

200mA High Speed LDO Regulator, Output Capacitor-Less, Low Power Consumption

■ GENERAL DESCRIPTION

The XC6501 series is a high speed, low noise CMOS LDO regulator that can provide stable output voltages even without a load capacitor C_L . This is possible because phase compensation is carried out internally unlike other LDOs where it is done externally. The series consists of a reference voltage source, driver transistor, error amplifier, current limit circuit, and phase compensation circuit.

The CE function enables the circuit to be put into stand-by mode by inputting a low level signal to the CE pin thereby reducing current consumption from an already low $13 \mu\text{A}$ (in operation) to less than $0.1 \mu\text{A}$. In the stand-by mode, if a C_L capacitor is used, the electric charge stored at C_L can be discharged via the internal auto-discharge switch and as a result, the V_{OUT} pin quickly returns to the V_{SS} level.

The current limit fold-back circuit operates as a short circuit protection and a current limiter function for the output pin.

■ APPLICATIONS

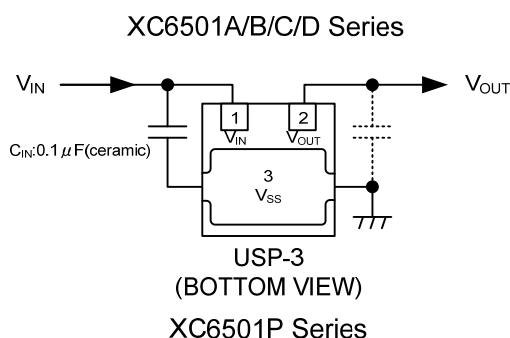
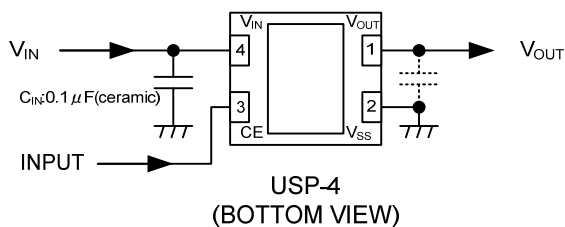
- Smart phones / Mobile phones
- Portable games
- Modules (wireless, cameras, etc.)
- Bluetooth
- Digital-TV tuners

■ FEATURES

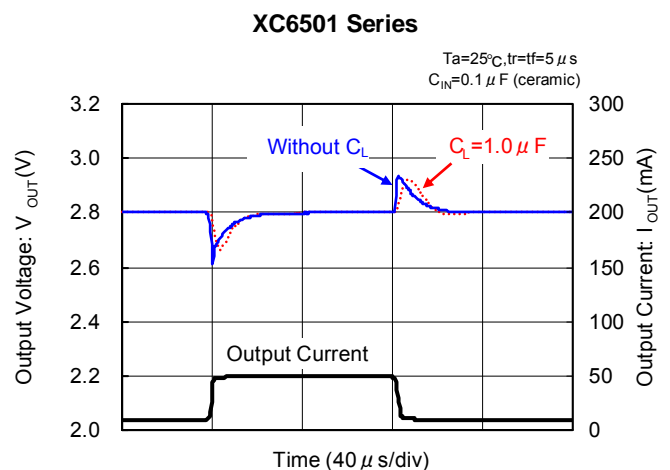
| | |
|---|--|
| Maximum Output Current | : 200mA |
| Operating Voltage Range | : 1.4~6.0V |
| Output Voltage Range | : 2.0~5.0V ($\pm 1\%$) ^(*) 1.2~1.95V ($\pm 0.02\text{V}$) ^(*) |
| Dropout Voltage | : 150mV@ $I_{OUT}=100\text{mA}$, $V_{OUT}=2.8\text{V}$ |
| Low Power Supply | : $13 \mu\text{A}$ @ $V_{OUT}=2.8\text{V}$ |
| Stand-by Current | : Less than $0.1 \mu\text{A}$ |
| Ripple Rejection | : 50dB@ $f=1\text{kHz}$, $V_{OUT}=2.8\text{V}$ |
| Protection Circuits | : Current limit (300mA, TYP.) Short circuit protection |
| Output capacitor is not required | : Internal phase compensation |
| C_L High Speed Auto Discharge | |
| Operating Ambient Temperature | : $-40^\circ\text{C} \sim +85^\circ\text{C}$ |
| Packages | : SOT-25, SSOT-24, USP-4, USPN-4, USP-3, WLP-4-01 |
| Environmentally Friendly | : EU RoHS Compliant, Pb Free |

(*) WLP-4-01 : 2.0~5.0V($\pm 2\%$), 1.2~1.95V($\pm 0.03\text{V}$)

■ TYPICAL APPLICATION CIRCUIT



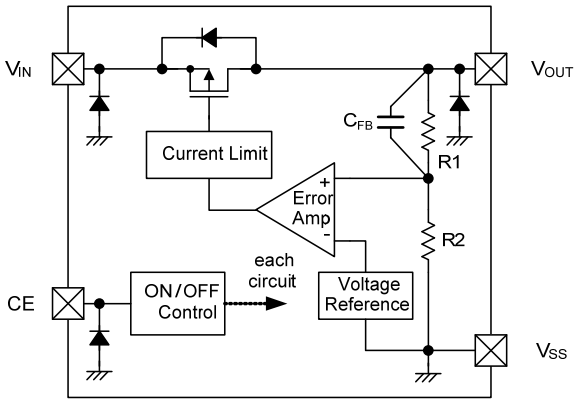
■ TYPICAL PERFORMANCE CHARACTERISTICS



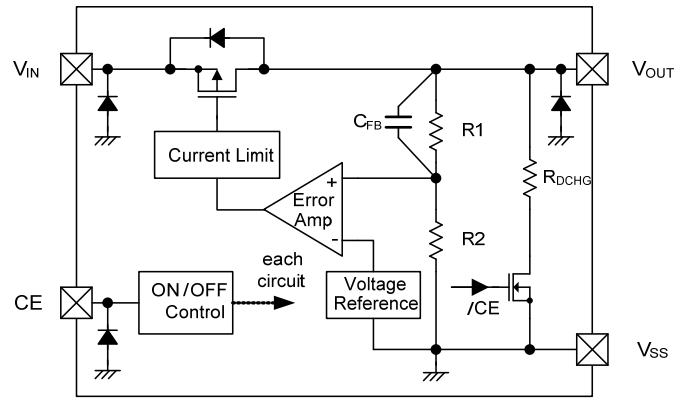
XC6501 Series

BLOCK DIAGRAMS

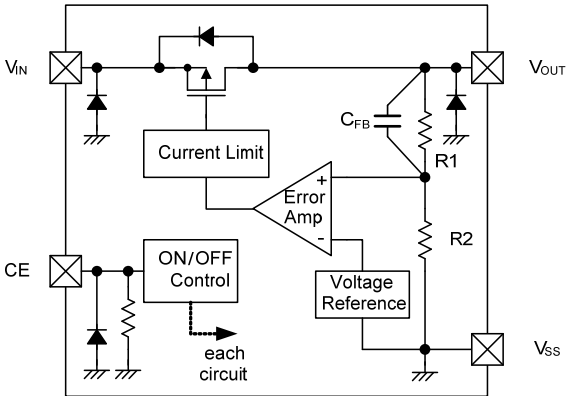
1) XC6501 Series A type



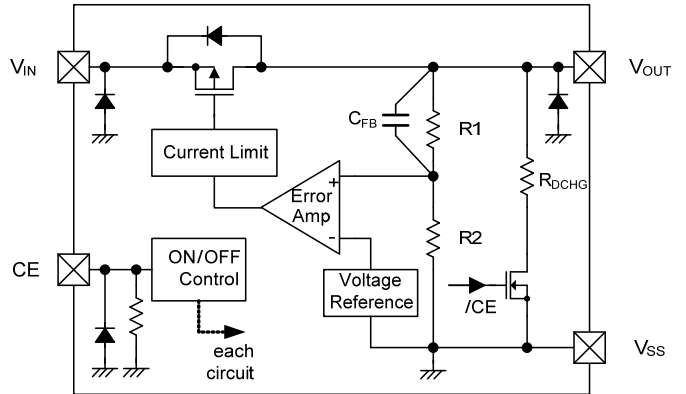
2) XC6501 Series B type



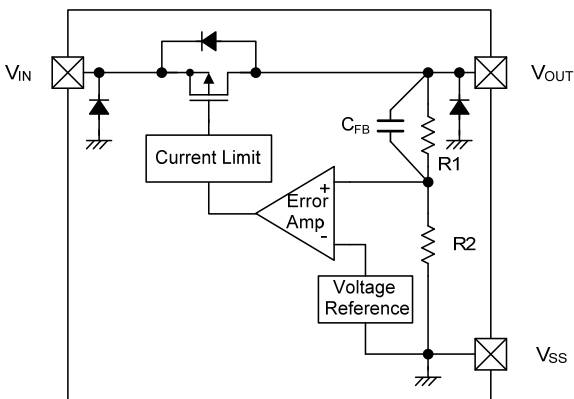
3) XC6501 Series C type



4) XC6501 Series D type



5) XC6501 Series P type



*Diodes inside the circuit are an ESD protection diode and a parasitic diode.

■ PRODUCT CLASSIFICATION

● Ordering Information

XC6501①②③④⑤⑥-⑦^(*)

| DESIGNATOR | ITEM | SYMBOL | DESCRIPTION |
|---------------------|-----------------------------------|------------------|---|
| ① | Regulator Type | A | CE High Active, Without CE Pull-down, Without C _L discharge |
| | | B | CE High Active, Without CE Pull-down, With C _L discharge |
| | | C | CE High Active, With CE Pull-down, Without C _L discharge |
| | | D | CE High Active, With CE Pull-down, With C _L discharge |
| | | P | 3 pin, without CE pin (USP-3) |
| ②③ | Output Voltage | 12~50 | ex.)28V → ②=2, ③=8 |
| ④ | Output Voltage Type [Accuracy] | 1 ^(*) | 0.1V increments ex.)1.80V → ②=1, ③=8, ④=1 [±0.02V @ 1.2V~1.9V, ±1% @ 2.0V~5.0V] |
| | | A ^(*) | 0.05V increments ex.)1.85V → ②=1, ③=8, ④=A [±0.02V @ 1.25V~1.95V, ±1% @ 2.05V~4.95V] |
| | | 2 ^(*) | 0.1V increments ex.)1.80V → ②=1, ③=8, ④=2 [±0.03V @ 1.2V~1.4V, ±2% @ 1.5V~5.0V] |
| | | B ^(*) | 0.05V increments ex.)1.85V → ②=1, ③=8, ④=B [±0.03V @ 1.25V~1.45V, ±2% @ 1.55V~4.95V] |
| ⑤⑥-⑦ ^(*) | Packages (Order Unit) | HR | USP-3 ^(*) (3,000pcs/Reel) |
| | | HR-G | USP-3 ^(*) (3,000pcs/Reel) |
| | | GR | USP-4 (3,000pcs/Reel) |
| | | GR-G | USP-4 (3,000pcs/Reel) |
| | | NR | SSOT-24 (3,000pcs/Reel) |
| | | NR-G | SSOT-24 (3,000pcs/Reel) |
| | | MR | SOT-25 (3,000pcs/Reel) |
| | | MR-G | SOT-25 (3,000pcs/Reel) |
| | | 7R-G | USPN-4 (5,000pcs/Reel) |
| 0R-G | WLP-4-01 (5,000pcs/Reel) | | |

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

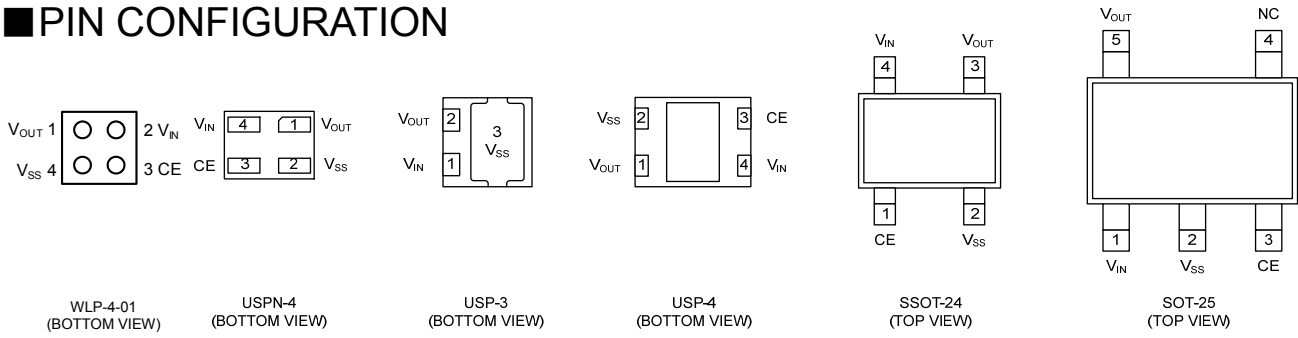
^(*) USP-3 is available only for XC6501P series.

^(*) WLP-4-01 only.

^(*) They are not used in the WLP-4-01.

XC6501 Series

PIN CONFIGURATION



*The heat dissipation pad of the USP-4 package is reference to solder as the reference mount pattern and metal mask pattern for mounting strength. The mount pattern should be electrically opened or connected to the V_{SS} (No.2) pin.

PIN ASSIGNMENT

| PIN NUMBER | | | | | | PIN NAME | FUNCTIONS |
|------------|-------|-------|---------|--------|--------|------------------|--------------------|
| WLP-4-01 | USP-3 | USP-4 | SSOT-24 | SOT-25 | USPN-4 | | |
| 2 | 1 | 4 | 4 | 1 | 4 | V _{IN} | Power Supply Input |
| 1 | 2 | 1 | 3 | 5 | 1 | V _{OUT} | Output |
| 4 | 3 | 2 | 2 | 2 | 2 | V _{SS} | Ground |
| 3 | - | 3 | 1 | 3 | 3 | CE | ON/OFF Control |
| - | - | - | - | 4 | - | NC | No Connection |

FUNCTION CHART

1)XC6501 series A/B type

| PIN NAME | SIGNAL | STATUS |
|----------|--------|--------|
| CE | L | OFF |
| | H | ON |
| | OPEN | OFF |

2)XC6501 series C/D type

| PIN NAME | SIGNAL | STATUS |
|----------|--------|-----------|
| CE | L | OFF |
| | H | ON |
| | OPEN | Undefined |

ABSOLUTE MAXIMUM RATINGS

| PARAMETER | | SYMBOL | RATINGS | UNITS |
|---------------------|-----------------------------------|------------------|---|---------|
| Input Voltage | | V _{IN} | -0.3~+6.5 | V |
| Output Current | | I _{OUT} | 400 ^(*1) | mA |
| Output Voltage | | V _{OUT} | -0.3~V _{IN} +0.3 or +6.5 ^(*2) | V |
| CE Input Voltage | | V _{CE} | -0.3~+6.5 | V |
| Power Dissipation | USPN-4 | Pd | 100 | mW |
| | | | 600 (PCB mounted) ^(*3) | |
| | USP-3 | | 120 | |
| | | | 1000 (PCB mounted) ^(*3) | |
| | USP-4 | | 120 | |
| | | | 1000 (PCB mounted) ^(*3) | |
| | SSOT-24 | | 150 | |
| | | | 500 (PCB mounted) ^(*3) | |
| SOT-25 | 250 | | | |
| | 600 (PCB mounted) ^(*3) | | | |
| WLP-4-01 | 660 (PCB mounted) ^(*3) | | | |
| | Operating Ambient Temperature | | Topr | -40~+85 |
| Storage Temperature | | Tstg | -55~+125 | °C |

* All voltages are described based on the V_{SS} pin.

(*1) I_{OUT} ≤ Pd / (V_{IN} - V_{OUT})

(*2) The maximum value should be V_{IN}+0.3 or +6.5 in the lowest.

(*3) The power dissipation figure shown is PCB mounted and is for reference only.

Please see the power dissipation page for the mounting condition.

■ ELECTRICAL CHARACTERISTICS

● XC6501 Series A/B/C/D Type

Ta=25°C

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNITS | CIRCUIT | |
|--|---|---|--|----------------------|--|--------|---------|---|
| Output Voltage | V _{OUT(E)} ^(*) | V _{OUT(T)} ^(**) ≤ 1.95V V _{CE} =V _{IN} , I _{OUT} =10mA | -0.02 ^(***) -0.03 ^(***) | V _{OUT(T)} | +0.02 ^(***) +0.03 ^(***) | V | ① | |
| | | V _{OUT(T)} ≥ 2.0V V _{CE} =V _{IN} , I _{OUT} =10mA | ×0.99 ^(***) ×0.98 ^(***) | | ×1.01 ^(***) ×1.02 ^(***) | | | |
| Maximum Output Current | I _{OUTMAX} | V _{CE} =V _{IN} | 200 | - | - | mA | ① | |
| Load Regulation | ΔV _{OUT} | V _{CE} =V _{IN} , 0.1mA ≤ I _{OUT} ≤ 100mA | - | 15 | 45 | mV | ① | |
| Dropout Voltage ^(*) | V _{dif} | V _{CE} =V _{IN} , I _{OUT} =100mA | - | E-1 ^(***) | | mV | ① | |
| Supply Current | I _{SS} | V _{IN} =V _{CE} =6.0V, I _{OUT} =0mA | E-2 ^(***) | | | μA | ② | |
| Stand-by Current | I _{STBY} | V _{IN} =6.0V, V _{CE} =V _{SS} | - | 0.01 | 0.1 | μA | ② | |
| Line Regulation | ΔV _{OUT} / (ΔV _{IN} ·V _{OUT}) | V _{OUT(T)} +0.5V ≤ V _{IN} ≤ 6.0V, V _{CE} =V _{IN} , I _{OUT} =30mA | - | 0.10 | 0.20 | %/V | ① | |
| Input Voltage | V _{IN} | | 1.4 | - | 6.0 | V | ① | |
| Output Voltage Temperature Characteristics | ΔV _{OUT} / (ΔT _{opr} ·V _{OUT}) | V _{CE} =V _{IN} , I _{OUT} =30mA -40°C ≤ T _{opr} ≤ 85°C | - | ±100 | - | ppm/°C | ① | |
| Power Supply Rejection Ratio | PSRR | V _{OUT(T)} ≤ 4.75V V _{IN} =[V _{OUT(T)} +1.0]V _{DC} +0.5V _{p-pAC} V _{CE} =V _{IN} , I _{OUT} =30mA, f=1kHz | - | 50 | - | dB | ③ | |
| | | V _{OUT(T)} ≥ 4.80V V _{IN} =5.75V _{DC} +0.5V _{p-pAC} V _{CE} =V _{IN} , I _{OUT} =30mA, f=1kHz | | | | | | |
| Current Limit | I _{LIM} | V _{CE} =V _{IN} | 210 | 300 | - | mA | ① | |
| Short - Circuit Current | I _{SHORT} | V _{CE} =V _{IN} , V _{OUT} is short-circuited at the V _{SS} level | - | 25 | - | mA | ① | |
| CE High Level Voltage | V _{CEH} | | 1.0 | - | 6.0 | V | ① | |
| CE Low Level Voltage | V _{CEL} | | V _{SS} | - | 0.25 | V | ① | |
| CE High Level Current | I _{CEH} | V _{CE} =V _{IN} =6.0V | XC6501A/B | -0.1 | - | 0.1 | μA | ① |
| | | | XC6501C/D | 3.5 | 6.0 | 10 | | |
| CE Low Level Current | I _{CEL} | V _{CE} =V _{IN} | -0.1 | - | 0.1 | μA | ① | |
| Auto-Discharge Resistance ^(*) | R _{DCHG} | V _{IN} =6.0V, V _{OUT} =1.2V, V _{CE} =V _{SS} | - | 250 | 300 | Ω | ① | |
| | | V _{IN} =6.0V, V _{OUT} =5.0V, V _{CE} =V _{SS} | - | 400 | 480 | Ω | | |

Notes:

Unless otherwise stated regarding input voltage conditions, V_{IN}=V_{OUT(T)}^(**)+1.0V.

*1: V_{OUT(E)}: An actual output voltage when an amply stabilized(V_{OUT(T)}+1.0V) is supplied with constant I_{OUT}.

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

*3: MIN and MAX values of V_{OUT(E)} are shown in the voltage table "E-0".

*4: V_{dif}={V_{IN1} - V_{OUT1}}

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

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

*5: Please refer to page E-1.

*6: Please refer to page E-2.

*7: This function is built in the XC6501B/D series only.

The XC6501A/C series discharges by only R1+ R2 resistors as shown in the block diagrams.

ELECTRICAL CHARACTERISTICS (Continued)

●XC6501 Series P Type

Ta=25°C

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNITS | CIRCUIT |
|--|--|---|-----------------------|---------------------|-----------------------|-------|---------|
| Output Voltage | V _{OUT(E)} ^(*1) | V _{OUT(T)} ^(*2) ≤ 1.95V I _{OUT} = 10mA | -0.02 ^(*3) | V _{OUT(T)} | +0.02 ^(*3) | V | ① |
| | | V _{OUT(T)} ≥ 2.0V I _{OUT} = 10mA | ×0.99 ^(*3) | | ×1.01 ^(*3) | | |
| Maximum Output Current | I _{OUTMAX} | | 200 | - | - | mA | ① |
| Output Voltage | ΔV _{OUT} | 0.1mA ≤ I _{OUT} ≤ 100mA | - | 15 | 45 | mV | ① |
| Dropout Voltage ^(*4) | V _{dif} | I _{OUT} = 100mA | - | E-1 ^(*5) | | mV | ① |
| Supply Current | I _{SS} | V _{IN} = 6.0V, I _{OUT} = 0mA | E-2 ^(*6) | | | μA | ② |
| Line Regulation | ΔV _{OUT} / (ΔV _{IN} · V _{OUT}) | V _{OUT(T)} + 0.5V ≤ V _{IN} ≤ 6.0V, I _{OUT} = 30mA | - | 0.10 | 0.20 | %/V | ① |
| Input Voltage | V _{IN} | | 1.4 | - | 6.0 | V | ① |
| Output Voltage Temperature Characteristics | ΔV _{OUT} / (ΔT _{opr} · V _{OUT}) | I _{OUT} = 30mA -40°C ≤ T _{opr} ≤ 85°C | - | ±100 | - | ppm | ① |
| Power Supply Rejection Ratio | PSRR | V _{OUT(T)} ≤ 4.75V V _{IN} = {V _{OUT(T)} + 1.0} V _{DC} + 0.5V _{p-pAC} I _{OUT} = 30mA, f = 1kHz | - | 50 | - | dB | ③ |
| | | V _{OUT(T)} ≥ 4.80V V _{IN} = 5.75V _{DC} + 0.5V _{p-pAC} I _{OUT} = 30mA, f = 1kHz | | | | | |
| Current Limit | I _{LIM} | | 210 | 300 | - | mA | ① |
| Short Circuit Current | I _{SHORT} | V _{OUT} is short-circuited at the V _{SS} level | - | 25 | - | mA | ① |

Notes:

Unless otherwise stated regarding input voltage conditions, V_{IN} = V_{OUT(T)}^(*2) + 1.0V.

*1: V_{OUT(E)}: An actual output voltage when an amply stabilized (V_{OUT(T)} + 1.0V) is supplied with constant I_{OUT}.

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

*3: MIN and MAX values of V_{OUT(E)} are shown in the voltage table "E-0".

*4: V_{dif} = {V_{IN1} - V_{OUT1}}

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

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

*5: Please refer to page E-1.

*6: Please refer to page E-2.

■ ELECTRICAL CHARACTERISTICS (Continued)

● Voltage Chart

| NOMINAL VOLTAGE (V) | E-0 | | | | E-1 | | E-2 | | |
|---------------------|--------------------------------------|--------|-------------------------------|--------|----------------------|------|---------------------|------|------|
| | OUTPUT VOLTAGE (Except WLP-4-01) (V) | | OUTPUT VOLTAGE (WLP-4-01) (V) | | DROPOUT VOLTAGE (mV) | | SUPPLY CURRENT (μA) | | |
| | V _{OUT(E)} | | V _{OUT(E)} | | V _{diff} | | I _{SS} | | |
| V _{OUT(T)} | MIN. | MAX. | MIN. | MAX. | TYP. | MAX. | MIN. | TYP. | MAX. |
| 1.20 | 1.1800 | 1.2200 | 1.1700 | 1.2300 | 440 | 690 | 5 | 11 | 17 |
| 1.25 | 1.2300 | 1.2700 | 1.2200 | 1.2800 | | | | | |
| 1.30 | 1.2800 | 1.3200 | 1.2700 | 1.3300 | | | | | |
| 1.35 | 1.3300 | 1.3700 | 1.3200 | 1.3800 | | | | | |
| 1.40 | 1.3800 | 1.4200 | 1.3700 | 1.4300 | 300 | 610 | | | |
| 1.45 | 1.4300 | 1.4700 | 1.4200 | 1.4800 | | | | | |
| 1.50 | 1.4800 | 1.5200 | 1.4700 | 1.5300 | | | | | |
| 1.55 | 1.5300 | 1.5700 | 1.5190 | 1.5810 | 260 | 530 | | | |
| 1.60 | 1.5800 | 1.6200 | 1.5680 | 1.6320 | | | | | |
| 1.65 | 1.6300 | 1.6700 | 1.6170 | 1.6830 | | | | | |
| 1.70 | 1.6800 | 1.7200 | 1.6660 | 1.7340 | | | | | |
| 1.75 | 1.7300 | 1.7700 | 1.7150 | 1.7850 | 230 | 470 | | | |
| 1.80 | 1.7800 | 1.8200 | 1.7640 | 1.8360 | | | | | |
| 1.85 | 1.8300 | 1.8700 | 1.8130 | 1.8870 | | | | | |
| 1.90 | 1.8800 | 1.9200 | 1.8620 | 1.9380 | | | | | |
| 1.95 | 1.9300 | 1.9700 | 1.9110 | 1.9890 | 200 | 430 | 6 | 12 | 18 |
| 2.00 | 1.9800 | 2.0200 | 1.9600 | 2.0400 | | | | | |
| 2.05 | 2.0295 | 2.0705 | 2.0090 | 2.0910 | | | | | |
| 2.10 | 2.0790 | 2.1210 | 2.0580 | 2.1420 | | | | | |
| 2.15 | 2.1285 | 2.1715 | 2.1070 | 2.1930 | | | | | |
| 2.20 | 2.1780 | 2.2220 | 2.1560 | 2.2440 | 190 | 410 | | | |
| 2.25 | 2.2275 | 2.2725 | 2.2050 | 2.2950 | | | | | |
| 2.30 | 2.2770 | 2.3230 | 2.2540 | 2.3460 | | | | | |
| 2.35 | 2.3265 | 2.3735 | 2.3030 | 2.3970 | | | | | |
| 2.40 | 2.3760 | 2.4240 | 2.3520 | 2.4480 | 210 | 380 | | | |
| 2.45 | 2.4255 | 2.4745 | 2.4010 | 2.4990 | | | | | |
| 2.50 | 2.4750 | 2.5250 | 2.4500 | 2.5500 | | | | | |
| 2.55 | 2.5245 | 2.5755 | 2.4990 | 2.6010 | | | | | |
| 2.60 | 2.5740 | 2.6260 | 2.5480 | 2.6520 | 150 | 360 | 7 | 14 | 20 |
| 2.65 | 2.6235 | 2.6765 | 2.5970 | 2.7030 | | | | | |
| 2.70 | 2.6730 | 2.7270 | 2.6460 | 2.7540 | | | | | |
| 2.75 | 2.7225 | 2.7775 | 2.6950 | 2.8050 | | | | | |
| 2.80 | 2.7720 | 2.8280 | 2.7440 | 2.8560 | 150 | 360 | 7 | 14 | 20 |
| 2.85 | 2.8215 | 2.8785 | 2.7930 | 2.9070 | | | | | |
| 2.90 | 2.8710 | 2.9290 | 2.8420 | 2.9580 | | | | | |
| 2.95 | 2.9205 | 2.9795 | 2.8910 | 3.0090 | | | | | |
| 3.00 | 2.9700 | 3.0300 | 2.9400 | 3.0600 | 150 | 360 | 7 | 14 | 20 |
| 3.05 | 3.0195 | 3.0805 | 2.9890 | 3.1110 | | | | | |

XC6501 Series

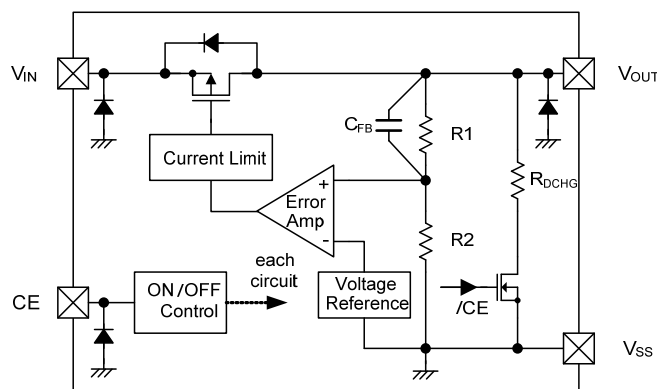
■ ELECTRICAL CHARACTERISTICS (Continued)

● Voltage Table (continued)

| NOMINAL VOLTAGE (V) | E-0 | | | | E-1 | | E-2 | | |
|---------------------|--------------------------------------|--------|-------------------------------|--------|----------------------|------|---------------------|------|------|
| | OUTPUT VOLTAGE (Except WLP-4-01) (V) | | OUTPUT VOLTAGE (WLP-4-01) (V) | | DROPOUT VOLTAGE (mV) | | SUPPLY CURRENT (μA) | | |
| | $V_{OUT(E)}$ | | $V_{OUT(E)}$ | | V_{dif} | | I_{SS} | | |
| $V_{OUT(T)}$ | MIN. | MAX. | MIN. | MAX. | TYP. | MAX. | MIN. | TYP. | MAX. |
| 3.10 | 3.0690 | 3.1310 | 3.0380 | 3.1620 | 150 | 360 | 7 | 14 | 21 |
| 3.15 | 3.1190 | 3.1820 | 3.0870 | 3.2130 | | | | | |
| 3.20 | 3.1680 | 3.2320 | 3.1360 | 3.2640 | 140 | 350 | | | |
| 3.25 | 3.2175 | 3.2825 | 3.1850 | 3.3150 | | | | | |
| 3.30 | 3.2670 | 3.3330 | 3.2340 | 3.3660 | | | | | |
| 3.35 | 3.3165 | 3.3835 | 3.2830 | 3.4170 | | | | | |
| 3.40 | 3.3660 | 3.4340 | 3.3320 | 3.4680 | | | | | |
| 3.45 | 3.4155 | 3.4845 | 3.3810 | 3.5190 | | | | | |
| 3.50 | 3.4650 | 3.5350 | 3.4300 | 3.5700 | | | | | |
| 3.55 | 3.5145 | 3.5855 | 3.4790 | 3.6210 | | | | | |
| 3.60 | 3.5640 | 3.6360 | 3.5280 | 3.6720 | 130 | 340 | | | |
| 3.65 | 3.6135 | 3.6865 | 3.5770 | 3.7230 | | | | | |
| 3.70 | 3.6630 | 3.7370 | 3.6260 | 3.7740 | | | | | |
| 3.75 | 3.7125 | 3.7875 | 3.6750 | 3.8250 | | | | | |
| 3.80 | 3.7620 | 3.8380 | 3.7240 | 3.8760 | | | | | |
| 3.85 | 3.8115 | 3.8885 | 3.7730 | 3.9270 | | | | | |
| 3.90 | 3.8610 | 3.9390 | 3.8220 | 3.9780 | | | | | |
| 3.95 | 3.9105 | 3.9895 | 3.8710 | 4.0290 | | | | | |
| 4.00 | 3.9600 | 4.0400 | 3.9200 | 4.0800 | | | | | |
| 4.05 | 4.0095 | 4.0905 | 3.9690 | 4.1310 | | | | | |
| 4.10 | 4.0590 | 4.1410 | 4.0180 | 4.1820 | 120 | 330 | | | |
| 4.15 | 4.1085 | 4.1915 | 4.0670 | 4.2330 | | | | | |
| 4.20 | 4.1580 | 4.2420 | 4.1160 | 4.2840 | | | | | |
| 4.25 | 4.2075 | 4.2925 | 4.1650 | 4.3350 | | | | | |
| 4.30 | 4.2570 | 4.3430 | 4.2140 | 4.3860 | | | | | |
| 4.35 | 4.3065 | 4.3935 | 4.2630 | 4.4370 | | | | | |
| 4.40 | 4.3560 | 4.4440 | 4.3120 | 4.4880 | | | | | |
| 4.45 | 4.4055 | 4.4945 | 4.3610 | 4.5390 | | | | | |
| 4.50 | 4.4550 | 4.5450 | 4.4100 | 4.5900 | | | | | |
| 4.55 | 4.5045 | 4.5955 | 4.4590 | 4.6410 | | | | | |
| 4.60 | 4.5540 | 4.6460 | 4.5080 | 4.6920 | 8 | 16 | | | |
| 4.65 | 4.6035 | 4.6965 | 4.5570 | 4.7430 | | | | | |
| 4.70 | 4.6530 | 4.7470 | 4.6060 | 4.7940 | | | | | |
| 4.75 | 4.7025 | 4.7975 | 4.6550 | 4.8450 | | | | | |
| 4.80 | 4.7520 | 4.8480 | 4.7040 | 4.8960 | | | | | |
| 4.85 | 4.8015 | 4.8985 | 4.7530 | 4.9470 | | | | | |
| 4.90 | 4.8510 | 4.9490 | 4.8020 | 4.9980 | | | | | |
| 4.95 | 4.9005 | 4.9995 | 4.8510 | 5.0490 | | | | | |
| 5.00 | 4.9500 | 5.0500 | 4.9000 | 5.1000 | | | | | |
| | | | | | | | | | |
| | | | | | | | | | 23 |

■ 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 & stabilized by a system of negative feedback. The current limit circuit and short protect circuit operate in relation to the level of output current. Further, the IC's internal circuitry can be shutdown via the CE pin's signal.



XC6501 Series B Type

<C_L High Speed Auto-Discharge Function>

The XC6501B/D series can discharge the electric charge in the output capacitor C_L, when a low signal to the CE pin, which enables a whole IC circuit turn off, is inputted via the N-channel transistor located between the V_{OUT} pin and the V_{SS} pin as shown in the BLOCK DIAGRAM. The C_L auto-discharge resistance value is set at 400Ω (V_{OUT}=5.0V @ V_{IN}=6.0V at typical). The discharge time of the output capacitor C_L is set by the C_L auto-discharge resistance R and the output capacitor C_L. By setting time constant of a C_L auto-discharge resistance value R_{DCHG} and an output capacitor value C_L as τ (τ=C x R_{DCHG}), the output voltage after discharge via the N-channel transistor is calculated by the following formulas.

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

or an expanded formula is

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

V : Output voltage after discharge

V_{OUT(E)} : Output voltage

t : Discharge time

τ : R_{DCHG} × C_L

R_{DCHG} : C_L auto-discharge resistance

C_L : Output capacitor

<Current Limiter, Short-Circuit Protection>

The XC6501 series' fold-back circuit operates as an output current limiter and a short protection of the output pin. When the load current reaches the current limit level, the fixed current limiter circuit operates and output voltage drops. When the output voltage is shorted to the V_{SS}, its current flow reached and minimized to about 25mA.

<CE Pin>

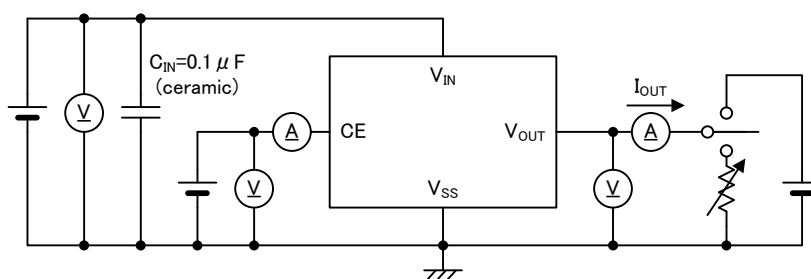
The IC's internal circuitry can be shutdown via the signal from the CE pin with the XC6501 series. In shutdown mode output at the V_{OUT} pin will be pulled down to the V_{SS} level via R1 & R2. However, as for the XC6501B/D series, the C_L auto-discharge resistor is connected in parallel to R1 and R2 while the power supply is applied to the V_{IN} pin. Therefore, time until the V_{OUT} pin reaches the V_{SS} level becomes short. The output voltage becomes unstable, when the CE pin is open. If this IC is used with the correct output voltage for the CE pin, the logic is fixed and the IC will operate normally. However, supply current may increase as a result of through current in the IC's internal circuitry when medium voltage is input.

■ NOTES ON USE

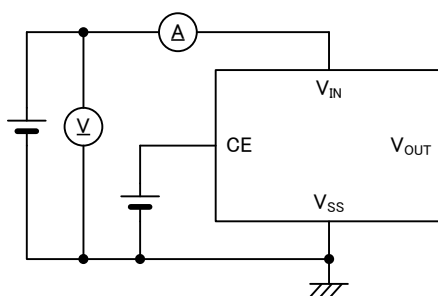
1. Please use this IC within the stated absolute maximum ratings. The IC is liable to malfunction should the ratings be exceeded.
2. This IC achieves stable operation without an output capacitor C_L by internal phase compensation. However, wiring impedance is high, operations may become unstable due to noise and/or phase lag depending on output current. Please wire the input capacitor C_{IN} and the output capacitor C_L as close to the IC as possible.
3. Torex places an importance on improving our products and their reliability. We request that users incorporate fail-safe designs and post-aging protection treatment when using Torex products in their systems.

TEST CIRCUITS

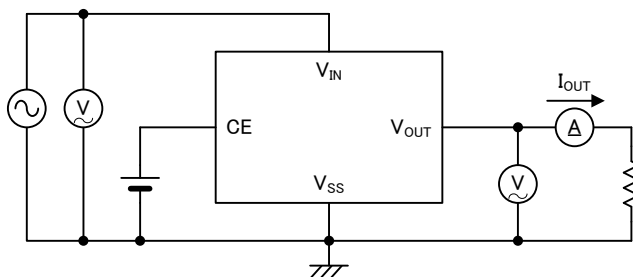
● Circuit ①



● Circuit ②



● Circuit ③

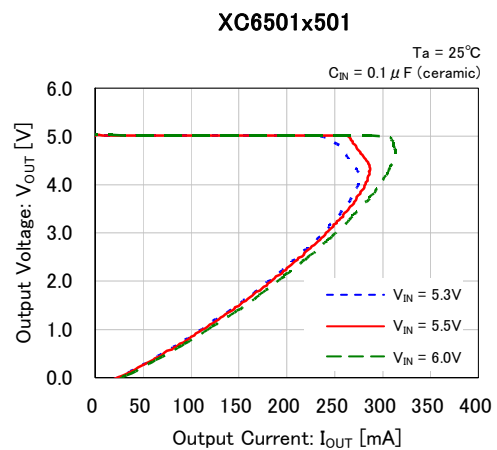
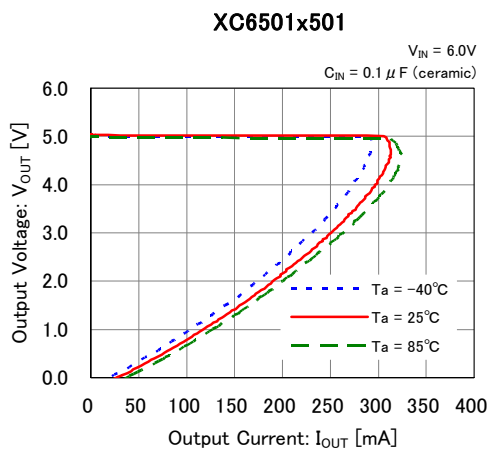
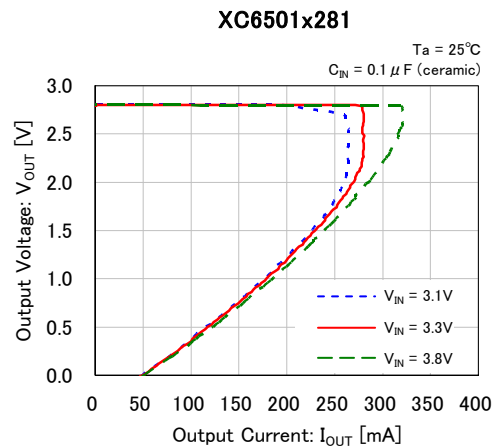
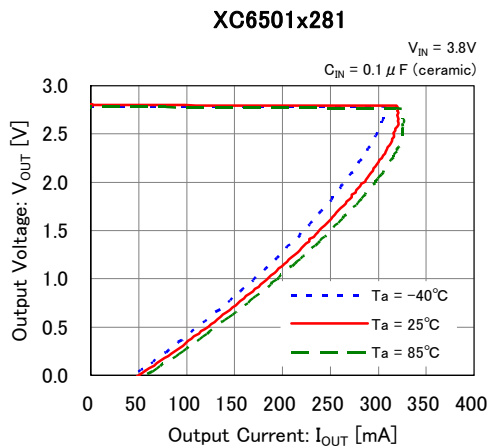
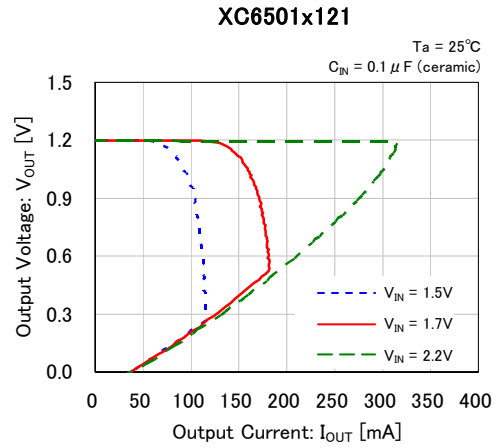
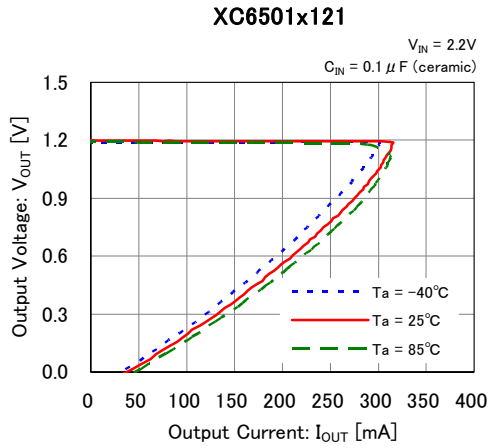


The CE pin does not exist in the XC6501 series P type, please disregard CE description in above test circuit.

TYPICAL PERFORMANCE CHARACTERISTICS

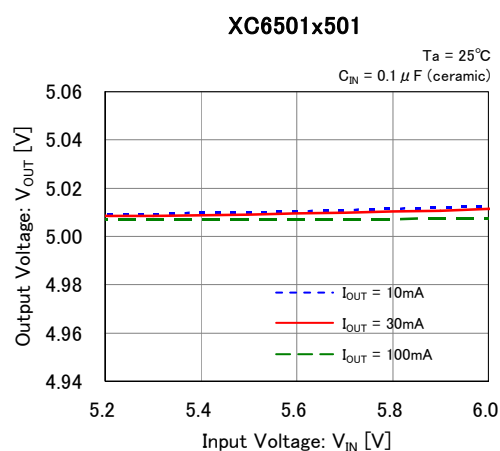
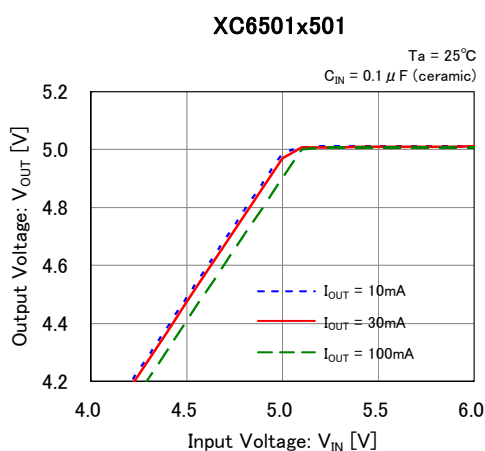
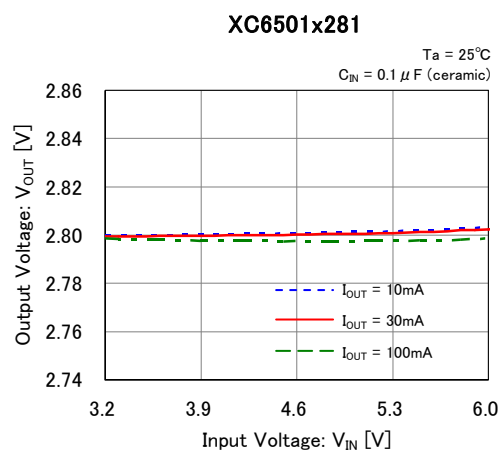
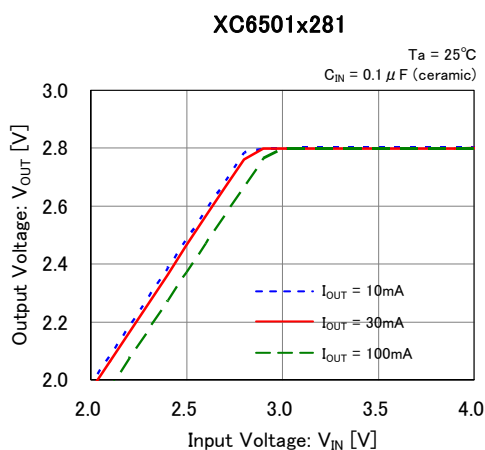
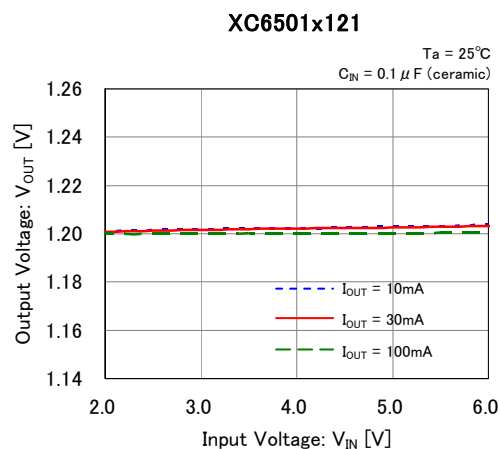
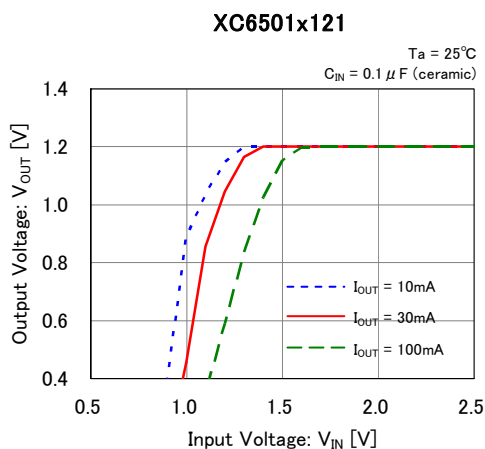
*CE Voltage condition: Unless otherwise stated, $V_{CE} = V_{IN}$

(1) Output Voltage vs. Output Current



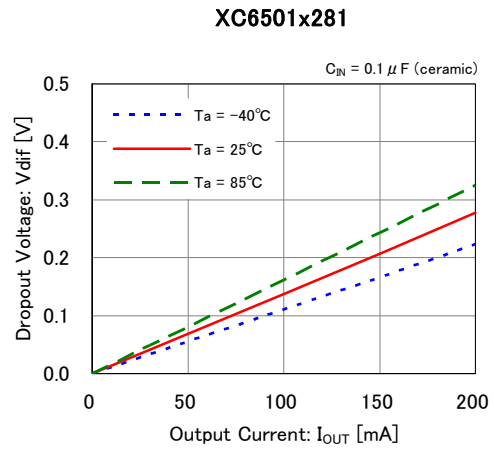
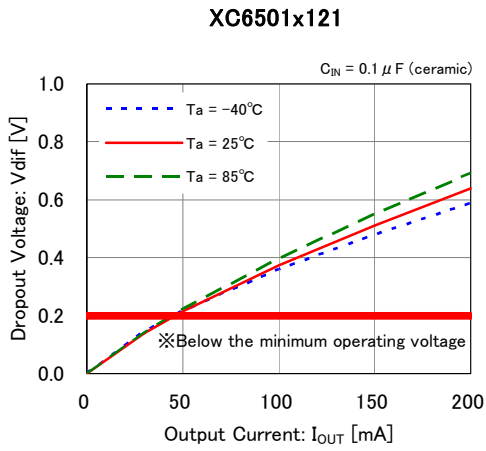
■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2) Output Voltage vs. Input Voltage

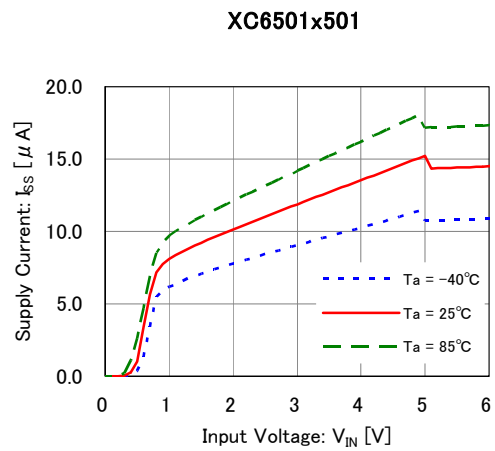
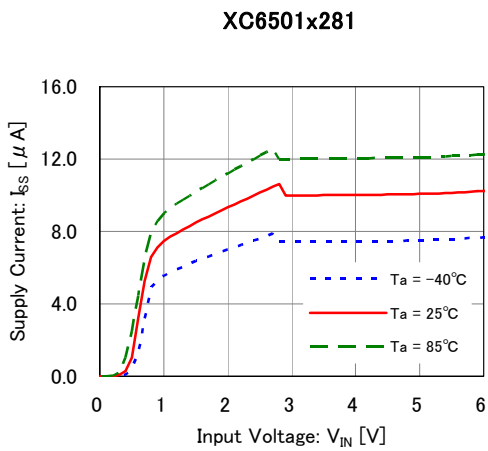
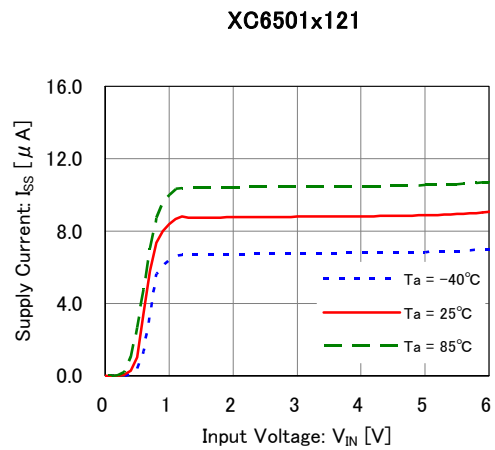
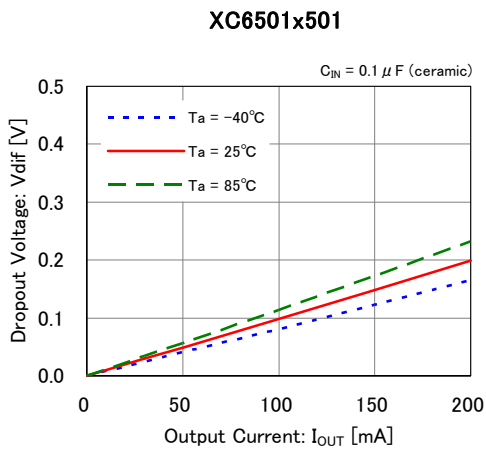


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(3) Dropout Voltage vs. Output Current

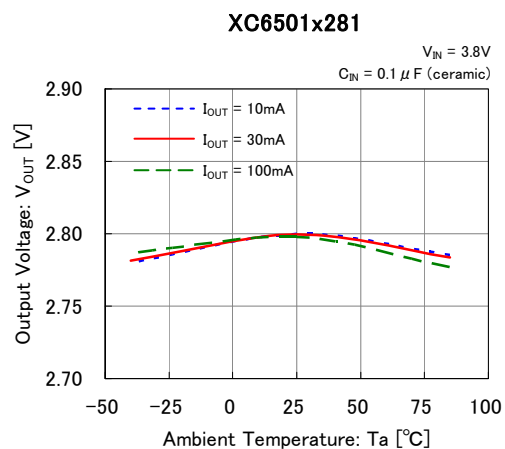
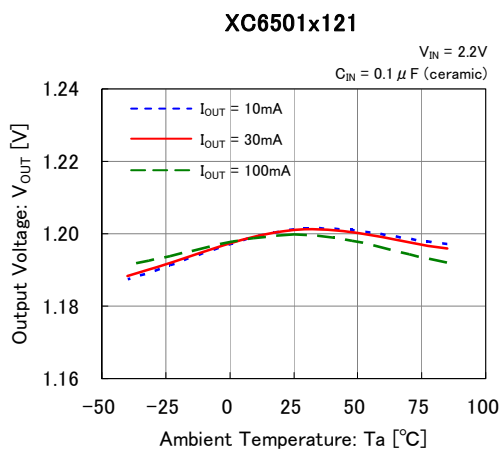


(4) Supply Current vs. Input Voltage

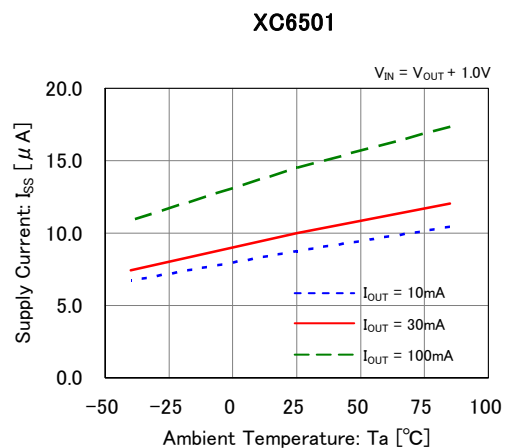
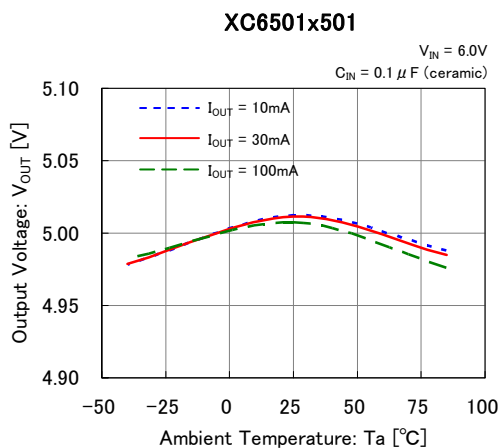


■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

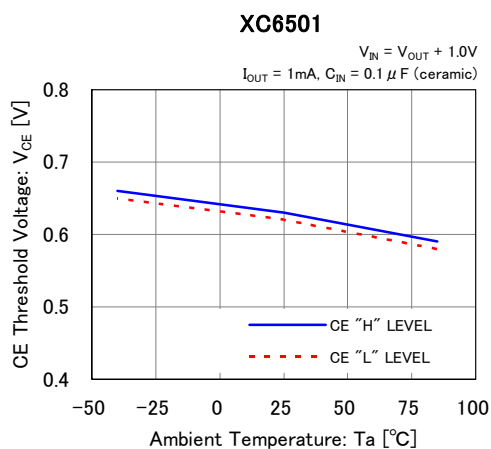
(5) Output Voltage vs. Ambient Temperature



(6) Supply Current vs. Ambient Temperature

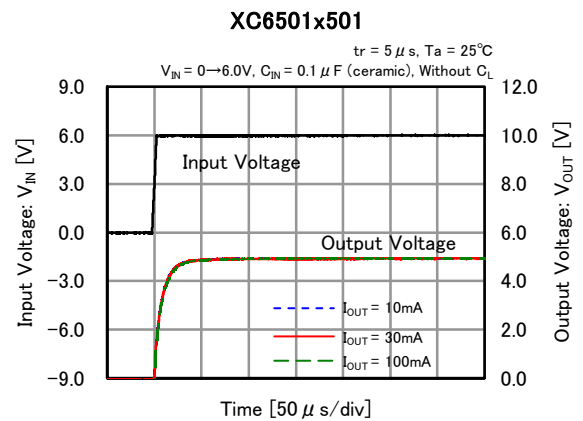
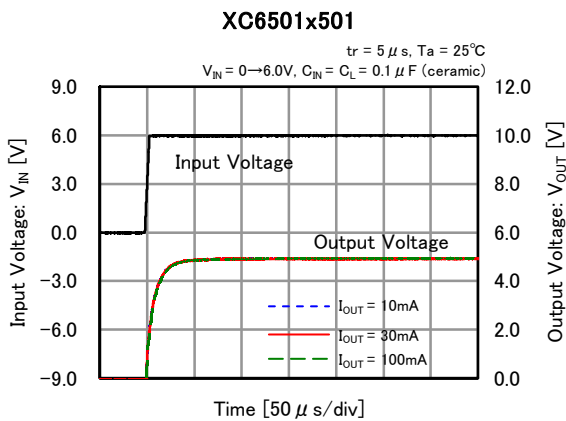
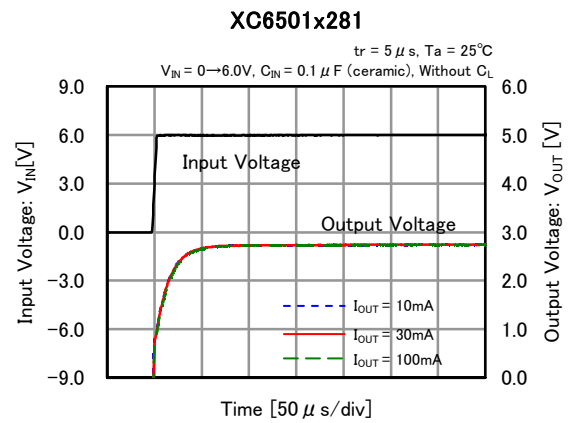
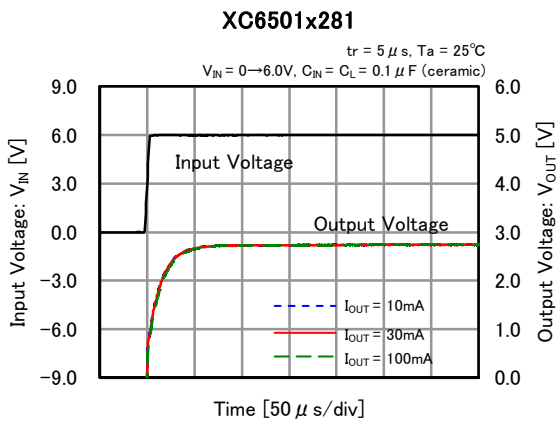
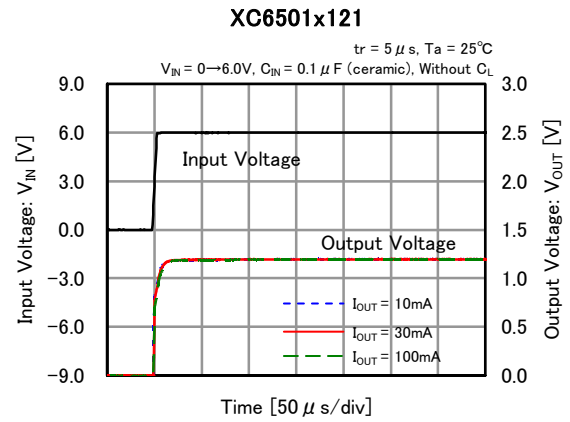
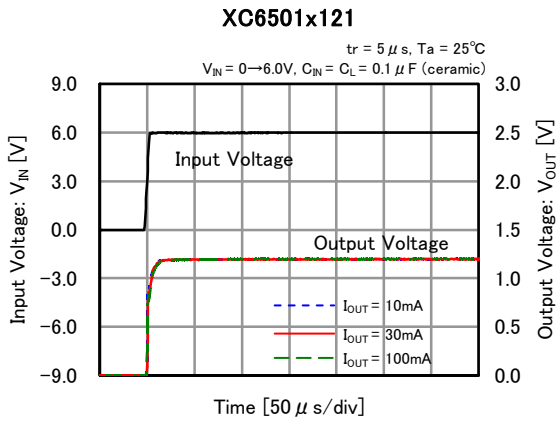


(7) CE Threshold Voltage vs. Ambient Temperature



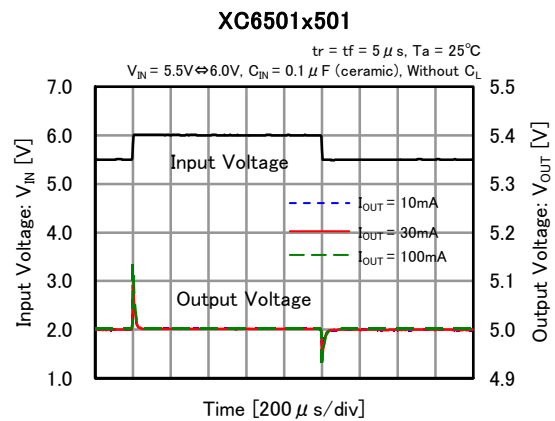
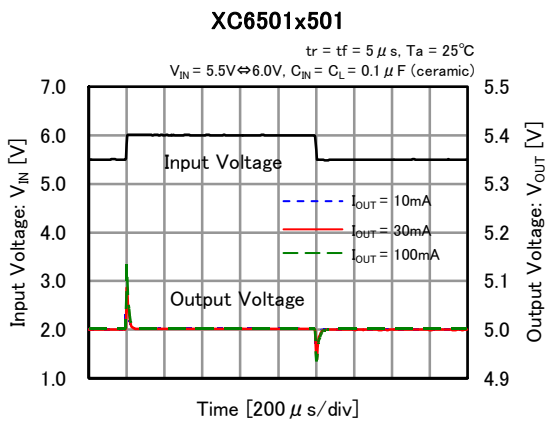
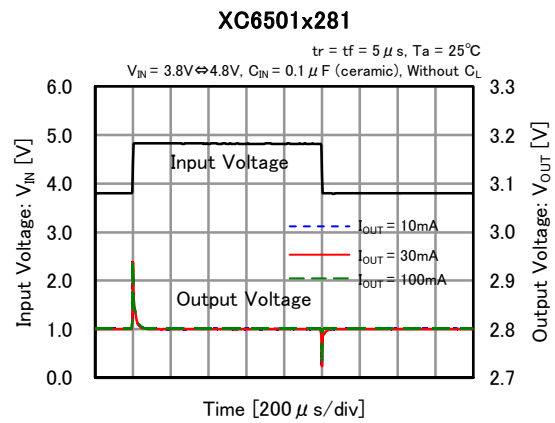
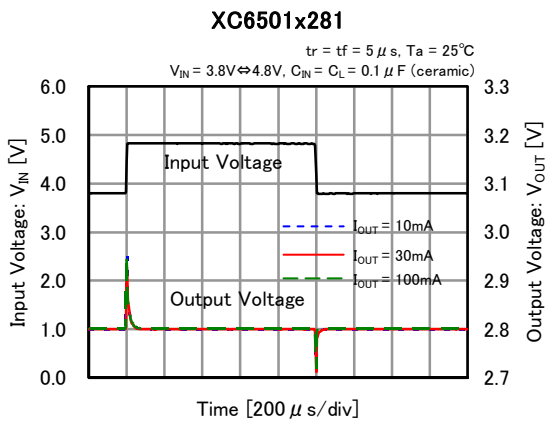
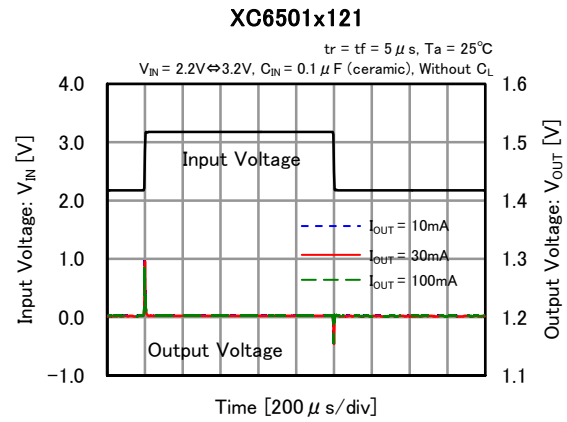
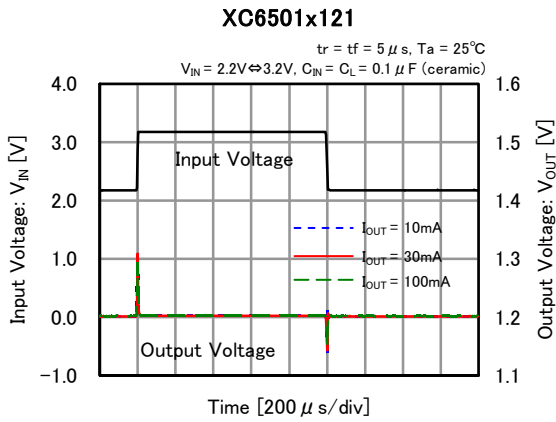
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(8) Rising Response Time



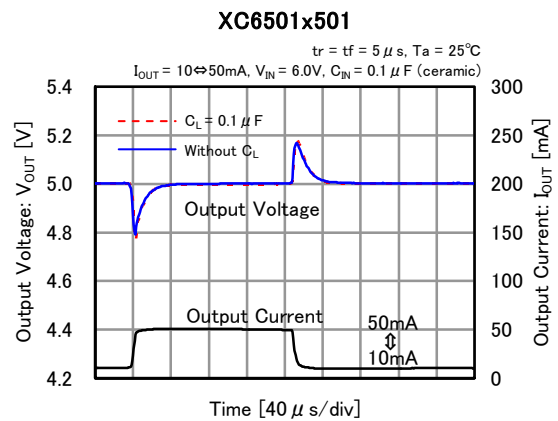
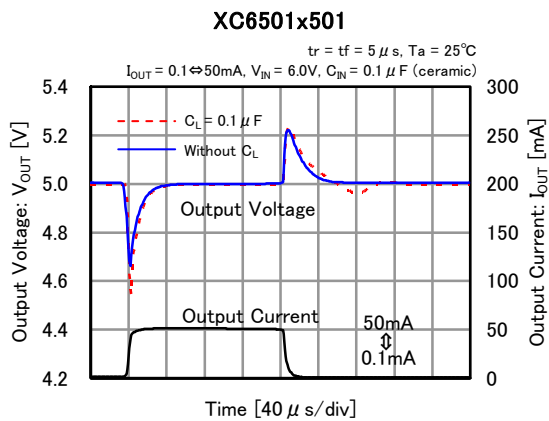
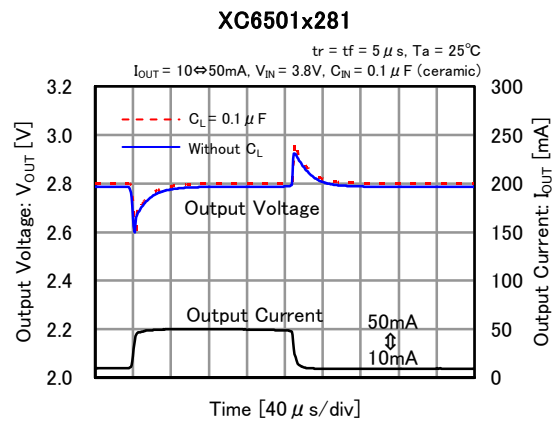
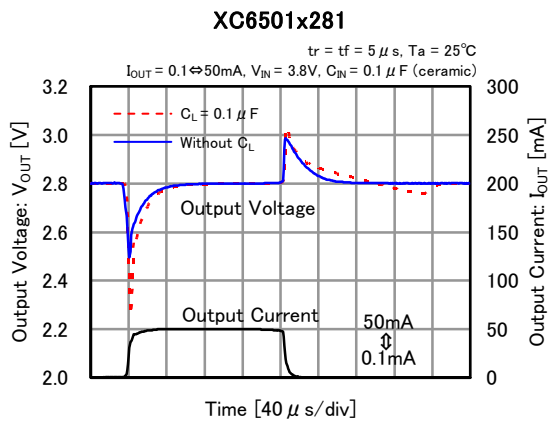
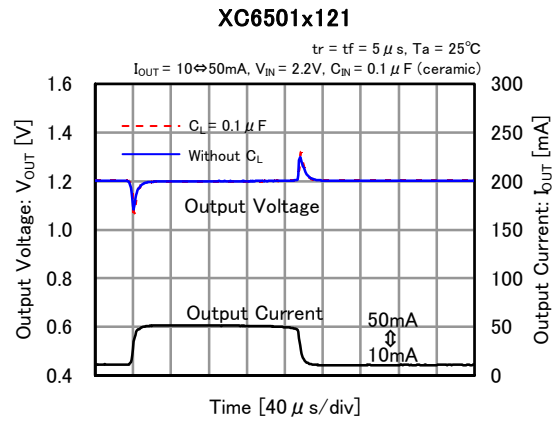
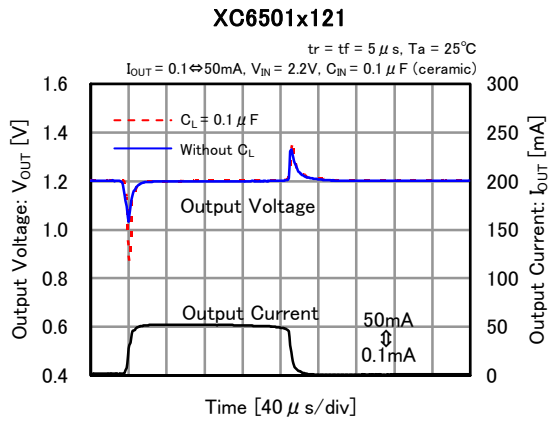
■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(9) Input Transient Response



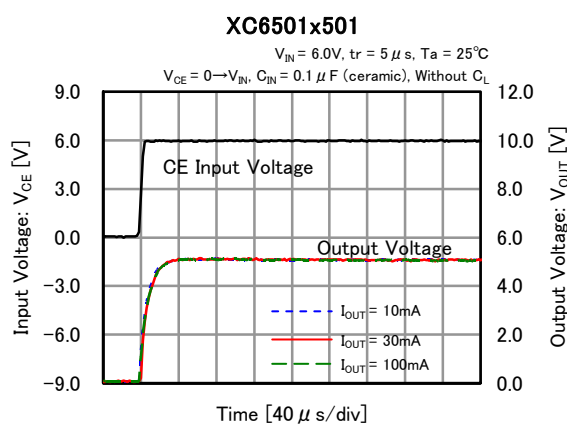
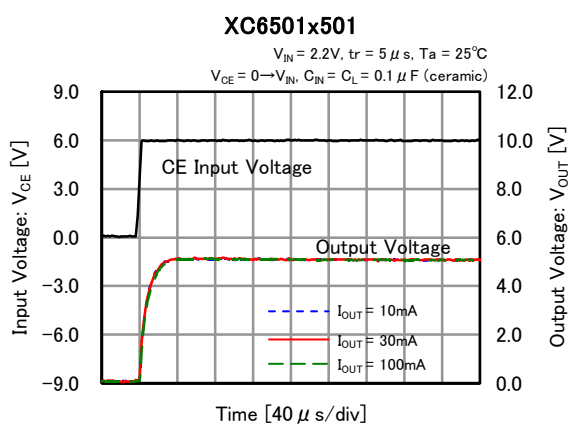
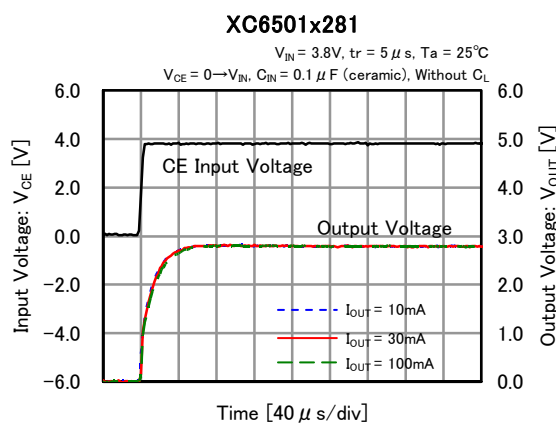
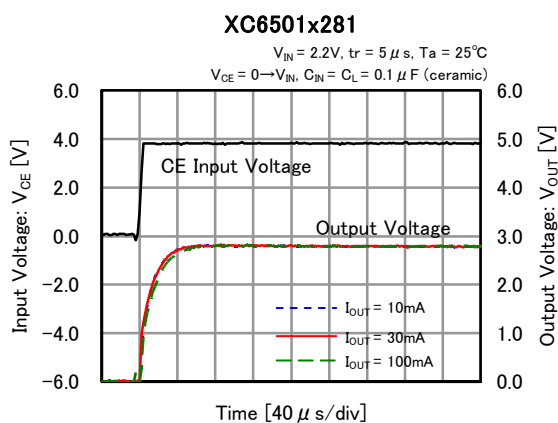
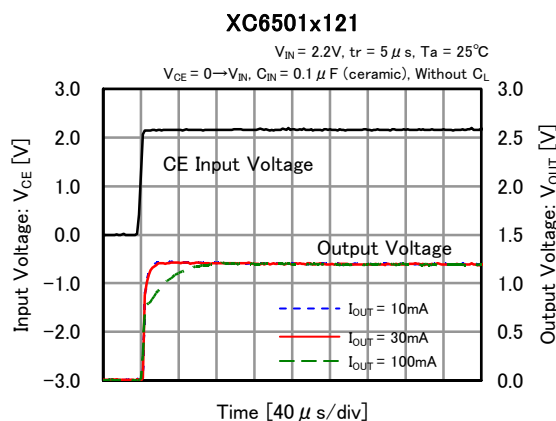
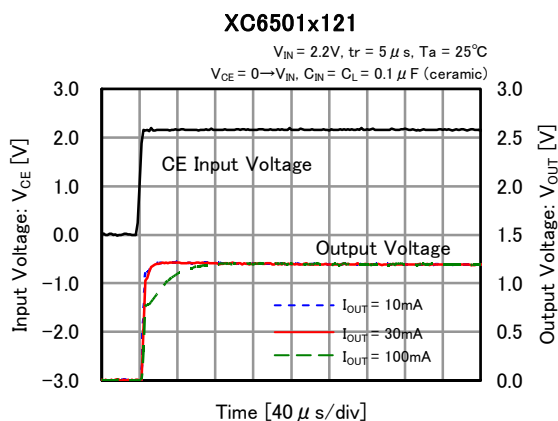
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(10) Load Transient Response



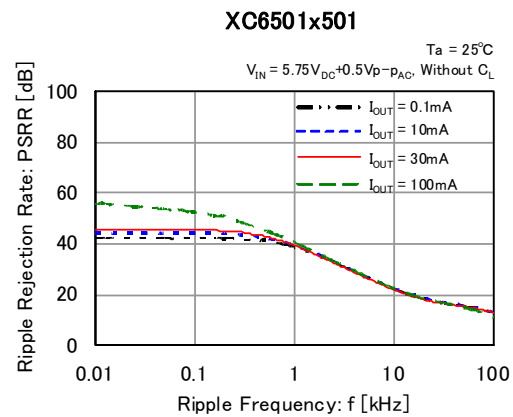
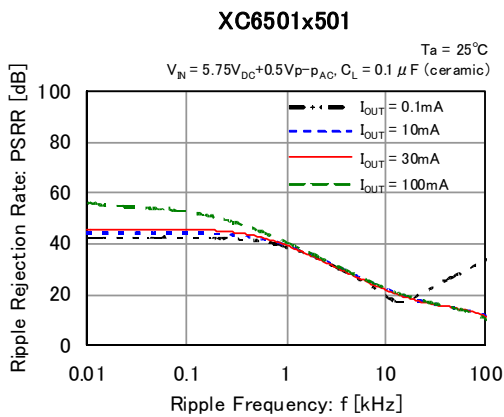
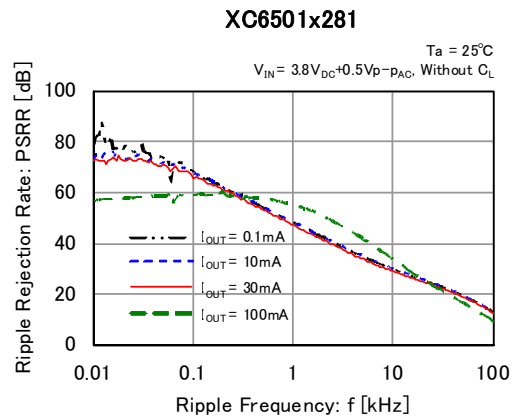
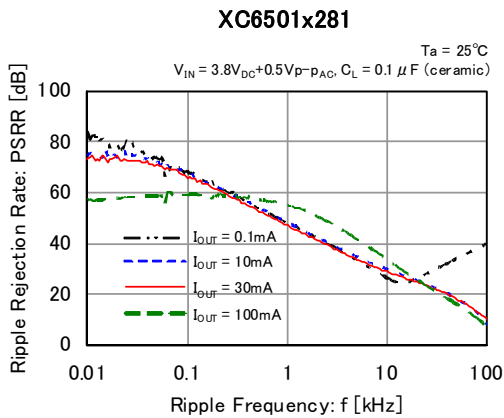
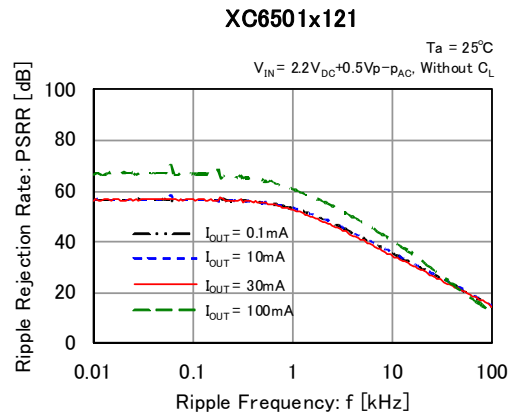
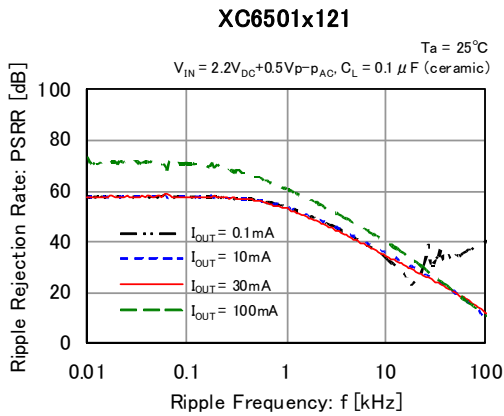
■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(11) CE Rising Respose Time



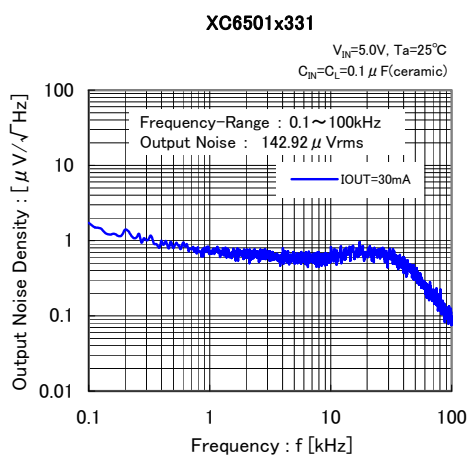
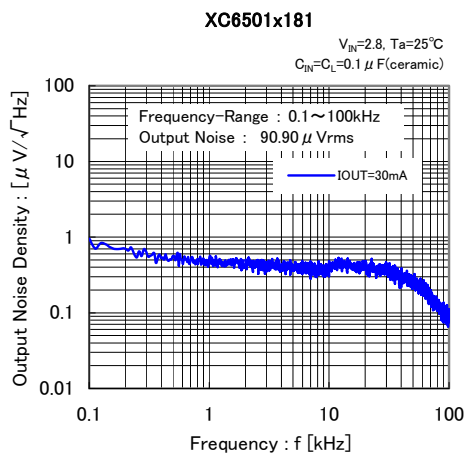
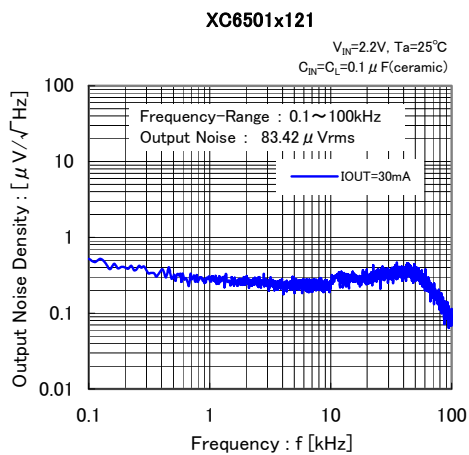
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(12) Ripple Rejection Rate



■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

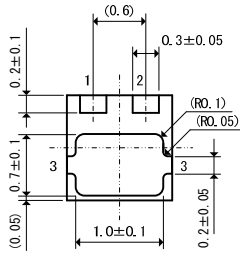
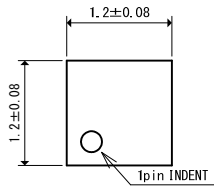
(13) Output Noise Density



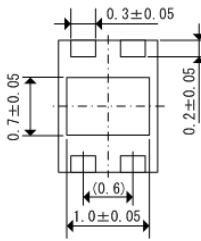
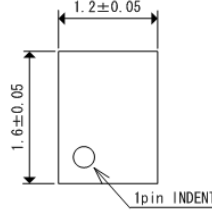
XC6501 Series

PACKAGING INFORMATION

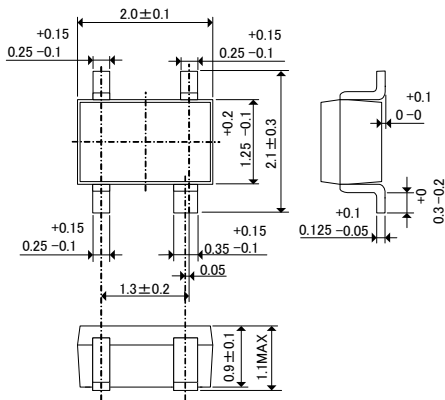
● USP-3



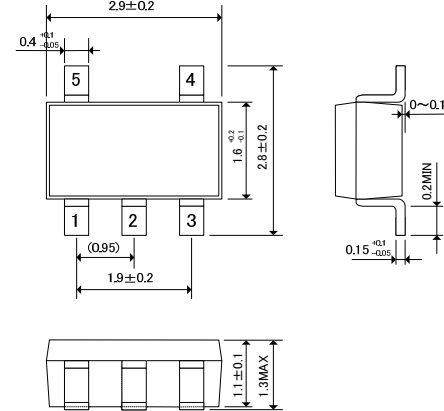
● USP-4



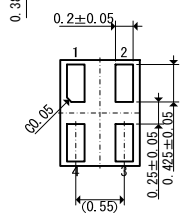
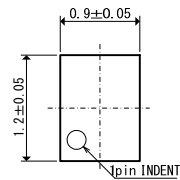
● SSOT-24



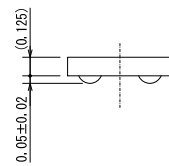
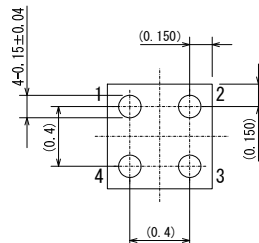
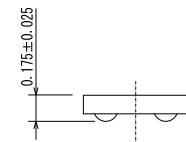
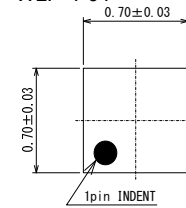
● SOT-25



● USPN-4

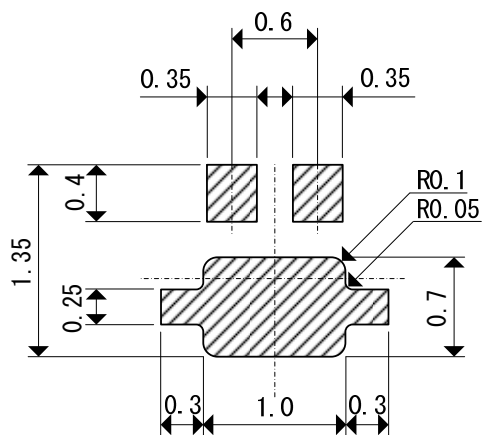


● WLP-4-01

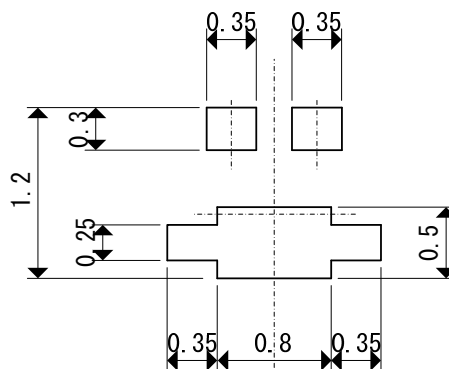


■ PACKAGING INFORMATION (Continued)

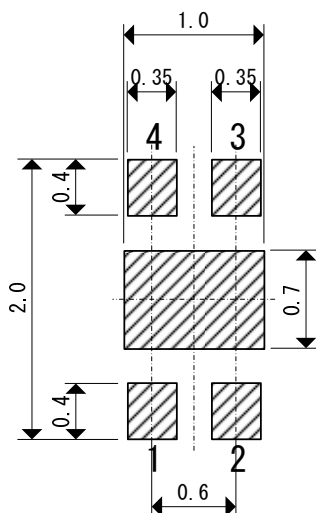
● USP-3 Reference Pattern Layout



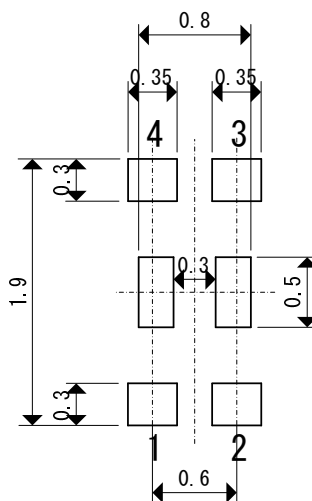
● USP-3 Reference Metal Mask Design



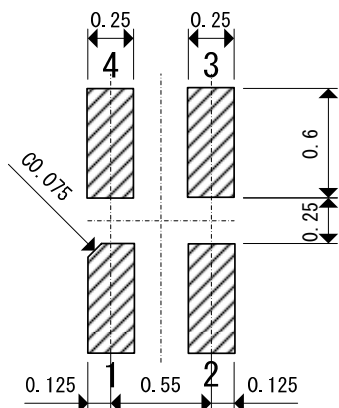
● USP-4 Reference Pattern Layout



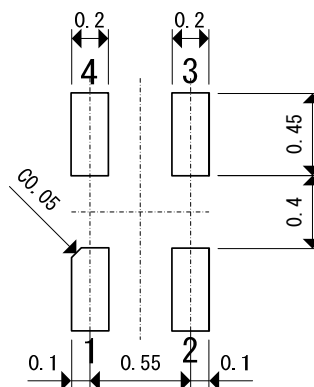
● USP-4 Reference Metal Mask Design



● USPN-4 Reference Pattern Layout



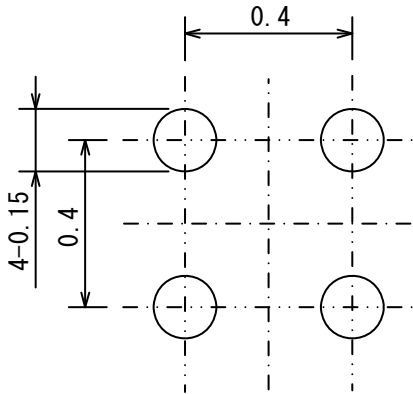
● USPN-4 Reference Metal Mask Design



PACKAGING INFORMATION (Continued)

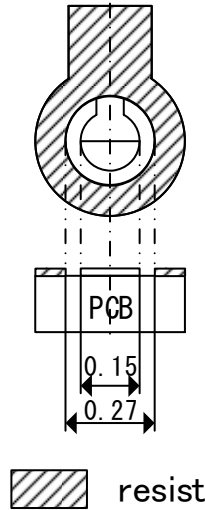
●WLP-4-01

Reference Pattern Layout



●WLP-4-01

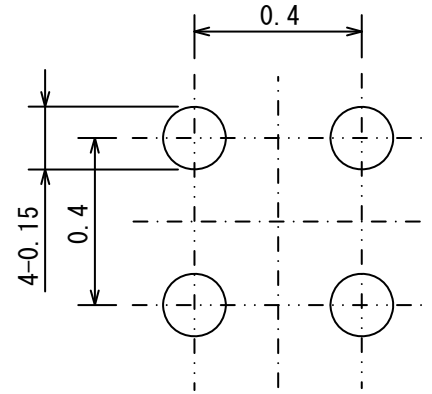
Reference Pattern Layout detail



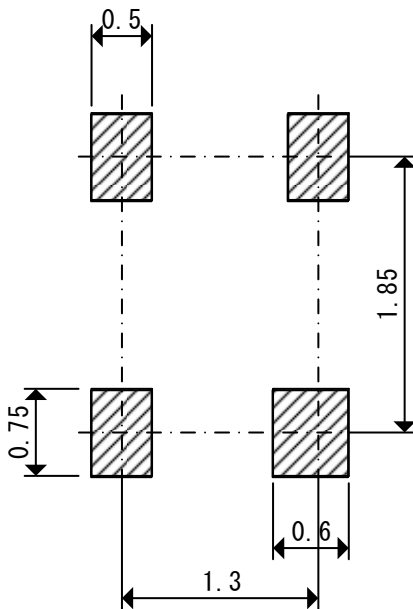
 resist

●WLP-4-01

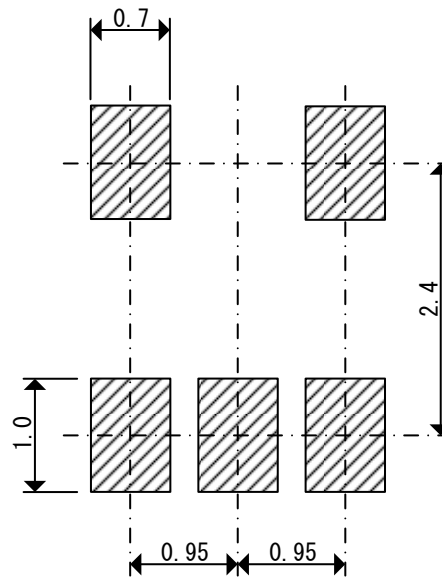
Reference Metal Mask Design



●SSOT-24 Reference Pattern Layout



●SOT-25 Reference Pattern Layout



● USPN-4 Power Dissipation

Power dissipation data for the USPN-4 is shown in this page.

The value of power dissipation varies with the mount board conditions.

Please use this data as the reference data taken in the following condition.

1. Measurement Condition

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.

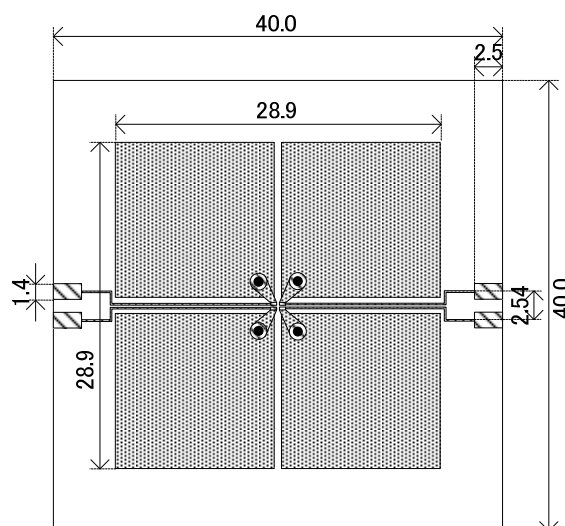
The USPN-4 package has for terminals.

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

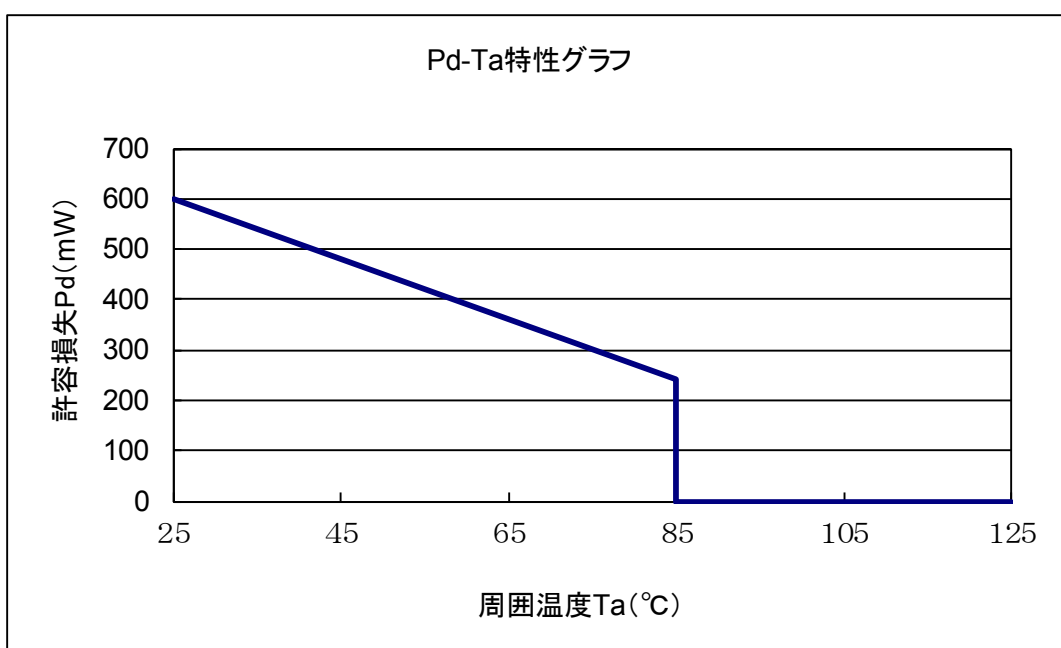


評価基板レイアウト(単位: mm)

2. Power Dissipation vs. Ambient Temperature

Board Mount (T_j max = 125°C)

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



● USP-4 Power Dissipation

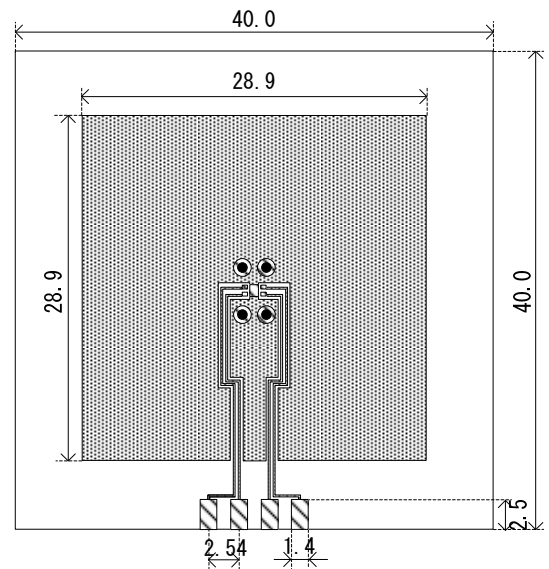
Power dissipation data for the USP-4 is shown in this page.

The value of power dissipation varies with the mount board conditions.

Please use this data as the reference data taken in the following condition.

1. Measurement Condition

- 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 : 1.6mm
- Through-hole : 4 x 0.8 Diameter

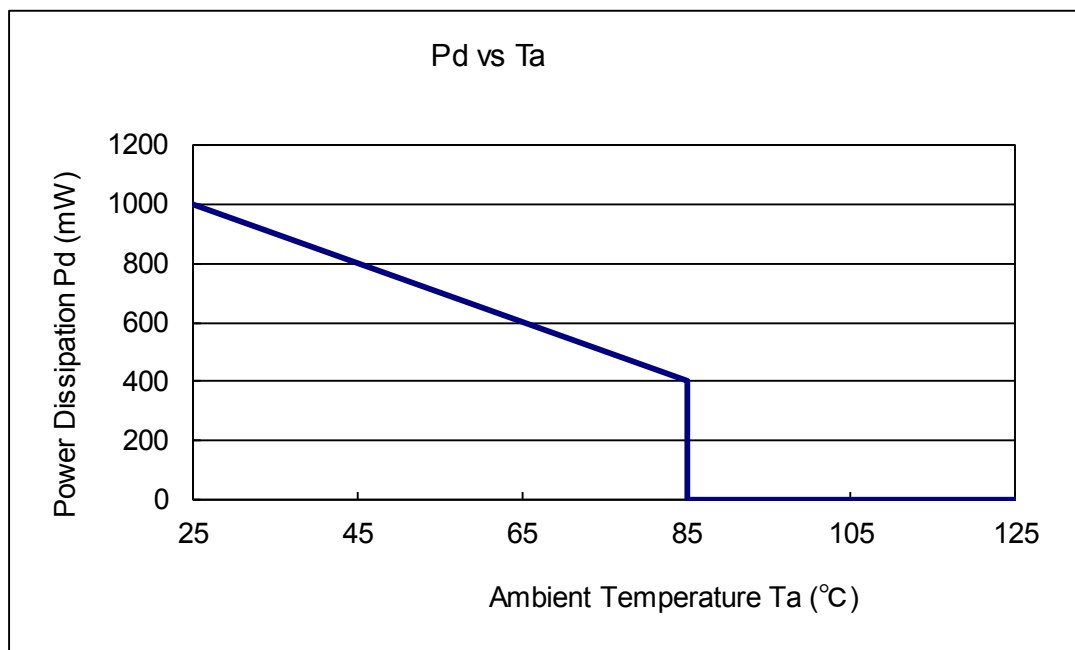


Evaluation Board (Unit : mm)

2. Power Dissipation vs. Ambient Temperature

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

| Ambient Temperature ($^\circ\text{C}$) | Power Dissipation P_d (mW) | Thermal Resistance ($^\circ\text{C}/\text{W}$) |
|--|------------------------------|--|
| 25 | 1000 | 100.00 |
| 85 | 400 | |

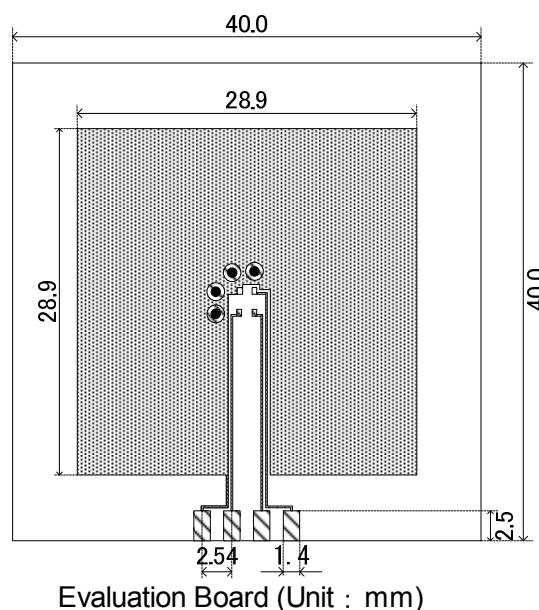


● **SSOT-24 Power Dissipation**

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 the reference data taken in the following condition.

1. Measurement Condition

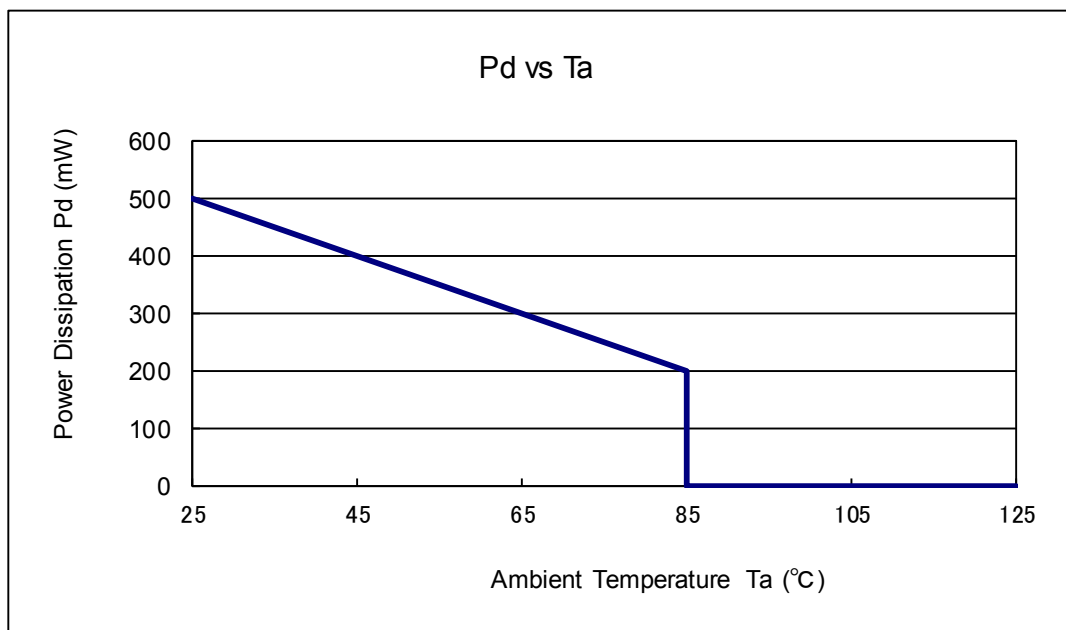
- Condition : Mount on a board
- Ambient : Natural convection
- Soldering : Lead (Pb) free
- Board : Dimensions 40 x 40 mm
(1600 mm² in one side)
Copper (Cu) traces occupy 50% of the board area in top and back faces
Package heat-sink is tied to the copper traces
- Material : Glass Epoxy (FR-4)
- Thickness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



2. Power Dissipation vs. Ambient Temperature

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

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

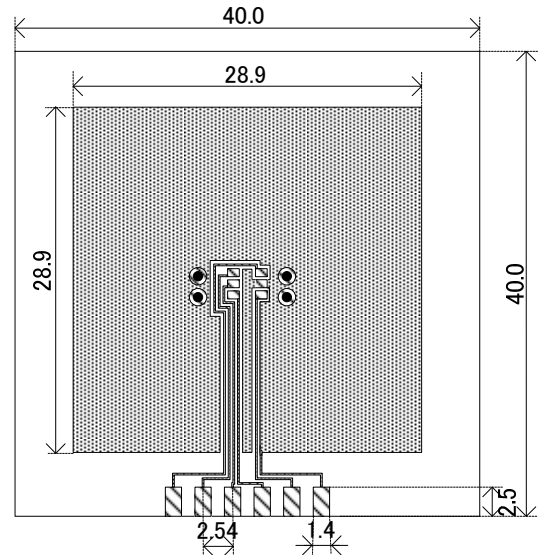


● SOT-25 Power Dissipation

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 the reference data taken in the following condition.

1. Measurement Condition

- 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: 1.6mm
- Through-hole: 4 x 0.8 Diameter

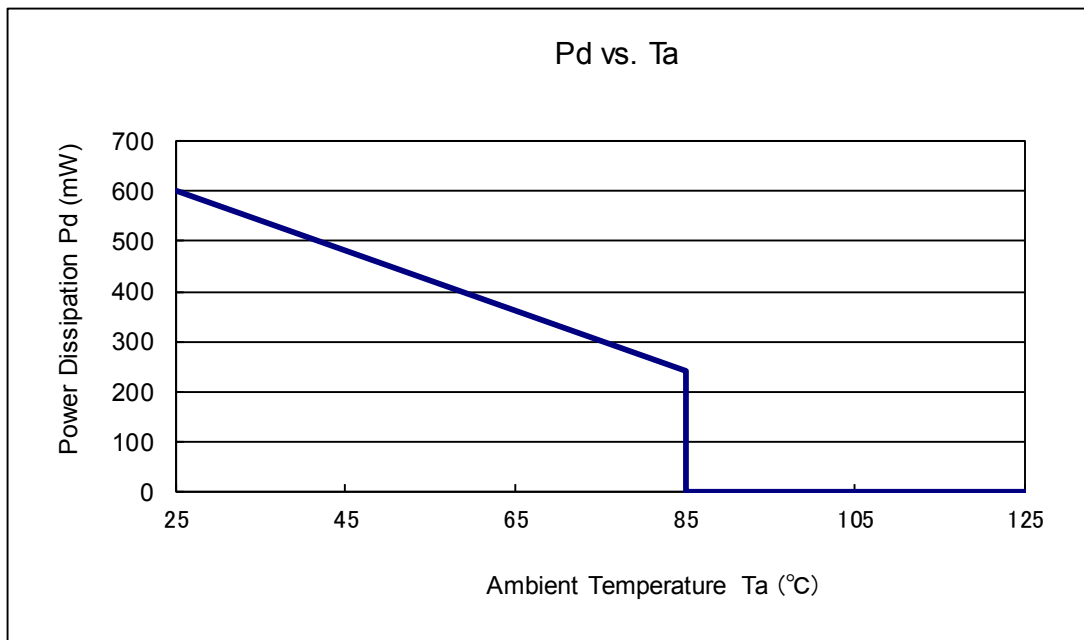


Evaluation Board (Unit: mm)

2. Power Dissipation vs. Ambient Temperature

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

| Ambient Temperature ($^\circ\text{C}$) | Power Dissipation P_d (mW) | Thermal Resistance ($^\circ\text{C}/\text{W}$) |
|--|------------------------------|--|
| 25 | 600 | 166.67 |
| 85 | 240 | |

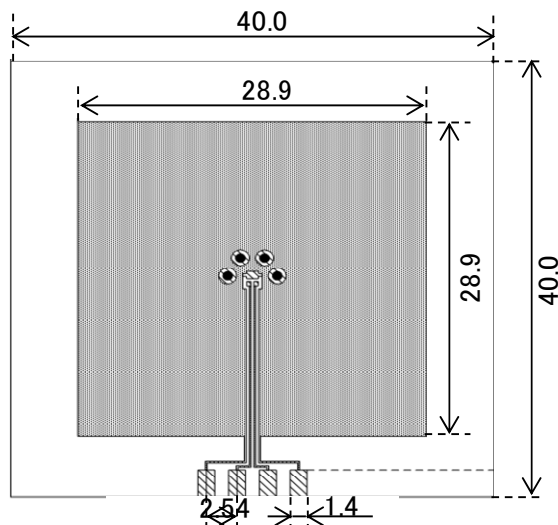


● **USP-3 Power Dissipation**

Power dissipation data for the USP-3 is shown in this page.
The value of power dissipation varies with the mount board conditions.
Please use this data as the reference data taken in the following condition.

1. Measurement Condition

- 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 : 1.6mm
- Through-hole : 4 x 0.8 Diameter

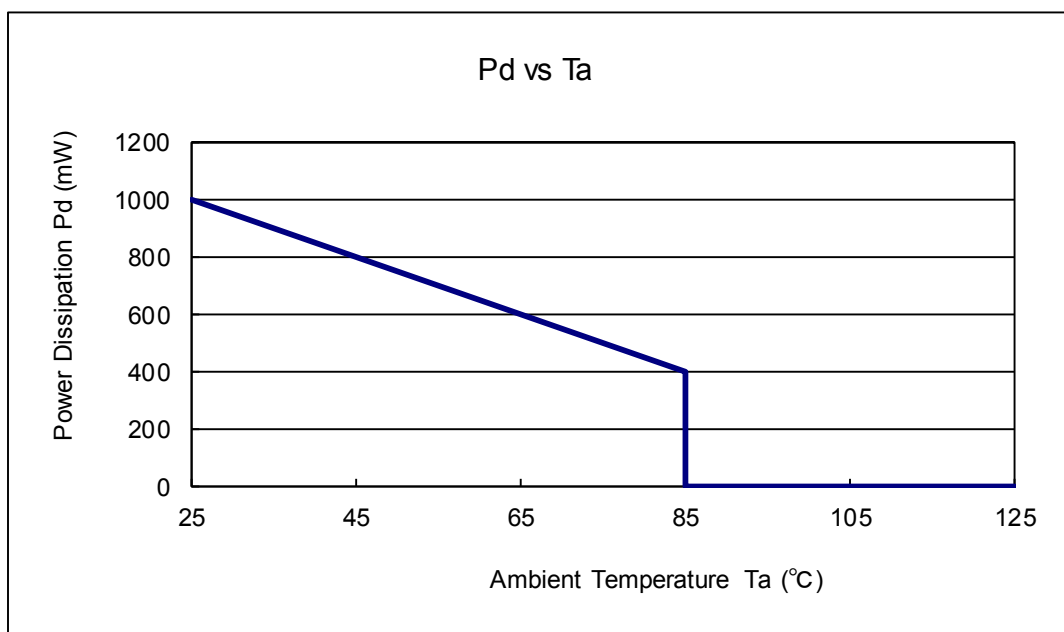


Evaluation Board (Unit : mm)

2. Power Dissipation vs. Ambient Temperature

Board Mount (T_j max = 125°C)

| Ambient Temperature(°C) | Power Dissipation Pd(mW) | Thermal Resistance (°C/W) |
|-------------------------|--------------------------|---------------------------|
| 25 | 1000 | 100.00 |
| 85 | 400 | |

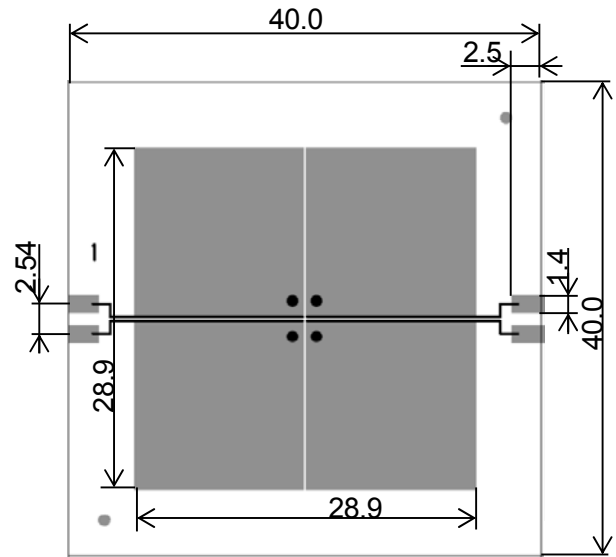


● WLP-4-01 Power Dissipation

Power dissipation data for the WLP-4-01 is shown in this page.
 The value of power dissipation varies with the mount board conditions.
 Please use this data as the reference data taken in the following condition.

1. Measurement Condition

- Condition : Mount on a board
- Ambient : Natural convection
- Soldering : Lead (Pb) free
- Board Dimensions : 40 x 40 mm (1600mm²)
- Board Structure : 1st Meter layer about 50%
- 2nd Inner Metal layer about 50%
- 3rd Inner Metal layer about 50%
- 4th Metal layer about 50%
- 4 separations is each layer connected to each pin
- Material : Glass Epoxy (FR-4)
- Thickness : 1.6 mm
- Through-hole : 4 x 0.8 Diameter

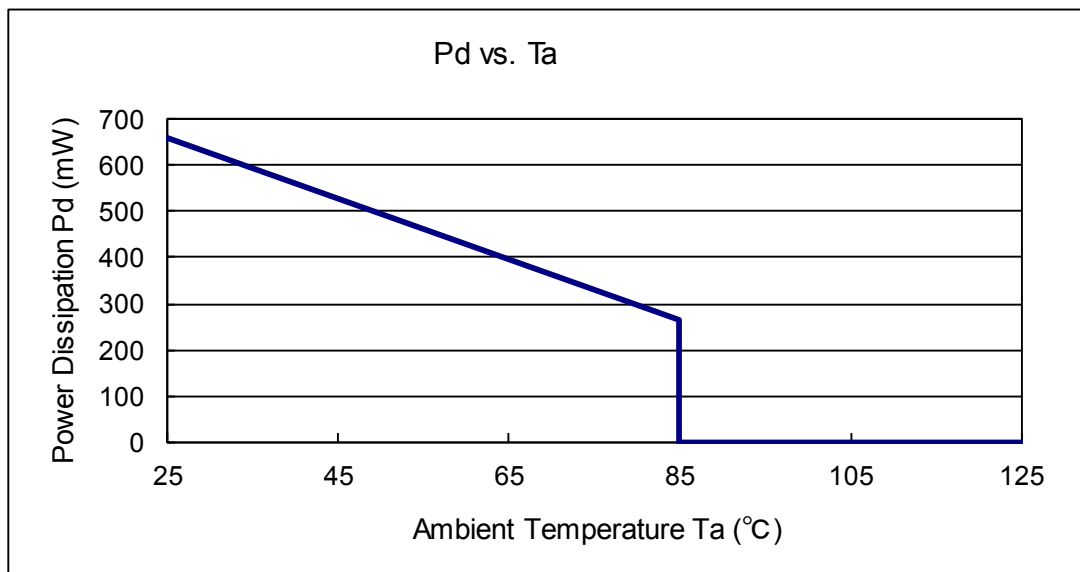


Evaluation Board (Unit: mm)

2. Power Dissipation vs. Ambient Temperature

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

| Ambient Temperature ($^\circ\text{C}$) | Power Dissipation Pd (mW) | Thermal Resistance ($^\circ\text{C}/\text{W}$) |
|--|---------------------------|--|
| 25 | 660 | 151.52 |
| 85 | 264 | |



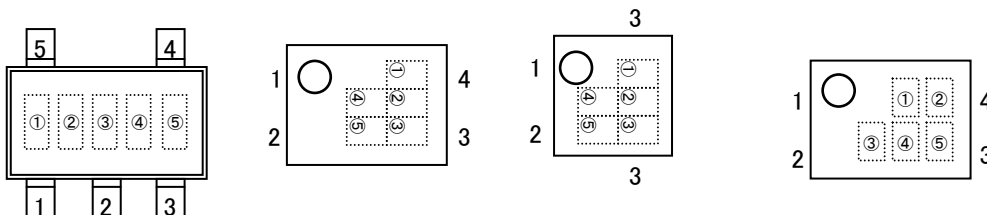
MARKING RULE

SOT-25

USP-4

USP-3

USPN-4



MARKING RULES FOR SOT-25/USP-4/USP-3/USPN-4

① represents product series

| MARK | PRODUCT SERIES |
|------|----------------|
| A | XC6501***** |

② represents type of regulator

| MARK | | | | PRODUCT SERIES |
|-----------------------------------|----------------------|------------------------------------|------------------------|----------------|
| OUTPUT VOLTAGE 0.1V INCREMENTS | | OUTPUT VOLTAGE 0.05V INCREMENTS | | |
| VOLTAGE= 1.2~3.0V | VOLTAGE= 3.1~5.0V | VOLTAGE= 1.25~3.05V | VOLTAGE= 3.15~4.95V | |
| U | A | E | M | XC6501A***** |
| V | B | F | N | XC6501B***** |
| X | C | H | R | XC6501C***** |
| Y | D | K | S | XC6501D***** |
| Z | P | L | T | XC6501P***** |

③ represents type of output voltage range

| MARK | OUTPUT VOLTAGE (V) | | | | MARK | OUTPUT VOLTAGE (V) | | | |
|------|--------------------|------|------|------|------|--------------------|------|------|------|
| 0 | - | 3.10 | - | 3.15 | F | 1.60 | 4.60 | 1.65 | 4.65 |
| 1 | - | 3.20 | - | 3.25 | H | 1.70 | 4.70 | 1.75 | 4.75 |
| 2 | - | 3.30 | - | 3.35 | K | 1.80 | 4.80 | 1.85 | 4.85 |
| 3 | - | 3.40 | - | 3.45 | L | 1.90 | 4.90 | 1.95 | 4.95 |
| 4 | - | 3.50 | - | 3.55 | M | 2.00 | 5.00 | 2.05 | - |
| 5 | - | 3.60 | - | 3.65 | N | 2.10 | - | 2.15 | - |
| 6 | - | 3.70 | - | 3.75 | P | 2.20 | - | 2.25 | - |
| 7 | - | 3.80 | - | 3.85 | R | 2.30 | - | 2.35 | - |
| 8 | - | 3.90 | - | 3.95 | S | 2.40 | - | 2.45 | - |
| 9 | - | 4.00 | - | 4.05 | T | 2.50 | - | 2.55 | - |
| A | - | 4.10 | - | 4.15 | U | 2.60 | - | 2.65 | - |
| B | 1.20 | 4.20 | 1.25 | 4.25 | V | 2.70 | - | 2.75 | - |
| C | 1.30 | 4.30 | 1.35 | 4.35 | X | 2.80 | - | 2.85 | - |
| D | 1.40 | 4.40 | 1.45 | 4.45 | Y | 2.90 | - | 2.95 | - |
| E | 1.50 | 4.50 | 1.55 | 4.55 | Z | 3.00 | - | 3.05 | - |

④,⑤ represents production lot number

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

G, I, J, O, Q, W excepted.

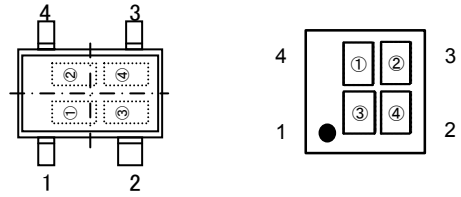
*No character inversion used.

XC6501 Series

MARKING RULE (Continued)

SSOT-24

WLP-4-01



SSOT-24/WLP-4-01

① represents type of regulator

| MARK | | | | PRODUCT SERIES |
|-----------------------|-----------------------|-----------------------|----------------------|----------------|
| VOLTAGE= 1.2~2.15V | VOLTAGE= 2.2~3.15V | VOLTAGE= 3.2~4.15V | VOLTAGE= 4.2~5.0V | |
| 5 | 6 | 7 | 8 | XC6501A***** |
| D | E | F | H | XC6501B***** |
| R | S | T | 0 | XC6501C***** |
| V | X | Y | Z | XC6501D***** |

② represents type of output voltage range

| MARK | OUTPUT VOLTAGE (V) | | | | MARK | OUTPUT VOLTAGE (V) | | | |
|------|--------------------|------|------|------|------|--------------------|------|------|------|
| A | 1.20 | 2.20 | 3.20 | 4.20 | N | 1.70 | 2.70 | 3.70 | 4.70 |
| B | 1.25 | 2.25 | 3.25 | 4.25 | P | 1.75 | 2.75 | 3.75 | 4.75 |
| C | 1.30 | 2.30 | 3.30 | 4.30 | R | 1.80 | 2.80 | 3.80 | 4.80 |
| D | 1.35 | 2.35 | 3.35 | 4.35 | S | 1.85 | 2.85 | 3.85 | 4.85 |
| E | 1.40 | 2.40 | 3.40 | 4.40 | T | 1.90 | 2.90 | 3.90 | 4.90 |
| F | 1.45 | 2.45 | 3.45 | 4.45 | U | 1.95 | 2.95 | 3.95 | 4.95 |
| H | 1.50 | 2.50 | 3.50 | 4.50 | V | 2.00 | 3.00 | 4.00 | 5.00 |
| K | 1.55 | 2.55 | 3.55 | 4.55 | X | 2.05 | 3.05 | 4.05 | - |
| L | 1.60 | 2.60 | 3.60 | 4.60 | Y | 2.10 | 3.10 | 4.10 | - |
| M | 1.65 | 2.65 | 3.65 | 4.65 | Z | 2.15 | 3.15 | 4.15 | - |

③,④ represents production lot number

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

G, I, J, O, Q, W excepted.

*No character inversion used.