

## Regulated Voltage Step-Up Charge Pump ICs

## ■ 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 100mV steps within a 2.5V ~ 6.0V range.

Control of the 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.

## ■ APPLICATIONS

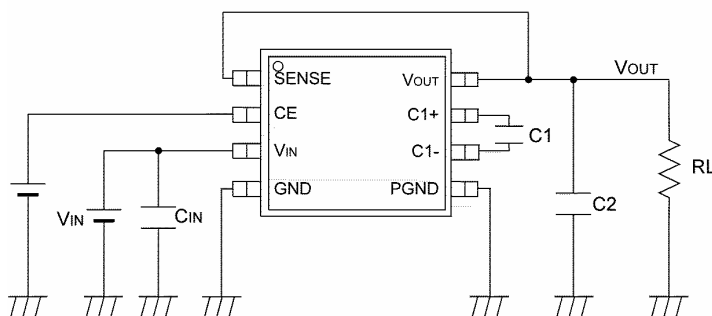
- Palm top computers, PDAs
- On board local power supplies
- Various battery powered devices

## ■ FEATURES

<b>Input Voltage Range</b>	: 1.8V ~ 5.5V
<b>Output Voltage Range</b>	: 2.5V ~ 6.0V
<b>Small Input Current</b>	: 80 $\mu$ A (no load:XC9802)
<b>Output Current</b>	: 80mA (3.6V→5.0V step-up)
<b>Oscillation Frequency</b>	: 300kHz
<b>Stand-by Current (CE 'L')</b>	: 2.0 $\mu$ A (MAX.)
<b>PFM Operation During Light Loads (XC9802)</b>	
<b>CE (Chip Enable) Function</b>	
<b>Can be used as a step-up doubler (sense = 0V)</b>	
<b>Packages</b>	: MSOP-8A, USP-8

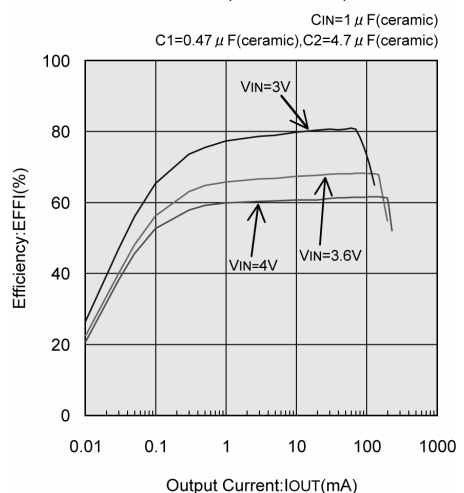
## ■ TYPICAL APPLICATION CIRCUIT

Regulation Output

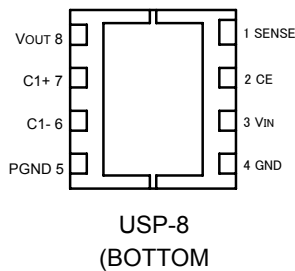
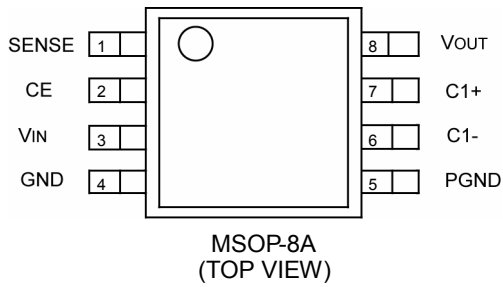


## ■ TYPICAL PERFORMANCE CHARACTERISTICS

XC9802B503KR(300kHz,5.0V)



## PIN CONFIGURATION



## PIN ASSIGNMENT

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

## PRODUCT CLASSIFICATION

### ● Selection Guide

SERIES	PULSE SKIP MODE
XC9801	Not Available
XC9802	Available

### ● Ordering Information

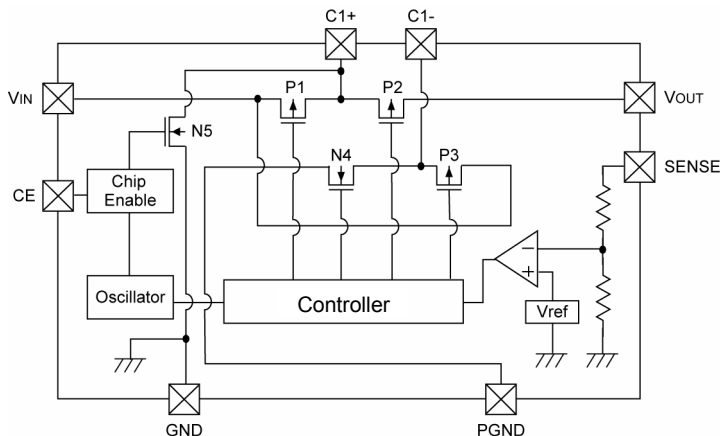
XC9801/02 ①②③④⑤⑥

DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
①	True Logic Level at CE Pin	B	: Positive
② ③	Output Voltage	50	: Standard voltage V <sub>OUT</sub> =5.0V→②=5, ③=0
		25 ~ 60	: Semi-custom voltage e.g. V <sub>OUT</sub> =2.5V→②=2, ③=5
④	Oscillation Frequency	3	: 300kHz
⑤	Package	K	: MSOP-8A
		D	: USP-8
⑥	Device Orientation	R	: Embossed tape, standard feed
		L	: Embossed tape, reverse feed

Regulated output voltage function cannot be used by the following input voltage condition:

$$V_{IN} < (V_{OUT}/2), \text{ or } V_{IN} \geq V_{OUT}$$

## ■ 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 V<sub>OUT</sub>, output voltage can be feedback and the difference between the feedback voltage and the reference voltage (V<sub>ref</sub>) are compared by the internal operational amplifier. Output voltage can be stabilized (\* 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.

\* 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 V<sub>OUT</sub> 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

T<sub>a</sub> = 25°C, GND = 0V

PARAMETER	SYMBOL	CONDITIONS	UNITS
V <sub>IN</sub> pin Voltage	V <sub>IN</sub>	-0.3~6.0	V
V <sub>OUT</sub> pin Voltage	V <sub>OUT</sub>	-0.3~12.0	V
C1 + pin Voltage	C1+	-0.3~V <sub>OUT</sub> +0.3	V
C1 - pin Voltage	C1-	-0.3~V <sub>OUT</sub> +0.3	V
CE pin Voltage	V <sub>CE</sub>	-0.3~V <sub>IN</sub> +0.3	V
V <sub>OUT</sub> Pin Output Current	I <sub>OUT</sub>	200	mA
Power Dissipation	MSOP-8A	P <sub>d</sub>	mW
	USP-8		
Operating Temperature Range	T <sub>opr</sub>	-40~+85	°C
Storage Temperature Range	T <sub>stg</sub>	-40~+125	°C

## ELECTRICAL CHARACTERISTICS

XC9801B503KR V<sub>OUT</sub>=5.0V

T<sub>a</sub>=25°C

PARAMETER	SYMBOL	CONDITIONS		MIN.	TYP.	MAX.	UNITS
Output Voltage	V <sub>OUT</sub>	Regulation Output	I <sub>OUT</sub> =1mA	4.875	5.000	5.125	V
Load Regulation	ΔV <sub>OUT</sub>	Regulation Output	1mA ≤ I <sub>OUT</sub> ≤ 80mA	-100	-	100	mV
Operating Voltage Range	V <sub>IN</sub>	Doubler Output, V <sub>OUT</sub> > V <sub>IN</sub> × 2 × 0.95		1.8	-	5.5	V
Supply Current	I <sub>DD</sub>	V <sub>IN</sub> =3.6V, External Components=C <sub>IN</sub> only, SENSE=0V, V <sub>OUT</sub> =V <sub>IN</sub>		1	3	6	mA
Stand-by Current	I <sub>STB</sub>	CE=0V		-	-	2.0	μA
Oscillation Frequency	F <sub>OSC</sub>	External Component=C <sub>IN</sub> only, SENSE=0V, V <sub>OUT</sub> open		255	300	345	kHz
Output Impedance	R <sub>OUT</sub>	Doubler Output	I <sub>OUT</sub> =10mA	-	20	40	Ω
Input Current	I <sub>IN</sub>	Doubler Output		-	5	-	mA
	I <sub>IN2</sub>	Regulation Output		-	1.5	-	mA
Voltage Converting Efficiency	V <sub>EFF1</sub>	Doubler Output		95	99	-	%
Power Converting Efficiency	EFF1	Doubler Output	I <sub>OUT</sub> =10mA	73	78	-	%
	EFFI2	Regulation Output	I <sub>OUT</sub> =1mA	-	40	-	%
	EFFI3		I <sub>OUT</sub> =80mA	64	69	-	%
CE / 'H' Level Voltage	V <sub>CEH</sub>			1.5	-	-	V
CE / 'L' Level Voltage	V <sub>CEL</sub>			-	-	0.25	V
CE / Input Current	I <sub>CE</sub>	V <sub>IN</sub> =5.5V, SENSE=0V, External Components=C <sub>IN</sub> only		-2.0	-	2.0	μA

Test Conditions: Unless otherwise stated, Typical Application Circuit, V<sub>IN</sub>=3.6V,  
GND=0V, CE=V<sub>IN</sub>, No Load, SENSE=V<sub>OUT</sub> (Regulation Output)

XC9802B503KR V<sub>OUT</sub>=5.0V

T<sub>a</sub>=25°C

PARAMETER	SYMBOL	CONDITIONS		MIN.	TYP.	MAX.	UNITS
Output Voltage	V <sub>OUT</sub>	Regulation Output	I <sub>OUT</sub> =1mA	4.875	5.000	5.125	V
Load Regulation	ΔV <sub>OUT</sub>	Regulation Output	1mA ≤ I <sub>OUT</sub> ≤ 80mA	-100	-	100	mV
Operating Voltage Range	V <sub>IN</sub>	Doubler Output, V <sub>OUT</sub> > V <sub>IN</sub> × 2 × 0.95		1.8	-	5.5	V
Supply Current	I <sub>DD</sub>	V <sub>IN</sub> =3.6V, External Components=C <sub>IN</sub> only, SENSE=0V, V <sub>OUT</sub> =V <sub>IN</sub>		1	3	6	mA
Stand-by Current	I <sub>STB</sub>	CE=0V		-	-	2.0	μA
Oscillation Frequency	F <sub>OSC</sub>	External Component = C <sub>IN</sub> only, SENSE=0V, V <sub>OUT</sub> open		255	300	345	kHz
Switching Pulse Frequency	F <sub>OSC2</sub>	Regulation Output	I <sub>OUT</sub> =1mA	-	10	-	kHz
Output Impedance	R <sub>OUT</sub>	Doubler Output	I <sub>OUT</sub> =10mA	-	20	40	Ω
Input Current	I <sub>IN</sub>	Doubler Output		-	5	-	mA
	I <sub>IN2</sub>	Regulation Output		-	0.08	-	mA
Voltage Converting Efficiency	V <sub>EFF1</sub>	Doubler Output		98	99	-	%
Power Converting Efficiency	EFF1	Doubler Output	I <sub>OUT</sub> =10mA	73	78	-	%
	EFFI2	Regulation Output	I <sub>OUT</sub> =1mA	-	59	-	%
	EFFI3		I <sub>OUT</sub> =80mA	64	69	-	%
CE / 'H' Level Voltage	V <sub>CEH</sub>			1.5	-	-	V
CE / 'L' Level Voltage	V <sub>CEL</sub>			-	-	0.25	V
CE / Input Current	I <sub>CE</sub>	V <sub>IN</sub> =5.5V, SENSE=0V, External Components=C <sub>IN</sub> only		-2.0	-	2.0	μA

Test Conditions: Unless otherwise stated, Typical Application Circuit, V<sub>IN</sub>=3.6V,  
GND=0V, CE=V<sub>IN</sub>, No Load, SENSE=V<sub>OUT</sub> (Regulation Output)

## ■ ELECTRICAL CHARACTERISTICS (Continued)

XC9801B333KR  $V_{OUT}=3.3V$

$T_a=25^{\circ}C$

PARAMETER	SYMBOL	CONDITIONS		MIN.	TYP.	MAX.	UNITS
Output Voltage	$V_{OUT}$	Regulation Output	$I_{OUT}=1mA$	3.218	3.300	3.383	V
Load Regulation	$\Delta V_{OUT}$	Regulation Output	$1mA \leq I_{OUT} \leq 2mA$	-66	-	66	mV
Operating Voltage Range	$V_{IN}$	Doubler Output, $V_{OUT} > V_{IN} \times 2 \times 0.95$		1.8	-	5.5	V
Supply Current	$I_{DD}$	$V_{IN}=3.6V$ , External components= $C_{IN}$ only, SENSE=0V, $V_{OUT}=V_{IN}$		1	3	6	mA
Stand-by Current	$I_{STB}$	CE=0V		-	-	2.0	$\mu A$
Oscillation Frequency	FOSC	External component= $C_{IN}$ only, SENSE=0V, $V_{OUT}$ open		255	300	345	kHz
Output Impedance	$R_{OUT}$	Doubler Output	$I_{OUT}=10mA$	-	20	40	$\Omega$
Input Current	$I_{IN}$	Doubler Output		-	5	-	mA
	$I_{IN2}$	Regulation Output		-	1.1	-	mA
Voltage Converting Efficiency	$V_{EFF1}$	Doubler Output		95	99	-	%
Power Converting Efficiency	$EFF1$	Doubler Output	$I_{OUT}=10mA$	73	78	-	%
	$EFFI2$	Regulation Output	$I_{OUT}=1mA$	-	40	-	%
	$EFFI3$		$I_{OUT}=32mA$	64	69	-	%
CE / 'H' Level Voltage	$V_{CEH}$			1.5	-	-	V
CE / 'L' Level Voltage	$V_{CEL}$			-	-	0.25	V
CE / Input Current	$I_{CE}$	$V_{IN}=5.5V$ , SENSE=0V, External Components= $C_{IN}$ only		-2.0	-	2.0	$\mu A$

Test Conditions: Unless otherwise stated, Typical Application Circuit,  $V_{IN}=2.376V$ ,  
GND=0V, CE= $V_{IN}$ , No Load, SENSE= $V_{OUT}$  (Regulation Output)

XC9802B333KR  $V_{OUT}=3.3V$

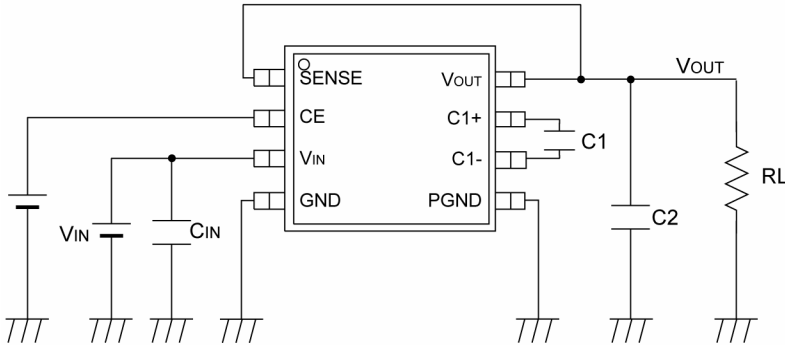
$T_a=25^{\circ}C$

PARAMETER	SYMBOL	CONDITIONS		MIN.	TYP.	MAX.	UNITS
Output Voltage	$V_{OUT}$	Regulation Output	$I_{OUT}=1mA$	3.218	3.300	3.383	V
Load Regulation	$\Delta V_{OUT}$	Regulation Output	$1mA \leq I_{OUT} \leq 32mA$	-66	-	66	mV
Operating Voltage Range	$V_{IN}$	Doubler Output, $V_{OUT} > V_{IN} \times 2 \times 0.95$		1.8	-	5.5	V
Supply Current	$I_{DD}$	$V_{IN}=3.6V$ , External Components= $C_{IN}$ only, SENSE=0V, $V_{OUT}=V_{IN}$		1	3	6	mA
Stand-by Current	$I_{STB}$	CE=0V		-	-	2.0	$\mu A$
Oscillation Frequency	FOSC	External Component = $C_{IN}$ only, SENSE=0V, $V_{OUT}$ open		255	300	345	kHz
Switching Pulse Frequency	FOSC2	Regulation Output	$I_{OUT}=1mA$	-	10	-	kHz
Output Impedance	$R_{OUT}$	Doubler Output	$I_{OUT}=10mA$	-	20	40	$\Omega$
Input Current	$I_{IN}$	Doubler Output		-	5	-	mA
	$I_{IN2}$	Regulation Output		-	0.08	-	mA
Voltage Converting Efficiency	$V_{EFF1}$	Doubler Output		98	99	-	%
Power Converting Efficiency	$EFF1$	Doubler Output	$I_{OUT}=10mA$	73	78	-	%
	$EFFI2$	Regulation Output	$I_{OUT}=1mA$	-	63	-	%
	$EFFI3$		$I_{OUT}=32mA$	64	69	-	%
CE / 'H' Level Voltage	$V_{CEH}$			1.5	-	-	V
CE / 'L' Level Voltage	$V_{CEL}$			-	-	0.25	V
CE / Input Current	$I_{CE}$	$V_{IN}=5.5V$ , SENSE=0V, External Components= $C_{IN}$ only		-2.0	-	2.0	$\mu A$

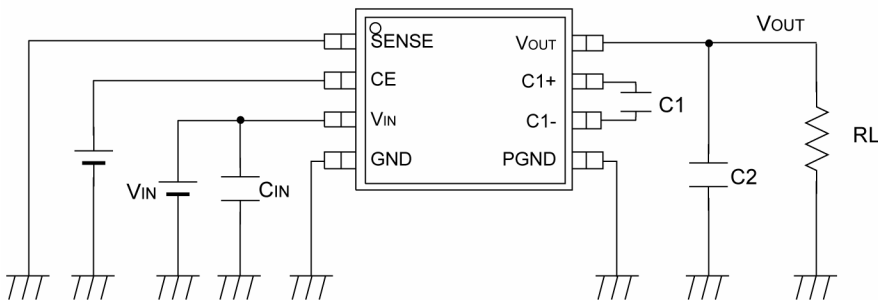
Test Conditions: Unless otherwise stated, Typical Application Circuit,  $V_{IN}=2.376V$ ,  
GND=0V, CE= $V_{IN}$ , No Load, SENSE= $V_{OUT}$  (Regulation Output)

## TYPICAL APPLICATION CIRCUITS

### ① Regulation Output



### ② Doubler Output



#### External Components:

$C_{IN}=1\ \mu\text{F}$  (Ceramic Capacitor: TAIYO YUDEN)

$C1=0.47\ \mu\text{F}$  (Ceramic Capacitor: TAIYO YUDEN)

$C2=4.7\ \mu\text{F}$  (Ceramic Capacitor: TAIYO YUDEN)

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

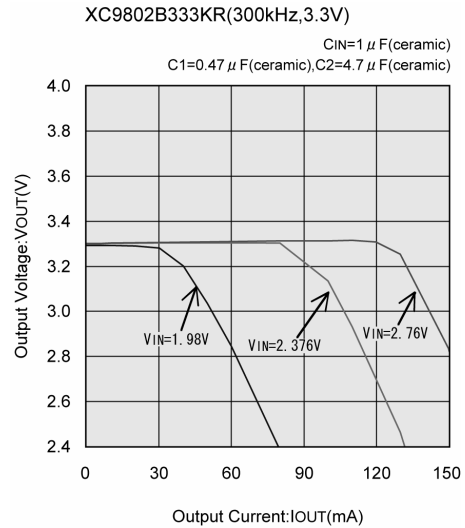
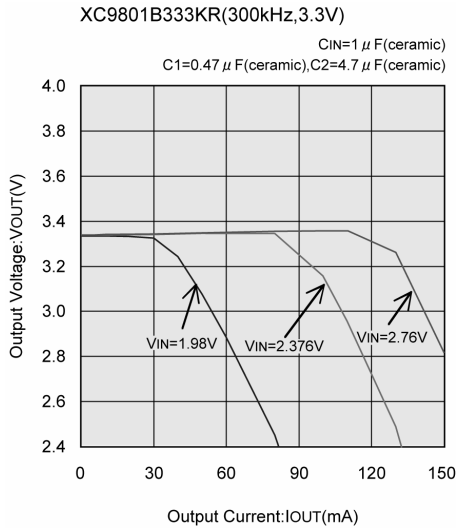
The application circuit of the doubler output (②) halts the regulated output function and operates as a normal voltage doubler.

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

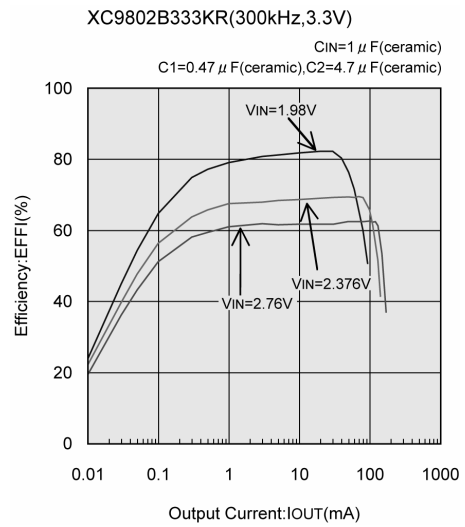
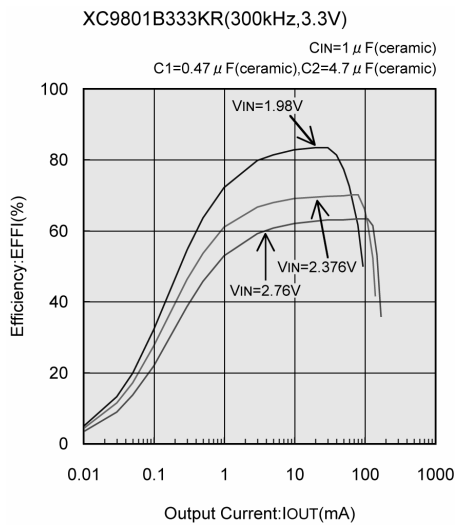
## TYPICAL PERFORMANCE CHARACTERISTICS

### ● XC9801B333KR (300kHz, 3.3V)

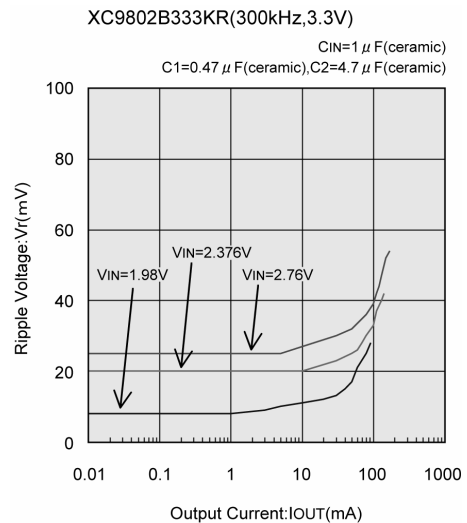
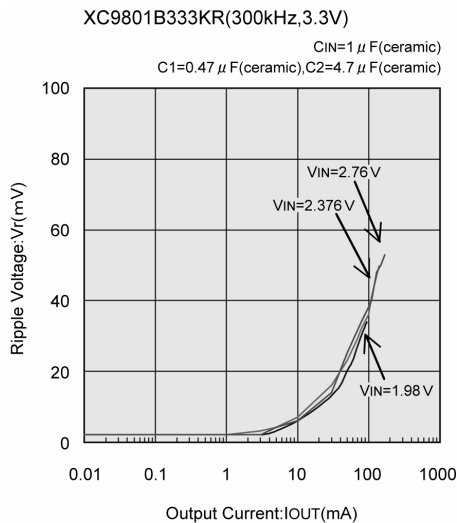
#### (1) Output Voltage vs. Output Current



#### (2) Efficiency vs. Output Current



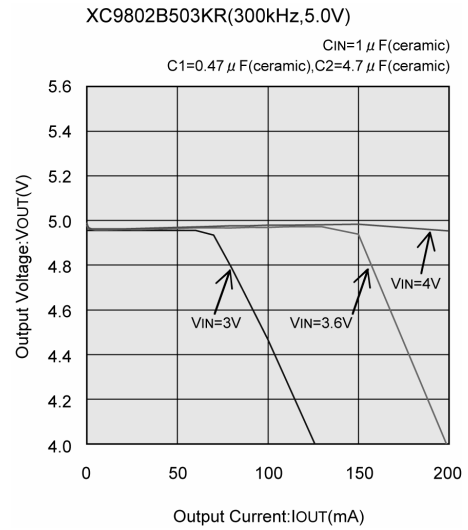
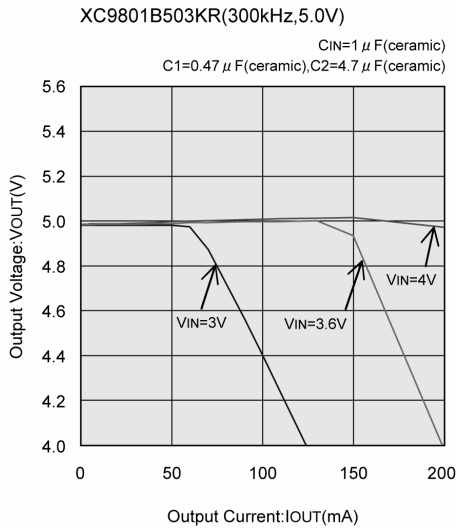
#### (3) Ripple Voltage vs. Output Current



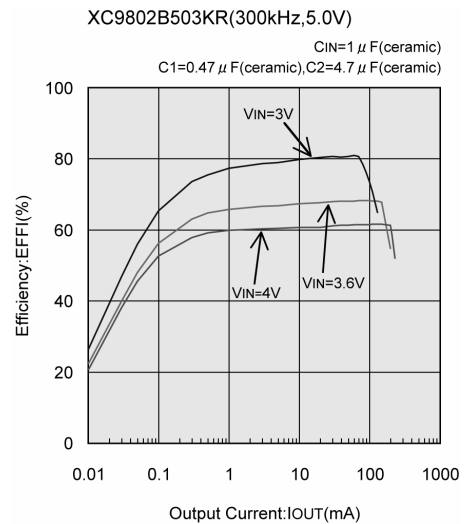
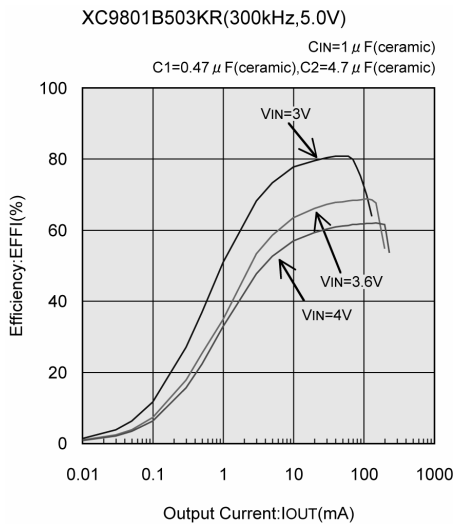
## ■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### ● XC9801B503KR (300kHz, 5.0V)

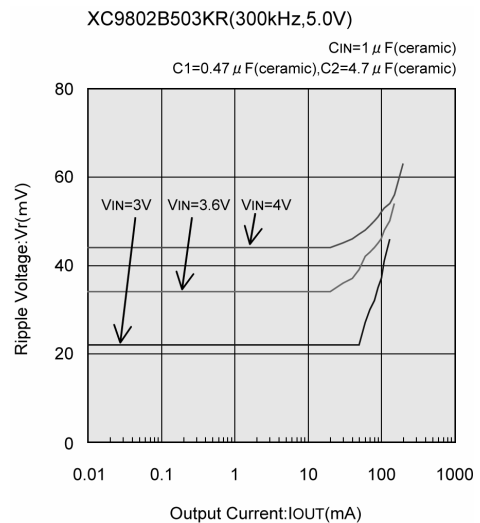
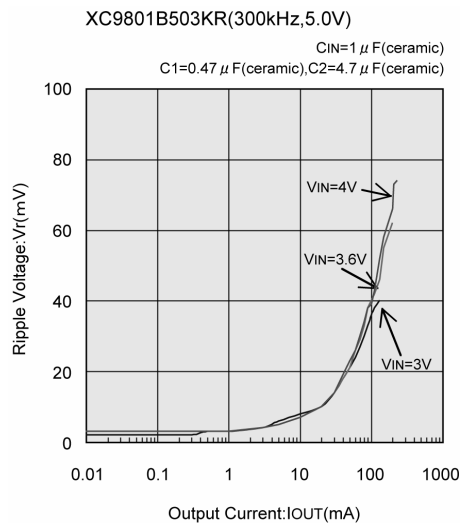
#### (1) Output Voltage vs. Output Current



#### (2) Efficiency vs. Output Current



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

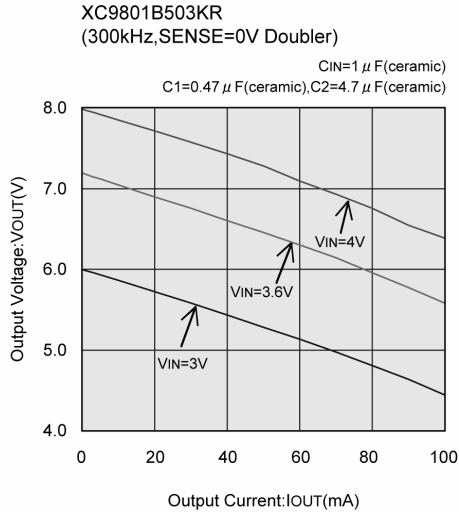




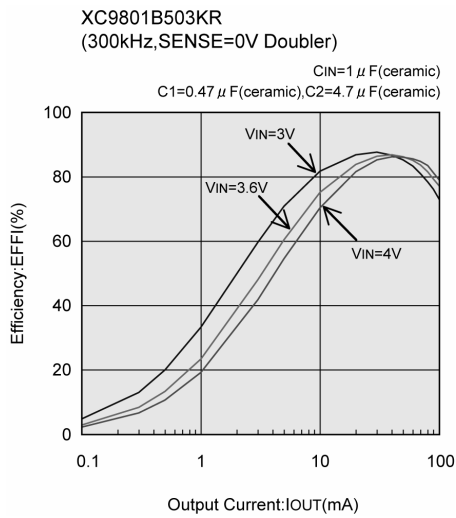
## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

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

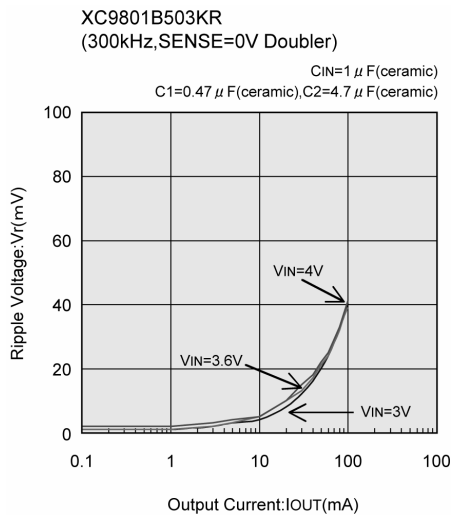
### (1) Output Voltage vs. Output Current



### (2) Efficiency vs. Output Current

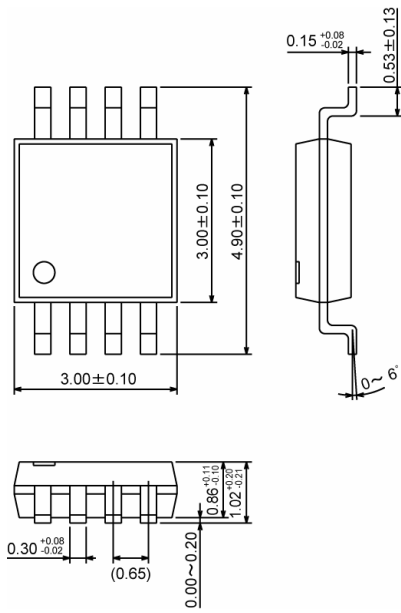


### (3) Ripple Voltage vs. Output Current

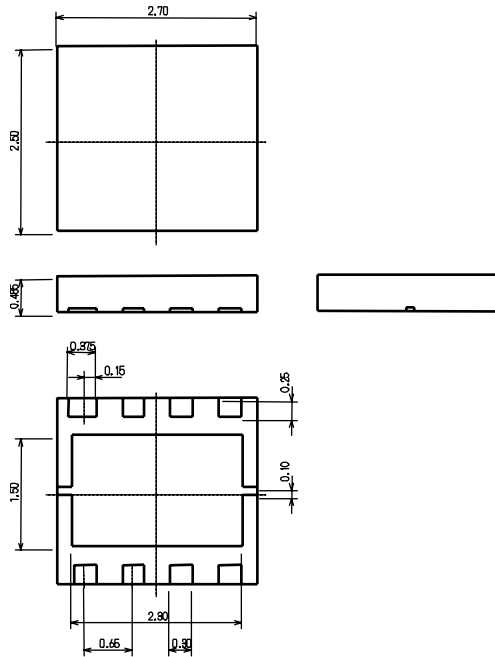


## PACKAGING INFORMATION

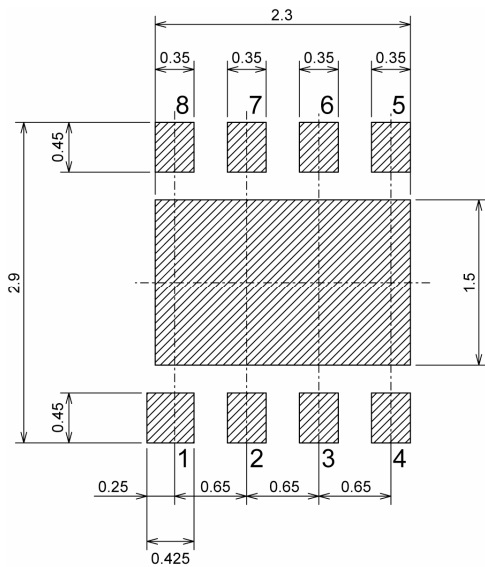
### ● MSOP-8A



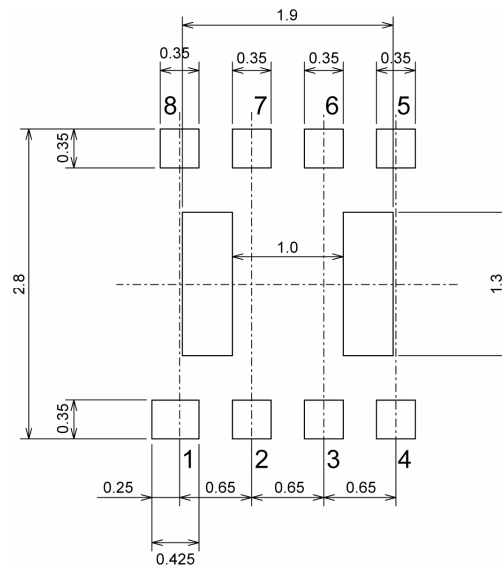
### ● USP-8



### ● USP-8 Recommended Pattern Layout

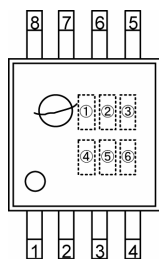


### ● USP-8 Recommended Metal Mask Design



## MARKING RULE

### ● MSOP-8A



MSOP-8A  
(TOP VIEW)

① Represents product series

MARK	PRODUCT SERIES
2	XC9801Bxx3Kx
3	XC9802Bxx3Kx

② Represents true logic level at the CE pin

MARK	PRODUCT SERIES
B	XC9801/9802Bxx3Kx

③④ Represents output voltage

MARK		VOLTAGE (V)	PRODUCT SERIES
③	④		
3	3	3.3	XC9801/9802B333Kx
5	0	5.0	XC9801/9802B503Kx

⑤ Represents oscillation frequency

MARK	OSCILLATION FREQUENCY (kHz)	PRODUCT SERIES
3	300	XC9801/9802Bxx3Kx

⑥ Represents production lot number  
0 to 9, A to Z repeated (G, I, J, O, Q, W excepted)  
Note: No character inversion used.

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