

300mA High Speed LDO Regulator with ON/OFF Switch

■ GENERAL DESCRIPTION

The XC6238 series is a high speed LDO regulator that features high accuracy, low noise, high ripple rejection, low dropout and low power consumption. The series consists of a voltage reference, an error amplifier, a driver transistor, a current limiter, a phase compensation circuit.

The CE function enables the circuit to be in stand-by mode by inputting low level signal. In the stand-by mode, the series enables the electric charge at the output capacitor C_L to be discharged via the internal switch, and as a result the V_{OUT} pin quickly returns to the V_{SS} level. The output stabilization capacitor C_L is also compatible with low ESR ceramic capacitors.

The output voltage is selectable in 0.05V increments within the range of 1.2V to 4.0V which fixed by laser trimming technologies. The over current protection circuit is built-in. This protection circuit will operate when the output current reaches current limit level.

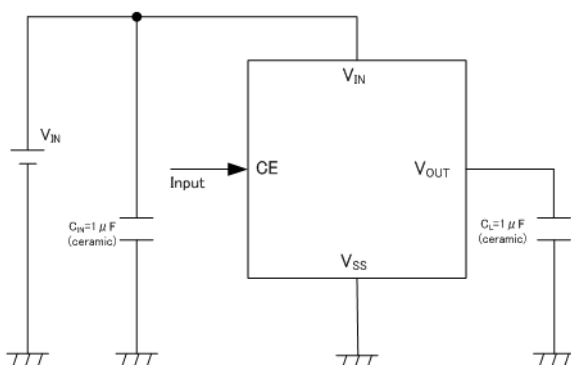
■ APPLICATIONS

- Mobile devices
- Wireless communications
- Modules
- Mobile phones

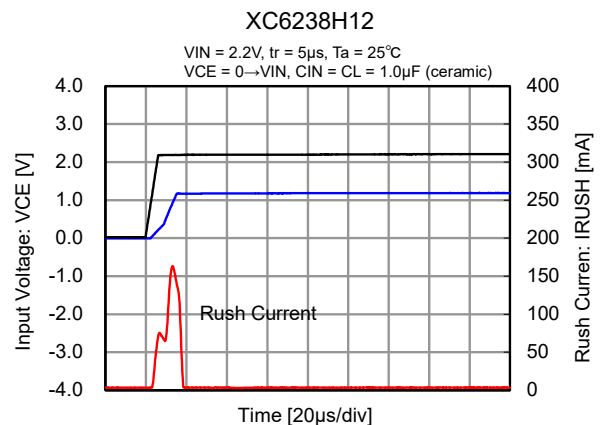
■ FEATURES

Maximum Output Current	: 300mA
Input Voltage Range	: 1.6 ~ 5.5V
Output Voltages	: 2.0 ~ 4.0V(Accuracy $\pm 1\%$) 1.2 ~ 1.95V(Accuracy $\pm 20mV$) 0.05V increments
Dropout Voltage	: 200mV@ $I_{OUT}=300mA$ ($V_{OUT}=3.0V$)
Low Power Consumption	: 100 μA
Stand-by Current	: 0.1 μA
High Ripple Rejection	: 80dB@ $f=1kHz$
Protection Circuits	: Current Limit (400mA) Short Circuit Protection Inrush Current Protection (Type H)
Low ESR Capacitors	: $C_{IN}=1\mu F$, $C_L=1\mu F$
CE Function	: Active High, C_L High Speed Discharge
Operating Ambient Temperature	: $-40^{\circ}C \sim 85^{\circ}C$
Small Package	: UFN-4A01
Environmentally Friendly	: EU RoHS Compliant, Pb Free

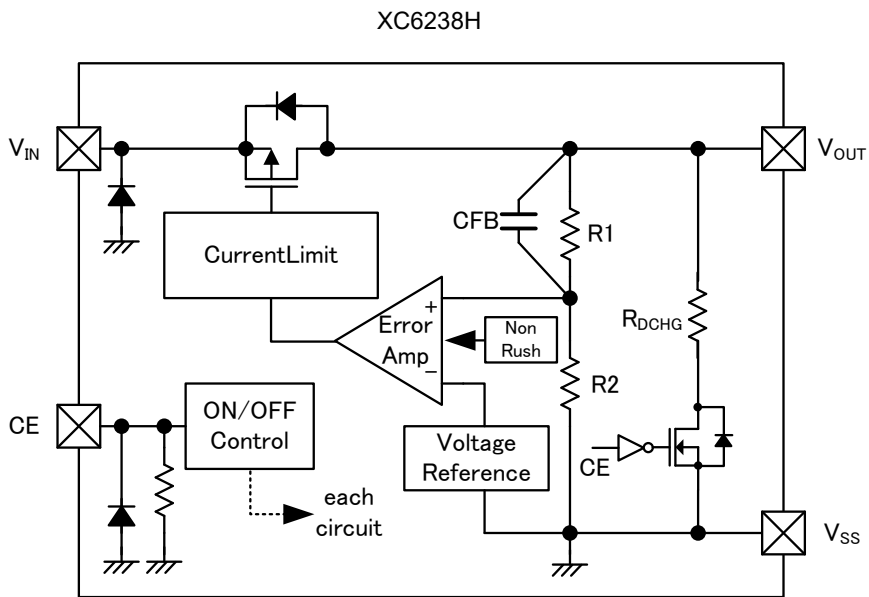
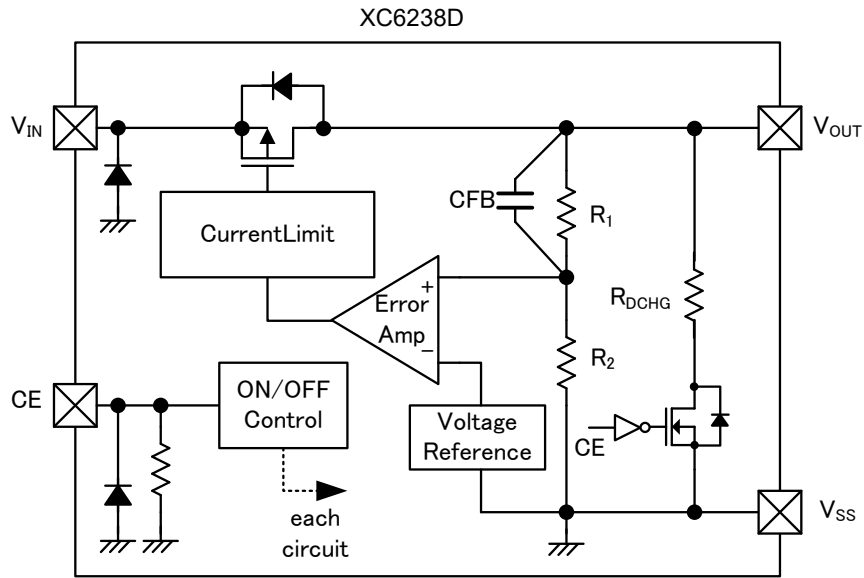
■ TYPICAL APPLICATION CIRCUIT



■ TYPICAL PERFORMANCE CHARACTERISTICS



■ BLOCK DIAGRAMS



* Diodes inside the circuits are ESD protection diodes and parasitic diodes.

■ PRODUCT CLASSIFICATION

● Ordering Information

XC6238①②③④⑤⑥-⑦ (*1)

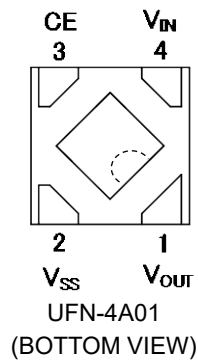
DESIGNATOR	ITEM	SYMBOL	DESCRIPTION
①	Regulator Type	D	No Inrush Current Control
		H	Inrush Current Prevention Circuit Built-in
②③	Output Voltage	12 ~ 40	ex.) 2.80V → ②=2, ③=8, ④=please see down below.
④	Output Voltage Accuracy	1	±1% ($V_{OUT} \geq 2.0V$) ±0.02V ($V_{OUT} < 2.0V$) In case of 2nd decimal place 0 (ex.2.80V → ④=1)
		B	±1% ($V_{OUT} \geq 2.0V$) ±0.02V ($V_{OUT} < 2.0V$) In case of 2nd decimal place 5 (ex.2.85V → ④=B)
⑤⑥-⑦ (*1)	Packages (Order Unit)	6R-G	UFN-4A01 (3,000pcs/Reel)

(*1) The "-G" suffix denotes Halogen and Antimony free as well as being fully EU RoHS compliant.

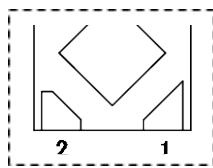
● Selection Guide

TYPE	CURRENT LIMIT	CE PULL-DOWN RESISTOR	C _L DISCHARGE	INRUSH CURRENT PROTECTION
D	Yes	Yes	Yes	No
H	Yes	Yes	Yes	Yes

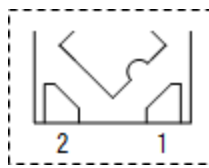
PIN CONFIGURATION



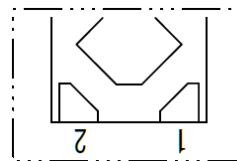
*Please note there are three types of metal plating of UFN-4A01 package; Au plating, Sn plating and Au flash Pd Plating.



Au plating



Sn plating



Au flash Pd plating

Reference picture: Identifying the types of pin plating

* The dissipation pad for the UFN-4A01 package should be solder-plated in reference 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 V_{SS} (No. 2) pin.

■ PIN ASSIGNMENT

PIN NUMBER	PIN NAME	FUNCTIONS
UFN-4A01		
1	V _{OUT}	Output
2	V _{SS}	Ground
3	CE	ON/OFF Control
4	V _{IN}	Power Supply Input

■ PIN FUNCTION ASSIGNMENT

PIN NAME	SIGNAL	STATUS
CE	L	Stand-by
	H	Active
	OPEN	Stand-by*

* An internal pull-down resistor maintains the CE pin voltage to be low.

■ ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATINGS	UNITS
V _{IN} Pin Voltage	V _{IN}	V _{SS} - 0.3 ~ V _{SS} + 7.0	V
V _{OUT} Pin Current	I _{OUT}	500 ^{(*)1}	mA
V _{OUT} Pin Voltage	V _{OUT}	V _{SS} - 0.3 ~ V _{IN} + 0.3	V
CE Pin Voltage	V _{CE}	V _{SS} - 0.3 ~ V _{SS} + 7.0	V
Power Dissipation	Pd	100	mW
		550 (40mm x 40mm Standard Board) ^{(*)2}	
Operating Ambient Temperature	T _{opr}	-40 ~ 85	°C
Storage Temperature	T _{stg}	-55 ~ 125	°C

* All voltages are described based on the V_{SS}.

^{(*)1} I_{OUT} ≤ Pd / (V_{IN} - V_{OUT})

^{(*)2} The power dissipation figure shown is PCB mounted and is for reference only.

Please refer to PACKAGING INFORMATION for the mounting condition.

ELECTRICAL CHARACTERISTICS

Ta=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUIT
Output Voltage	V _{OUT(E)} ^(*1)	V _{OUT(T)} ≥ 2.0V, V _{CE} =V _{IN} , I _{OUT} =10mA	V _{OUT(T)} × 0.99 ^(*2)	V _{OUT(T)} ^(*2)	V _{OUT(T)} × 1.01 ^(*2)	V	①
		V _{OUT(T)} < 2.0V, V _{CE} =V _{IN} , I _{OUT} = 10mA	V _{OUT(T)} - 20mV ^(*2)	V _{OUT(T)} ^(*2)	V _{OUT(T)} + 20mV ^(*2)		
Maximum Output Current	I _{OUTMAX}	V _{CE} =V _{IN}	300	-	-	mA	①
Load Regulation	ΔV _{OUT}	V _{CE} =V _{IN} , 0.1mA ≤ I _{OUT} ≤ 300mA	-	25	45	mV	①
Dropout Voltage	V _{dif} ^(*3)	V _{CE} =V _{IN} , I _{OUT} =300mA	-	E-1		mV	①
Supply Current	I _{SS}	V _{CE} =V _{IN}	-	100	220	μA	②
Stand-by Current	I _{STB}	V _{CE} =V _{SS}	-	0.01	0.4	μA	②
Line Regulation	ΔV _{OUT} / (ΔV _{IN} · V _{OUT})	V _{OUT(T)} +0.5V ≤ V _{IN} ≤ 5.5V V _{CE} =V _{IN} , I _{OUT} =50mA	-	0.01	0.1	%/V	①
Input Voltage	V _{IN}	-	1.6	-	5.5	V	①
Output Voltage Temperature Characteristics	ΔV _{OUT} / (ΔT _{opr} · V _{OUT})	V _{CE} =V _{IN} , I _{OUT} =10mA -40°C ≤ Ta ≤ 85°C	-	±100	-	ppm/°C	①
Power Supply Rejection Ratio	PSRR	V _{OUT(T)} < 2.5V V _{IN} =3.0V _{DC} +0.5V _{p-pAC} V _{CE} =V _{OUT(T)} +1.0V I _{OUT} =30mA, f=1kHz	-	80	-	dB	③
		V _{OUT(T)} ≥ 2.5V V _{IN} ={V _{OUT(T)} +1.0}V _{DC} +0.5V _{p-pAC} V _{CE} =V _{OUT(T)} +1.0V I _{OUT} =30mA, f=1kHz					
Current Limit	I _{LIM}	V _{CE} =V _{IN}	310	400	-	mA	①
Short Current	I _{SHORT}	V _{CE} =V _{IN} , V _{OUT} =V _{SS}	-	50	-	mA	①
CE High Level Voltage	V _{CEH}	-	1.0	-	5.5	V	④
CE Low Level Voltage	V _{CEL}	-	0	-	0.3	V	④
CE High Level Current	I _{CEH}	V _{CE} =V _{IN} =5.5V	3.0	5.5	9.0	μA	④
CE High Level Current	I _{CEL}	V _{CE} =V _{SS}	-0.1	-	0.1	μA	④
C _L Discharge Resistance	R _{DCHG}	V _{IN} =5.5V, V _{OUT} =2.0V, V _{CE} =V _{SS}	-	300	-	Ω	①
Inrush Current (Type H)	I _{RUSH}	V _{IN} =5.5V, V _{CE} =0→5.5V	-	150	-	mA	⑤

NOTE:

(*1)V_{OUT(E)}: Effective output voltage

(i.e. the output voltage when "V_{OUT(T)}+1.0V" is provided at the V_{IN} pin while maintaining a certain I_{OUT} value.)

(*2)V_{OUT(T)}: Nominal output voltage

(*3)V_{dif}=V_{IN1}^(*4)-V_{OUT1}^(*5) (V_{IN1} ≥ 1.6V)

(*4)V_{IN1}=The input voltage when V_{OUT1} appears as input voltage is gradually decreased.

(*5)V_{OUT1}=A voltage equal to 98% of the output voltage whenever an amply stabilized V_{OUT(T)}+1.0V is input for every I_{OUT}.

(*6)Unless otherwise stated regarding input voltage conditions, V_{IN}=V_{OUT(T)}+1.0V.

■ OUTPUT VOLTAGE CHART

● Voltage Chart 1

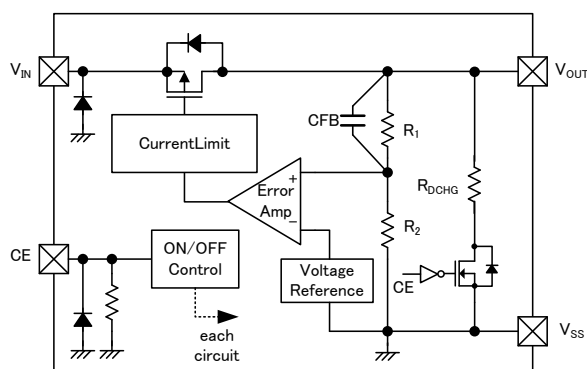
NOMINAL OUTPUT VOLTAGE (V)	OUTPUT VOLTAGE(±1%) (V)		DROPOUT VOLTAGE (mV) E-1	
V _{OUT(T)}	V _{OUT(E)}		V _{dif}	
	MIN.	MAX.	TYP.	MAX.
1.20	1.1800	1.2200	480	630
1.25	1.2300	1.2700		
1.30	1.2800	1.3200	440	580
1.35	1.3300	1.3700		
1.40	1.3800	1.4200	420	520
1.45	1.4300	1.4700		
1.50	1.4800	1.5200	420	460
1.55	1.5300	1.5700		
1.60	1.5800	1.6200	400	440
1.65	1.6300	1.6700		
1.70	1.6800	1.7200		
1.75	1.7300	1.7700		
1.80	1.7800	1.8200	300	410
1.85	1.8300	1.8700		
1.90	1.8800	1.9200		
1.95	1.9300	1.9700		
2.00	1.9800	2.0200		
2.05	2.0295	2.0705	270	380
2.10	2.0790	2.1210		
2.15	2.1285	2.1715		
2.20	2.1780	2.2220		
2.25	2.2275	2.2725		
2.30	2.2770	2.3230		
2.35	2.3265	2.3735		
2.40	2.3760	2.4240		
2.45	2.4255	2.4745		
2.50	2.4750	2.5250		
2.55	2.5245	2.5755	240	350
2.60	2.5740	2.6260		
2.65	2.6235	2.6765		
2.70	2.6730	2.7270		
2.75	2.7225	2.7775		

OUTPUT VOLTAGE CHART

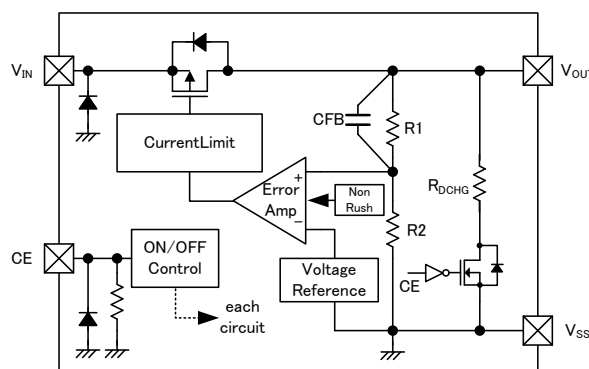
● Voltage Chart 1

NOMINAL OUTPUT VOLTAGE (V)	OUTPUT VOLTAGE(±1%) (V)		DROPOUT VOLTAGE (mV) E-1	
V _{OUT(T)}	V _{OUT(E)}		V _{dif}	
	MIN.	MAX.	TYP.	MAX.
2.80	2.7720	2.8280	240	350
2.85	2.8215	2.8785		
2.90	2.8710	2.9290		
2.95	2.9205	2.9795		
3.00	2.9700	3.0300	200	305
3.05	3.0195	3.0805		
3.10	3.0690	3.1310		
3.15	3.1185	3.1815		
3.20	3.1680	3.2320		
3.25	3.2175	3.2825		
3.30	3.2670	3.3330		
3.35	3.3165	3.3835		
3.40	3.3660	3.4340		
3.45	3.4155	3.4845		
3.50	3.4650	3.5350		
3.55	3.5145	3.5855		
3.60	3.5640	3.6360		
3.65	3.6135	3.6865		
3.70	3.6630	3.7370		
3.75	3.7125	3.7875		
3.80	3.7620	3.8380		
3.85	3.8115	3.8885		
3.90	3.8610	3.9390		
3.95	3.9105	3.9895		
4.00	3.9600	4.0400		

■ OPERATIONAL EXPLANATION



XC6238D



XC6238H

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 V_{OUT} pin is then driven by the subsequent output signal. The output voltage at the V_{OUT} pin is controlled and stabilized by a system of negative feedback. The current limit circuit and short circuit protection operate in relation to the level of output current and heat dissipation. Further, the IC's internal circuitry

<Low ESR Capacitor>

The XC6238 series needs an output capacitor C_L for phase compensation. Please place an output capacitor (C_L) at the output pin (V_{OUT}) and the ground pin (V_{SS}) as close as possible. Please use the output capacitor (C_L) is 1.0 μ F or larger. For a stable power input, please connect an input capacitor (C_{IN}) of 1.0 μ F between the V_{IN} pin and the V_{SS} pin.

<Current Limiter, Short-Circuit Protection>

The XC6238 has current limiter and droop shape of fold-back circuit. When the load current reaches the current limit, the droop current limiter circuit operates and the output voltage drops. When the output voltage dropped, the fold-back circuit operates and the output current goes to decrease. The output current finally falls at the level of 50mA when the output pin is short-circuited.

<CE Pin>

The IC's internal circuitry can be shutdown via the signal from the CE pin. In shutdown mode, the XC6238 series enables the electric charge at the output capacitor (C_L) to be discharged via the internal switch located between the V_{OUT} and V_{SS} pins, and as a result the V_{OUT} pin quickly returns to the V_{SS} level. The XC6238 series has a pull-down resistor at the CE pin inside, so that the CE pin input current flows.

<Inrush Current Protection>

The inrush current protection circuit is built in the XC6238H.

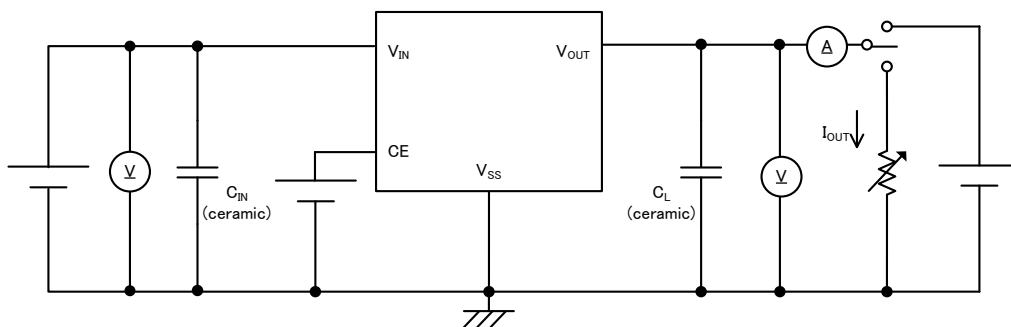
When the IC starts to operate, the protection circuit limits the inrush current from input pin (V_{IN}) to output pin (V_{OUT}) to charge C_L capacitor.

■ NOTES ON USE

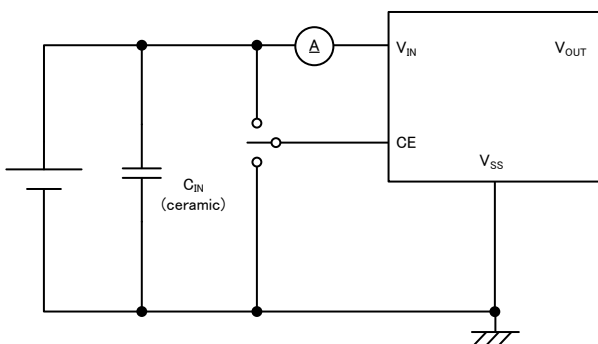
1. For temporary, transitional voltage drop or voltage rising phenomenon, the IC is liable to malfunction should the ratings be exceeded.
2. Where wiring impedance is high, operations may become unstable due to the noise and/or phase lag depending on output current. Please strengthen V_{IN} and V_{SS} wiring in particular.
3. The input capacitor C_{IN} and the output capacitor C_L should be placed to the as close as possible with a shorter wiring.
4. The IC is controlled with constant current start-up. Start-up sequence control is requested to draw a load current after even nominal output voltage rising up the output voltage.
5. Torex places an importance on improving our products and its reliability. However, by any possibility, we would request user fail-safe design and post-aging treatment on system or equipment.

TEST CIRCUITS

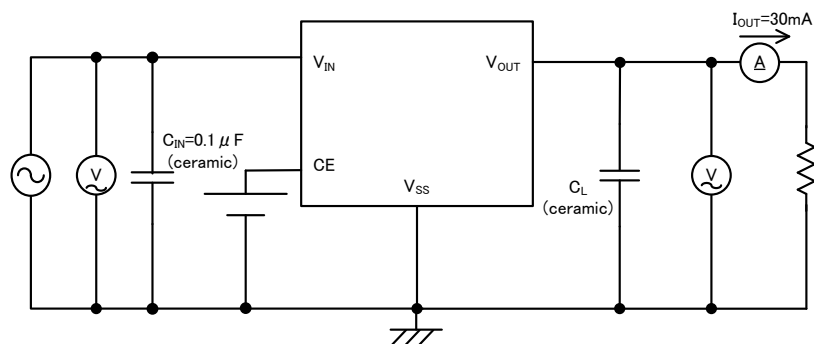
● Circuit ①



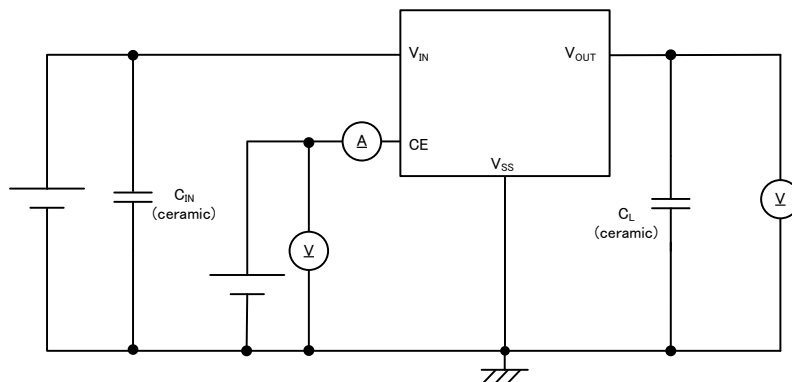
● Circuit ②



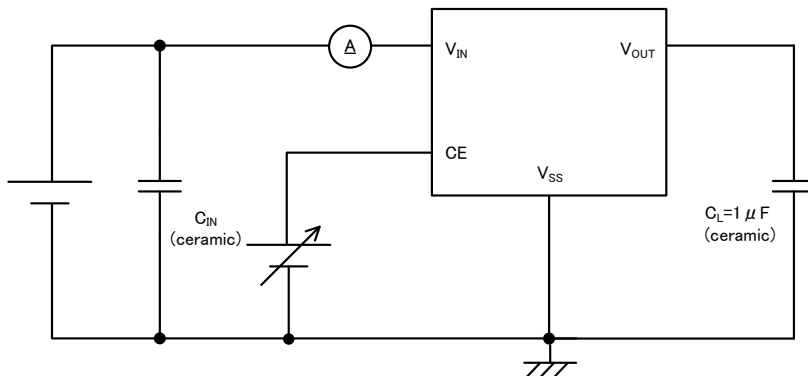
● Circuit ③



● Circuit ④

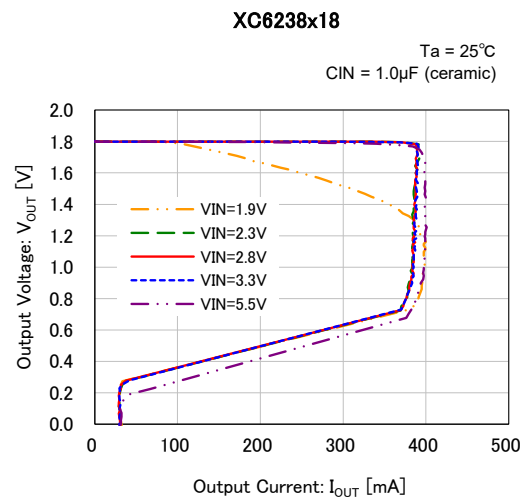
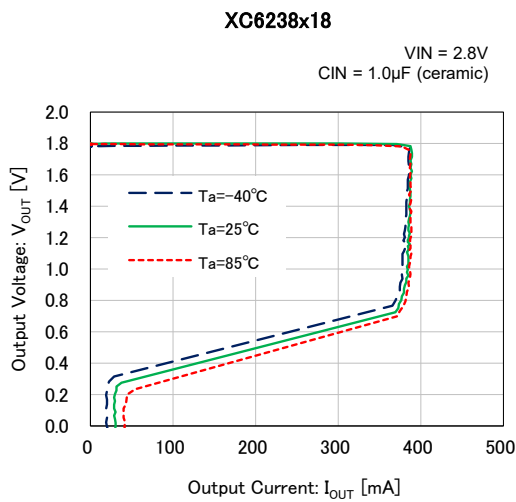
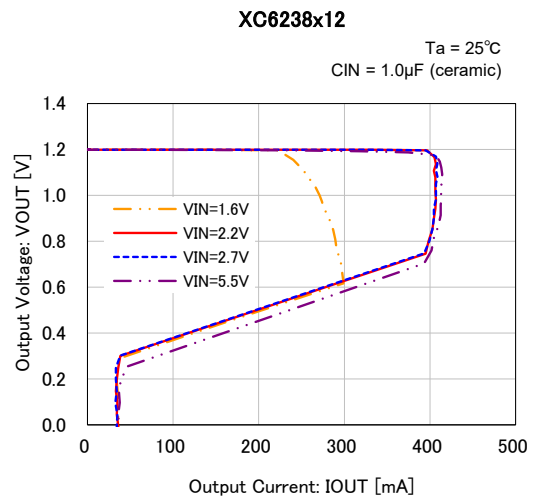
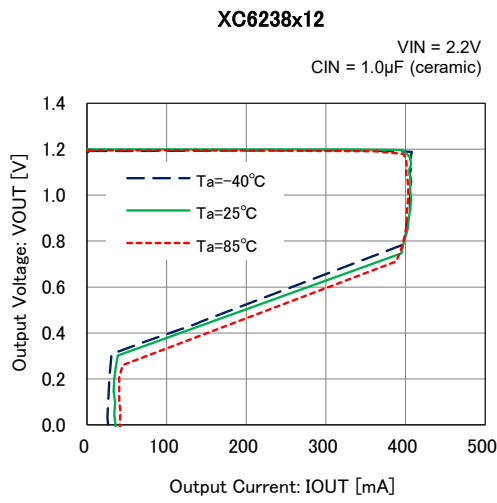


● Circuit ⑤



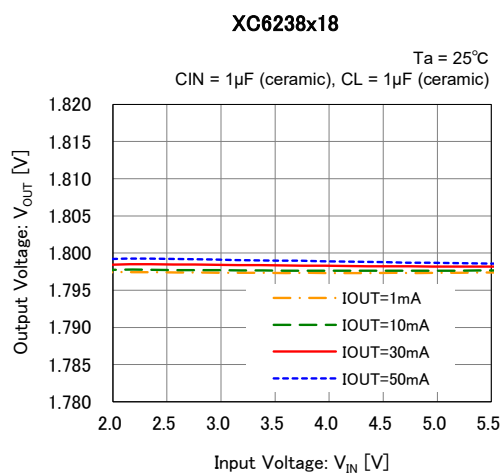
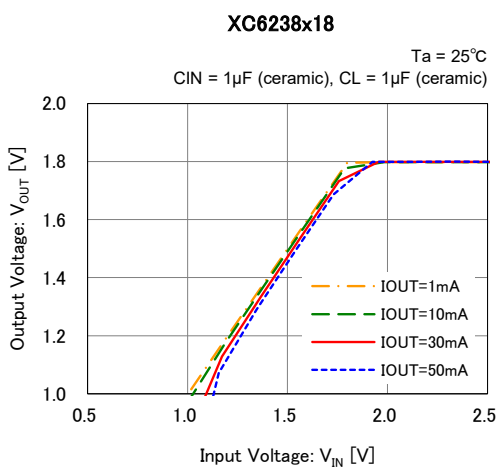
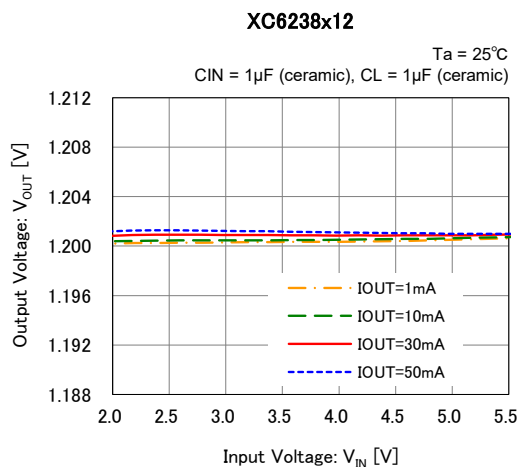
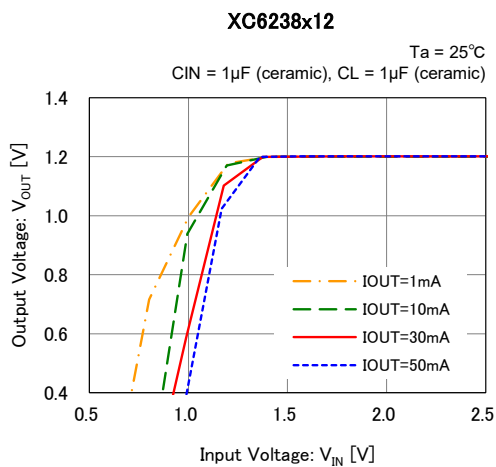
TYPICAL PERFORMANCE CHARACTERISTICS

(1) Output Voltage vs. Output Current



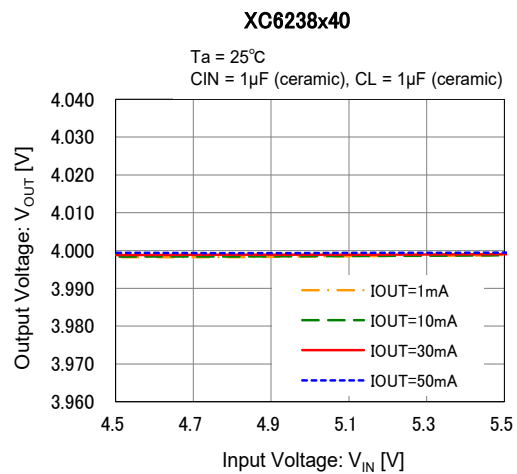
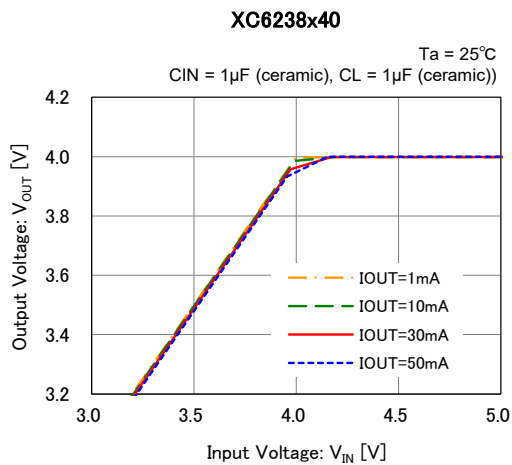
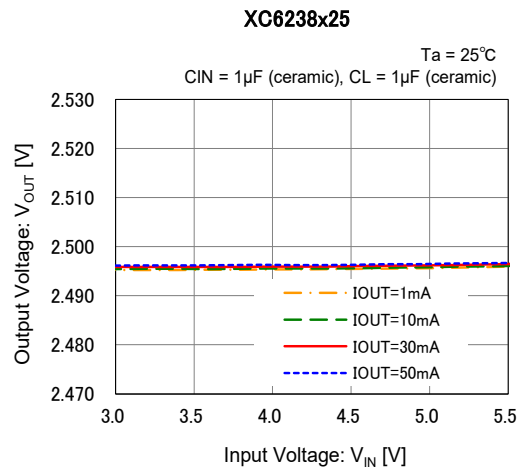
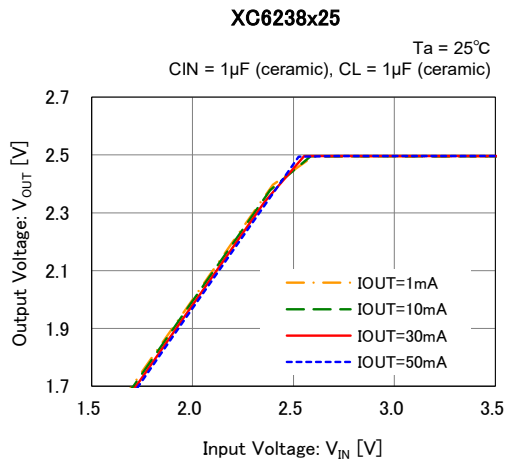
■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2) Output Voltage vs. Input Voltage

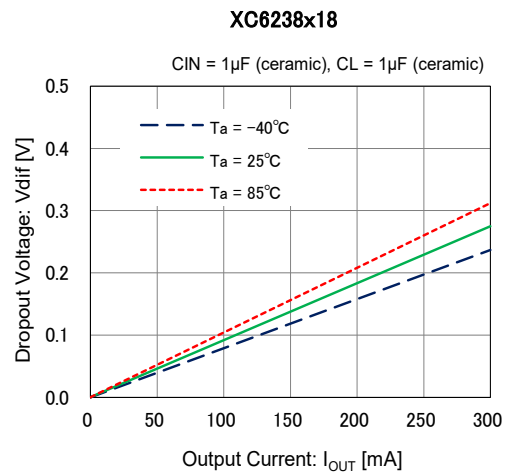
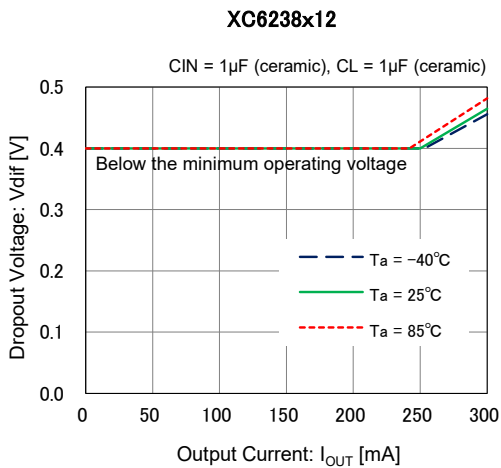


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2) Output Voltage vs. Input Voltage

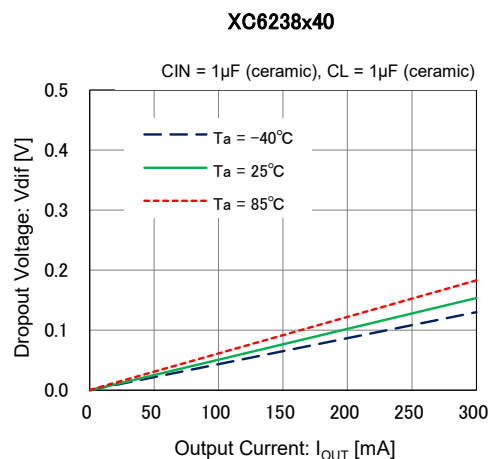
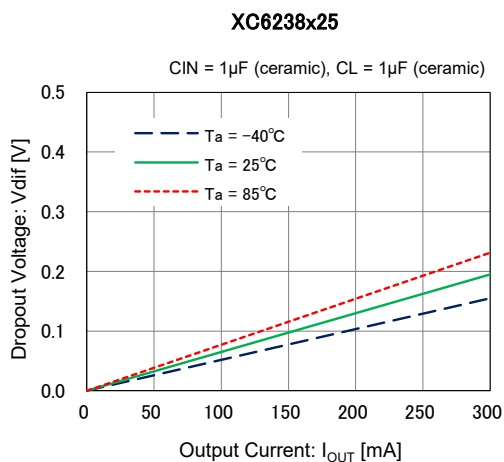


(3) Dropout Voltage vs. Output Current

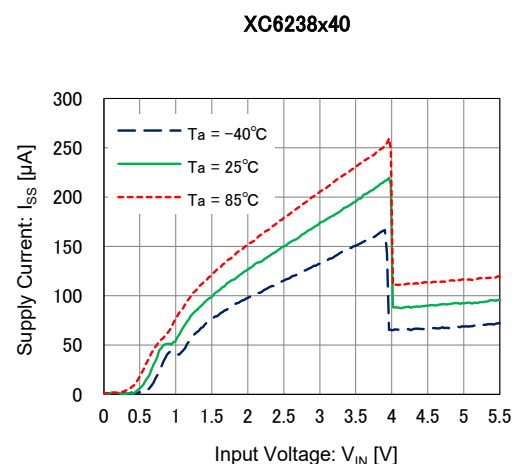
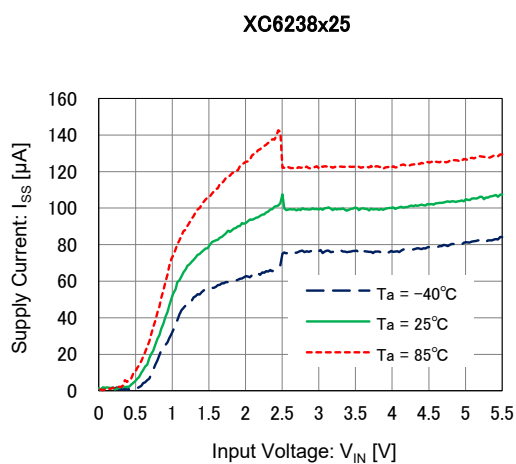
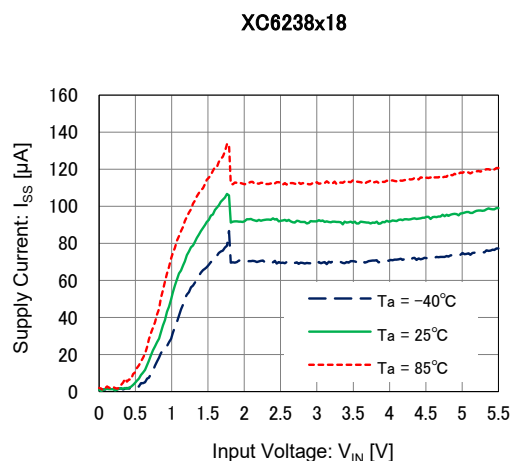
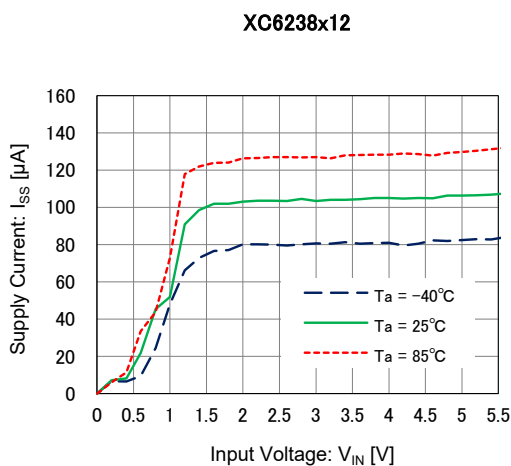


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(3) Dropout Voltage vs. Output Current

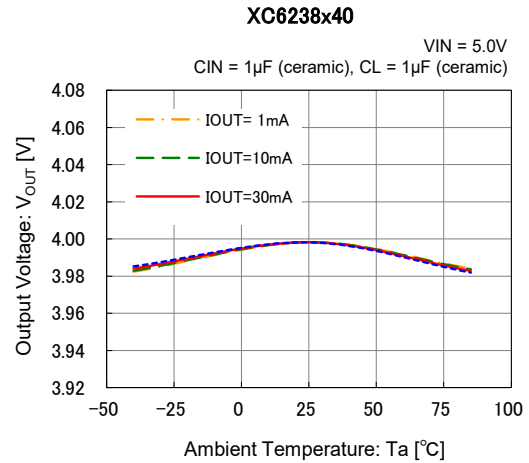
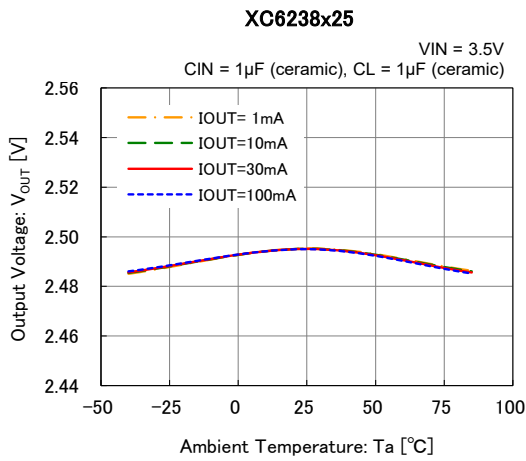
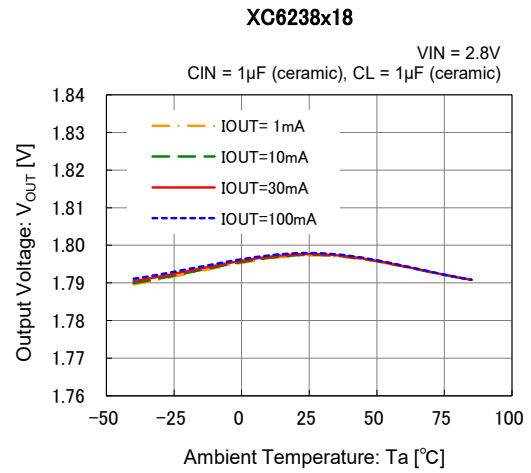
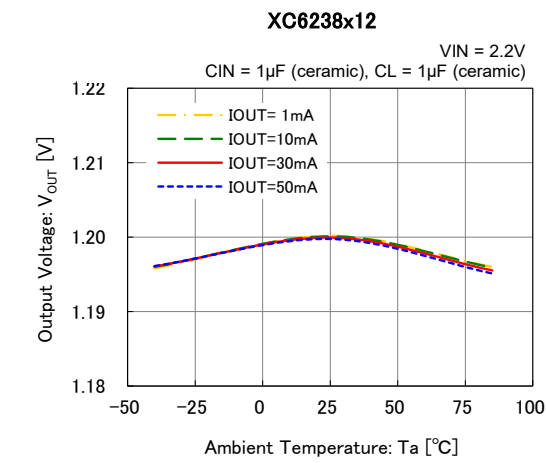


(4) Supply Current vs. Input Voltage

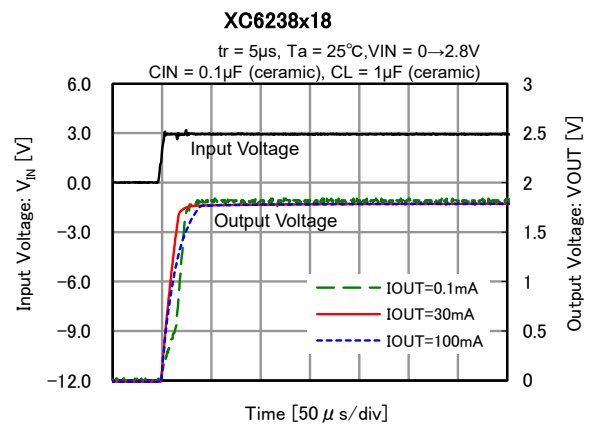
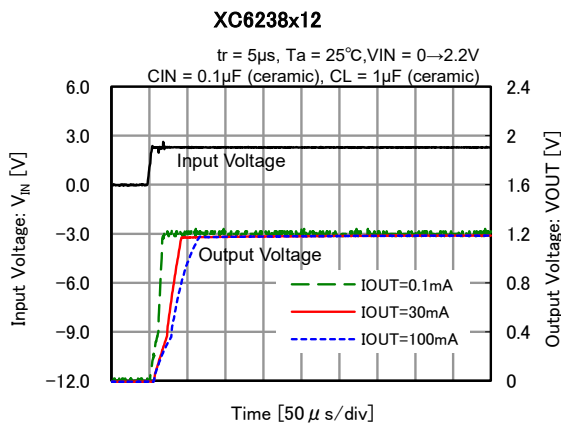


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(5) Output Voltage vs. Ambient Temperature

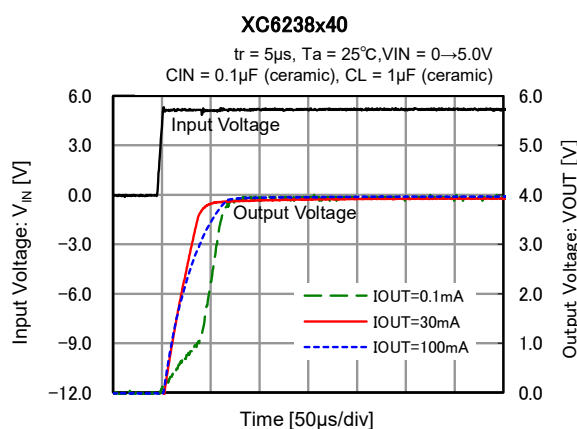
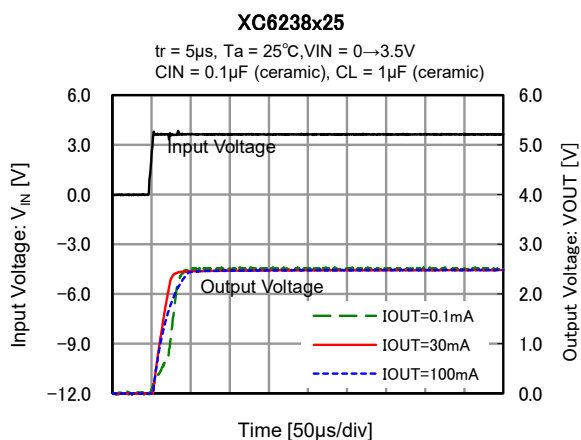


(6) Rising Response Time

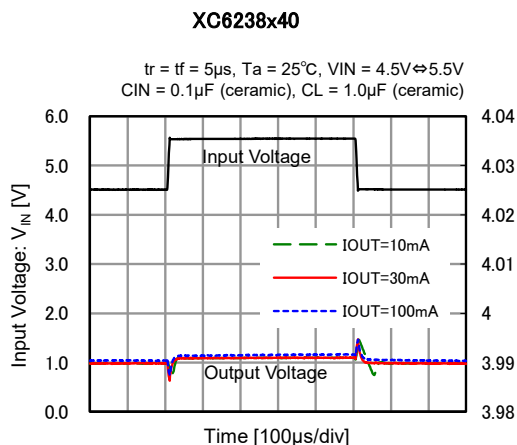
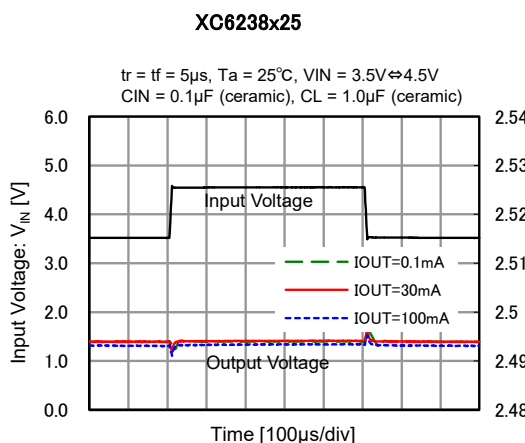
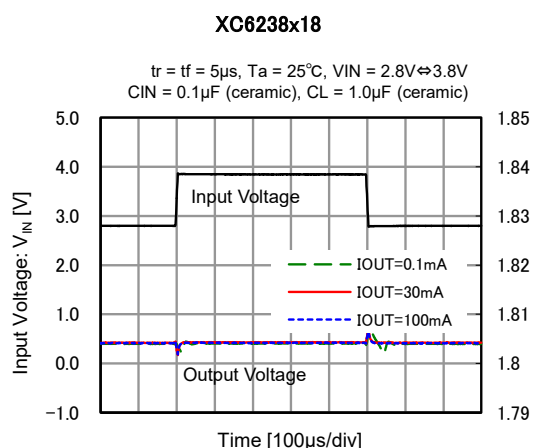
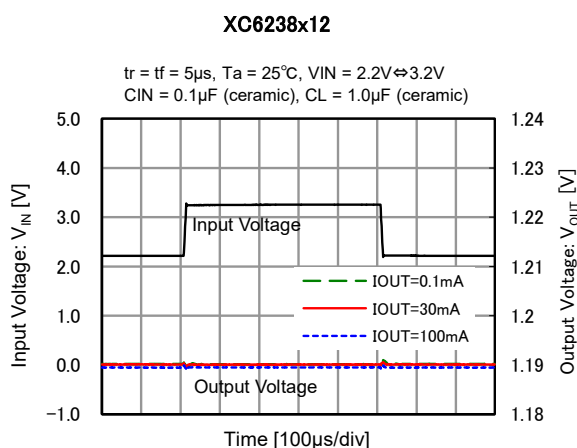


■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(6) Rising Response Time

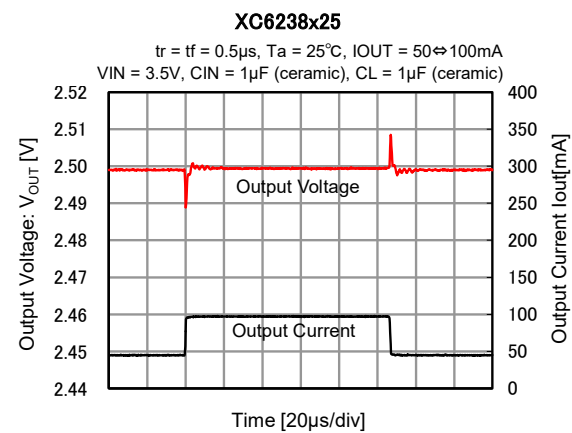
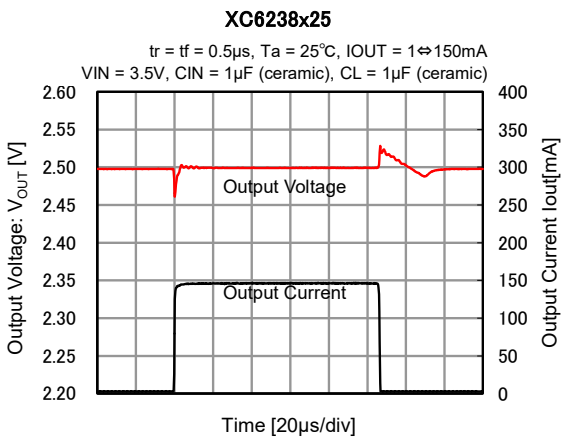
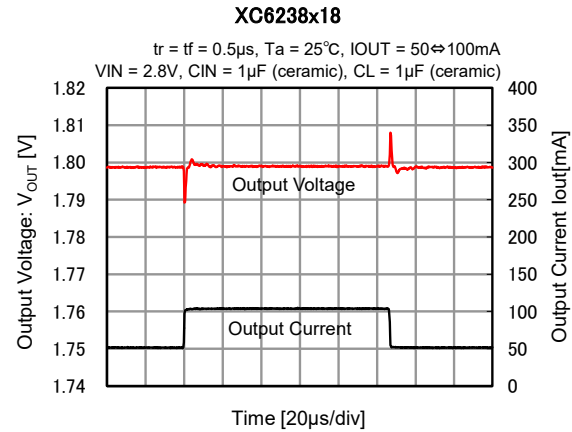
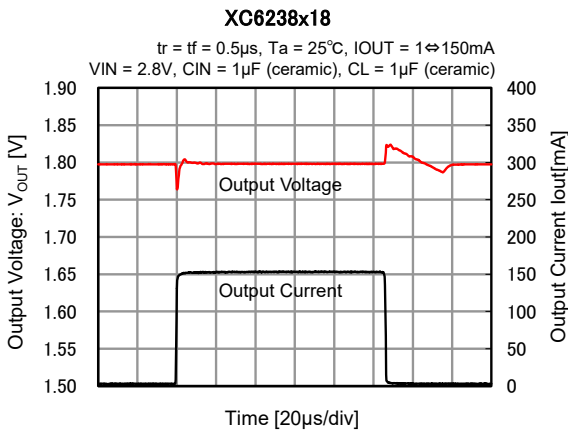
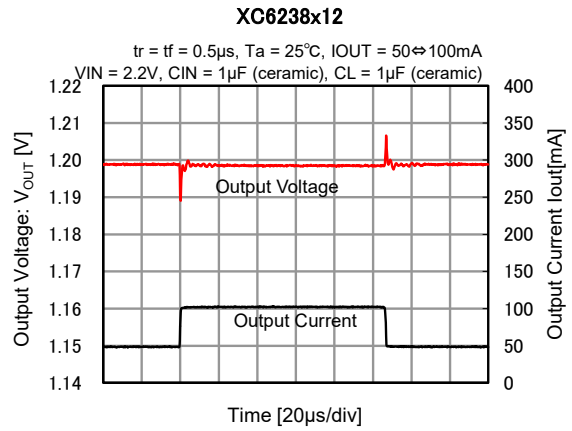
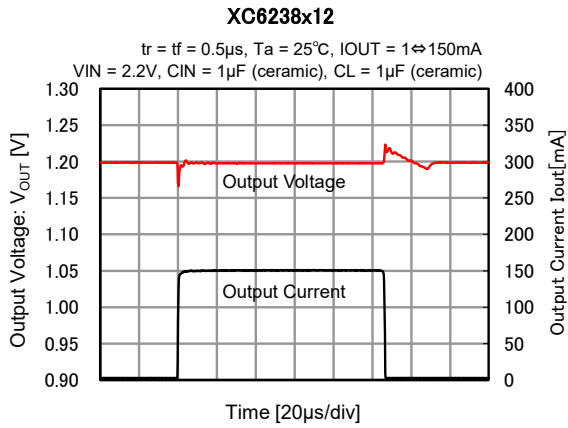


(7) Input Transient Response



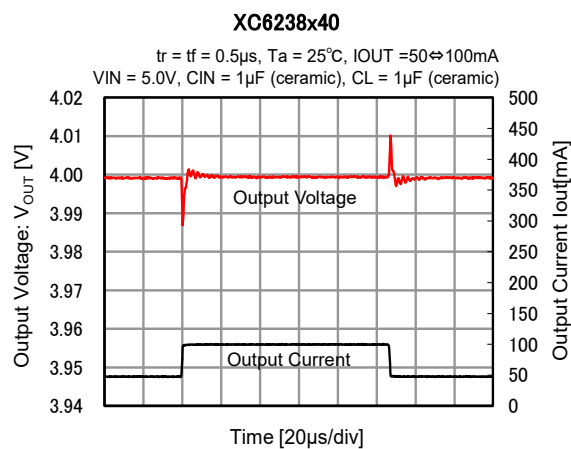
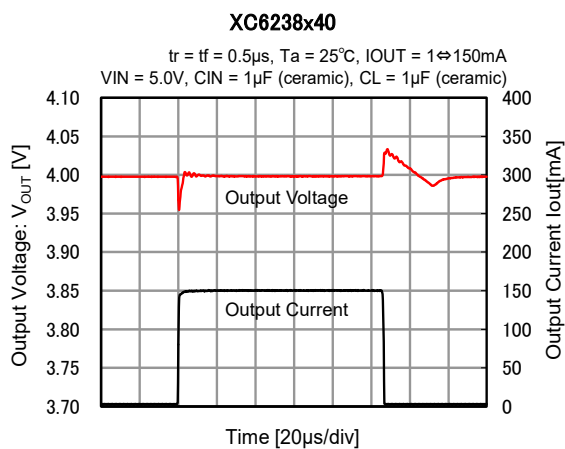
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(8) Load Transient Response ($t_r=t_f=0.5\mu s$)

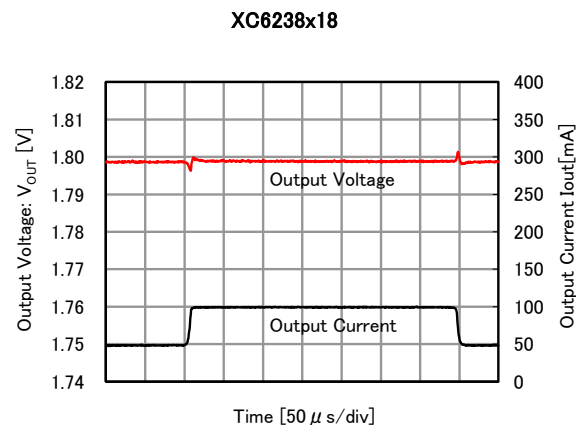
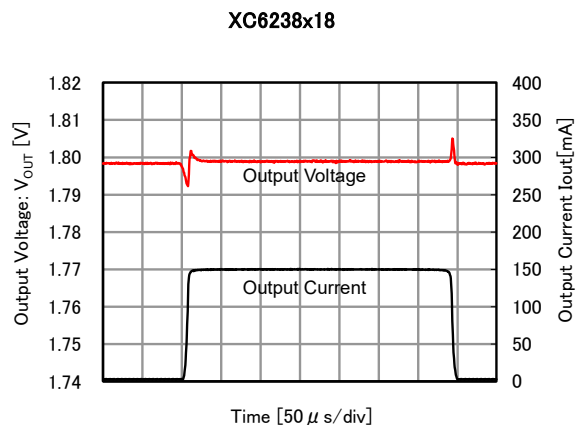
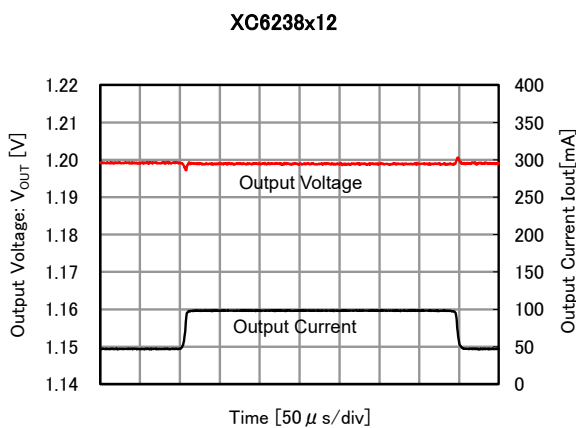
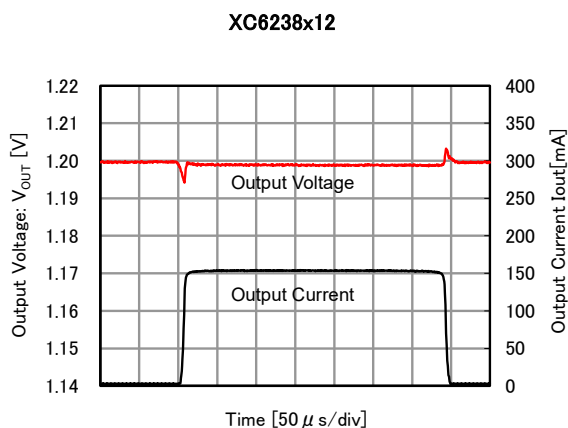


■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(8) Load Transient Response ($t_r=t_f=0.5\mu s$)

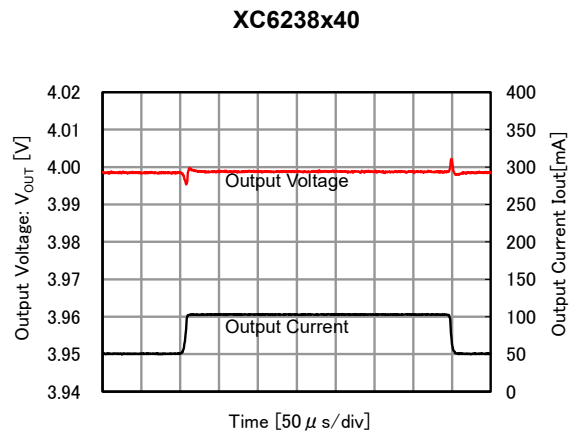
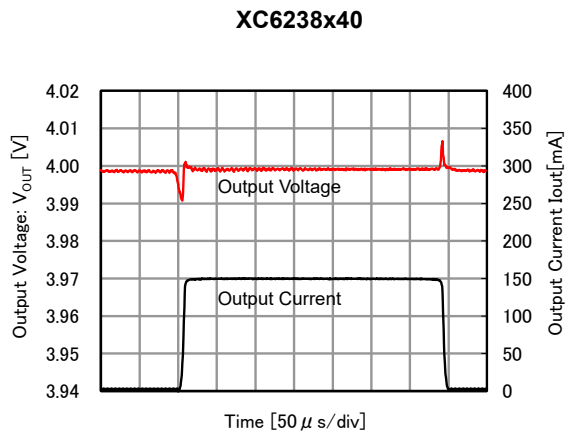
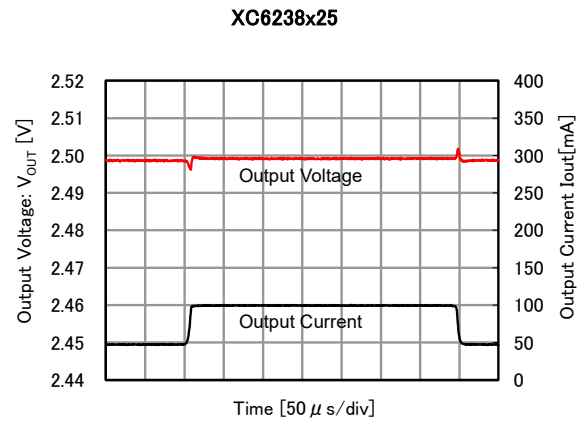
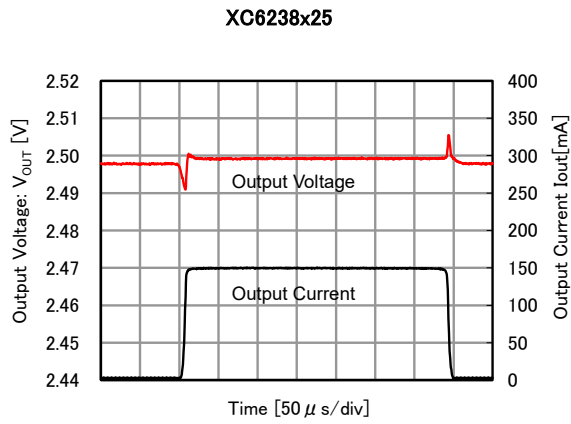


(8) Load Transient Response ($t_r=t_f=5\mu s$)

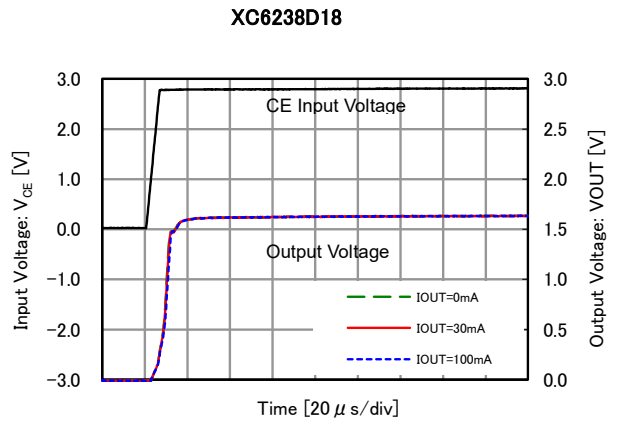
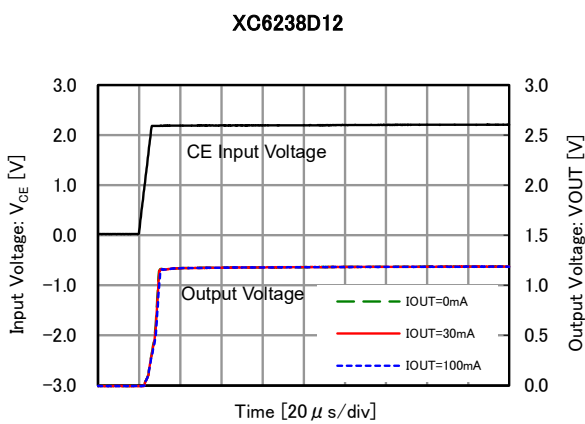


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(8) Load Transient Response ($t_r=t_f=5\mu s$)



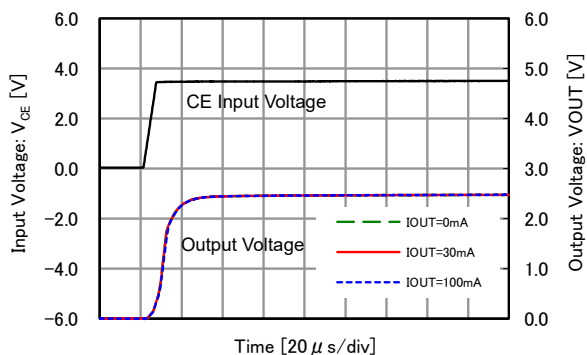
(9) CE Rising Response Time (Type D)



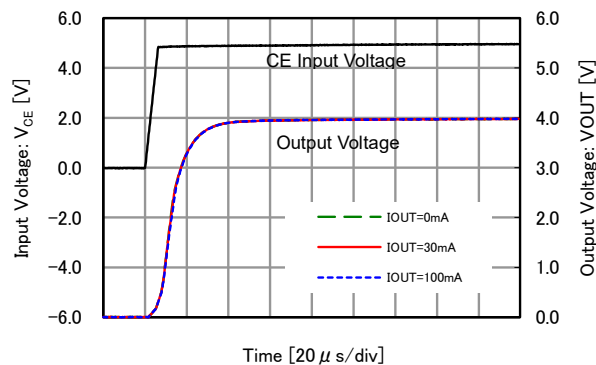
■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(9) CE Rising Response Time (Type D)

XC6238D25

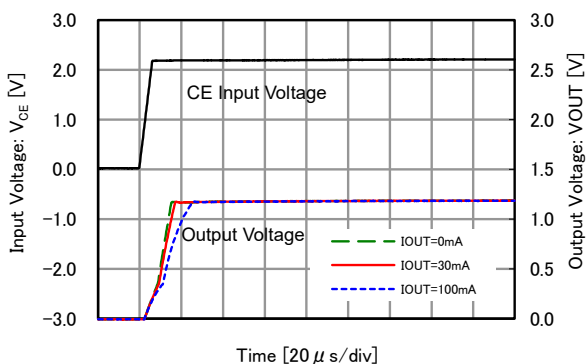


XC6238D40

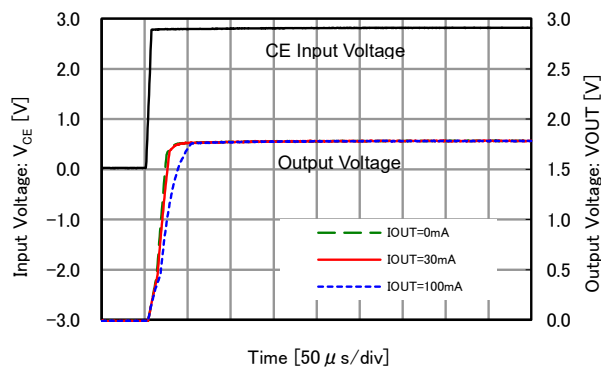


(9) CE Rising Response Time (Type H)

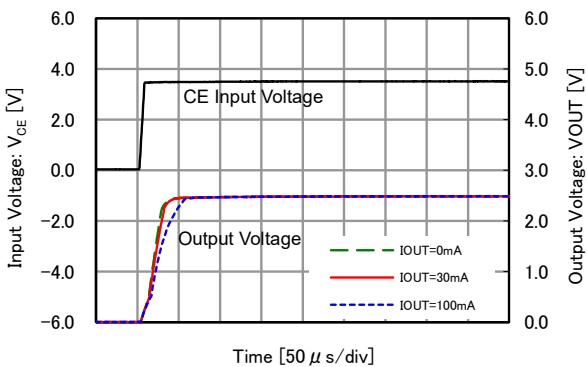
XC6238H12



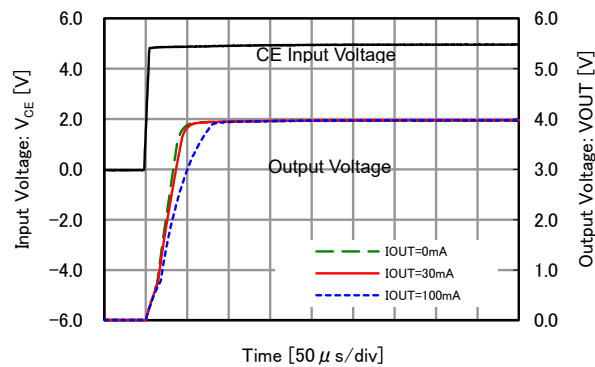
XC6238H18



XC6238H251



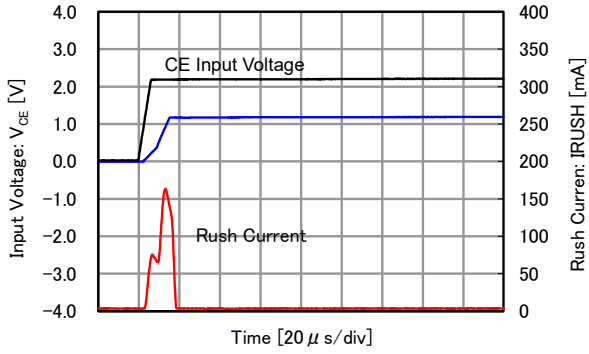
XC6238H40



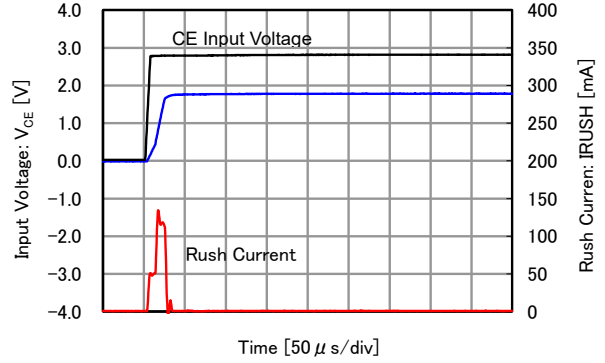
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(10) Inrush Current Response Time (Type H)

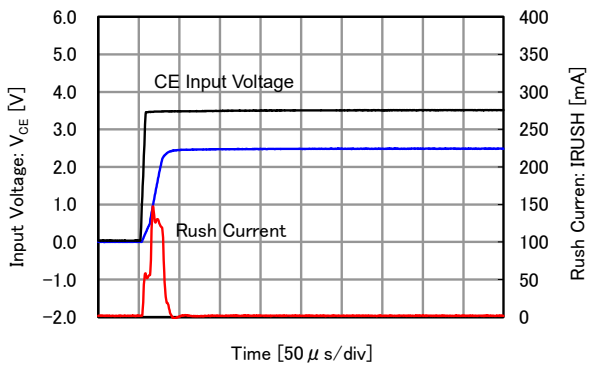
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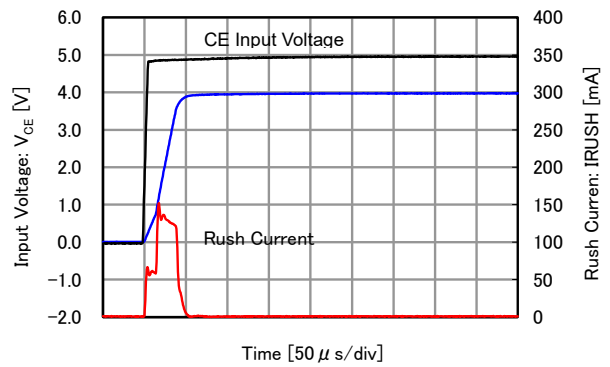
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XC6238H25



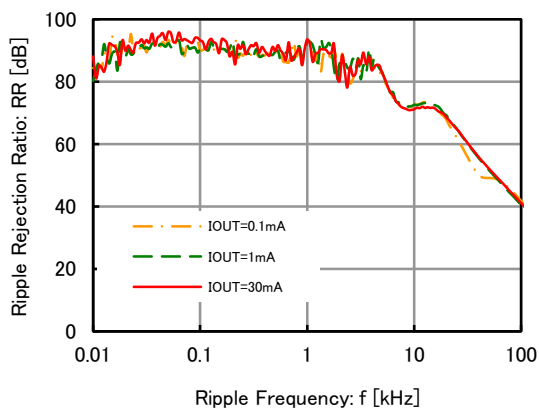
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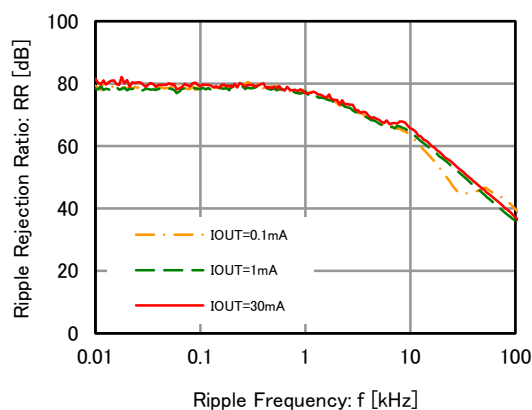
■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(11) Ripple Rejection Rate

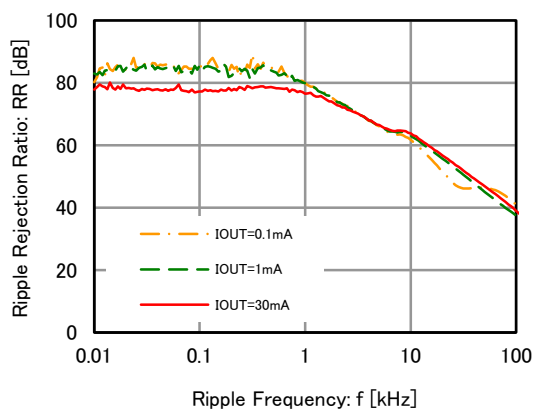
XC6238x12



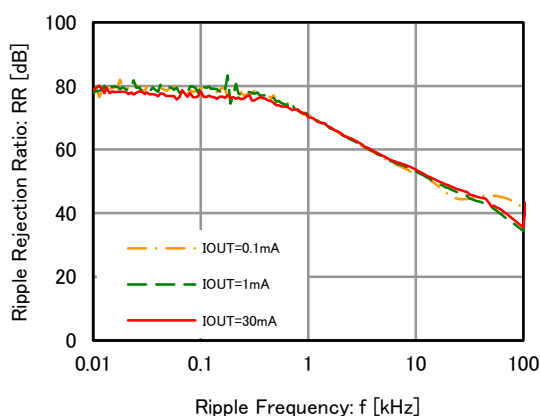
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XC6238x25

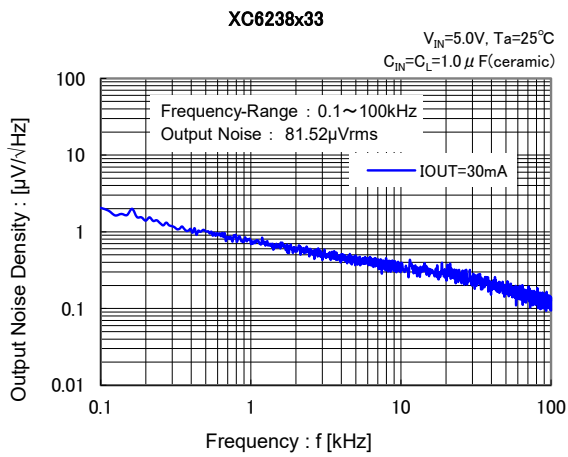
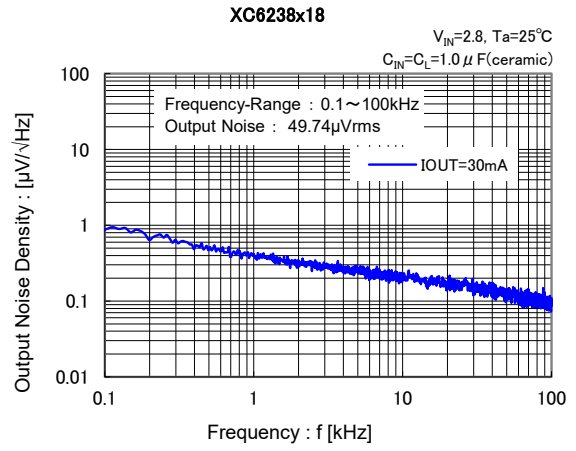
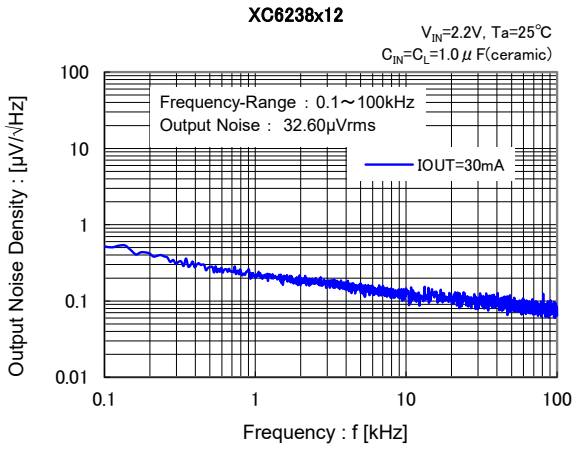


XC6238x33



TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(12) Output Noise Density



■ PACKAGING INFORMATION

For the latest package information go to, www.torexsemi.com/technical-support/packages

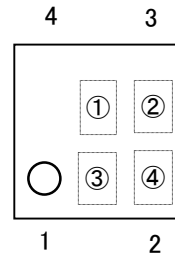
PACKAGE	OUTLINE / LAND PATTERN	THERMAL CHARACTERISTICS
UFN-4A01	UFN-4A01 PKG	UFN-4A01 Power Dissipation

MARKING RULE

● UFN-4A01

① represents product number

MARK	PRODUCT SERIES
H	XC6238D**1/26R-G
K	XC6238H**1/26R-G
L	XC6238D**A/B6R-G
M	XC6238H**A/B6R-G



UFN-4A01
(BOTTOM VIEW)

② represents output voltage

MARK	OUTPUT VOLTAGE (V)		MARK	OUTPUT VOLTAGE (V)	
0	1.2	1.25	F	2.7	2.75
1	1.3	1.35	H	2.8	2.85
2	1.4	1.45	K	2.9	2.95
3	1.5	1.55	L	3.0	3.05
4	1.6	1.65	M	3.1	3.15
5	1.7	1.75	N	3.2	3.25
6	1.8	1.85	P	3.3	3.35
7	1.9	1.95	R	3.4	3.45
8	2.0	2.05	S	3.5	3.55
9	2.1	2.15	T	3.6	3.65
A	2.2	2.25	U	3.7	3.75
B	2.3	2.35	V	3.8	3.85
C	2.4	2.45	X	3.9	3.95
D	2.5	2.55	Y	4.0	
E	2.6	2.65			

③④ represents production lot number

01 to 09, 0A to 0Z, 11 to 9Z, A1 to A9, AA to AZ, B1 to ZZ in order.

(G, I, J, O, Q, W excepted)

*No character inversion used.

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