XC6228 Series

ETR03116-001

300mA High Speed LDO Regulator with ON/OFF Switch

■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 V_{OUT} pin quickly returns to the V_{SS} level. The output stabilization capacitor C_L is also compatible with low ESR ceramic capacitors.

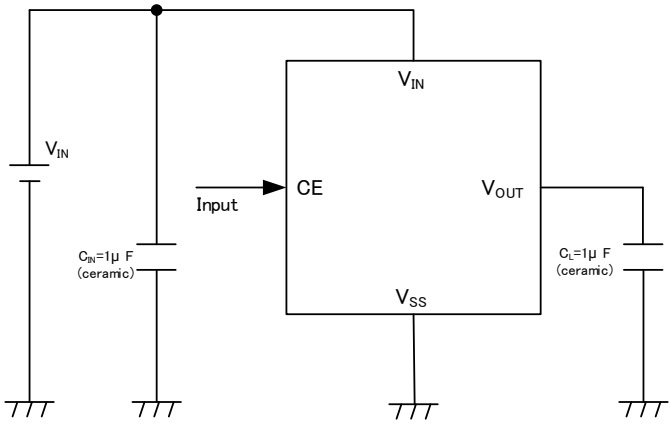
■APPLICATIONS

- Mobile devices
- Wireless communications
- Modules
- Mobile phones

■FEATURES

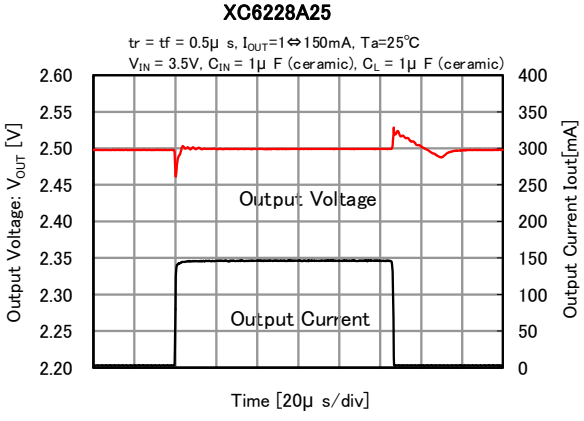
Maximum Output Current	: 300mA
Input Voltage Range	: 1.6V ~ 5.5V
Output Voltages	: 1.2V ~ 4.0V (Accuracy ±2%) 0.1V increments
Dropout Voltage	: 200mV@I_{OUT}=300mA (V_{OUT}=3.0V)
Low Power Consumption	: 100μA
Stand-by Current	: 0.1μA
High Ripple Rejection	: 80dB@f=1kHz
Protection Circuits	: Current Limit (400mA)
Low ESR Capacitors	: C_{IN}=1μF, C_L=1μF
CE Function	: Active High, C_L High Speed Discharge
Operating Ambient Temperature	: -40℃ ~ 85℃
Small Package	: USPQ-4B04
Environmentally Friendly	: EU RoHS Compliant, Pb Free

■TYPICAL APPLICATION CIRCUIT

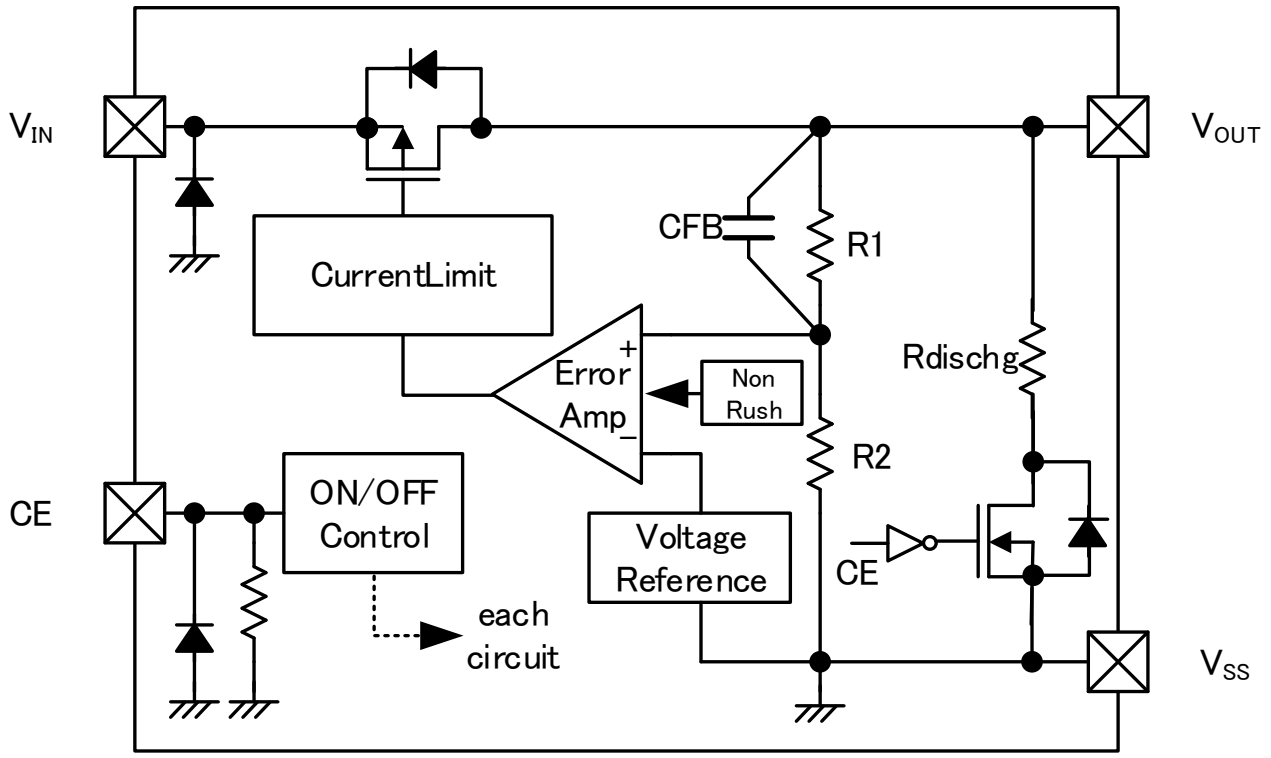


■ TYPICAL PERFORMANCE CHARACTERISTICS

●Load Transient Response



■BLOCK DIAGRAMS



XC6228A

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

■PRODUCT CLASSIFICATION

●Ordering Information

XC6228①②③④⑤⑥–⑦ (*1)

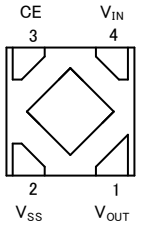
DESIGNATOR	ITEM	SYMBOL	DESCRIPTION
①	Regulator Type	A	Inrush Current Prevention Circuit Built-in
②③	Output Voltage	12 ~ 40	ex.) 2.80V → ②=2, ③=8
④	Output Voltage Accuracy	2	Output Voltage Accuracy : ±2%
⑤⑥–⑦ (*1)	Packages (Order Unit)	9R-G	USPQ-4B04 (3,000/Reel)

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

●Selection Guide

TYPE	CURRENT LIMITTER	CE PULL-DOWN RESISTOR	C_L DISCHARGE	INRUSH CURRENT PROTECTION
A	Yes	Yes	Yes	Yes

■PIN CONFIGURATION



USPQ-4B04
(BOTTOM VIEW)

* The dissipation pad for the USPQ-4B04 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
1	V_{OUT}	Output
2	V_{SS}	Ground
3	CE	ON/OFF Control
4	V_{IN}	Power Input

■PIN FUNCTION ASSIGNMENT

PIN NAME	SIGNAL	STATUS
CE	L	Stand-by
	H	Active
	OPEN	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}	-0.3 ~ 7.0	V
Output Voltage		V_{OUT}	0.3 ~ V_{IN} + 0.3 or 7.0 (*1)	V
CE Input Voltage		V_{CE}	-0.3 ~ 7.0	V
Power Dissipation (Ta=25℃)	USPQ-4B04	Pd	550 (40mm x 40mm Standard board) (*2)	mW
Operating Ambient Temperature		Topr	-40 ~ 85	℃
Storage Temperature		Tstg	-55 ~ 125	℃

All voltages are described based on the V_{SS}.
(*1) The maximum rating corresponds to the lowest value between V_{IN}+0.3V or 7.0V
(*2) The power dissipation figure shown is PCB mounted and is for reference only.
The mounting condition is please refer to PACKAGING INFORMATION.

■ELECTRICAL CHARACTERISTICS

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}/(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}/(ΔTopr・V_{OUT})	V_{CE}=V_{IN}, I_{OUT}=10mA -40℃≦Ta≦85℃	-	±100	-	ppm/℃	①
Power Supply Rejection Ratio	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	-	80	-	dB	③
		$V_{OUT(T)}$≧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					
Current Limit	I_{LIM}	V_{CE}=V_{IN}	310	400	-	mA	①
Short Current	I_{SHORT}	V_{CE}=V_{IN}, V_{OUT}=V_{SS}	-	140	-	mA	①
CE "H" Voltage	V_{CEH}	-	1.0	-	5.5	V	④
CE "L" Voltage	V_{CEL}	-	Vss	-	0.3	V	④
CE "H" Current	I_{CEH}	V_{CE}=V_{IN}=5.5V	3.0	5.5	9.0	μA	④
CE "L" 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	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) Vdif=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.

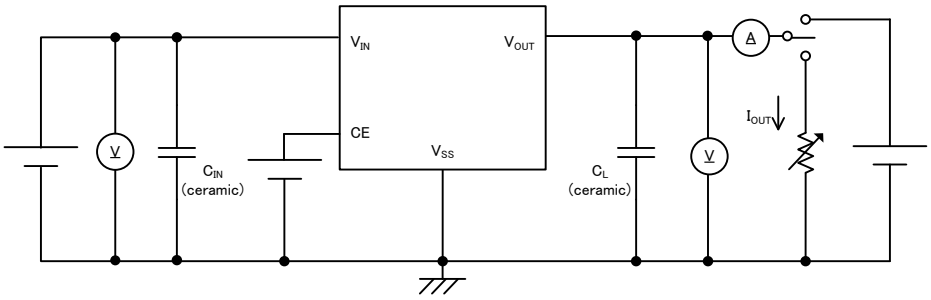
■OUTPUT VOLTAGE CHART

●Voltage Chart 1

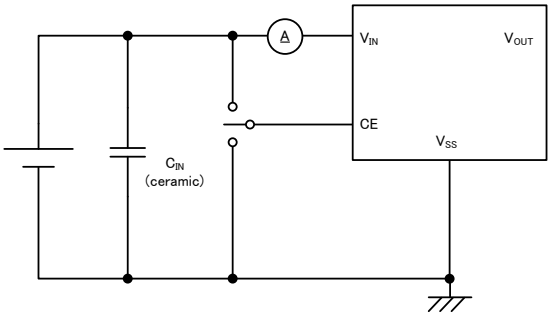
NOMINAL OUTPUT VOLTAGE (V)	OUTPUT VOLTAGE (V)		DROPOUT VOLTAGE (mV) E-1	
$V_{OUT(T)}$	$V_{OUT(E)}$		Vdif	
	MIN.	MAX.	TYP.	MAX.
1.20	1.176	1.224	480	630
1.30	1.274	1.326	440	580
1.40	1.372	1.428	420	520
1.50	1.470	1.530	420	460
1.60	1.568	1.632	400	440
1.70	1.666	1.734		
1.80	1.764	1.836	300	410
1.90	1.862	1.938		
2.00	1.960	2.040	270	380
2.10	2.058	2.142		
2.20	2.156	2.244		
2.30	2.254	2.346		
2.40	2.352	2.448		
2.50	2.450	2.550	240	350
2.60	2.548	2.652		
2.70	2.646	2.754		
2.80	2.744	2.856		
2.90	2.842	2.958		
3.00	2.940	3.060	200	305
3.10	3.038	3.162		
3.20	3.136	3.264		
3.30	3.234	3.366		
3.40	3.332	3.468		
3.50	3.430	3.570		
3.60	3.528	3.672		
3.70	3.626	3.774		
3.80	3.724	3.876		
3.90	3.822	3.978		
4.00	3.920	4.080		

■TEST CIRCUITS

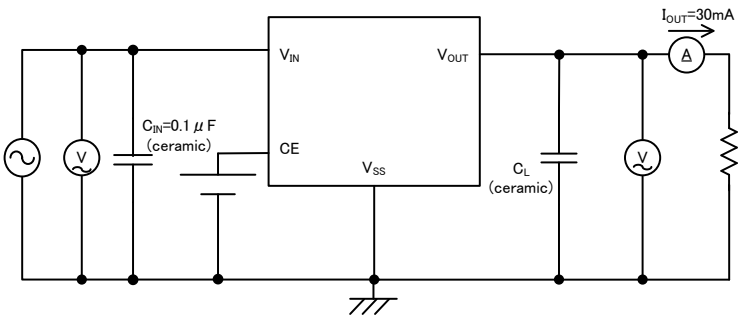
●Circuit ①



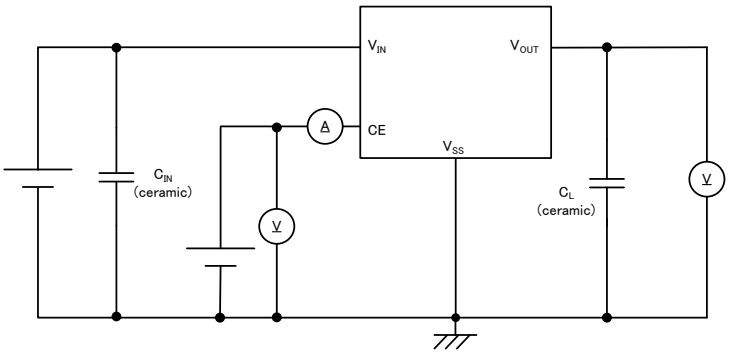
●Circuit ②



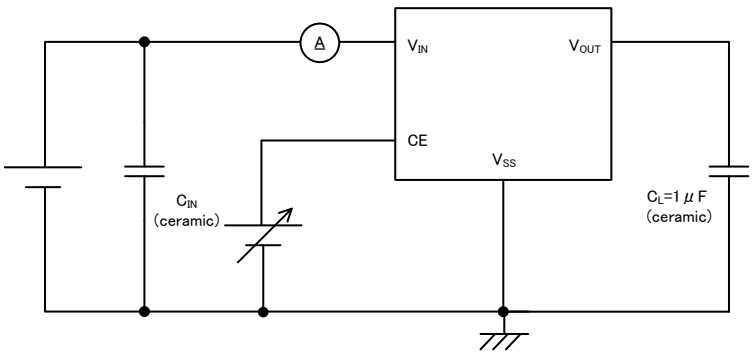
●Circuit ③



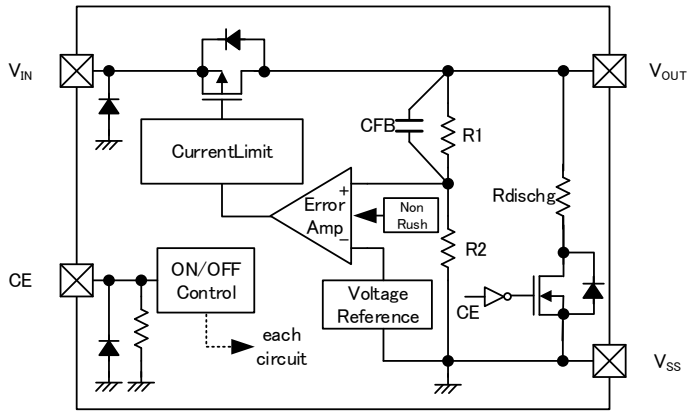
●Circuit ④



●Circuit ⑤



■ OPERATIONAL EXPLANATION



XC6228A

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 >

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.

<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.

<Inrush Current Protection>

The XC6228 series has a built-in inrush current protection function
This function is activated when the output voltage reaches within 30%(Typ.) of the set V_{OUT} after starting up.
The duration time of this function is 120us(TYP.), and during operation of the function, the current flowing from the input(V_{IN})to the output(V_{OUT}) is restrained within the IRUSH, Typ.150mA.

■ 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.

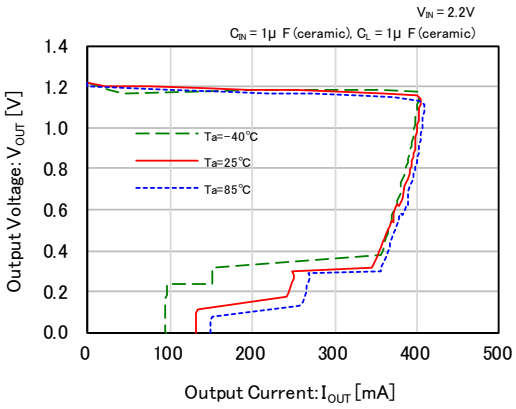
4. The IC is controlled with constant current start-up. Start-up sequence control is requested to draw a load current after even nominal output voltage rising up the output voltage.

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.

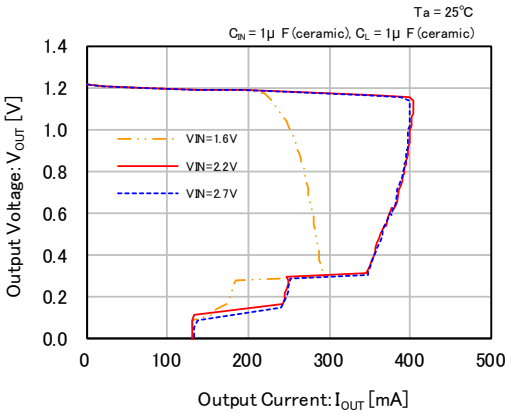
■TYPICAL PERFORMANCE CHARACTERISTICS

(1) Output Voltage vs. Output Current

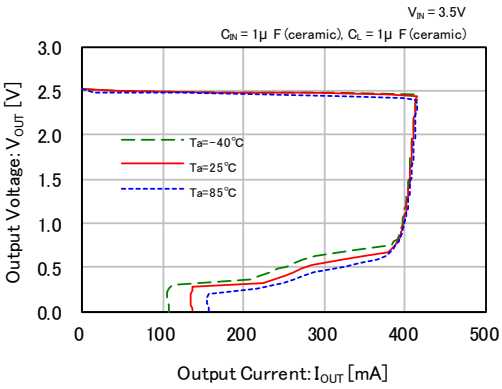
XC6228A12



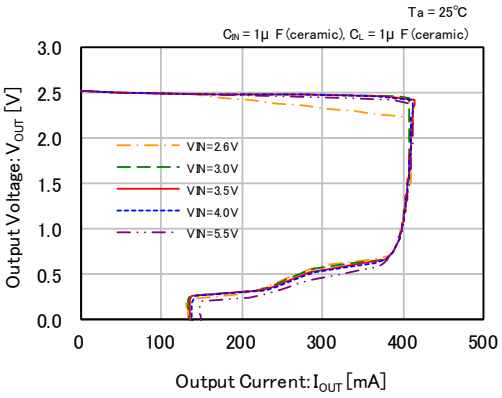
XC6228A12



XC6228A25



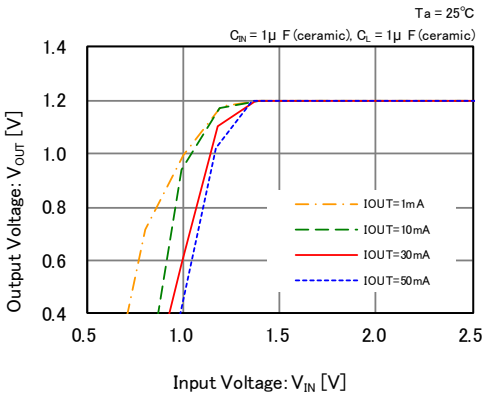
XC6228A25



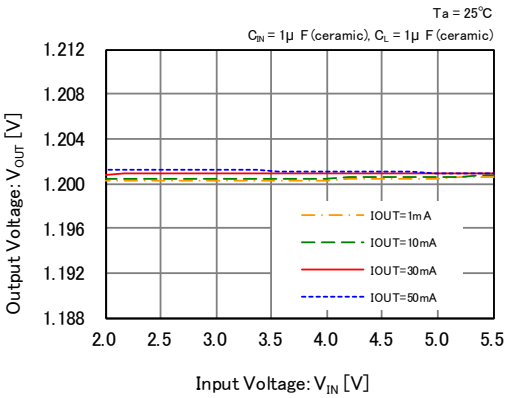
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2) Output Voltage vs. Input Voltage

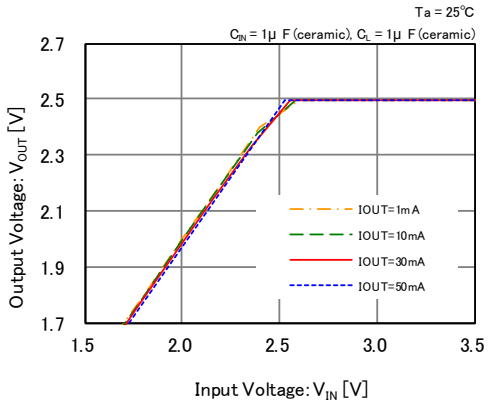
XC6228A12



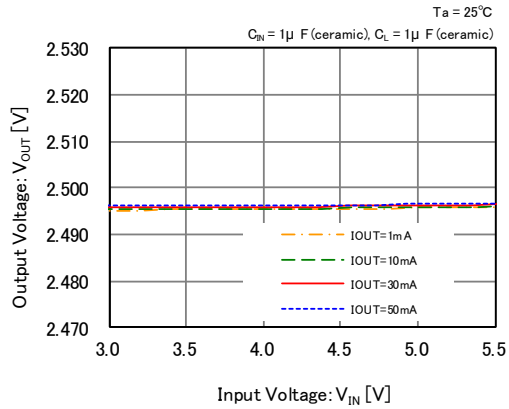
XC6228A12



XC6228A25

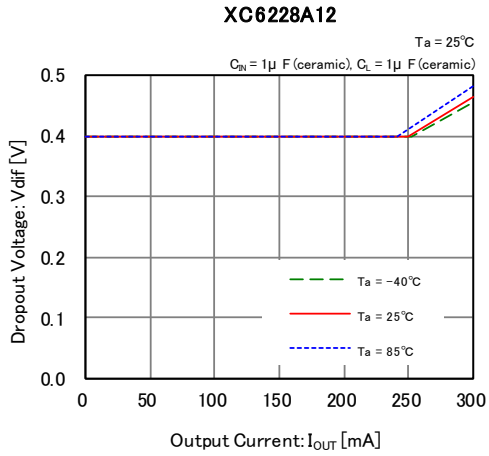


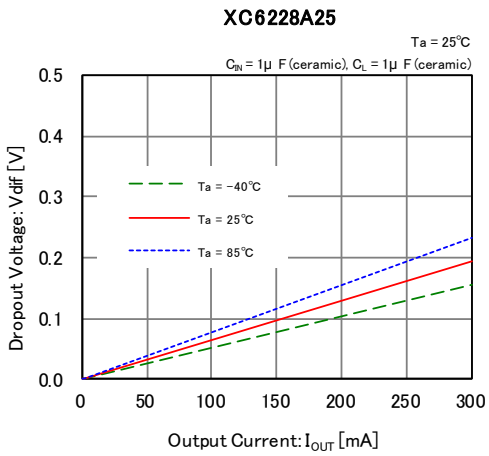
XC6228A25



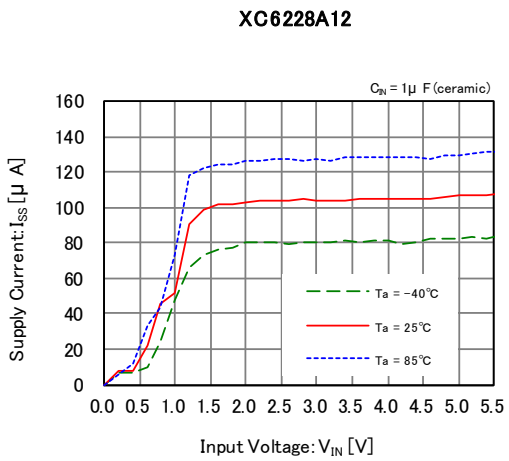
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

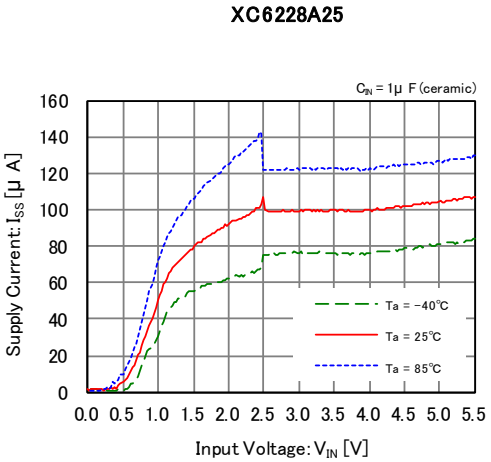
(3) Dropout Voltage vs. Output Current





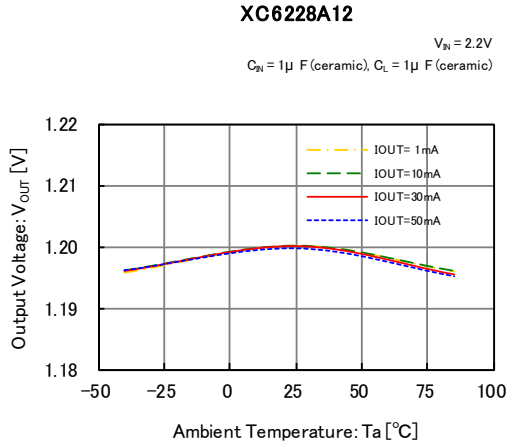
(4) Supply Current vs. Input Voltage

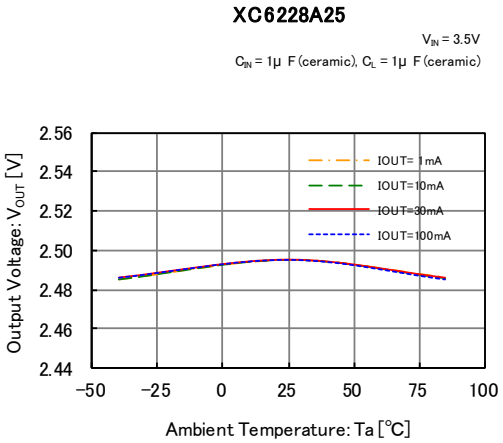




■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

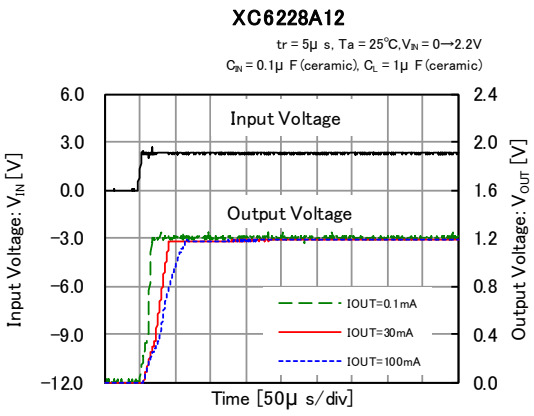
(5) Output Voltage vs. Ambient Temperature

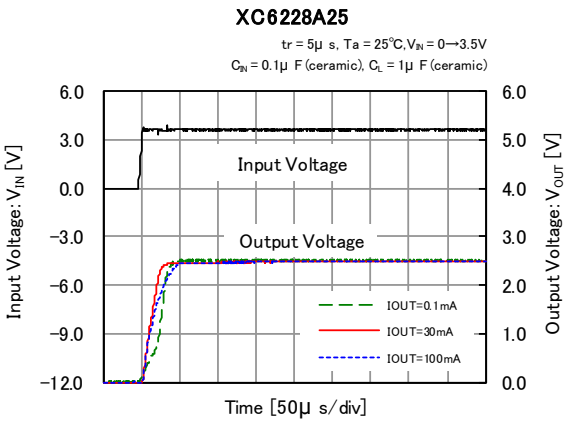




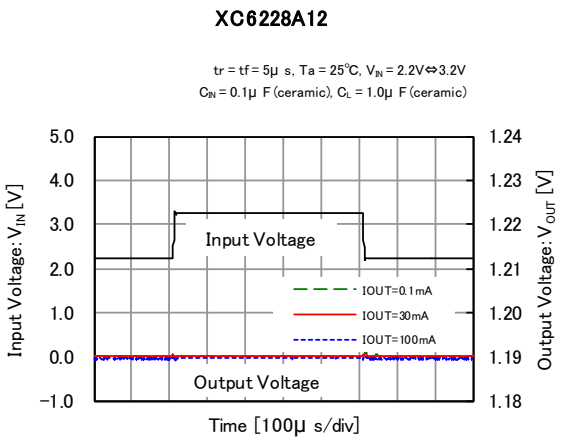
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

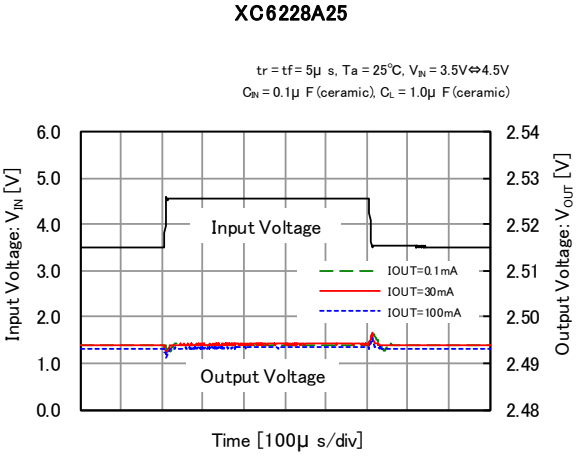
(6) Rising Response Time





(7) Input Transient Response



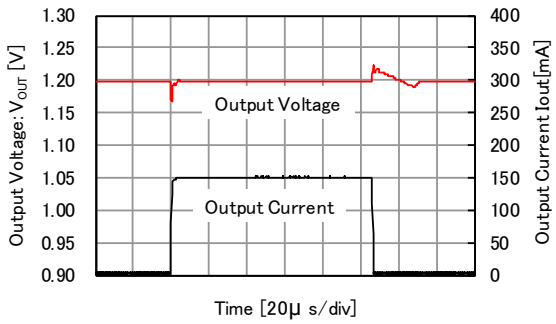


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(8) Load Transient Response

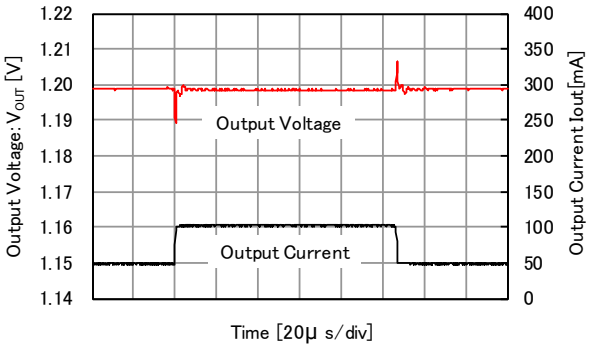
XC6228A12

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



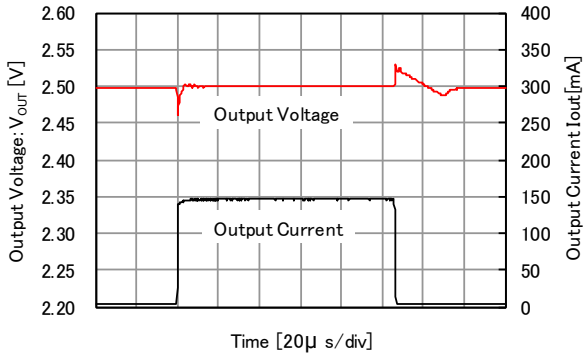
XC6228A12

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



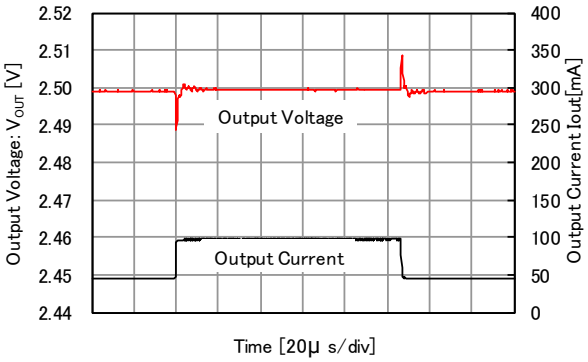
XC6228A25

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



XC6228A25

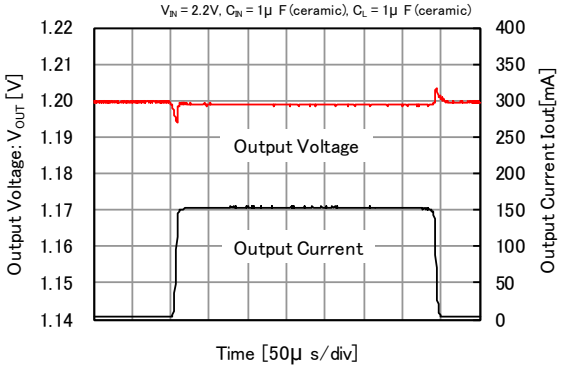
tr = tf = 0.5μ s, Ta = 25℃, I_{OUT} = 50mA⇔100mA
V_{IN} = 3.5V, C_{IN} = 1μ F (ceramic), C_L = 1μ F (ceramic)



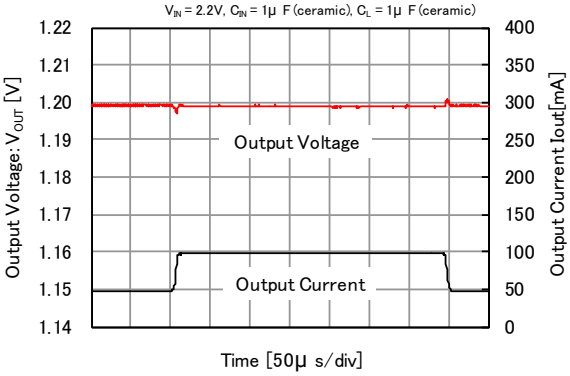
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(9) Load Transient Response

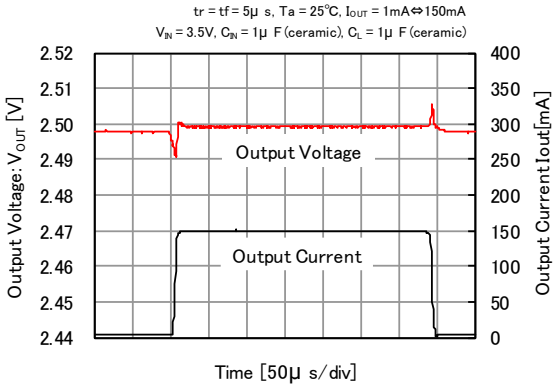
XC6228A12



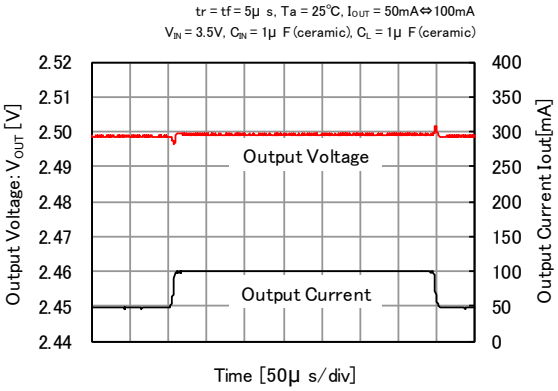
XC6228A12



XC6228A25

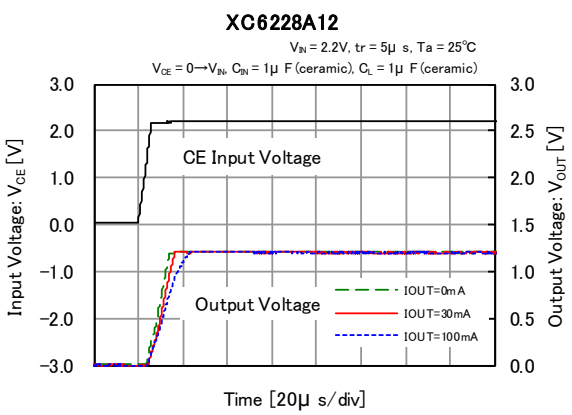


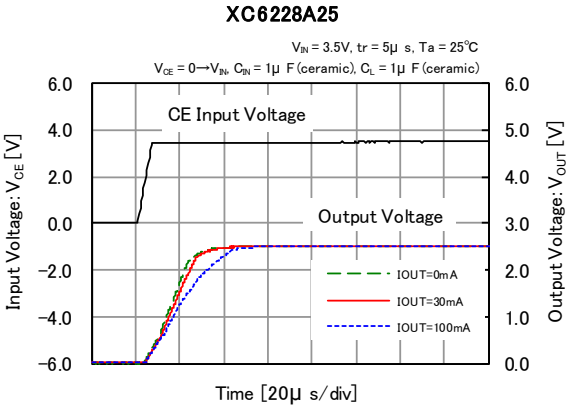
XC6228A25



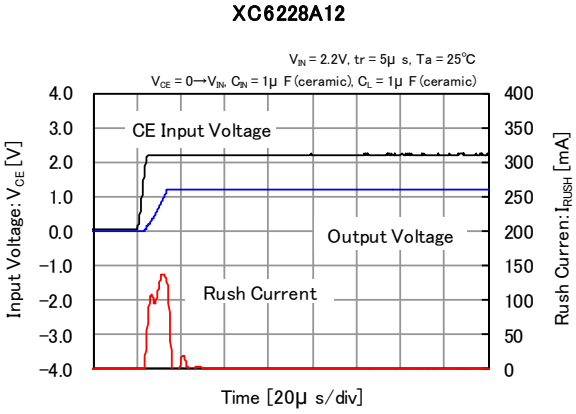
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

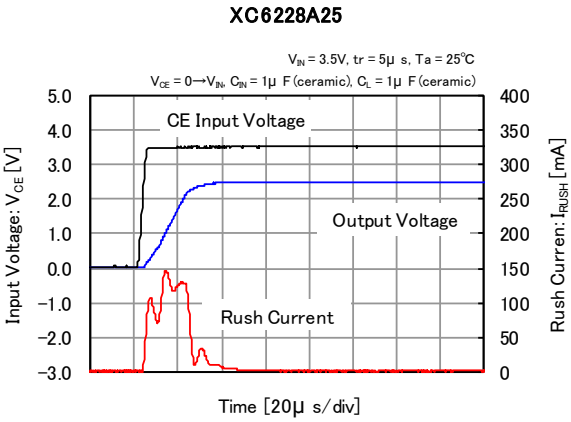
(10) CE Rising Response Time





(11) Inrush Current Response Time



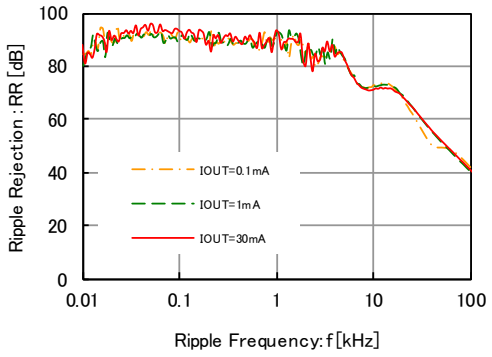


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(12) Ripple Rejection Rate

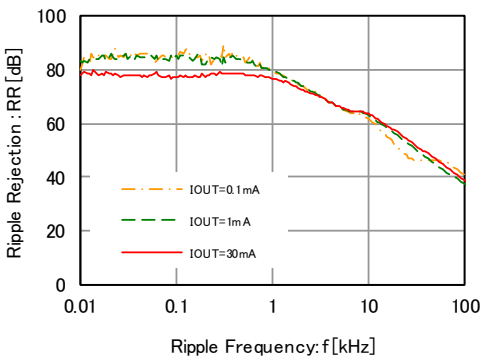
XC6228A12

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



XC6228A25

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



■PACKAGING INFORMATION

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

PACKAGE	OUTLIN / LAND PATTERN	THERMAL CHARACTERISTICS	
USPQ-4B04	USPQ-4B04 PKG	Standard Board	USPQ-4B04 Power Dissipation

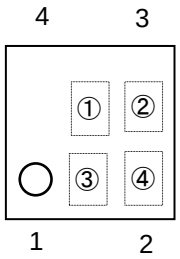
■MARKING RULE

●USPQ-4B04

①represents product series.

MARK	PRODUCT SERIES
T	XC6228A*****-G

USPQ-4B04



②represents products series, type of regulator and output voltage.

MARK	OUTPUT VOLTAGE (V)	PRODUCT SERIES	MARK	OUTPUT VOLTAGE (V)	PRODUCT SERIES
0	1.2	XC6228*12***-G	F	2.7	XC6228*27***-G
1	1.3	XC6228*13***-G	H	2.8	XC6228*28***-G
2	1.4	XC6228*14***-G	K	2.9	XC6228*29***-G
3	1.5	XC6228*15***-G	L	3.0	XC6228*30***-G
4	1.6	XC6228*16***-G	M	3.1	XC6228*31***-G
5	1.7	XC6228*17***-G	N	3.2	XC6228*32***-G
6	1.8	XC6228*18***-G	P	3.3	XC6228*33***-G
7	1.9	XC6228*19***-G	R	3.4	XC6228*34***-G
8	2.0	XC6228*20***-G	S	3.5	XC6228*35***-G
9	2.1	XC6228*21***-G	T	3.6	XC6228*36***-G
A	2.2	XC6228*22***-G	U	3.7	XC6228*37***-G
B	2.3	XC6228*23***-G	V	3.8	XC6228*38***-G
C	2.4	XC6228*24***-G	X	3.9	XC6228*39***-G
D	2.5	XC6228*25***-G	Y	4.0	XC6228*40***-G
E	2.6	XC6228*26***-G			

③,④ represents production lot number 01～09, 0A～0Z, 11～9Z, A1～A9, AA～AZ, B1～ZZ repeated (G, I, J, O, Q, W excluded)* No character inversion used.

1. The product 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. The information in this datasheet is intended to illustrate the operation and characteristics of our products. We neither make warranties or representations with respect to the accuracy or completeness of the information contained in this datasheet nor grant any license to any intellectual property rights of ours or any third party concerning with the information in this datasheet.

3. Applicable export control laws and regulations should be complied and the procedures required by such laws and regulations should also be followed, when the product or any information contained in this datasheet is exported.

4. The product is neither intended nor warranted for use in equipment of systems which require extremely high levels of quality and/or reliability and/or a malfunction or failure which may cause loss of human life, bodily injury, serious property damage including but not limited to devices or equipment used in 1) nuclear facilities, 2) aerospace industry, 3) medical facilities, 4) automobile industry and other transportation industry and 5) safety devices and safety equipment to control combustions and explosions. Do not use the product for the above use unless agreed by us in writing in advance.

5. Although we make continuous efforts to improve the quality and reliability of our products; nevertheless Semiconductors are likely to fail with a certain probability. So in order to prevent personal injury and/or property damage resulting from such failure, customers are required to incorporate adequate safety measures in their designs, such as system fail safes, redundancy and fire prevention features.

6. Our products are not designed to be Radiation-resistant.

7. Please use the product listed in this datasheet within the specified ranges.

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

9. All rights reserved. No part of this datasheet may be copied or reproduced unless agreed by Torex Semiconductor Ltd in writing in advance.

TOREX SEMICONDUCTOR LTD.