

## 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  $\mu$ 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.

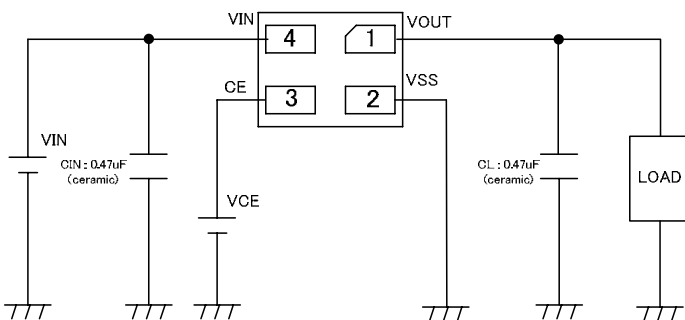
### APPLICATIONS

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

### FEATURES

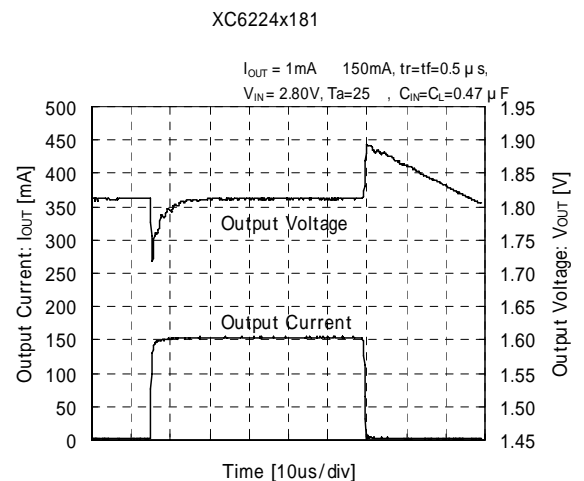
|                                      |   |
|--------------------------------------|---|
| <b>Maximum Output Current</b>        | : 150mA   |
| <b>Operating Voltage Range</b>       | : 1.2V ~ 3.6V   |
| <b>High Accuracy</b>                 | : $\pm 1.5\%$ ( $V_{OUT} = 1.25V \sim 3.0V$ )<br>$\pm 20mV$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

### TYPICAL APPLICATION CIRCUIT

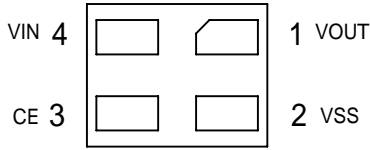


USPN-4B02 0.75mm x 0.95mm size  
 (BOTTOM VIEW)

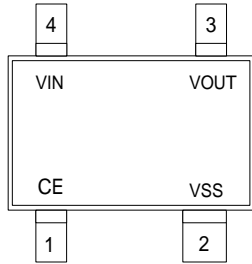
### TYPICAL PERFORMANCE CHARACTERISTICS



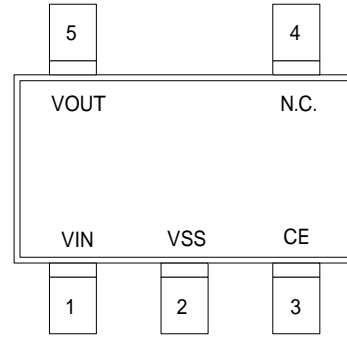
## PIN CONFIGURATION



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 <sub>IN</sub>  | Power Input    |
| 1          | 3       | 5      | V <sub>OUT</sub> | Output         |
| 2          | 2       | 2      | V <sub>SS</sub>  | Ground         |
| 3          | 1       | 3      | CE               | ON/OFF Control |
| -          | -       | 4      | NC               | No Connection  |

## PIN LOGIC CONDITION

| PIN NAME | DESIGNATOR | CONDITIONS                |
|----------|------------|---------------------------|
| CE       | L          | 0V V <sub>CE</sub> 0.3V   |
|          | H          | 1.0V V <sub>CE</sub> 3.6V |
|          | OPEN       | V <sub>CE</sub> =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

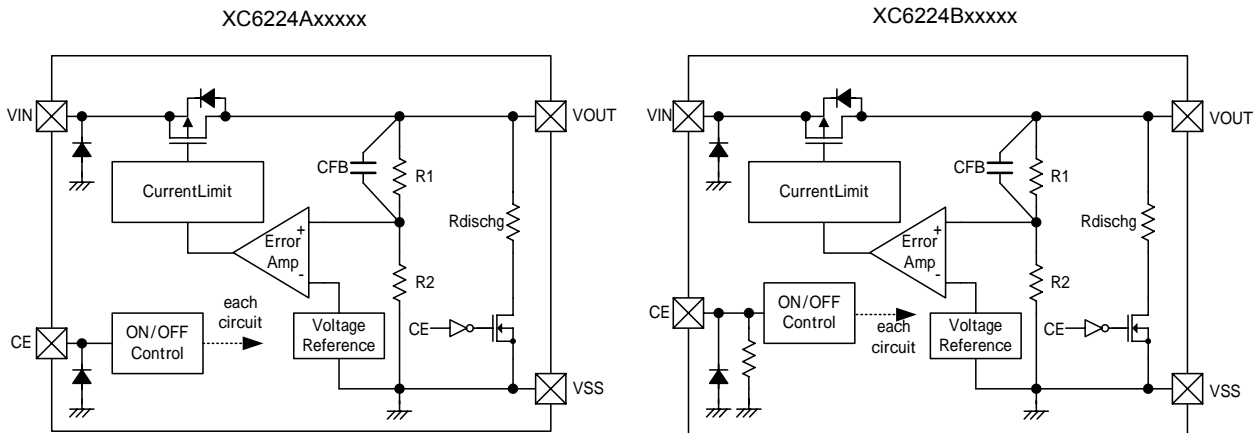
Ordering Information

XC6224 - (\*)

| DESIGNATOR | ITEM  | SYMBOL  | DESCRIPTION   |
|------------|---|---------|---|
|            | Type of Regulator                                     | A       | CE Active High, Without CE pull-down, with C <sub>L</sub> Discharge |
|            |   | B       | CE Active High, With CE pull-down, with C <sub>L</sub> Discharge    |
|            | Output Voltage  | 08 ~ 30 | ex.) 2.5V =2, =5  |
|            | Output Voltage<br>(The 2 <sup>nd</sup> Decimal Place) | 1       | {x.x0V} (the 2 <sup>nd</sup> decimal place is "0")                  |
|            |   | B       | {x.x5V} (the 2 <sup>nd</sup> 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 <sup>(*1)</sup>               | mA    |                                   |
| Output Voltage                    | $V_{OUT}$ | $V_{SS}-0.3 \sim V_{IN}+0.3$      | V     |                                   |
| CE Input Voltage                  | $V_{CE}$  | $V_{SS}-0.3 \sim 4.6$             | V     |                                   |
| Power Dissipation                 | USPN-4B02 | 100                               | mW    |                                   |
|                                   |           | 550 (PCB mounted) <sup>(*2)</sup> |       |                                   |
|                                   |           | SSOT24                            |       | 150                               |
|                                   |           |                                   |       | 500 (PCB mounted) <sup>(*2)</sup> |
|                                   |           | SOT-25                            |       | 250                               |
| 600 (PCB mounted) <sup>(*2)</sup> |           |                                   |       |                                   |
| 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 <sub>OUT(E)</sub> <sup>(3)</sup>                           | V <sub>OUT(T)</sub> 1.25V<br>V <sub>CE</sub> =V <sub>IN</sub> , I <sub>OUT</sub> =10mA   | V <sub>OUT(T)</sub> ×0.985 <sup>(2)</sup> | V <sub>OUT(T)</sub> <sup>(2)</sup> | V <sub>OUT(T)</sub> ×1.015 <sup>(2)</sup> | V     |          |
|  |  | V <sub>OUT(T)</sub> 1.2V<br>V <sub>CE</sub> =V <sub>IN</sub> , I <sub>OUT</sub> =10mA  | -20mV <sup>(7)</sup>                      | V <sub>OUT(T)</sub> <sup>(2)</sup> | +20mV <sup>(7)</sup>                      |       |          |
| Maximum Output Current                     | I <sub>OUTMAX</sub>  | V <sub>CE</sub> =V <sub>IN</sub>   | 150                                       | -                                  | -   | mA    |          |
| Load Regulation                            | ΔV <sub>OUT</sub>  | V <sub>CE</sub> =V <sub>IN</sub><br>0.1mA I <sub>OUT</sub> 150mA   | -   | 5                                  | 20  | mV    |          |
| Dropout Voltage <sup>(4)</sup>             | V <sub>dif</sub>   | I <sub>OUT</sub> =150mA<br>V <sub>CE</sub> =V <sub>IN</sub> , V <sub>IN</sub> =V <sub>OUT(E)</sub> ×0.98 <sup>(3)</sup>  | E-1                                       |                                    |   | mV    |          |
| Supply Current                             | I <sub>DD</sub>  | V <sub>CE</sub> =V <sub>IN</sub> , I <sub>OUT</sub> =0mA   | -   | 33                                 | 77  | μA    |          |
| Stand-by Current                           | I <sub>STBY</sub>  | V <sub>CE</sub> =V <sub>SS</sub>   |   | 0.01                               | 0.4                                       | μA    |          |
| Line Regulation                            | ΔV <sub>OUT</sub> /<br>(ΔV <sub>IN</sub> ·V <sub>OUT</sub> ) | V <sub>OUT(T)</sub> 1.10V<br>V <sub>OUT(T)</sub> +0.5V V <sub>IN</sub> 3.6V<br>V <sub>CE</sub> =V <sub>IN</sub> , I <sub>OUT</sub> =10mA <sup>(2)</sup>  | -   | 0.04                               | 0.37                                      | %V    |          |
|  |  | V <sub>OUT(T)</sub> 1.05V<br>1.6V V <sub>IN</sub> 3.6V<br>V <sub>CE</sub> =V <sub>IN</sub> , I <sub>OUT</sub> =10mA <sup>(2)</sup>   |   |                                    |   |       |          |
| Input Voltage                              | V <sub>IN</sub>  |  | 1.2                                       | -                                  | 3.6                                       | V     |          |
| Output Voltage Temperature Characteristics | ΔV <sub>OUT</sub> /<br>(ΔTa·V <sub>OUT</sub> )               | V <sub>CE</sub> =V <sub>IN</sub> , I <sub>OUT</sub> =30mA <sup>(1)</sup><br>-40 Ta 85  | -   | ± 100                              | -   | ppm/  |          |
| Power Supply Rejection Ratio               | PSRR   | V <sub>CE</sub> =V <sub>IN</sub><br>· When 0.80V V <sub>OUT(T)</sub> 2.60V,<br>V <sub>IN</sub> =3.0V + 0.5Vp-pAC<br>· 2.65V V <sub>OUT(T)</sub> 3.00V<br>V <sub>IN</sub> =3.3V+0.25Vp-pAC<br>I <sub>OUT</sub> =30mA, f=1kHz <sup>(2)</sup> | -   | 70                                 | -   | dB    |          |
| Current Limit                              | I <sub>LIM</sub>   | V <sub>CE</sub> =V <sub>IN</sub>   | 150                                       | 250                                | -   | mA    |          |
| Short Current                              | I <sub>SHORT</sub>   | V <sub>CE</sub> =V <sub>IN</sub> , V <sub>OUT</sub> is connected to V <sub>SS</sub>  | -   | 35                                 | -   | mA    |          |
| CE High Level Voltage                      | V <sub>CEH</sub>   |  | 1.0                                       | -                                  | 3.6                                       | V     |          |
| CE Low Level Voltage                       | V <sub>CEL</sub>   |  | -   | -                                  | 0.3                                       | V     |          |
| CE High Level Current                      | I <sub>CEH</sub>   | V <sub>CE</sub> =V <sub>IN</sub><br>A Type   | -0.1                                      | 0                                  | 0.1                                       | μA    |          |
| CE High Level Current                      | I <sub>CEL</sub>   | V <sub>CE</sub> =V <sub>SS</sub>   | -0.1                                      | 0                                  | 0.1                                       | μA    |          |
| C <sub>L</sub> Discharge Resistance        | R <sub>DCHG</sub>  | V <sub>IN</sub> =3.6V, V <sub>CE</sub> =V <sub>SS</sub>  | -   | 450                                | -   | Ω     |          |

**NOTE:**

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

0.80V V<sub>OUT(T)</sub> 2.60V : {V<sub>IN</sub>=V<sub>OUT(T)</sub>+1.0V}

2.65V V<sub>OUT(T)</sub> 2.80V : {V<sub>IN</sub>=3.3V}

2.85V V<sub>OUT(T)</sub> 3.00V : {V<sub>IN</sub>=3.5V}

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

\*3: V<sub>OUT(E)</sub>: Effective output voltage

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

\*4: V<sub>dif</sub> = {V<sub>IN1</sub><sup>(5)</sup> - V<sub>OUT1</sub><sup>(6)</sup>}

\*5: V<sub>IN1</sub>=The input voltage when V<sub>OUT1</sub> appears as input voltage is gradually decreased.

\*6: V<sub>OUT1</sub>=A voltage equal to 98% of the output voltage whenever an amply stabilized I<sub>OUT</sub> {V<sub>OUT(T)</sub>+1.0V} is input

\*7: V<sub>OUT(T)</sub>±20mV is the specification value of output voltage where V<sub>OUT(T)</sub> 1.20V

## ELECTRICAL CHARACTERISTICS (Continued)

XC6224Bxxxxx

Ta=25

| PARAMETER                                  | SYMBOL   | CONDITIONS  | MIN.                                     | TYP.                        | MAX.                                     | UNITS    | CIRCUITS |
|--|--|---|--|-----------------------------|--|----------|----------|
| Output Voltage                             | $V_{OUT(E)}$ <sup>(3)</sup>                            | $V_{OUT(T)}$ 1.25V<br>$V_{CE}=V_{IN}$ , $I_{OUT}=10mA$  | $V_{OUT(T)} \times 0.985$ <sup>(2)</sup> | $V_{OUT(T)}$ <sup>(2)</sup> | $V_{OUT(T)} \times 1.015$ <sup>(2)</sup> | V        |          |
|  |  | $V_{OUT(T)}$ 1.2V, $V_{IN}=2.5V$<br>$V_{CE}=V_{IN}$ , $I_{OUT}=10mA$  | -20mV <sup>(7)</sup>                     | $V_{OUT(T)}$ <sup>(2)</sup> | +20mV <sup>(7)</sup>                     |          |          |
| Maximum Output Current                     | $I_{OUTMAX}$   | $V_{CE}=V_{IN}$ <sup>(1)</sup>  | 150                                      | -                           | -  | mA       |          |
| Load Regulation                            | $\Delta V_{OUT}$                                       | $V_{CE}=V_{IN}$ <sup>(1)</sup><br>0.1mA $I_{OUT}$ 150mA   | -  | 5                           | 20                                       | mV       |          |
| Dropout Voltage <sup>(4)</sup>             | Vdif   | $I_{OUT}=150mA$ ,<br>$V_{CE}=V_{IN}$<br>$V_{IN}=V_{OUT(E)} \times 0.98$ <sup>(3)</sup>  | E-1                                      |                             |  | mV       |          |
| Supply Current                             | $I_{DD}$   | $V_{CE}=V_{IN}$ <sup>(1)</sup><br>$I_{OUT}=0mA$   | -  | 33                          | 77                                       | $\mu A$  |          |
| Stand-by Current                           | $I_{STBY}$   | $V_{CE}=V_{SS}$   | -  | 0.01                        | 0.4                                      | $\mu A$  |          |
| Line Regulation                            | $\frac{\Delta V_{OUT}}{(\Delta V_{IN} \cdot V_{OUT})}$ | $V_{OUT(T)}$ 1.10V<br>$V_{OUT(T)}+0.5V$ $V_{IN}$ 3.6V<br>$V_{CE}=V_{IN}$ , $I_{OUT}=10mA$ <sup>(2)</sup>  | -  | 0.04                        | 0.37                                     | %V       |          |
|  |  | $V_{OUT(T)}$ 1.05V<br>1.6V $V_{IN}$ 3.6V<br>$V_{CE}=V_{IN}$ , $I_{OUT}=10mA$ <sup>(2)</sup>   |  |                             |  |          |          |
| Input Voltage                              | $V_{IN}$   |   | 1.2                                      | -                           | 3.6                                      | V        |          |
| Output Voltage Temperature Characteristics | $\frac{\Delta V_{OUT}}{(\Delta Ta \cdot V_{OUT})}$     | $V_{CE}=V_{IN}$ , $I_{OUT}=30mA$ <sup>(1)</sup><br>-40 $Ta$ 85  | -  | $\pm 100$                   | -  | ppm/     |          |
| Power Supply Rejection Ratio               | PSRR   | $V_{CE}=V_{IN}$<br>· When 0.80V $V_{OUT(T)}$ 2.60V<br>$V_{IN}=3.0V + 0.5Vp-pAC$<br>· 2.65V $V_{OUT(T)}$ 3.00V<br>$V_{IN}=3.3V + 0.25Vp-pAC$<br>$I_{OUT}=30mA$ , $f=1kHz$ <sup>(2)</sup> | -  | 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                      | $I_{CEH}$  | $V_{CE}=V_{IN}$<br>B Type   | -  | 5.5                         | 13.0                                     | $\mu A$  |          |
| CE High Level Current                      | $I_{CEL}$  | $V_{CE}=V_{SS}$   | -0.1                                     | 0                           | 0.1                                      | $\mu A$  |          |
| $C_L$ Discharge Resistance                 | $R_{DCHG}$   | $V_{IN}=3.6V$ , $V_{CE}=V_{SS}$   | -  | 450                         | -  | $\Omega$ |          |

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

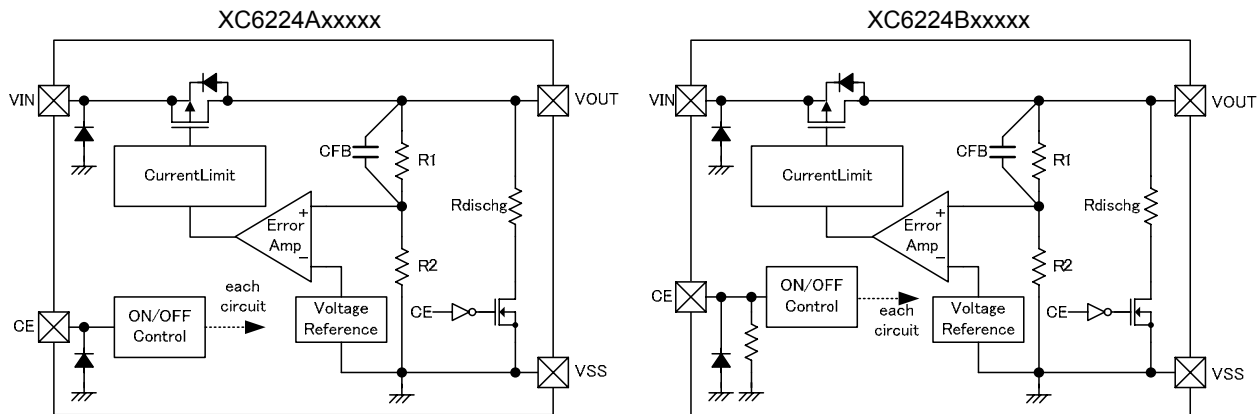
## ELECTRICAL CHARACTERISTICS (Continued)

Voltage Table

| NOMINAL<br>OUTPUT<br>VOLTAGE (V) | OUTPUT VOLTAGE <sup>(*)</sup><br>(V) |        | DROPOUT VOLTAGE (E-1)<br>(mV) |      |
|----------------------------------|--------------------------------------|--------|-------------------------------|------|
|                                  | V <sub>OUT(E)</sub>                  |        | V <sub>dif</sub>              |      |
| V <sub>OUT(T)</sub>              | 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<sub>OUT(T)</sub> 1.20V, the output voltage accuracy is ±20mV.  
When V<sub>OUT(T)</sub> 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<sub>OUT</sub> pin is then driven by the subsequent output signal. The output voltage at the V<sub>OUT</sub> 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<sub>L</sub> and a built-in phase compensation circuit for phase compensation. In order to ensure the stable phase compensation, please place an output capacitor C<sub>L</sub> of 0.47 μF or bigger at the V<sub>OUT</sub> pin as close as possible. For a stable power input, please connect an input capacitor C<sub>IN</sub> of 0.47 μF between the V<sub>IN</sub> pin and the V<sub>SS</sub> 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<sub>OUT</sub> pin will be pulled down to the V<sub>SS</sub> 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

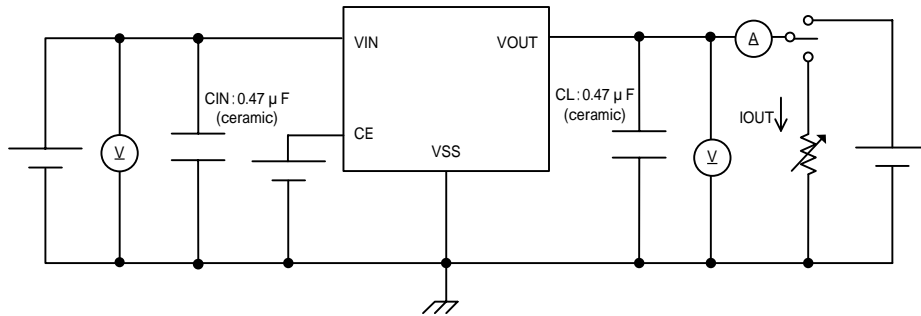
## NOTES ON USE

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<sub>IN</sub> and V<sub>SS</sub> wiring in particular.
4. The input capacitor C<sub>IN</sub> and the output capacitor C<sub>L</sub> should be placed to the IC as close as possible with a shorter wiring.

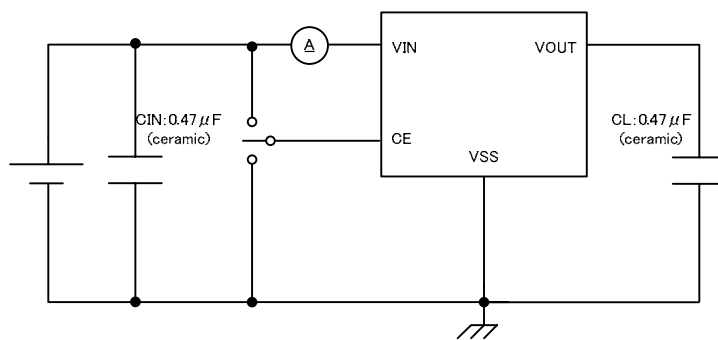


## TEST CIRCUITS

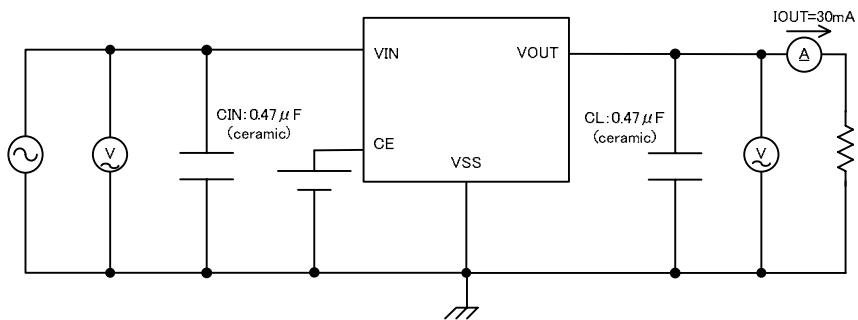
Circuit



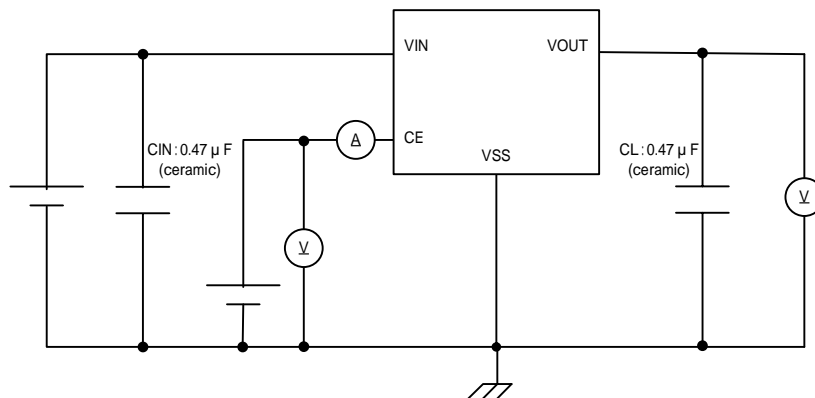
Circuit



Circuit

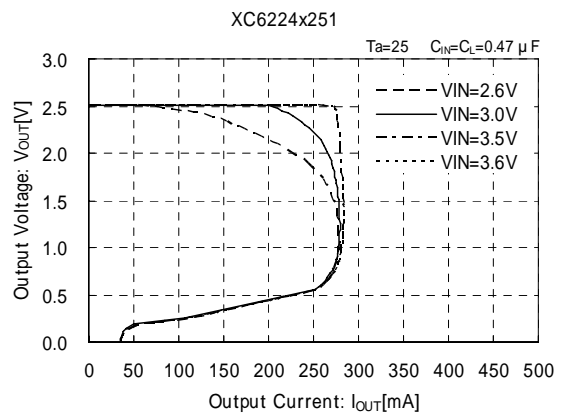
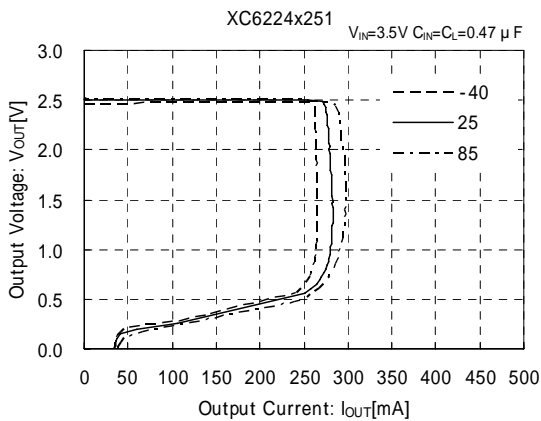
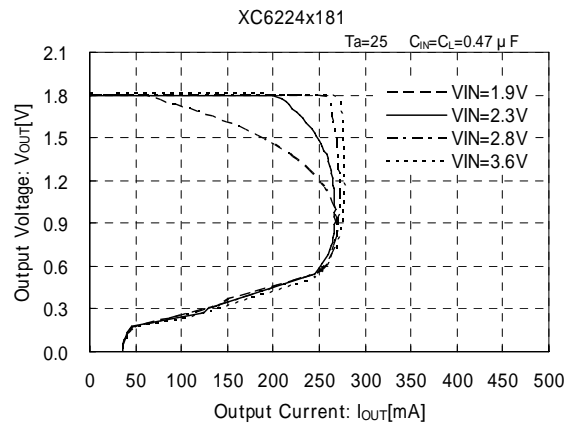
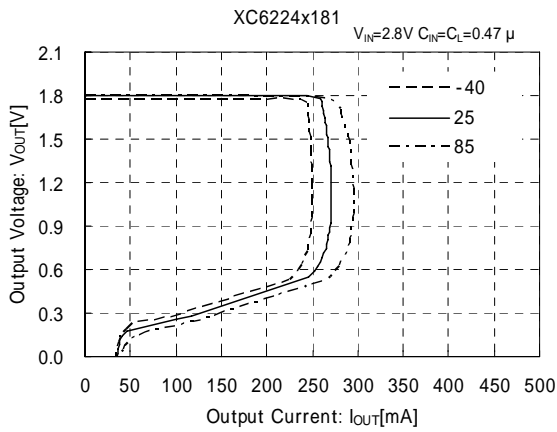
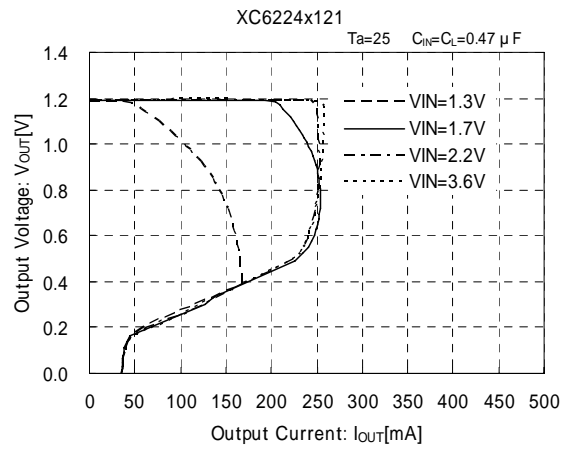
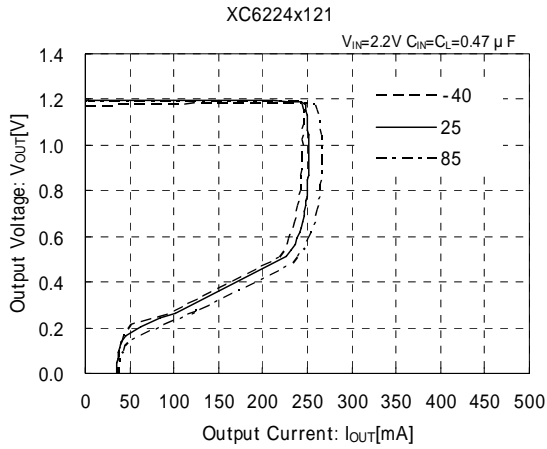


Circuit



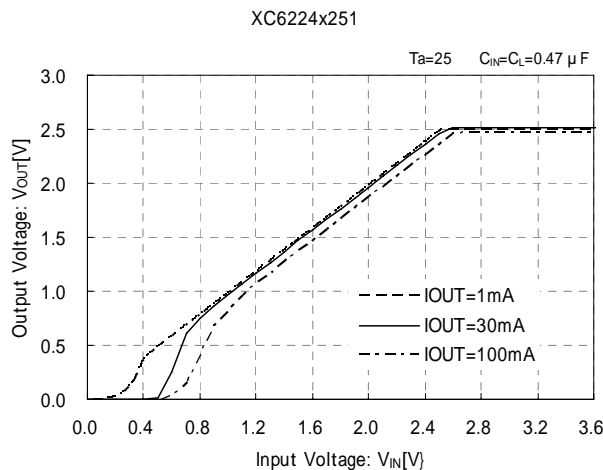
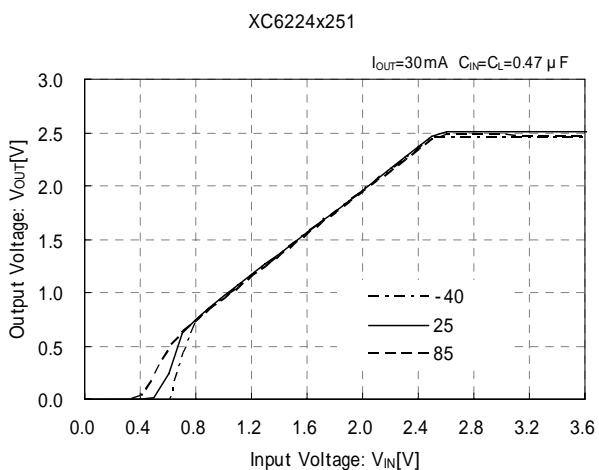
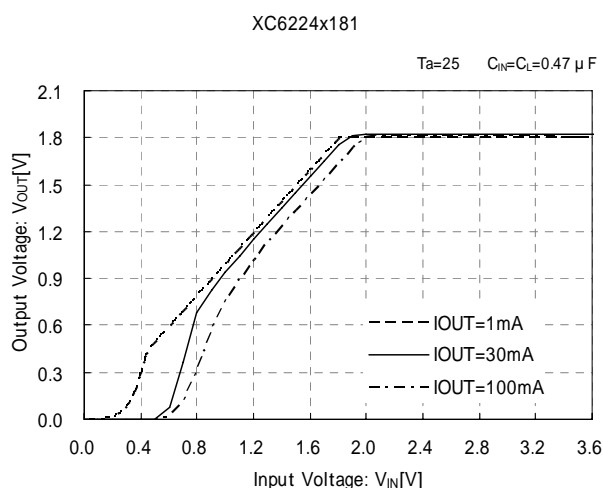
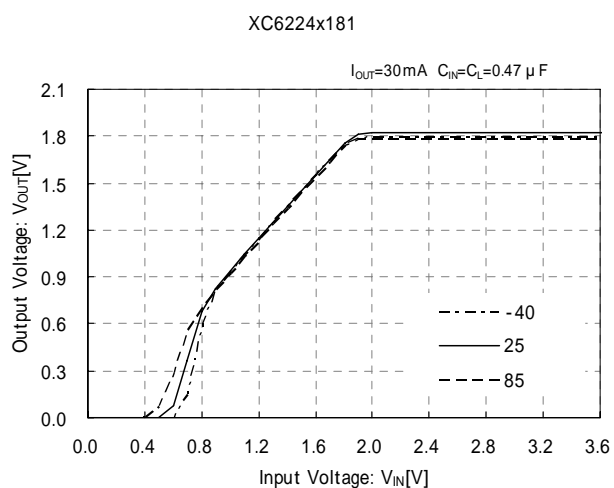
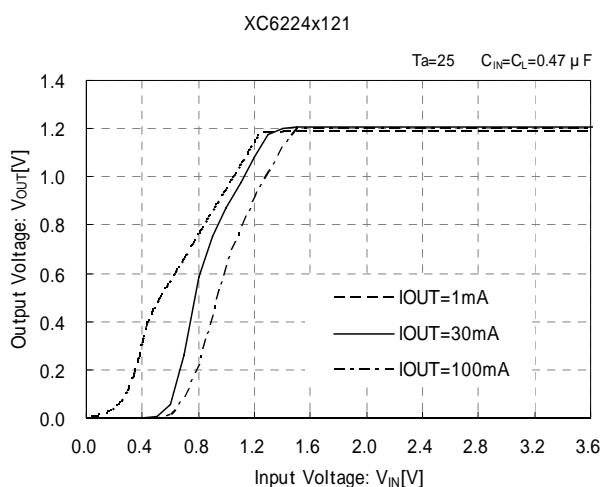
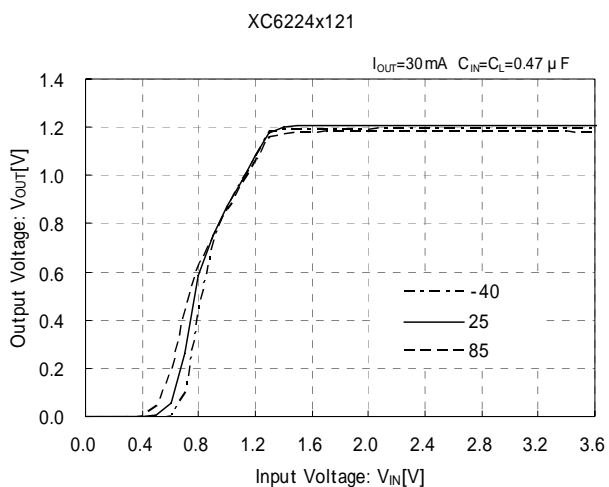
## TYPICAL PERFORMANCE CHARACTERISTICS

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



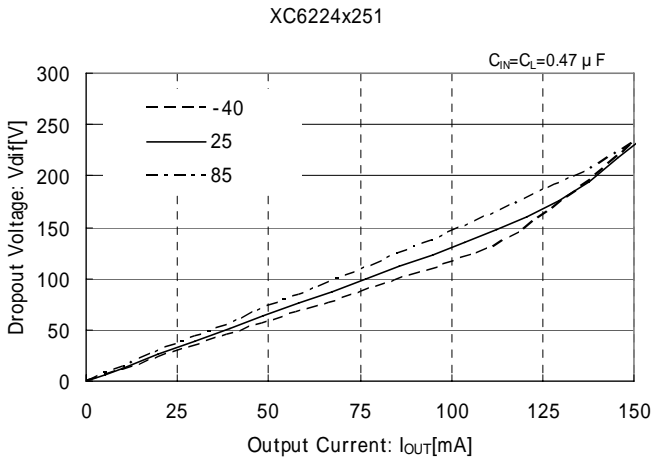
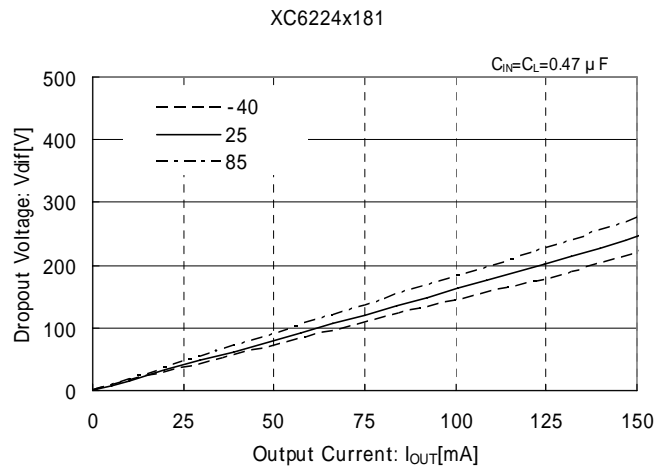
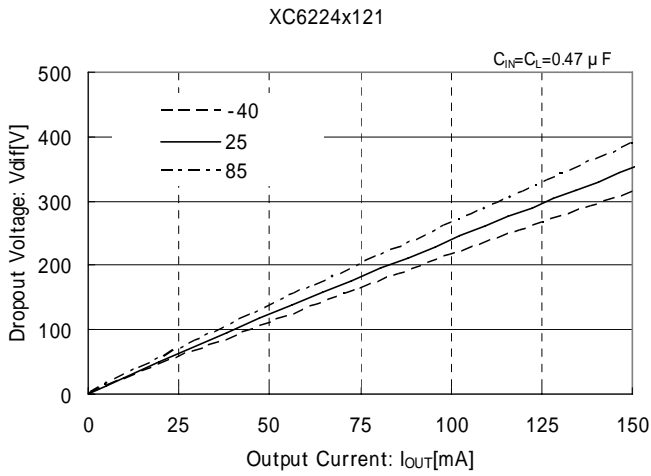
## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

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

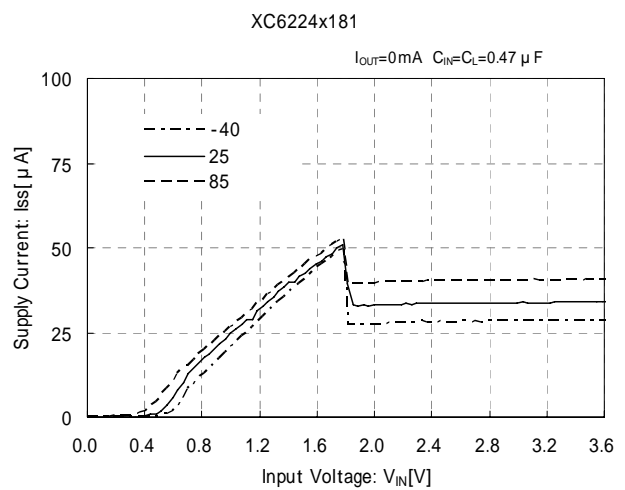
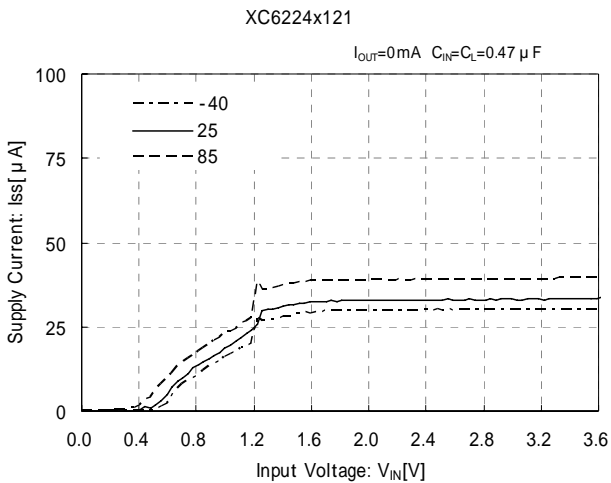


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

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

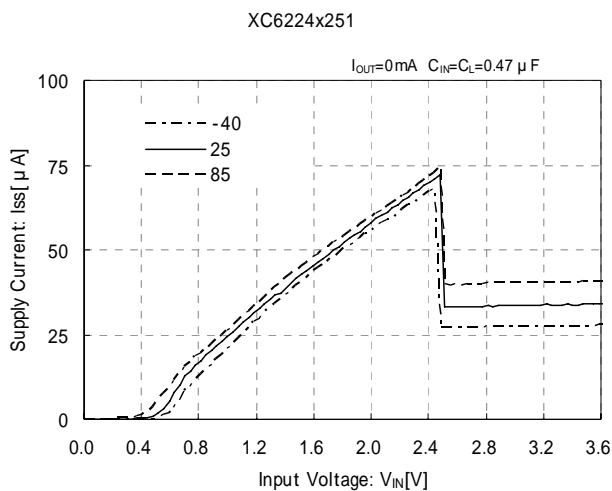


### (4) Supply Current vs. Input Voltage

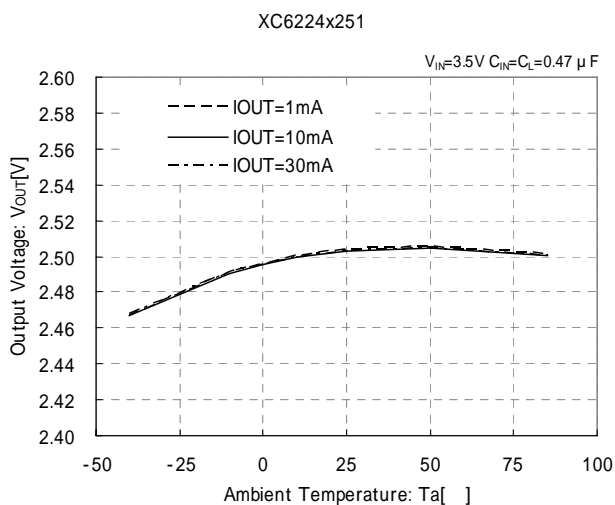
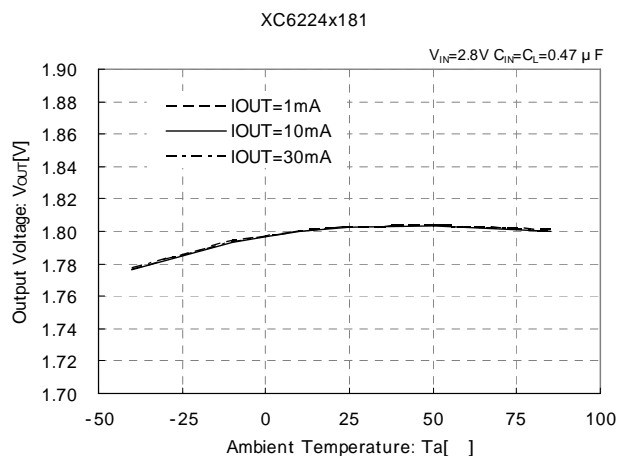
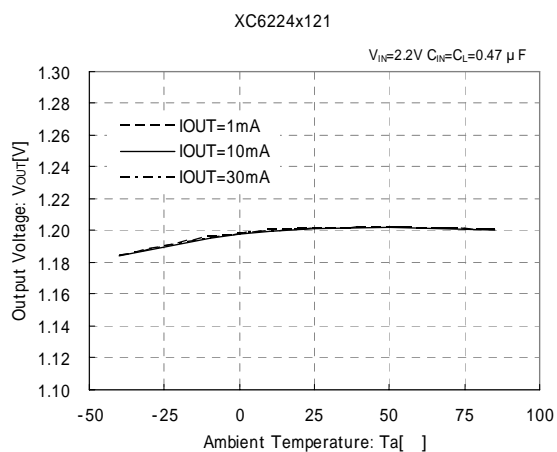


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

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

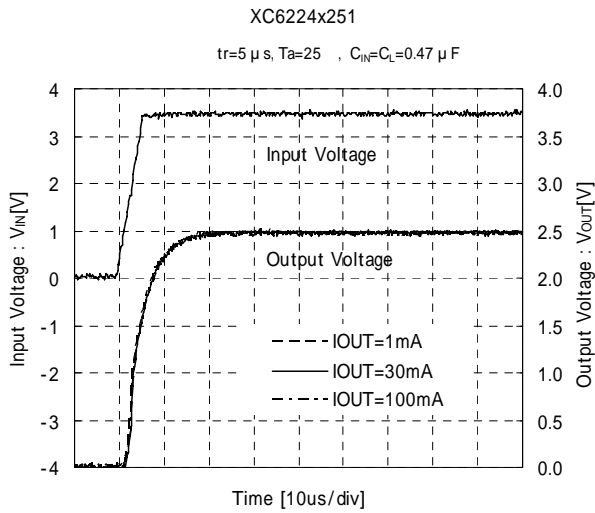
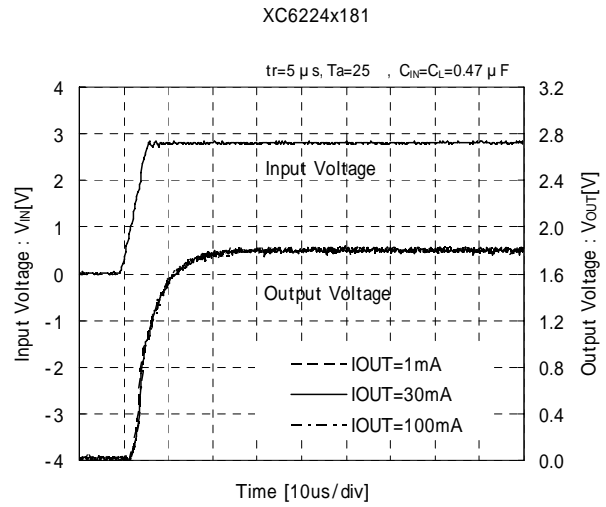
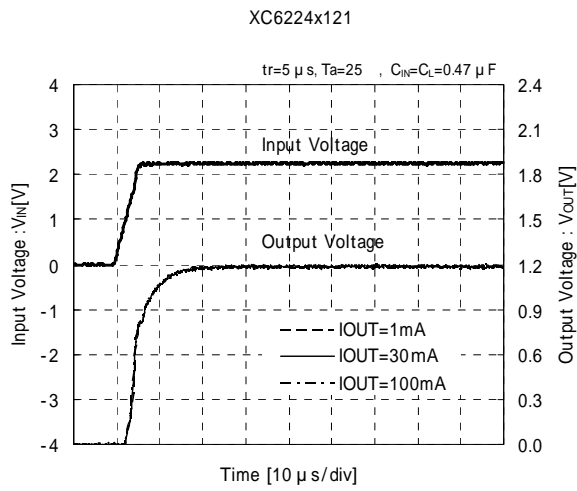


### (5) Output Voltage vs. Ambient Temperature

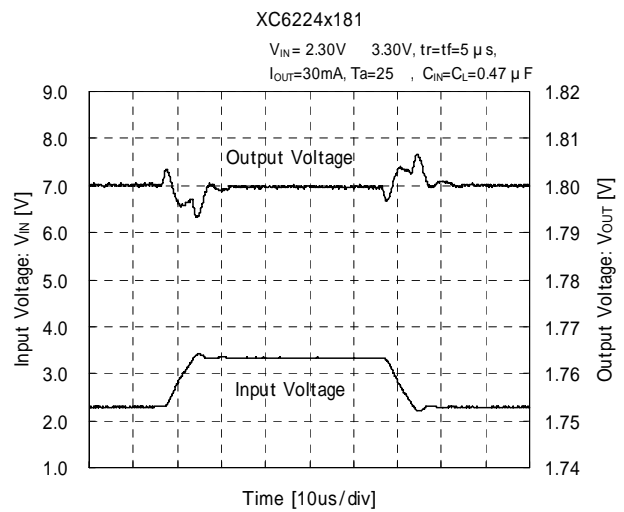
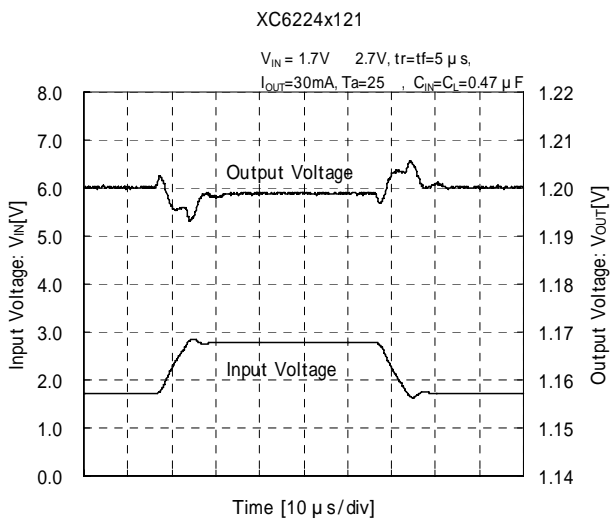


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (6) Rising Response Time

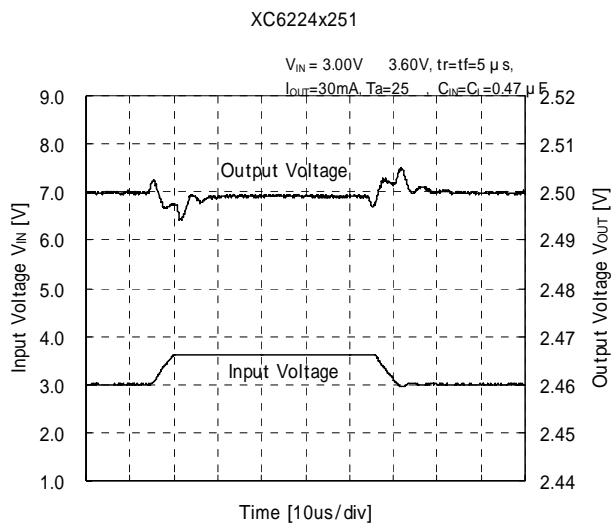


### (7) Input Transient Response

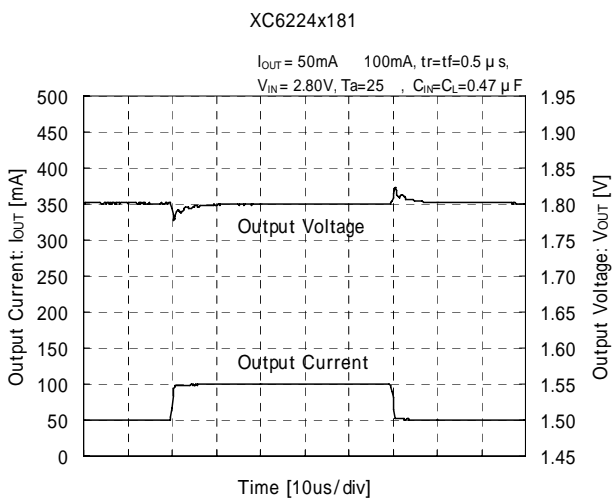
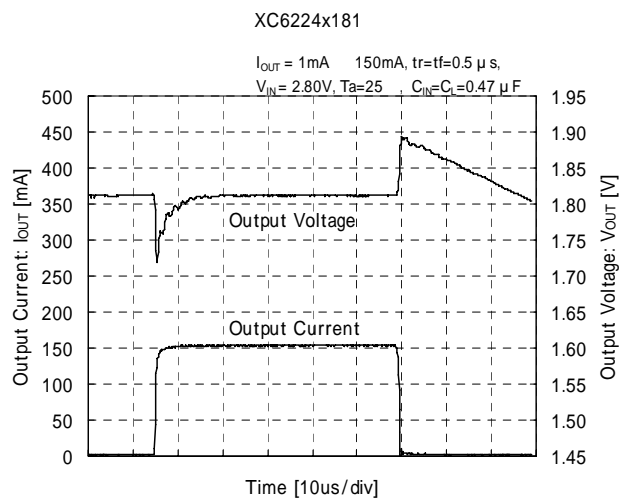
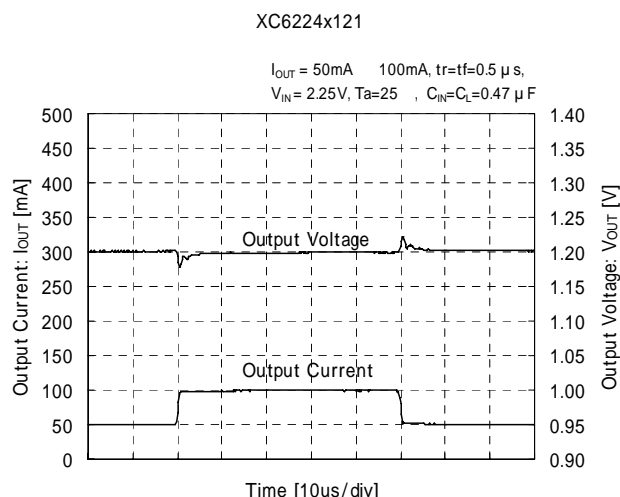
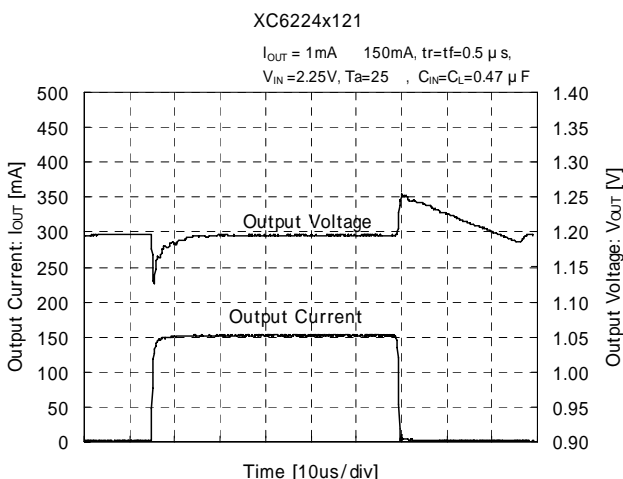


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (7) Input Transient Response (Continued)

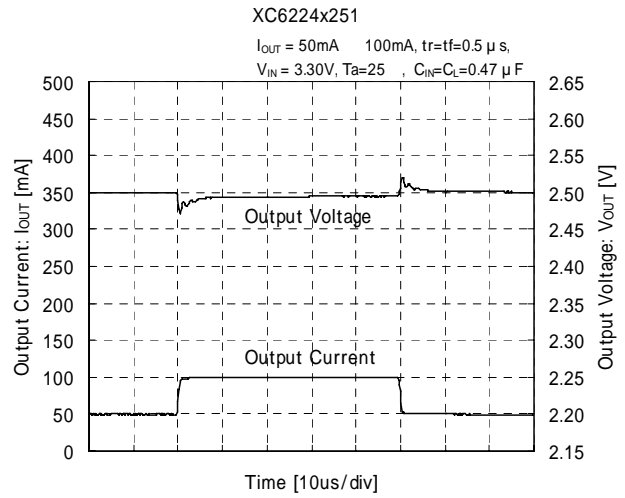
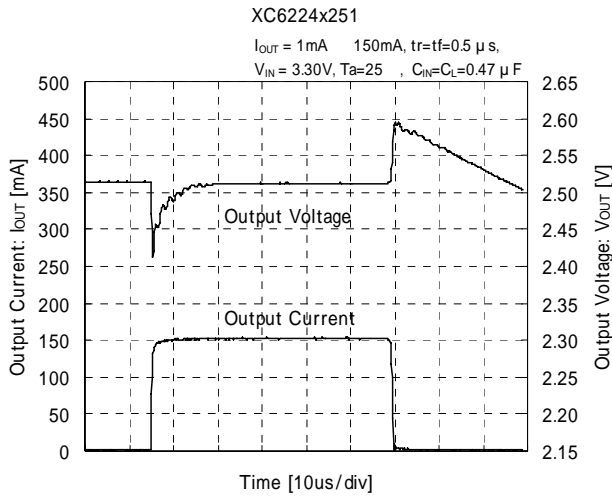


### (8) Load Transient Response

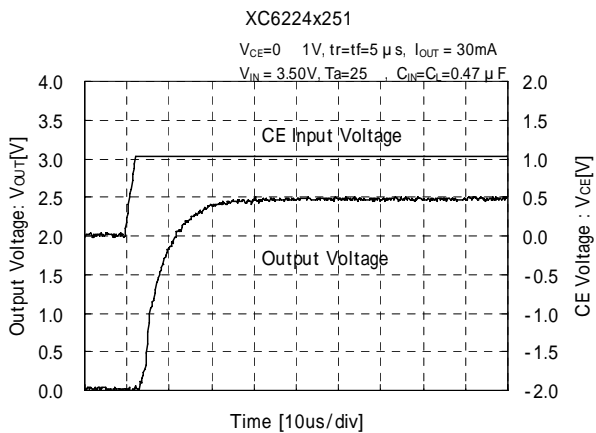
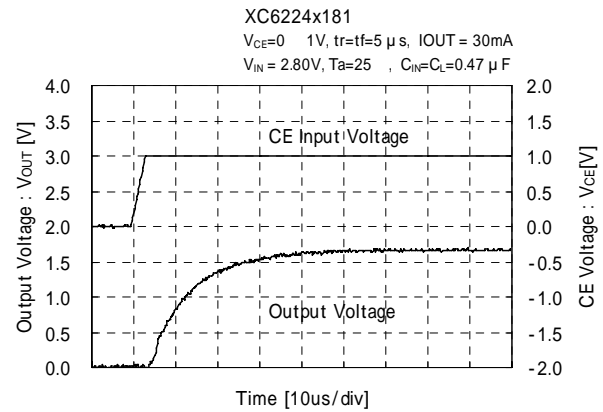
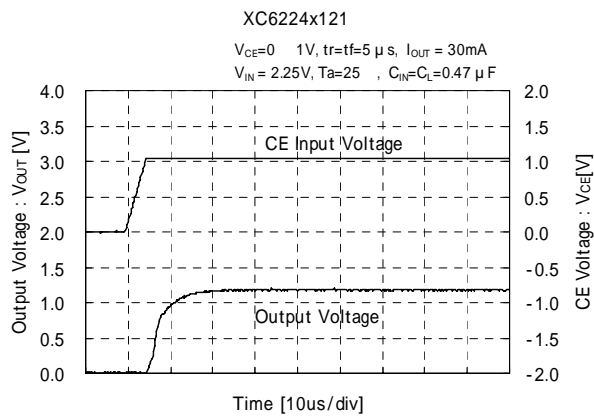


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (8) Load Transient Response (Continued)



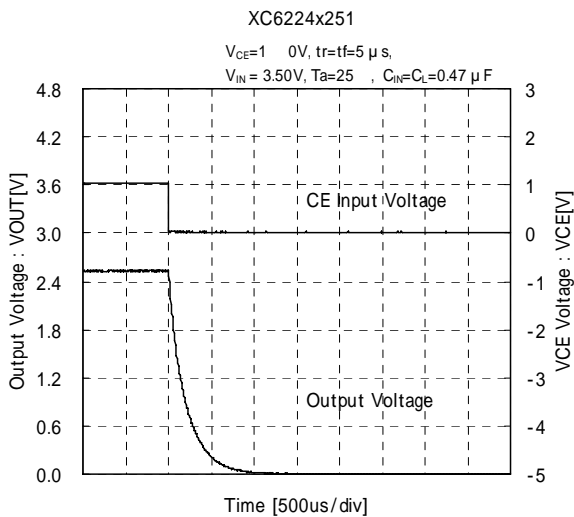
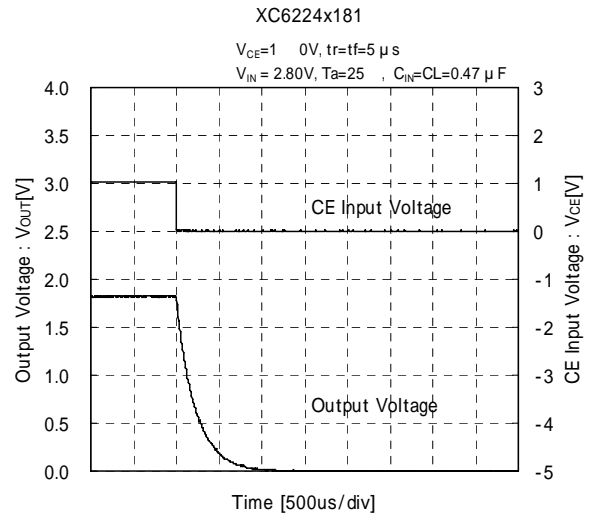
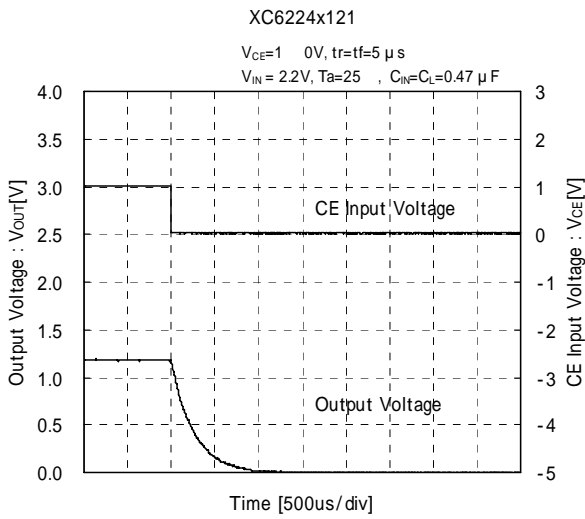
### (9) CE Rising Response Time



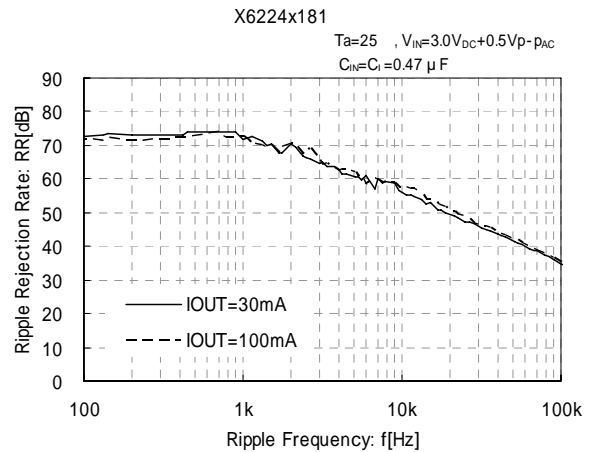
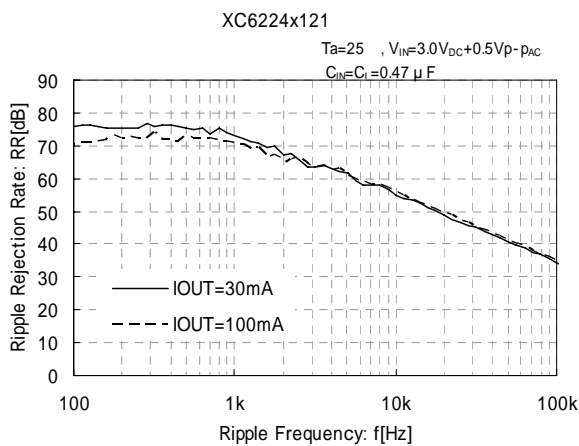


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (10) $C_L$ Discharge Response Time

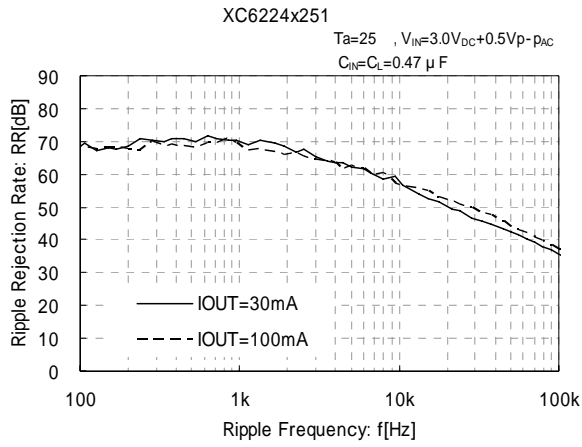


### (11) Ripple Rejection Rate

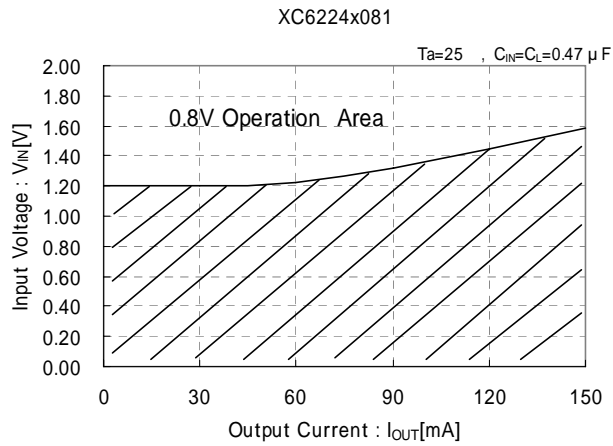


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (11) Ripple Rejection Rate



### (12) The Minimum Operating Voltage

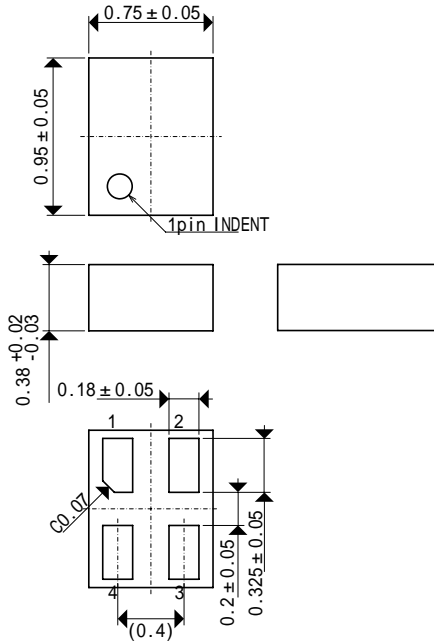


\* The graph shows minimum input voltages as a function of output current. The values are influenced by a driver ON resistance.

# PACKAGING INFORMATION

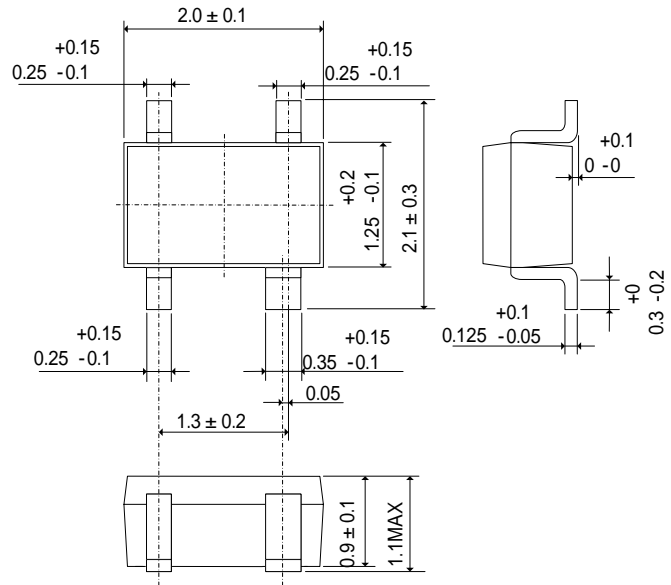
## USPN-4B02

(unit : mm)



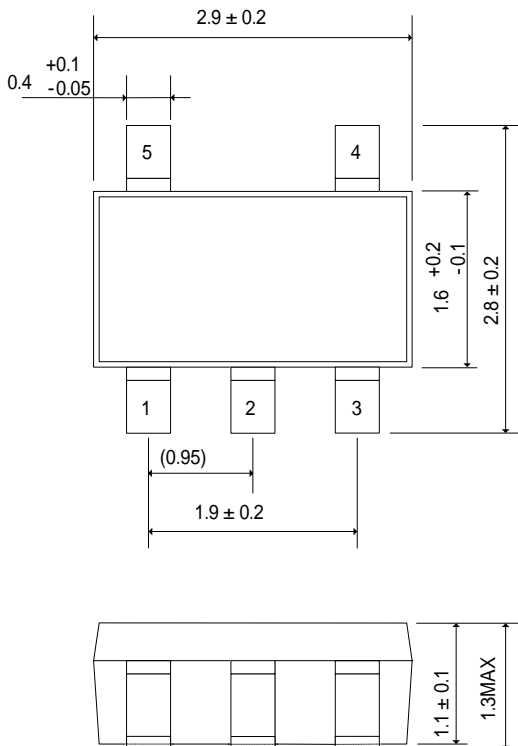
## SSOT-24

(unit : mm)



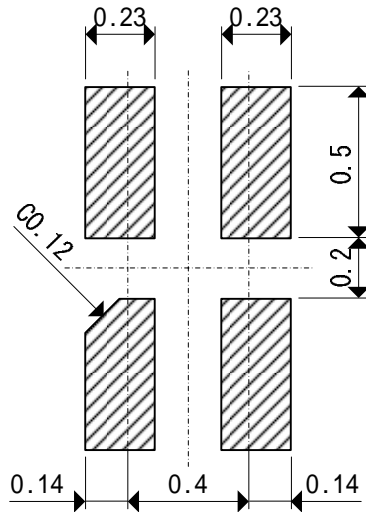
## SOT-25

(unit : mm)

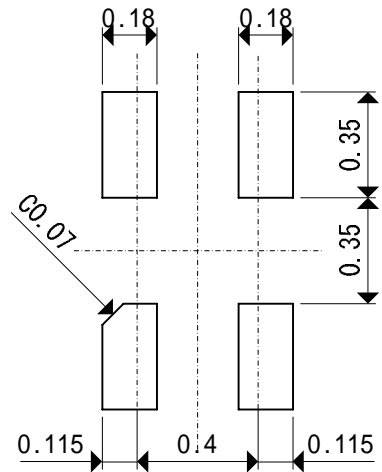


## PACKAGING INFORMATION (Continued)

USPN-4B02 Reference Pattern Layout



USPN-4B02 Reference Metal Mask Design



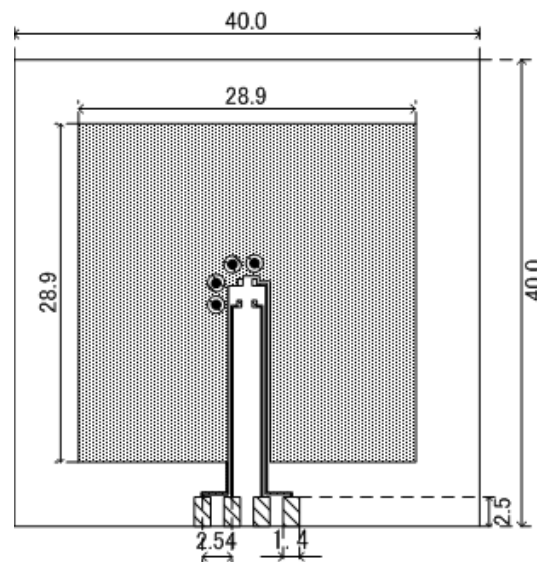
## PACKAGING INFORMATION (Continued)

### 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 mm<sup>2</sup> in one side)  
Copper (Cu) traces occupy 50% of the board area  
In top and back faces  
Package heat-sink is tied to the copper traces
- Material: Glass Epoxy (FR-4)
- Thickness: 1.6 mm
- Through-hole: 4 x 0.8 Diameter

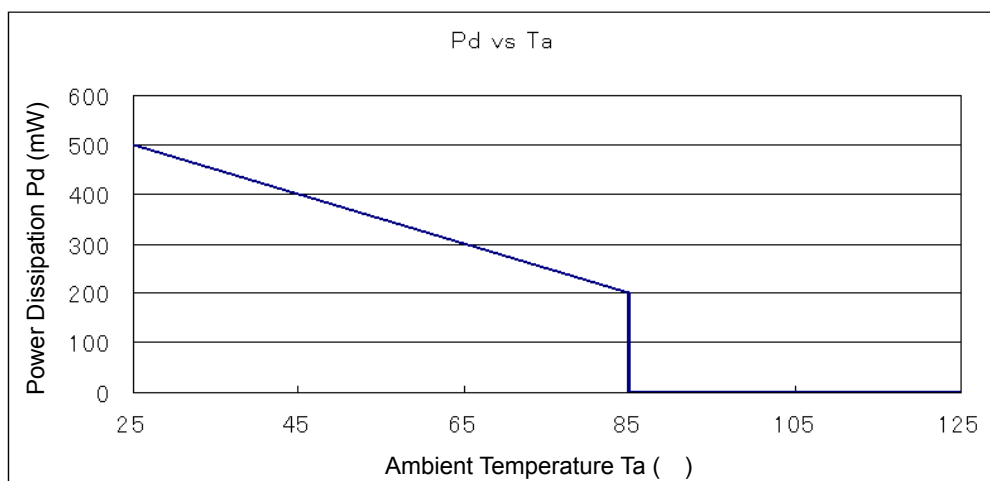


Evaluation Board (Unit: mm)

#### 2. Power Dissipation vs. Ambient temperature

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

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



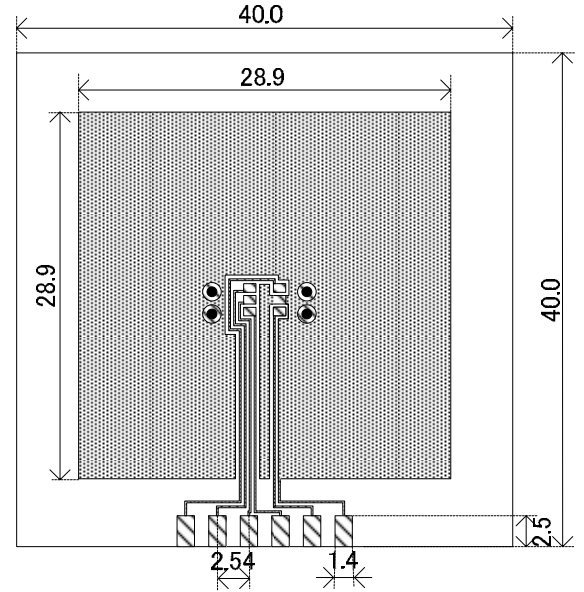
## PACKAGING INFORMATION (Continued)

### 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 mm<sup>2</sup> in one side)  
Copper (Cu) traces occupy 50% of the board area  
In top and back faces  
Package heat-sink is tied to the copper traces  
(Board of SOT-26 is used.)
- Material: Glass Epoxy (FR-4)
- Thickness: 1.6 mm
- Through-hole: 4 x 0.8 Diameter

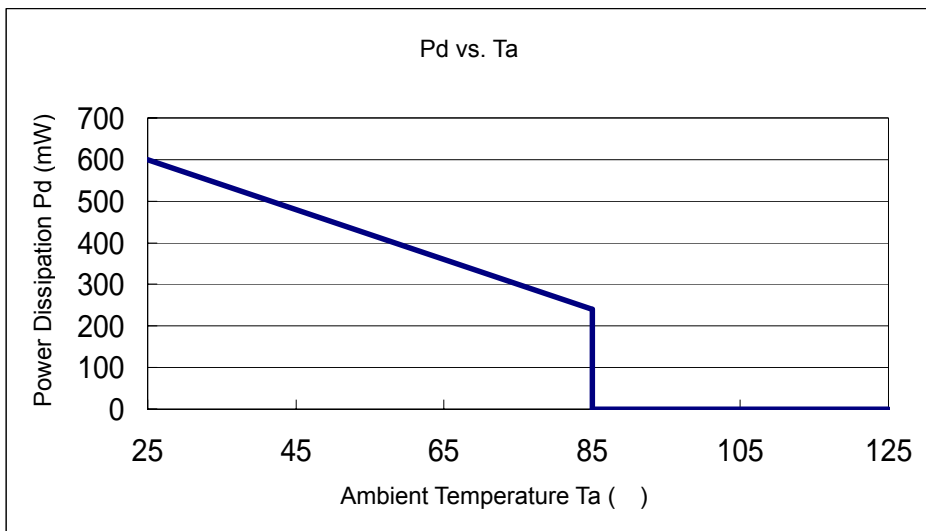


Evaluation Board (Unit: mm)

#### 2. Power Dissipation vs. Ambient temperature

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

| 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

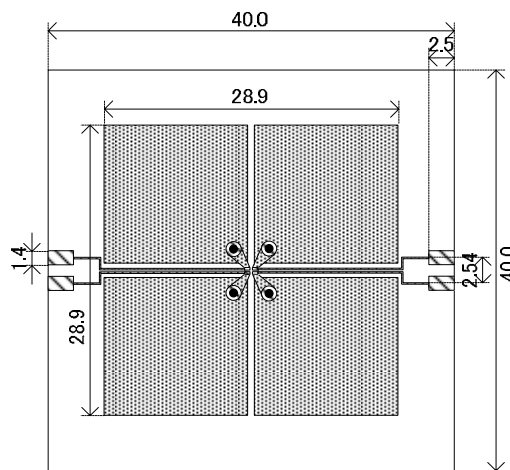
Soldering: Lead (Pb) free

Board: Dimensions 40 x 40 mm (1600 mm<sup>2</sup> 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

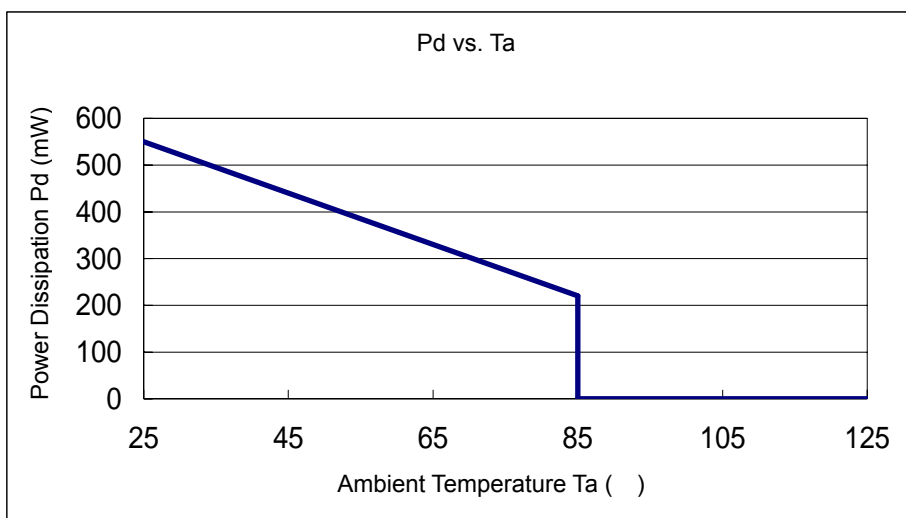


Evaluation Board (Unit: mm)

#### 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                       |                          |

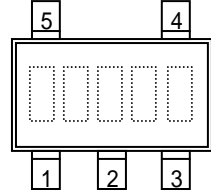


## MARKING RULE

### 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<br>0.1V INCREMENTS | OUTPUT VOLTAGE<br>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<br>INCREMENTS |   | 0.05V<br>INCREMENTS |   |      | 0.1V<br>INCREMENTS |   | 0.05V<br>INCREMENTS |   |
| 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

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

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

\* No character inversion used.

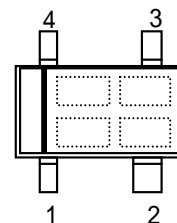


## MARKING RULE (Continued)

SSOT24 (with bar)

represents type of regulator and combination of output voltage

| MARK                              |                     |                                    |                       | PRODUCT SERIES |
|-----------------------------------|---------------------|------------------------------------|-----------------------|----------------|
| OUTPUT VOLTAGE<br>0.1V INCREMENTS |                     | OUTPUT VOLTAGE<br>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.)

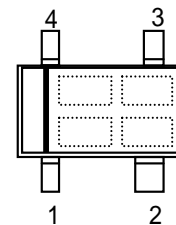
\* No character inversion used.

## MARKING RULE (Continued)

USPN-4B02

represents type of regulator and combination of output voltage

| MARK                              |                                    | PRODUCT SERIES |
|-----------------------------------|------------------------------------|----------------|
| OUTPUT VOLTAGE<br>0.1V INCREMENTS | OUTPUT VOLTAGE<br>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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