XC6228 Series

300mA High Speed LDO Regulator with ON/OFF Switch

TOREX 0755-29004755

■GENERAL DESCRIPTION

The XC6228 series is a high speed LDO regulator that features high accurate, 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 VOUT 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 from 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 3.0V, 3.1V, 3.3V 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

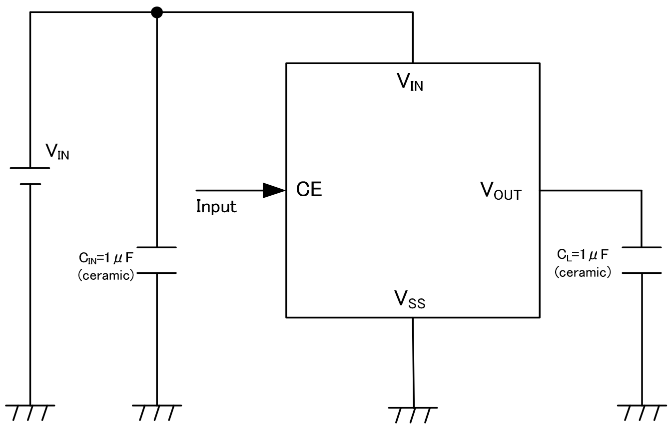
●Modules

●Mobile phones

■FEATURES

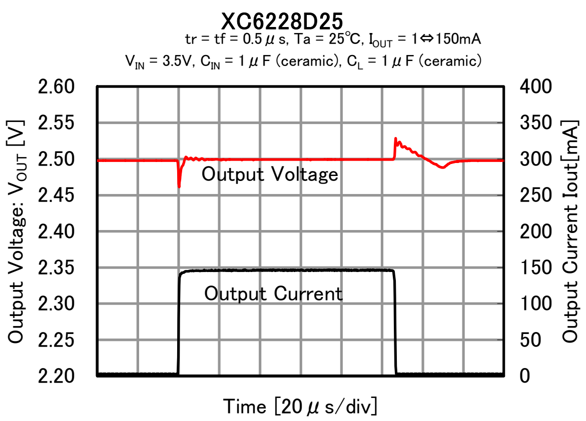
Maximum Output Current	: 300mA
Input Voltage Range	: 1.6～5.5V
Output Voltages	: 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 3.0V, 3.1V, 3.3V (±2%)
Dropout Voltage	: 200mV@I_{OUT}=300mA (V_{OUT}=3.0V)
Low Power Consumption	: 100 μ A
Stand-by Current	: 0.1 μ A
High Ripple Rejection	: 80dB@f=1kHz
Protection Circuits	: Current Limit（400mA） Short Circuit Protection
Low ESR Capacitors	: C_{IN}=1 μ F, C_L=1 μ F
CE Function	: Active High, C_L High Speed Discharge
Small Package	: SOT-25J
Environmentally Friendly	: EU RoHS Compliant, Pb Free

■TYPICAL APPLICATION CIRCUIT

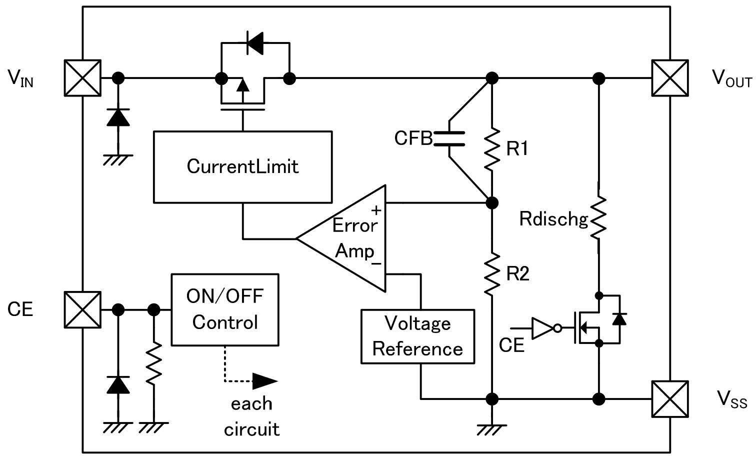


■ TYPICAL PERFORMANCE CHARACTERISTICS

●Load Transient Response



■BLOCK DIAGRAMS



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

■PRODUCT CLASSIFICATION

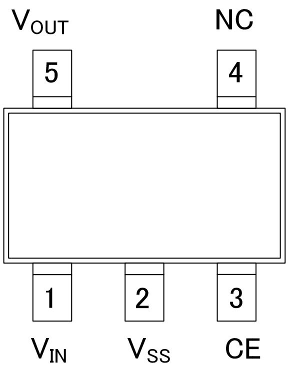
●Ordering Information

XC6228①②③④⑤⑥-⑦ (*1)

DESIGNATOR	ITEM	SYMBOL	DESCRIPTION
①	Regulator Type	D	CE Active High, CE pin Pull-down resistor, C_L discharge
②③	Output Voltage	12	1.2V
		15	1.5V
		18	1.8V
		25	2.5V
		28	2.8V
		30	3.0V
		31	3.1V
		33	3.3V
④	Output Voltage Accuracy	2	±2%
⑤⑥-⑦ (*1)	Package	VR-G	SOT-25J (3,000/Reel)

(*1) The "-G" suffix indicates that the products are Halogen and Antimony free as well as being fully RoHS compliant.

■PIN CONFIGURATION



SOT-25J
(TOP VIEW)

■PIN ASSIGNMENT

PIN NUMBER	PIN NAME	FUNCTIONS
1	V_{IN}	Power Input
5	V_{OUT}	Output
2	V_{SS}	Ground
3	CE	ON/OFF Control
4	NC	No Connection

■PIN FUNCTION ASSIGNMENT

CE INPUT SIGNAL	IC OPERATION STATE
H	ON
L	OFF (Stand-by)
OPEN	OFF (Stand-by) *

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

■ABSOLUTE MAXIMUM RATINGS

PARAMETER		SYMBOL	RATINGS	UNITS
Input Voltage		V_{IN}	V_{SS}-0.3～V_{SS}+7.0	V
Output Current		I_{OUT}	500 (*1)	mA
Output Voltage		V_{OUT}	V_{SS}-0.3～V_{IN}+0.3	V
CE Input Voltage		V_{CE}	V_{SS}-0.3～V_{SS}+7.0	V
Power Dissipation	SOT-25J	Pd	200	mW
			500 (PCB mounted) (*2)	
Operating Temperature Range		Topr	-40～+85	℃
Storage Temperature Range		Tstg	-55～+125	℃

(*1) I_{OUT}≦Pd / (V_{IN}-V_{OUT})

(*2) This is a reference data taken by using the test board.

■ELECTRICAL CHARACTERISTICS

●XC6228D Series

Ta=25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUITS
Output Voltage	$V_{OUT(E)}$ (*1)	$V_{CE}=V_{IN}$, I_{OUT}=10mA	$V_{OUT(T)}$×0.98 (*2)	$V_{OUT(T)}$ (*2)	$V_{OUT(T)}$×1.02 (*2)	V	①
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	Vdif (*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}/ ($\Delta V_{IN}\cdot V_{OUT}$)	$V_{OUT(T)}$+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}/ ($\Delta Topr\cdot V_{OUT}$)	$V_{CE}=V_{IN}$, I_{OUT}=10mA -40℃≦Ta≦85℃	-	±100	-	ppm/℃	①
Ripple Rejection Rate	PSRR	$V_{OUT(T)}$<2.5V V_{IN}=3.0V_{DC}+0.5Vp-p_{AC} $V_{CE}=V_{OUT(T)}$+1.0V I_{OUT}=30mA, f=1kHz $V_{OUT(T)}$≧2.5V V_{IN}={$V_{OUT(T)}$+1.0}V_{DC}+0.5Vp-p_{AC} $V_{CE}=V_{OUT(T)}$+1.0V I_{OUT}=30mA, f=1kHz	-	80	-	dB	③
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
CL Discharge Resistance	R_{DCHG}	V_{IN}=5.5V, V_{OUT}=2.0V, $V_{CE}=V_{SS}$	-	300	-	Ω	①

NOTE:

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

(*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) Vdif＝V_{IN1}－V_{OUT1} (V_{IN1}≧1.6V)

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

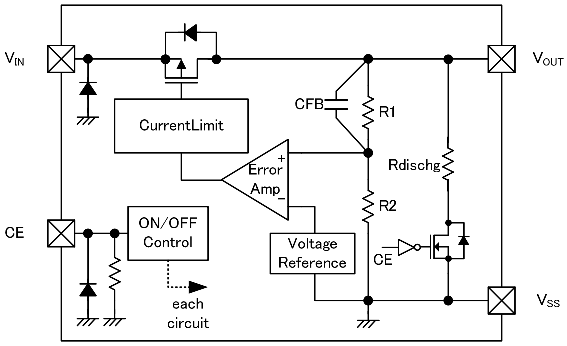
V_{OUT1}=A voltage equal to 98% of the output voltage whenever an amply stabilized $V_{OUT(T)}$+1.0V is input for every I_{OUT}.

■OUTPUT VOLTAGE CHART

●Voltage Chart 1

NOMINAL OUTPUT VOLTAGE (V)	OUTPUT VOLTAGE (V)		DROPOUT VOLTAGE (mV) E-1	
$V_{OUT(T)}$	$V_{OUT(E)}$		Vdif	
	MIN.	MAX.	TYP.	MAX.
1.20	1.176	1.224	480	630
1.50	1.470	1.530	420	460
1.80	1.764	1.836	300	410
2.50	2.450	2.550	240	350
2.80	2.744	2.856		
3.00	2.940	3.060	200	305
3.10	3.038	3.162		
3.30	3.234	3.366		

■ OPERATIONAL EXPLANATION



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 can be shutdown via the CE pin signal.

<Low ESR Capacitor>
The XC6228 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 1.0μF or larger. For a stable power input, please connect an input capacitor (C_{IN}) of 1.0μF between the V_{IN} pin and the V_{SS} pin.

<Current Limiter, Short-Circuit Protection>
The XC6228 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 XC6228 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 XC6228 series has a pull-down resistor at the CE pin inside, so that the CE pin input current flows.

■ NOTES ON USE

1. For temporary, transitional voltage drop or voltage rising phenomenon, the IC is liable to malfunction should the ratings be exceeded.

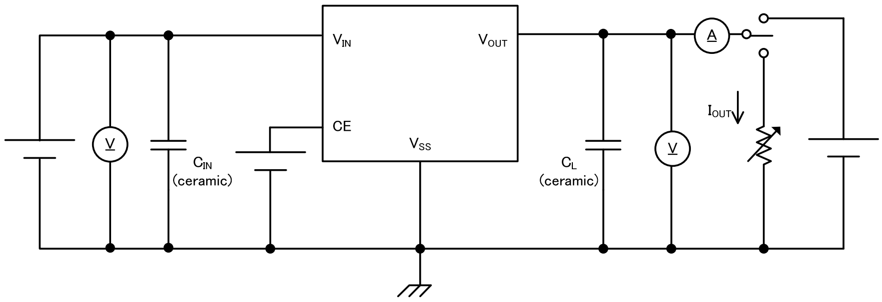
2. Where wiring impedance is high, operations may become unstable due to the noise and/or phase lag depending on output current. Please strengthen V_{IN} and V_{SS} wiring in particular.

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.

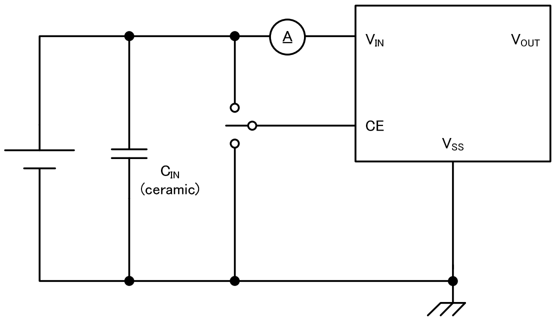
4. Torex places an importance on improving our products and its reliability.
   However, by any possibility, we would request user fail-safe design and post-aging treatment on system or equipment.

■TEST CIRCUITS

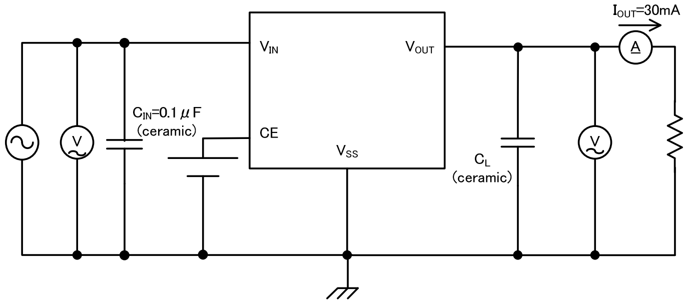
●Circuit ①



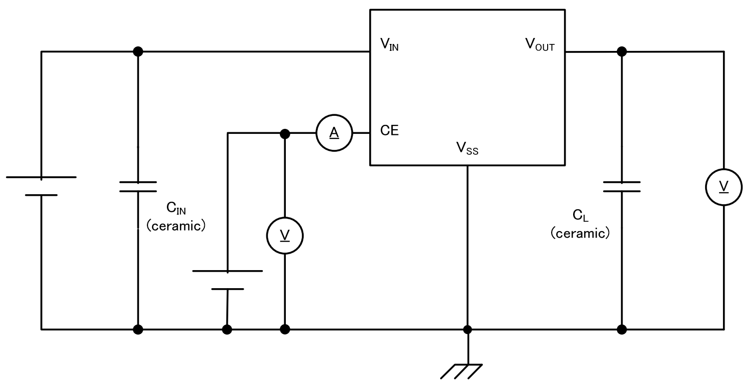
●Circuit ②



●Circuit ③

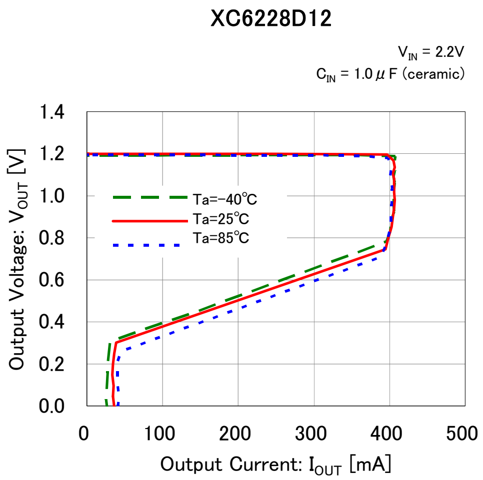


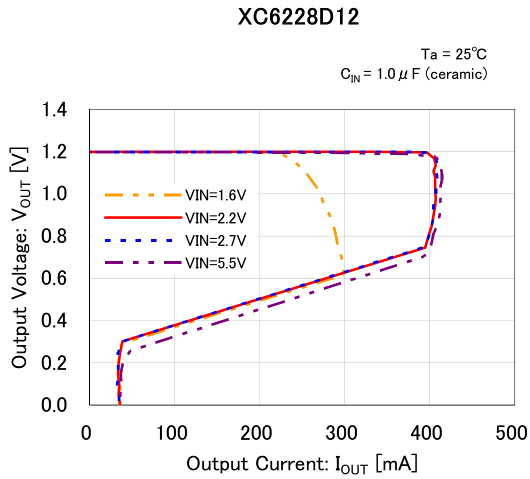
●Circuit ④

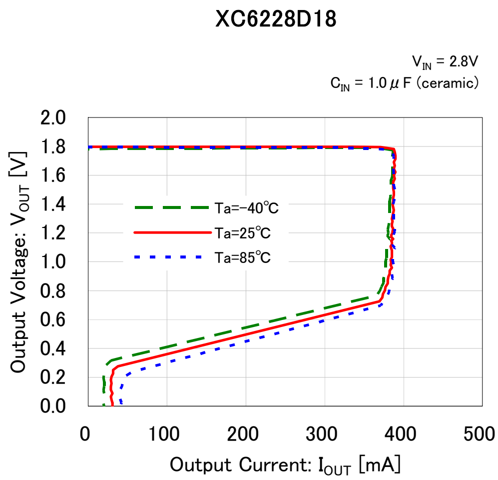


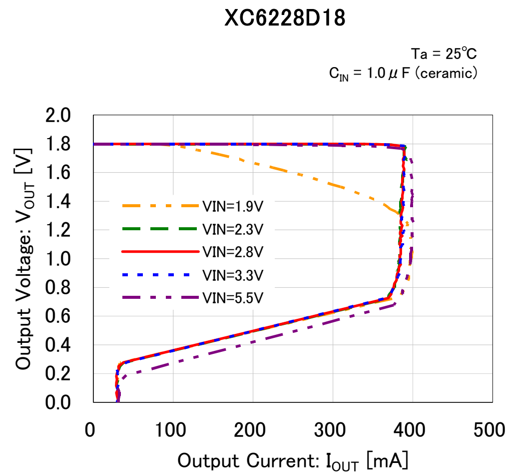
■TYPICAL PERFORMANCE CHARACTERISTICS

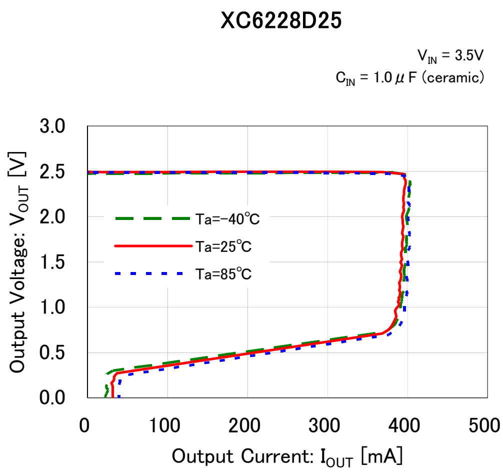
(1) Output Voltage vs. Output Current

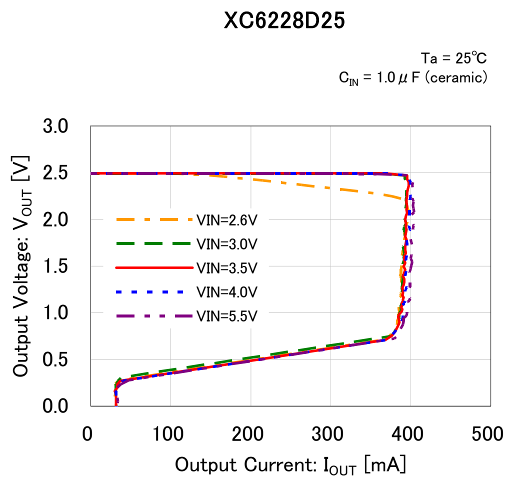






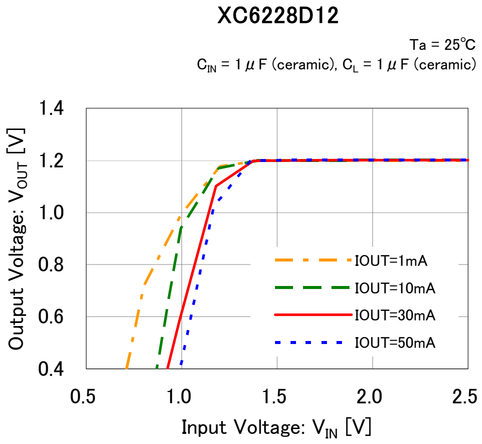


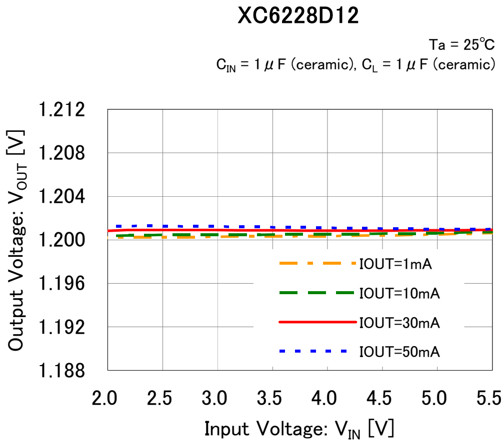


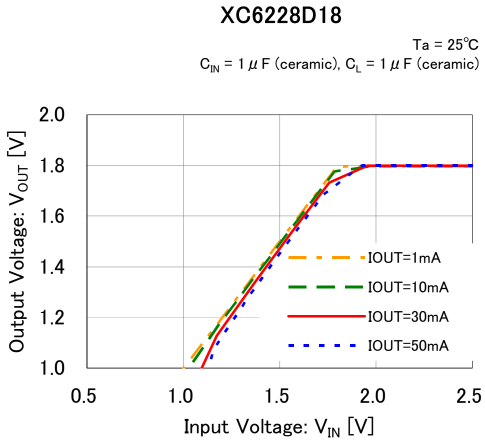


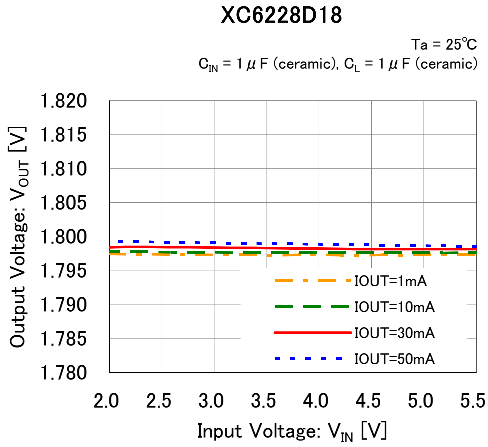
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

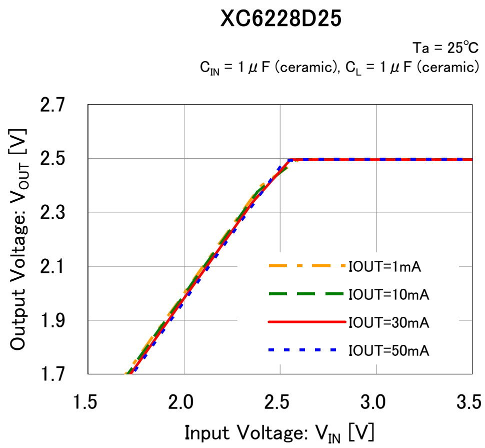
(2) Output Voltage vs. Input Voltage

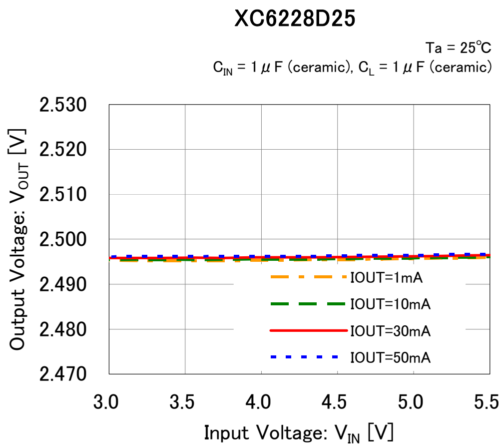






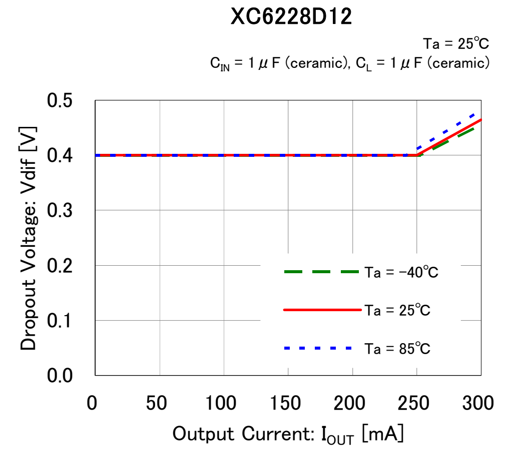


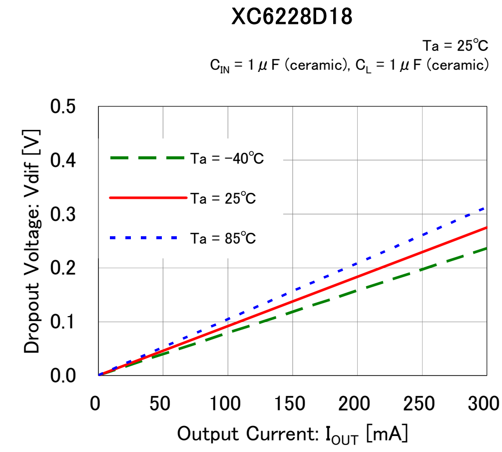


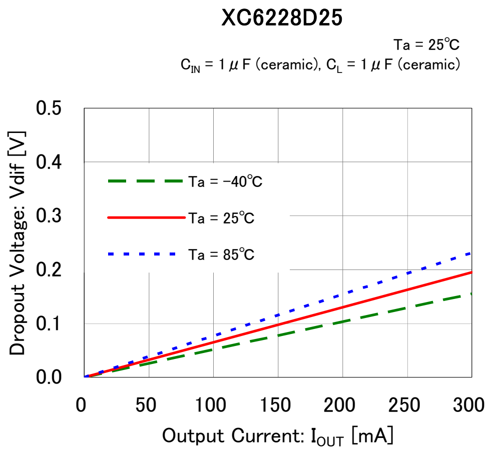


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

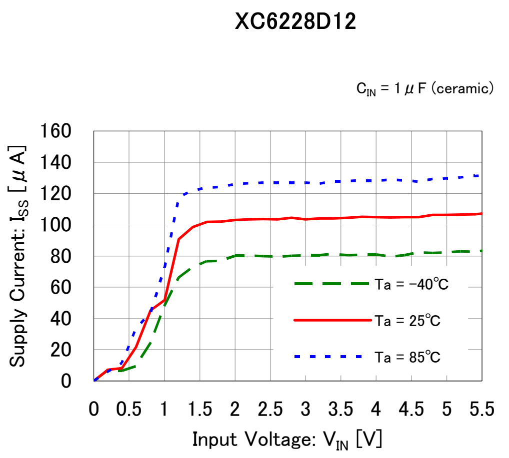
(3) Dropout Voltage vs. Output Current

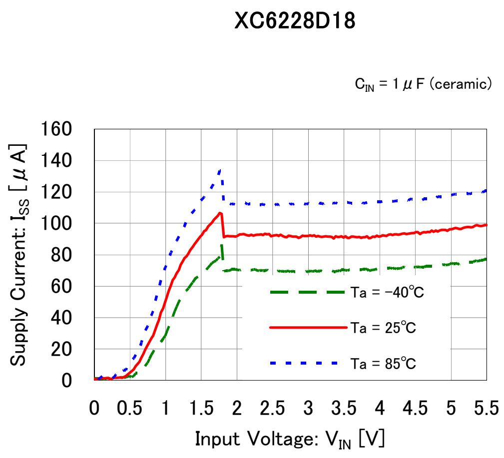






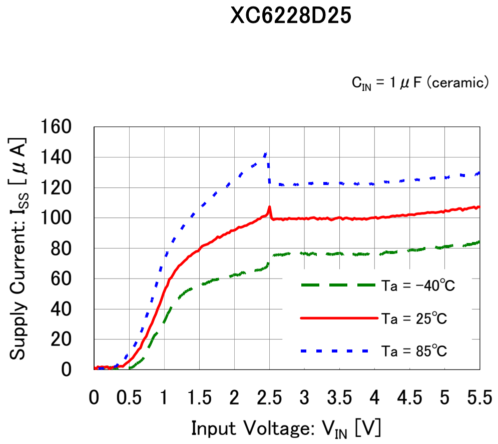
(4) Supply Current vs. Input Voltage



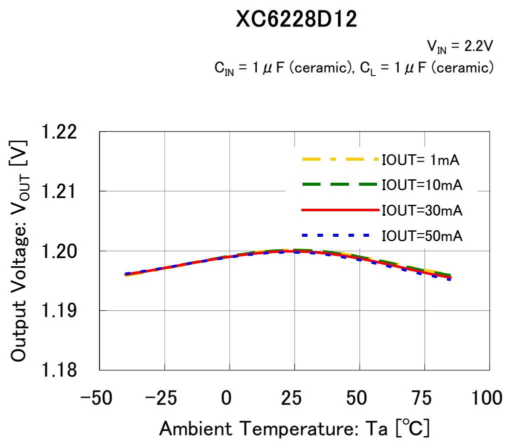


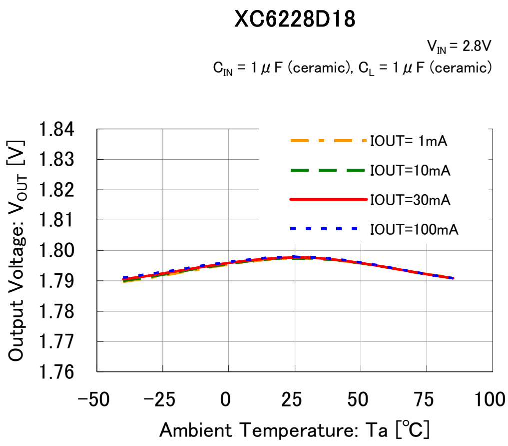
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

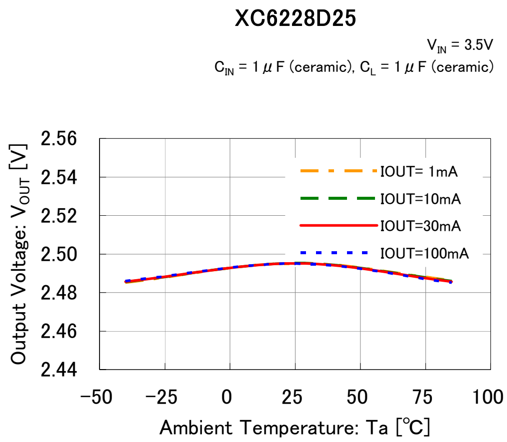
(4) Supply Current vs. Input Voltage (Continued)



(5) Output Voltage vs. Ambient Temperature

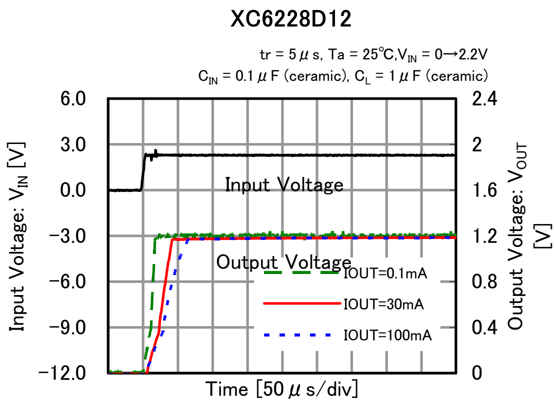


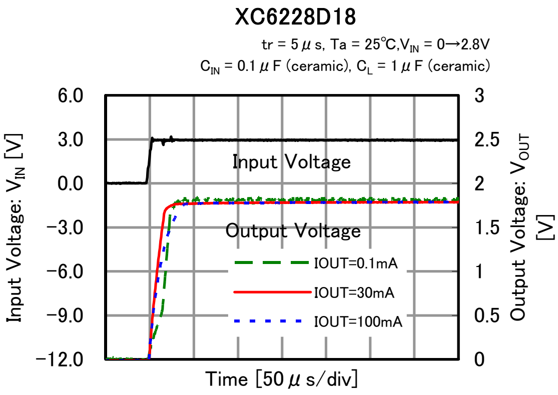


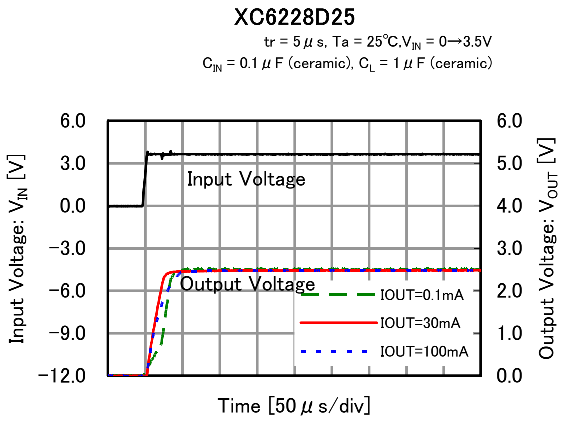


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

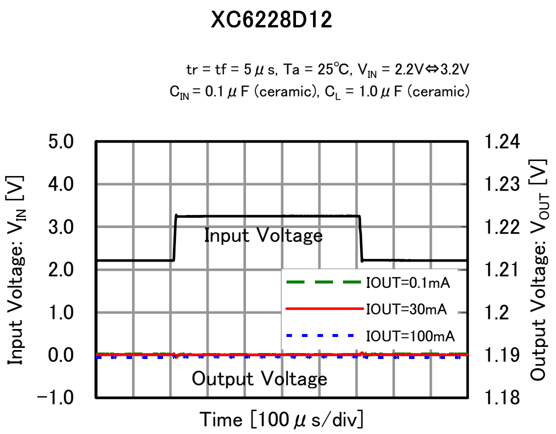
(6) Rising Response Time

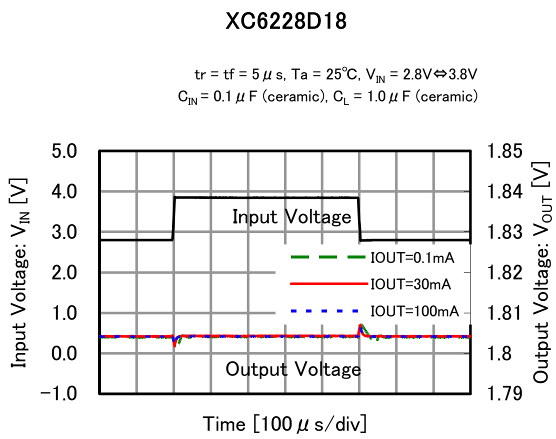






(7) Input Transient Response



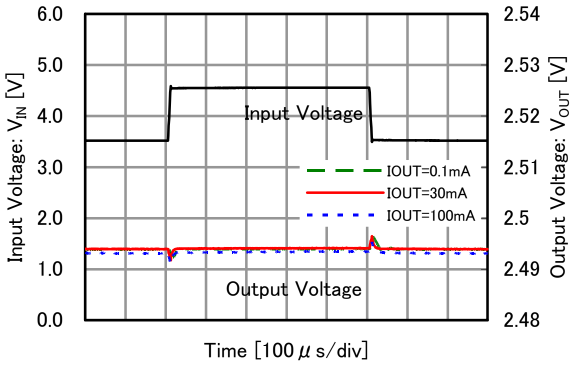


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(7) Input Transient Response (Continued)

XC6228D25

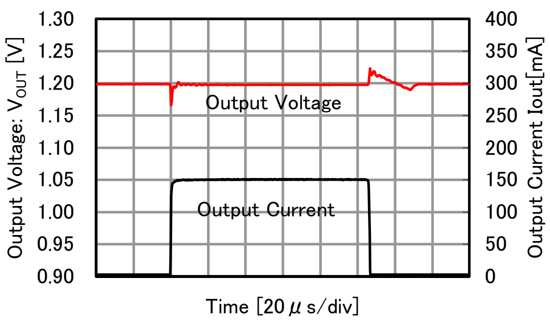
tr = tf = 5μs, Ta = 25℃, V_{IN} = 3.5V⇔4.5V
C_{IN} = 0.1μF (ceramic), C_L = 1.0μF (ceramic)



(8) Load Transient Response (tr=tf=0.5μs)

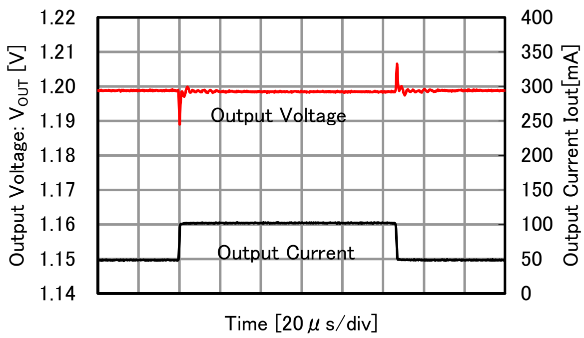
XC6228D12

tr = tf = 0.5μs, Ta = 25℃, I_{OUT} = 1⇔150mA
V_{IN} = 2.2V, C_{IN} = 1μF (ceramic), C_L = 1μF (ceramic)



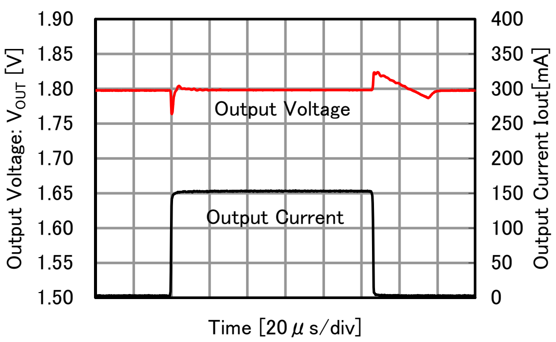
XC6228D12

tr = tf = 0.5μs, Ta = 25℃, I_{OUT} = 50⇔100mA
V_{IN} = 2.2V, C_{IN} = 1μF (ceramic), C_L = 1μF (ceramic)



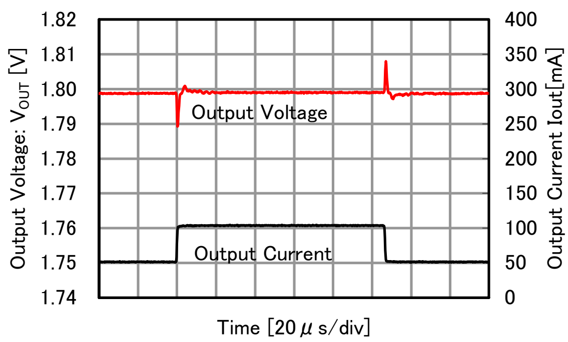
XC6228D18

tr = tf = 0.5μs, Ta = 25℃, I_{OUT} = 1⇔150mA
V_{IN} = 2.8V, C_{IN} = 1μF (ceramic), C_L = 1μF (ceramic)



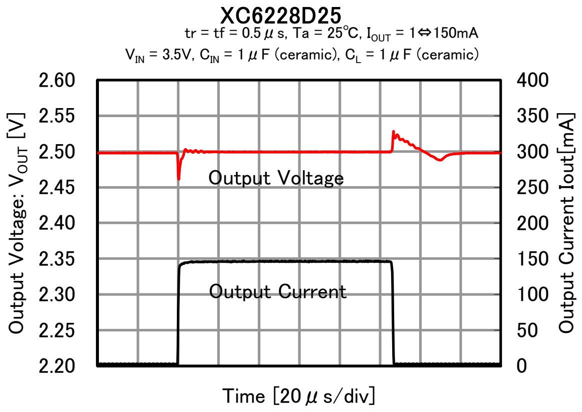
XC6228D18

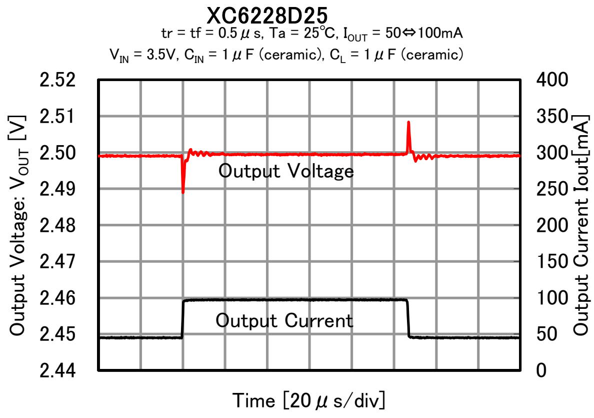
tr = tf = 0.5μs, Ta = 25℃, I_{OUT} = 50⇔100mA
V_{IN} = 2.8V, C_{IN} = 1μF (ceramic), C_L = 1μF (ceramic)



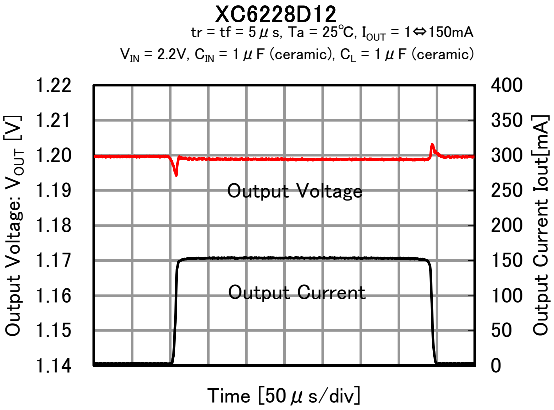
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

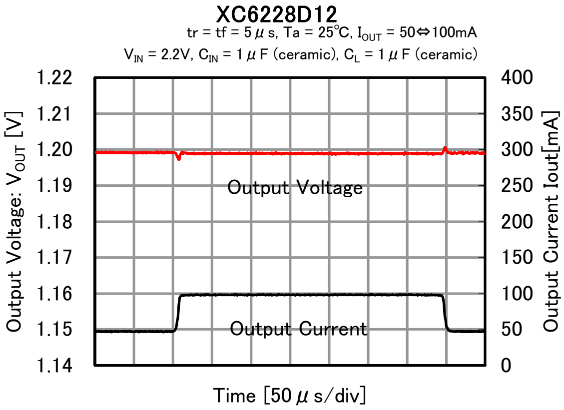
(8) Load Transient Response (tr=tf=0.5μs) (Continued)

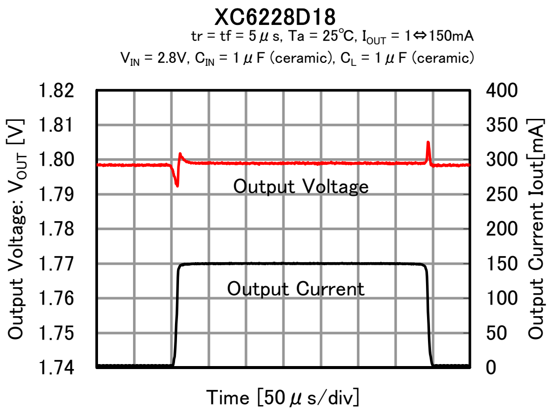


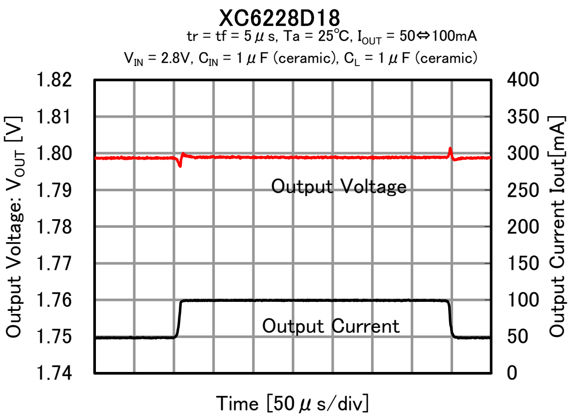


(9) Load Transient Response (tr=tf=5μs)







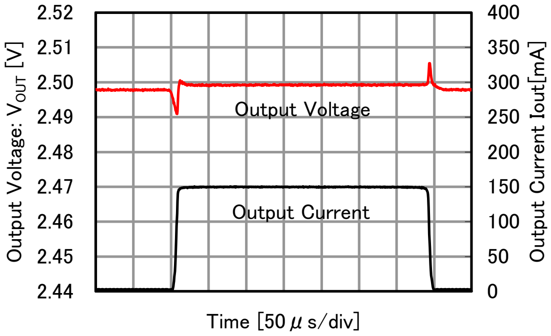


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(9) Load Transient Response (tr=tf=5 μ s) (Continued)

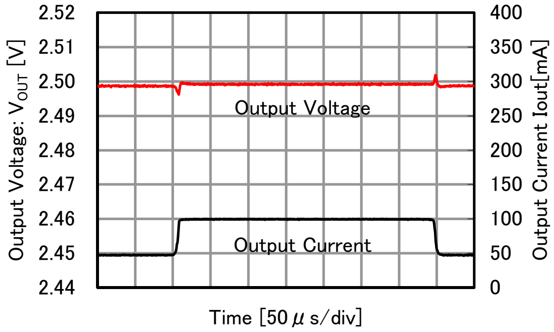
XC6228D25

tr = tf = 5 μ s, Ta = 25℃, I_{OUT} = 1⇔150mA
V_{IN} = 3.5V, C_{IN} = 1 μ F (ceramic), C_L = 1 μ F (ceramic)



XC6228D25

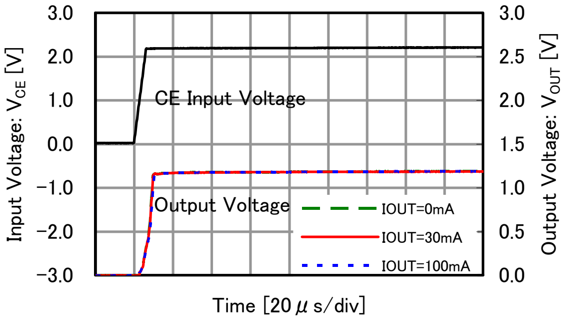
tr = tf = 5 μ s, Ta = 25℃, I_{OUT} = 50⇔100mA
V_{IN} = 3.5V, C_{IN} = 1 μ F (ceramic), C_L = 1 μ F (ceramic)



(10) CE Rising Response Time

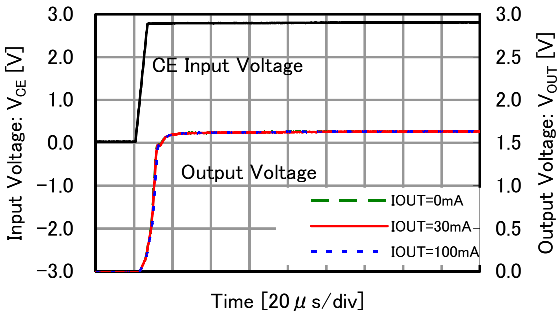
XC6228D12

V_{IN} = 2.2V, tr = 5 μ s, Ta = 25℃
V_{CE} = 0→V_{IN}, C_{IN} = C_L = 1.0 μ F (ceramic)



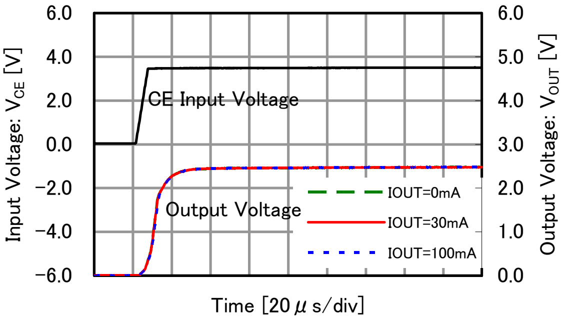
XC6228D18

V_{IN} = 2.8V, tr = 5 μ s, Ta = 25℃
V_{CE} = 0→V_{IN}, C_{IN} = C_L = 1.0 μ F (ceramic)



XC6228D25

V_{IN} = 3.5V, tr = 5 μ s, Ta = 25℃
V_{CE} = 0→V_{IN}, C_{IN} = C_L = 1.0 μ F (ceramic)

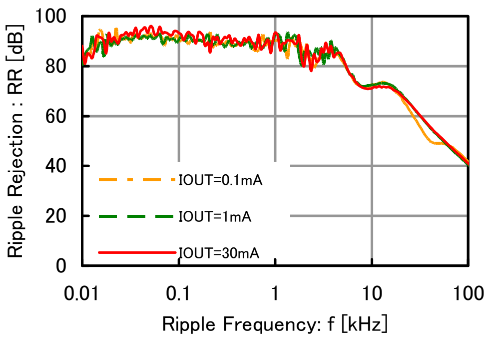


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(11) Ripple Rejection Rate

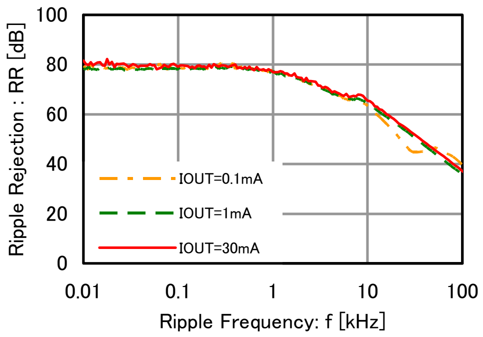
XC6228D12

Ta = 25℃, V_{IN} = 3.0VDC+0.5Vp-pAC
C_{IN} = 0.1 μF (ceramic), C_L = 1 μF (ceramic)



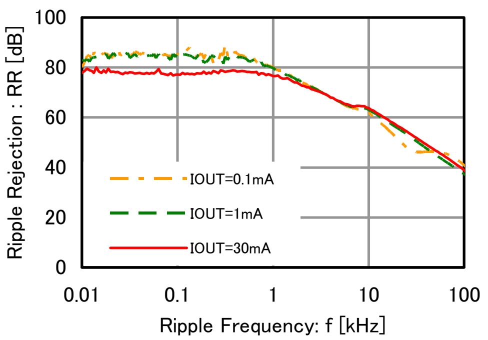
XC6228D18

Ta = 25℃, V_{IN} = 3.0VDC+0.5Vp-pAC
C_{IN} = 0.1 μF (ceramic), C_L = 1 μF (ceramic)



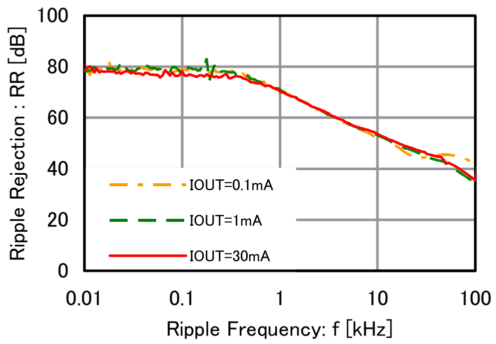
XC6228D25

Ta = 25℃, V_{IN} = 3.5VDC+0.5Vp-pAC
C_{IN} = 0.1 μF (ceramic), C_L = 1 μF (ceramic)



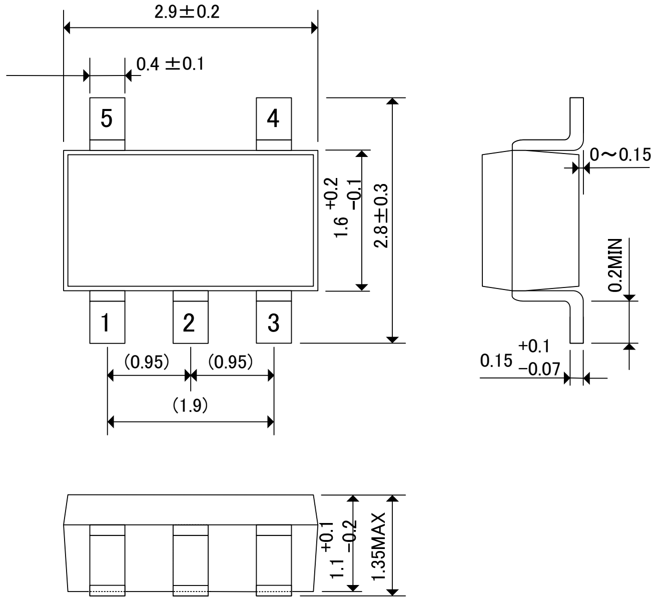
XC6228D33

Ta = 25℃, V_{IN} = 4.3VDC+0.5Vp-pAC
C_{IN} = 0.1 μF (ceramic), C_L = 1 μF (ceramic)



■PACKAGING INFORMATION

●SOT-25J



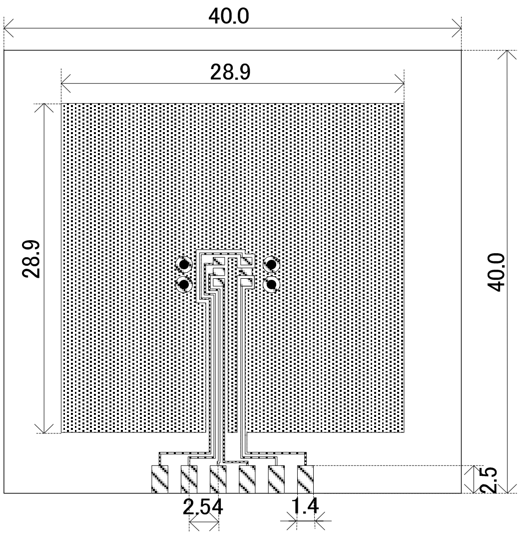
■PACKAGING INFORMATION (Continued)

●SOT-25J Power Dissipation

Power dissipation data for the SOT-25J is shown in this page.
The value of power dissipation varies with the mount board conditions.
Please use this data as one of reference data taken in the described condition.

1. Measurement Condition (Reference data)

Condition: Mount on a board
Ambient: Natural convection
Soldering: Lead (Pb) free
Board: Dimensions 40 x 40 mm (1600 mm^2 in one side)
Copper (Cu) traces occupy 50% of the board area
In top and back faces
Package heat-sink is tied to the copper traces
(Board of SOT-26 is used.)
Material: Glass Epoxy (FR-4)
Thickness: 1.6 mm
Through-hole: 4 x 0.8 Diameter

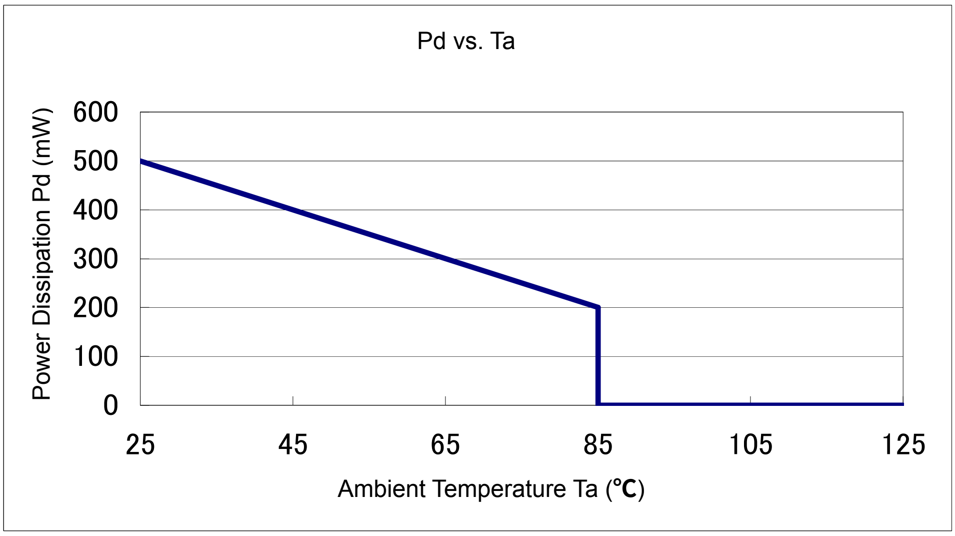


Evaluation Board (Unit: mm)

2. Power Dissipation vs. Ambient temperature

Board Mount (Tj max = 125℃)

Ambient Temperature (℃)	Power Dissipation Pd (mW)	Thermal Resistance (℃/W)
25	500	200.00
85	200	

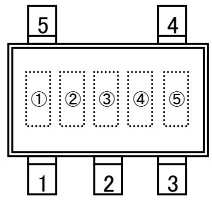


■MARKING RULE

●SOT-25J

① represents product series.

MARK	PRODUCT SERIES
9	XC6228******-G



SOT-25J
(TOP VIEW)

② represents type of regulator and combination of output voltage.

MARK	PRODUCT SERIES
P	XC6228D*****-G

③ represents output voltage.

MARK	OUTPUT VOLTAGE (V)	PRODUCT SERIES
2	1.2	XC6228*12***-G
5	1.5	XC6228*15***-G
8	1.8	XC6228*18***-G
F	2.5	XC6228*25***-G
L	2.8	XC6228*28***-G
N	3.0	XC6228*30***-G
P	3.1	XC6228*31***-G
S	3.3	XC6228*33***-G

④⑤ represents production lot number.
01 to 09, 0A to 0Z, 11 to 9Z, A1 to A9, AA to Z9, ZA to ZZ in order.
(G, I, J, O, Q, W excepted)
*No character inversion used.

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