

- Low Power Consumption : 25 $\mu$ A (TYP.)
- Dropout Voltage : 30mV @ 60mA  
: 100mV @ 200mA
- Output Current : 150mA (XC6209A ~D series)  
: 300mA (XC6209E ~H series)
- Highly Accurate :  $\pm 2\%$  ( $\pm 30$ mV less than 1.5V)
- Output Voltage Range : 0.9V ~ 6.0V (50mV Step)
- Low ESR capacitor compatible

### GENERAL DESCRIPTION

The XC6209 series are precise, low noise, positive voltage LDO regulators manufactured using CMOS processes. The series achieves high ripple rejection and low dropout and consists of a voltage reference, an error amplifier, a current limiter and a phase compensation circuit plus a driver transistor.

Output voltage is selectable in 50mV increments within a range of 0.9V ~ 6.0V.

The series is also compatible with low ESR ceramic capacitors which give added output stability. This stability can be maintained even during load fluctuations due to the excellent transient response of the series.

The current limiter's foldback circuit also operates as a short protect for the output current limiter and the output pin.

The CE function enables the output to be turned off, resulting in greatly reduced power consumption.

### APPLICATIONS

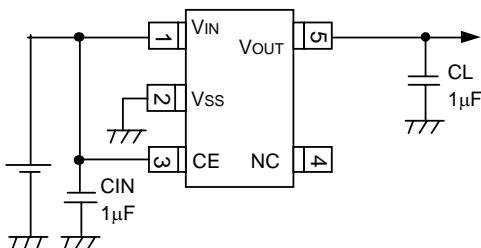
- Mobile phones, Cordless phones
- Wireless communication equipment
- Portable games
- Cameras, Video recorders
- Portable AV equipment
- Reference voltage
- Battery powered equipment

### FEATURES

Maximum Output Current (*)	: 150mA (XC6209A ~ D series) : 300mA (XC6209E ~ H series)
Dropout Voltage	: 200mV @ IOUT=100mA
Operating Voltage Range	: 2.0V ~ 10V
Output Voltage Range	: 0.9V ~ 6.0V (50mV Step)
Highly Accurate	: $\pm 2\%$ (VOUT>1.5V) : $\pm 30$ mV (VOUT $\leq$ 1.5V)
Low Power Consumption	: 25 $\mu$ A (TYP.)
Standby Current	: Less than 0.1 $\mu$ A (TYP.)
High Ripple Rejection	: 70dB (10kHz)
Operating Temperature Range	: - 40°C ~ + 85°C
Low ESR Capacitor Compatible	: Ceramic capacitor
Ultra Small Packages	: SOT-25 SOT-89-5 USP-6B

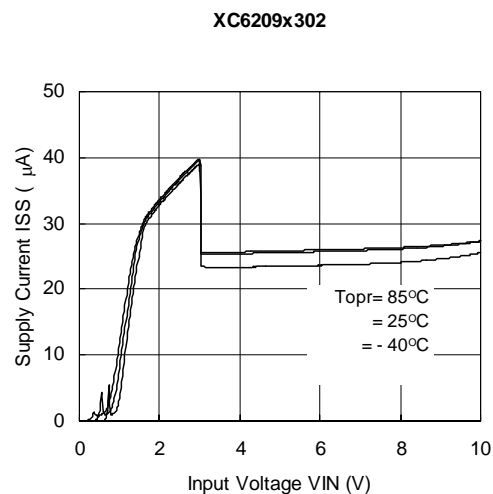
\* Maximum output current of the XC6209E ~ H series depends on the setting voltage.

### TYPICAL APPLICATION CIRCUIT



### TYPICAL PERFORMANCE CHARACTERISTICS

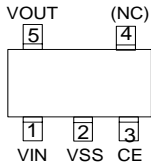
- Supply Current vs. Input Voltage



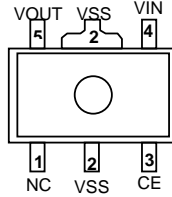
# XC6209 Series

High Speed LDO Regulators, Low ESR Cap. Compatible, Output On/Off Control

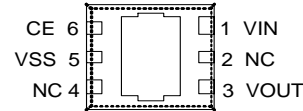
## PIN CONFIGURATION



SOT-25 (TOP VIEW)



SOT-89 (TOP VIEW)



USP-6B (BOTTOM VIEW)

\*Please do not connect a heat dissipation pad to the circuitry. If the pad needs to be connected to the circuitry, it should be connected to the VSS pin.

## PIN ASSIGNMENT

PIN NUMBER			PIN NAME	FUNCTION
SOT-25	SOT-89-5	USP-6B		
1	4	1	VIN	Input
2	2	5	VSS	Ground
3	3	6	CE	ON/OFF Control
4	1	2, 4	NC	No Connection
5	5	3	VOUT	Output

## SELECTION GUIDE

The following options for the CE pin logic and internal pull-up/down are available:

- High Active + no pull-down resistor built-in (standard)
- High Active + 2.0MΩ pull-down resistor built-in <between CE-VSS> (semi-custom)
- Low Active + no pull-up resistor built-in (semi-custom)
- Low Active + 2.0MΩ pull-up resistor built-in <between VIN-CE> (semi-custom)

Note: \*With the pull-up resistor or pull-down resistor built-in types, the supply current during operation will increase by  $V_{IN} / 2.0M\Omega$  (TYP.).

## ORDERING INFORMATION

### XC6209①②③④⑤⑥

DESIGNATOR	SYMBOL	DESCRIPTION	DESIGNATOR	SYMBOL	DESCRIPTION
① (*Note1)	A / E	High Active (pull-down resistor built in, semi-custom)	④	2	Output Voltage : 100mV Step Accuracy : within $\pm 2\%$ (*Note2) e.g. ②=2, ③=8, ④=2 $\Rightarrow$ 2.80V
	B / F	High Active (no pull-down resistor built in, standard)		A	Output Voltage : 50mV Step Accuracy : within $\pm 2\%$ (*Note 2) e.g. ②=2, ③=8, ④=A $\Rightarrow$ 2.85V
	C / G	Low Active (pull-up resistor built in, semi-custom)	⑤	M	Package Type : SOT-25 SOT-89 USP - 6B
	D / H	Active 'Low' (no pull-up resistor built in, stanard)		P	
② ③	Integer	Output Voltage : e.g. 3.0V = ② : 3, ③ : 0	⑥	D	
				R	
				L	

(Note 1) Maximum output current of the XC6209E ~ H series depend on the setting voltage.

(Note 2) Within  $\pm 30mV$  ( $V_{OUT} \leq 1.5V$ )



# XC6209 Series

High Speed LDO Regulators, Low ESR Cap. Compatible, Output On/Off Control

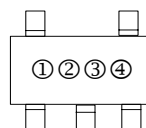
## MARKING RULE

### ○ SOT-25 & SOT-89-5

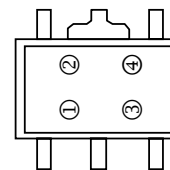
① Represents product series

SYMBOL	PRODUCT SERIES
9	XC6209xxxxx

\* Sequential number for custom products (0 to 9 or A to Z)



SOT-25  
(TOP VIEW)



SOT-89-5  
(TOP VIEW)

② Represents the type of voltage regulator

SYMBOL				PRODUCT SERIES
VOUT 100mV STEPS		VOUT 50mV STEPS		
VOUT= 0.1~3.0V	VOUT= 3.1~6.0V	VOUT= 0.15~3.05V	VOUT= 3.15~6.05V	
V	A	E	L	XC6209Axxxxx
X	B	F	M	XC6209Bxxxxx
Y	C	H	N	XC6209Cxxxxx
Z	D	K	P	XC6209Dxxxxx
<u>V</u>	<u>A</u>	<u>E</u>	<u>L</u>	XC6209Exxxxx
<u>X</u>	<u>B</u>	<u>F</u>	<u>M</u>	XC6209Fxxxxx
<u>Y</u>	<u>C</u>	<u>H</u>	<u>N</u>	XC6209Gxxxxx
<u>Z</u>	<u>D</u>	<u>K</u>	<u>P</u>	XC6209Hxxxxx

③ Represents output voltage

SYMBOL	OUTPUT VOLTAGE (V)				SYMBOL	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	5.05
5	-	3.60	-	3.65	N	2.10	5.10	2.15	5.15
6	-	3.70	-	3.75	P	2.20	5.20	2.25	5.25
7	-	3.80	-	3.85	R	2.30	5.30	2.35	5.35
8	0.90	3.90	0.95	3.95	S	2.40	5.40	2.45	5.45
9	1.00	4.00	1.05	4.05	T	2.50	5.50	2.55	5.55
A	1.10	4.10	1.15	4.15	U	2.60	5.60	2.65	5.65
B	1.20	4.20	1.25	4.25	V	2.70	5.70	2.75	5.75
C	1.30	4.30	1.35	4.35	X	2.80	5.80	2.85	5.85
D	1.40	4.40	1.45	4.45	Y	2.90	5.90	2.95	5.95
E	1.50	4.50	1.55	4.55	Z	3.00	6.00	3.05	-

④ Represents production lot number

0 to 9, A to Z, reversed character of 0 to 9 and A to Z repeated (G, I, J, O, Q excepted)

# XC6209 Series

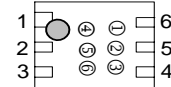
High Speed LDO Regulators, Low ESR Cap. Compatible, Output On/Off Control

## MARKING RULE (Continued)

○ USP-6B

① ② Represents product series

SYMBOL		PRODUCT SERIES
①	②	
0	9	XC6209AxxxDx



USP-6B  
(TOP VIEW)

③ Represents the type of voltage regulator

SYMBOL	TYPE	PRODUCT SERIES
A	CE Pin, High Active with pull-down resistor	XC6209AxxxDx
B	CE Pin, High Active with no pull-down resistor	XC6209BxxxDx
C	CE Pin, High Active with pull-up resistor	XC6209CxxxDx
D	CE Pin, High Active with no pull-up resistor	XC6209DxxxDx

④ Represents the integer of output voltage

SYMBOL	TYPE	PRODUCT SERIES
3	3.X	XC6209x3xxDx
5	5.X	XC6209x5xxDx

⑤ Represents the decimal point of output voltage

SYMBOL	OUTPUT VOLTAGE (V)		SYMBOL	OUTPUT VOLTAGE (V)	
0	X.0	XC6209xx0xDx	A	X.05	XC6209xx0ADx
1	X.1	XC6209xx1xDx	B	X.15	XC6209xx1ADx
2	X.2	XC6209xx2xDx	C	X.25	XC6209xx2ADx
3	X.3	XC6209xx3xDx	D	X.35	XC6209xx3ADx
4	X.4	XC6209xx4xDx	E	X.45	XC6209xx4ADx
5	X.5	XC6209xx5xDx	F	X.55	XC6209xx5ADx
6	X.6	XC6209xx6xDx	H	X.65	XC6209xx6ADx
7	X.7	XC6209xx7xDx	K	X.75	XC6209xx7ADx
8	X.8	XC6209xx8xDx	L	X.85	XC6209xx8ADx
9	X.9	XC6209xx9xDx	M	X.95	XC6209xx9ADx

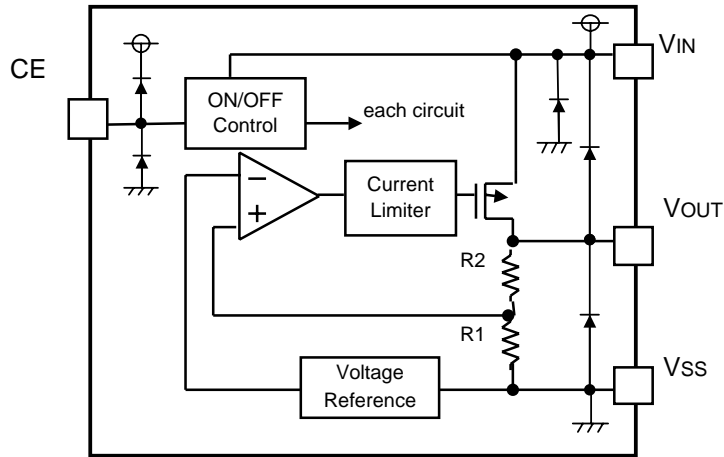
④ Represents production lot number

0 to 9, A to Z, reversed character of 0 to 9 and A to Z repeated (G,I,J,O,Q excepted)

# XC6209 Series

High Speed LDO Regulators, Low ESR Cap. Compatible, Output On/Off Control

## ■ BLOCK DIAGRAM



## ■ ABSOLUTE MAXIMUM RATINGS

Ta=25°C

PARAMETER	SYMBOL	RATINGS	UNITS
Input Voltage	VIN	12	V
Output Current	IOUT	500	mA
Output Voltage	VOUT	VSS -0.3 ~ VIN +0.3	V
CE Input Voltage	VCE	VSS -0.3 ~ VIN +0.3	V
Power Dissipation	SOT-25	Pd	250
	SOT-89-5		500
	USP-6B		100
Operating Temperature Range	Topr	- 40 ~ + 85	°C
Storage Temperature Range	Tstg	- 55 ~ + 125	°C

\* IOUT should be less than Pd / (VIN - VOUT)

### ELECTRICAL CHARACTERISTICS

XC6209B Series

Ta=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	CIRCUIT
Output Voltage	VOUT (E)	IOUT=30mA (1.55V~)	× 0.98	VOUT(T)	× 1.02	V	①
		IOUT=30mA (0.9 ~ 1.5V)	- 0.03		+ 0.03		
Maximum Output Current	IOUTMAX		150	-	-	mA	①
Load Regulation	ΔVOUT	1mA ≤ IOUT ≤ 100mA	-	15	50	mV	①
Dropout Voltage	Vdif1	IOUT=30mA	E-2 (page 9)			mV	①
	Vdif2	IOUT=100mA	E-3 (page 9)			mV	
Supply Current	IDD	VCE=VIN	-	25	50	μA	②
Standby Current	Istby	VCE=VSS	-	0.01	0.10	μA	②
Line Regulation	$\frac{\Delta VOUT}{\Delta VIN \cdot VOUT}$	VOUT(T)+1.0V ≤ VIN ≤ 10V IOUT=30mA (VOUT > 1.0V)	-	0.01	0.20	% / V	①
		2.0V ≤ VIN ≤ 10V IOUT=30mA (VOUT ≤ 1.0V)					
Input Voltage	VIN		2	-	10	V	-
Output Voltage Temperature Characteristics	$\frac{\Delta VOUT}{\Delta T_{opr} \cdot VOUT}$	IOUT=30mA -40°C ≤ Topr ≤ 85°C	-	100	-	ppm/°C	①
Ripple Rejection Rate	PSRR	IOUT=50mA, f=10kHz	-	70	-	dB	④
Current Limiter	Ilim		-	300	-	mA	①
Short-circuit Current	Ishort		-	50	-	mA	①
CE "High" Voltage	VCEH		1.60	-	VIN	V	①
CE "Low" Voltage	VCEL		-	-	0.25	V	②
CE "High" Current	ICEH	VCE=VIN	-0.10	-	0.10	μA	②
CE "Low" Current	ICEL	VCE=VSS	-0.10	-	0.10	μA	②

(NOTE 1) VOUT(T)=Specified Output Voltage

(NOTE 2) VOUT(E)=Effective Output Voltage

(I.e. the output voltage when "VOUT(T)+1.0V" is provided at the VIN pin while maintaining a certain IOUT value).

(NOTE 3)  $V_{dif} = \{VIN1^{(NOTE5)} - VOUT1^{(NOTE4)}\}$

(NOTE 4) VOUT1=A voltage equal to 98% of the Output Voltage whenever an amply stabilized IOUT {VOUT(T)+1.0V} is input.

(NOTE 5) VIN1=The Input Voltage when VOUT1 appears as Input Voltage is gradually decreased.

(NOTE 6) Unless otherwise stated, VIN=VOUT(T)+1.0V. If VOUT is less than 1.0V, VIN=2.0V.

### ELECTRICAL CHARACTERISTICS

XC6209F Series

Ta=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	CIRCUIT
Output Voltage	VOUT (E)	IOUT=30mA (1.55V~)	× 0.98	VOUT(T)	× 1.02	V	①
		IOUT=30mA (0.9 ~ 1.5V)	- 0.03		+ 0.03		
Maximum Output Current	IOUTMAX		E-1 (page 9)			mA	①
Load Regulation	ΔVOUT	1mA ≤ IOUT ≤ 100mA	-	15	50	mV	①
Dropout Voltage	Vdif1	IOUT=30mA	E-2 (page 9)			mV	①
	Vdif2	IOUT=100mA	E-3 (page 9)			mV	
Supply Current	IDD	VCE=VIN	-	25	50	μA	②
Standby Current	Istby	VCE=VSS	-	0.01	0.10	μA	②
Line Regulation	$\frac{\Delta VOUT}{\Delta VIN \cdot VOUT}$	VOUT(T)+1.0V ≤ VIN ≤ 10V IOUT=30mA (VOUT>1.0V)	-	0.01	0.20	% / V	①
		2.0V ≤ VIN ≤ 10V IOUT=30mA (VOUT ≤ 1.0V)					
Input Voltage	VIN		2	-	10	V	-
Output Voltage Temperature Characteristics	$\frac{\Delta VOUT}{\Delta T_{opr} \cdot VOUT}$	IOUT=30mA -40°C ≤ Topr ≤ 85°C	-	100	-	ppm/°C	①
Ripple Rejection Rate	PSRR	IOUT=50mA, f=10kHz	-	70	-	dB	④
Current Limiter	Ilim		-	380	-	mA	①
Short-circuit Current	Ishort		-	50	-	mA	①
CE "High" Voltage	VCEH		1.60	-	VIN	V	①
CE "Low" Voltage	VCEL		-	-	0.25	V	②
CE "High" Current	ICEH	VCE=VIN	-0.10	-	0.10	μA	②
CE "Low" Current	ICEL	VCE=VSS	-0.10	-	0.10	μA	②

(NOTE 1) VOUT(T)=Specified Output Voltage

(NOTE 2) VOUT(E)=Effective Output Voltage

(I.e. the output voltage when "VOUT(T)+1.0V" is provided at the VIN pin while maintaining a certain IOUT value).

(NOTE 3)  $V_{dif} = \{VIN1^{(NOTE5)} - VOUT1^{(NOTE4)}\}$

(NOTE 4) VOUT1=A voltage equal to 98% of the Output Voltage whenever an amply stabilized IOUT (VOUT(T)+1.0V) is input.

(NOTE 5) VIN1=The Input Voltage when VOUT1 appears as Input Voltage is gradually decreased.

(NOTE 6) Unless otherwise stated, VIN=VOUT(T)+1.0V. If VOUT is less than 1.0V, VIN=2.0V.



## ■ MAXIMUM OUTPUT CURRENT, OUTPUT VOLTAGE

XC6209E ~ H series

E-1		
OUTPUT VOLTAGE (V)	CONDITION	IOUTMAX (mA)
		MIN
0.90 ~ 0.95	VIN = 2.5V	260
1.00 ~ 1.05	VIN = 2.5V	260
1.10 ~ 1.15	VIN = 2.6V	270
1.20 ~ 1.25	VIN = 2.7V	290
1.30 ~ 1.35	VIN = 2.8V	300
1.40 ~ 1.45	VIN = 2.9V	
1.50 ~ 1.95	VIN = 3.0V	
2.00 ~ 6.00	VIN = VOUT + 1.0V	

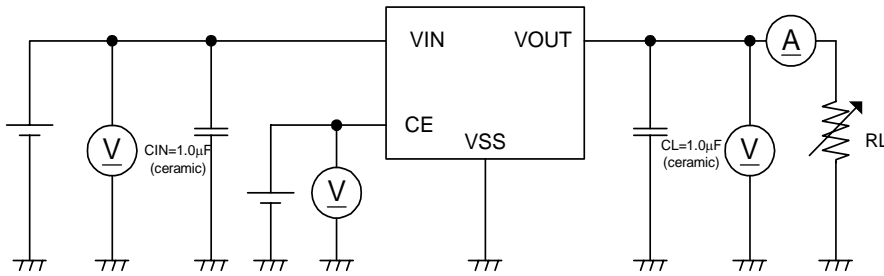
## ■ DROPOUT VOLTAGE

SYMBOL PARAMETER	E-2			E-3		
	Dropout Voltage 1 (mV)			Dropout Voltage 2 (mV)		
	MIN	TYP	MAX	MIN	TYP	MAX
OUTPUT VOLTAGE						
0.90 ~ 0.95	1100	1100	1110	1100	1150	1200
1.00 ~ 1.05	1000	1000	1010	1000	1050	1100
1.10 ~ 1.15	900	900	910	900	950	1000
1.20 ~ 1.25	800	800	810	800	850	900
1.30 ~ 1.35	700	700	710	700	750	800
1.40 ~ 1.45	600	600	610	600	650	700
1.50 ~ 1.55	500	500	510	500	550	600
1.60 ~ 1.65	400	400	410	400	500	550
1.70 ~ 1.75	300	300	310	300	400	450
1.80 ~ 1.85	200	200	210	200	300	400
1.90 ~ 1.95	100	120	150	100	280	380
2.00 ~ 2.05	-	80	120	-	240	350
2.10 ~ 2.25	-	80	120	-	240	330
2.30 ~ 2.45	-	80	120	-	240	310
2.50 ~ 2.75	-	70	100	-	220	290
2.80 ~ 2.95	-	70	100	-	220	270
3.00 ~ 3.05	-	60	90	-	200	270
3.10 ~ 3.95	-	60	90	-	200	250
4.00 ~ 4.95	-	60	80	-	180	230
5.00 ~ 6.00	-	50	70	-	160	210

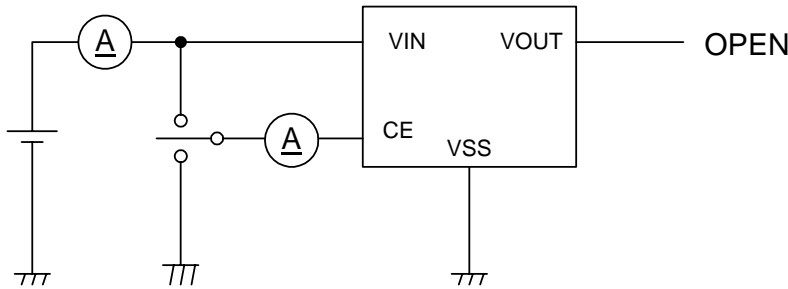
\* The input voltage 2.0V (MIN.) is needed to operate the series. When the output voltage is less than 2.0V, 2.0V-VOUT(T) of dropout voltage is needed at minimum.

## TEST CIRCUITS

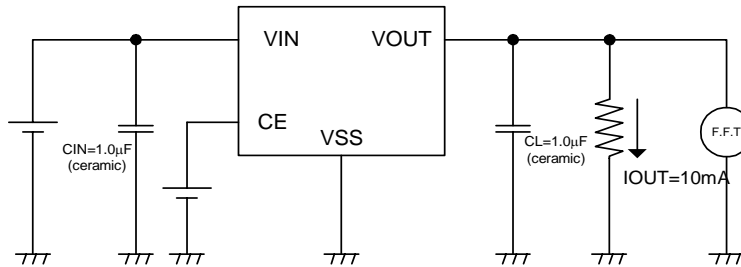
Circuit ①



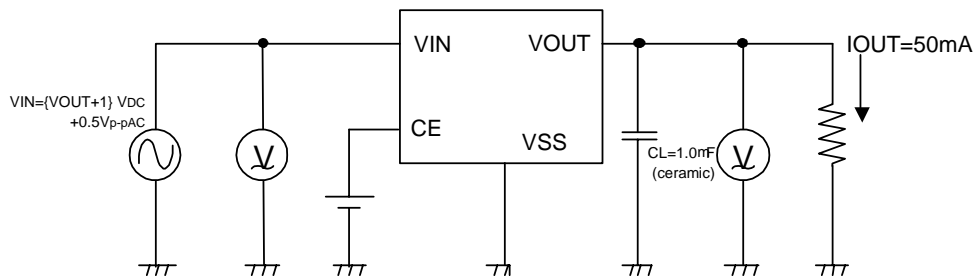
Circuit ②



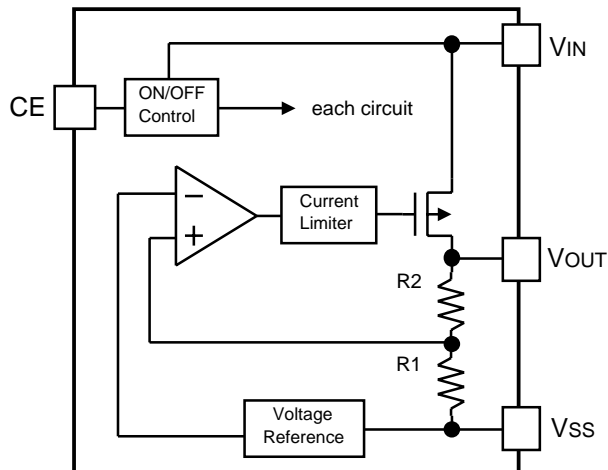
Circuit ③



Circuit ④



### ■ OPERATIONAL EXPLANATION



Output voltage control with the XC6209 series :

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 VOUT pin, is then driven by the subsequent output signal. The output voltage at the VOUT 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.

#### Low ESR Capacitors

With the XC6209 series, a stable output voltage is achievable even if used with low ESR capacitors as a phase compensation circuit is built-in. In order to ensure the effectiveness of the phase compensation, we suggest that an output capacitor (CL) is connected as close as possible to the output pin (VOUT) and the VSS pin. Please use an output capacitor with a capacitance value of at least 1  $\mu\text{F}$ . Also, please connect an input capacitor (CIN) of 0.1  $\mu\text{F}$  between the VIN pin and the VSS pin in order to ensure a stable power input.

#### Current Limiter, Short-Circuit Protection

The XC6209 series includes a combination of a fixed current limiter circuit & a foldback circuit which aid the operations of the current limiter and circuit protection. 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, output voltage drops further and output current decreases. When the output pin is shorted, a current of about 50mA flows.

#### CE Pin

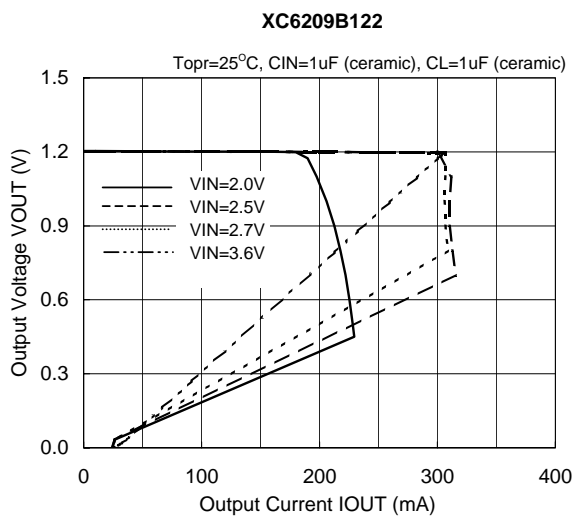
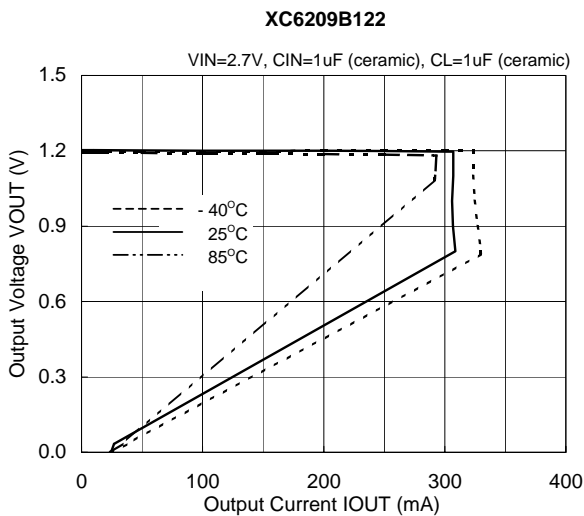
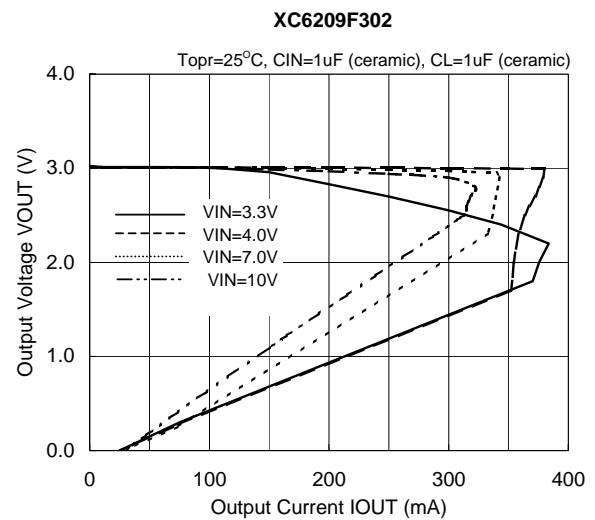
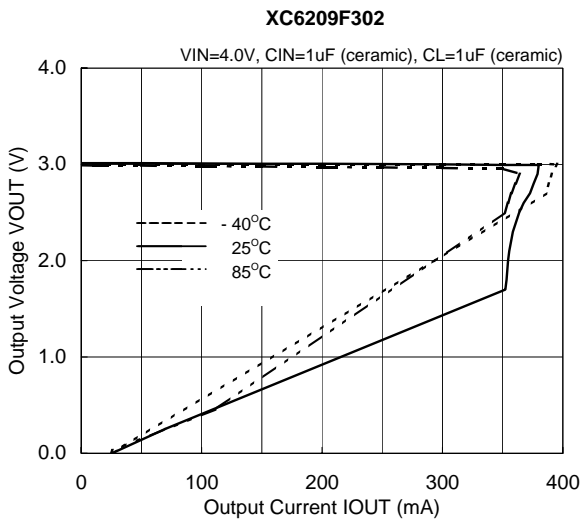
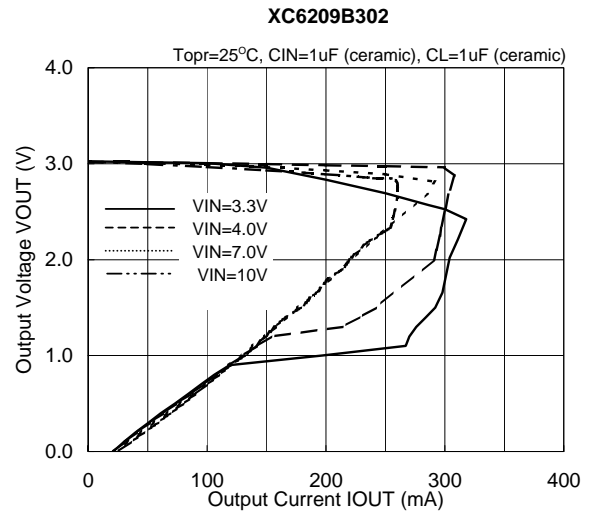
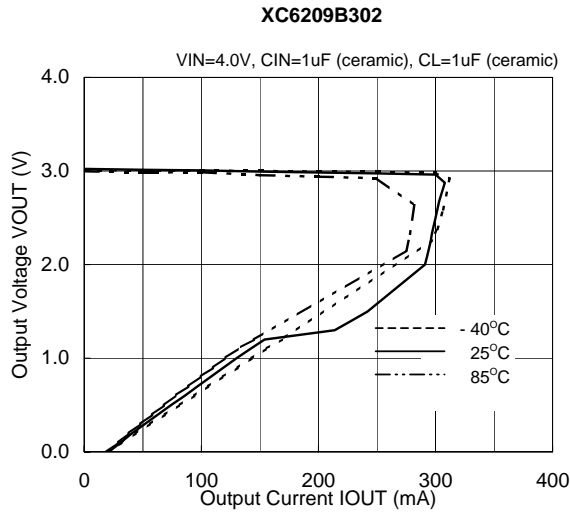
The IC's internal circuitry can be shutdown via the signal from the CE pin with the XC6209 series. In shutdown mode, output at the VOUT pin will be pulled down to the VSS level via R1 & R2. The operational logic of the IC's CE pin is selectable (please refer to the selection guide on page 3). Note that as the standard XC6209B/F type is '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.

### ■ 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.

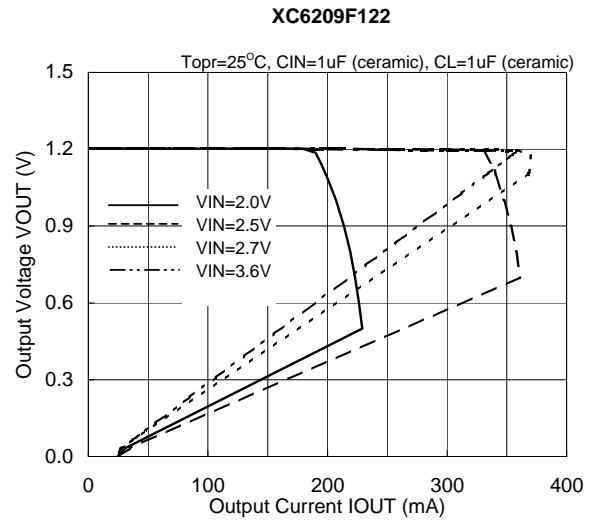
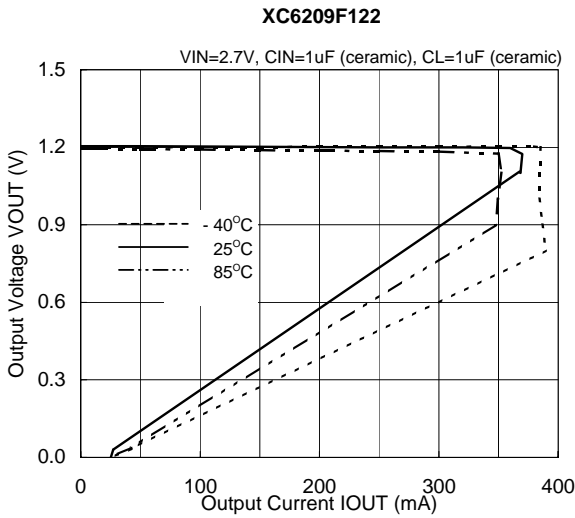
### TYPICAL PERFORMANCE CHARACTERISTICS

(1) Output Voltage vs. Output Current

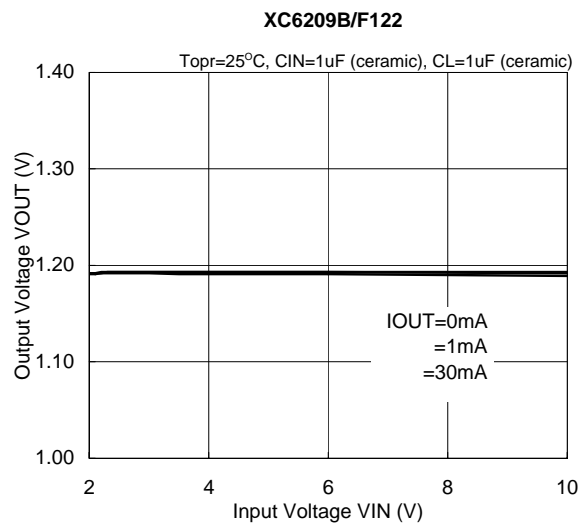
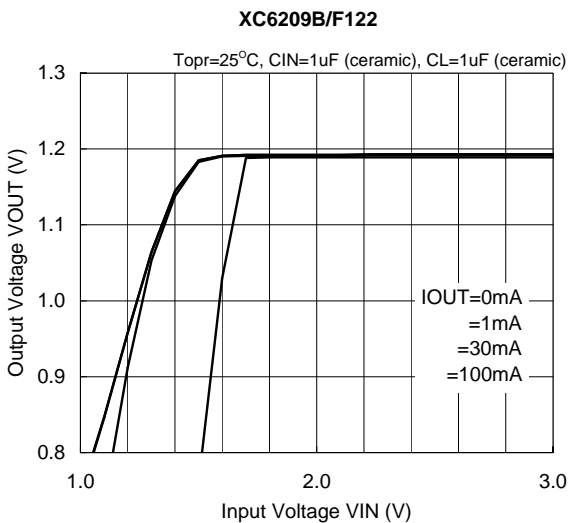
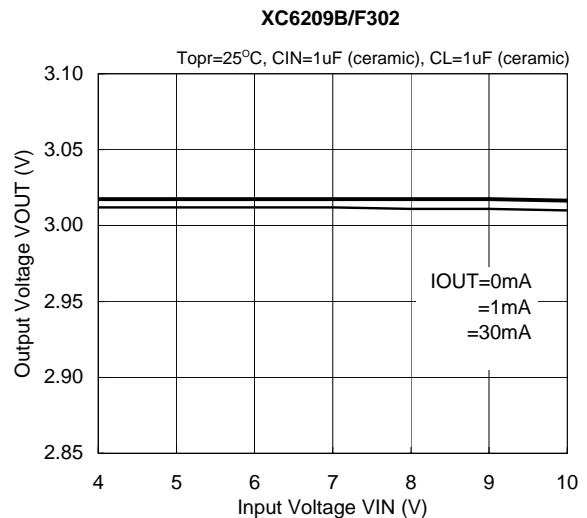
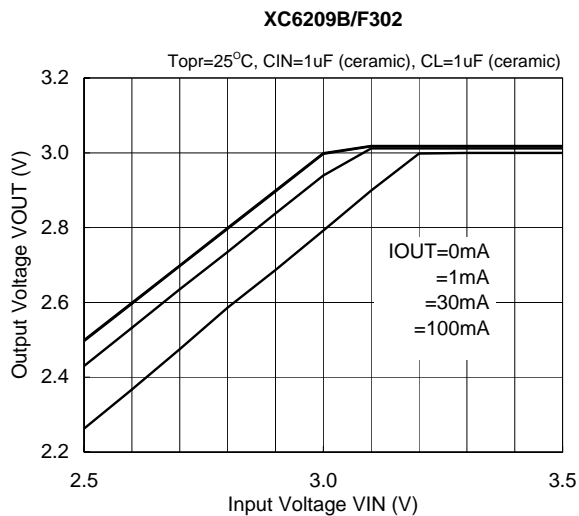


### TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

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

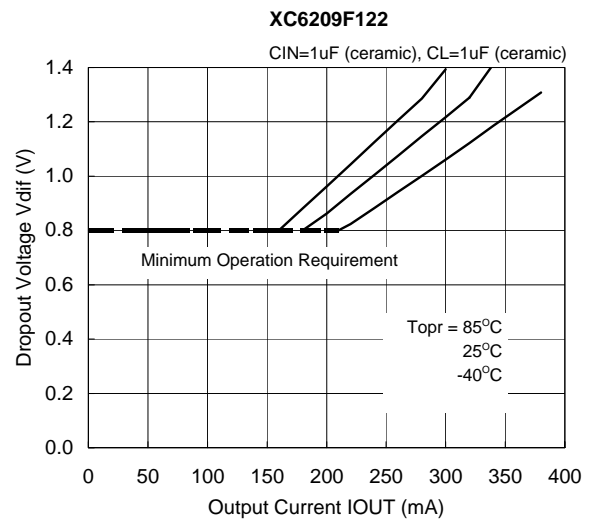
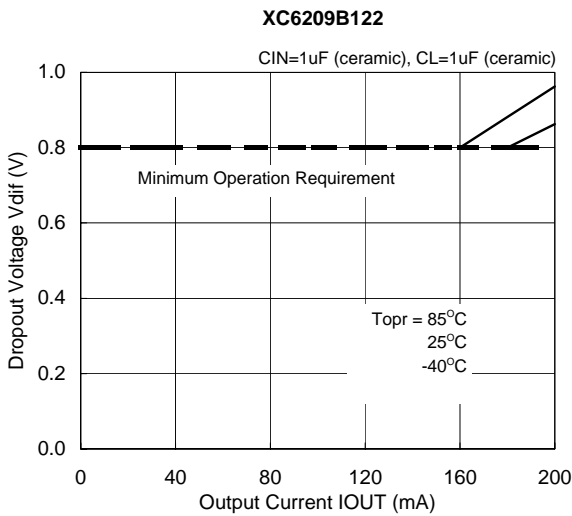
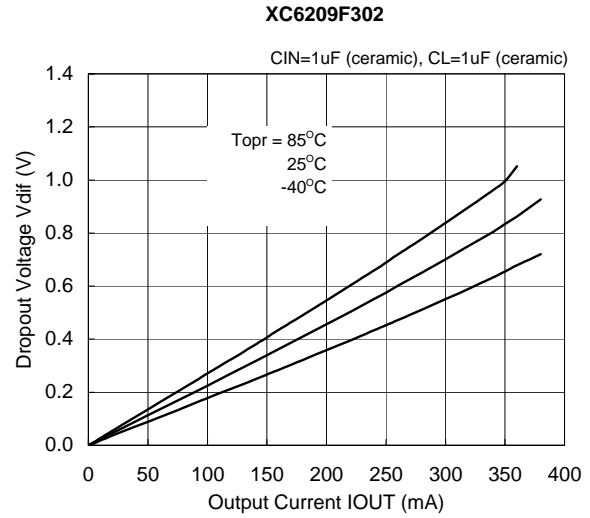
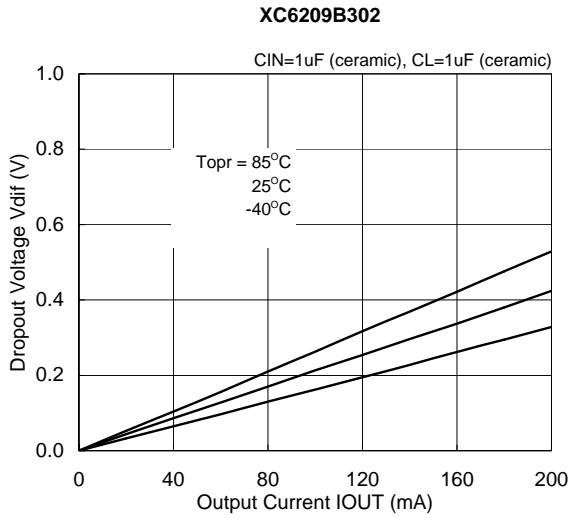


(2) Output Voltage vs. Input Voltage

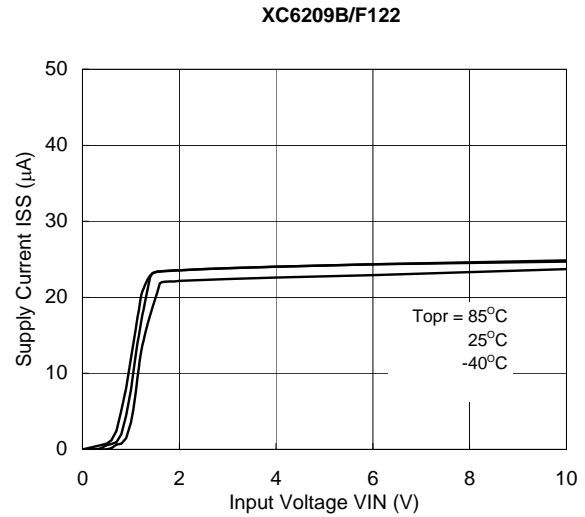
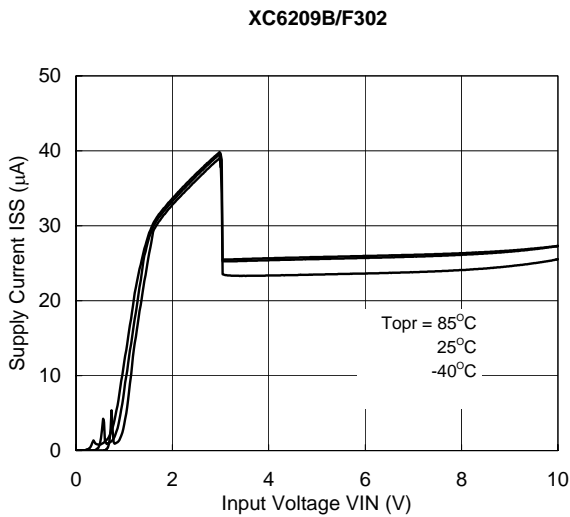


### ■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(3) Dropout Voltage vs. Output Current

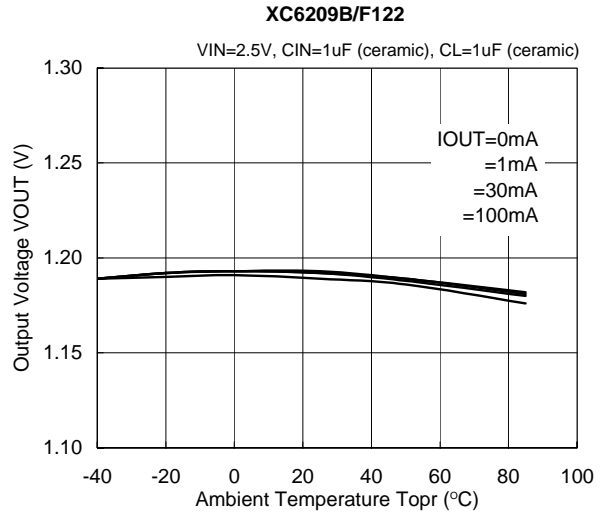
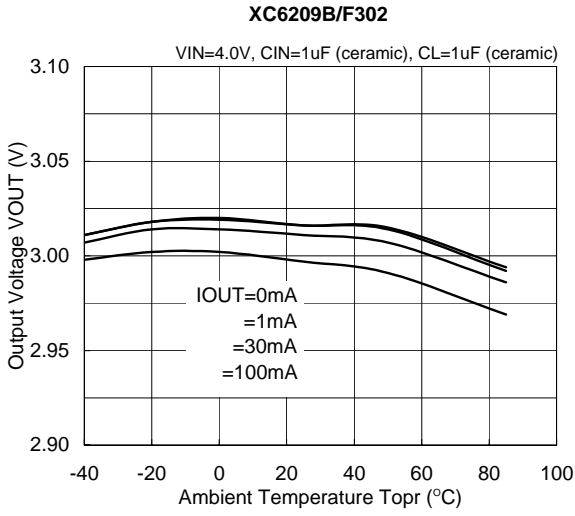


(4) Supply Current vs. Input Voltage

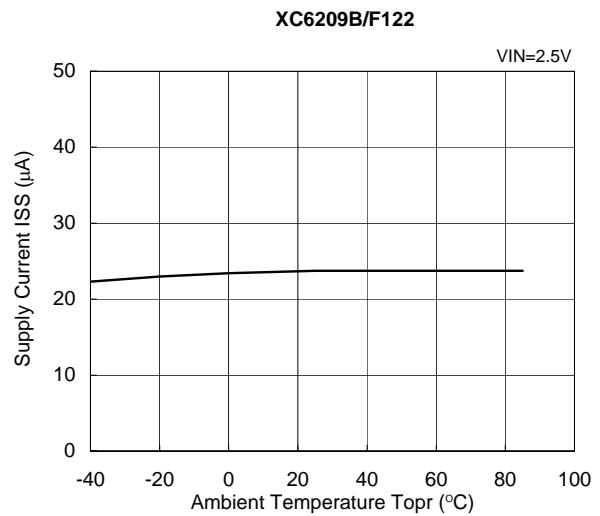
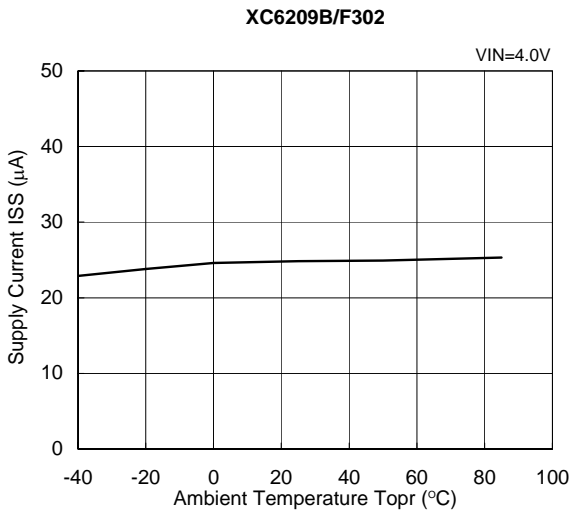


## ■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

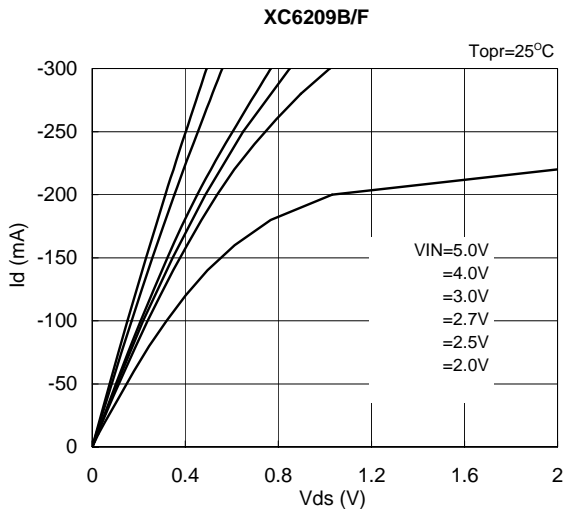
(5) Output Voltage vs. Ambient Temperature



(6) Supply Current vs. Ambient Temperature

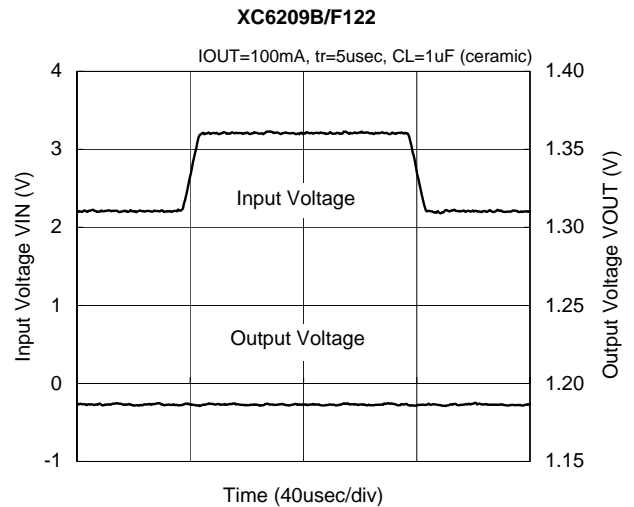
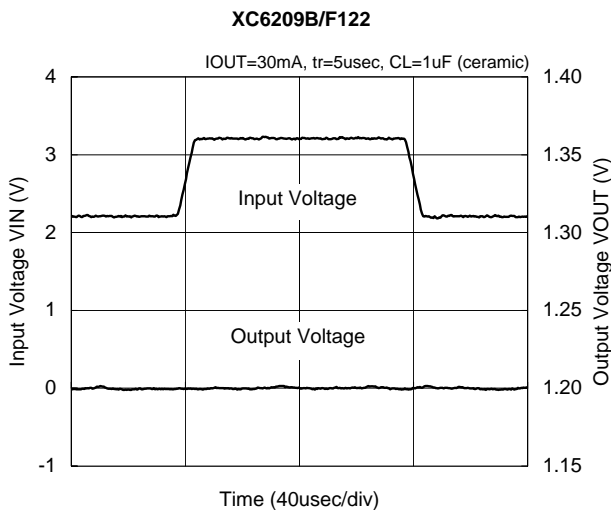
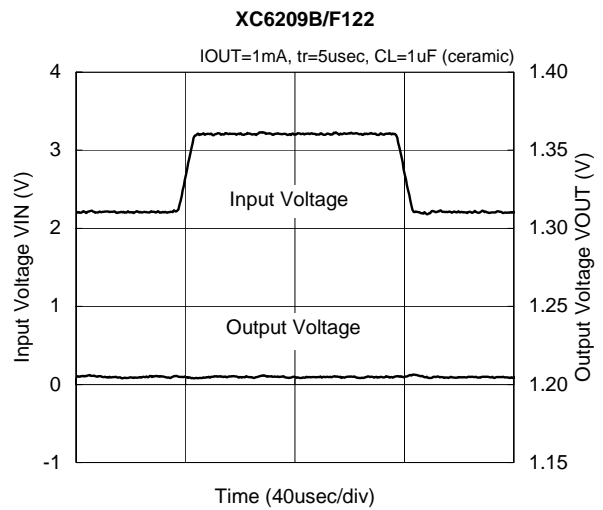
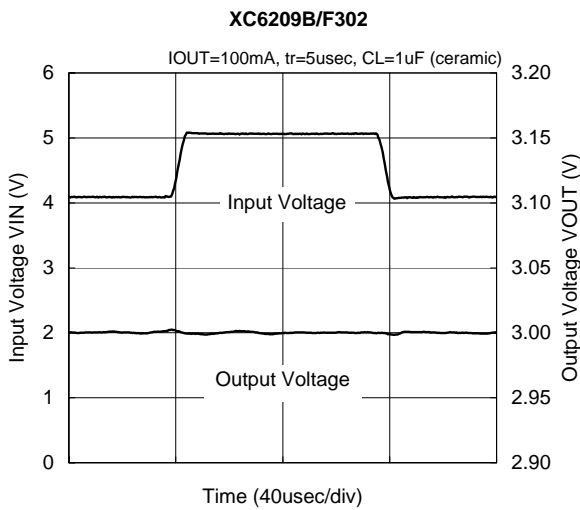
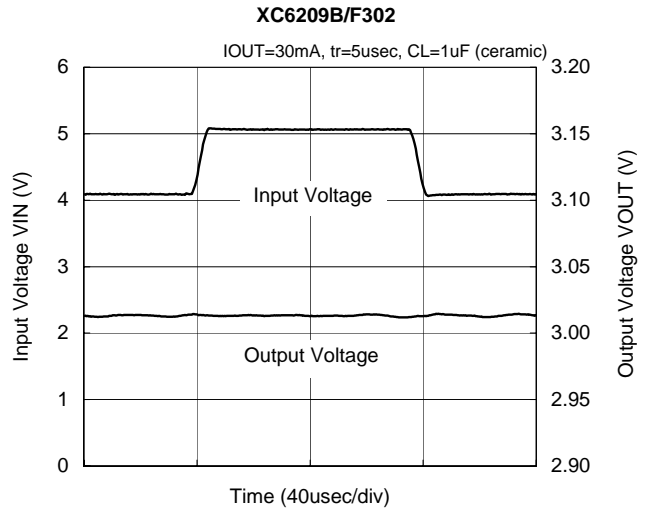
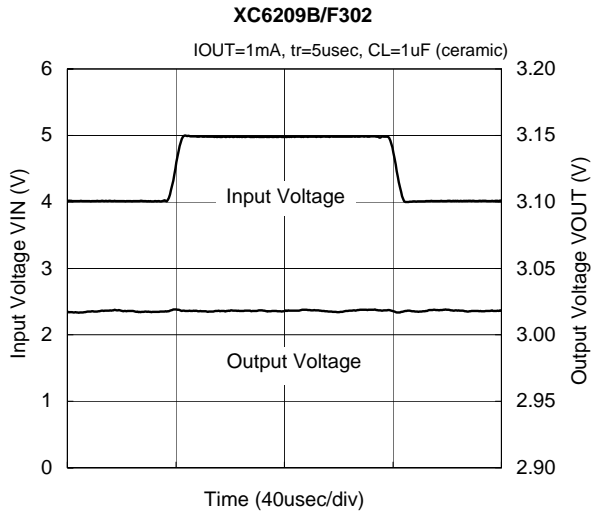


(7) P-ch Driver Transistor Characteristics



## ■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

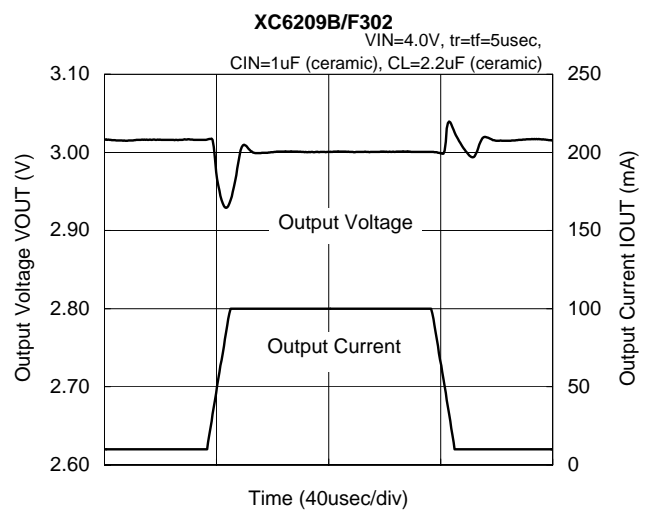
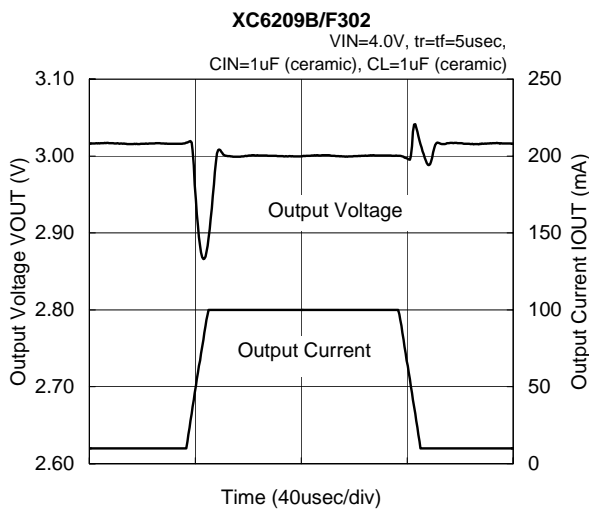
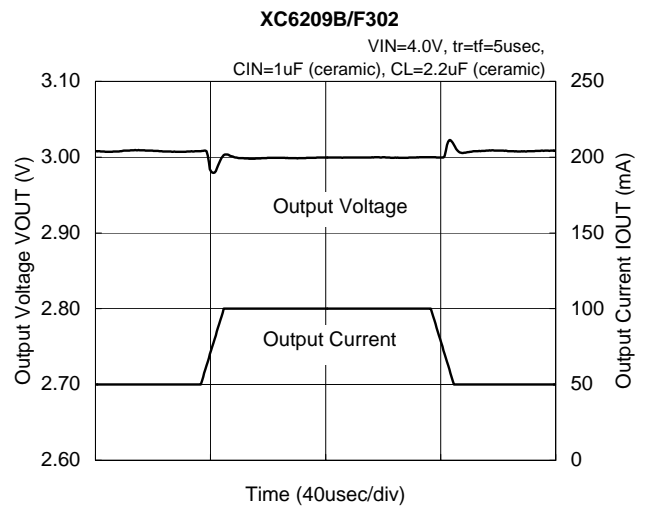
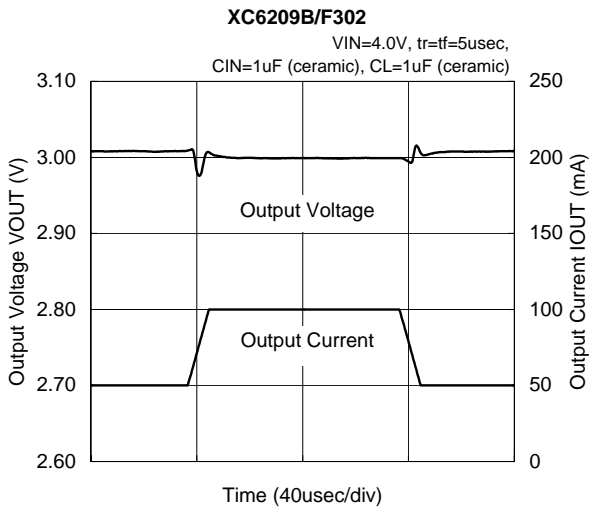
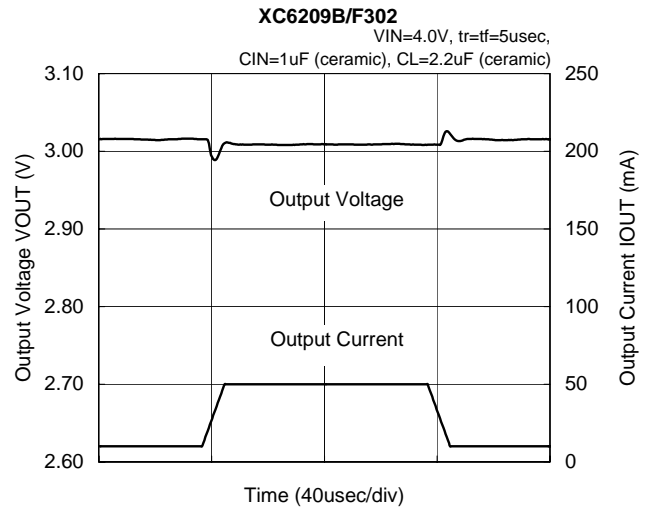
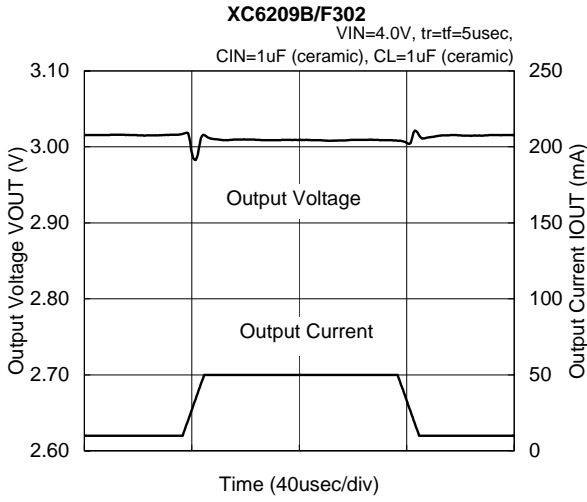
### (8) Input Transient Response





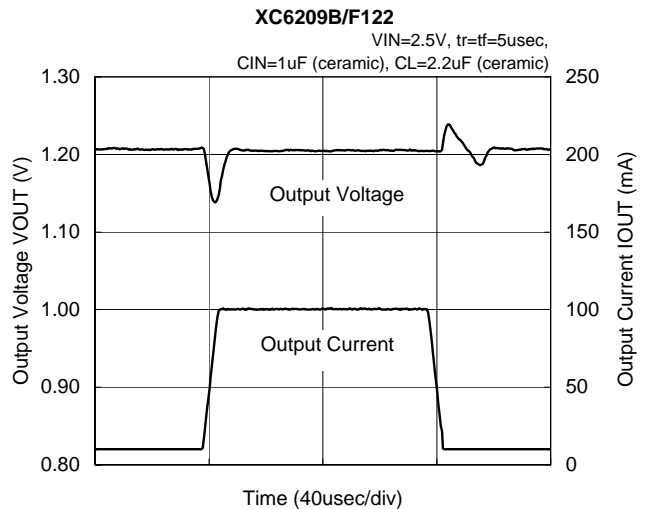
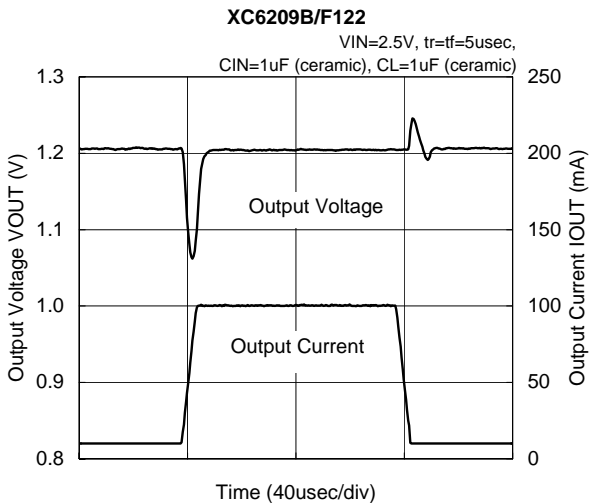
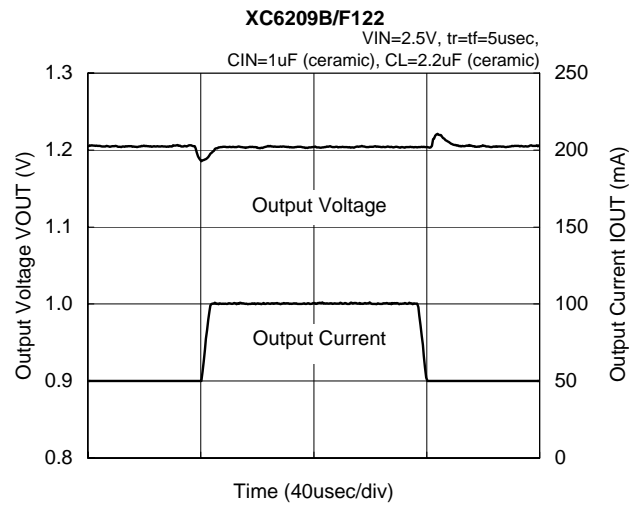
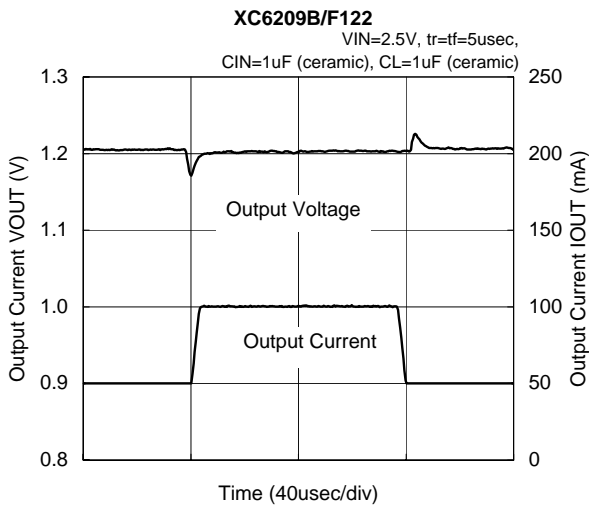
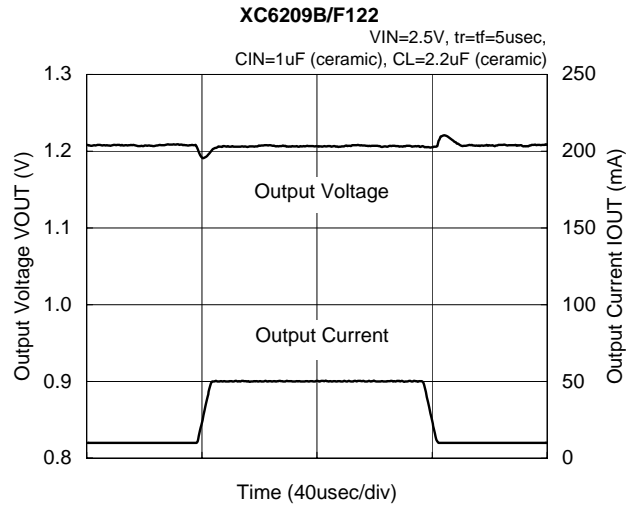
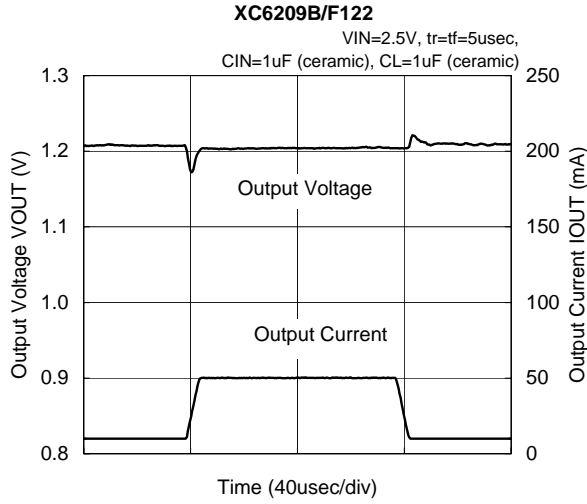
### ■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(9) Load Transient Response



### TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

#### (9) Load Transient Response



## ■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(10) Ripple Rejection Rate

