

## High Current High Speed Dual LDO Regulator

## GENERAL DESCRIPTION

The XCM406 series is a high current, dual LDO regulator in an ultra small USP-12B01 package which measures just 2.8mm x 2.8mm. The IC is basically two XC6210 high speed CMOS LDOs which are precise, low noise, high current, regulators consisting of a voltage reference, an error amplifier, a current limiter and phase compensation circuit plus a driver transistor. The low ON resistance of the built-in driver transistor means that batteries can be used to a minimal input-output voltage differential and can therefore be used for a longer time. The series can be used with low ESR ceramic capacitors and output voltages are selectable in 0.1V increments within a range of 0.8V to 5.0V per channel. The fold-back current limit circuit also operates as the output current limiter and the output pin protector.

The IC can be placed in stand-by mode via the CE function so that power consumption is greatly reduced.

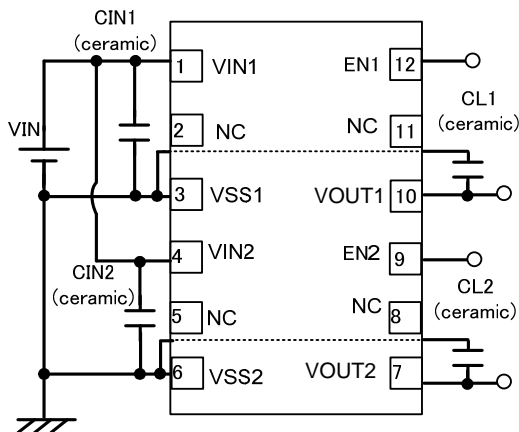
## APPLICATIONS

- Mobile phone
- Bluetooth equipment
- Portable AV equipment
- Portable gaming equipment

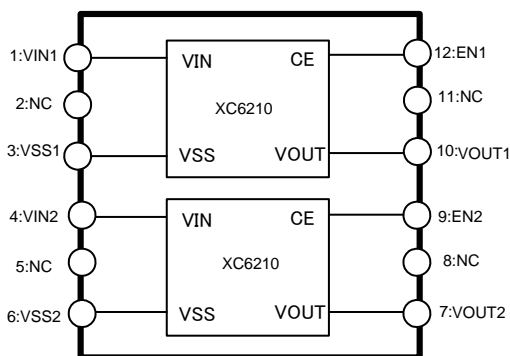
## FEATURES

Maximum Output Current	: 700mA (TYP.: 800mA limit) ( $1.6V \leq V_{OUT(T)} \leq 5.0V$ )
Dropout Voltage	: 50mV @ $I_{OUT}=100mA$
Operating Voltage Range	: 1.5V ~ 6.0V
Output Voltage Setting Range	: 0.8V ~ 5.0V (0.1V increments)
Accuracy	: $\pm 2\%$
Low Power Consumption	: 35 $\mu A$ (TYP.)
High Ripple Rejection	: 60dB @ 1kHz
Operating Temperature Range	: -40 $^{\circ}C$ ~ 85 $^{\circ}C$
Package	: USP-12B01

## TYPICAL APPLICATION CIRCUIT

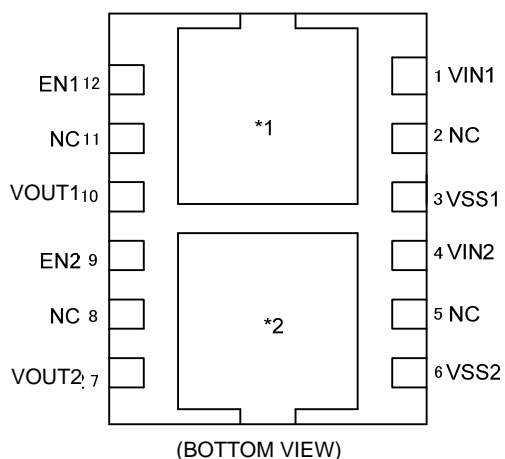


\* The dotted lines in the circuit indicates the connection using through-holes at the backside of the PC board



(TOP VIEW)

## PIN CONFIGURATION



\* A dissipation pad on the reverse side of the package should be electrically isolated.

\*1: Electrical potential of the XC6210 series' dissipation pad should be the Vss level.

\*2: Electrical potential of the XC6210 series' dissipation pad should be the Vss level.

Care must be taken for an electrical potential of each dissipation pad so as to enhance mounting strength and heat release when the pad needs to be connected to the circuit.

## PIN ASSIGNMENT

PIN NUMBER	PIN NAME			FUNCTION
	XCM406	XC6210	XC6210	
1	VIN1	VIN	-	VR1 Power Input
2	NC	-	-	No Connection
3	VSS1	Vss	-	VR1 Ground
4	VIN2	-	VIN	VR2 Power Input
5	NC	-	-	No Connection
6	VSS2	-	Vss	VR2 Ground
7	VOUT2	-	VOUT	VR2 Output
8	NC	-	-	No Connection
9	EN2	-	CE	VR2 ON/OFF Control
10	VOUT1	VOUT	-	VR1 Output
11	NC	-	-	No Connection
12	EN1	CE	-	VR1 ON/OFF Control

## PRODUCT CLASSIFICATION

### Ordering Information

XCM406 \_\_\_\_\_

DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
	Combination of the Series and Options Output Voltage	AA	: XC6210Bxx2 + XC6210Bxx2 (High Active, Without Pull-down resistor)
		AB	: XC6210Axx2 + XC6210Axx2 (High Active, With Pull-down resistor)
	Output Voltages	01 ~	: Internally set sequential number relating to output voltage V <sub>OUT1</sub> selection output voltage range : 0.8V ~ 5.0V (0.1V increments) V <sub>OUT2</sub> selection output voltage range : 0.8V ~ 5.0V (0.1V increments)
	Device Orientation	D	: USP-12B01
		R	: Embossed tape, standard feed

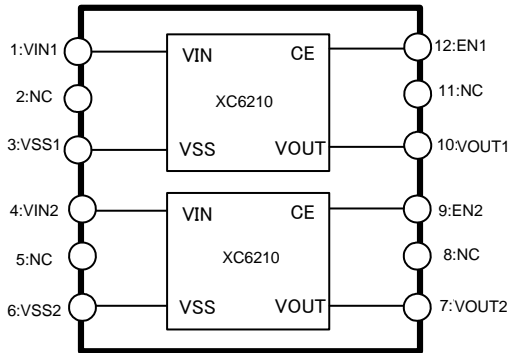
### DESIGNATOR ( Output Voltage )

	VOUT1	VOUT2
01	1.3	1.5
02	1.8	3.3
03	2.5	3.3
04	3.3	1.5

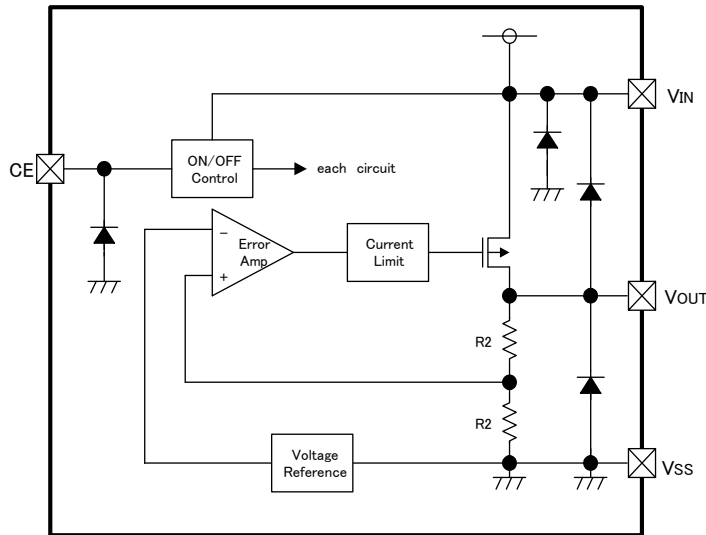
The XCM406 series are semi-custom products. For other combinations, output voltages and etc., please ask your sales contacts.

## BLOCK DIAGRAMS

### XCM406



### XC6210



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

## ABSOLUTE MAXIMUM RATINGS

PARAMETER		SYMBOL	RATINGS	UNITS
Input Voltage		V <sub>IN</sub>	6.5	V
Output Current *		I <sub>OUT</sub>	900	mA
Output Voltage		V <sub>OUT</sub>	V <sub>SS</sub> - 0.3 ~ V <sub>IN</sub> + 0.3	V
CE Voltage		V <sub>CE</sub>	V <sub>SS</sub> - 0.3 ~ 6.5	V
Power Dissipation	USP-12B01	P <sub>d</sub>	150	mW
Junction Temperature		T <sub>j</sub>	125	
Ambient Temperature Range		T <sub>opr</sub>	- 40 ~ + 85	
Storage Temperature Range		T <sub>stg</sub>	- 55 ~ + 125	

## ELECTRICAL CHARACTERISTICS

VR Block ( XC6210 Series )

Ta=25

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUIT
Output Voltage <sup>(*2), (*3)</sup>	V <sub>OUT(E)</sub>	V <sub>IN</sub> =V <sub>OUT(T)</sub> +1.0V, I <sub>OUT</sub> =30mA V <sub>CE</sub> =ON(V <sub>IN</sub> or V <sub>SS</sub> )	× 0.98	V <sub>OUT(T)</sub>	× 1.02	V	
		V <sub>OUT(T)</sub> 1.5V, I <sub>OUT</sub> =30mA V <sub>CE</sub> =ON(V <sub>IN</sub> or V <sub>SS</sub> )	(-30mV)	V <sub>OUT(T)</sub>	(+30mV)		
Maximum Output Current V <sub>OUT(E)</sub> > 1.6V	I <sub>OUTMAX</sub>	V <sub>IN</sub> =V <sub>OUT(T)</sub> +1.0V, V <sub>CE</sub> =ON(V <sub>IN</sub> or V <sub>SS</sub> )	700	-	-	mA	
Maximum Output Current V <sub>OUT(E)</sub> 1.5V	I <sub>OUTMAX</sub>	V <sub>IN</sub> =V <sub>OUT(T)</sub> +1.0V, V <sub>CE</sub> =ON(V <sub>IN</sub> or V <sub>SS</sub> )	500	-	-	mA	
Load Regulation	V <sub>OUT</sub>	1mA I <sub>OUT</sub> 100mA, V <sub>CE</sub> =ON(V <sub>IN</sub> or V <sub>SS</sub> )	-	15	60	mV	
Dropout Voltage <sup>(*4)</sup>	V <sub>dif1</sub>	I <sub>ROUT</sub> =30mA, V <sub>CE</sub> =ON(V <sub>IN</sub> or V <sub>SS</sub> )	E-1			mV	
	V <sub>dif2</sub>	I <sub>ROUT</sub> =100mA, V <sub>CE</sub> =ON(V <sub>IN</sub> or V <sub>SS</sub> )	E-2			mV	
Supply Current (A type)	I <sub>DD</sub>	V <sub>IN</sub> =V <sub>CE</sub> =V <sub>OUT(T)</sub> +1.0V	E-3			μA	
Supply Current (B type)		V <sub>IN</sub> =V <sub>CE</sub> =V <sub>OUT(T)</sub> +1.0V	-	35	55		
Stand-by Current	I <sub>STBY</sub>	V <sub>IN</sub> =6.0V, CE=OFF(V <sub>IN</sub> or V <sub>SS</sub> )	-0.10	-	0.10	μA	
Line Regulation	$\frac{V_{OUT}}{Topr} \cdot V_{OUT}$	V <sub>OUT(T)</sub> +1.0V V <sub>IN</sub> 6.0V V <sub>OUT(T)</sub> 4.5V, 5.5V V <sub>IN</sub> 6.0V V <sub>CE</sub> =ON(V <sub>IN</sub> or V <sub>SS</sub> ), I <sub>OUT</sub> =30mA	-	0.01	0.20	% / V	
Input Voltage	V <sub>IN</sub>		1.5	-	6.0	V	-
Output Voltage Temperature Characteristics	$\frac{V_{OUT}}{Topr} \cdot V_{OUT}$	I <sub>OUT</sub> =30mA, V <sub>CE</sub> =ON(V <sub>IN</sub> or V <sub>SS</sub> ) -40 Topr 85	-	± 100	-	ppm /	
Ripple Rejection Rate	PSRR	V <sub>IN</sub> =[V <sub>OUT(T)</sub> +1.0]VDC+0.5Vp-pAC V <sub>OUT(T)</sub> 4.75V V <sub>IN</sub> =5.75VDC+0.5Vp-pAC V <sub>CE</sub> =ON(V <sub>IN</sub> or V <sub>SS</sub> ), I <sub>OUT</sub> =30mA, f=1kHz	-	60	-	dB	
Current Limiter V <sub>OUT(E)</sub> > 1.6V	I <sub>lim</sub>	V <sub>IN</sub> =V <sub>OUT(T)</sub> +1.0V, V <sub>CE</sub> =ON(V <sub>IN</sub> or V <sub>SS</sub> )	700	800	-	mA	
Current Limiter V <sub>OUT(E)</sub> 1.5V	I <sub>lim</sub>	V <sub>IN</sub> =V <sub>OUT(T)</sub> +1.0V, V <sub>CE</sub> =ON(V <sub>IN</sub> or V <sub>SS</sub> )	-	800	-	mA	
Short-Circuit Current	I <sub>short</sub>	V <sub>IN</sub> =V <sub>OUT(T)</sub> +1.0V, V <sub>CE</sub> =ON(V <sub>IN</sub> or V <sub>SS</sub> )	-	50	-	mA	
CE "High" Level Voltage	V <sub>CEH</sub>		1.3	-	6.0	V	
CE "Low" Level Voltage	V <sub>CEL</sub>		-	-	0.25	V	
CE "High" Level Current (A type)	I <sub>CEH</sub>	V <sub>CE</sub> =V <sub>IN</sub> =V <sub>OUT(T)</sub> +1.0V	E-4			μA	
CE "High" Level Current (B type)	I <sub>CEH</sub>		-0.10	-	0.10	μA	
CE "Low" Level Current (A·B type)	I <sub>CEL</sub>	V <sub>IN</sub> =V <sub>OUT(T)</sub> +1.0V, V <sub>CE</sub> =V <sub>SS</sub>	-0.10	-	0.10	μA	

**NOTE:**

\*1: Unless otherwise stated, V<sub>IN</sub>=V<sub>OUT(T)</sub>+1.0V

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

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

(i.e. the output voltage when " V<sub>OUT(T)</sub>+1.0V" is provided while maintaining a certain I<sub>OUT</sub> value).

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

\*5: A voltage equal to 98% of the output voltage whenever a stabilized V<sub>OUT1</sub>=I<sub>OUT</sub>{V<sub>OUT(T)</sub>+1.0V} is input.

\*6: V<sub>IN1</sub>= the input voltage when V<sub>OUT1</sub>, which appears as input voltage is gradually decreased.

\*7: V<sub>OUT(T)≤1.50V</sub> MIN. : V<sub>OUT(T)</sub> - 30mV, MAX. : V<sub>OUT(T)</sub> +30mV

\*8: CE conditions: XC6210A / B type: ON=V<sub>IN</sub>, OFF=V<sub>SS</sub>

## VOLTAGE CHART

XC6210 Series Dropout Voltage, Supply Current, CE"H / L" Level Current Table

PARAMETER SPECIFIED OUTPUT VOLTAGE	E-0		E-1		E-2		E-3		E-4							
	OUTPUT VOLTAGE (V)		DROPOUT VOLTAGE 1 (mV) ( $I_{OUT}=30mA$ )		DROPOUT VOLTAGE 2 (mV) ( $I_{OUT}=100mA$ )		SUPPLY CURRENT ( $\mu A$ )		CE "H" LEVEL CURRENT ( $\mu A$ )							
			Ta=25		Ta=25		Ta=25		Ta=25							
	$V_{OUT(T)}$		$V_{dif1}$		$V_{dif2}$		$I_{DD}$		ICEH							
	MIN	MAX	TYP	MAX	TYP	MAX	TYP	MAX	MIN	MAX						
0.80	0.770	.0830	100	700	250	800	38.0	60.0	1.50	5.00						
0.85	0.820	0.880		600		700										
0.90	0.870	0.930		50		500					150	600	38.5	61.5	2.00	6.50
0.95	0.920	0.980				400						500				
1.00	0.970	1.030	30		300	100	400	39.0	63.0	2.50		8.00				
1.05	1.020	1.080			200		300									
1.10	1.070	1.130		100	250											
1.15	1.120	1.180		27	41		90				135		39.0	63.0	2.50	8.00
1.20	1.170	1.230														
1.25	1.220	1.280														
1.30	1.270	1.330														
1.35	1.320	1.380														
1.40	1.370	1.430														
1.45	1.420	1.480														
1.50	1.470	1.530														
1.55	1.519	1.581														
1.60	1.568	1.632														
1.65	1.617	1.683														
1.70	1.666	1.734														
1.75	1.715	1.785														
1.80	1.764	1.836														
1.85	1.813	1.887														
1.90	1.862	1.938														
1.95	1.911	1.989														
2.00	1.960	2.040														
2.05	2.009	2.091														
2.10	2.058	2.142														
2.15	2.107	2.193														
2.20	2.156	2.244														
2.25	2.205	2.295														
2.30	2.254	2.346														
2.35	2.303	2.397														
2.40	2.352	2.448														
2.45	2.401	2.499														
2.50	2.450	2.550														
2.55	2.499	2.601														
2.60	2.548	2.652														
2.65	2.597	2.703														
2.70	2.646	2.754														
2.75	2.695	2.805														
2.80	2.744	2.856														
2.85	2.793	2.907														
2.90	2.842	2.958														
2.95	2.891	3.009														

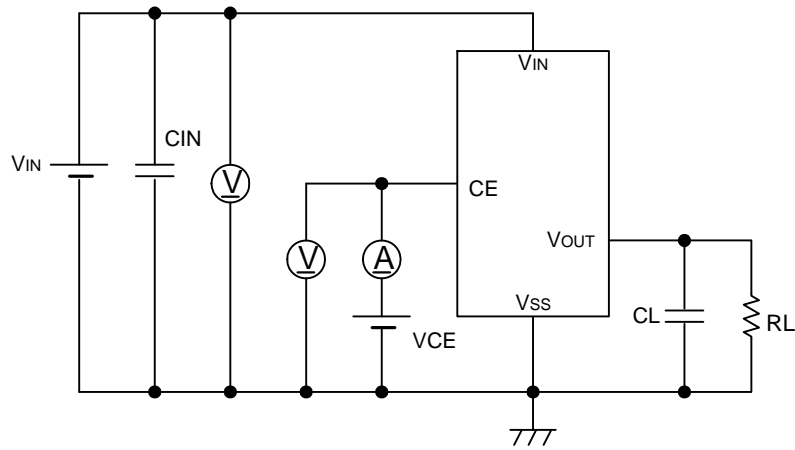
# VOLTAGE CHART (Continued)

XC6210 Series Voltage Table 2

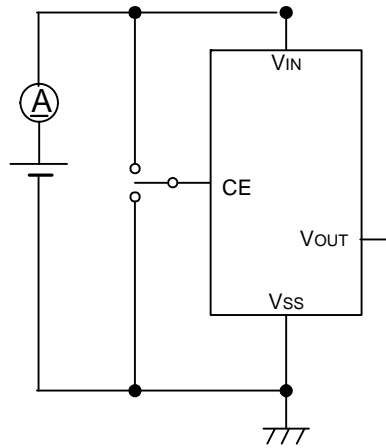
PARAMETER SPECIFIED OUTPUT VOLTAGE	E-0		E-1		E-2		E-3		E-4	
	OUTPUT VOLTAGE (V)		DROPOUT VOLTAGE 1 (mV) (I <sub>OUT</sub> =30mA)		DROPOUT VOLTAGE 2 (mV) (I <sub>OUT</sub> =100mA)		SUPPLY CURRENT (μA)		CE "H" LEVEL CURRENT (μA)	
	V <sub>OUT(T)</sub>		V <sub>dif1</sub>		V <sub>dif2</sub>		I <sub>DD</sub>		ICEH	
	MIN	MAX	TYP	MAX	TYP	MAX	TYP	MAX	MIN	MAX
3.00	2.940	3.060	15	23	50	75	40.5	67.5	4.00	12.50
3.05	2.989	3.111								
3.10	3.038	3.162								
3.15	3.087	3.213								
3.20	3.136	3.264								
3.25	3.185	3.315								
3.30	3.234	3.366								
3.35	3.283	3.417								
3.40	3.332	3.468								
3.45	3.381	3.519								
3.50	3.430	3.570								
3.55	3.479	3.621								
3.60	3.528	3.672								
3.65	3.577	3.723								
3.70	3.626	3.774								
3.75	3.675	3.825								
3.80	3.724	3.876								
3.85	3.773	3.927								
3.90	3.822	3.978								
3.95	3.871	4.029								
4.00	3.920	4.080	15	23	50	75	41.5	70.5	4.85	15.50
4.05	3.969	4.131								
4.10	4.018	4.182								
4.15	4.067	4.233								
4.20	4.116	4.284								
4.25	4.165	4.335								
4.30	4.214	4.386								
4.35	4.263	4.437								
4.40	4.312	4.488								
4.45	4.361	4.539								
4.50	4.410	4.590								
4.55	4.459	4.641								
4.60	4.508	4.692								
4.65	4.557	4.743								
4.70	4.606	4.794								
4.75	4.655	4.845								
4.80	4.704	4.896								
4.85	4.753	4.947								
4.90	4.802	4.998								
4.95	4.851	5.049								
5.00	4.900	5.100								

## TEST CIRCUITS

Circuit

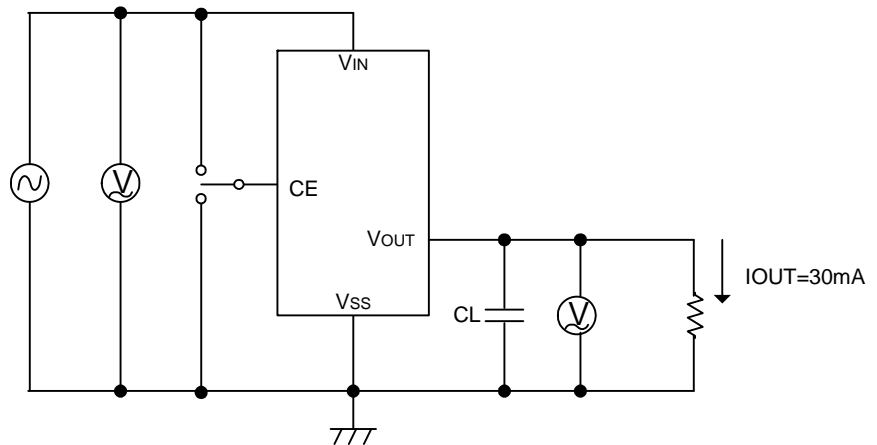


Circuit



Circuit

$V_{IN} = \{V_{OUT} + 1.0V\}V_{DC} + 0.5V_{p-pAC}$   
 $V_{OUT} = 4.75V$   
 $V_{IN} = 5.75V_{DC} + 0.5V_{p-pAC}$



VR	OUTPUT VOLTAGE	0.8V~1.45V	1.5V ~ 1.75V	1.8V ~ 5.0V
	CL	6.8 $\mu F$	4.7 $\mu F$	1.0 $\mu F$



## OPERATIONAL EXPLANATION

### <Output Voltage Regulator Control>

The voltage, divided by resistors R1 & R2, which are connected to the VOUT pin is compared with the internal reference voltage by the error amplifier. The P-channel MOSFET connected to the VOUT pin is then driven by the subsequent output signal. The output voltage at the VOUT pin is controlled and stabilized by negative feedback. The constant current limit circuit and short circuit protection operate in relation to the level of output current.

### <Low ESR Capacitor>

With the XC6210 series regulator, a stable output voltage is achievable even if low ESR capacitors are used, as a phase compensation circuit is built into the regulator. In order to ensure the effectiveness of the phase compensation, we suggest that an output capacitor (CL) will be connected as close as possible between the output pin (VOUT) and the VSS pin. Please use an output capacitor (CL) with a capacitance based on the chart below. We also suggest an input capacitor (CIN) of 1  $\mu$ F. This should be connected between VIN and VSS in order to stabilize input power source.

Output Capacitor Corresponding Table

VOUT	0.8V ~ 1.45V	1.5V ~ 1.75V	1.8V ~ 5.0V
CL	6.8 $\mu$ F	4.7 $\mu$ F	1.0 $\mu$ F

### <Current Limiter, Short-Circuit Protection>

The XC6210 series regulator offers a combination of current limit and short circuit protection by means of a built-in fixed current limiter circuit and a foldback circuit. When the load current reaches the current limit level, the fixed current limiter circuit operates and output voltage drops. As a result of this drop in output voltage, the foldback circuit operates, the output voltage drops further and output current decreases. When the output pin is shorted, a current of about 50mA flows.

### <CE Pin>

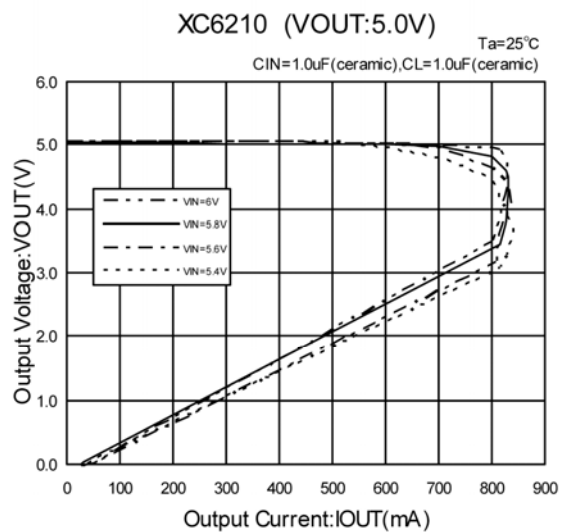
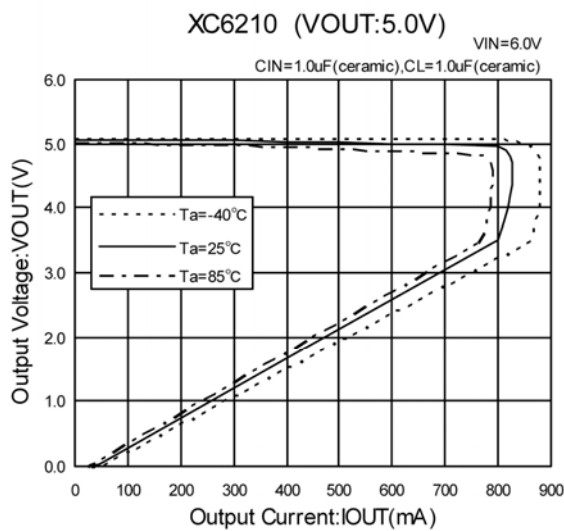
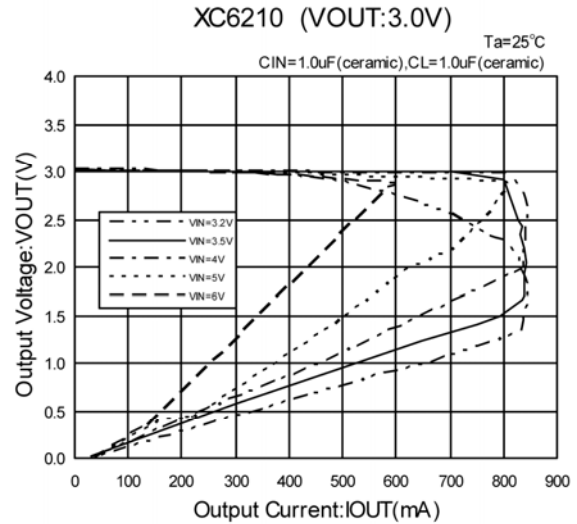
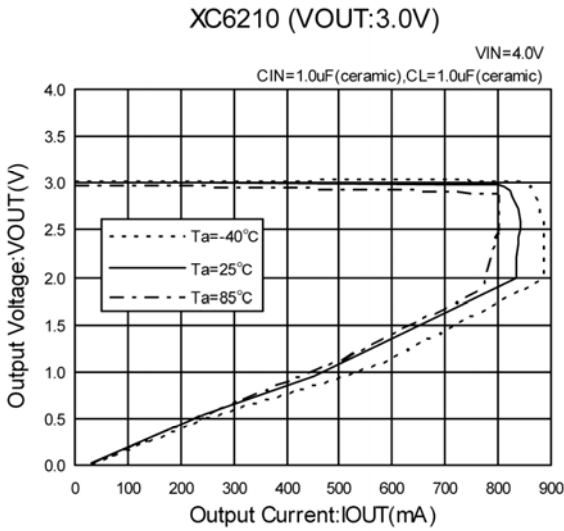
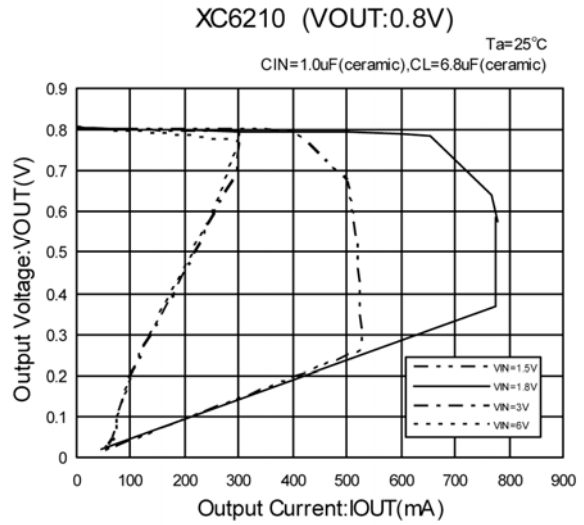
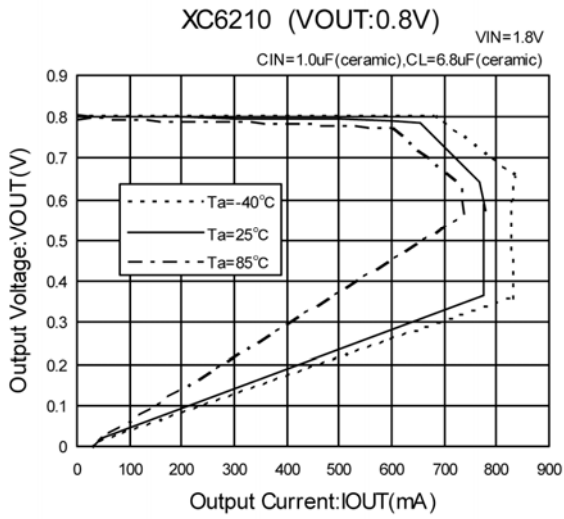
The IC's internal regulator circuitry can be shut down via the signal from the CE pin with the XC6210 series. In shutdown mode, output at the VOUT pin will be pulled down to the VSS level via R1 & R2. Options are available for the CE pin logic (See the product classification). Note that as the XC6210B types are 'High Active / No Pull-Down', operations will become unstable with the CE pin open. Although the CE pin is equal to an inverter input with CMOS hysteresis, with either the pull-up or pull-down options, the CE pin input current will increase when the IC is in operation. We suggest that you use this IC with either a VIN voltage or a VSS voltage input at the CE pin. If this IC is used with the correct specifications for the CE pin, the IC will operate normally. However, supply current may increase as a result of through current in the IC's internal circuitry if a voltage other than VIN or VSS is applied.

## 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. Where wiring impedance is high, operations may become unstable due to noise and/or phase lag depending on output current. Please strengthen VIN and VSS wiring in particular.
3. Please wire the input capacitor (CIN) and the output capacitor (CL) as close to the IC as possible. When rapid input fluctuation or load fluctuation occurs, please increase the capacitor value such as CIN or CL to stabilize the operation.

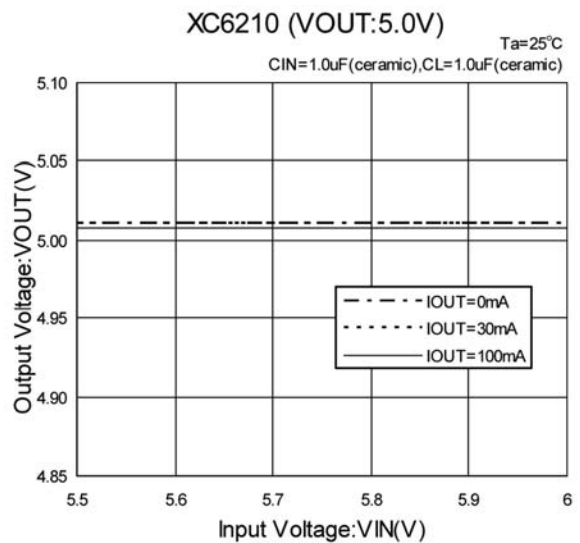
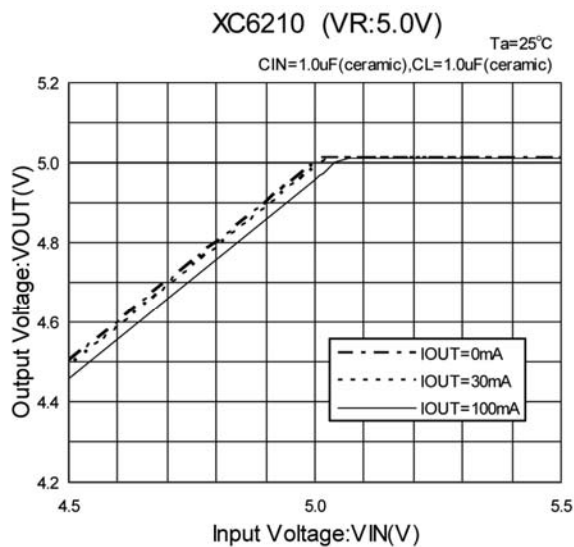
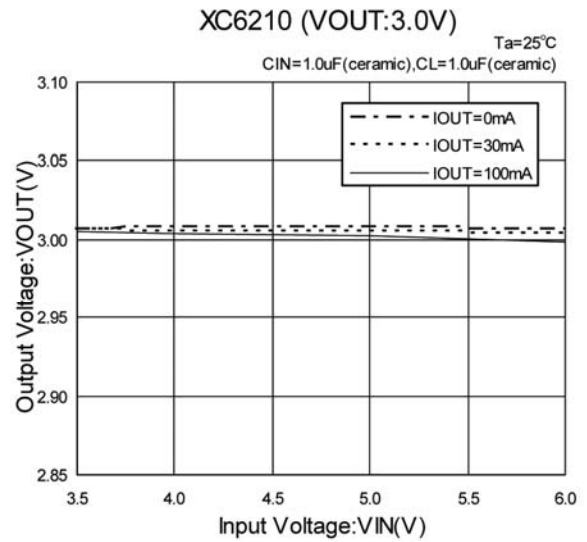
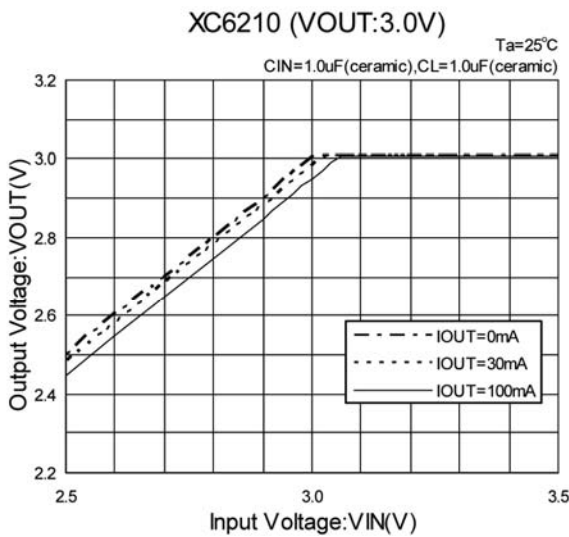
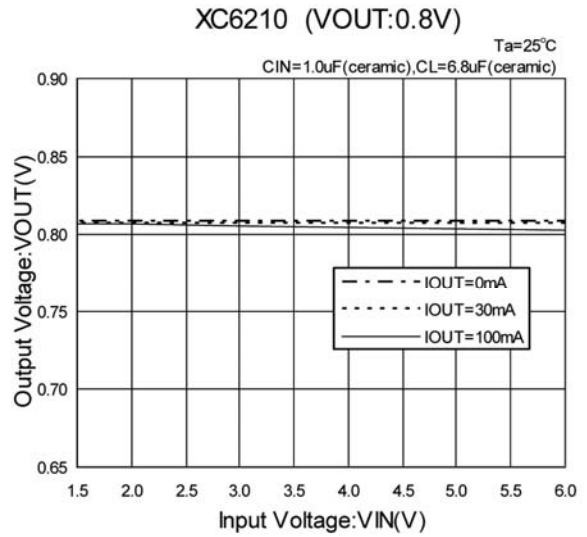
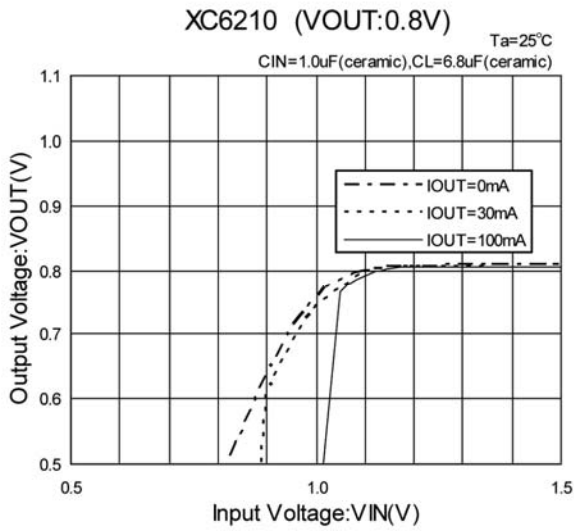
## TYPICAL PERFORMANCE CHARACTERISTICS

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



## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

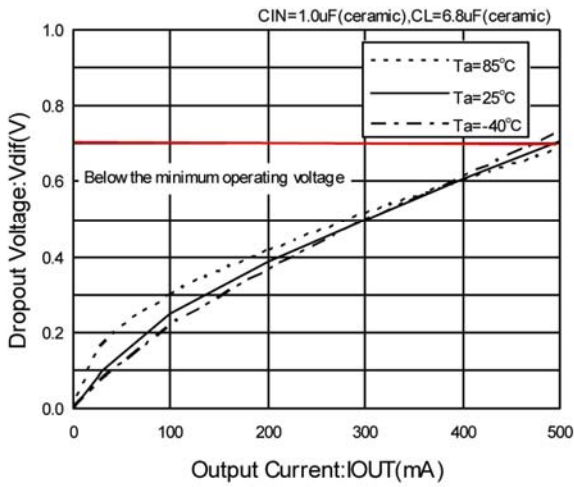
### (2) Output Voltage vs. Input Voltage



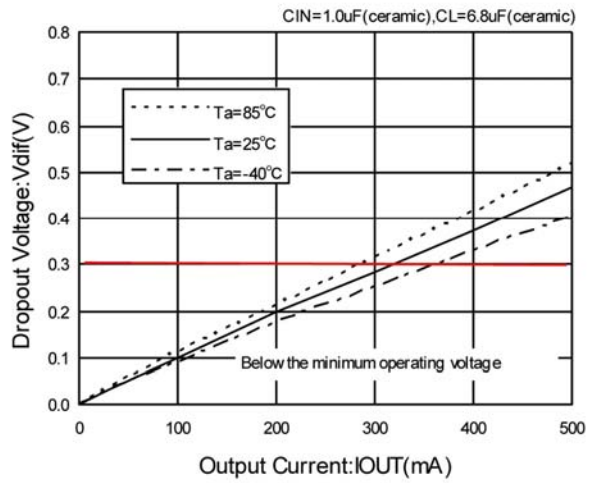
## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

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

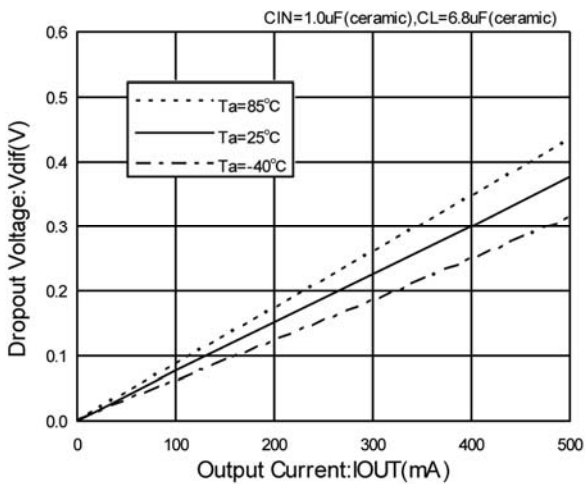
XC6210 (VOUT:0.8V)



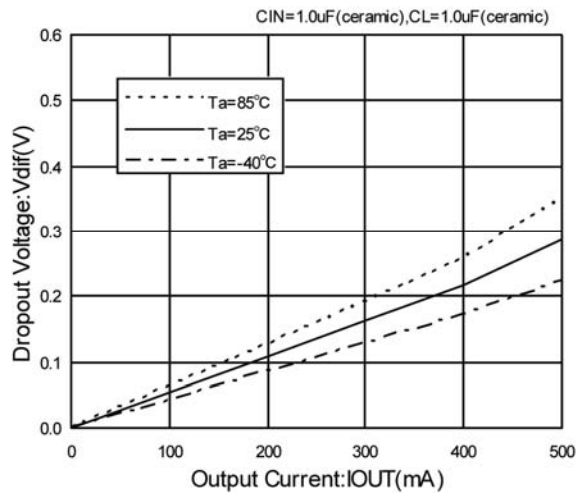
XC6210 (VOUT:1.2V)



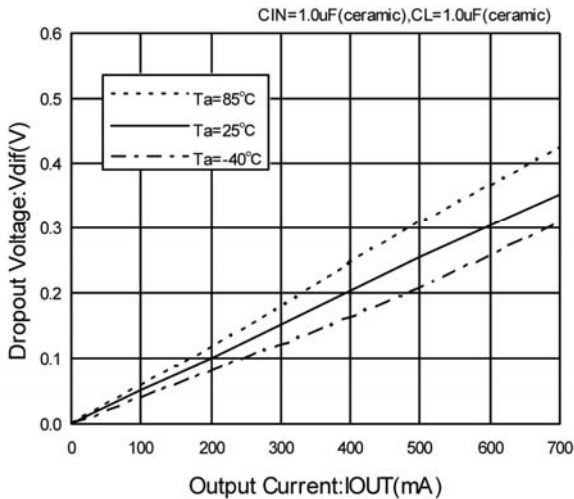
XC6210 (VOUT:1.5V)



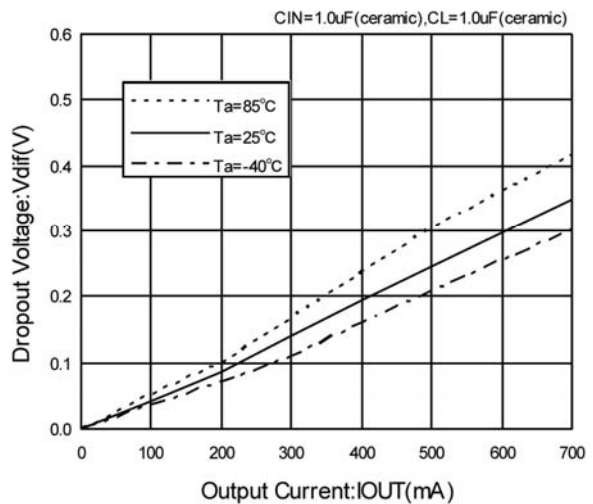
XC6210 (VOUT:2.5V)



XC6210 (VOUT:3.0V)

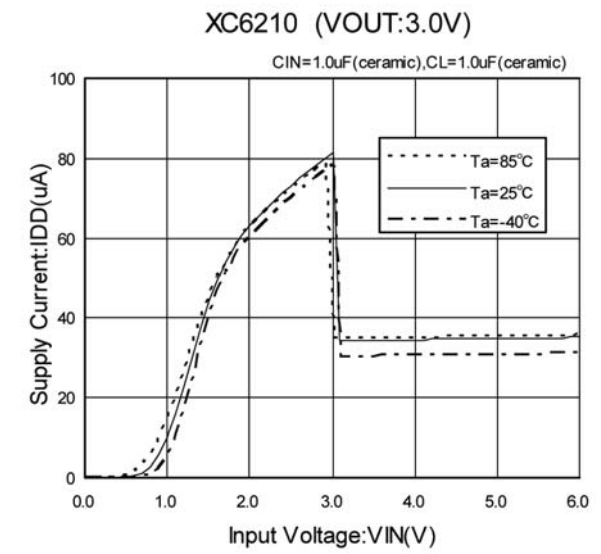
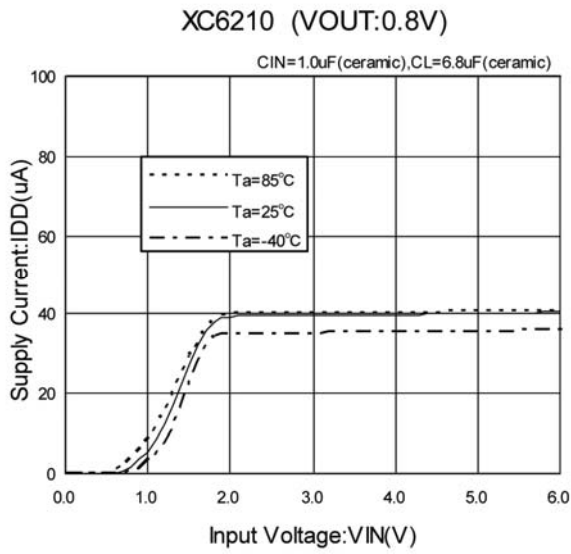


XC6210 (VOUT:5.0V)

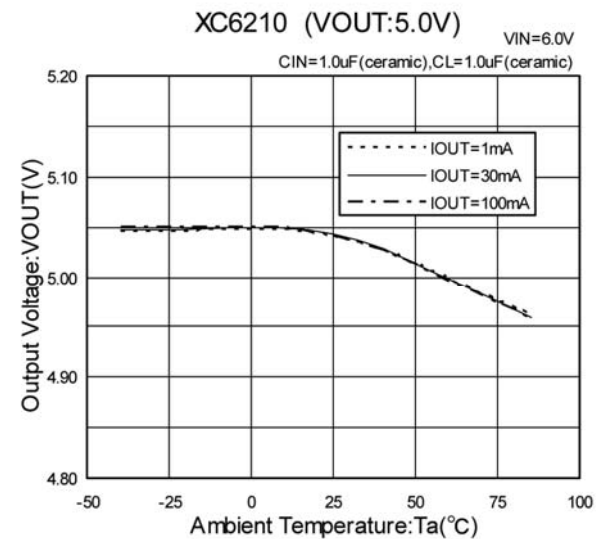
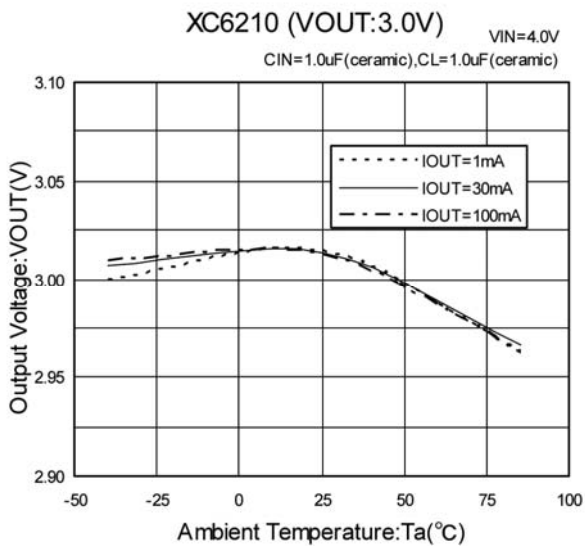
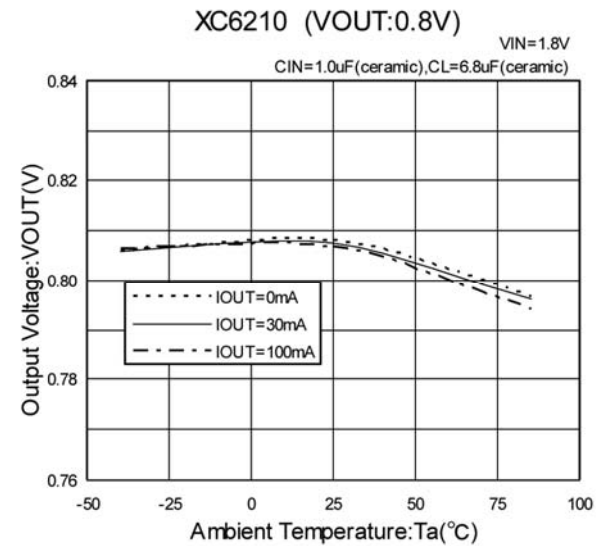
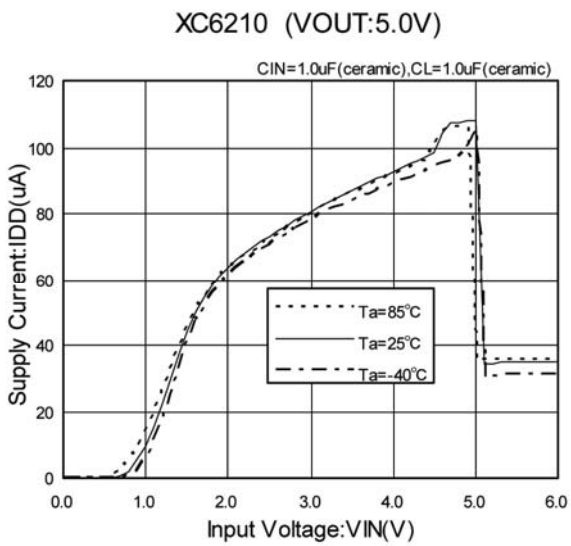


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(4) Supply Current vs. Input Voltage

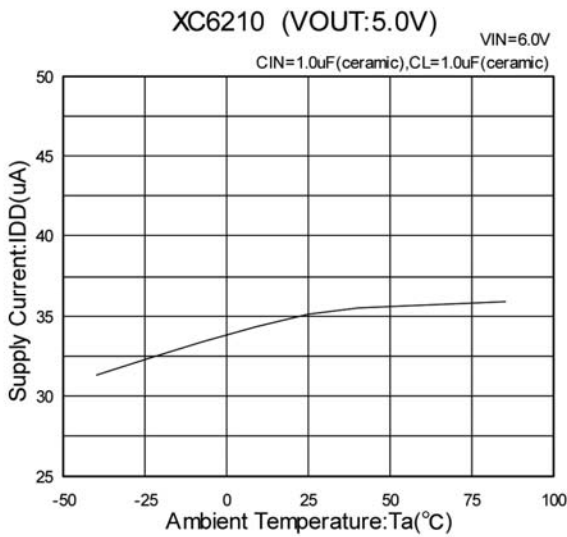
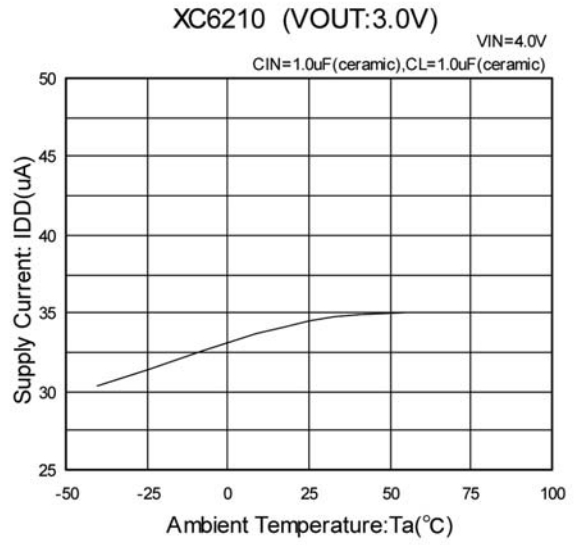
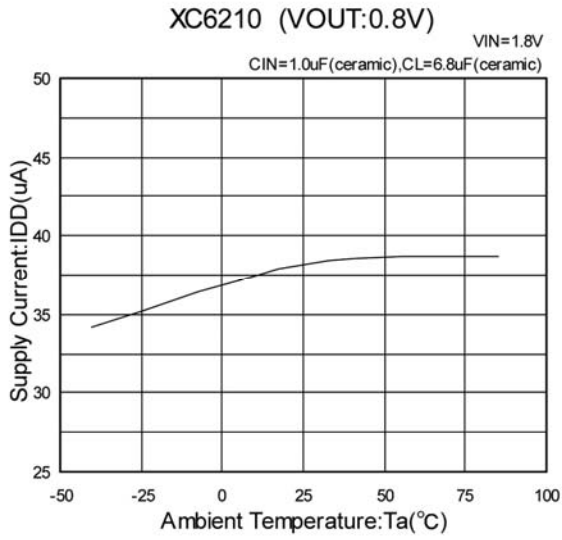


(5) Output Voltage vs. Ambient Temperature

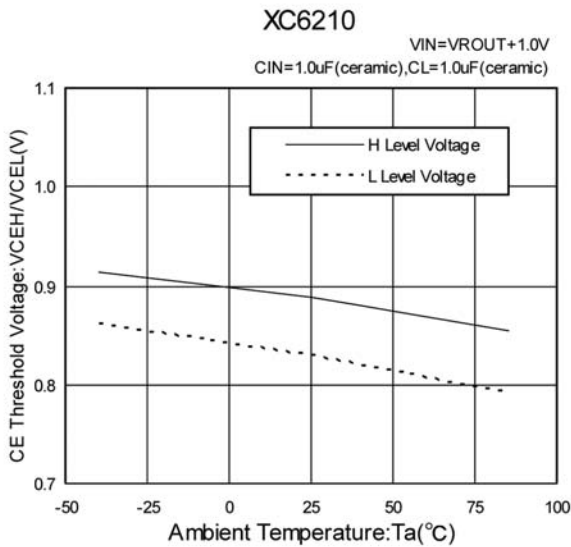


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (6) Supply Current vs. Ambient Temperature

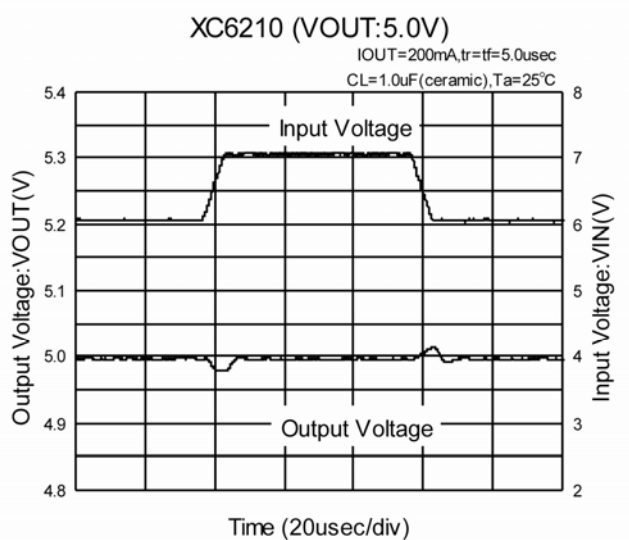
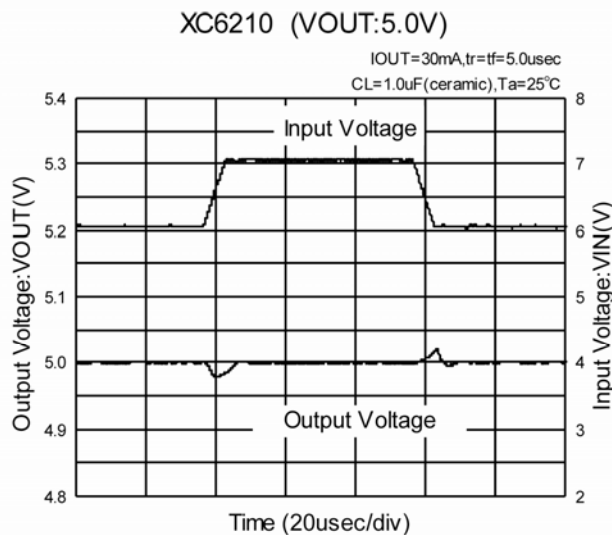
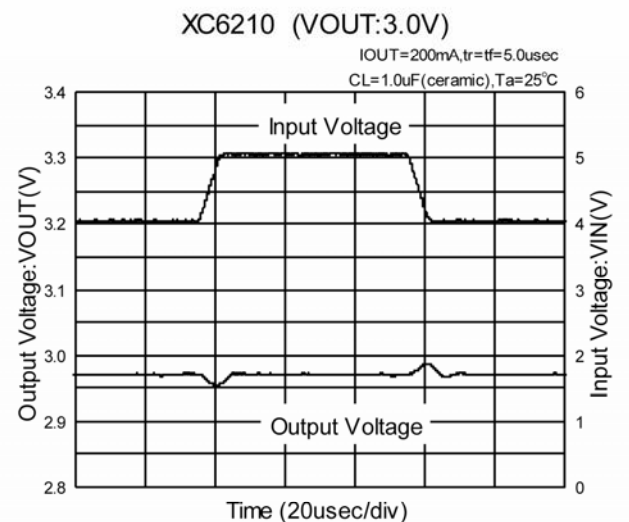
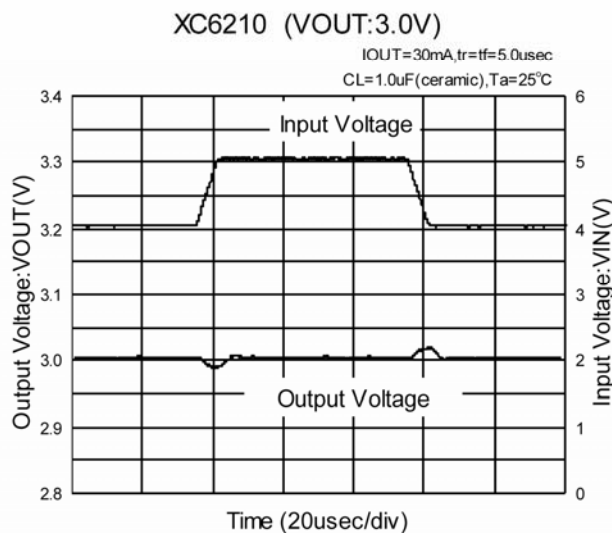
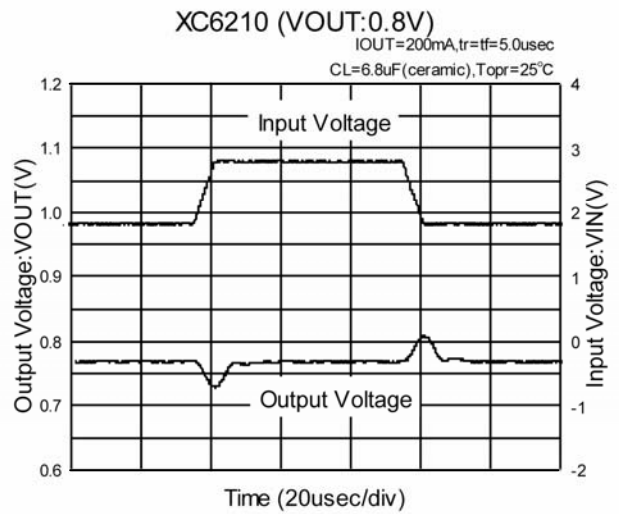
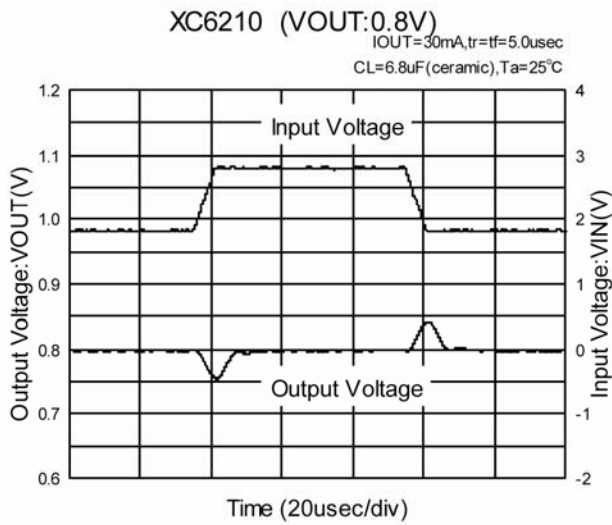


### (7) CE Pin Threshold Voltage vs. Ambient Temperature



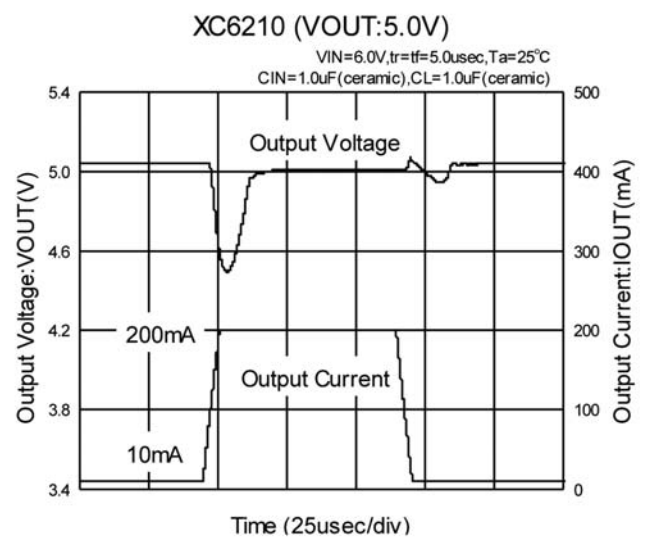
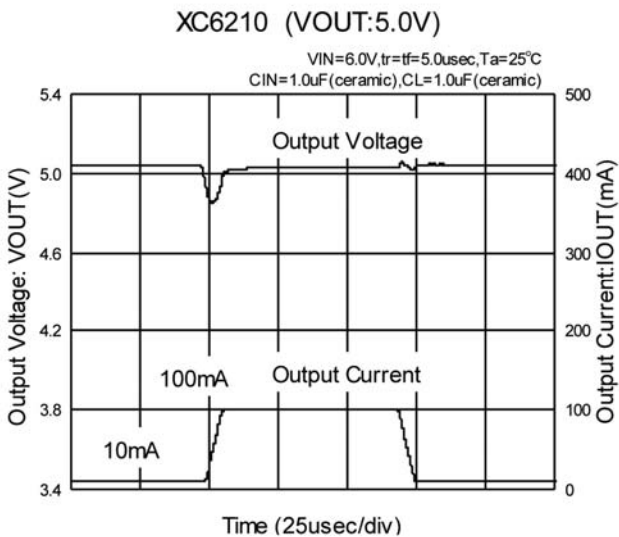
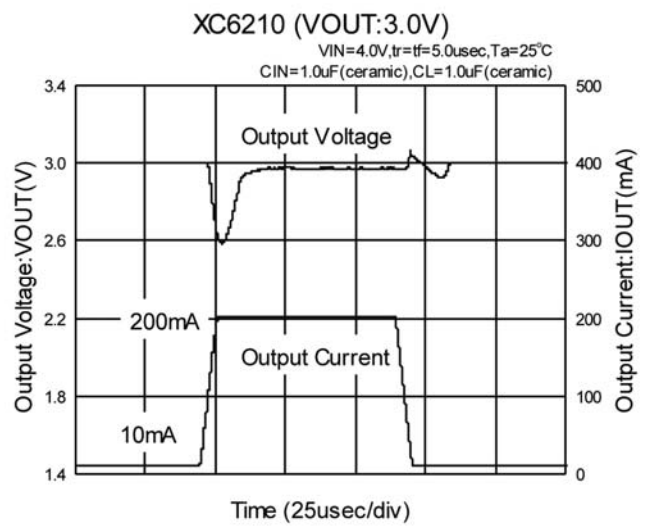
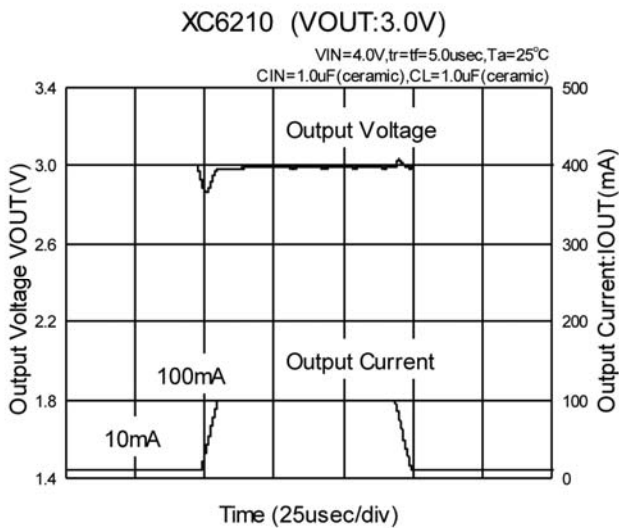
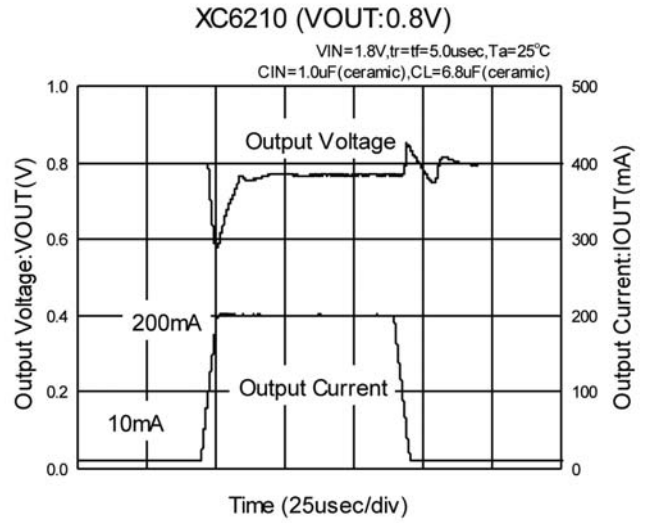
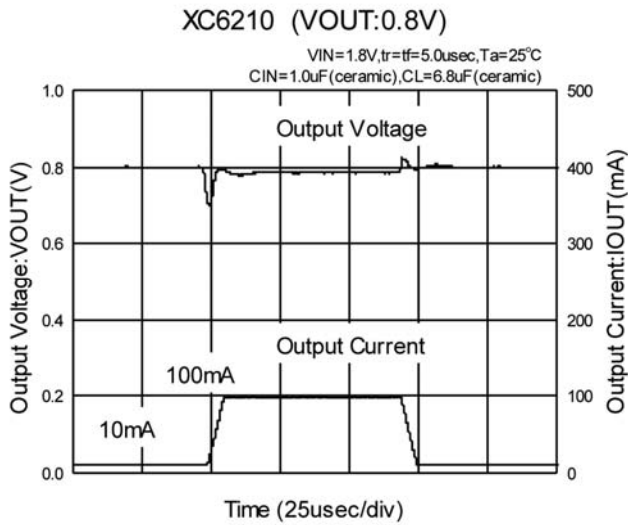
## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (8) Input Transient Response



## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

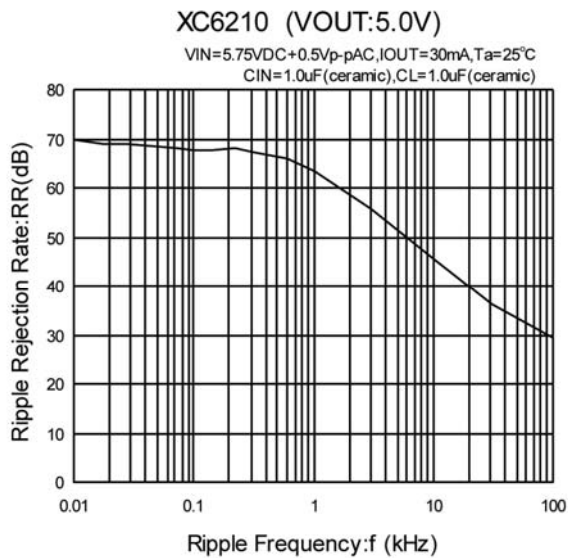
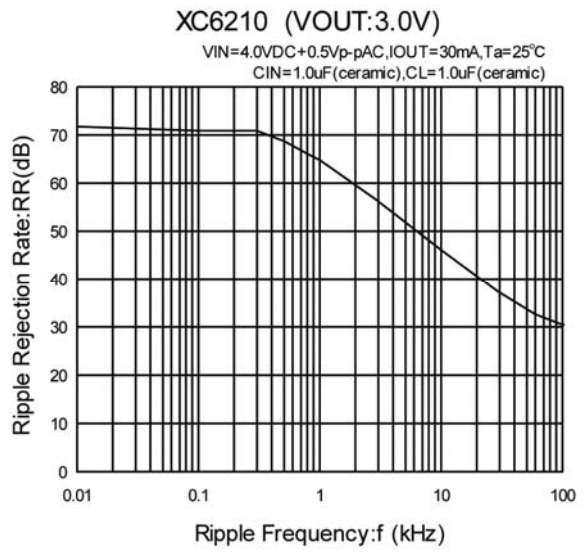
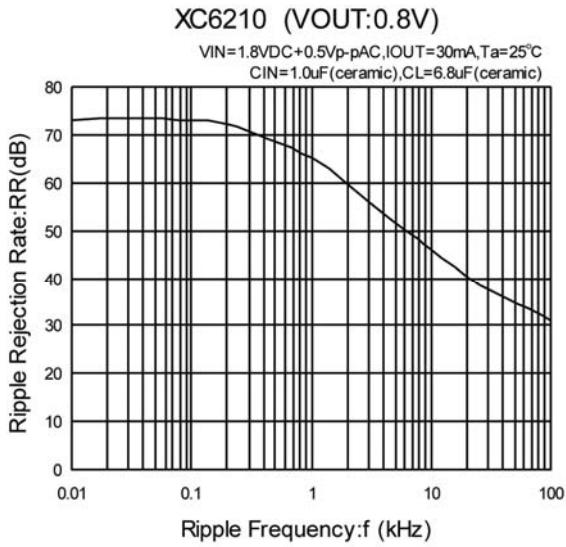
### (9) Output Transient Response





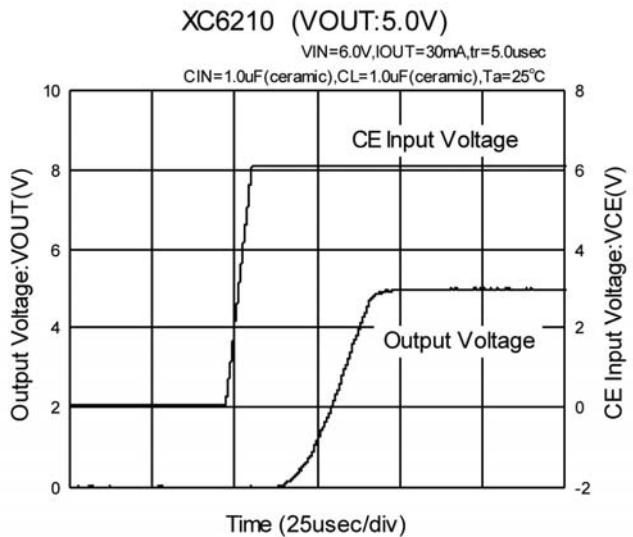
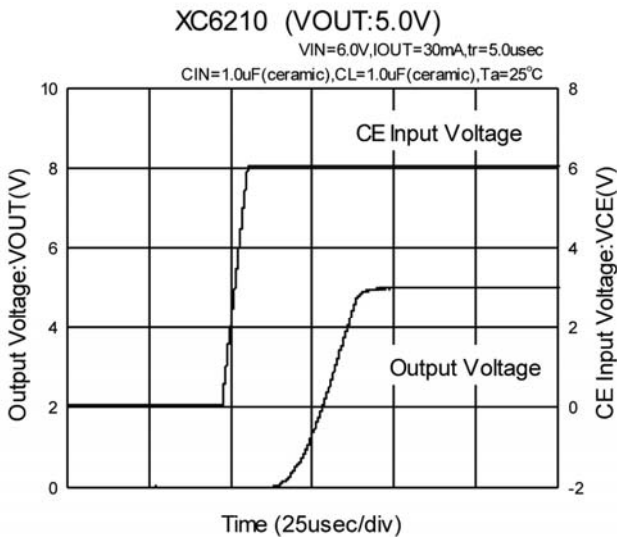
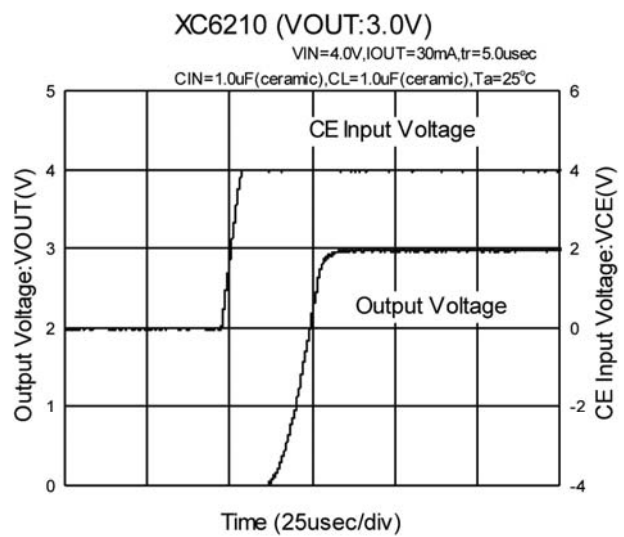
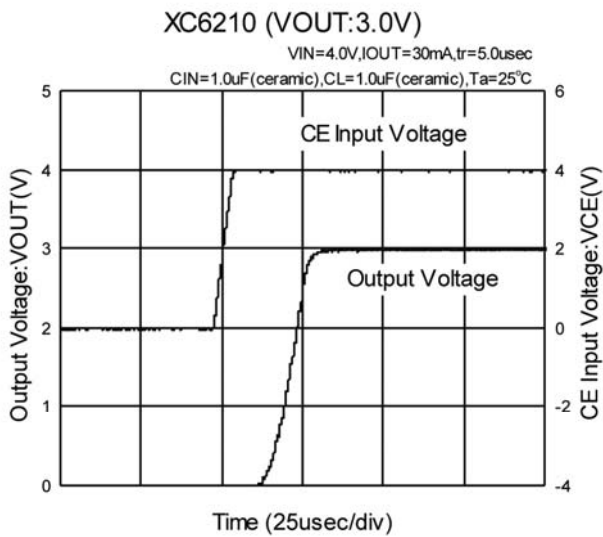
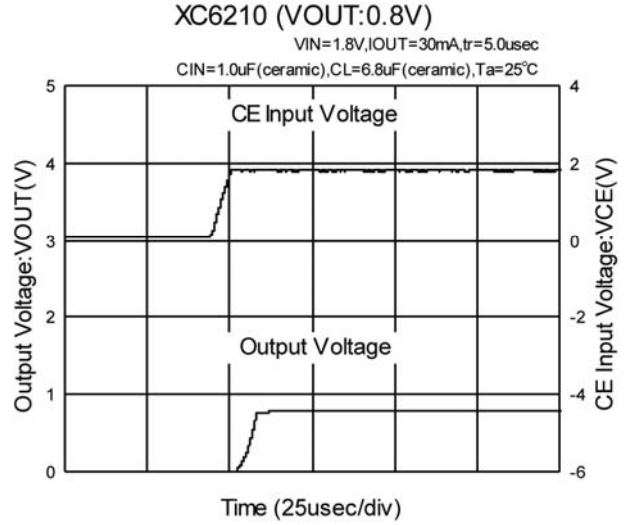
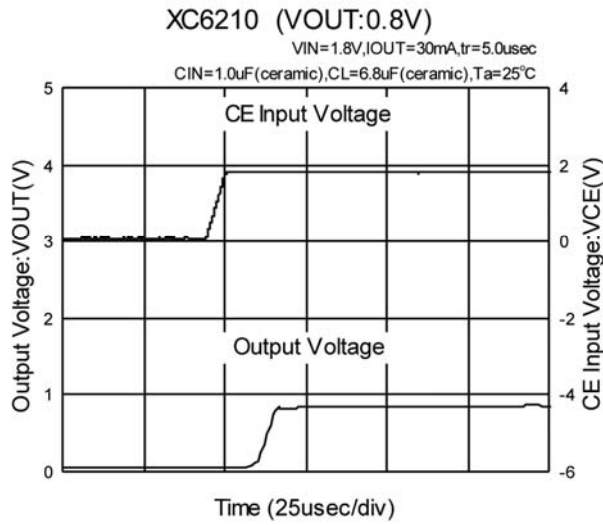
## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (10) Ripple Rejection Rate



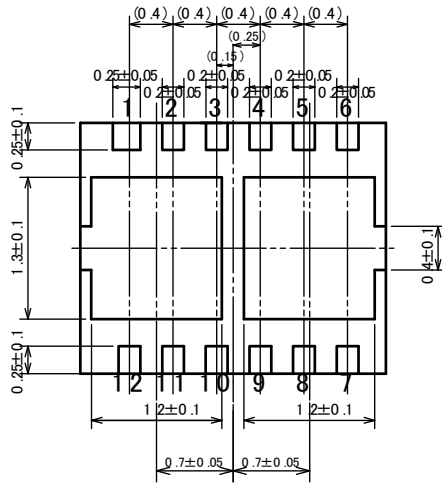
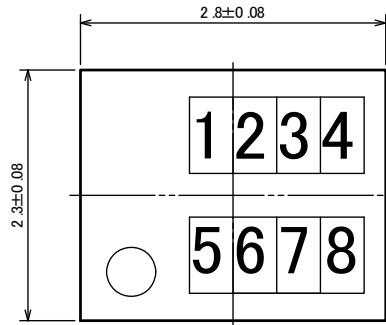
## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(11) CE Rise Time



# PACKAGING INFORMATION

USP-12B01



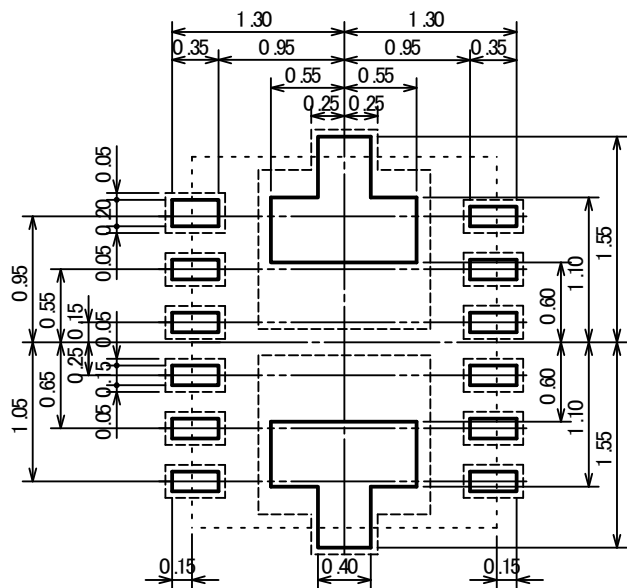
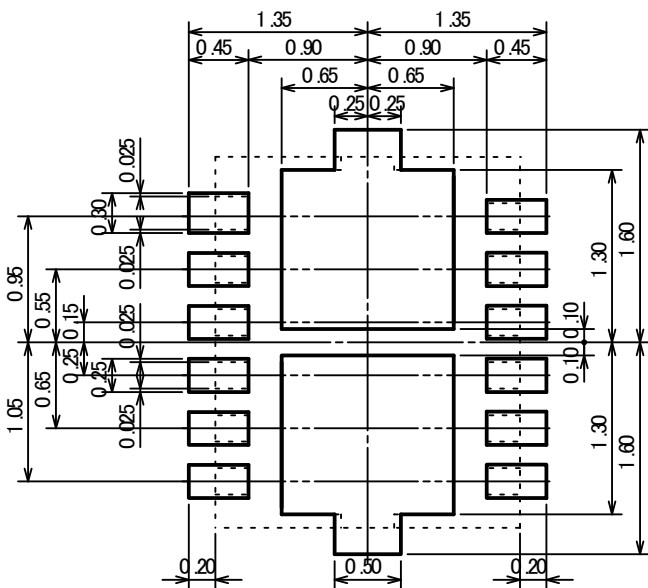
Lead Treatment: Au 0.3 μm Min.

- \*1: Soldering fillet surface is not formed because the sides of the pins are not plated.
- \*2: Pin No. 1 is wider than the other pins.

20/1 Unit : mm

USP-12B01 Reference Pattern Layout

USP-12B01 Reference Metal Mask Design



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