XC6402 Series

ETR1001_001

High Current, High Speed LDO Regulators, Voltage Detector Function

■GENERAL DESCRIPTION

The XC6402 series are precise, low noise, high current, positive voltage low dropout regulators with built-in voltage detector. They are fabricated using Torex's CMOS process. The series features a voltage reference, an error amplifier, a current limiter, a voltage detector and a phase compensation circuit plus a driver transistor.
The output voltage of the LDO and detect voltage of the detector is selectable in 50mV increments within the range of 0.8V to 5.0V. With a low ON resistance driver transistor built-in, batteries can be used until input-output voltage differential is minimal and can accordingly be used for a longer time.
The series is also compatible with low ESR ceramic capacitors which give added output stability. The series provides options to the user to select from a variety of circuit features, such as detector monitoring, detector output logic, EN pin input logic, and internal pull-up / down resistance (semi-custom). The IC's internal regulator circuit can be placed in stand-by mode via the EN function (XC6402C series). In the stand-by mode, power consumption is greatly reduced. The XC6402F series offers the option of a delay on the detector output: the delay time can be controlled by the use of an external capacitor.

■APPLICATIONS

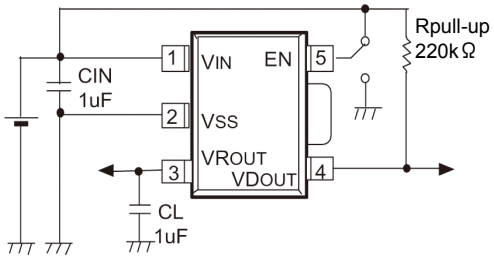
- ●CD-ROM, CD-R / RW drive
- ●DVD drive
- ●HDD drive
- ●Cameras, Video recorders
- ●Portable AV equipment
- ●Battery powered equipment

■FEATURES

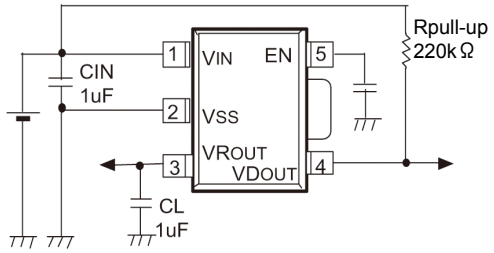
Maximum Output Current	: More than 700mA (800mA limit) (1.6V≦$V_{ROUT(T)}$≦5.0V)
Dropout Voltage	: 50mV @ 100mA 100mV @ 200mA
Maximum Operating Voltage	: 1.5V ~ 6.0V
VR Output Voltage Range	: 0.8V ~ 5.0V (50mV increments)
VD Detect Voltage Range	: 0.8V ~ 5.0V (50mV increments) More than 1.5V (V_{IN} sensing)
Highly Accurate	: ± 2%
Low Power Consumption	: 35μA (TYP.)
High Ripple Rejection	: 60dB @1kHz
Ambient Temperature	: - 40℃ ~ 85℃
Low ESR Capacitor	: Ceramic capacitor compatible
Ultra Small Packages	: SOT-25, SOT-89-5, USP-6B,
	* VD: Voltage Detector

■TYPICAL APPLICATIONS CIRCUITS

●XC6402C Series

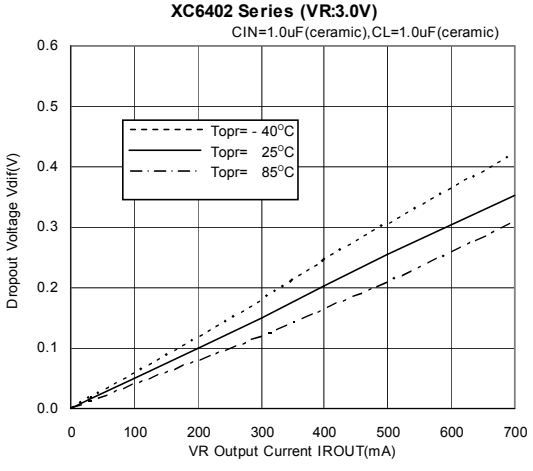


●XC6402F Series

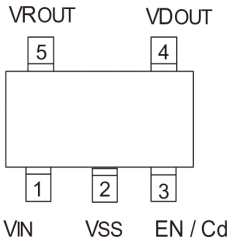


■TYPICAL PERFORMANCE CHARACTERISTICS

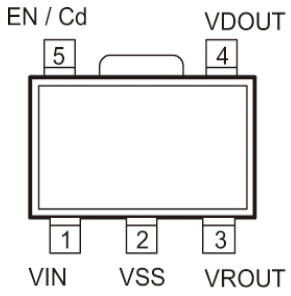
●Dropout Voltage vs. VR Output Current



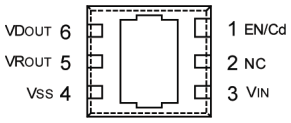
■PIN CONFIGURATION



SOT-25 (TOP VIEW)



SOT-89-5 (TOP VIEW)



USP-6B (BOTTOM VIEW)

*The dissipation pad for the USP-6B package should be solder-plated in recommended mount pattern and metal masking so as to enhance mounting strength and heat release.
If the pad needs to be connected to other pins, it should be connected to the VSS pin.

■PIN ASSIGNMENT

PIN NUMBER			PIN NAME	FUNCTION
SOT-25	SOT-89-5	USP-6B		
1	1	3	VIN	Power Input
2	2	4	VSS	Ground
5	3	5	VROUT	VR Output
4	4	6	VDOUT	VD Output
3	5	1	EN	VR ON/OFF Control (C Series)
3	5	1	Cd	Delay Capacitor Connection (F Series)
-	-	2	NC	No Connection

■PRODUCT CLASSIFICATION

●Selection Guide

1. EN Input Logic, Internal Pull-up / down as option

SERIES	CE INPUT LOGIC
XC6402 * A ~ D	High Active with pull-down resistance
XC6402 * E ~ K	High Active with no pull-down resistance
XC6402 * L ~ P	Low Active with pull-up resistance
XC6402 * R ~ U	Low Active with no pull-up resistance

2. VD Sense as option

SERIES	VD SENSE PIN
XC6402 * A, B, E, F, L, M, R, S, V, X	VIN
XC6402 * C, D, H, K, N, P, T, U, Y, Z	VROUT

3. VD Output Logic as option

SERIES	VD OUTPUT LOGIC
XC6402 * A, C, E, H, L, N, R, T, V, Y	Detect L
XC6402 * B, D, F, K, M, P, S, U, X, Z	Detect H

■PRODUCT CLASSIFICATION (Continued)

●Ordering Information

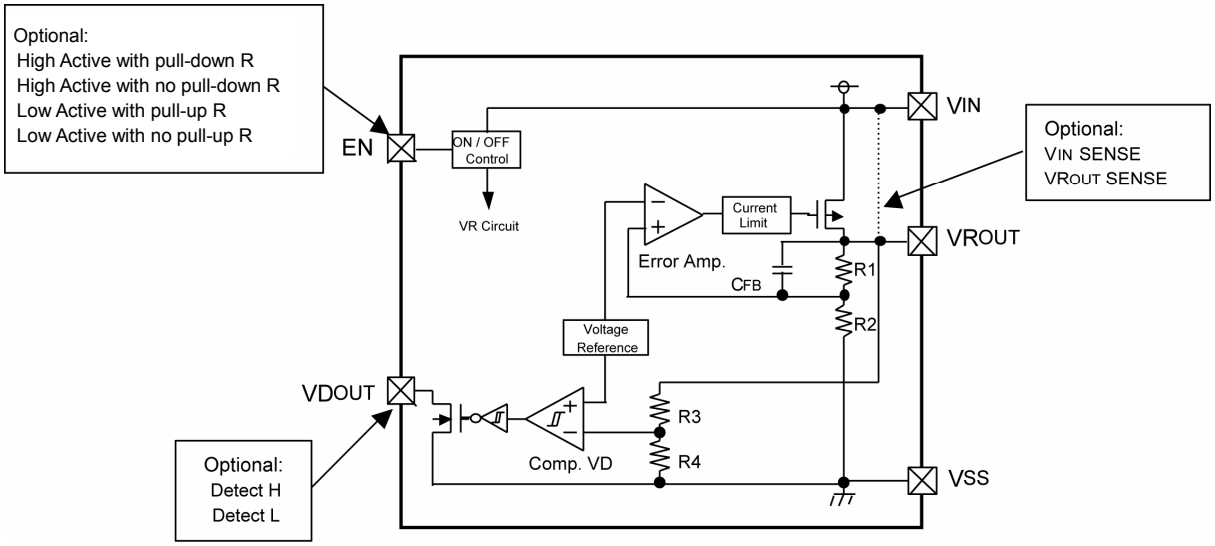
XC6402 ①②③④⑤⑥

DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
①	Operational Function	C	: EN function
		F	: Cd Pin
②	Type of Regulator	-	: As in the chart below
③ ④	Output Voltage & Detect Voltage	-	: Internally set sequential number relating to output voltage and detect voltage. VR setting output voltage range: 0.8V ~ 5.0V Detect voltage setting range: 0.8V ~ 5.0V 50mV increments are available
⑤	Package	M	: SOT-25 (SOT-23-5)
		P	: SOT-89
		D	: USP-6B
⑥	Device Orientation	R	: Embossed tape, standard feed
		L	: Embossed tape, reverse feed

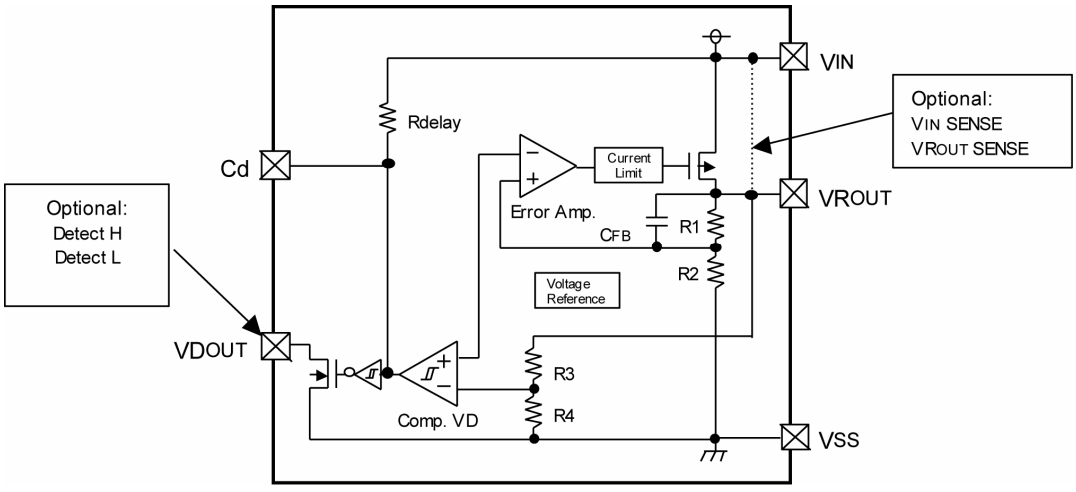
PIN NUMBER : ② Types

②	EN FUNCTION	EN LOGIC	PULL UP/DOWN RESISTANCE	VD SENSE PIN	VD OUTPUT LOGIC	PIN NUMBER ①
A	Functional	High Active	Pull-down Function	VIN	Detect L	C Series
B	Functional	High Active	Pull-down Function	VIN	Detect H	
C	Functional	High Active	Pull-down Function	VROUT	Detect L	
D	Functional	High Active	Pull-down Function	VROUT	Detect H	
E	Functional	High Active	Nonfunctional	VIN	Detect L	
F	Functional	High Active	Nonfunctional	VIN	Detect H	
H	Functional	High Active	Nonfunctional	VROUT	Detect L	
K	Functional	High Active	Nonfunctional	VROUT	Detect H	
L	Functional	Low Active	Pull-up Function	VIN	Detect L	
M	Functional	Low Active	Pull-up Function	VIN	Detect H	
N	Functional	Low Active	Pull-up Function	VROUT	Detect L	
P	Functional	Low Active	Pull-up Function	VROUT	Detect H	
R	Functional	Low Active	Nonfunctional	VIN	Detect L	
S	Functional	Low Active	Nonfunctional	VIN	Detect H	
T	Functional	Low Active	Nonfunctional	VROUT	Detect L	
U	Functional	Low Active	Nonfunctional	VROUT	Detect H	
V	Nonfunctional	-	-	VIN	Detect L	F Series
X	Nonfunctional	-	-	VIN	Detect H	
Y	Nonfunctional	-	-	VROUT	Detect L	
Z	Nonfunctional	-	-	VROUT	Detect H	

■BLOCK DIAGRAMS



XC6402C Series



XC6402F Series

■ABSOLUTE MAXIMUM RATINGS

Ta = 25℃

PARAMETER		SYMBOL	RATINGS	UNITS
Input Voltage		V_{IN}	6.5	V
VR Output Current		I_{ROUT}	800	mA
VR Output Voltage		V_{ROUT}	V_{SS} -0.3 ~ V_{IN} +0.3	V
VD Output Current		I_{DOUT}	50	mA
VD Output Voltage		V_{DOUT}	V_{SS} -0.3 ~ 6.5	V
V_{EN} / Cd Pin Voltage		V_{EN} / Cd	V_{SS} -0.3 ~ V_{IN} + 0.3	V
Power Dissipation	SOT-25	Pd	250	mW
	SOT-89-5		500	
	USP-6B		100	
Operating Temperature Range		Topr	- 40 ~ + 85	℃
Storage Temperature Range		Tstg	- 55 ~ + 125	℃

■ELECTRICAL CHARACTERISTICS

XC6402C Series

Ta=25℃

	PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUIT
VOLTAGE REGULATOR (V_{ROUT}=1.8V)	Output Voltage (*2, 3)	$V_{ROUT(E)}$	V_{IN}=$V_{ROUT(T)}$+1.0V, I_{ROUT}=30mA	×0.98 (-30m)	$V_{ROUT(T)}$	×1.02 (+30mV)	V	①
	Maximum Output Current [$V_{ROUT(E)}$≧1.6V]	$I_{ROUTMAX}$	V_{IN}=$V_{ROUT(T)}$+1.0V V_{EN}=ON(V_{IN} or V_{SS})	700	-	-	mA	①
	Maximum Output Current [$V_{ROUT(E)}$＜1.6V]	$I_{ROUTMAX}$	V_{IN}=$V_{ROUT(T)}$+1.0V V_{EN}=ON(V_{IN} or V_{SS})	500	-	-	mA	①
	Load Regulation	△V_{ROUT}	1mA≦I_{ROUT}≦100mA	-	15	60	mV	①
	Dropout Voltage (*4)	Vdif1	I_{ROUT}=30mA	E-1			mV	①
		Vdif2	I_{ROUT}=100mA	E-2				
	Supply Current (CA/CB/CC/CD type)	I_{DD}	V_{EN}=V_{IN}=$V_{ROUT(T)}$+1.0V, I_{ROUT}=0mA	E-3			μA	②
	Supply Current (CL/CM/CN/CP type)	I_{DD}	V_{EN}=$V_{ROUT(T)}$+1.0V, V_{IN}=V_{SS}, I_{ROUT}=0mA	E-3			μA	②
	Supply Current (CE/CF/CH/CK type)	I_{DD}	V_{EN}=V_{IN}=$V_{ROUT(T)}$+1.0V, I_{ROUT}=0mA	-	35	70	μA	②
	Supply Current (CR/CS/CT/CU type)	I_{DD}	V_{EN}=$V_{ROUT(T)}$+1.0V, V_{IN}=V_{SS}, I_{ROUT}=0mA	-	35	70	μA	②
	Line Regulation	$\frac{\triangle V_{ROUT}}{\triangle V_{IN} \cdot V_{ROUT}}$	$V_{ROUT(T)}$+1.0V≦V_{IN}≦6.0V V_{EN}=ON(V_{IN} or V_{SS}), I_{ROUT}=30mA	-	0.01	0.20	%/V	①
	Input Voltage	V_{IN}		1.5	-	6.0	V	-
	Output Voltage Temperature Characteristics	$\frac{\triangle V_{ROUT}}{\triangle Topr \cdot V_{ROUT}}$	I_{ROUT}=30mA -40℃≦Topr≦85℃	-	±100	-	ppm / ℃	①
	Ripple Rejection Rate	PSRR	V_{IN}=[$V_{ROUT(T)}$+1.0]V_{DC}+0.5V_{p-pAC} When $V_{ROUT(T)}$≧4.75V → V_{IN}=5.75V+0.5V_{p-pAC} I_{ROUT}=30mA, f=1kHz	-	60	-	dB	③
	Current Limiter [$V_{ROUT(E)}$≧1.6V]	I_{Rlim}	V_{IN}= $V_{ROUT(T)}$+1.0V V_{EN}=ON(V_{IN} or V_{SS})	700	800	-	mA	①
	Current Limiter [$V_{ROUT(E)}$＜1.6V]	I_{Rlim}	V_{IN}= $V_{ROUT(T)}$+1.0V V_{EN}=ON(V_{IN} or V_{SS})	-	800	-	mA	①
	Short-Circuit Current	I_{Rshort}	V_{IN}= $V_{ROUT(T)}$+1.0V V_{EN}=ON(V_{IN} or V_{SS})	-	30	-	mA	①

■ELECTRICAL CHARACTERISTICS (Continued)

XC6402C Series (Continued)

Ta=25℃

	PARAMETER	SYMBOL	CONDITIONS		MIN.	TYP.	MAX.	UNITS	CIRCUIT
VOLTAGE DETECTOR	Detect Voltage (*7, 8)	$V_{DF(E)}$			×0.98 (-30mV)	$V_{DF(T)}$	×1.02 (+30mV)	V	④
	Hysteresis Range (*7)	V_{HYS}			$V_{DF(E)}$ ×0.02	$V_{DF(E)}$ ×0.05	$V_{DF(E)}$ ×0.08	V	④
	Supply Current	I_{DDVD}	V_{EN} = OFF (V_{IN} or V_{SS})	V_{IN} = 1.5V	-	5.0	14.0	μA	②
				V_{IN} = 2.0V	-	5.5	14.5		
				V_{IN} = 3.0V	-	6.0	15.0		
				V_{IN} = 4.0V	-	6.5	15.5		
				V_{IN} = 5.0V	-	7.0	16.0		
				V_{IN} = 6.0V	-	7.5	17.0		
	Output Current (*9)	I_{DOUT}	V_{DOUT} = 0.5V	V_{IN} = 1.5V	1.5	3.0	-	mA	⑤
				V_{IN} = 2.0V	1.8	3.5	-		
				V_{IN} = 3.0V	1.8	3.7	-		
				V_{IN} = 4.0V	1.9	3.8	-		
				V_{IN} = 5.0V	1.9	3.9	-		
				V_{IN} = 6.0V	2.0	4.0	-		
	Detect Voltage Temperature Characteristics	$\frac{\Delta V_{DF}}{\Delta Topr \cdot V_{DF}}$	-40℃≦Topr≦85℃		-	±100	-	ppm / ℃	④
SWITCH	EN "High" Level Voltage	V_{ENH}			1.30	-	V_{IN}	V	①
	EN "Low" Level Voltage	V_{ENL}			-	-	0.25	V	①
	EN "High" Level Current (CA/CB/CC/CD type)	I_{ENH}	V_{EN}=V_{IN}=$V_{ROUT(T)}$+1.0V		-0.10	-	E-4	μA	①
	EN "High" Level Current (CE/CF/CH/CK/CL/ CM/CN/CP/CR/CS/ CT/CU type)	I_{ENH}			-0.10	-	0.10	μA	①
	EN "High" Level Current (CL/CM/CN/CP type)	I_{ENL}	V_{IN}=$V_{ROUT(T)}$+1.0V, V_{EN}=V_{SS}		E-5	-	0.10	μA	①
	EN "High" Level Current (CA/CB/CC/CD/CE/ CF/CH/CK/CR/CS/ CT/CU type)	I_{ENL}	V_{IN}=$V_{ROUT(T)}$+1.0V, V_{EN}=V_{SS}		-0.10	-	0.10	μA	①

NOTE:
*1: Unless otherwise stated, V_{IN}=$V_{ROUT(T)}$+1.0V
*2: $V_{ROUT(T)}$=Specified VR output voltage
*3: $V_{ROUT(E)}$=Effective VR output voltage.
(i.e. the VR output voltage when "$V_{ROUT(T)}$+1.0V" is provided at the V_{IN} pin while maintaining a certain I_{ROUT} value).
*4: Vdif={V_{IN1}(*6) - V_{ROUT1}(*5)}
*5: A voltage equal to 98% of the VR output voltage whenever a stabilized V_{ROUT1}=I_{ROUT}{$V_{ROUT(T)}$+1.0V} is input.
*6: V_{IN1}=The input voltage when V_{OUT1}, which appears as input voltage is gradually decreased.
*7: $V_{DF(T)}$: Specified detect voltage value
*8: $V_{DF(E)}$: Effective detect voltage value.
*9: VD output current value of detect 'L' type equal to current value during detection and that of Detect 'H' type equal to current value before detection.
*10: $V_{ROUT(T)}$≦1.45V, $V_{DF(T)}$≦1.45V → MIN : $V_{ROUT(T)}$ -30mV, $V_{DF(T)}$ -30mV,
→ MAX : $V_{ROUT(T)}$ +30mV, $V_{DF(T)}$ +30mV
*11: EN conditions: XC6402CZ / CB / CC / CD / CE / CF / CH / CK type: ON=V_{IN}, OFF=V_{SS}
XC6402CL / CM / CN / CP / CR / CS / CT / CU type: ON=V_{SS}, OFF=V_{IN}
*12: VD detect voltage: For V_{IN} sense version, XC6402CA / CB / CE / CF / CL / CM / CR / CS, only $V_{DF(T)}$≧1.5V type are available.

■ELECTRICAL CHARACTERISTICS (Continued)

XC6402F Series

Ta=25℃

	PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUIT
VOLTAGE REGULATOR	Output Voltage (*2, 3)	$V_{ROUT(E)}$	$V_{IN}=V_{ROUT(T)}+1.0V$, $I_{ROUT}=30mA$	×0.98 (-30mV)	$V_{ROUT(T)}$	×1.02 (+30mV)	V	①
	Maximum Output Current [$V_{ROUT(E)}$≧1.6V]	$I_{ROUTMAX}$	$V_{IN}= V_{ROUT(T)}+1.0V$	700	-	-	mA	①
	Maximum Output Current [$V_{ROUT(E)}$＜1.6V]	$I_{ROUTMAX}$	$V_{IN}= V_{ROUT(T)}+1.0V$	500	-	-	mA	①
	Load Regulation	ΔV_{ROUT}	1mA≦I_{ROUT}≦100mA	-	15	60	mV	①
	Dropout Voltage (*4)	Vdif1	I_{ROUT} =30mA	E-1			mV	①
		Vdif2	I_{ROUT} =100mA	E-2				
	Supply Current	I_{DD}	$V_{IN}= V_{ROUT(T)}+1.0V$	-	35	70	μA	②
	Line Regulation	$\frac{\Delta V_{ROUT}}{\Delta V_{IN} \cdot V_{ROUT}}$	$V_{ROUT(T)}+1.0V$≦V_{IN}≦6.0V I_{ROUT}=30mA	-	0.01	0.20	% / V	①
	Input Voltage	V_{IN}		1.5	-	6.0	V	-
	Output Voltage Temperature Characteristics	$\frac{\Delta V_{ROUT}}{\Delta Topr \cdot V_{ROUT}}$	I_{ROUT}=30mA -40℃≦Topr≦85℃	-	±100	-	ppm / ℃	①
	Ripple Rejection Rate	PSRR	$V_{IN}=[V_{ROUT(T)}+1.0]V_{DC}+0.5V_{p\text{-}pAC}$ When $V_{ROUT(T)}$≧4.75V → V_{IN}=5.75V+0.5Vp-pAC I_{ROUT}=30mA, f=1kHz	-	60	-	dB	③
	Current Limiter [$V_{ROUT(E)}$≧1.6V]	I_{Rlim}	$V_{IN}=V_{ROUT(T)}+1.0V$	700	800	-	mA	①
	Current Limiter [$V_{ROUT(E)}$＜1.6V]	I_{Rlim}	$V_{IN}=V_{ROUT(T)}+1.0V$	-	800	-	mA	①
	Short-Circuit Current	I_{Rshort}	$V_{IN}=V_{ROUT(T)}+1.0V$	-	30	-	mA	①
VOLTAGE DETECTOR	Detect Voltage (*7, 8)	$V_{DF(E)}$		×0.98 (-30mV)	$V_{DF(T)}$	×1.02 (+30mV)	V	④
	Hysteresis Range (*7)	V_{HYS}		$V_{DF(E)}$ ×0.02	$V_{DF(E)}$ ×0.05	$V_{DF(E)}$ ×0.08	V	④
	Output Current (*9)	I_{DOUT}	V_{DOUT}=0.5V, V_{IN} = 1.5V	-	1.5	3.0	μA	⑤
			V_{IN} = 2.0V	-	1.8	3.5		
			V_{IN} = 3.0V	-	1.8	3.7		
			V_{IN} = 4.0V	-	1.9	3.8		
			V_{IN} = 5.0V	-	1.9	3.9		
			V_{IN} = 6.0V	-	2.0	4.0		
	Detect Voltage Temperature Characteristics	$\frac{\Delta V_{DF} /}{\Delta Topr \cdot V_{DF}}$	-40℃≦Topr≦85℃	-	±100	-	ppm / ℃	④
	Delay Resistance	Rdelay	V_{IN}=6.0V, V_{CD}=0V	1.0	2.0	3.5	MΩ	⑥

NOTE:
*1: Unless otherwise stated, $V_{IN}=V_{ROUT(T)}+1.0V$
*2: $V_{ROUT(T)}$=Specified VR output voltage
*3: $V_{ROUT(E)}$=Effective VR output voltage.
(i.e. the VR output voltage when "$V_{ROUT(T)}$+1.0V" is provided at the V_{IN} pin while maintaining a certain I_{ROUT} value).
*4: Vdif={V_{IN1}(*6) - V_{ROUT1}(*5)}
*5: A voltage equal to 98% of the VR output voltage whenever a stabilized $V_{ROUT1}=I_{ROUT}\{V_{ROUT(T)}+1.0V\}$ is input.
*6: V_{IN1}=The input voltage when V_{OUT1}, which appears as input voltage is gradually decreased.
*7: $V_{DF(T)}$: Specified detect voltage value
*8: $V_{DF(E)}$: Effective detect voltage value.
*9: VD output current value of Detect 'L' type equal to current value during detection
and that of Detect 'H' type equal to current value before detection.
*10: $V_{ROUT(T)}$≦1.45V, $V_{DF(T)}$≦1.45V → MIN: $V_{ROUT(T)}$ -30mV, $V_{DF(T)}$ -30mV,
→ MAX: $V_{ROUT(T)}$ +30mV, $V_{DF(T)}$ +30mV
*11: VD detect voltage: For V_{IN} Sense version, XC6402FV / FX, only $V_{DF(T)}$>1.5V type are available.

■ELECTRICAL CHARACTERISTICS (Continued)

●Dropout Voltage, Supply Current, EN'H/L' Level Current

XC6402C Series

SETTING OUTPUT VOLTAGE (V)	VR OUTPUT VOLTAGE VD DETECT VOLTAGE (V)		E-1		E-2		E-3		E-4	E-5
			DROPOUT VOLTAGE 1 (mV)		DROPOUT VOLTAGE 2 (mV)		SUPPLY CURRENT (μA)		EN'H'LEVEL CURRENT (μA)	EN'H'LEVEL CURRENT (μA)
	VOUT		Vdif1		Vdif2		IDD		IENH	IENL
VROUT(T)	MIN.	MAX.	TYP.	MAX.	TYP.	MAX.	TYP.	MAX.	TYP.	MAX.
0.80	0.770	0.830	100	700	250	800	38.0	80.0	5.0	-5.0
0.85	0.820	0.880								
0.90	0.870	0.930		600		700				
0.95	0.920	0.980								
1.00	0.970	1.030	50	500	150	600	38.5	81.5	6.5	-6.5
1.05	1.020	1.080								
1.10	1.070	1.130		400		500				
1.15	1.120	1.180								
1.20	1.170	1.230	30	300	100	400				
1.25	1.220	1.280								
1.30	1.270	1.330		200		300				
1.35	1.320	1.380								
1.40	1.370	1.430		100		250				
1.45	1.420	1.480								
1.50	1.470	1.530	27.0	41.0	90.0	135.0	39.0	83.0	8.0	-8.0
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	25.0	37.0	80.0	120.0	39.5	84.5	9.5	-9.5
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	18.0	28.0	60.0	90.0	40.0	86.0	11.0	-11.0
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								

■ELECTRICAL CHARACTERISTICS (Continued)

●Dropout Voltage, Supply Current, EN'H/L' Level Current (Continued)

XC6402C Series (Continued)

SETTING OUTPUT VOLTAGE (V)	VR OUTPUT VOLTAGE VD DETECT VOLTAGE (V)		E-1 DROPOUT VOLTAGE 1 (mV)		E-2 DROPOUT VOLTAGE 2 (mV)		E-3 SUPPLY CURRENT (μA)		E-4 EN'H'LEVEL CURRENT (μA)	E-5 EN'H'LEVEL CURRENT (μA)
	VOUT		Vdif1		Vdif2		IDD		IENH	IENL
VROUT(T)	MIN.	MAX.	TYP.	MAX.	TYP.	MAX.	TYP.	MAX.	TYP.	MAX.
3.00	2.940	3.060	15.0	23.0	50.0	75.0	40.5	87.5	12.5	-12.5
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					41.0	89.0	14.0	-14.0
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	3.882	3.978								
3.95	3.871	4.029								
4.00	3.920	4.080					41.5	90.5	15.5	-15.5
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					42.0	92.0	17.0	-17.0
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								

■ELECTRICAL CHARACTERISTICS (Continued)

●Dropout Voltage

XC6402F Series

SETTING OUTPUT VOLTAGE (V)	VR OUTPUT VOLTAGE VD DETECT VOLTAGE (V)		E-1		E-2	
			DROPOUT VOLTAGE 1 (mV)		DROPOUT VOLTAGE 2 (mV)	
	VOUT		Vdif1		Vdif2	
VROUT(T)	MIN.	MAX.	TYP.	MAX.	TYP.	MAX.
0.80	0.770	0.830	100	700	250	800
0.85	0.820	0.880				
0.90	0.870	0.930		600		700
0.95	0.920	0.980				
1.00	0.970	1.030	50	500	150	600
1.05	1.020	1.080				
1.10	1.070	1.130		400		500
1.15	1.120	1.180				
1.20	1.170	1.230	30	300	100	400
1.25	1.220	1.280				
1.30	1.270	1.330		200		300
1.35	1.320	1.380				
1.40	1.370	1.430		100		250
1.45	1.420	1.480				
1.50	1.470	1.530	27.0	41.0	90.0	135.0
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	25.0	37.0	80.0	120.0
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	18.0	28.0	60.0	90.0
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				

■ELECTRICAL CHARACTERISTICS (Continued)

●Dropout Voltage (Continued)

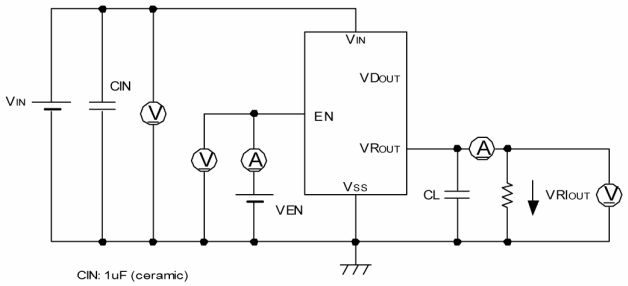
XC6402F Series (Continued)

SETTING OUTPUT VOLTAGE (V)	VR OUTPUT VOLTAGE VD DETECT VOLTAGE (V)		E-1		E-2	
			DROPOUT VOLTAGE 1 (mV)		DROPOUT VOLTAGE 2 (mV)	
	VOUT		Vdif1		Vdif2	
VROUT(T)	MIN.	MAX.	TYP.	MAX.	TYP.	MAX.
3.00	2.940	3.060				
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	3.159				
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	3.882	3.978				
3.95	3.871	4.029				
4.00	3.920	4.080	15.0	23.0	50.0	75.0
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				

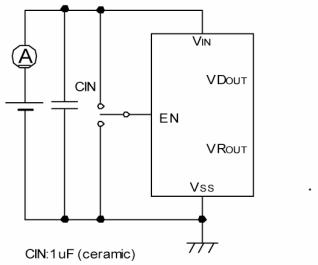
■TEST CIRCUITS

XC6402C Series

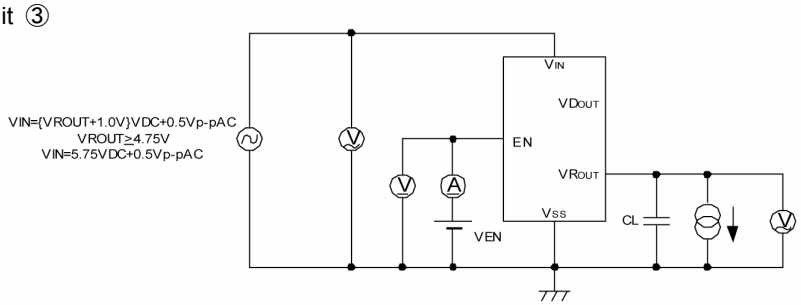
Circuit ①



Circuit ②

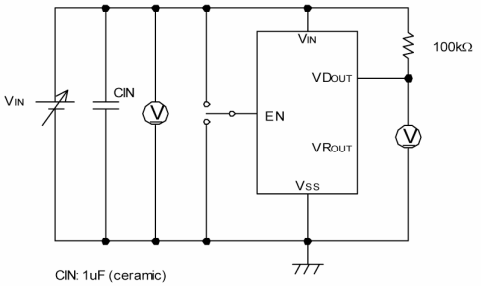


Circuit ③

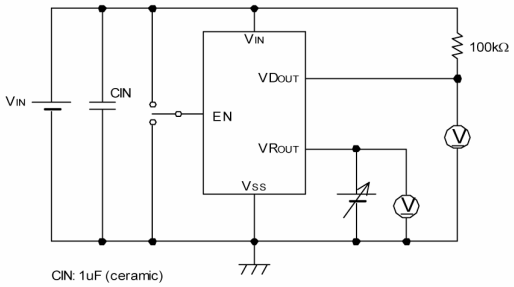


Circuit ④

XC6402CA / CB / CE / CF/ CL / CM / CS type

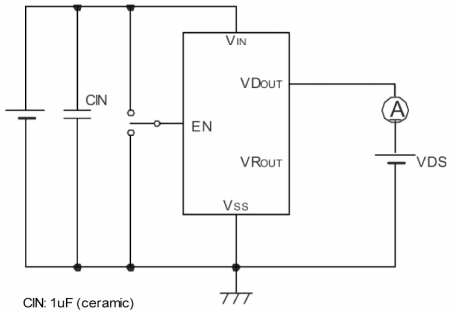


XC6402 CC / CD / CH / CK / CN / CP / CT / CU type

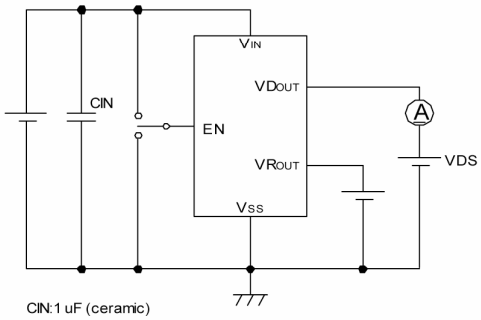


Circuit ⑤

XC6402CA / CB / CE / CF/ CL / CM / CS type



XC6402 CC / CD / CH / CK / CN / CP / CT / CU type



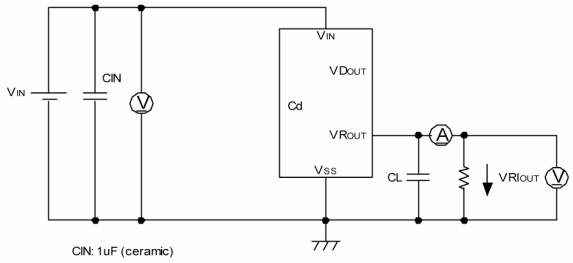
Output Capacitor Corresponding Chart

VR OUTPUT VOLTAGE	0.8 ~1.45V	1.5 ~ 1.75V	1.8V ~ 5.0V
CL	6.8 μF	2.2 μF	1.0 μF

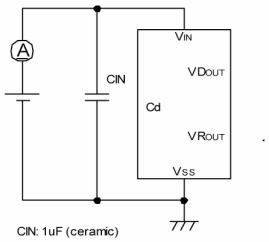
■TEST CIRCUITS (Continued)

XC6402F Series

Circuit ①

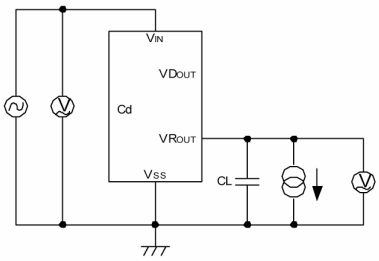


Circuit ②



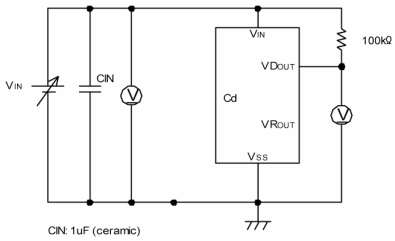
Circuit ③

VIN={VROUT+1.0V}VDC+0.5Vp-pAC
VROUT≥4.75V
VIN=5.75VDC+0.5Vp-pAC

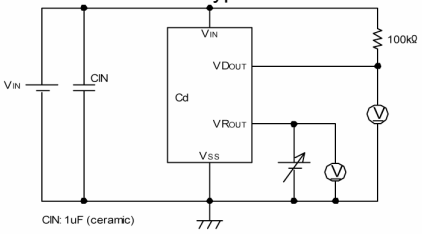


Circuit ④

XC6402FY / FX type

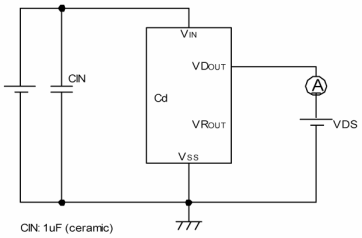


XC6402FY / FZ type

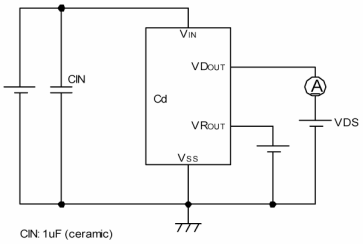


Circuit ⑤

XC6402FY / FX type

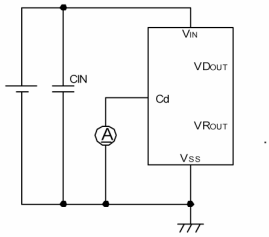


XC6402FY / FZ type

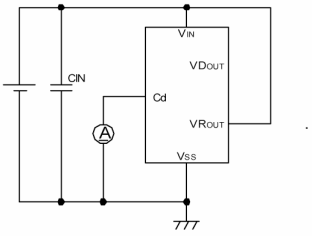


Circuit ⑥

XC6402FY / FX type



XC6402FY / FZ type



Output Capacitor Corresponding Chart

VR OUTPUT VOLTAGE	0.8 ~1.45V	1.5 ~ 1.75V	1.8V ~ 5.0V
CL	6.8μF	2.2μF	1.0μF

■OPERATIONAL EXPLANATION

<Output Voltage Regulator Control>
The voltage, divided by resistors R1 & R2 which are connected to the VROUT pin is compared with the internal reference voltage by the error amplifier. The P-channel MOSFET, which is connected to the VROUT pin, is then driven by the subsequent output signal. The output voltage at the VROUT pin is controlled & stabilized by negative feedback. The current limit circuit and short circuit protection operate in relation to the level of output current. Further, the voltage regulator's internal circuitry can be shutdown via the EN pin's signal.

<Detector Function with the XC6402 Series>
The series' detector function monitors the voltage divided by resistors R3 & R4 which are connected to the VROUT pin or the VIN pin, as well as monitoring the voltage of the internal reference voltage source via the comparator.
The VDSEN pin has options (please refer to the Selection Guide, item 2).
A 'High' or 'Low' signal level can be output from the VDOUT pin when the VD pin voltage level goes below the detect voltage. The VD output logic has options (please refer to the Selection Guide, item 3). As VDOUT is an open-drain N-channel output, a pull-up resistor of about 220kΩ is needed to achieve a voltage output. Because of hysteresis at the detector function, output at the VDOUT pin will invert when the detect voltage level increases above the release voltage (105% of the detect voltage).
For the XC6402C type, in stand-by, if a voltage of the recovery voltage is present at the VROUT pin (from another power source), the VDOUT pin will be high impedance mode, and the pull up voltage will be output at VDOUT. By connecting the Cdelay pin to a capacitor (Cd), the XC6402F series can apply a delay time to VDOUT voltage when releasing voltage. The delay time can be calculated from the internal resistance, Rdelay (2MΩ TYP. fixed) and the value of Cd as per the following equation.

Delay Time = Cdelay x Rdelay x 0.7

Delay Time Rdelay standard : 1.0 ~ 3.5MΩ TYP : 2.0MΩ

Cdelay	DELAY TIME (TYP.)	DELAY TIME (TYP.)
0.01μF	14 msec	7.0 ~ 24.5 msec
0.022μF	30.8 msec	15.4 ~ 53.9 msec
0.047μF	65.8 msec	32.9 ~ 115.15 msec
0.1μF	140 msec	70.0 ~ 245.0 msec
0.22μF	308 msec	154.0 ~ 539.0 msec
0.47μF	658 msec	329.0 ~ 1151.5 msec
1μF	1400 msec	700.0 ~ 2450.0 msec

<Low ESR Capacitors>
With the XC6402 series regulator, a stable output voltage is achievable even if low ESR capacitors are used, as a phase compensation circuit is built-in to the regulator. In order to ensure the effectiveness of the phase compensation, we suggest that an output capacitor (CL) be connected as close as possible, between the output pin (VROUT) 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 1μF : this should be connected between VIN and VSS in order to stabilize input power source.

Output Capacitor Corresponding Chart

VR OUTPUT VOLTAGE	0.8 ~1.45V	1.5 ~ 1.75V	1.8V ~ 5.0V
CL	6.8μF	2.2μF	1.0μF

<Current Limiter, Short-Circuit Protection>
The XC6402 series regulator offers a combination of current limit and 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 30mA flows.

■OPERATIONAL EXPLANATION (Continued)

<EN Pin>
The IC's internal regulator circuitry can be shut down via the signal from the EN pin with the XC6402C series. In shutdown mode, output at the V_{ROUT} pin will be pulled down to the V_{SS} level via R1 & R2. Note that as the XC6402*E to K types of the XC6402C series are 'High Active / No Pull-Down' and XC6402*R to U types of the XC6402C series are 'Active LOW / No Pull-Up', operations will become unstable with the EN pin open (See the chart below).

SERIES	EN INPUT LOGIC
XC6402C A ~ D	High Active with pull-down resistor
XC6402C E ~ K	High Active with no pull-down resistor
XC6402C L ~ P	Low Active with pull-up resistor
XC6402C R ~ U	Low Active with no pull-up resistor

We suggest that you use this IC with either a V_{IN} voltage or a V_{SS} voltage input at the EN pin. If this IC is used with the correct specifications for the EN 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 V_{IN} or V_{SS} is applied.

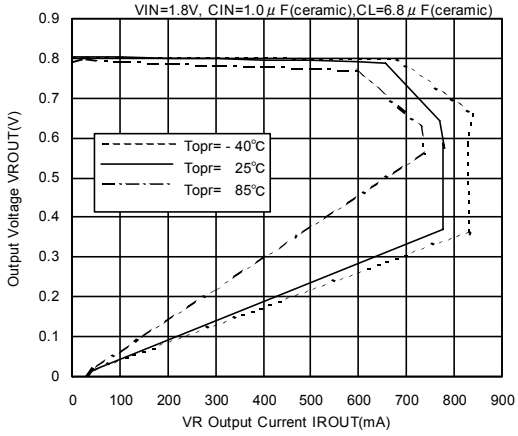
■NOTES ON USE

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 V_{IN} and V_{SS} wiring in particular.
3. Please wire the input capacitor (C_{IN}) and the output capacitor (C_L) as close to the IC as possible.
   Should rapid input fluctuation or load fluctuation occur, please increase the capacitor value such as C_{IN} or C_L to stabilize the operation.

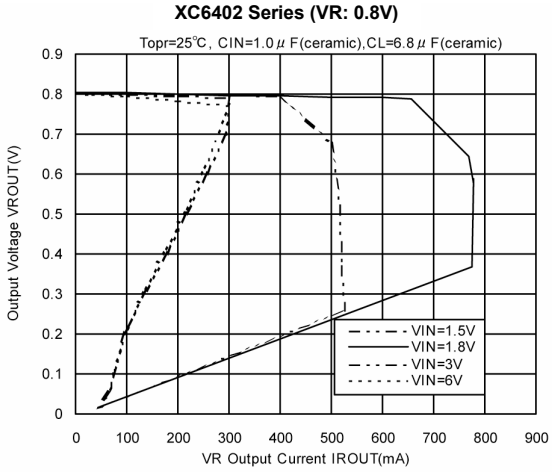
■TYPICAL PERFORMANCE CHARACTERISTICS

(1) VR Output Voltage vs. VR Output Current

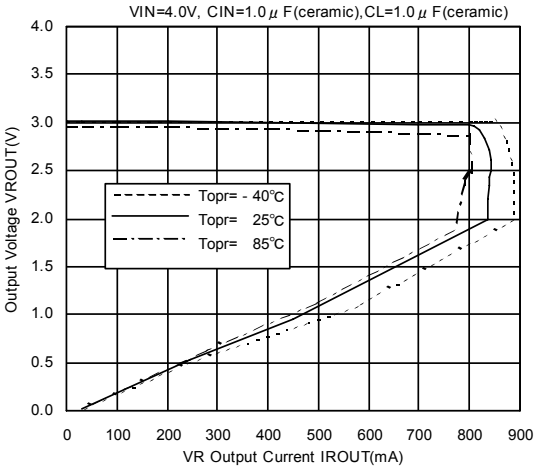
XC6402 Series (VR: 0.8V)



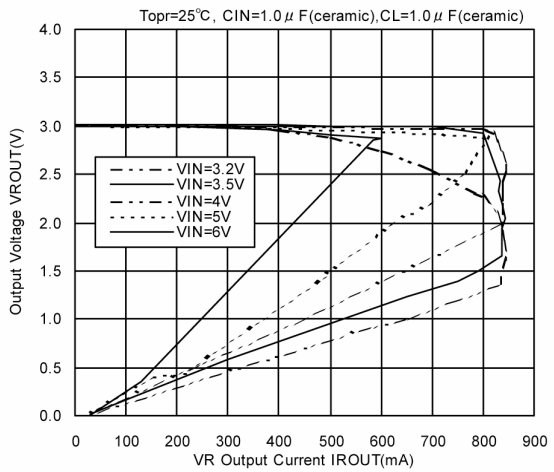
XC6402 Series (VR: 0.8V)



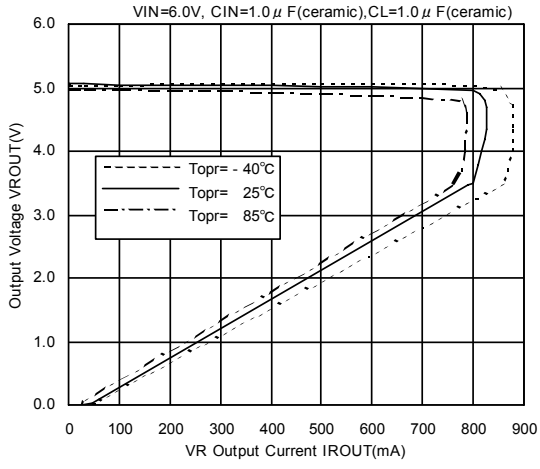
XC6402 Series (VR: 3.0V)



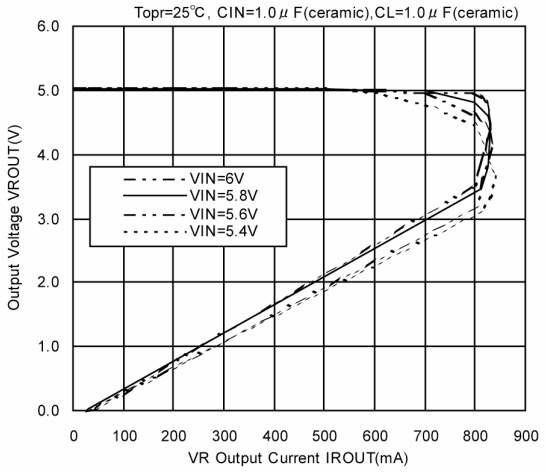
XC6402 Series (VR: 3.0V)



XC6402 Series (VR: 5.0V)

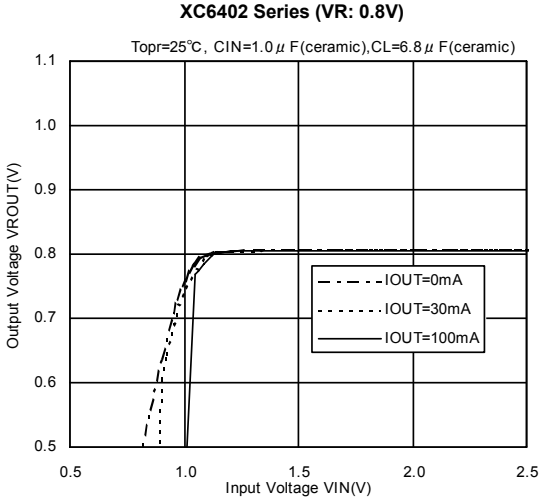


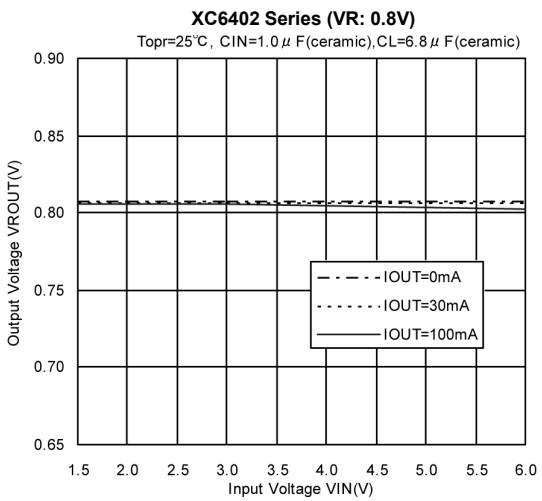
XC6402 Series (VR: 5.0V)

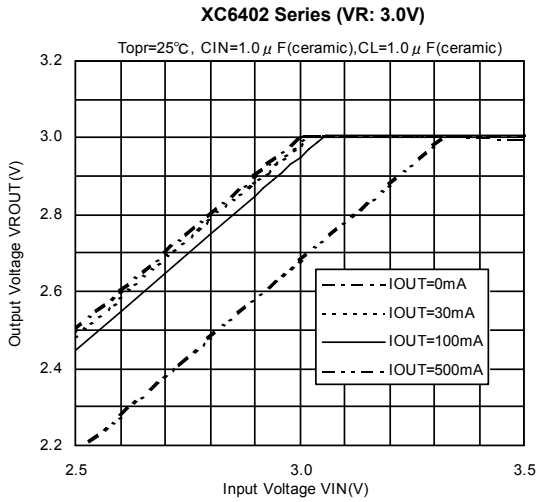


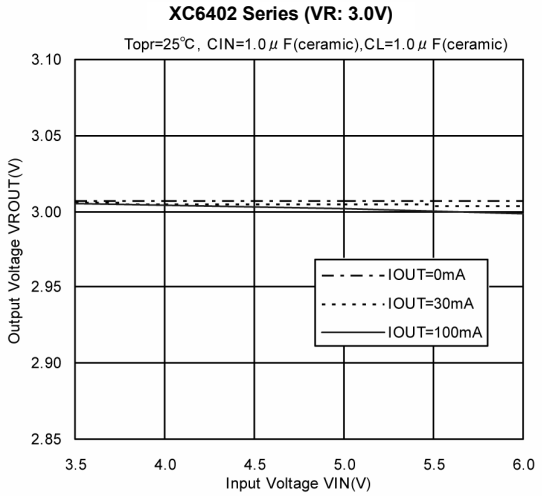
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

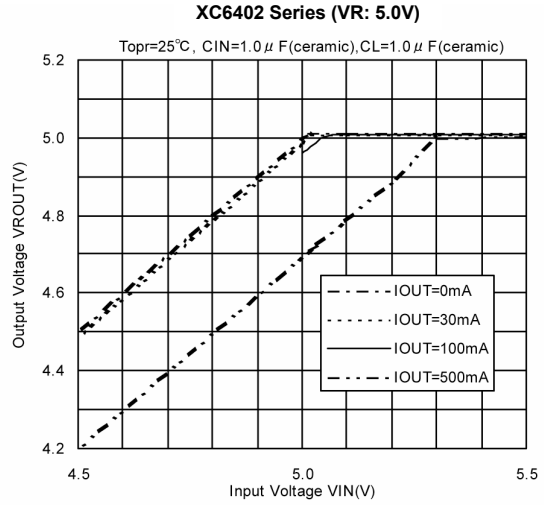
(2) VR Output Voltage vs. Input Voltage

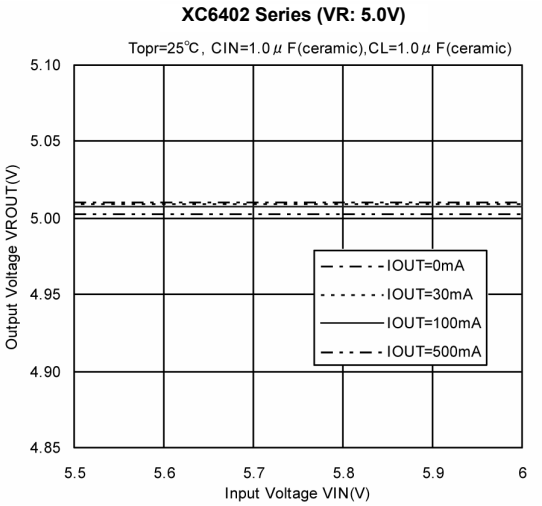








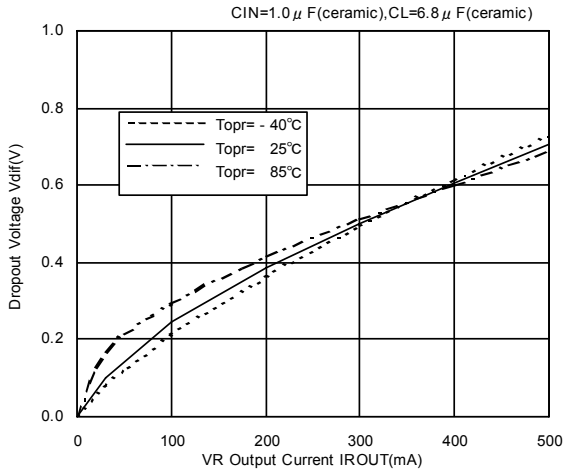




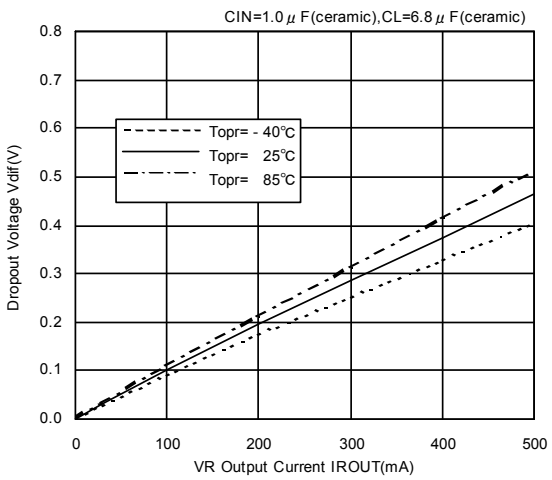
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(3) Dropout Voltage vs. Output Current

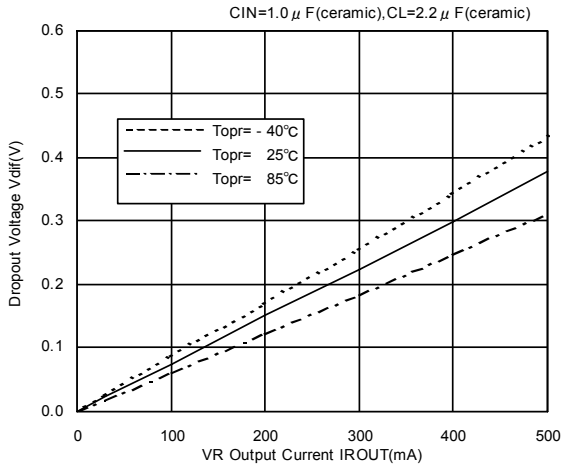
XC6402 Series (VR: 0.8V)



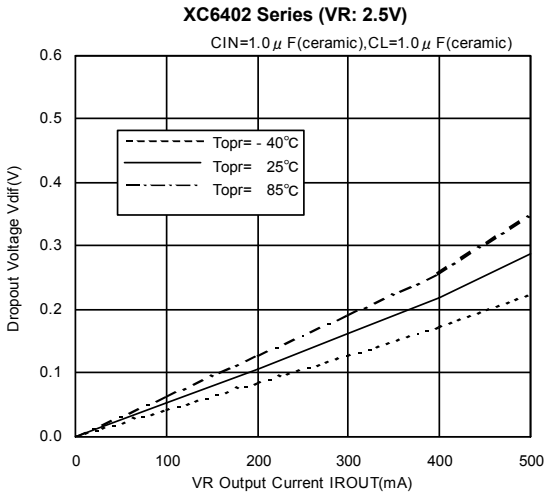
XC6402 Series (VR: 1.2V)



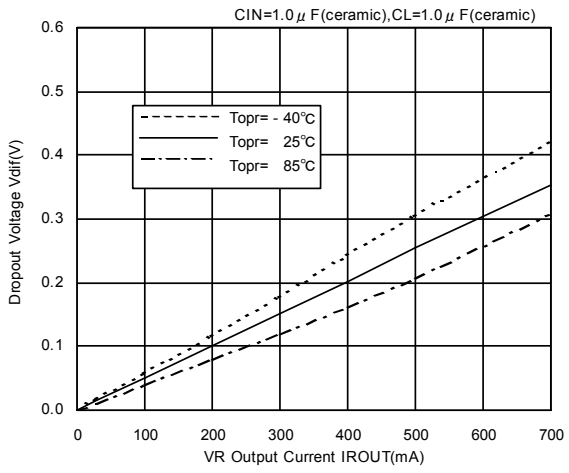
XC6402 Series (VR: 1.5V)



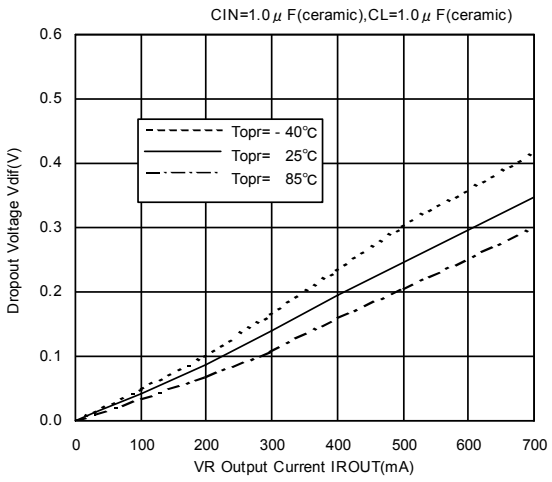
XC6402 Series (VR: 2.5V)



XC6402 Series (VR: 3.0V)

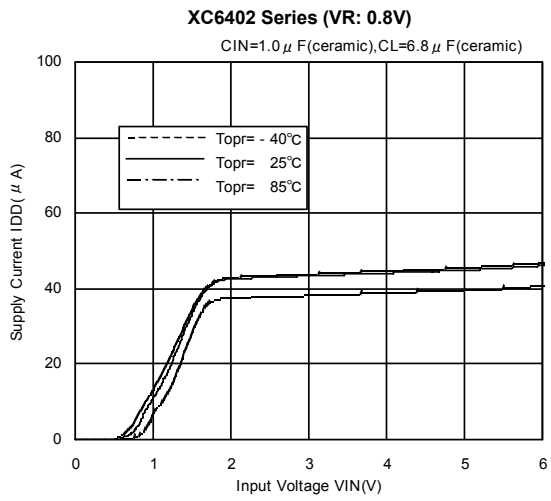


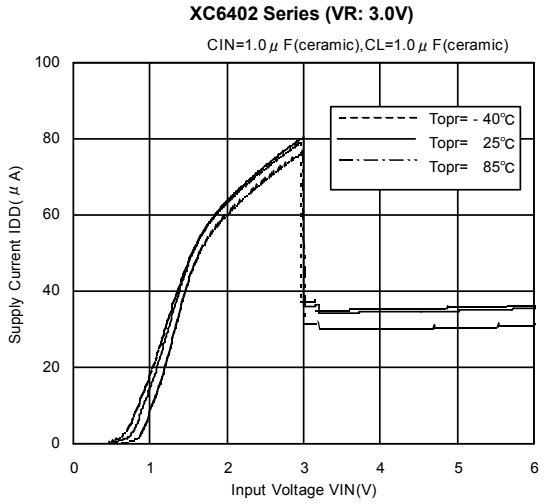
XC6402 Series (VR: 5.0V)

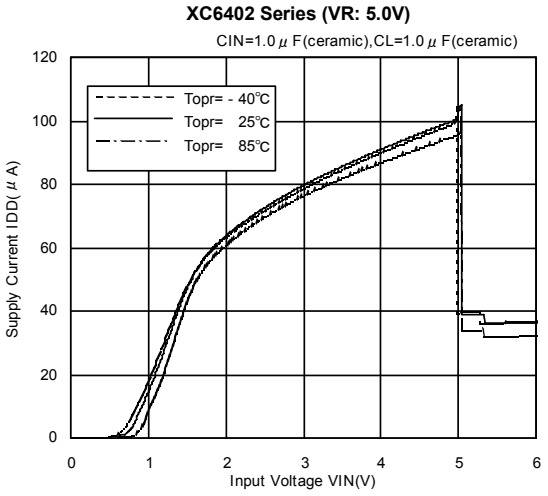


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

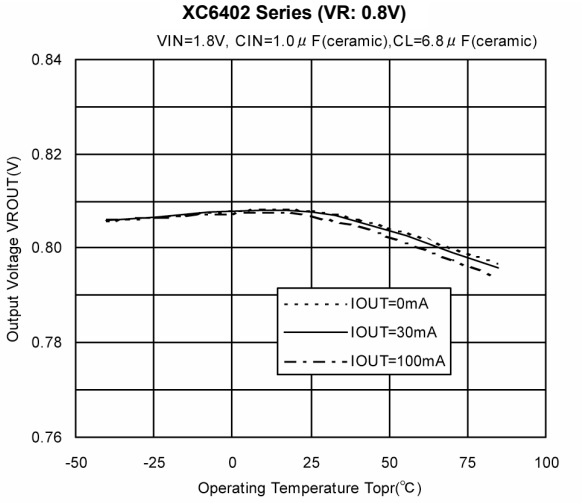
(4) Supply Current vs. Input Voltage

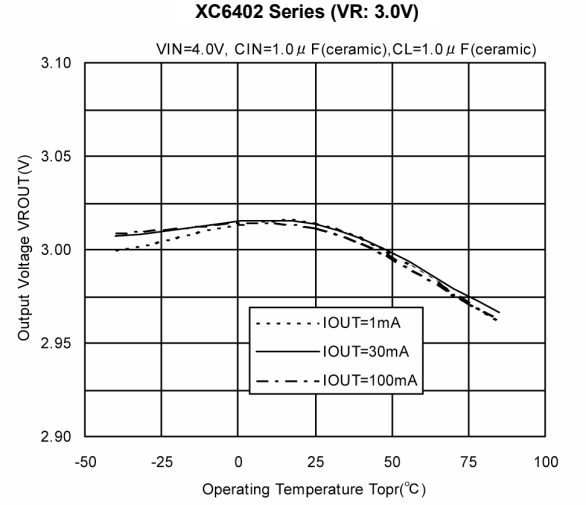


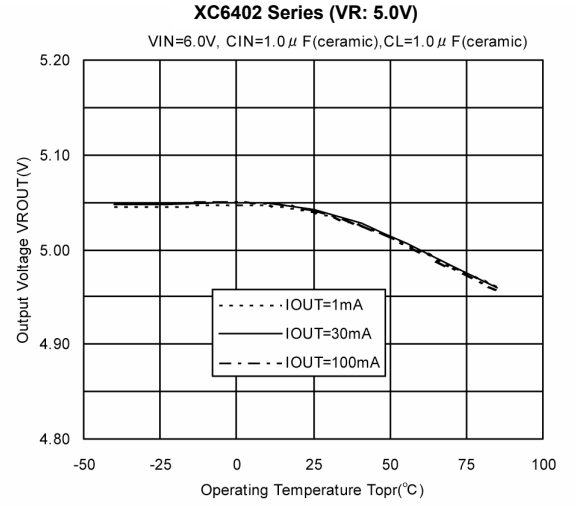




(5) VR Output Voltage vs. Operating Temperature

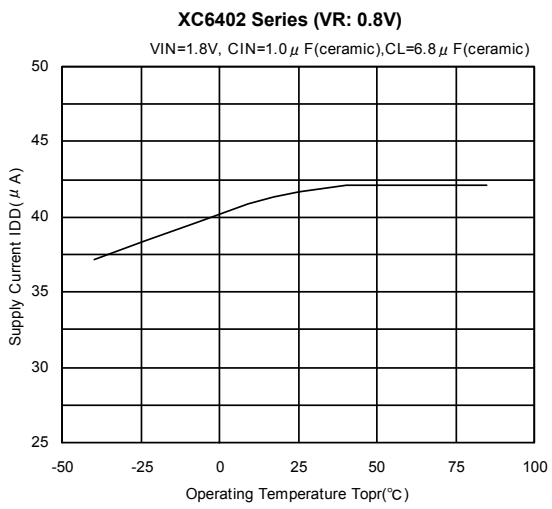


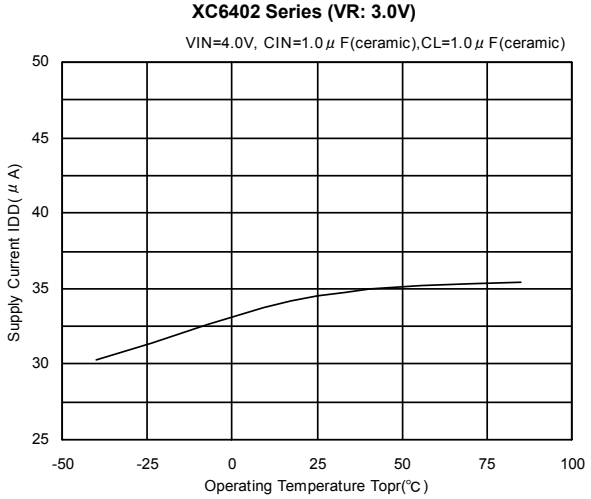


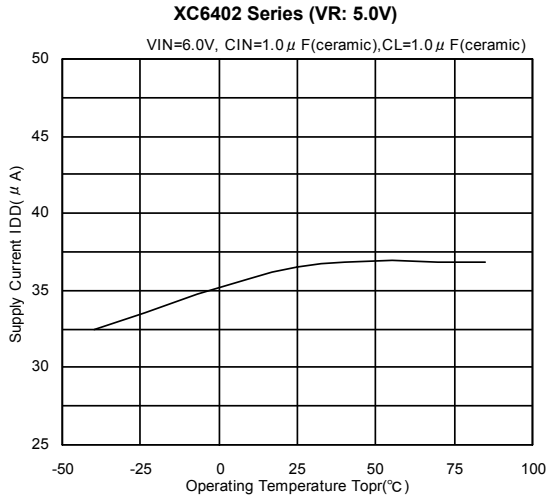


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

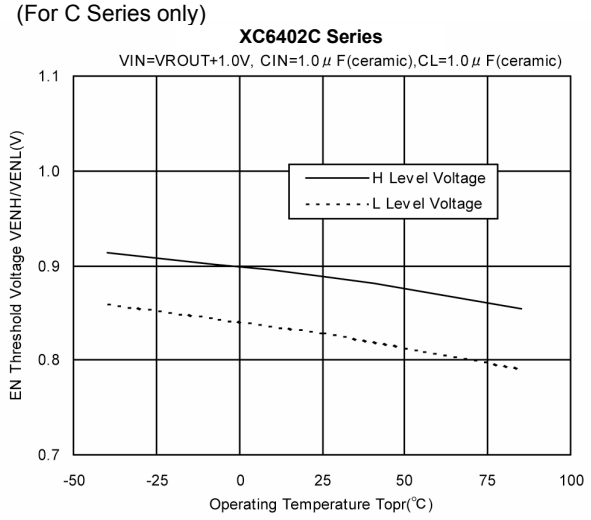
(6) Supply Current vs. Operating Temperature



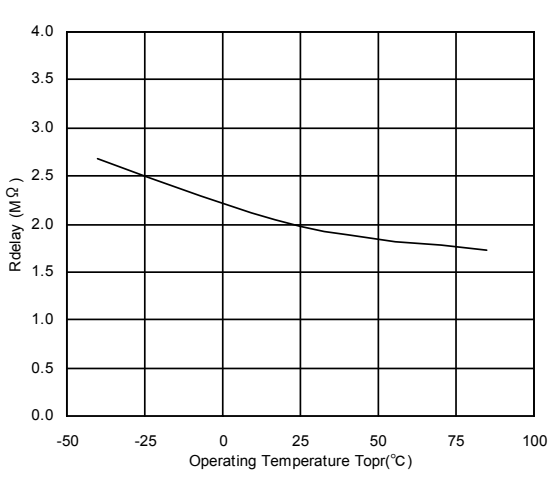




(7) EN Threshold Voltage vs. Operating Temperature
(For C Series only)



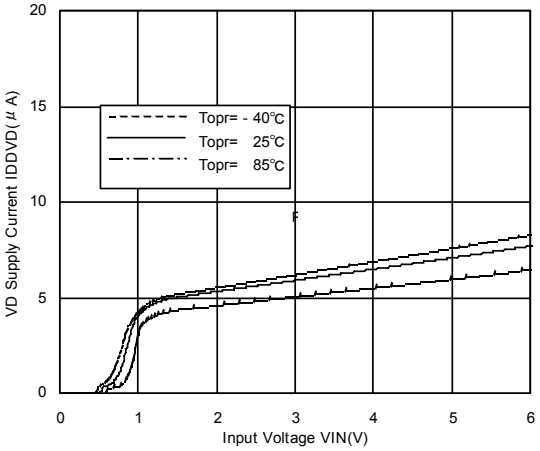
(8) Rdelay vs. Operating Temperature (For F Series only)



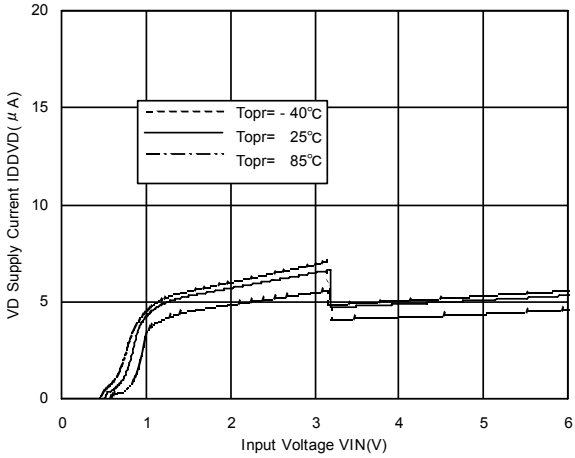
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(9) VD Supply Current vs. Input Voltage (For C Series only)

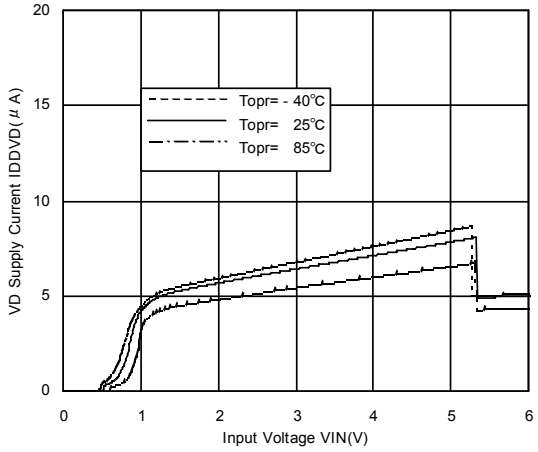
XC6402C Series (VD: 0.8V)



XC6402C Series (VD: 3.0V)

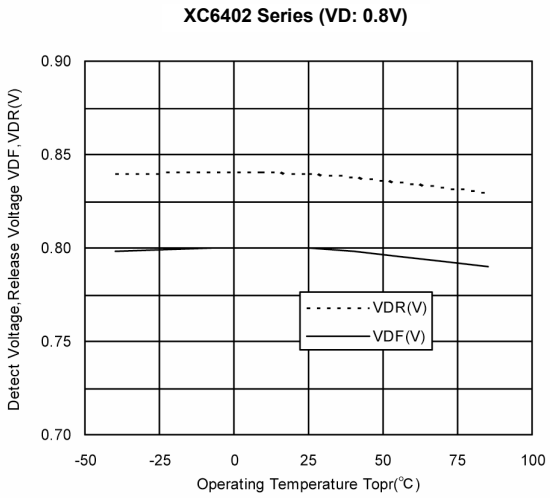


XC6402C Series (VD: 5.0V)

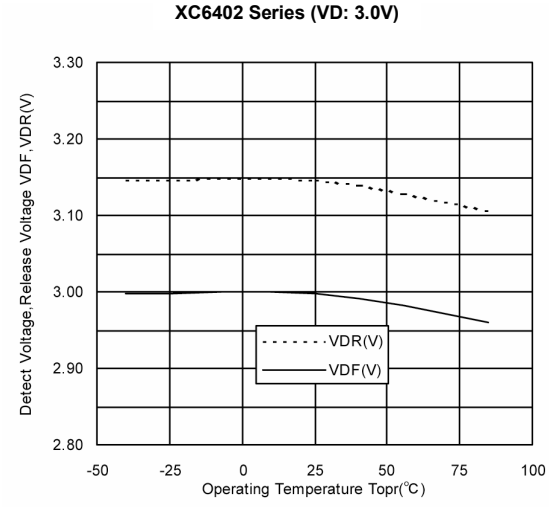


(10) Detect Voltage & Release Voltage vs. Operating Temperature

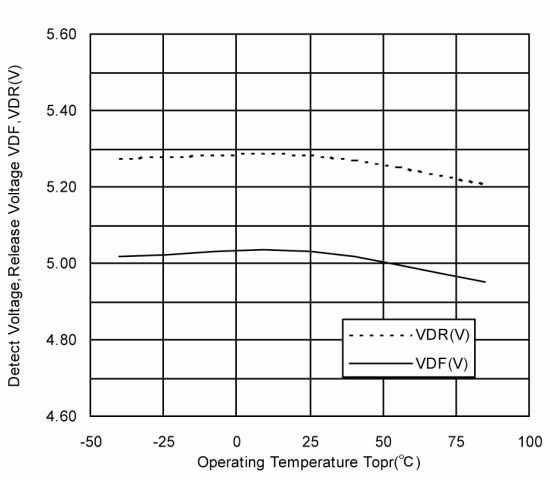
XC6402 Series (VD: 0.8V)



XC6402 Series (VD: 3.0V)

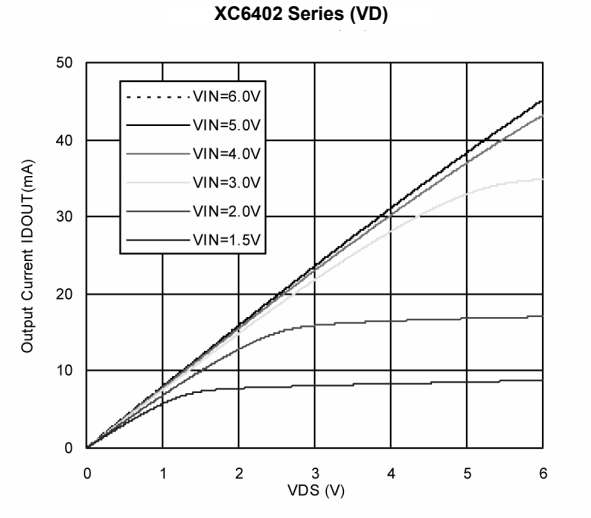


XC6402 Series (VD: 5.0V)

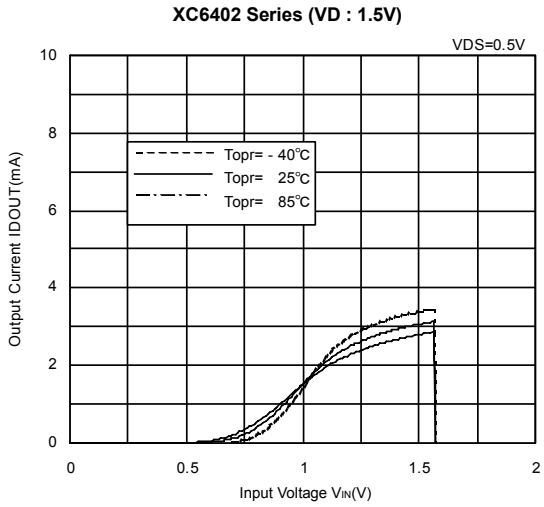


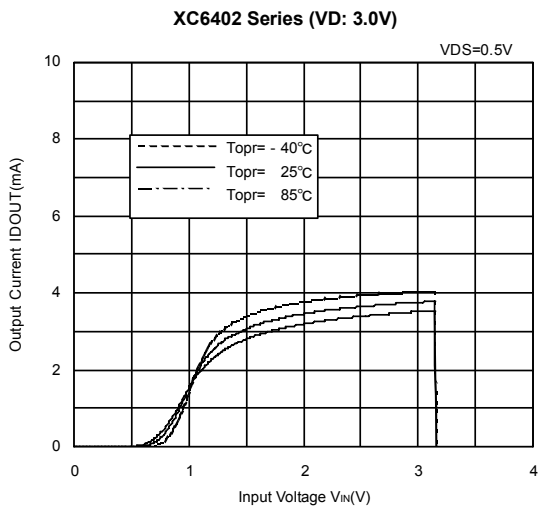
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

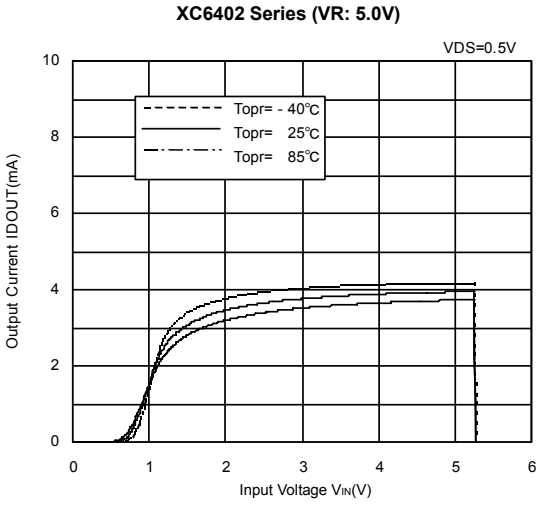
(11) VD N-ch Driver Tr. Output Current vs. V_{DS}



(12) VD N-ch Driver Tr. Output Current vs. Input Voltage





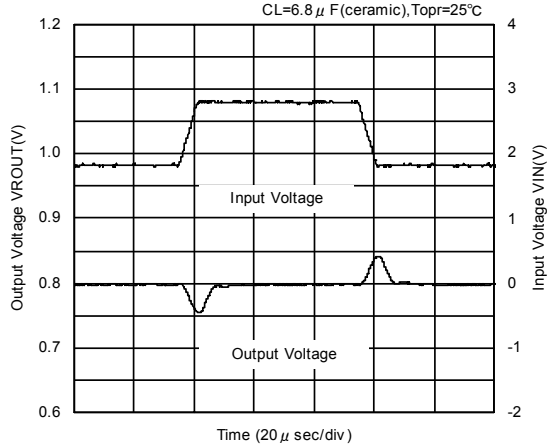


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(13) VR Input Transient Response

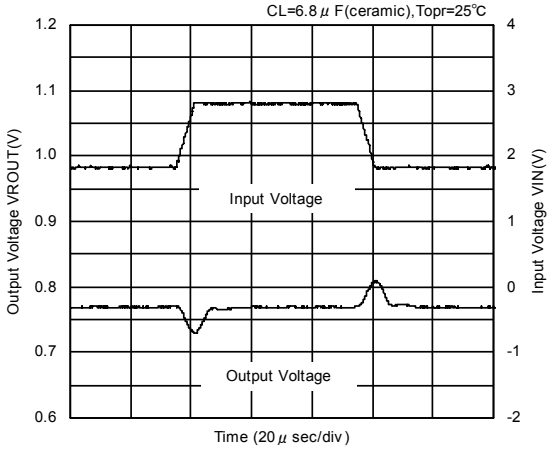
XC6402 Series (VR: 0.8V)

IOUT=30mA, tr=tf=5.0μsec
CL=6.8μF(ceramic), Topr=25℃



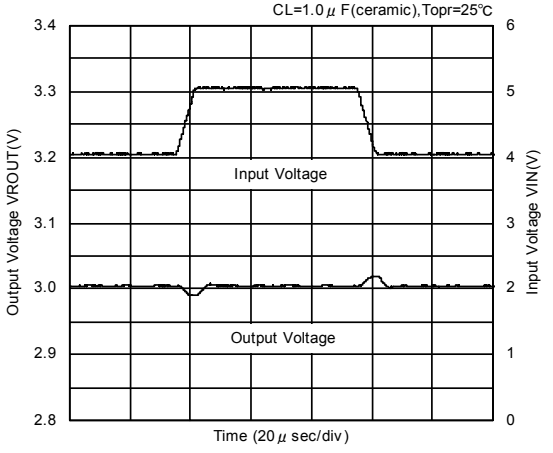
XC6402 Series (VR: 0.8V)

IOUT=200mA, tr=tf=5.0μsec
CL=6.8μF(ceramic), Topr=25℃



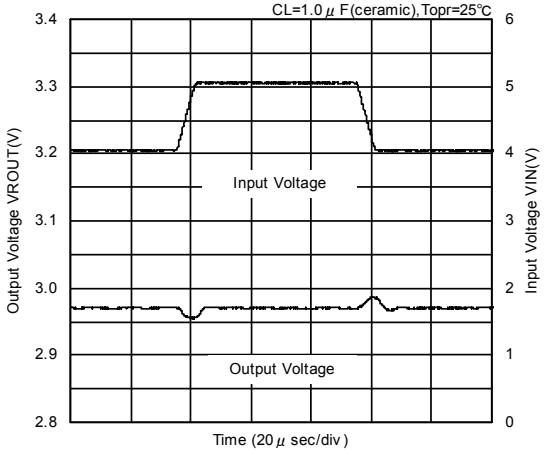
XC6402 Series (VR: 3.0V)

IOUT=30mA, tr=tf=5.0μsec
CL=1.0μF(ceramic), Topr=25℃



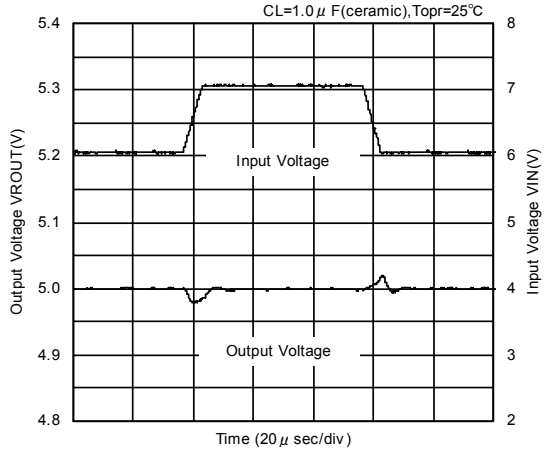
XC6402 Series (VR: 3.0V)

IOUT=200mA, tr=tf=5.0μsec
CL=1.0μF(ceramic), Topr=25℃



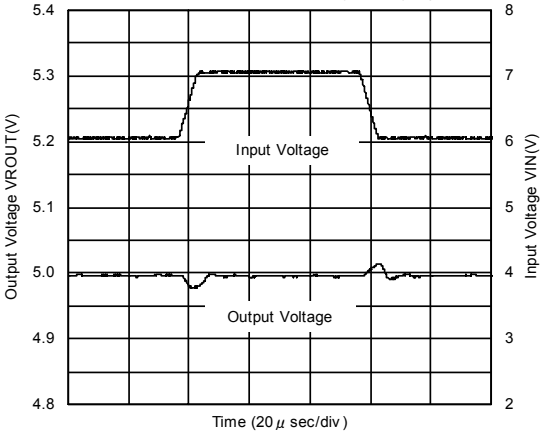
XC6402 Series (VR: 5.0V)

IOUT=30mA, tr=tf=5.0μsec
CL=1.0μF(ceramic), Topr=25℃



XC6402 Series (VR: 5.0V)

IOUT=200mA, tr=tf=5.0μsec
CL=1.0μF(ceramic), Topr=25℃

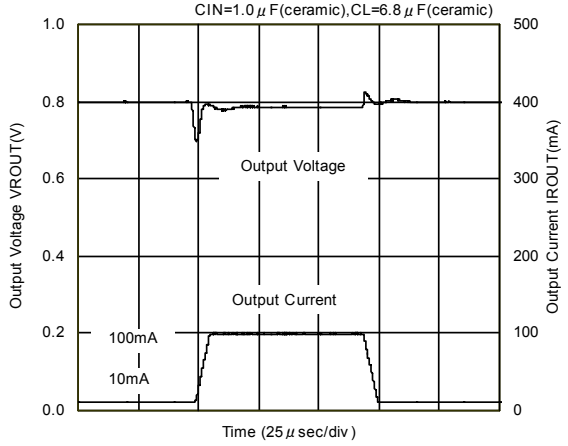


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(14) VR Load Transient Response

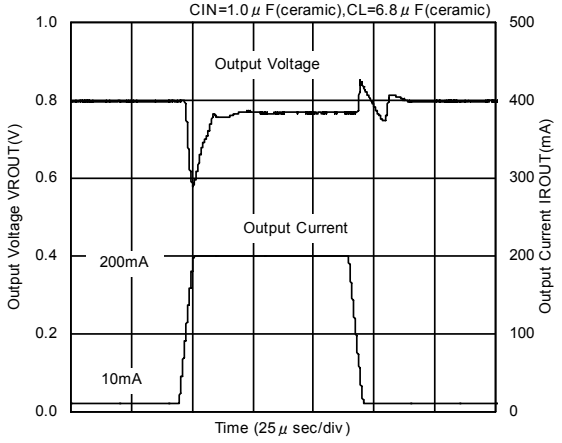
XC6402 Series (VR: 0.8V)

VIN=1.8V,tr=tf=5.0μsec,Topr=25℃
CIN=1.0μF(ceramic),CL=6.8μF(ceramic)



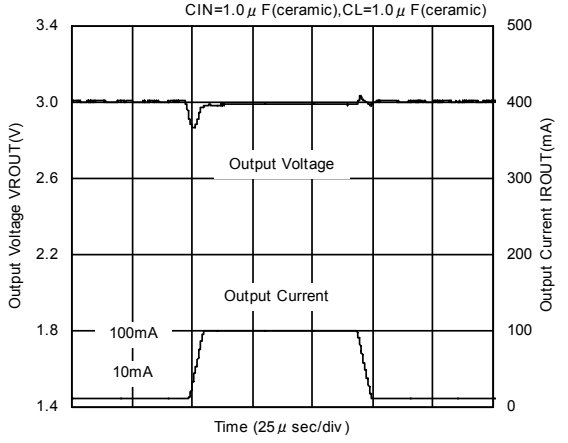
XC6402 Series (VR: 0.8V)

VIN=1.8V,tr=tf=5.0μsec,Topr=25℃
CIN=1.0μF(ceramic),CL=6.8μF(ceramic)



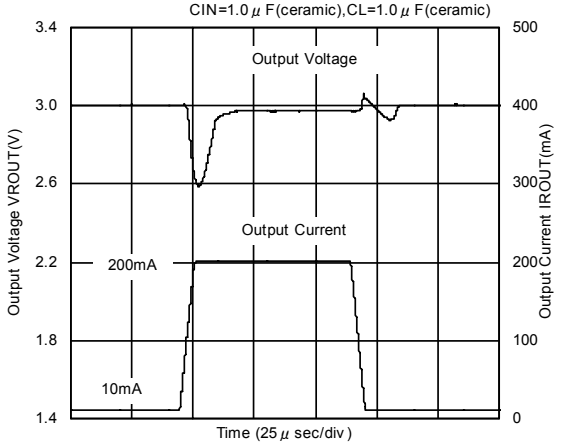
XC6402 Series (VR: 3.0V)

VIN=4.0V,tr=tf=5.0μsec,Topr=25℃,
CIN=1.0μF(ceramic),CL=1.0μF(ceramic)



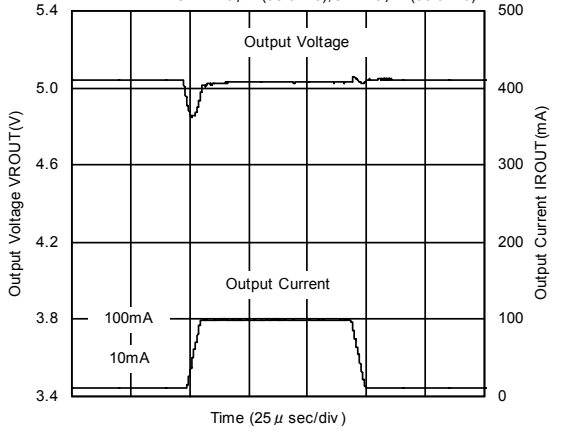
XC6402 Series (VR: 3.0V)

VIN=4.0V,tr=tf=5.0μsec,Topr=25℃
CIN=1.0μF(ceramic),CL=1.0μF(ceramic)



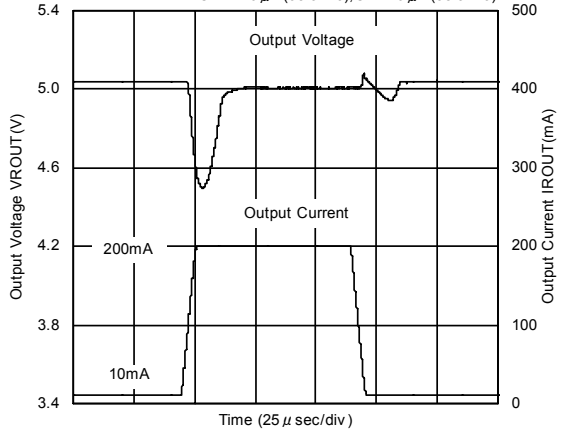
XC6402 Series (VR: 5.0V)

VIN=6.0V,tr=tf=5.0μsec,Topr=25℃
CIN=1.0μF(ceramic),CL=1.0μF(ceramic)



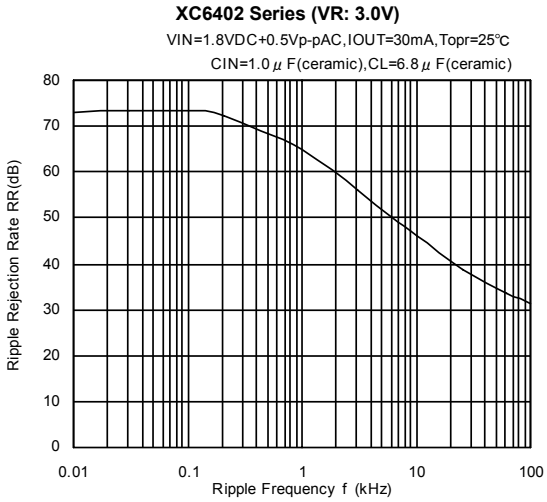
XC6402 Series (VR: 5.0V)

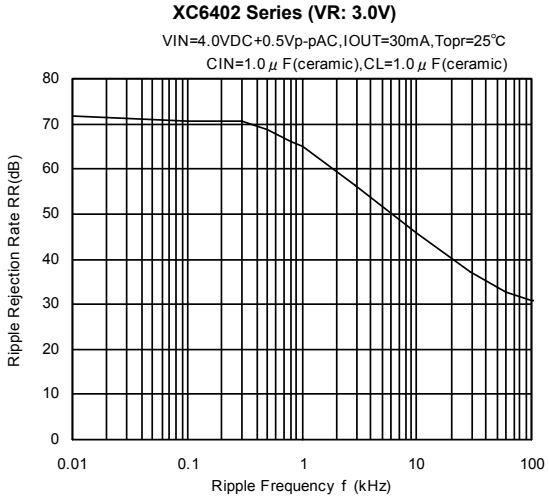
VIN=6.0V,tr=tf=5.0μsec,Topr=25℃
CIN=1.0μF(ceramic),CL=1.0μF(ceramic)

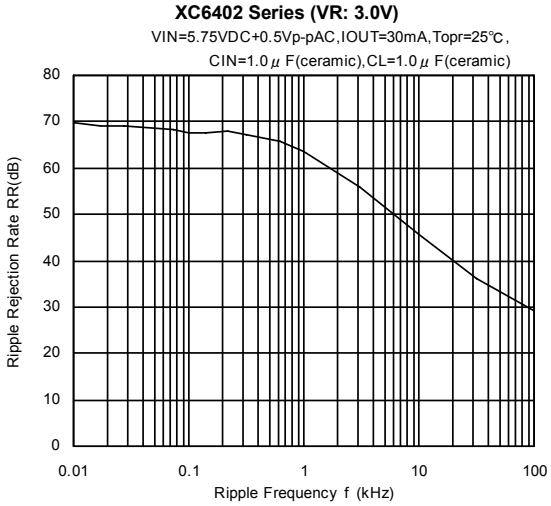


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(15) Ripple Rejection Rate





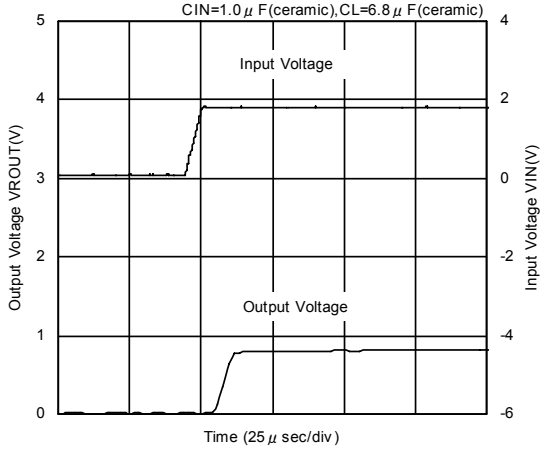


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(16) Rising Response Time

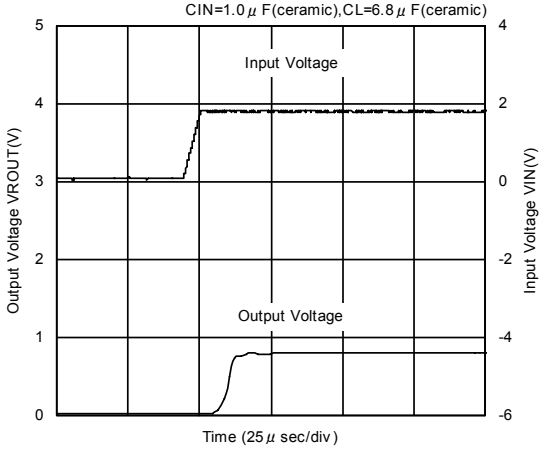
XC6402 Series (VR: 0.8V)

IOUT=30mA,tr=5.0μsec,Topr=25℃
CIN=1.0μF(ceramic),CL=6.8μF(ceramic)



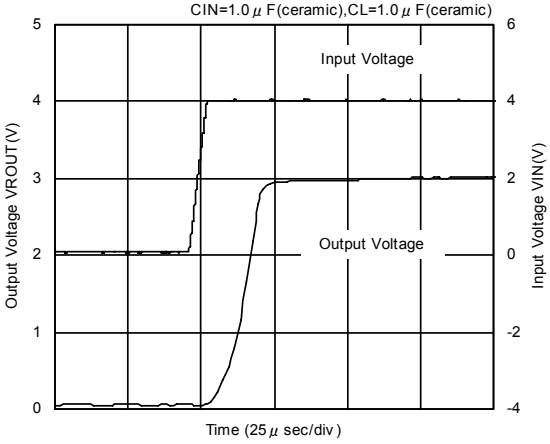
XC6402 Series (VR: 0.8V)

IOUT=200mA,tr=5.0μsec,Topr=25℃
CIN=1.0μF(ceramic),CL=6.8μF(ceramic)



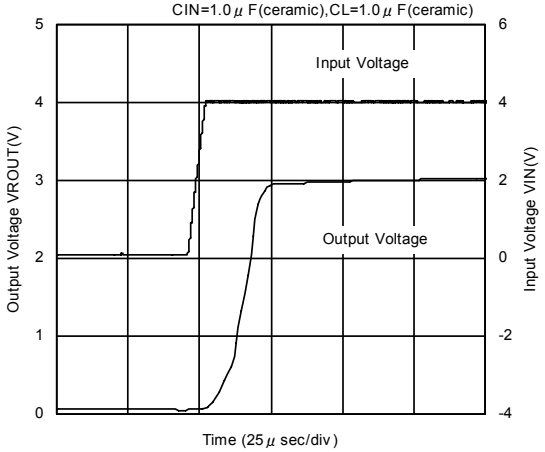
XC6402 Series (VR: 3.0V)

IOUT=30mA,tr=5.0μsec,Topr=25℃
CIN=1.0μF(ceramic),CL=1.0μF(ceramic)



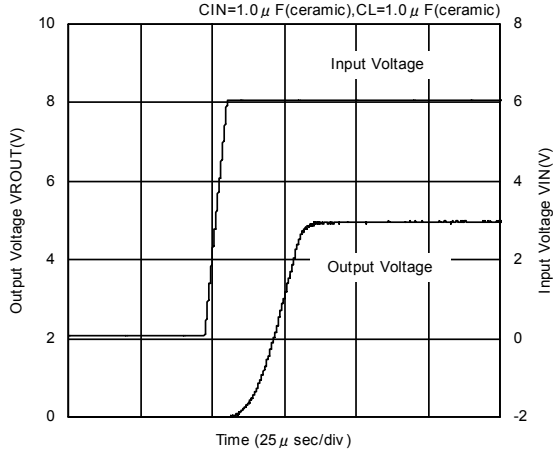
XC6402 Series (VR: 3.0V)

IOUT=200mA,tr=5.0μsec,Topr=25℃
CIN=1.0μF(ceramic),CL=1.0μF(ceramic)



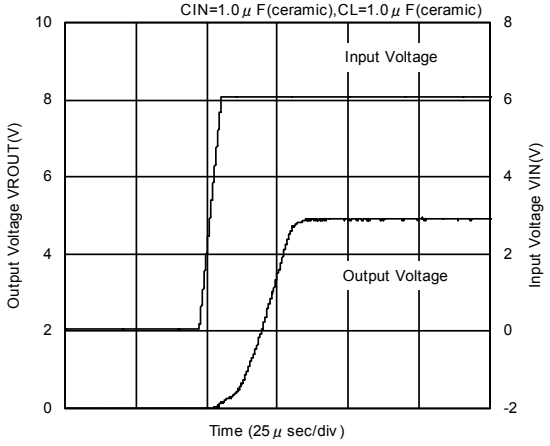
XC6402 Series (VR: 5.0V)

IOUT=30mA,tr=5.0μsec,Topr=25℃
CIN=1.0μF(ceramic),CL=1.0μF(ceramic)



XC6402 Series (VR: 5.0V)

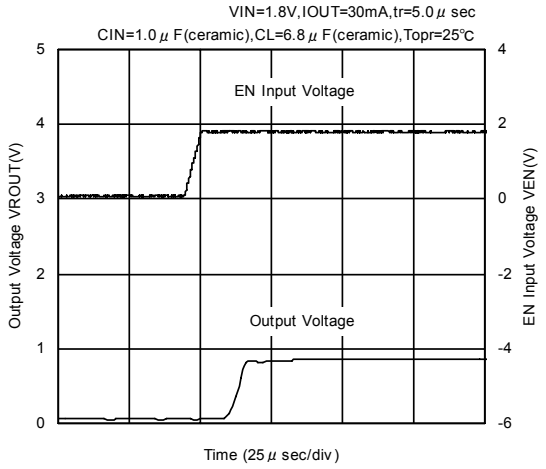
IOUT=200mA,tr=5.0μsec,Topr=25℃
CIN=1.0μF(ceramic),CL=1.0μF(ceramic)



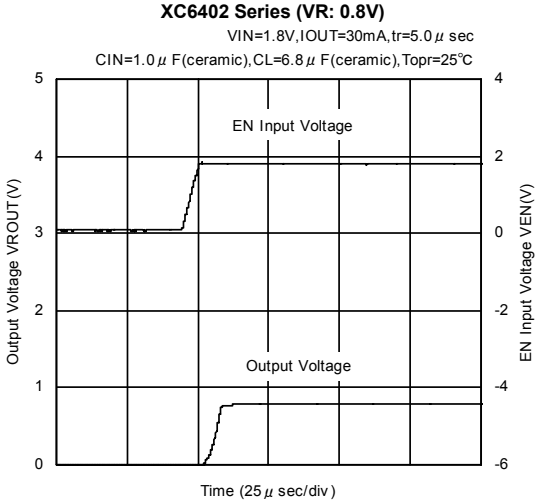
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(17) EN Rising Response Time (For C Series only)

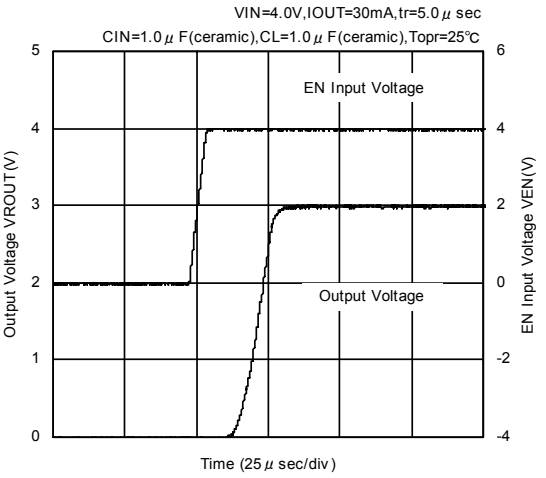
XC6402 Series (VR: 0.8V)



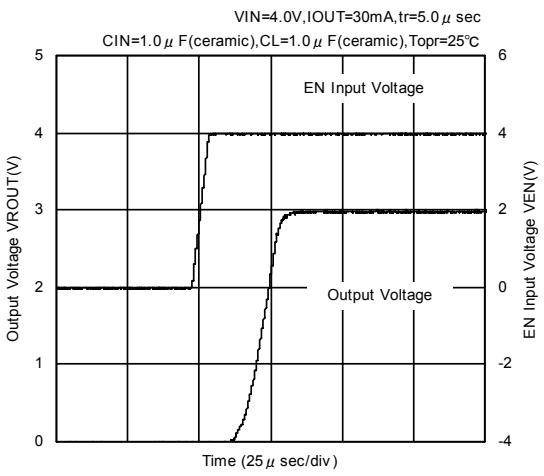
XC6402 Series (VR: 0.8V)



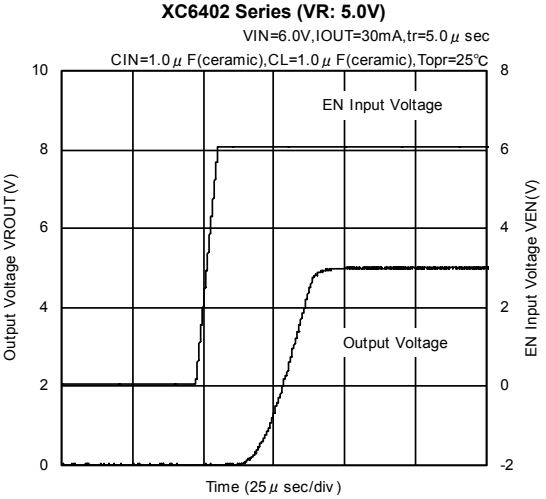
XC6402 Series (VR: 3.0V)



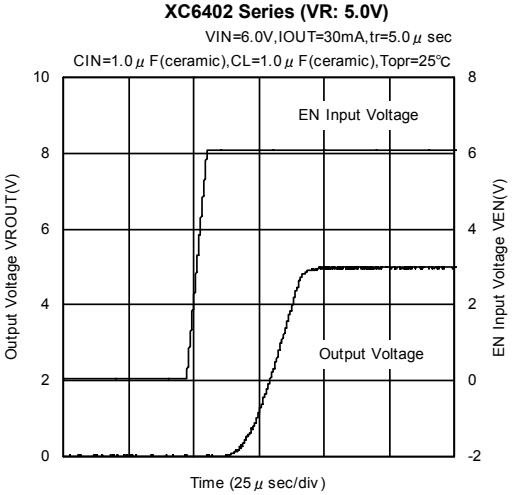
XC6402 Series (VR: 3.0V)



XC6402 Series (VR: 5.0V)

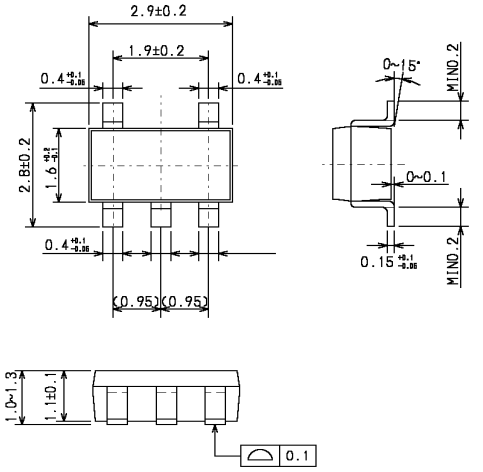


XC6402 Series (VR: 5.0V)

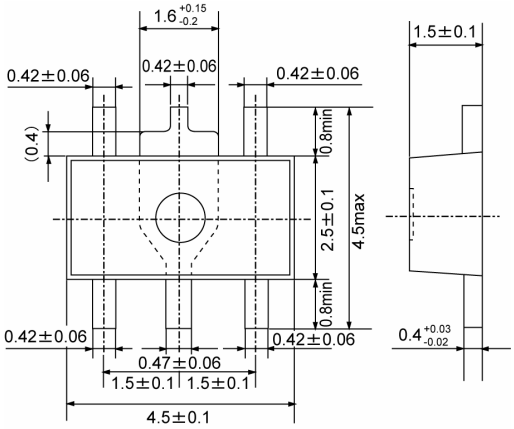


■PACKAGING INFORMATION

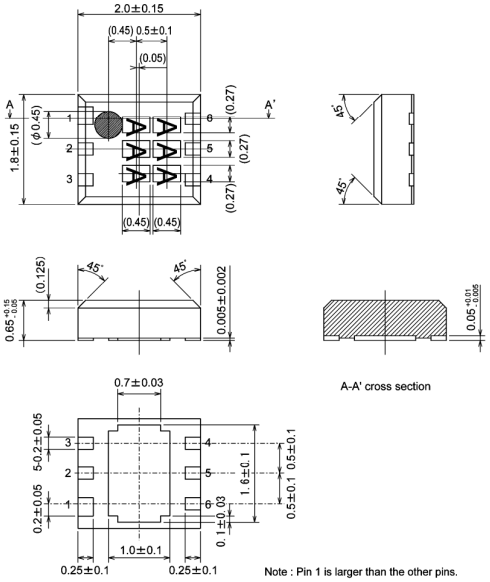
●SOT-25



●SOT-89-5

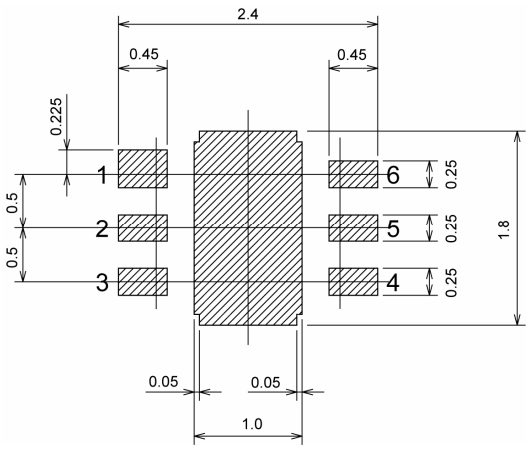


●USP-6B

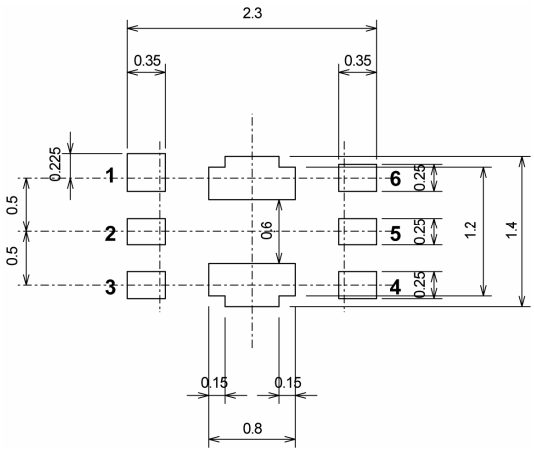


■PACKAGING INFORMATION (Continued)

●USP-6B Recommended Pattern Layout

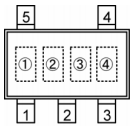


●USP-6B Recommended Metal Mask Design

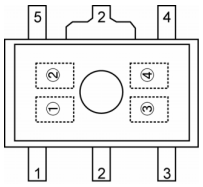


■MARKING RULE

●SOT-25 / SOT-89-5



SOT-25
(TOP VIEW)



SOT-89-5
(TOP VIEW)

① Represents product series

MARK	PRODUCT SERIES
2	XC6402xxxxxx

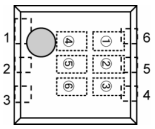
②③ Represents internal sequential number
Sequential numbering rule

ORDER	NUMBERING RULE
1	01~09
2	10~99
3	A0~A9
4	B0~B9
5	~Z9

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

④ Represents production lot number
0 to 9,A to Z reverse character 0 to 9, A to Z repeated (G, I, J, O, Q, W excepted)

●USP-6B



USP-6B
(TOP VIEW)

① Represents product series

MARK	PRODUCT SERIES
5	XC6402xxxxDx

② Represents optional functions

MARK	PRODUCT SERIES
C	XC6402CxxxDx
F	XC6402FxxxDx

③ Represents product type

MARK	CE/EN FUNCTION	EN/CE LOGIC	PULL UP/DOWN RESISTANCE	VD OUTPUT LOGIC	PRODUCT SERIES
A	Function	High Active	Pull-down Function	Detect L	XC6402xAxxDx
B	Function	High Active	Pull-down Function	Detect H	XC6402xBxxDx
C	Function	High Active	Pull-down Function	Detect L	XC6402xCxxDx
D	Function	High Active	Pull-down Function	Detect H	XC6402xDxxDx
E	Function	High Active	Nonfunctional	Detect L	XC6402xExxDx
F	Function	High Active	Nonfunctional	Detect H	XC6402xFxxDx
H	Function	High Active	Nonfunctional	Detect L	XC6402xHxxDx
K	Function	High Active	Nonfunctional	Detect H	XC6402xKxxDx
L	Function	Low Active	Pull-up Function	Detect L	XC6402xLxxDx
M	Function	Low Active	Pull-up Function	Detect H	XC6402xMxxDx
N	Function	Low Active	Pull-up Function	Detect L	XC6402xNxxDx
P	Function	Low Active	Pull-up Function	Detect H	XC6402xPxxDx
R	Function	Low Active	Nonfunctional	Detect L	XC6402xRxxDx
S	Function	Low Active	Nonfunctional	Detect H	XC6402xSxxDx
T	Function	Low Active	Nonfunctional	Detect L	XC6402xTxxDx
U	Function	Low Active	Nonfunctional	Detect H	XC6402xUxxDx
V	Nonfunctional	-	-	Detect L	XC6402xVxxDx
X	Nonfunctional	-	-	Detect H	XC6402xXxxDx
Y	Nonfunctional	-	-	Detect L	XC6402xYxxDx
Z	Nonfunctional	-	-	Detect H	XC6402xZxxDx

④,⑤ Represents output voltage and detect voltage
ex.)

MARK		OUTPUT VOLTAGE		PRODUCT SERIES
③	④	VROUT (V)	VDOUT (V)	
0	6	1.5	2.8	XC6402xx06Dx

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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