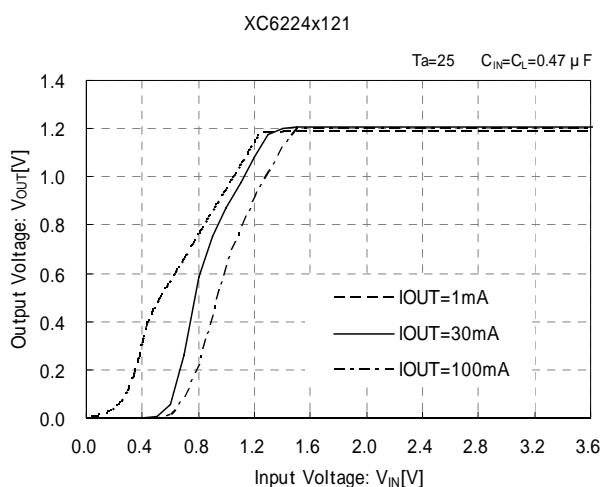
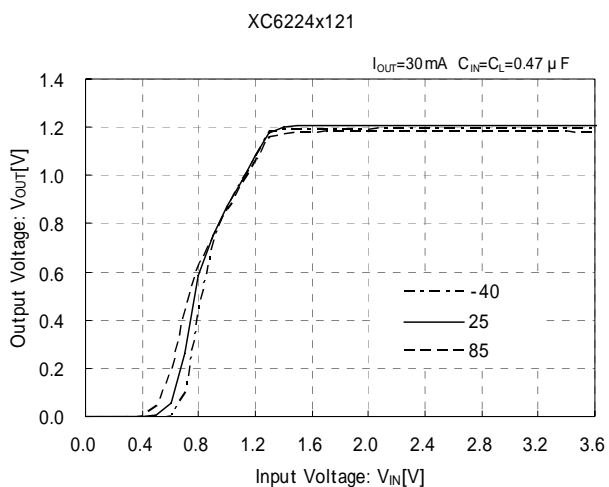
TYPICAL PERFORMANCE CHARACTERISTICS

(1) Output Voltage vs. Output Current



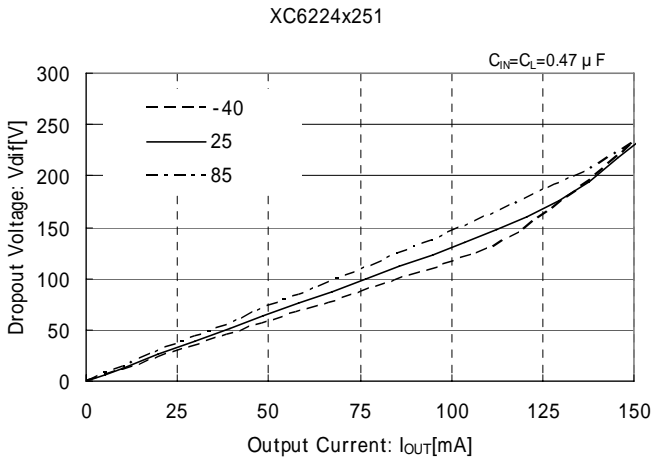
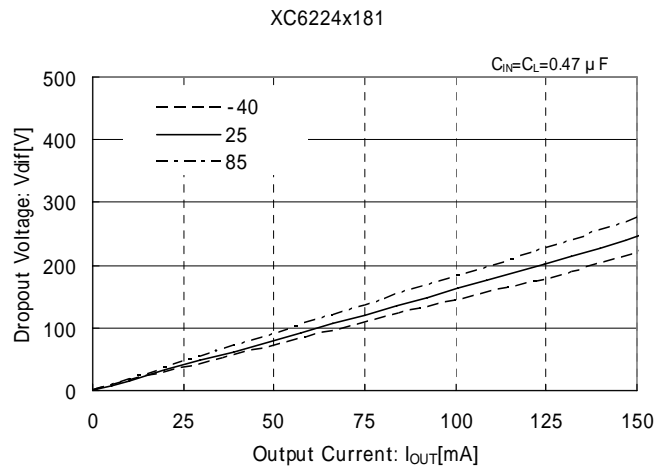
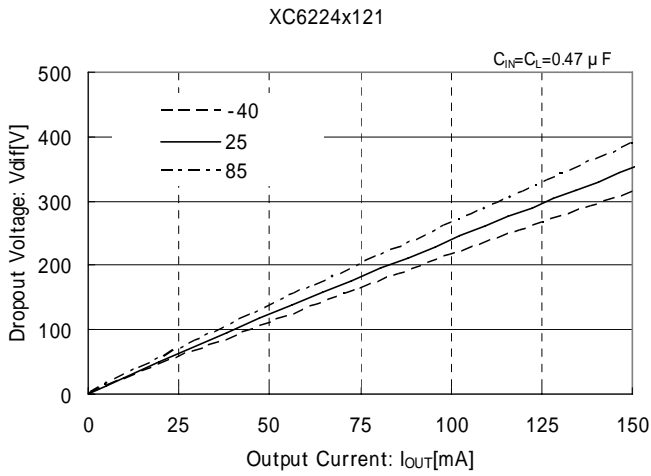
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2) Output Voltage vs. Input Voltage

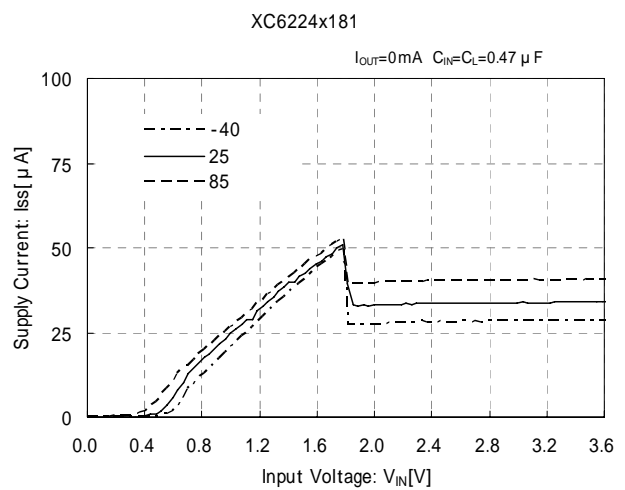
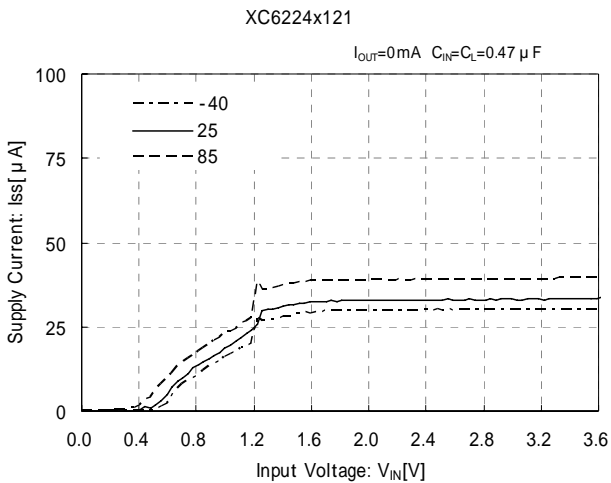


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(3) Dropout Voltage vs. Output Current

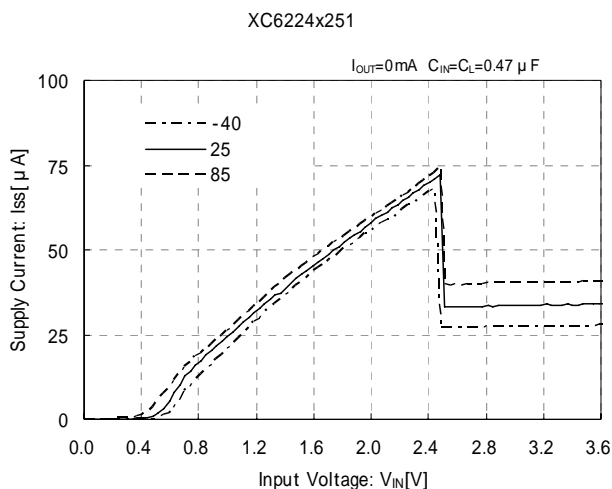


(4) Supply Current vs. Input Voltage

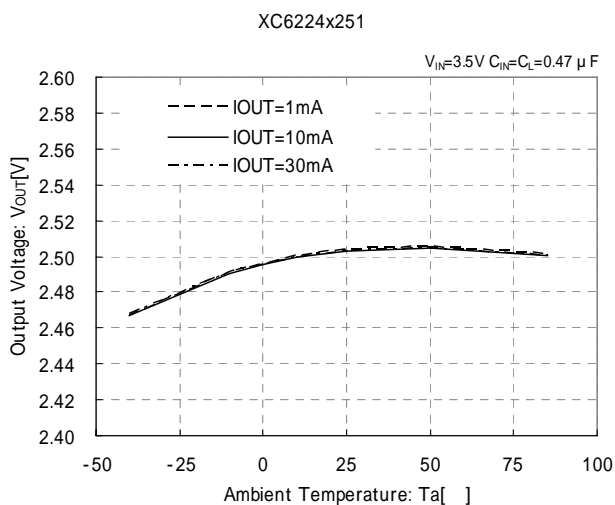
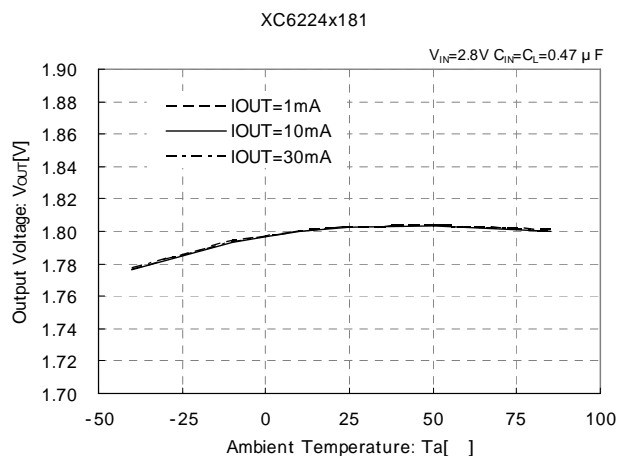
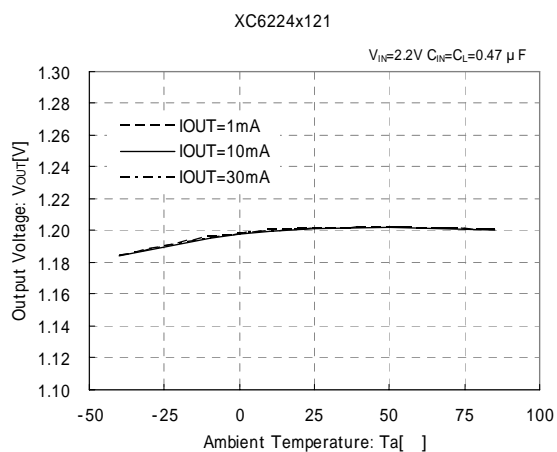


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

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

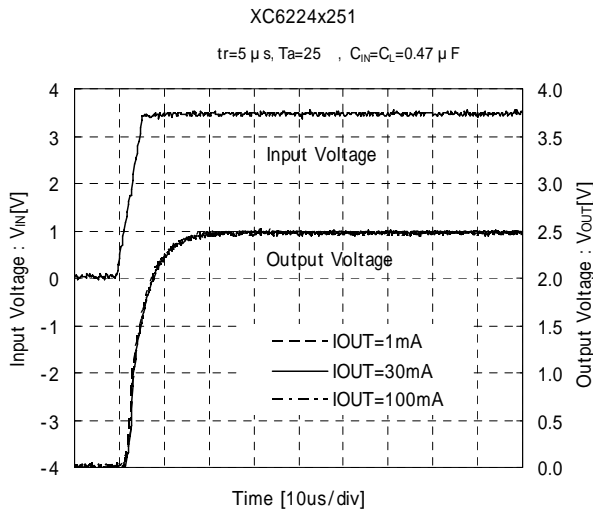
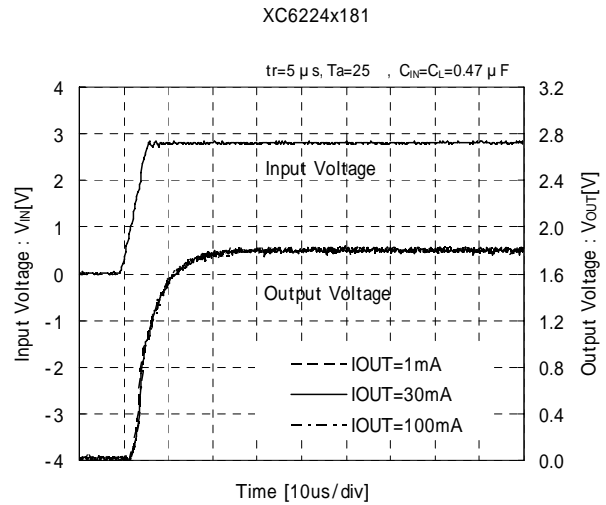
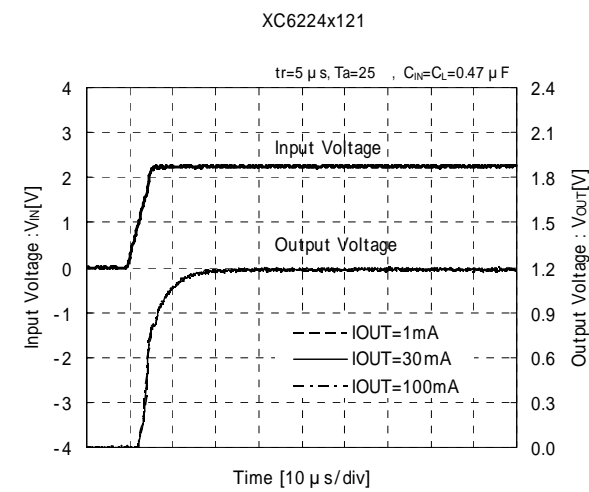


(5) Output Voltage vs. Ambient Temperature

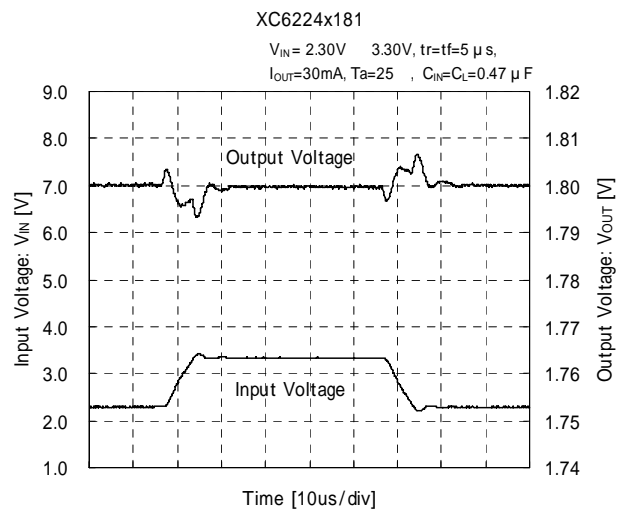
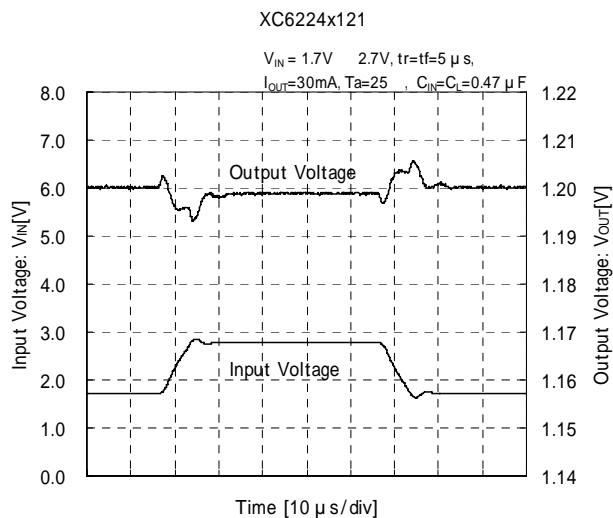


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(6) Rising Response Time

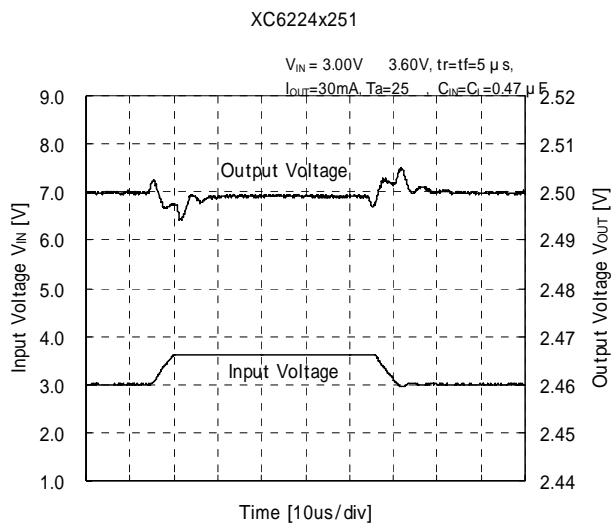


(7) Input Transient Response

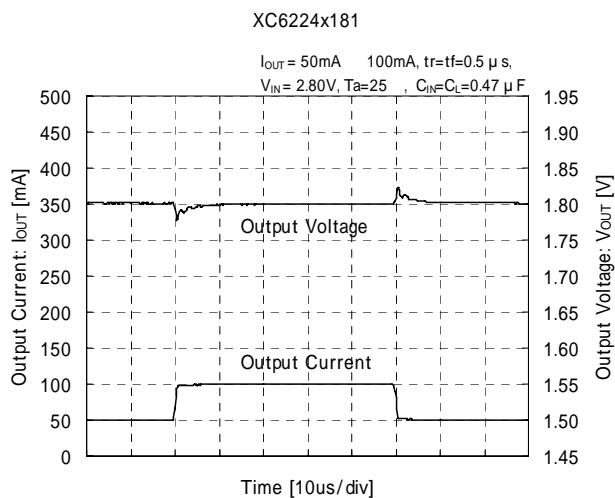
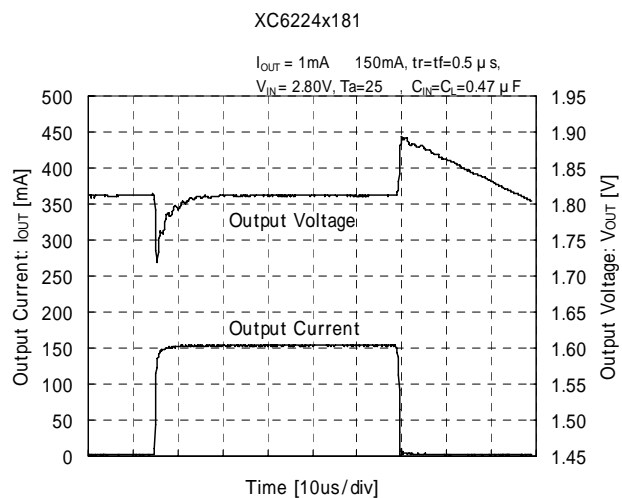
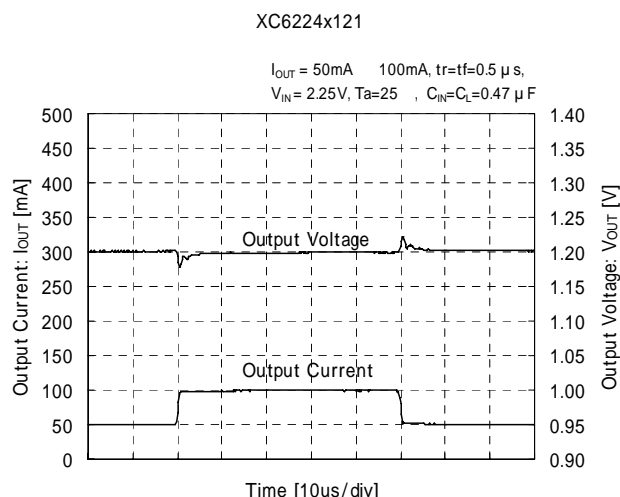
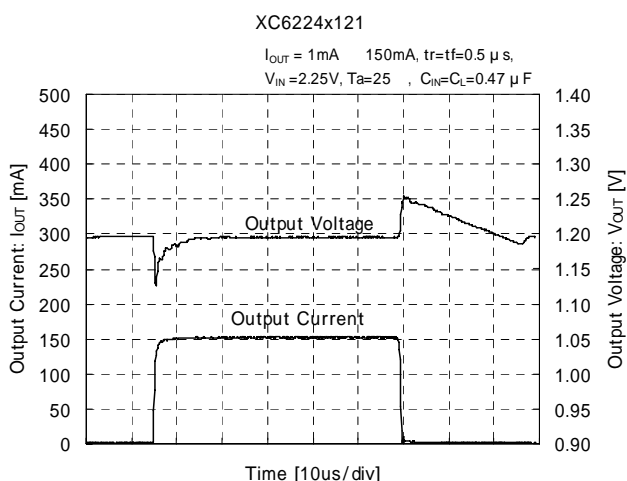


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(7) Input Transient Response (Continued)

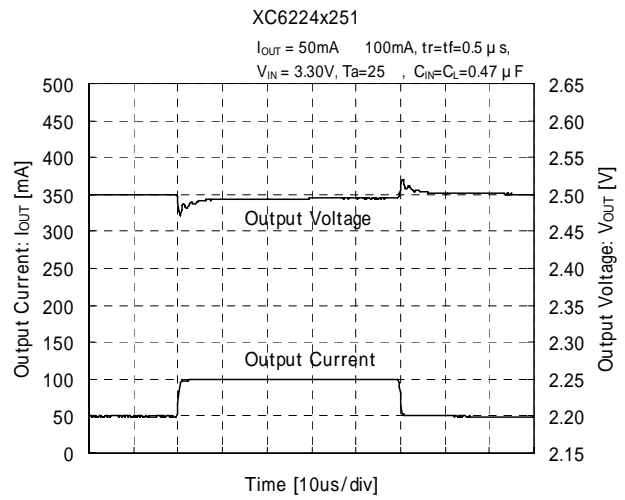
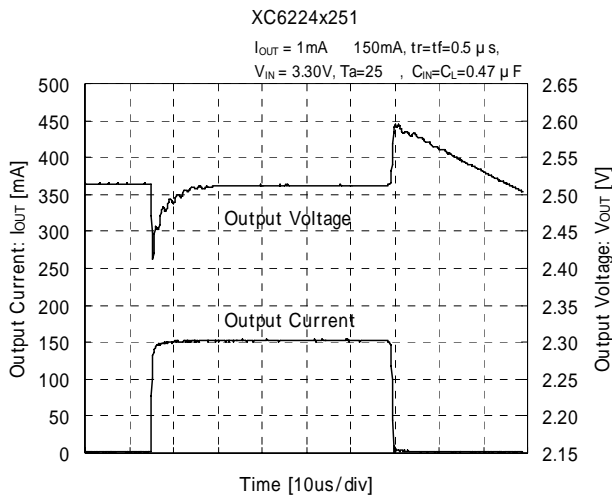


(8) Load Transient Response

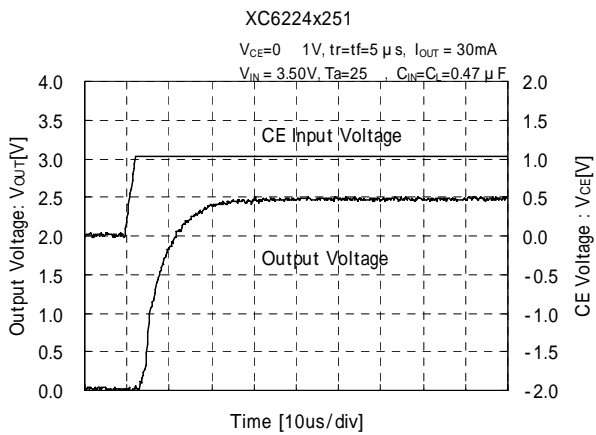
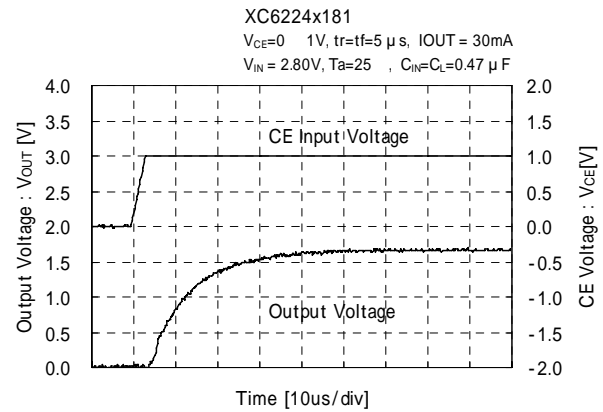
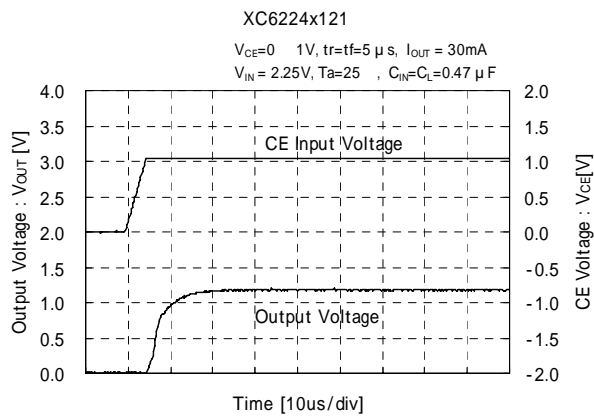


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(8) Load Transient Response (Continued)

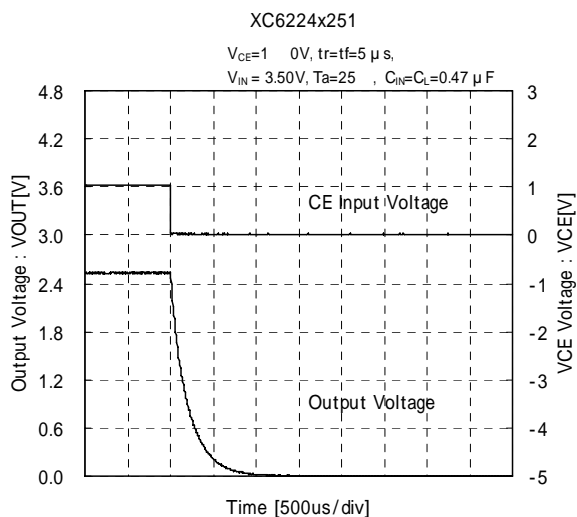
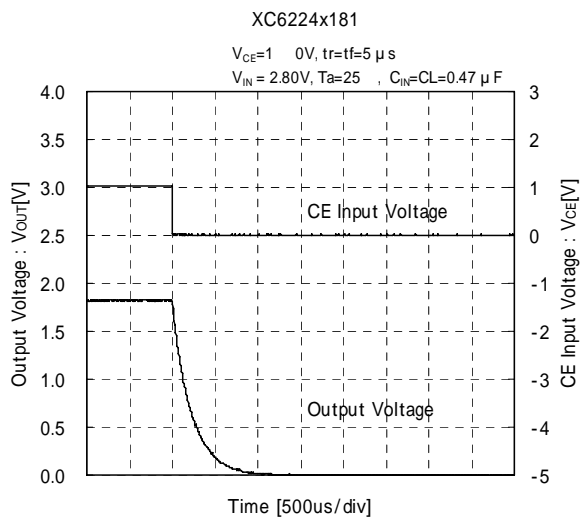
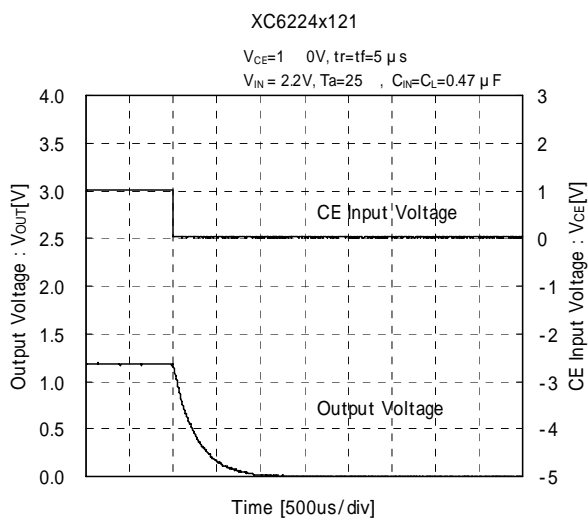


(9) CE Rising Response Time

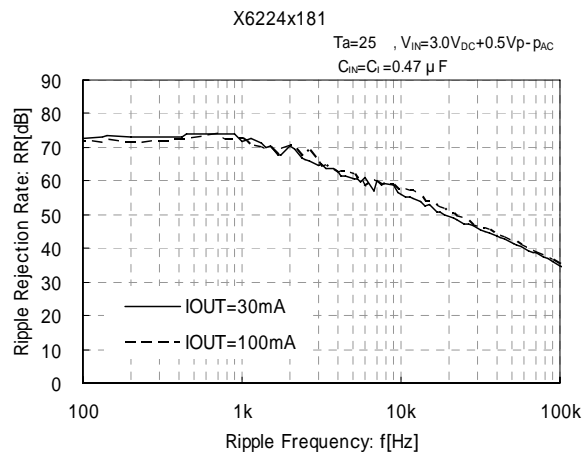
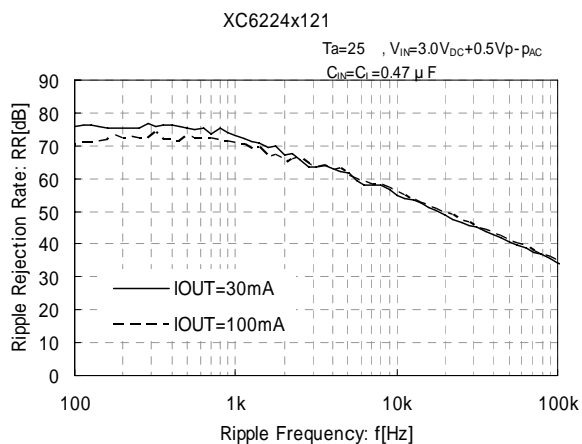


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(10) C_L Discharge Response Time

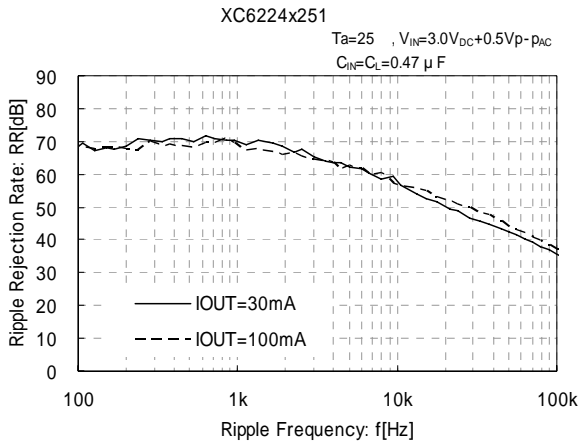


(11) Ripple Rejection Rate

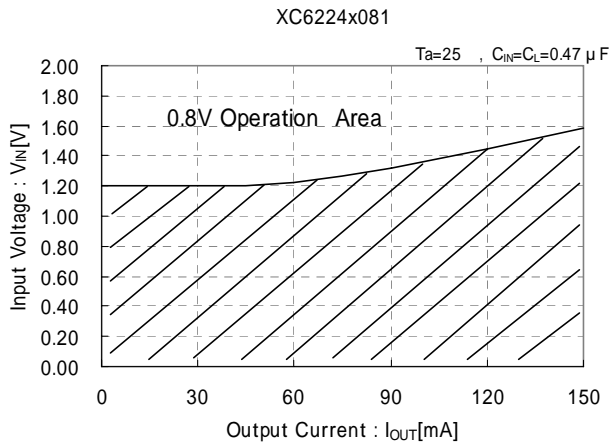


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(11) Ripple Rejection Rate



(12) The Minimum Operating Voltage

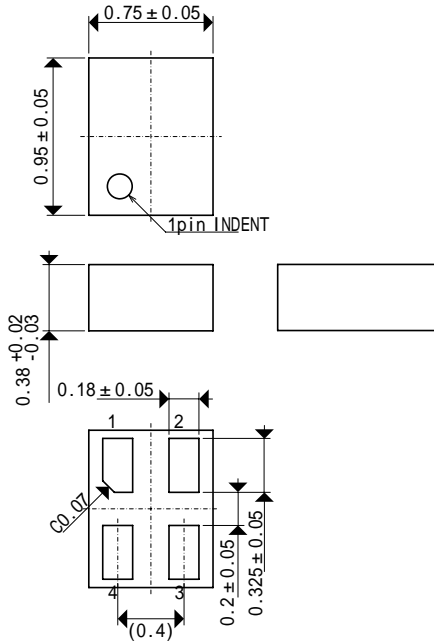


* The graph shows minimum input voltages as a function of output current. The values are influenced by a driver ON resistance.

PACKAGING INFORMATION

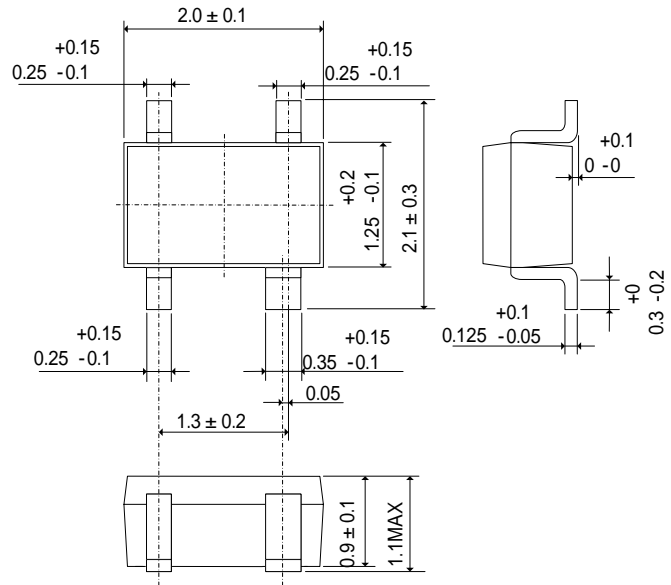
USPN-4B02

(unit : mm)



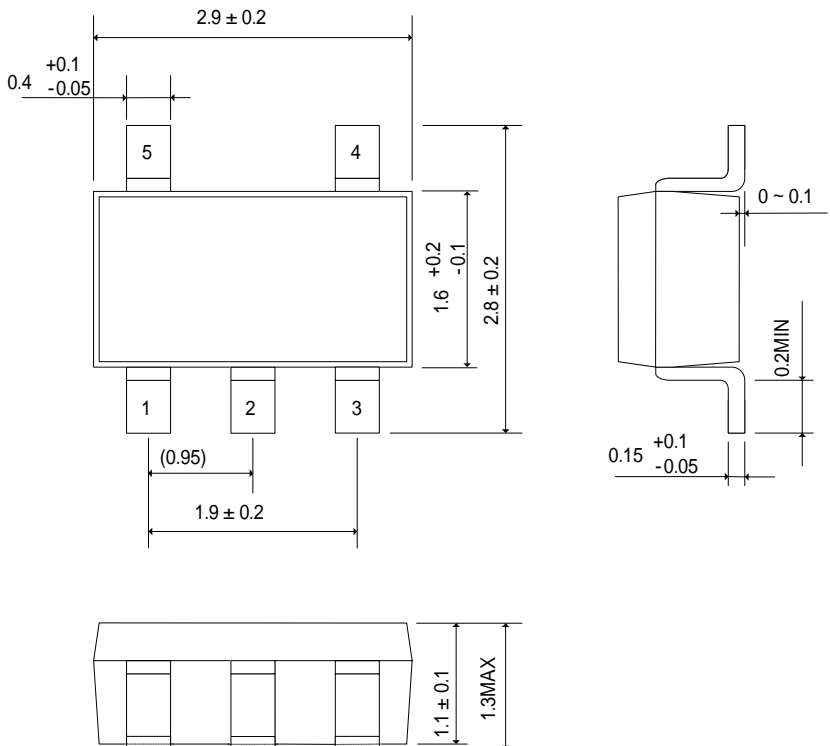
SSOT-24

(unit : mm)



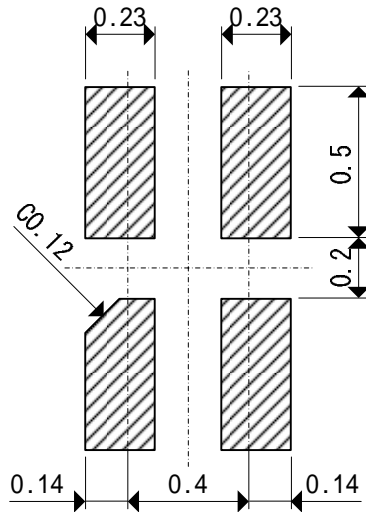
SOT-25

(unit : mm)

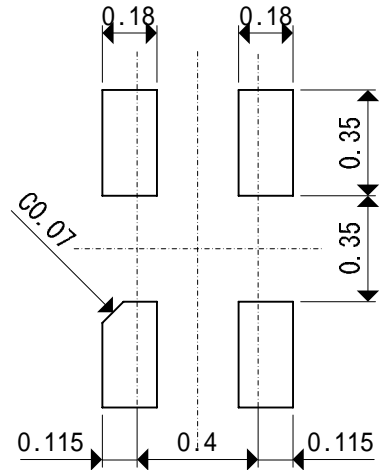


PACKAGING INFORMATION (Continued)

USPN-4B02 Reference Pattern Layout



USPN-4B02 Reference Metal Mask Design



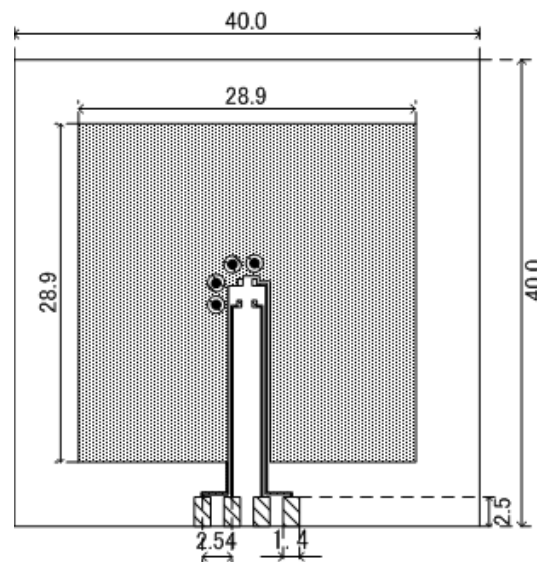
PACKAGING INFORMATION (Continued)

SSOT-24 Power Dissipation

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

1. Measurement Condition (Reference data)

- Condition: Mount on a board
- Ambient: Natural convection
- Soldering: Lead (Pb) free
- Board: Dimensions 40 x 40 mm (1600 mm² in one side)
Copper (Cu) traces occupy 50% of the board area
In top and back faces
Package heat-sink is tied to the copper traces
- Material: Glass Epoxy (FR-4)
- Thickness: 1.6 mm
- Through-hole: 4 x 0.8 Diameter

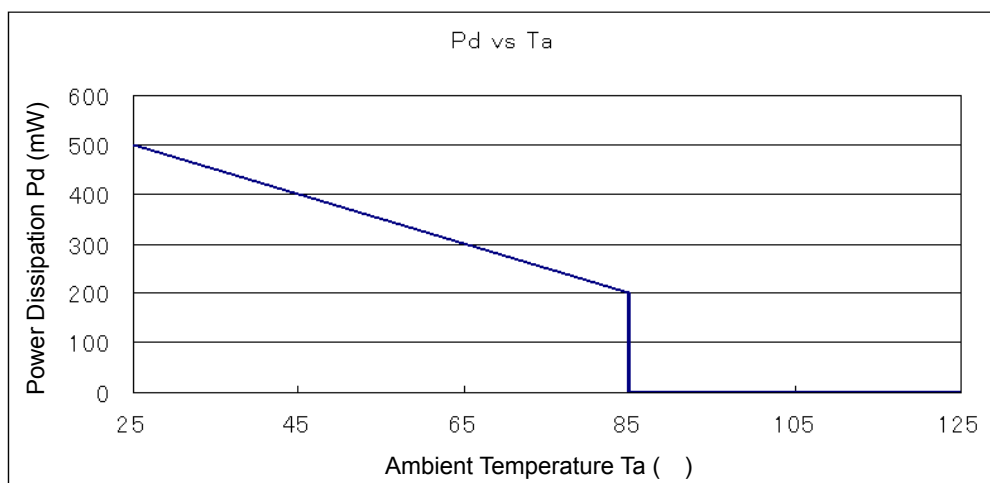


Evaluation Board (Unit: mm)

2. Power Dissipation vs. Ambient temperature

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

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



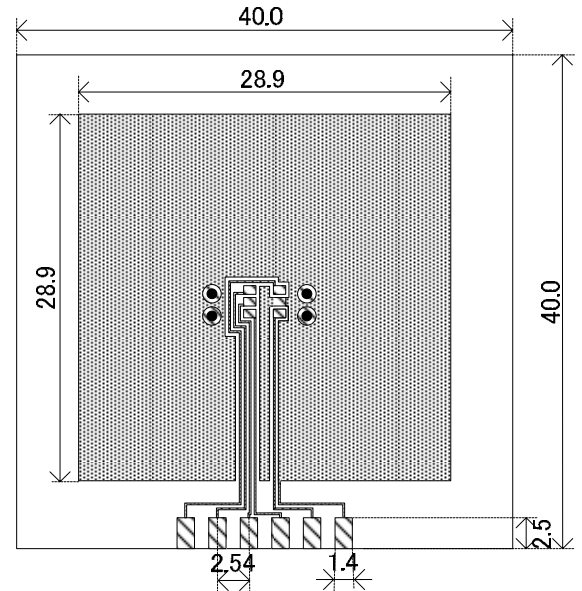
PACKAGING INFORMATION (Continued)

SOT-25 Power Dissipation

Power dissipation data for the SOT-25 is shown in this page.
The value of power dissipation varies with the mount board conditions.
Please use this data as one of reference data taken in the described condition.

1. Measurement Condition (Reference data)

- Condition: Mount on a board
- Ambient: Natural convection
- Soldering: Lead (Pb) free
- Board: Dimensions 40 x 40 mm (1600 mm² in one side)
Copper (Cu) traces occupy 50% of the board area
In top and back faces
Package heat-sink is tied to the copper traces
(Board of SOT-26 is used.)
- Material: Glass Epoxy (FR-4)
- Thickness: 1.6 mm
- Through-hole: 4 x 0.8 Diameter

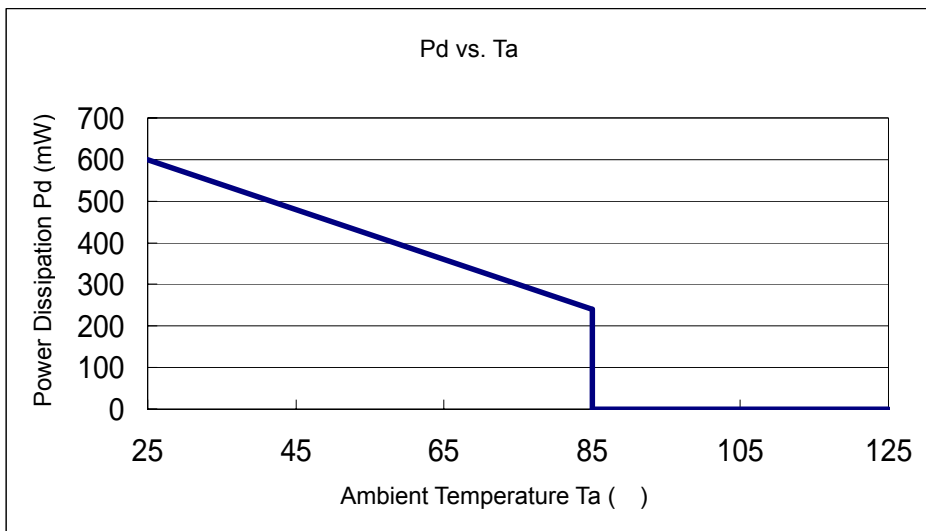


Evaluation Board (Unit: mm)

2. Power Dissipation vs. Ambient temperature

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

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



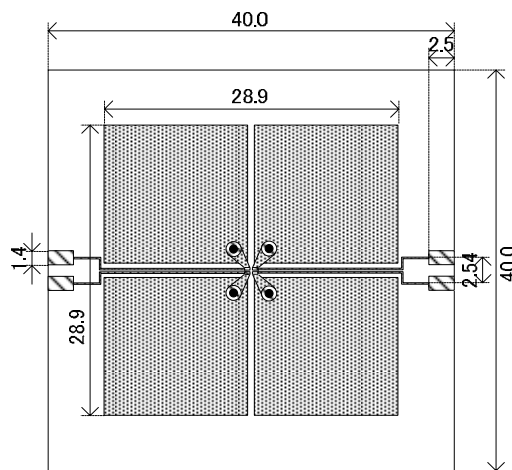
PACKAGING INFORMATION (Continued)

USPN-4B02 Power Dissipation

Power dissipation data for the USPN-4B02 is shown in this page.
The value of power dissipation varies with the mount board conditions.
Please use this data as one of reference data taken in the described condition.

1. Measurement Condition (Reference data)

- Condition: Mount on a board
- Ambient: Natural convection
- Soldering: Lead (Pb) free
- Board: Dimensions 40 x 40 mm (1600 mm² in one side)
Copper (Cu) traces occupy 50% of the front and 50% of the back.
The copper area is divided into four block,
one block is 12.5% of total.
The USPN-4 package has for terminals.
Each terminal connects one copper block in the front
and one in the back.
- Material: Glass Epoxy (FR-4)
- Thickness: 1.6 mm
- Through-hole: 4 x 0.8 Diameter

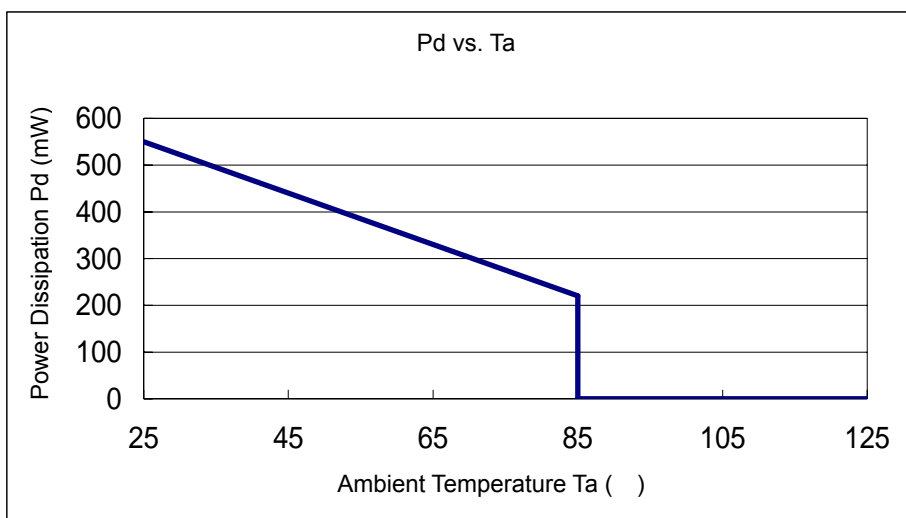


Evaluation Board (Unit: mm)

2. Power Dissipation vs. Ambient temperature

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

| Ambient Temperature () | Power Dissipation Pd (mW) | Thermal Resistance (/W) |
|-------------------------|---------------------------|--------------------------|
| 25 | 550 | 181.82 |
| 85 | 220 | |

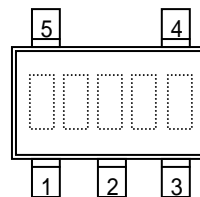


MARKING RULE

SOT-25

represents product series

| MARK | PRODUCT SERIES |
|------|----------------|
| 1 | XC6224*****-G |



represents type of regulator and combination of output voltage

| MARK | | PRODUCT SERIES |
|-----------------------------------|------------------------------------|----------------|
| OUTPUT VOLTAGE 0.1V INCREMENTS | OUTPUT VOLTAGE 0.05V INCREMENTS | |
| 0.8 ~ 3.0V | 0.85 ~ 2.95V | |
| C | H | XC6224A*****-G |
| D | K | XC6224B*****-G |

represents output voltage

| MARK | OUTPUT VOLTAGE (V) | | MARK | OUTPUT VOLTAGE (V) | |
|------|--------------------|---------------------|------|--------------------|---------------------|
| | 0.1V INCREMENTS | 0.05V INCREMENTS | | 0.1V INCREMENTS | 0.05V INCREMENTS |
| 0 | 0.80 | - | F | 2.30 | - |
| 1 | 0.90 | - | H | 2.40 | - |
| 2 | 1.00 | - | K | 2.50 | - |
| 3 | 1.10 | - | L | 2.60 | - |
| 4 | 1.20 | - | M | 2.70 | - |
| 5 | 1.30 | - | N | 2.80 | - |
| 6 | 1.40 | - | P | 2.90 | - |
| 7 | 1.50 | - | R | 3.00 | - |
| 8 | 1.60 | - | S | - | - |
| 9 | 1.70 | - | T | - | - |
| A | 1.80 | - | U | - | - |
| B | 1.90 | - | V | - | - |
| C | 2.00 | - | X | - | - |
| D | 2.10 | - | Y | - | - |
| E | 2.20 | - | Z | - | - |

represents production lot number

1 ~ 09, 0A ~ 0Z, 11...9Z, A1 ~ A9, AA...Z9, ZA ~ ZZ repeated.

(G, I, J, O, Q, W excluded.)

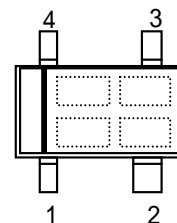
* No character inversion used.

MARKING RULE (Continued)

SSOT24 (with bar)

represents type of regulator and combination of output voltage

| MARK | | | | PRODUCT SERIES |
|-----------------------------------|---------------------|------------------------------------|-----------------------|----------------|
| OUTPUT VOLTAGE 0.1V INCREMENTS | | OUTPUT VOLTAGE 0.05V INCREMENTS | | |
| VOLTAGE =0.8 ~ 2.4V | VOLTAGE =2.5 ~ 3.0V | VOLTAGE =0.85 ~ 1.95V | VOLTAGE =2.05 ~ 2.95V | |
| A | F | F | Z | XC6224A****-G |
| H | P | P | R | XC6224B****-G |



represents output voltage

| MARK | OUTPUT VOLTAGE (V) | | | | | MARK | OUTPUT VOLTAGE (V) | | | |
|------|--------------------|------|------|---------|---|------|--------------------|------|---------|---|
| | XC6224A/B | | | XC6224A | | | XC6224A/B | | XC6224B | |
| 0 | 0.80 | 0.85 | - | 2.05 | - | F | - | - | - | - |
| 1 | 0.90 | 0.95 | - | 2.15 | - | H | - | - | - | - |
| 2 | 1.00 | 1.05 | - | 2.25 | - | K | - | - | - | - |
| 3 | 1.10 | 1.15 | - | 2.35 | - | L | - | - | - | - |
| 4 | 1.20 | 1.25 | - | 2.45 | - | M | - | - | - | - |
| 5 | 1.30 | 1.35 | - | 2.55 | - | N | 2.10 | - | 2.05 | - |
| 6 | 1.40 | 1.45 | - | 2.65 | - | P | - | - | 2.15 | - |
| 7 | 1.50 | 1.55 | - | 2.75 | - | R | - | - | 2.25 | - |
| 8 | 1.60 | 1.65 | - | 2.85 | - | S | - | - | 2.35 | - |
| 9 | 1.70 | 1.75 | - | 2.95 | - | T | - | - | 2.45 | - |
| A | 1.80 | 1.85 | - | - | - | U | 2.20 | 2.60 | 2.55 | - |
| B | 1.90 | 1.95 | - | - | - | V | 2.30 | 2.70 | 2.65 | - |
| C | 2.00 | - | 2.50 | - | - | X | 2.40 | 2.80 | 2.75 | - |
| D | - | - | - | - | - | Y | - | 2.90 | 2.85 | - |
| E | - | - | - | - | - | Z | - | 3.00 | 2.95 | - |

represents production lot number

01 ~ 09, 0A ~ 0Z, 11...9Z, A1 ~ A9, AA...Z9, ZA ~ ZZ repeated.

(G, I, J, O, Q, W excluded.)

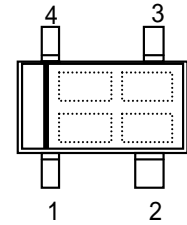
* No character inversion used.

MARKING RULE (Continued)

USPN-4B02

represents type of regulator and combination of output voltage

| MARK | | PRODUCT SERIES |
|-----------------------------------|------------------------------------|----------------|
| OUTPUT VOLTAGE 0.1V INCREMENTS | OUTPUT VOLTAGE 0.05V INCREMENTS | |
| VOLTAGE =0.8 ~ 3.0V | VOLTAGE =0.85 ~ 2.95V | |
| 0 | 1 | XC6224A****-G |
| 2 | 3 | XC6224B****-G |



represents output voltage

| MARK | OUTPUT VOLTAGE (V) | | MARK | OUTPUT VOLTAGE (V) | |
|------|--------------------|------|------|--------------------|------|
| 0 | 0.80 | 0.85 | F | 2.30 | 2.35 |
| 1 | 0.90 | 0.95 | H | 2.40 | 2.45 |
| 2 | 1.00 | 1.05 | K | 2.50 | 2.55 |
| 3 | 1.10 | 1.15 | L | 2.60 | 2.65 |
| 4 | 1.20 | 1.25 | M | 2.70 | 2.75 |
| 5 | 1.30 | 1.35 | N | 2.80 | 2.85 |
| 6 | 1.40 | 1.45 | P | 2.90 | 2.95 |
| 7 | 1.50 | 1.55 | R | 3.00 | - |
| 8 | 1.60 | 1.65 | S | - | - |
| 9 | 1.70 | 1.75 | T | - | - |
| A | 1.80 | 1.85 | U | - | - |
| B | 1.90 | 1.95 | V | - | - |
| C | 2.00 | 2.05 | X | - | - |
| D | 2.10 | 2.15 | Y | - | - |
| E | 2.20 | 2.25 | Z | - | - |

represents production lot number

0 ~ 9, A ~ Z repeated.

(G, I, J, O, Q, W excluded.)

* No character inversion used.

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