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	: 100μA
Stand-by Current	: 0.1μA
High Ripple Rejection	: 80dB@f=1kHz
Protection Circuits	: Current Limit（400mA） Short Circuit Protection
Low ESR Capacitors	: C_{IN}=1μF, C_L=1μF
CE Function	: Active High, C_L High Speed Discharge
Small Package	: SOT-25J
Environmentally Friendly	: EU RoHS Compliant, Pb Free

TYPICAL APPLICATION CIRCUIT
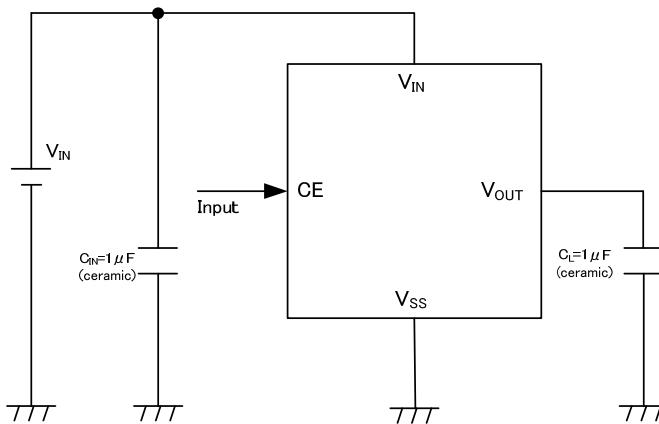
TYPICAL PERFORMANCE CHARACTERISTICS

● Load Transient Response
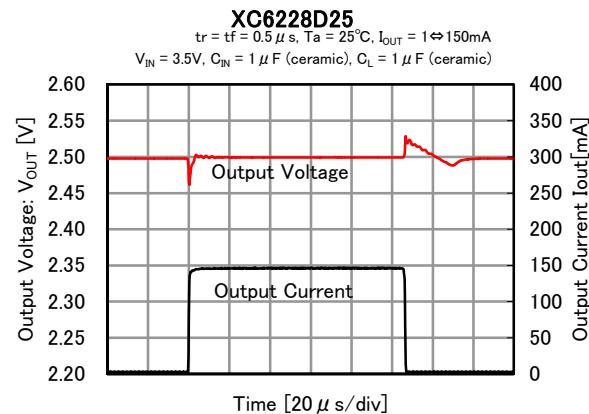
BLOCK DIAGRAMS
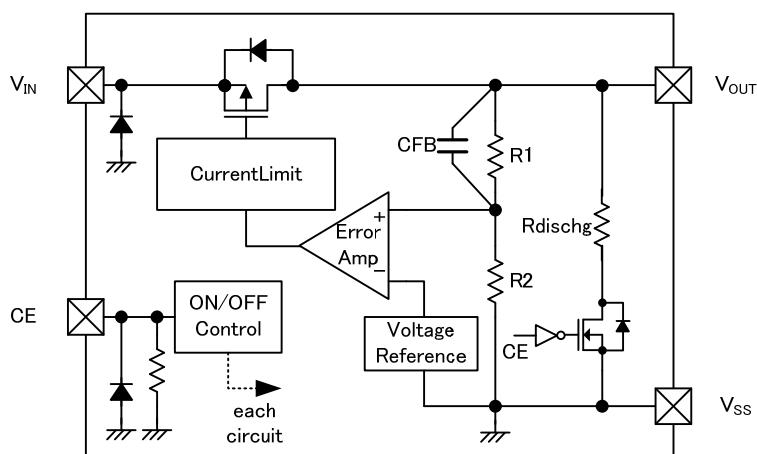
* Diodes inside the circuits are ESD protection diodes and parasitic diodes.

PRODUCT CLASSIFICATION

Ordering Information

XC6228 _____ – _____ [(*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

V_{OUT} NC

```
  5           4
┌───────────────┐
│               │
│               │
│               │
└───────────────┘
  1     2     3
```

V_{IN} V_{SS} CE
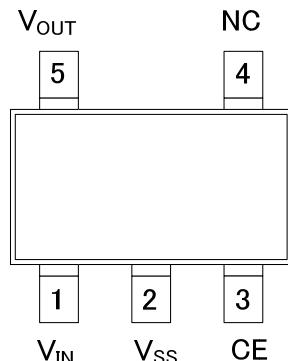
SOT−25J
（TOP VIEW）

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

(*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]	$V_{CE}=V_{IN}$, $I_{OUT}=10mA$	$V_{OUT(T)} \times 0.98$ [*2]	$V_{OUT(T)}$ [*2]	$V_{OUT(T)} \times 1.02$ [*2]	V	①
Maximum Output Current	I_{OUTMAX}	$V_{CE}=V_{IN}$	300	-	-	mA	①
Load Regulation	ΔV_{OUT}	$V_{CE}=V_{IN}$, $0.1mA \leqq I_{OUT} \leqq 300mA$	-	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	$\Delta V_{OUT} / (\Delta V_{IN} \cdot V_{OUT})$	$V_{OUT(T)}+0.5V \leqq V_{IN} \leqq 5.5V$ $V_{CE}=V_{IN}$, $I_{OUT}=50mA$	-	0.01	0.1	%/V	①
Input Voltage	V_{IN}	-	1.6	-	5.5	V	①
Output Voltage Temperature Characteristics	$\Delta V_{OUT} / (\Delta Topr \cdot V_{OUT})$	$V_{CE}=V_{IN}$, $I_{OUT}=10mA$ $-40℃ \leqq Ta \leqq 85℃$	-	±100	-	ppm/℃	①
Ripple Rejection Rate	PSRR	$V_{OUT(T)} < 2.5V$ $V_{IN}=3.0V_{DC}+0.5Vp\text{-}p_{AC}$ $V_{CE}=V_{OUT(T)}+1.0V$ $I_{OUT}=30mA$, f=1kHz $V_{OUT(T)} \geqq 2.5V$ $V_{IN}=\{V_{OUT(T)}+1.0\}V_{DC}+0.5Vp\text{-}p_{AC}$ $V_{CE}=V_{OUT(T)}+1.0V$ $I_{OUT}=30mA$, 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	
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＝$V_{IN1}-V_{OUT1}$ ($V_{IN1} \geqq 1.6V$)

　　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
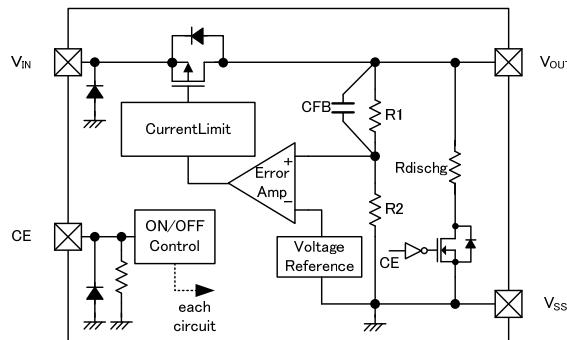
The voltage divided by resistors R1 & R2 is compared with the internal reference voltage by the error amplifier. The P-channel MOSFET which is connected to the V_{OUT} pin is then driven by the subsequent output signal. The output voltage at the V_{OUT} pin is controlled and stabilized by a system of 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 1.0μ 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 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
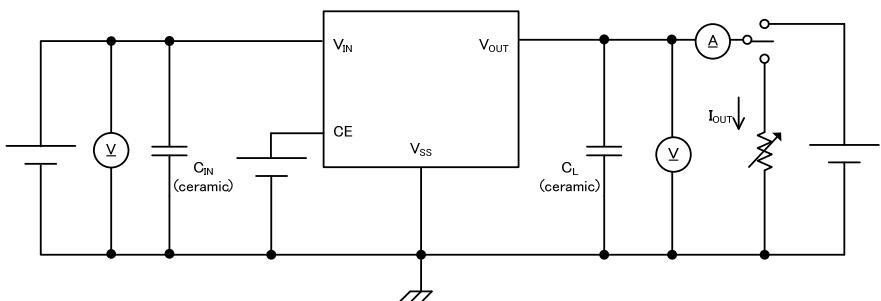
Circuit
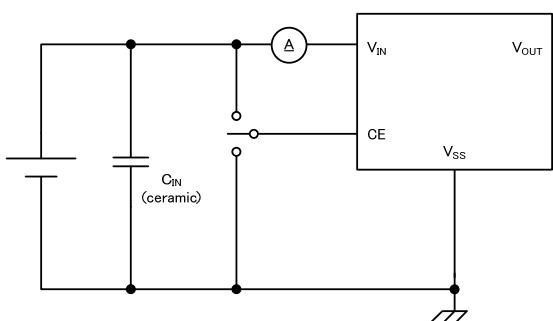
Circuit
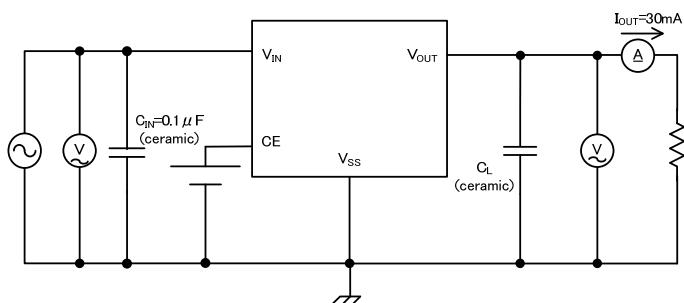
Circuit
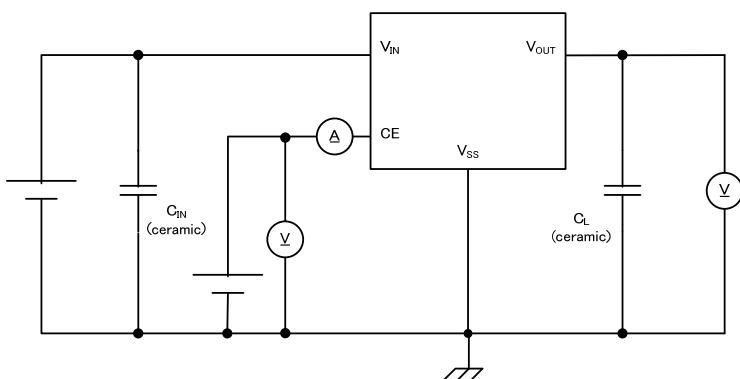
# TYPICAL PERFORMANCE CHARACTERISTICS

(1) Output Voltage vs. Output Current
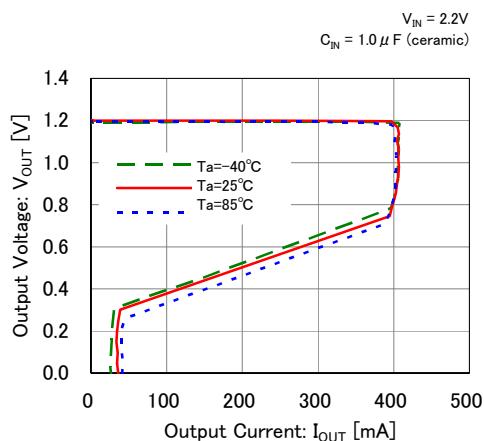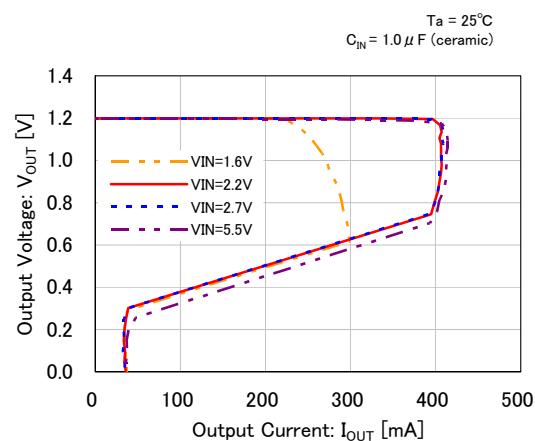
XC6228D12

V_{IN} = 2.2V
C_{IN} = 1.0 μ F (ceramic)

XC6228D12

Ta = 25℃
C_{IN} = 1.0 μ F (ceramic)

XC6228D18

V_{IN} = 2.8V
C_{IN} = 1.0 μ F (ceramic)

XC6228D18

Ta = 25℃
C_{IN} = 1.0 μ F (ceramic)

XC6228D25

V_{IN} = 3.5V
C_{IN} = 1.0 μ F (ceramic)

XC6228D25

Ta = 25℃
C_{IN} = 1.0 μ F (ceramic)
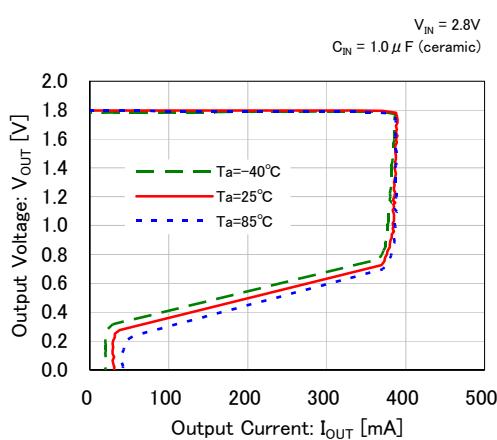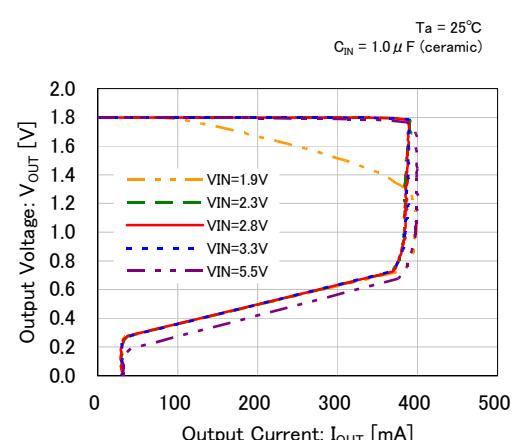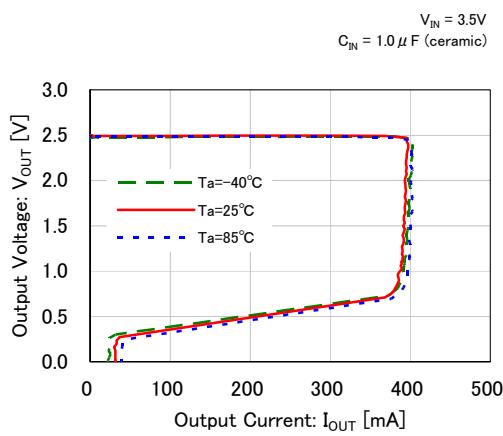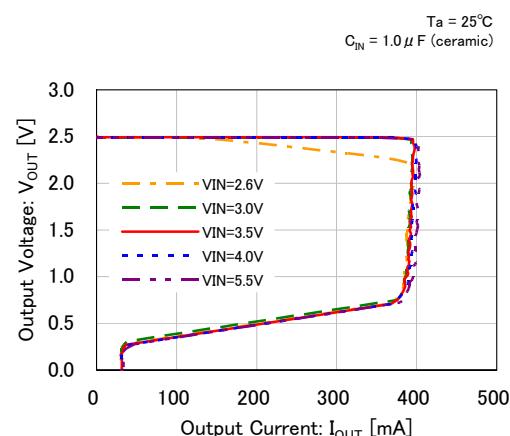
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2) Output Voltage vs. Input Voltage

XC6228D12

Ta = 25℃
C_{IN} = 1 μF (ceramic), C_L = 1 μF (ceramic)

XC6228D12

Ta = 25℃
C_{IN} = 1 μF (ceramic), C_L = 1 μF (ceramic)

XC6228D18

Ta = 25℃
C_{IN} = 1 μF (ceramic), C_L = 1 μF (ceramic)

XC6228D18

Ta = 25℃
C_{IN} = 1 μF (ceramic), C_L = 1 μF (ceramic)

XC6228D25

Ta = 25℃
C_{IN} = 1 μF (ceramic), C_L = 1 μF (ceramic)

XC6228D25

Ta = 25℃
C_{IN} = 1 μF (ceramic), C_L = 1 μF (ceramic)
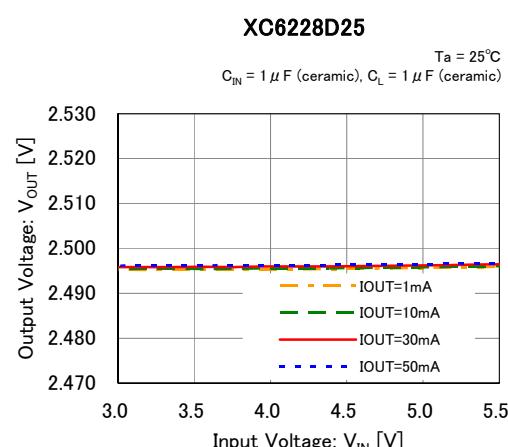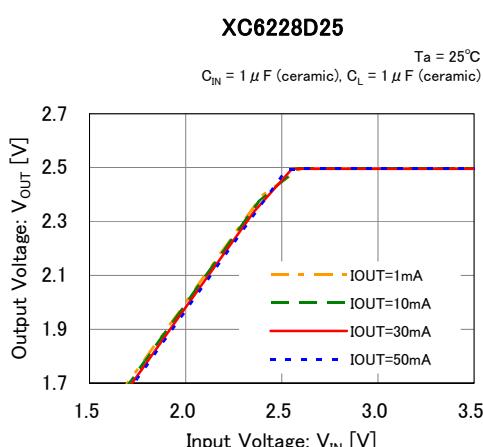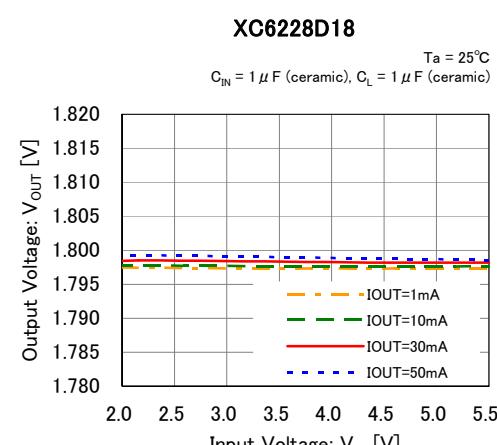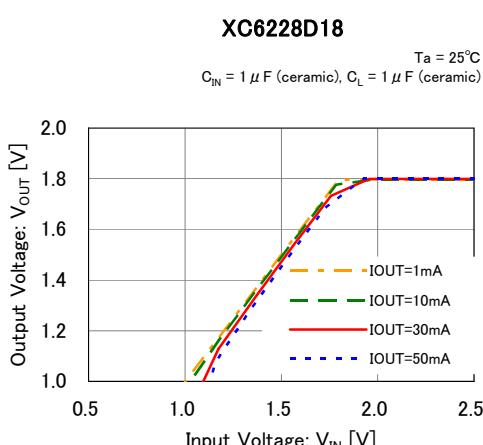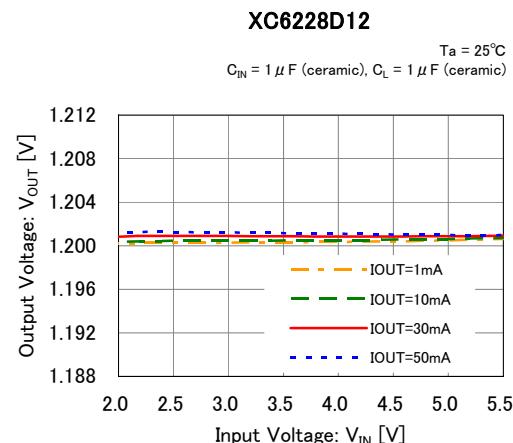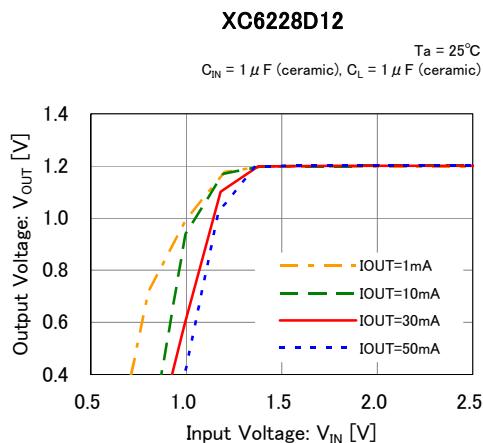
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(3) Dropout Voltage vs. Output Current

XC6228D12

Ta = 25℃
C_{IN} = 1 μF (ceramic), C_L = 1 μF (ceramic)

XC6228D18

Ta = 25℃
C_{IN} = 1 μF (ceramic), C_L = 1 μF (ceramic)

XC6228D25

Ta = 25℃
C_{IN} = 1 μF (ceramic), C_L = 1 μF (ceramic)

(4) Supply Current vs. Input Voltage
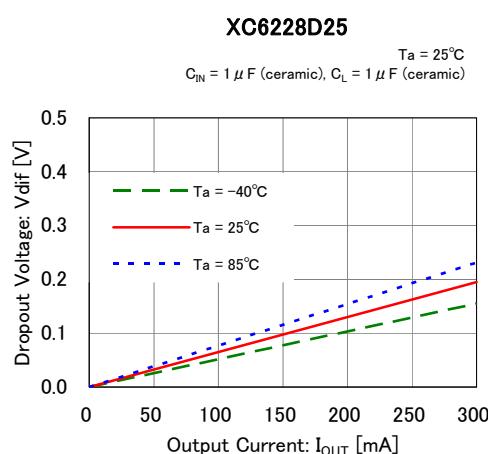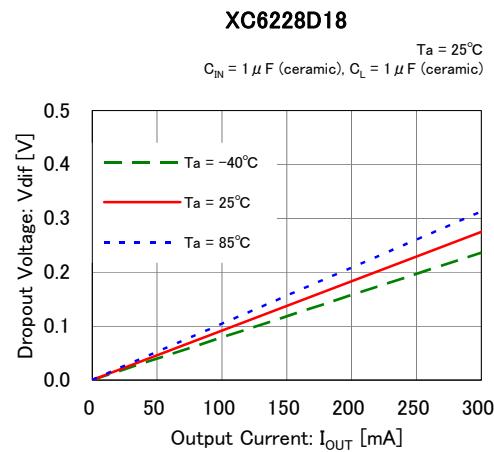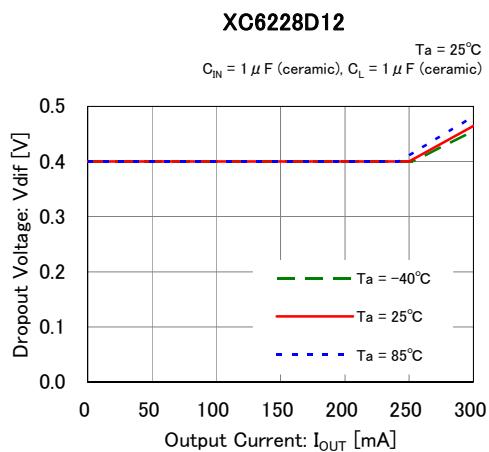
XC6228D12

C_{IN} = 1 μF (ceramic)

XC6228D18
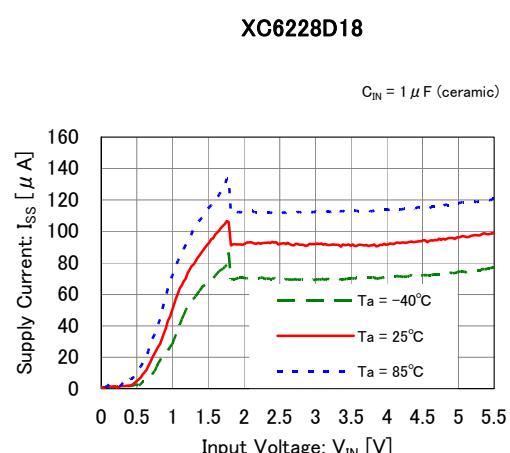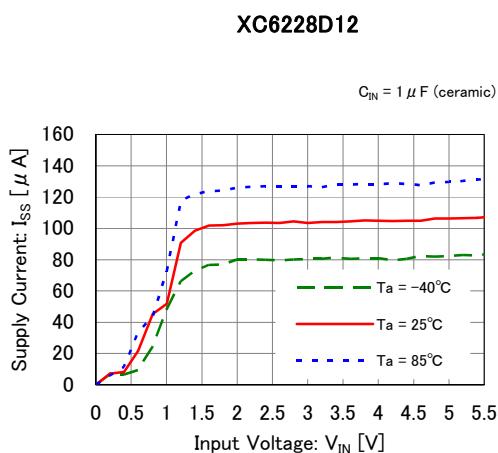
C_{IN} = 1 μF (ceramic)

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

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

XC6228D25
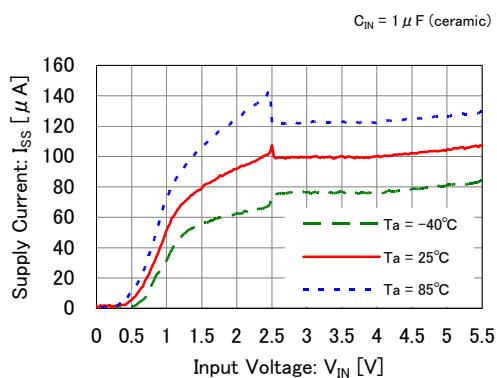
$C_{IN} = 1 \mu F$ (ceramic)

(5) Output Voltage vs. Ambient Temperature

XC6228D12

$V_{IN} = 2.2V$
$C_{IN} = 1 \mu F$ (ceramic), $C_L = 1 \mu F$ (ceramic)
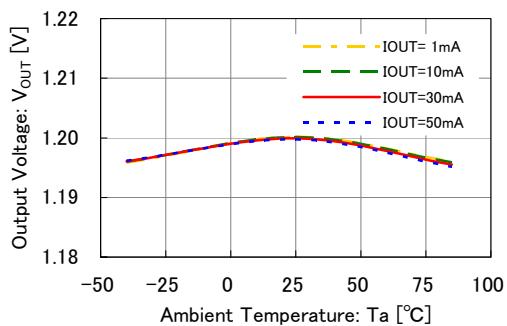
XC6228D18

$V_{IN} = 2.8V$
$C_{IN} = 1 \mu F$ (ceramic), $C_L = 1 \mu F$ (ceramic)
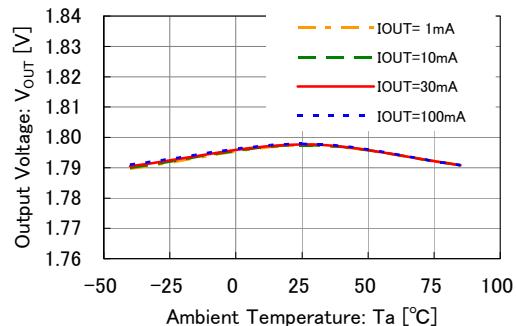
XC6228D25

$V_{IN} = 3.5V$
$C_{IN} = 1 \mu F$ (ceramic), $C_L = 1 \mu F$ (ceramic)
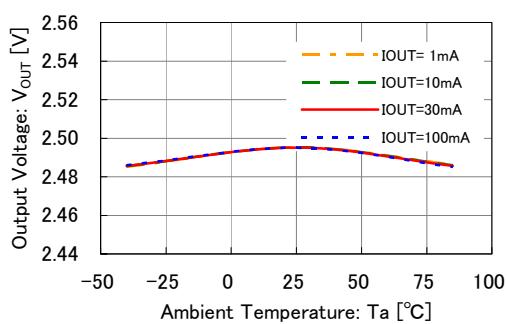
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(6) Rising Response Time

XC6228D12

tr = 5 μ s, Ta = 25℃,V$_{IN}$ = 0→2.2V
C$_{IN}$ = 0.1 μ F (ceramic), C$_L$ = 1 μ F (ceramic)
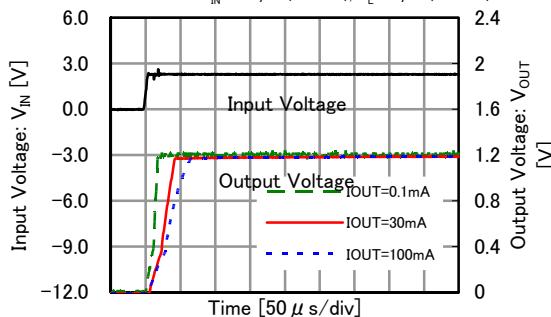
XC6228D18

tr = 5 μ s, Ta = 25℃,V$_{IN}$ = 0→2.8V
C$_{IN}$ = 0.1 μ F (ceramic), C$_L$ = 1 μ F (ceramic)
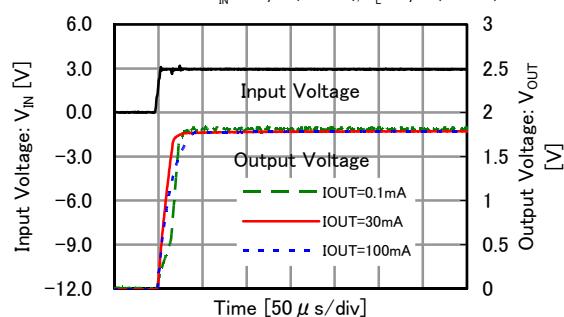
XC6228D25

tr = 5 μ s, Ta = 25℃,V$_{IN}$ = 0→3.5V
C$_{IN}$ = 0.1 μ F (ceramic), C$_L$ = 1 μ F (ceramic)
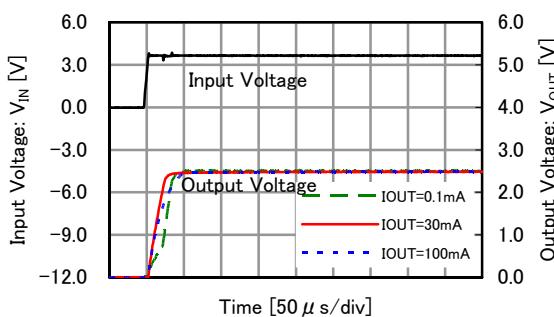
(7) Input Transient Response

XC6228D12

tr = tf = 5 μ s, Ta = 25℃, V$_{IN}$ = 2.2V⇔3.2V
C$_{IN}$ = 0.1 μ F (ceramic), C$_L$ = 1.0 μ F (ceramic)
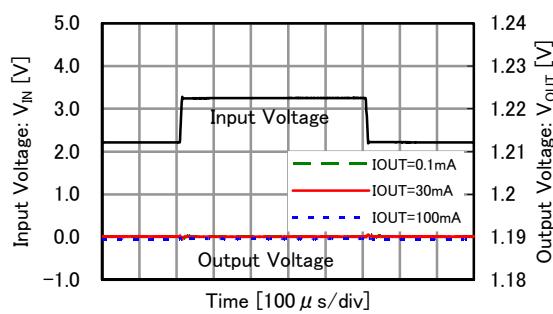
XC6228D18

tr = tf = 5 μ s, Ta = 25℃, V$_{IN}$ = 2.8V⇔3.8V
C$_{IN}$ = 0.1 μ F (ceramic), C$_L$ = 1.0 μ F (ceramic)
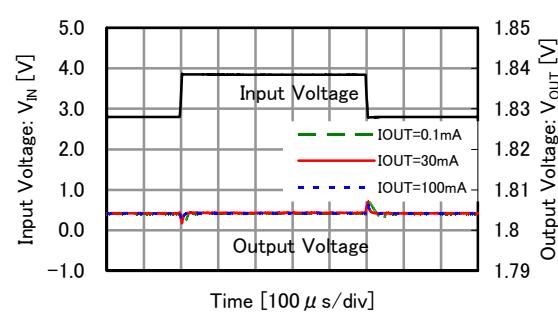
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(7) Input Transient Response (Continued)

XC6228D25

tr = tf = 5 μ s, Ta = 25℃, V$_{IN}$ = 3.5V⇔4.5V
C$_{IN}$ = 0.1 μ F (ceramic), C$_L$ = 1.0 μ F (ceramic)

(8) Load Transient Response (tr=tf=0.5 μ s)

XC6228D12

tr = tf = 0.5 μ s, Ta = 25℃, I$_{OUT}$ = 1⇔150mA
V$_{IN}$ = 2.2V, C$_{IN}$ = 1 μ F (ceramic), C$_L$ = 1 μ F (ceramic)

XC6228D12

tr = tf = 0.5 μ s, Ta = 25℃, I$_{OUT}$ = 50⇔100mA
V$_{IN}$ = 2.2V, C$_{IN}$ = 1 μ F (ceramic), C$_L$ = 1 μ F (ceramic)

XC6228D18

tr = tf = 0.5 μ s, Ta = 25℃, I$_{OUT}$ = 1⇔150mA
V$_{IN}$ = 2.8V, C$_{IN}$ = 1 μ F (ceramic), C$_L$ = 1 μ F (ceramic)
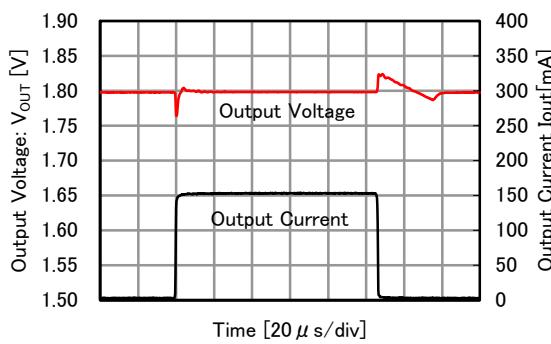
XC6228D18

tr = tf = 0.5 μ s, Ta = 25℃, I$_{OUT}$ = 50⇔100mA
V$_{IN}$ = 2.8V, C$_{IN}$ = 1 μ F (ceramic), C$_L$ = 1 μ F (ceramic)

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(8) Load Transient Response (tr=tf=0.5 μ s) (Continued)

XC6228D25
tr = tf = 0.5 μ s, Ta = 25°C, I_{OUT} = 1⇔150mA
V_{IN} = 3.5V, C_{IN} = 1 μ F (ceramic), C_L = 1 μ F (ceramic)

XC6228D25
tr = tf = 0.5 μ s, Ta = 25°C, I_{OUT} = 50⇔100mA
V_{IN} = 3.5V, C_{IN} = 1 μ F (ceramic), C_L = 1 μ F (ceramic)

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

XC6228D12
tr = tf = 5 μ s, Ta = 25°C, I_{OUT} = 1⇔150mA
V_{IN} = 2.2V, C_{IN} = 1 μ F (ceramic), C_L = 1 μ F (ceramic)

XC6228D12
tr = tf = 5 μ s, Ta = 25°C, I_{OUT} = 50⇔100mA
V_{IN} = 2.2V, C_{IN} = 1 μ F (ceramic), C_L = 1 μ F (ceramic)

XC6228D18
tr = tf = 5 μ s, Ta = 25°C, I_{OUT} = 1⇔150mA
V_{IN} = 2.8V, C_{IN} = 1 μ F (ceramic), C_L = 1 μ F (ceramic)

XC6228D18
tr = tf = 5 μ s, Ta = 25°C, I_{OUT} = 50⇔100mA
V_{IN} = 2.8V, C_{IN} = 1 μ F (ceramic), C_L = 1 μ F (ceramic)

## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

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

XC6228D25

tr = tf = 5 μ s, Ta = 25°C, 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°C, 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°C
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°C
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°C
V_{CE} = 0→V_{IN}, C_{IN} = C_L = 1.0 μ F (ceramic)
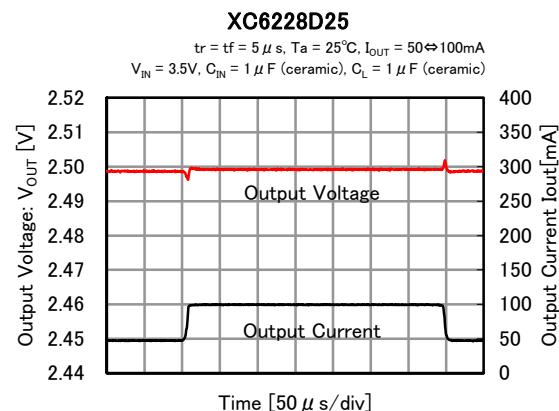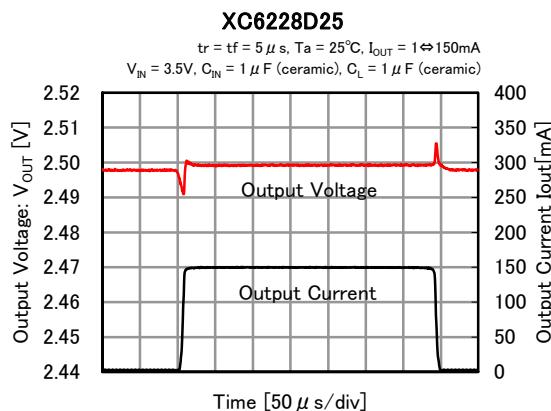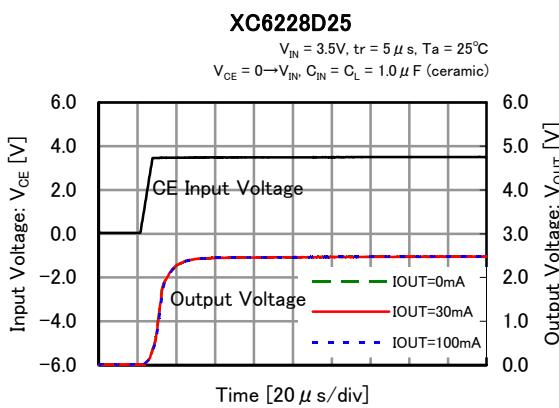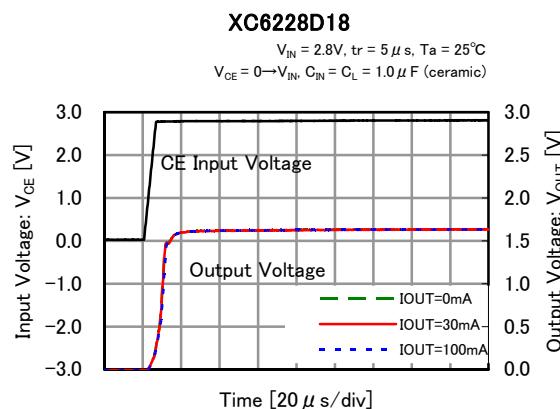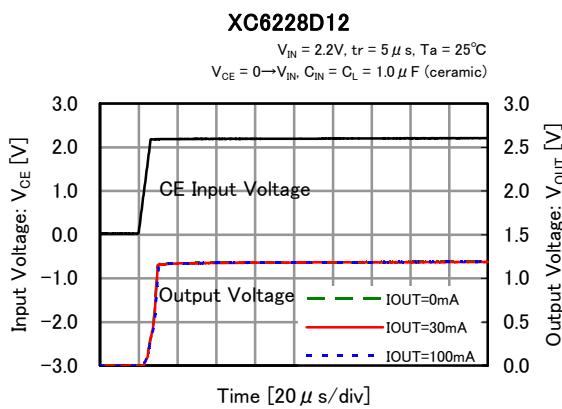
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(11) Ripple Rejection Rate

XC6228D12

Ta = 25℃, V_{IN} = 3.0VDC+0.5Vp−pAC
C_{IN} = 0.1μF (ceramic), C_L = 1μF (ceramic)
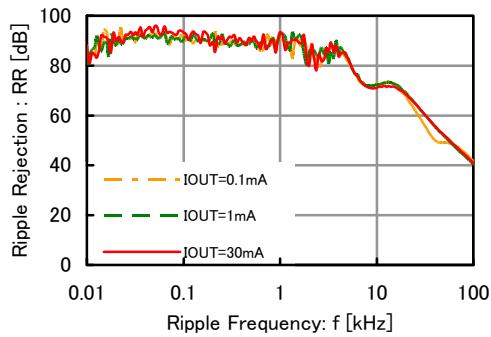
XC6228D18

Ta = 25℃, V_{IN} = 3.0VDC+0.5Vp−pAC
C_{IN} = 0.1μF (ceramic), C_L = 1μF (ceramic)
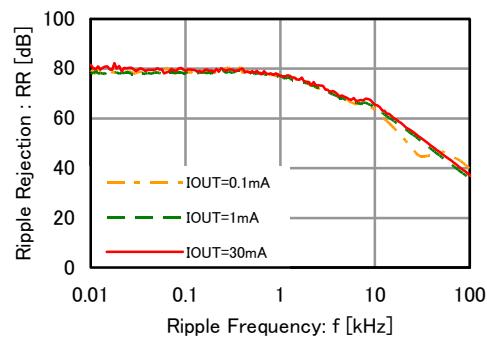
XC6228D25

Ta = 25℃, V_{IN} = 3.5VDC+0.5Vp−pAC
C_{IN} = 0.1μF (ceramic), C_L = 1μF (ceramic)
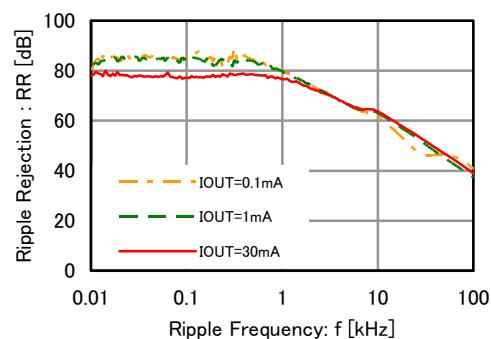
XC6228D33

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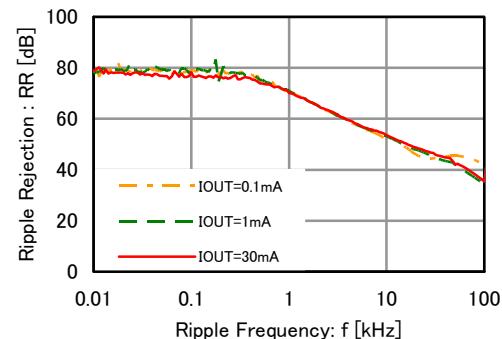
PACKAGING INFORMATION

● SOT-25J
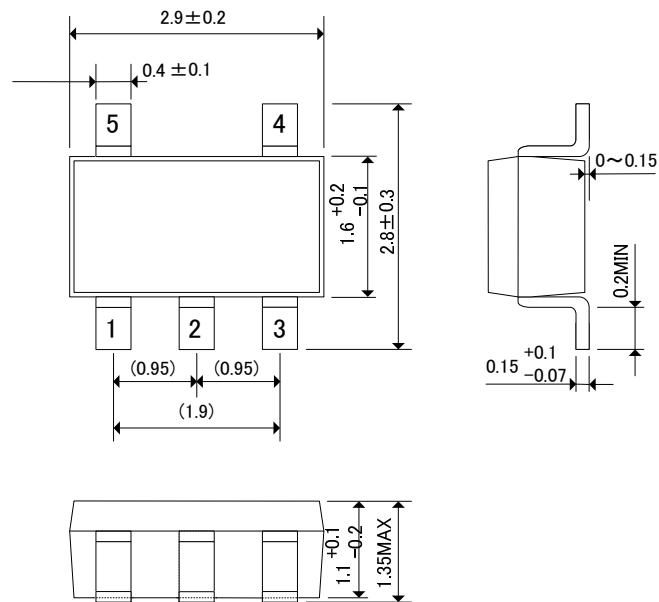
PACKAGING INFORMATION (Continued)

●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
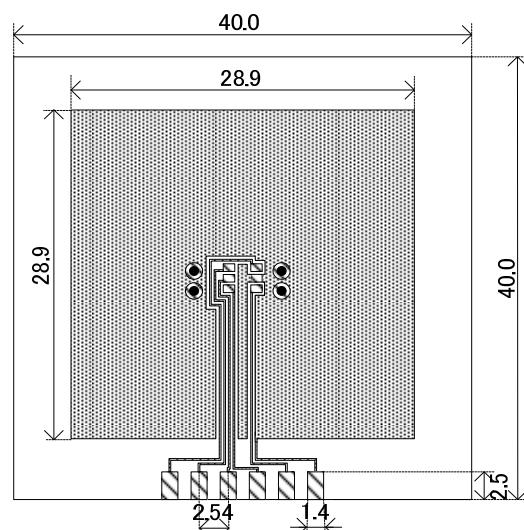
Evaluation Board (Unit: mm)

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	

Pd vs. Ta
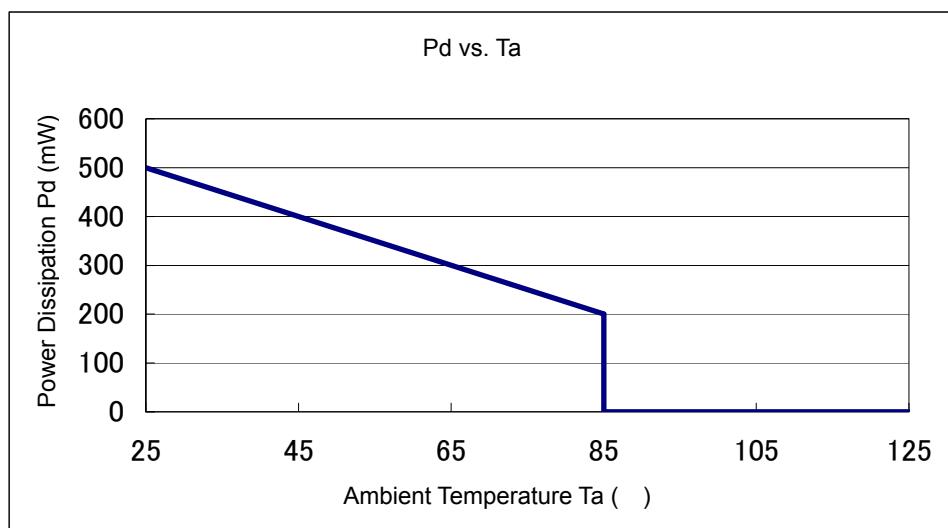
XC6228 Series

MARKING RULE

●SOT-25J

represents product series.

MARK	PRODUCT SERIES
9	XC6228******-G
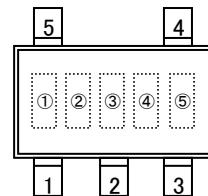
represents type of regulator and combination of output voltage.

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.

SOT-25J
(TOP VIEW)

1. The products and product specifications contained herein are subject to change without notice to improve performance characteristics. Consult us, or our representatives before use, to confirm that the information in this datasheet is up to date.

2. We assume no responsibility for any infringement of patents, patent rights, or other rights arising from the use of any information and circuitry in this datasheet.

3. Please ensure suitable shipping controls (including fail-safe designs and aging protection) are in force for equipment employing products listed in this datasheet.

4. The products in this datasheet are not developed, designed, or approved for use with such equipment whose failure of malfunction can be reasonably expected to directly endanger the life of, or cause significant injury to, the user.
   (e.g. Atomic energy; aerospace; transport; combustion and associated safety equipment thereof.)

5. Please use the products listed in this datasheet within the specified ranges.
   Should you wish to use the products under conditions exceeding the specifications, please consult us or our representatives.

6. We assume no responsibility for damage or loss due to abnormal use.

7. All rights reserved. No part of this datasheet may be copied or reproduced without the prior permission of TOREX SEMICONDUCTOR LTD.

TOREX SEMICONDUCTOR LTD.

X-ON Electronics

Largest Supplier of Electrical and Electronic Components

Click to view similar products for Linear Voltage Regulators *category:*

Click to view products by Torex Semiconductor *manufacturer:*

Other Similar products are found below :

LV5684PVD-XH MCDTSA6-2R L7815ACV-DG 714954EB ZMR500QFTA BA033LBSG2-TR LV5680P-E L79M05T-E L78LR05D-MA-E NCV317MBTG NTE7227 MP2018GZD-33-P MP2018GZD-5-P LV5680NPVC-XH LT1054CN8 ZTS6538SE UA78L09CLP UA78L09CLPR CAT6221-PPTD-GT3 MC78M09CDTRK NCV51190MNTAG 78M05 HT7150-1 UM1540DB-18 XC6234H281VR-G WL2834CA-6/TR TPL730F33-5TR TLS850F1TA V50 TPS549B22RVFR UM1540DB-33 WL9200P3-50B WL9100P3-33B WL9005D4-33 XC6219B152MR WL2855K33-3/TR PJ54BM33SE PJ9500M25SA MD7218E33PC1 H7533-2PR SK7812AU SD1A30 78L33 TP78L33T3 L78L33ACUTR SK6513ST3A-50 SK6054D4-09 SK6054D4-18 SK6054D4-11 SK6054D4-10 LM79L12F