

- ◆ Input Voltage Range : 1.8V ~ 5.5V
- ◆ Output Voltage Range : 2.5V ~ 5.2V
- ◆ Oscillator Frequency : 300kHz
- ◆ Maximum Output Current : 80mA (3.6→5V step-up)
- ◆ PFM (pulse skip) Operation During Light Loads (XC9802)
- ◆ CE (chip enable) Function
- ◆ MSOP-8A and USP-8 Packages

■ General Description

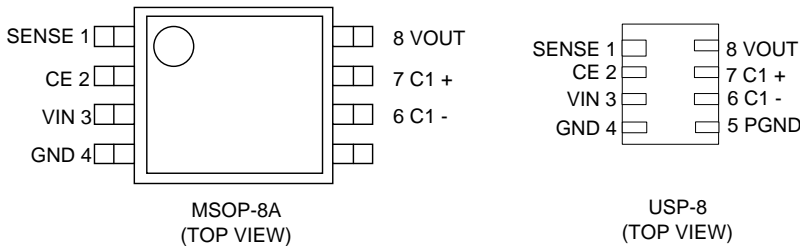
The XC9801 series are fixed regulated voltage step-up charge pump ICs which provide stable, highly efficient, positive voltages with the only external components required being 2 capacitors.

Since regulating is done via the control of the charge pump's gate voltage waveform, ripple is minimal. Output voltage is selectable in 0.1V steps within a 2.5V ~ 5.2V range.

Control of XC9802 switches to PFM (pulse skip) during light loads without affecting output impedance or ripple so that the IC is protected against drops in efficiency. Connecting the SENSE pin to the GND pin allows the IC to be used as a voltage doubler.

As well as the ultra small MSOP-8A and USP-8 packages, the small consumption current and high efficiencies of the series make the XC9801 suitable for use with all types of battery operated applications.

■ Pin Configuration



■ Applications

- Palm top computers, PDAs
- On Board Local Power Supplies
- Various Battery Powered Devices

■ Features

- Input Voltage Range : 1.8V ~ 5.5V
- Output Voltage Range : 2.5V ~ 5.2V
- Small Input Current : 80µA (no load:XC9802)
- Output Current : 80mA (3.6V→ 5V step-up)
- Oscillator Frequency : 300kHz
- Stand-By Current (CE 'L') : 2.0µA (max)
- Can be used as a Step-Up Doubler (sense = 0V)
- MSOP-8A and USP-8 Package

■ Pin Assignment

| PIN NUMBER | | PIN NAME | FUNCTION |
|------------|-------|----------|------------------------|
| MSOP-8A | USP-8 | | |
| 1 | 1 | SENSE | Output Voltage Monitor |
| 2 | 2 | CE | Chip Enable |
| 3 | 3 | VIN | Input (power supply) |
| 4 | 4 | GND | Ground |
| 5 | 5 | PGND | Power Ground |
| 6 | 6 | C1 - | External Capacitor - |
| 7 | 7 | C1 + | External Capacitor + |
| 8 | 8 | VOUT | Output |

■ Selection Guide

| SERIES | FUNCTION | |
|--------|------------|---|
| XC9801 | pulse skip | x |
| XC9802 | pulse skip | o |

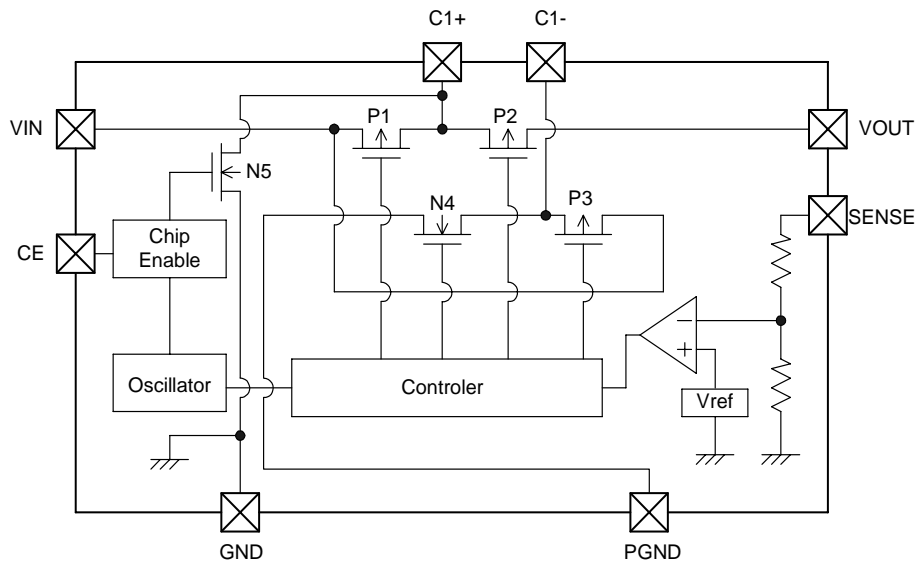
■ Ordering Information

XC9801/02 ①②③④⑤⑥

| DESIGNATOR | DESCRIPTION | |
|------------|-------------|--|
| ① | B | True Logic Level at CE Pin : Positive |
| ② ③ | 25-52 | Output Voltage* 5V: standard 2.5V ~ 5.2V: semi-custom 5.0V → ②=5, ③=0 |
| ④ | 3 | Oscillator Frequency : 300kHz |
| ⑤ | K | Package : MSOP-8A |
| | D | Package : USP-8 |
| ⑥ | R | Embossed tape. Standard Feed |
| | L | Embossed tape. Reverse Feed |

* Avoid the following condition VIN < (VOUT/2) or VIN > 3 VOUT

■ Block Diagram



(1) Basic Operations

Using the XC9801/02's clock generated by the internal oscillator, a step-up charge pump operation can be brought about as a result of the alternate switching between operating conditions where P1 & N4 are ON with P2 & P3 OFF (or) P1 & N4 are OFF with P2 & P3 ON. By connecting the SENSE pin to VOUT, output voltage can be feedback and the difference between the feedback voltage and the reference voltage (Vref) are compared by the internal operational amplifier. Output voltage can be stabilized (Note 2) by controlling P3's gate voltage waveform via the signal generated by the internal amplifier.

Please note that this stabilizing function will not operate with $V_{IN} < (V_{OUT}/2)$ or $V_{IN} \geq V_{OUT}$.

By connecting SENSE to ground, the output stability function, as described above, can be halted and the IC can be used as a step-up doubler.

Note 2 : As a result of P3 gradually reaching an ON state with each clock (signal), rush current is controlled, the ripple decreases and with the combination of the independent phase compensation circuit, output voltage is stabilized

(2) Stand-by Function

When the voltage at CE (chip enable) is 'low' (0V), P1,P2 & P3 will be OFF with N4 & N5 ON. The external capacitor C1 will discharge and impedance at Vout will be high.

(3) PFM (Pulse Skip) Operations

Whilst maintaining output voltage, the XC9802 provides the added security of protection against drops in efficiency during light loads as a result of the pulse, generated by the internal oscillator, being skipped and the operating frequency being changed.

■ Absolute Maximum Ratings

Ta = 25 °C, GND = 0V

| PARAMETER | SYMBOL | CONDITIONS | UNITS |
|---|--------|-------------------|-------|
| VIN pin voltage | VIN | -0.3 ~ 6 | V |
| VOUT pin voltage | VOUT | -0.3 ~ 12 | V |
| C1 + pin voltage | C1+ | -0.3 ~ VOUT + 0.3 | V |
| C1 - pin voltage | C1- | -0.3 ~ VOUT + 0.3 | V |
| CE pin voltage | VCE | -0.3 ~ VIN + 0.3 | V |
| VOUT pin output current | IOUT | 200 | mA |
| Power dissipation $\frac{\text{MSOP-8A}}{\text{USP-8}}$ | Pd | 150 | mW |
| | | TBD | |
| Operating Temperature | Topr | - 40 ~ + 85 | °C |
| Storage Temperature | Tstg | - 40 ~ + 125 | °C |

■ Electrical Characteristics

XC9801B503KR VOUT=5.0V

Ta=25°C

| PARAMETER | SYMBOL | CONDITIONS | | MIN. | TYP. | MAX. | UNITS |
|-------------------------------|--------|---|-------------------|-------|------|-------|-------|
| Output Voltage | VOUT | Regulation Output | IOUT=1mA | 4.875 | 5.0 | 5.125 | V |
| Load Regulation | ΔVOUT | Regulation Output | 1mA ≤ IOUT ≤ 80mA | -100 | | 100 | mV |
| Operating Voltage Range | VIN | Doubler Output, VOUT > VIN × 2 × 0.95 | | 1.8 | | 5.5 | V |
| Supply Current | IDD | VIN=3.6V, External Components=CIN, SENSE=0V, VOUT=VIN | | 1 | 3 | 6 | mA |
| Stand-by Current | ISTB | CE=0V | | | | 2.0 | μA |
| Oscillator Frequency | FOSC | External Component=CIN, SENSE=0V, VOUT open | | 255 | 300 | 345 | kHz |
| Output Impedance | ROUT | Doubler Output | IOUT=10mA | | 20 | 40 | Ω |
| Input Current | IIN | Doubler Output | | | 5 | | mA |
| | IIN2 | Regulation Output | | | 1.5 | | mA |
| Voltage Converting Efficiency | VEFF1 | Doubler Output | | 95 | 99 | | % |
| Power Converting Efficiency | EFF1 | Doubler Output | IOUT=10mA | 73 | 78 | | % |
| | EFFI2 | Regulation Output | IOUT=1mA | | 40 | | % |
| | EFFI3 | | IOUT=80mA | 64 | 69 | | % |
| CE / 'H' Level Voltage | VCEH | | | 1.5 | | | V |
| CE / 'L' Level Voltage | VCEL | | | | | 0.25 | V |
| CE / Input Current | ICE | VIN=5.5V, SENSE=0V, External Components=CIN | | -2.0 | | 2.0 | μA |

Test Conditions : Unless otherwise stated, Typical Application Circuit, VIN=3.6V, GND=0V, CE=VIN, No Load, SENSE=VIN(Regulation Output)

XC9802B503KR VOUT=5.0V

Ta=25°C

| PARAMETER | SYMBOL | CONDITIONS | | MIN. | TYP. | MAX. | UNITS |
|-------------------------------|--------|---|-------------------|-------|------|-------|-------|
| Output Voltage | VOUT | Regulation Output | IOUT=1mA | 4.875 | 5.0 | 5.125 | V |
| Load Regulation | ΔVOUT | Regulation Output | 1mA ≤ IOUT ≤ 80mA | -100 | | 100 | mV |
| Operating Voltage Range | VIN | Doubler Output, VOUT > VIN × 2 × 0.95 | | 1.8 | | 5.5 | V |
| Supply Current | IDD | VIN=3.6V, External Components=CIN, SENSE=0V, VOUT=VIN | | 1 | 3 | 6 | mA |
| Stand-by Current | ISTB | CE=0V | | | | 2.0 | μA |
| Oscillator Frequency | FOSC | External Component : CIN, SENSE=0V, VOUT open | | 255 | 300 | 345 | kHz |
| Switching Pulse Frequency | FOSC2 | Regulation Output | IOUT=1mA | | 10 | | kHz |
| Output Impedance | ROUT | Doubler Output | IOUT=10mA | | 20 | 40 | Ω |
| Input Current | IIN | Doubler Output | | | 5 | | mA |
| | IIN2 | Regulation Output | | | 0.08 | | mA |
| Voltage Converting Efficiency | VEFF1 | Doubler Output | | 98 | 99 | | % |
| Power Converting Efficiency | EFF1 | Doubler Output | IOUT=10mA | 73 | 78 | | % |
| | EFFI2 | Regulation Output | IOUT=1mA | | 59 | | % |
| | EFFI3 | | IOUT=80mA | 64 | 69 | | % |
| CE / 'H' Level Voltage | VCEH | | | 1.5 | | | V |
| CE / 'L' Level Voltage | VCEL | | | | | 0.25 | V |
| CE / Input Current | ICE | VIN=5.5V, SENSE=0V, External Components=CIN | | -2.0 | | 2.0 | μA |

Test Conditions : Unless otherwise stated, Typical Application Circuit, VIN=3.6V, GND=0V, CE=VIN, No Load, SENSE=VIN(Regulation Output)

■ Electrical Characteristics

XC9801B333KR VOUT=3.3V

Ta=25°C

| PARAMETER | SYMBOL | CONDITIONS | | MIN. | TYP. | MAX. | UNITS |
|-------------------------------|--------|---|-------------------|-------|------|-------|-------|
| Output Voltage | VOUT | Regulation Output | IOUT=1mA | 3.218 | 3.3 | 3.383 | V |
| Load Regulation | ΔVOUT | Regulation Output | 1mA ≤ IOUT ≤ 32mA | -66 | | 66 | mV |
| Operating Voltage Range | VIN | Doubler Output, VOUT > VIN × 2 × 0.95 | | 1.8 | | 5.5 | V |
| Supply Current | IDD | VIN=3.6V, External Components=CIN, SENSE=0V, VOUT=VIN | | 1 | 3 | 6 | mA |
| Stand-by Current | ISTB | CE=0V | | | | 2.0 | μA |
| Oscillator Frequency | FOSC | External Component=CIN, SENSE=0V, VOUT open | | 255 | 300 | 345 | kHz |
| Output Impedance | ROUT | Doubler Output | IOUT=10mA | | 20 | 40 | Ω |
| Input Current | IIN | Doubler Output | | | 5 | | mA |
| | IIN2 | Regulation Output | | | 1.5 | | mA |
| Voltage Converting Efficiency | VEFF1 | Doubler Output | | 95 | 99 | | % |
| Power Converting Efficiency | EFF1 | Doubler Output | IOUT=10mA | 73 | 78 | | % |
| | EFFI2 | Regulation Output | IOUT=1mA | | 40 | | % |
| | EFFI3 | | IOUT=80mA | 64 | 69 | | % |
| CE / 'H' Level Voltage | VCEH | | | 1.5 | | | V |
| CE / 'L' Level Voltage | VCEL | | | | | 0.25 | V |
| CE / Input Current | ICE | VIN=5.5V, SENSE=0V, External Components=CIN | | -2.0 | | 2.0 | μA |

Test Conditions : Unless otherwise stated, Typical Application Circuit, VIN=3.6V, GND=0V, CE=VIN, No Load, SENSE=VIN(Regulation Output)

XC9802B333KR VOUT=3.3V

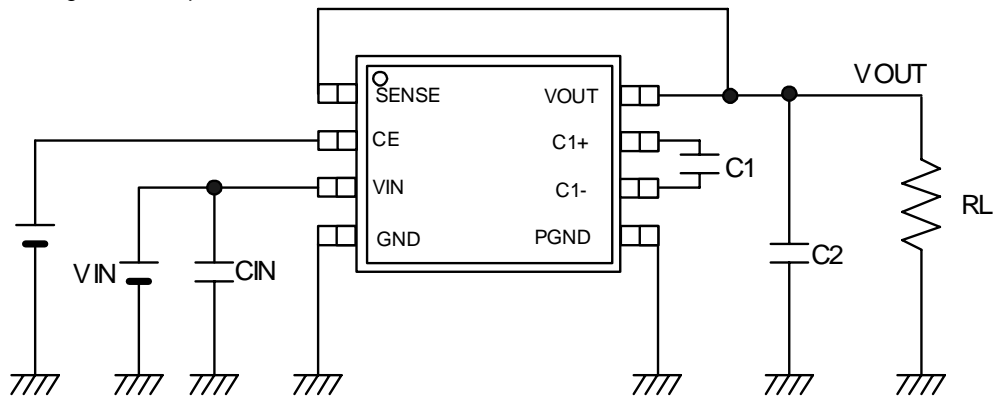
Ta=25°C

| PARAMETER | SYMBOL | CONDITIONS | | MIN. | TYP. | MAX. | UNITS |
|-------------------------------|--------|---|-------------------|-------|------|-------|-------|
| Output Voltage | VOUT | Regulation Output | IOUT=1mA | 3.218 | 3.3 | 3.383 | V |
| Load Regulation | ΔVOUT | Regulation Output | 1mA ≤ IOUT ≤ 32mA | -66 | | 66 | mV |
| Operating Voltage Range | VIN | Doubler Output, VOUT > VIN × 2 × 0.95 | | 1.8 | | 5.5 | V |
| Supply Current | IDD | VIN=3.6V, External Components=CIN, SENSE=0V, VOUT=VIN | | 1 | 3 | 6 | mA |
| Stand-by Current | ISTB | CE=0V | | | | 2.0 | μA |
| Oscillator Frequency | FOSC | External Component : CIN, SENSE=0V, VOUT open | | 255 | 300 | 345 | kHz |
| Switching Pulse Frequency | FOSC2 | Regulation Output | IOUT=1mA | | 10 | | kHz |
| Output Impedance | ROUT | Doubler Output | IOUT=10mA | | 20 | 40 | Ω |
| Input Current | IIN | Doubler Output | | | 5 | | mA |
| | IIN2 | Regulation Output | | | 0.08 | | mA |
| Voltage Converting Efficiency | VEFF1 | Doubler Output | | 98 | 99 | | % |
| Power Converting Efficiency | EFF1 | Doubler Output | IOUT=10mA | 73 | 78 | | % |
| | EFFI2 | Regulation Output | IOUT=1mA | | 63 | | % |
| | EFFI3 | | IOUT=80mA | 64 | 69 | | % |
| CE / 'H' Level Voltage | VCEH | | | 1.5 | | | V |
| CE / 'L' Level Voltage | VCEL | | | | | 0.25 | V |
| CE / Input Current | ICE | VIN=5.5V, SENSE=0V, External Components=CIN | | -2.0 | | 2.0 | μA |

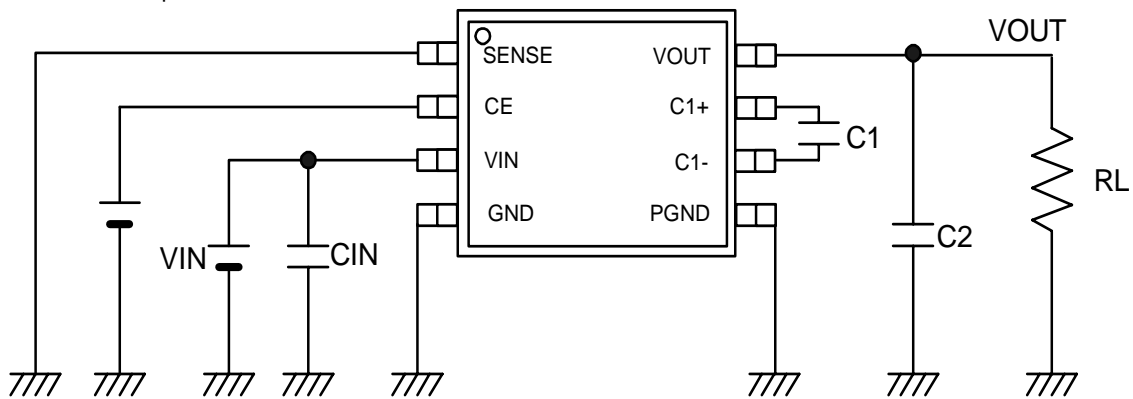
Test Conditions : Unless otherwise stated, Typical Application Circuit, VIN=3.6V, GND=0V, CE=VIN, No Load, SENSE=VIN(Regulation Output)

■ Typical Application Circuits

① Regulation Output



② Doubler Output



External Components

CIN=1 μ F (Ceramic Capacitor: Taiyo Yuden)

C1=0.47 μ F (Ceramic Capacitor: Taiyo Yuden)

C2=4.7 μ F (Ceramic Capacitor: Taiyo Yuden)

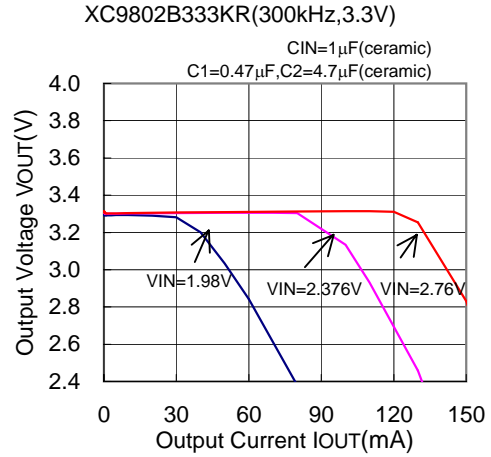
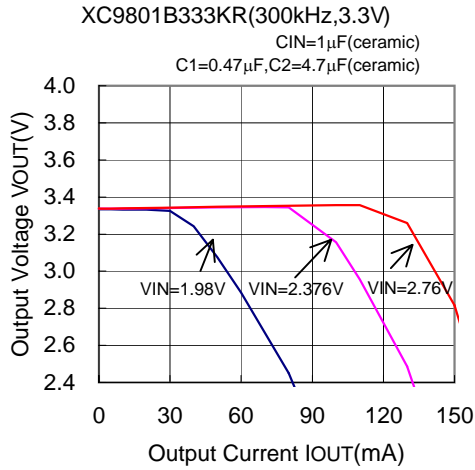
Note : The XC9801 series are step-up charge pump voltage doublers which provide regulated output voltage.

The application circuit of the doubler output (②) halts the regulated output function and operates as a normal voltage doubler.

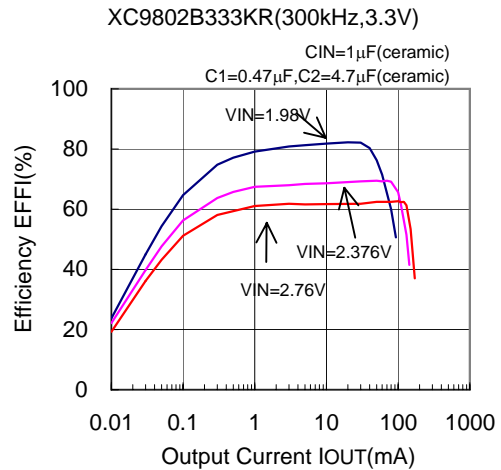
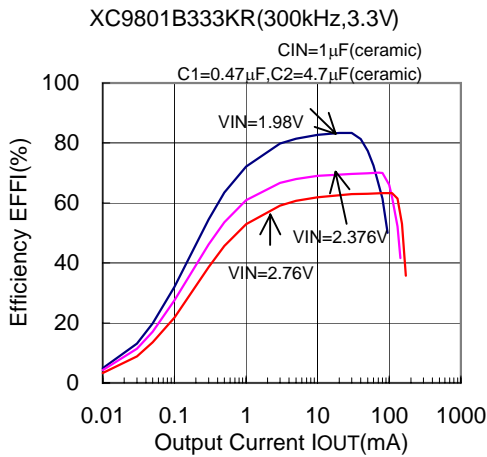
The output voltage is stable when connected as in (①) above, except when $V_{IN} < (V_{OUT} / 2)$ and $V_{IN} \geq V_{OUT}$.

■ Electrical Characteristics (3.3V)

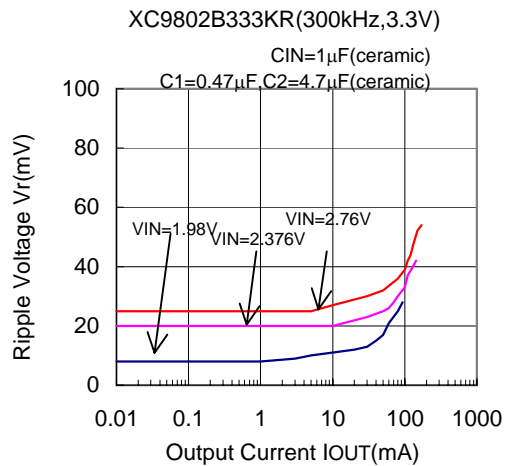
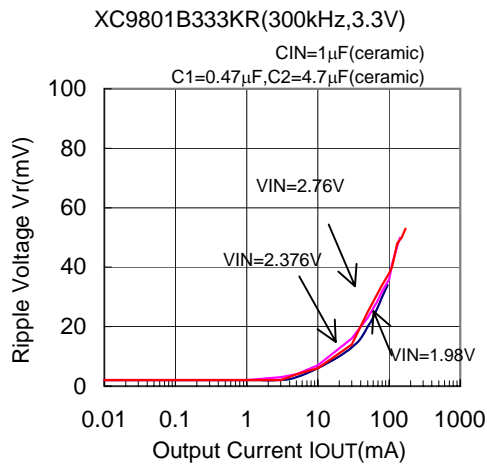
(1) Output Voltage vs. Output Current



(2) Efficiency vs. Output Current

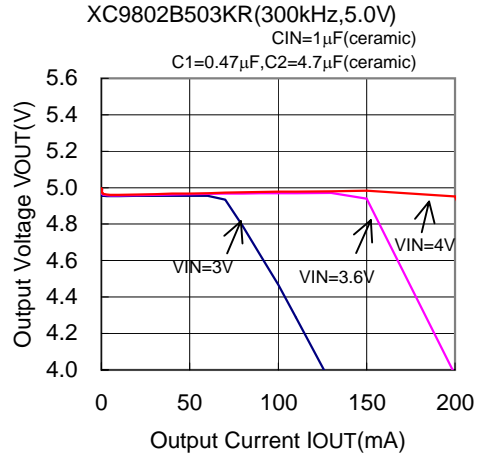
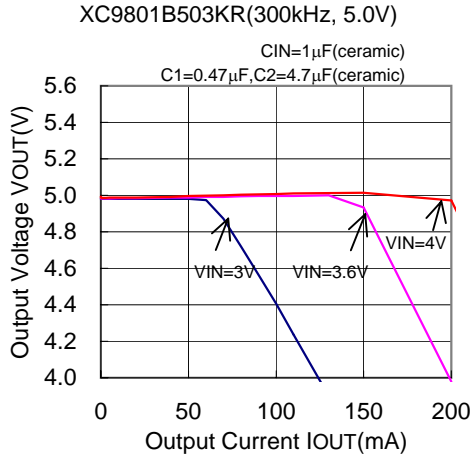


(3) Output Current vs. Ripple Voltage

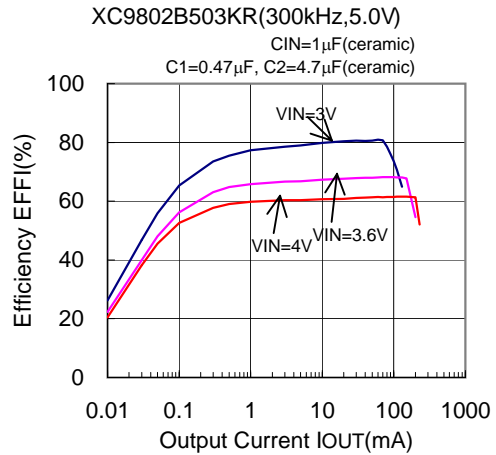
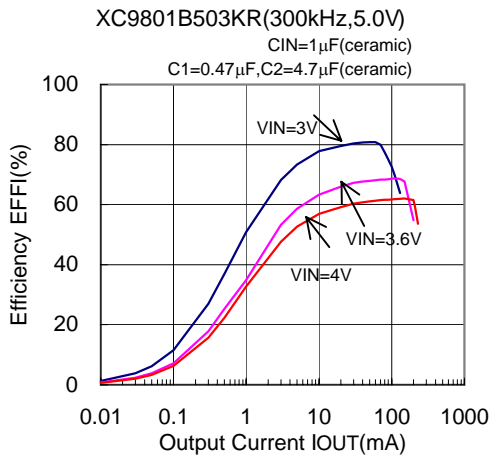


■ Electrical Characteristics (5.0V)

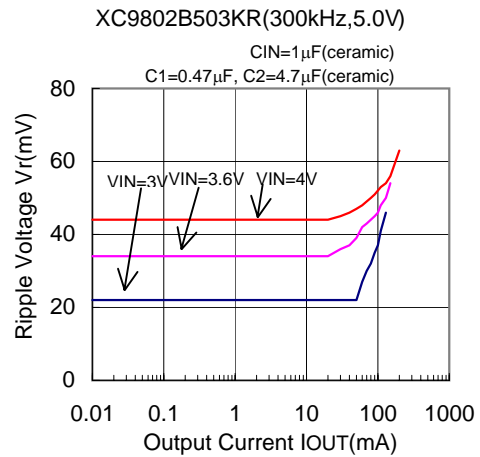
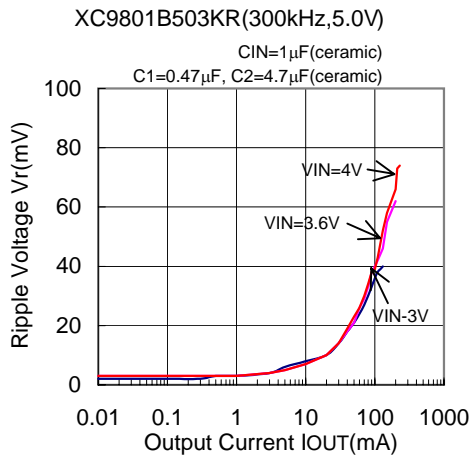
(1) Output Voltage vs. Output Current



(2) Efficiency vs. Output Current



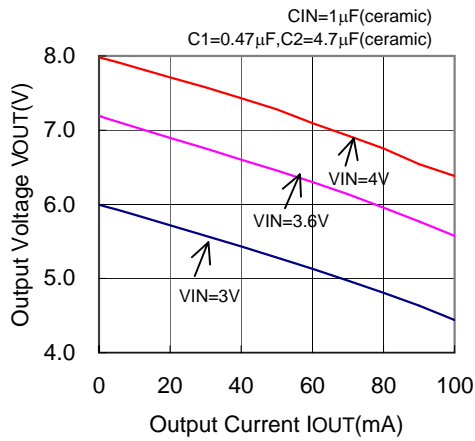
(3) Output Voltage vs. Ripple Voltage



■ Electrical Characteristics (Doubler)

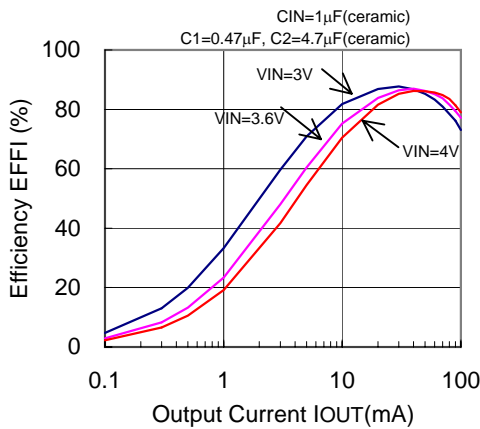
(1) Output Voltage vs. Output Current

XC9801B503KR
(300kHz, SENSE=0V Doubler)



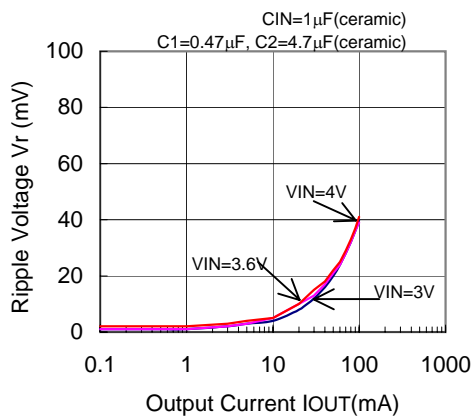
(2) Efficiency vs. Output Current

XC9801B503KR
(300kHz, SENSE=0V Doubler)

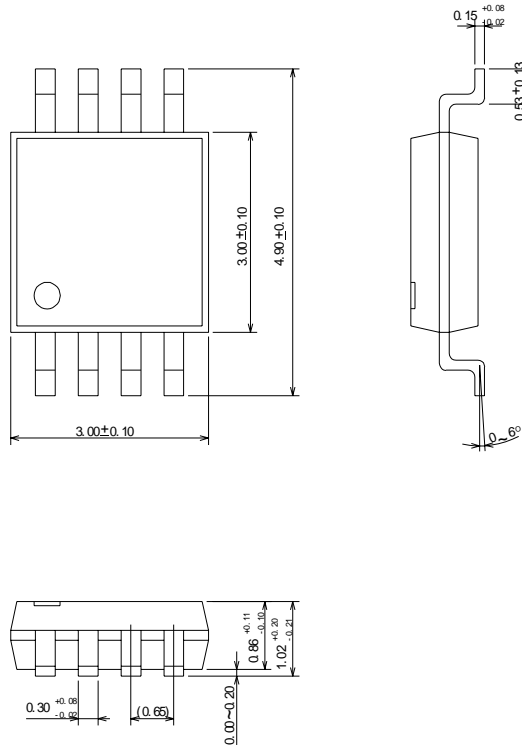


(3) Ripple Voltage vs. Output Current

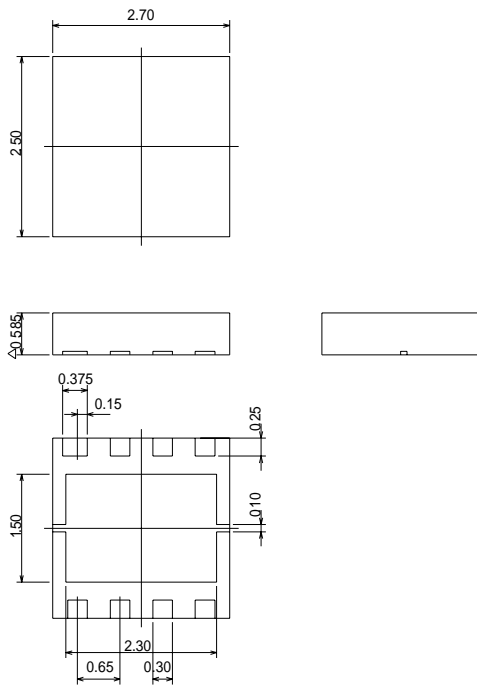
XC9801B503KR
(300kHz, SENSE=0V, Doubler)



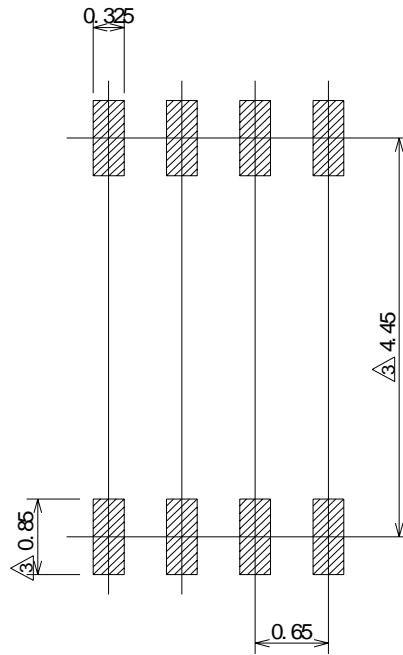
- Packaging Information (Dimensions : mm)
MSOP-8A : (1,000 pcs./reel)



- USP-8 : (1,000 pcs./reel)



- Recommended Pattern Layout (Dimensions : mm)
MSOP-8A



USP-8

