XC6223 Series

Built-in Inrush Current Protection, 300mA High Speed LDO Voltage Regulator

■GENERAL DESCRIPTION

The XC6223 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, a thermal shutdown circuit and an inrush current protection 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 and the thermal shutdown circuit are built-in. These two protection circuits will operate when the output current reaches current limit level or the junction temperature reaches temperature limit level.

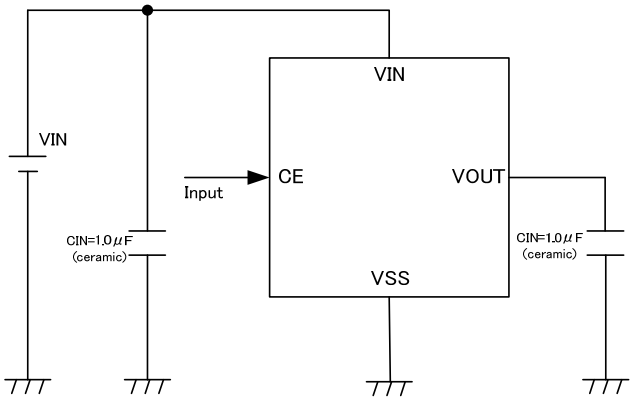
■APPLICATIONS

- ●Digital still cameras
- ●Smart phones / Mobile phones
- ●Portable game consoles
- ●Modules (wireless, cameras, etc.)
- ●IC recorders
- ●Mobile devices / terminals
- ●Bluetooth
- ●Wireless LAN
- ●Digital TV tuners

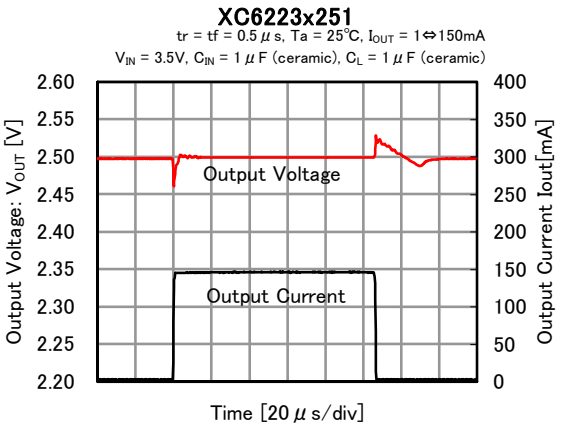
■FEATURES

Maximum Output Current	: 300mA
Input Voltage Range	: 1.6～5.5V
Output Voltages	: 2.0～4.0V（Accuracy ±1%） 1.2～1.95V（Accuracy ±20mV） 0.05V 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） Short Circuit Protection Over Heat Protection Inrush Current Protection
Low ESR Capacitors	: C_{IN} =1.0μF, C_L=1.0μF
CE Function	: Active High C_L High Speed Discharge
Operating Ambient Temperature	: -40℃～+105℃
Packages	: USPQ-4B03 USP-4 SSOT-24 SOT-25 SOT-89-5
Environmentally Friendly	: EU RoHS Compliant, Pb Free

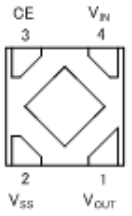
■TYPICAL APPLICATION CIRCUIT



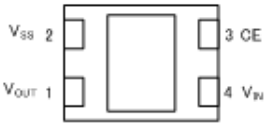
■ TYPICAL PERFORMANCE CHARACTERISTICS



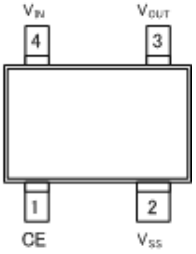
■PIN CONFIGURATION



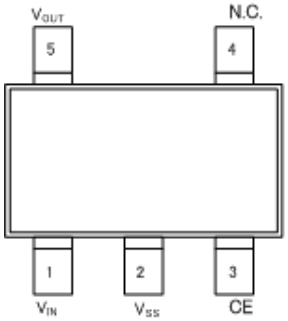
USPQ-4B03
(BOTTOM VIEW)



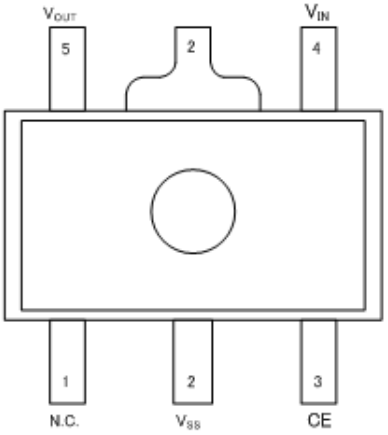
USP-4
(BOTTOM VIEW)



SSOT-24
(TOP VIEW)



SOT-25
(TOP VIEW)



SOT-89-5
(TOP VIEW)

*The dissipation pad for the USPQ-4B03,USP-4 packages 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
USPQ-4B03	USP-4	SSOT-24	SOT-25	SOT-89-5		
4	4	4	1	4	V_{IN}	Power Input
1	1	3	5	5	V_{OUT}	Output
2	2	2	2	2	V_{SS}	Ground
3	3	1	3	3	CE	ON/OFF Control
-	-	-	4	1	NC	No Connection

■LOGIC CONDITION FOR THE PIN

PIN NAME	DESIGNATOR	CONDITION
CE	L	$0V \leqq V_{CE} \leqq 0.3V$
	H	$1.0V \leqq V_{CE} \leqq 5.5V$
	OPEN	CE=OPEN

■PIN FUNCTION ASSIGNMENT

CE LOGIC CONDITION	IC OPERATION
H	Operation ON
L	Operation OFF(Stand-by)
OPEN	*

* Undefined state in XC6223 A/B/E/F/J/K/P/Q. On the other hand, Operation OFF states in XC6223C/D/G/H/M/N/R/T because that an internal pull-down resister maintains the CE pin voltage to be low.

■PRODUCT CLASSIFICATION

●Ordering Information

XC6223①②③④⑤⑥−⑦(*1)

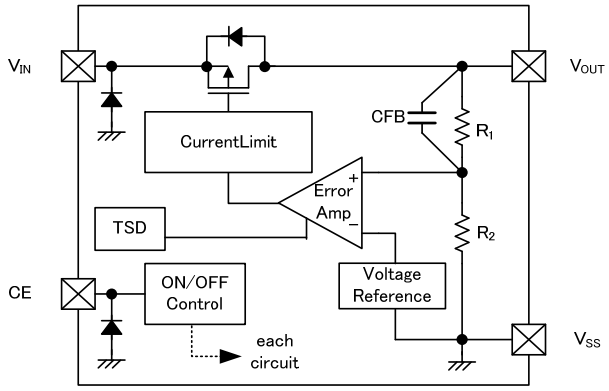
DESIGNATOR	ITEM	SYMBOL	DESCRIPTION
①	Type of Regulator	A/J(*3)	Without Inrush Current Protection, Without CE Pull-down, Without C_L discharge (Semi-Custom)
		B/K(*3)	Without Inrush Current Protection, Without CE Pull-down, With C_L discharge (Semi-Custom)
		C/M(*3)	Without Inrush Current Protection, With CE Pull-down(*2), Without C_L discharge (Semi-Custom)
		D/N(*3)	Without Inrush Current Protection, With CE Pull-down(*2), With C_L discharge
		E/P(*3)	With Inrush Current Protection, Without CE Pull-down, Without CL discharge (Semi-Custom)
		F/Q(*3)	With Inrush Current Protection, Without CE Pull-down, With C_L discharge (Semi-Custom)
		G/R(*3)	With Inrush Current Protection, With CE Pull-down(*2), Without C_L discharge (Semi-Custom)
		H/T(*3)	With Inrush Current Protection, With CE Pull-down(*2), With C_L discharge
②③	Output Voltage	12～40	ex.) 2.80V → ②=2, ③=8, ④=please see down below.
④	Output Accuracy	1	±1% (V_{OUT}≧2.0V) ±0.02V (V_{OUT}＜2.0V) In case of 2nd decimal place 0 (ex.2.80V → ④=1)
		B	±1% (V_{OUT}≧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)	9R-G	USPQ-4B03 (5,000/Reel)
		GR-G	USP-4 (3,000/Reel)
		NR-G	SSOT-24 (3,000/Reel)
		MR-G	SOT-25 (3,000/Reel)
		PR-G	SOT-89-5 (1,000/Reel)

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

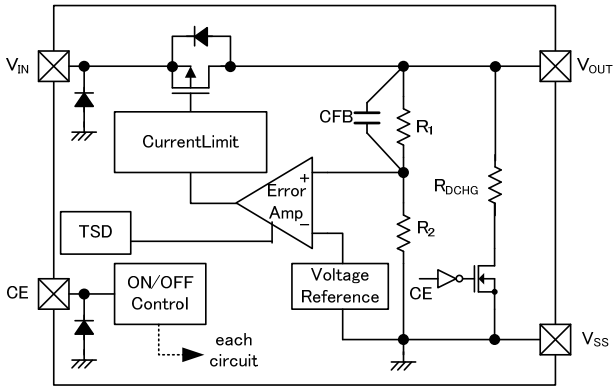
(*2) With CE pin pull-down resistor.

(*3) Product types A/B/C/D/E/F/G/H are for pre-existing customers who were or are already using these types of products.
For customers who intend to adopt this product newly, please select from types J/K/M/N/P/Q/R/T which have been extended the operating temperature range (105℃compliance).

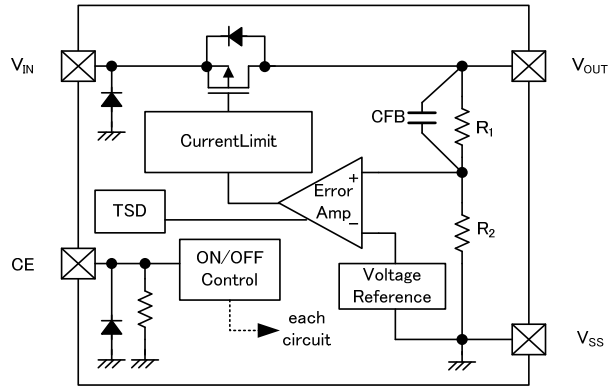
■BLOCK DIAGRAMS



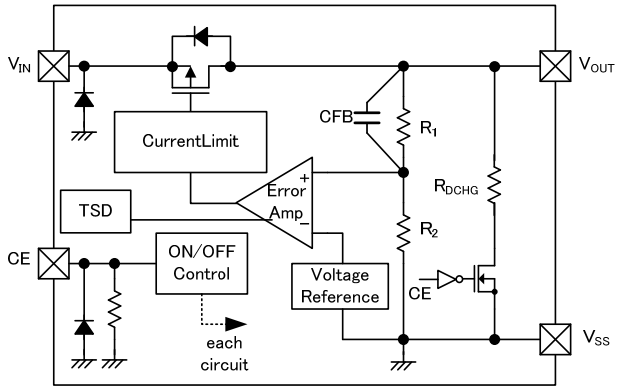
XC6223A/J series



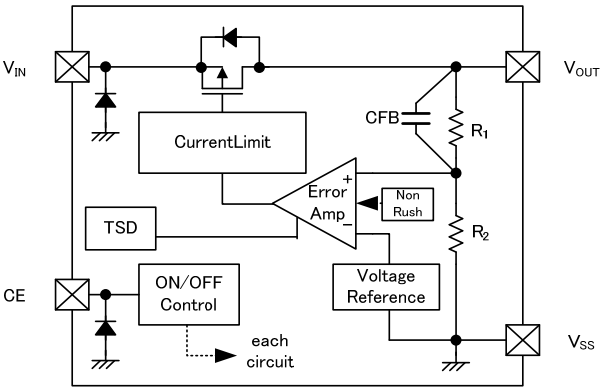
XC6223B/K series



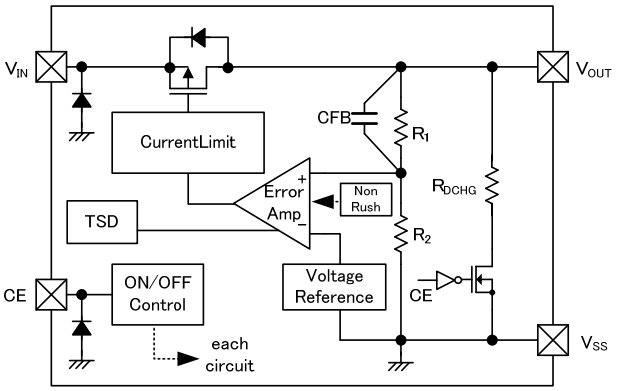
XC6223C/M series



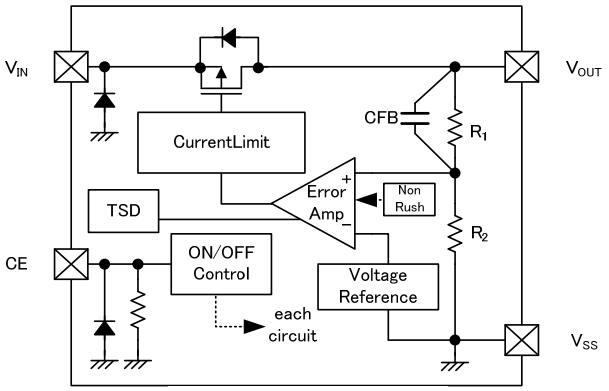
XC6223D/N series



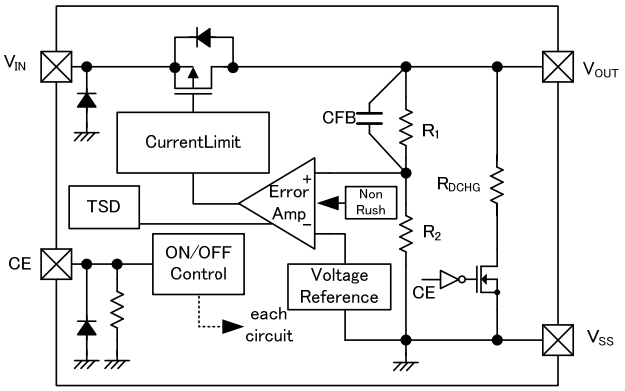
XC6223E/P series



XC6223F/Q series



XC6223G/R series



XC6223H/T series

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

■ABSOLUTE MAXIMUM RATINGS

●XC6223A/B/C/D/E/F/G/H Series

Ta=25℃

PARAMETER		SYMBOL	RATINGS	UNITS
Input Voltage		V_{IN}	V_{SS}-0.3～+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～+7.0	V
Power Dissipation	USPQ-4B03	Pd	100	mW
			550 (PCB mounted) (*2)	
	USP-4		120	
			1000 (PCB mounted) (*2)	
	SSOT-24		150	
			500 (PCB mounted) (*2)	
	SOT-25		250	
			600 (PCB mounted) (*2)	
	SOT-89-5		500	
			1300 (PCB mounted) (*2)	
Operating Ambient Temperature		Topr	-40～+85	℃
Storage Temperature		Tstg	-55～+125	℃

(*1) : $I_{OUT} \leqq Pd / (V_{IN}-V_{OUT})$

(*2) : The power dissipation figure shown is PCB mounted. Please refer to page 29～33 for details.

●XC6223J/K/M/N/P/Q/R/T Series

Ta=25℃

PARAMETER		SYMBOL	RATINGS	UNITS
Input Voltage		V_{IN}	V_{SS}-0.3～+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～+7.0	V
Power Dissipation	USPQ-4B03	Pd	100	mW
			550 (PCB mounted) (*2)	
	USP-4		120	
			1000 (PCB mounted) (*2)	
	SSOT-24		150	
			500 (PCB mounted) (*2)	
	SOT-25		250	
			600 (PCB mounted) (*2)	
	SOT-89-5		500	
			1300 (PCB mounted) (*2)	
Operating Ambient Temperature		Topr	-40～+105	℃
Storage Temperature		Tstg	-55～+125	℃

(*1) : $I_{OUT} \leqq Pd / (V_{IN}-V_{OUT})$

(*2) : The power dissipation figure shown is PCB mounted. Please refer to page 29～33 for details.

■ELECTRICAL CHARACTERISTICS

●XC6223A/B/C/D/E/F/G/H/J/K/M/N/P/Q/R/T Series

Ta=25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUITS
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(*3)	$V_{OUT(T)}$-20mV (*2)	$V_{OUT(T)}$ (*2)	$V_{OUT(T)}$+20mV (*2)	V	
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 (*4)	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 (A/B/C/D/E/F/G/H Type)	ΔV_{OUT}/ (ΔTa・V_{OUT})	V_{CE}=V_{IN}, I_{OUT}=10mA -40℃≦Ta≦85℃	-	±100	-	ppm / ℃	①
Output Voltage Temperature Characteristics (J/K/M/N/P/Q/R/T Type)	ΔV_{OUT}/ (ΔTa・V_{OUT})	V_{CE}=V_{IN}, I_{OUT}=10mA -40℃≦Ta≦105℃	-	±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}	-	50	-	mA	①
CE High Level Voltage	V_{CEH}	-	1.0	-	5.5	V	④
CE Low Level Voltage	V_{CEL}	-	-	-	0.3	V	④
CE High Level Current (A/B/E/F/J/K/P/Q Type)	I_{CEH}	V_{CE}=V_{IN}＝5.5V	-0.1	-	0.1	μA	④
CE High Level Current (C/D/G/H/M/N/R/T Type)	I_{CEH}	V_{CE}=V_{IN}=5.5V	3.0	5.5	9.0	μA	④
CE Low Level Current	I_{CEL}	V_{CE}=V_{SS}	-0.1	-	0.1	μA	④
C_L Discharge Resistance (Only B/D/F/H/K/N/Q/T Type)	R_{DCHG}	V_{IN}=5.5V, V_{OUT}=2.0V, V_{CE}=V_{SS}	-	300	-	Ω	①
Inrush Current (Only E/F/G/H/P/Q/R/T Type)	Irush	V_{IN}=V_{CE}=5.5V	-	150	-	mA	⑤
Thermal Shutdown Detect Temperature	T_{TSD}	Junction Temperature	-	150	-	℃	①
Thermal Shutdown Release Temperature	T_{TSR}	Junction Temperature	-	120	-	℃	
Thermal Shutdown Hysteresis Width	T_{TSD} - T_{TSR}	Junction Temperature	-	30	-	℃	

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: The standard output voltage is specified in $V_{OUT(T)}$±20mV where $V_{OUT(T)}$＜2.0V.

*4: Vdif＝{V_{IN1}{*5}－V_{OUT1}{*6}} (V_{IN1}≧1.6V)

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

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

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

■ELECTRICAL CHARACTERISTICS (Continued)

●Voltage Chart 1

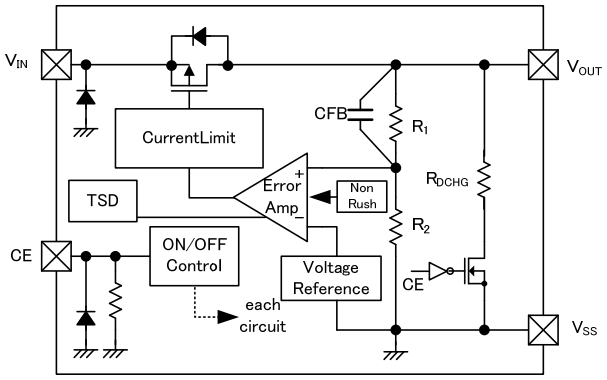
SYMBOL	E-0		E-1	
PARAMETER / NOMINAL OUTPUT VOLTAGE (V)	OUTPUT VOLTAGE (V)		DROPOUT VOLTAGE (mV)	
$V_{OUT(T)}$	$V_{OUT(E)}$		Vdif	
	MIN	MAX	TYP	MAX
1.20	1.1800	1.2200	480	630
1.25	1.2300	1.2700		
1.30	1.2800	1.3200	440	580
1.35	1.3300	1.3700		
1.40	1.3800	1.4200	420	520
1.45	1.4300	1.4700		
1.50	1.4800	1.5200		
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	270	380
2.05	2.0295	2.0705		
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	240	350
2.55	2.5245	2.5755		
2.60	2.5740	2.6260		
2.65	2.6235	2.6765		
2.70	2.6730	2.7270		
2.75	2.7225	2.7775		

■ELECTRICAL CHARACTERISTICS (Continued)

●Voltage Chart2

SYMBOL	E-0		E-1	
PARAMETER / NOMINAL OUTPUT VOLTAGE (V)	OUTPUT VOLTAGE (V)		DROPOUT VOLTAGE (mV)	
$V_{OUT(T)}$	$V_{OUT(E)}$		Vdif	
	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



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 Output pin (V_{OUT}) is then driven by the subsequent control signal. The output voltage at the Output pin (V_{OUT}) 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 (CE) signal.

<Low ESR Capacitor>

The XC6223 series needs an output capacitor C_L for phase compensation. In order to ensure the stable phase compensation, please place an output capacitor of 1.0μF or bigger at the V_{OUT} pin and V_{SS} pin as close as possible. For a stable power input, please connect an input capacitor (C_{IN}) of 1.0μF between the input pin (V_{IN}) and the ground pin (V_{SS}).

<Current Limiter, Short-Circuit Protection>

The protection circuit operates as a combination of an output current limiter and fold-back short circuit protection. When load current reaches the current limit level, the output voltage drops. As a result, the load current starts to reduce with showing fold-back curve. 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 (CE). In shutdown mode, the XC6223B/D/F/H/K/N/Q/T series enables the electric charge at the output capacitor (C_L) to be discharged via the internal auto-discharge switch, and as a result the output pin (V_{OUT}) quickly returns to the ground pin (V_{SS}) level. When the CE pin (CE) is open, the output voltage becomes undefined state in the XC6223A/B/E/F/J/K/P/Q series because of a high active and no pull-down. On the other hand, the XC6223C/D/G/H/M/N/R/T series has a pull-down resistor at the CE pin (CE) inside, so that the CE pin (CE) input current flows.

<Thermal Shutdown>

When the junction temperature of the built-in driver transistor reaches the temperature limit, the thermal shutdown circuit operates and the driver transistor will be set to OFF. The IC resumes its operation when the thermal shutdown function is released and the IC's operation is automatically restored because the junction temperature drops to the level of the thermal shutdown release voltage.

<Inrush Current Protection>

The inrush current protection circuit is built in the XC6223 series.

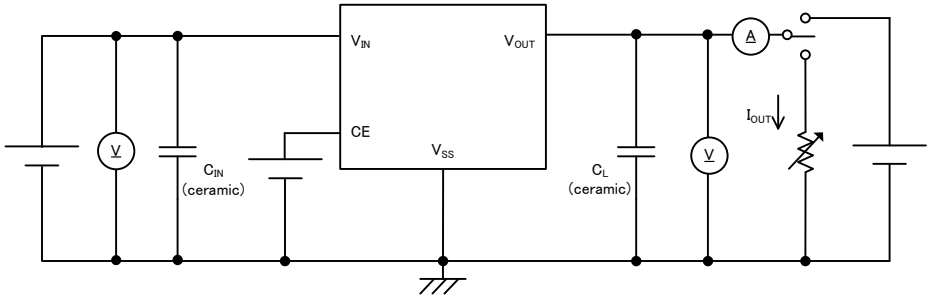
When the IC starts to operate, the protection circuit limits the inrush current from input pin (V_{IN}) to output pin (V_{OUT}) to charge C_L capacitor. This function is built in the XC6223E/F/G/H/P/Q/R/T series.

■ NOTES ON USE

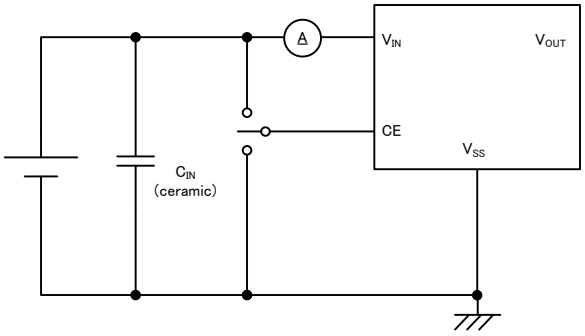
1. Where wiring impedance is high, operations may become unstable due to the noise and/or phase lag depending on output current. Please strengthen input pin (V_{IN}) and output pin (V_{OUT}) wiring in particular.
2. The input capacitor C_{IN} and the output capacitor C_L should be placed to the as close as possible with a shorter wiring.
3. 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.
4. For temporary, transitional voltage drop or voltage rising phenomenon, the IC is liable to malfunction should the ratings be exceeded.
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

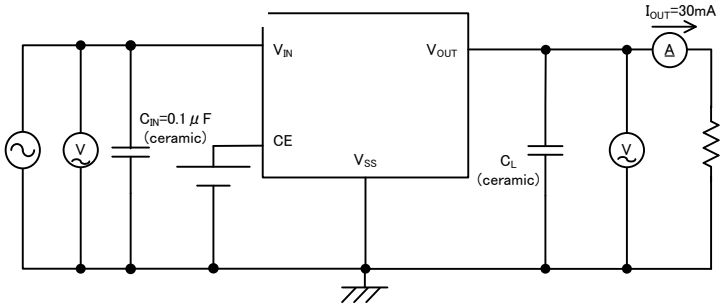
●Circuit ①



●Circuit ②

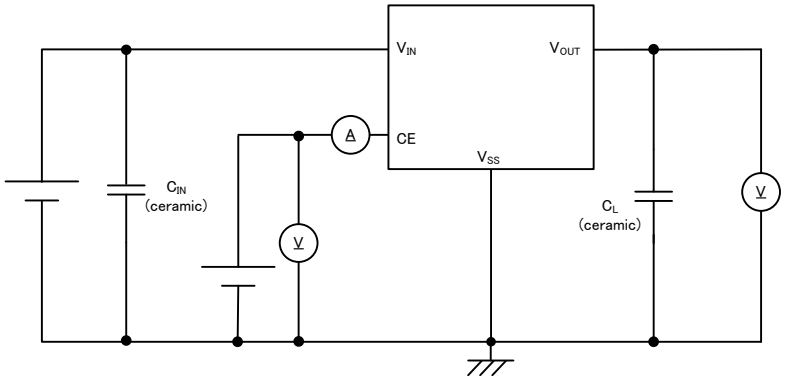


●Circuit ③

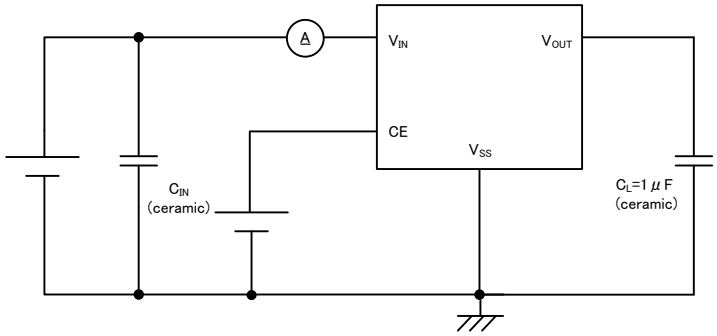


■TEST CIRCUITS (Continued)

●Circuit ④



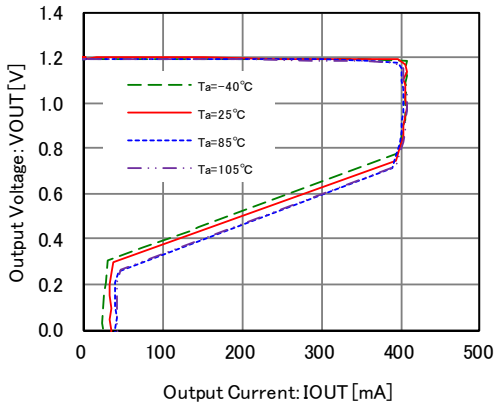
●Circuit ⑤



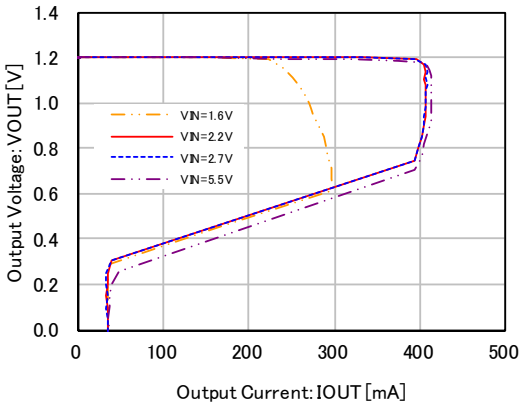
■TYPICAL PERFORMANCE CHARACTERISTICS

(1) Output Voltage vs. Output Current

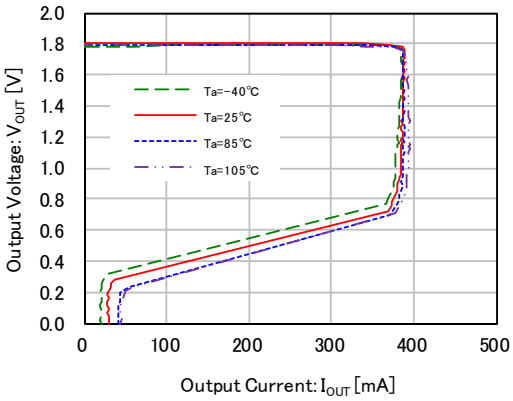
XC6223x121



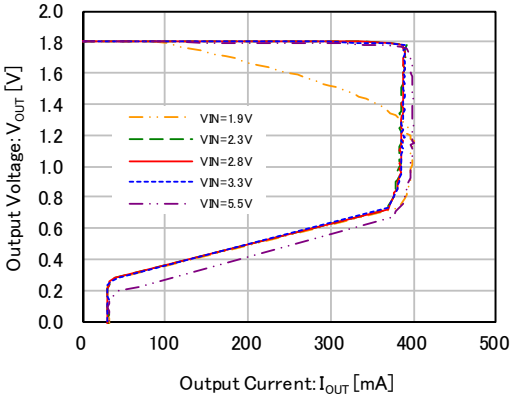
XC6223x121



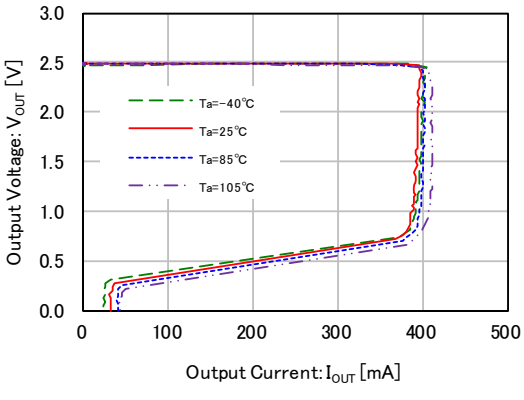
XC6223x181



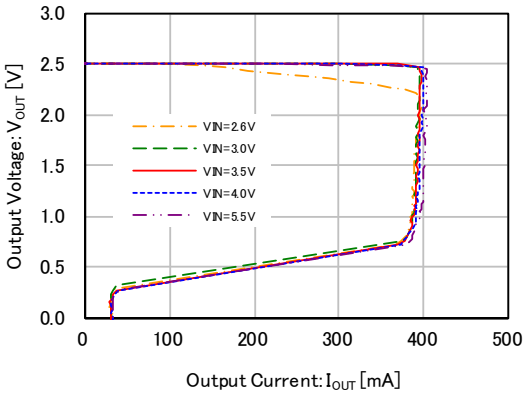
XC6223x181



XC6223x251

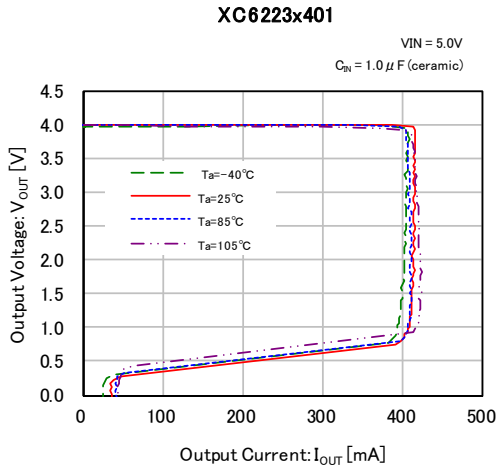


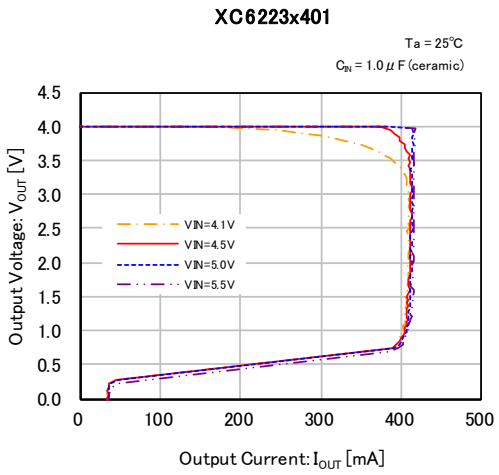
XC6223x251



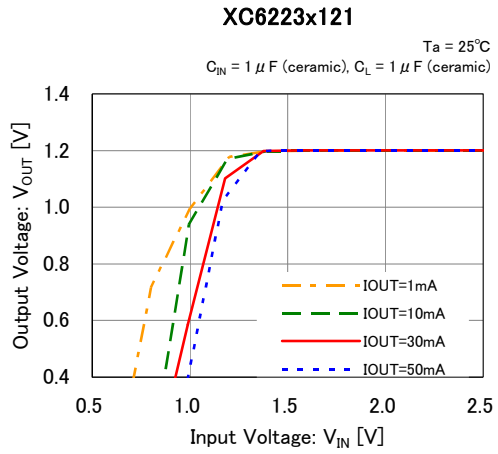
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

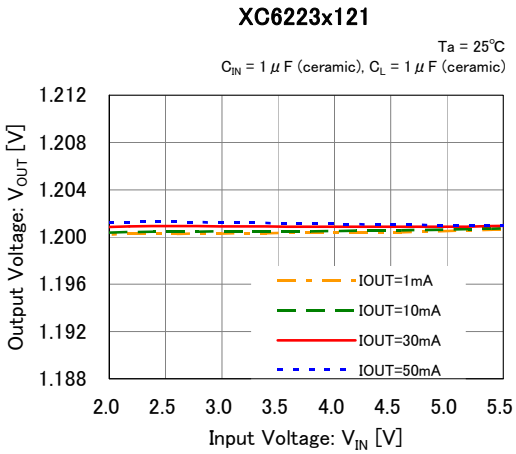
(1) Output Voltage vs. Output Current (Continued)

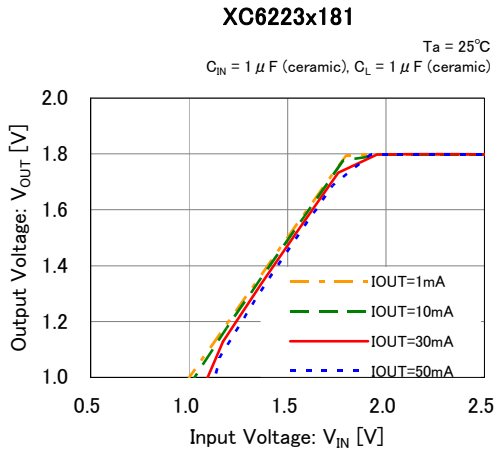


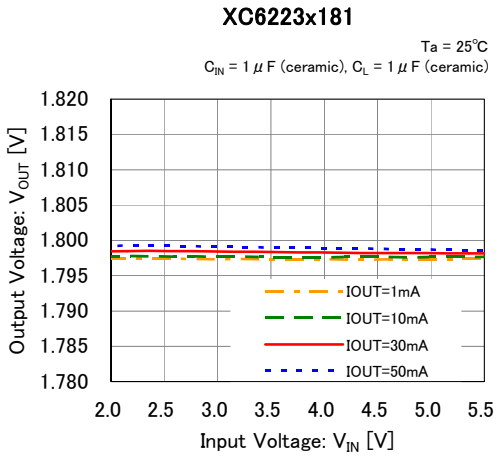


(2) Output Voltage vs. Input Voltage





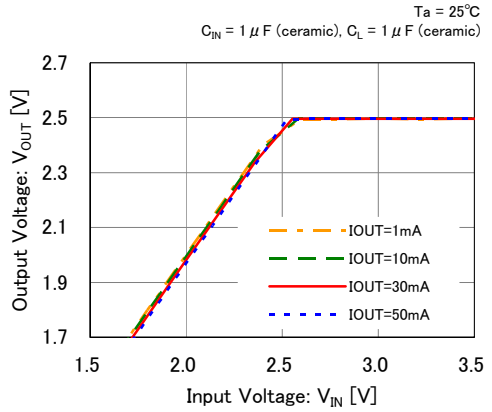




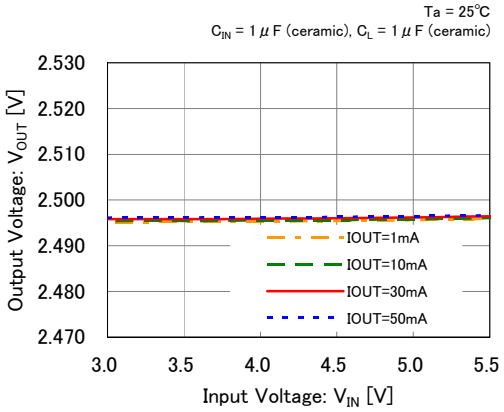
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2) Output Voltage vs. Input Voltage (Continued)

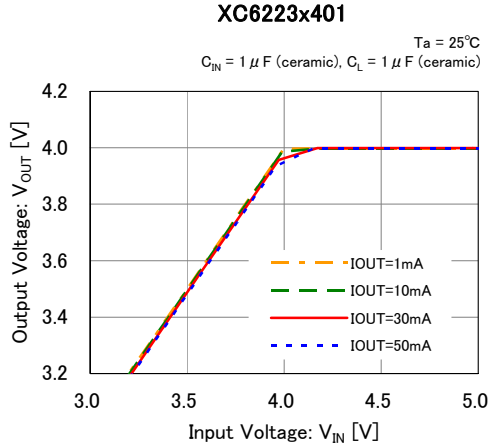
XC6223x251



XC6223x251



XC6223x401



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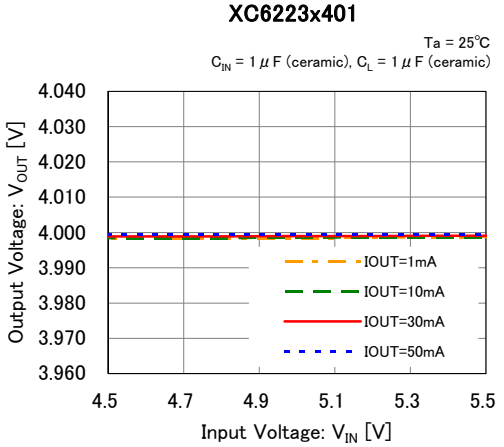
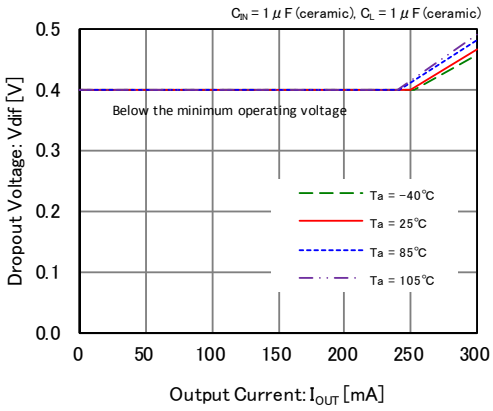
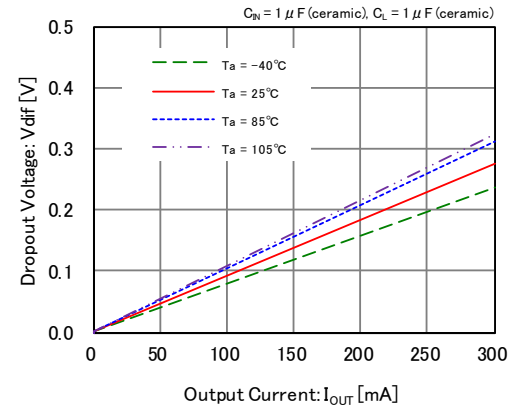


(3) Dropout Voltage vs. Output Current

XC6223x121



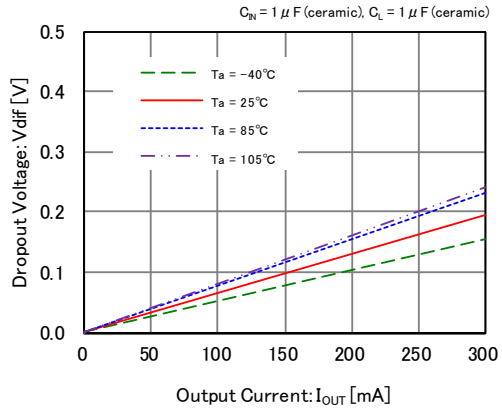
XC6223x181



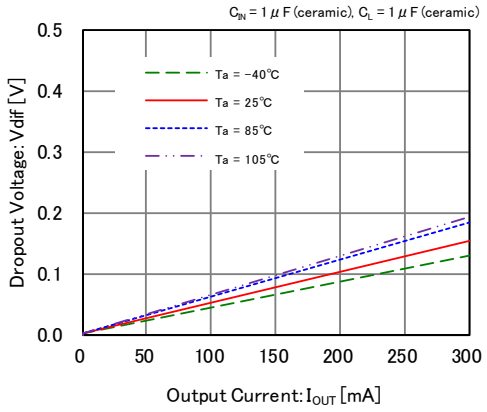
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(3) Dropout Voltage vs. Output Current (Continued)

XC6223x251

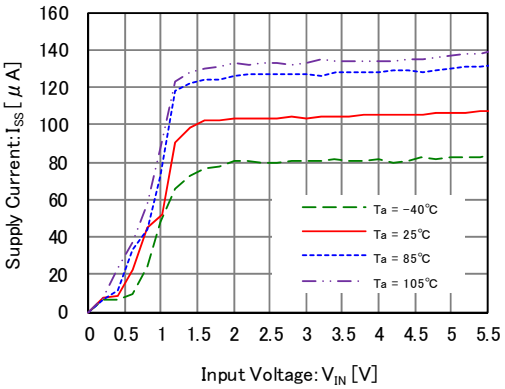


XC6223x401

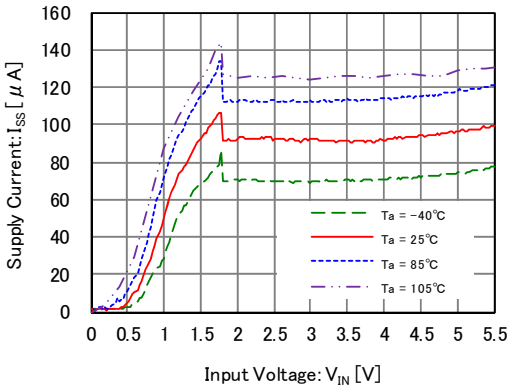


(4) Supply Current vs. Input Voltage

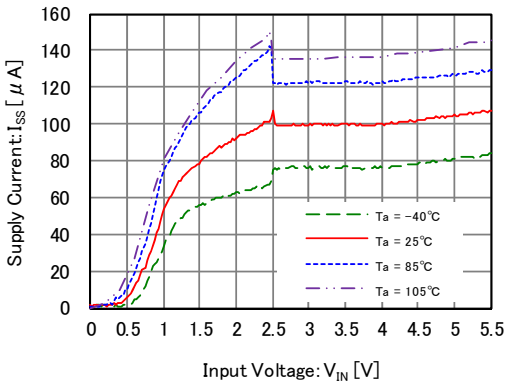
XC6223x121



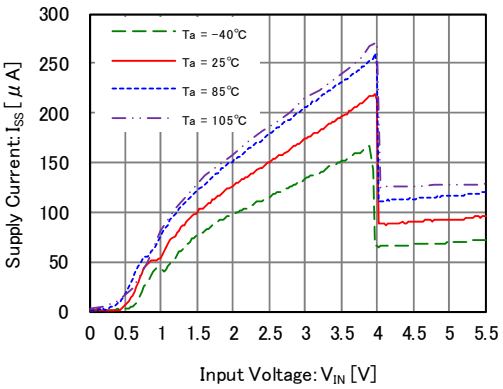
XC6223x181



XC6223x251



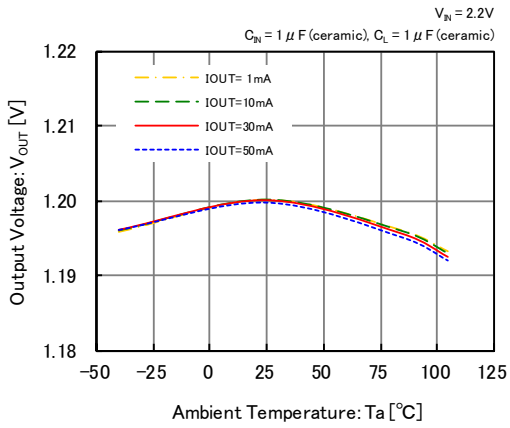
XC6223x401



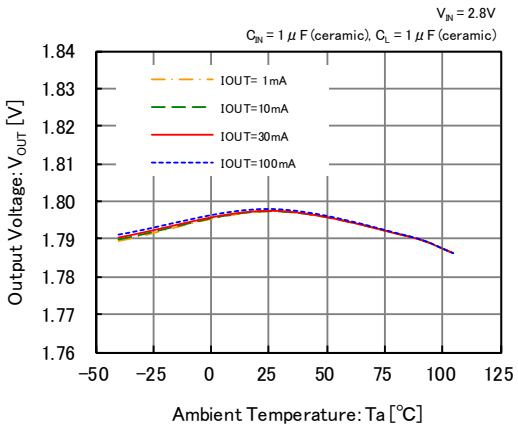
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(5) Output Voltage vs. Ambient Temperature

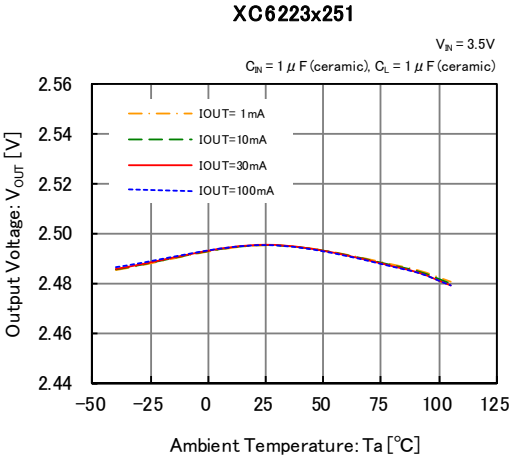
XC6223x121



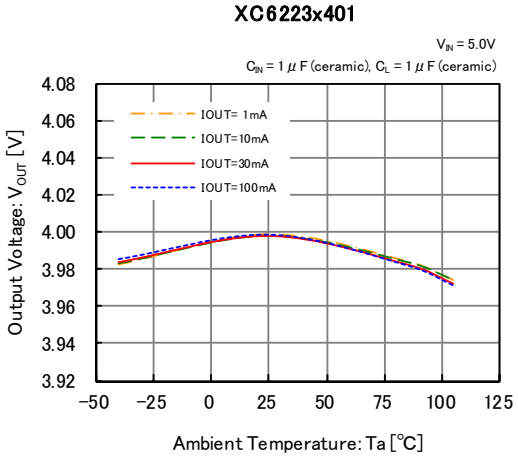
XC6223x181



XC6223x251

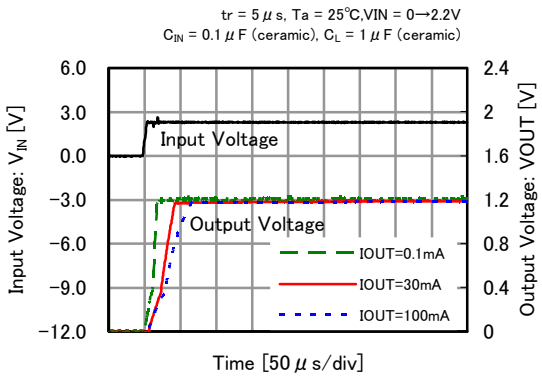


XC6223x401

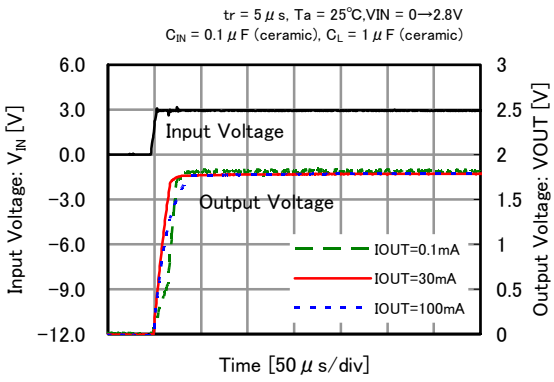


(6) Rising Response Time

XC6223x121



XC6223x181

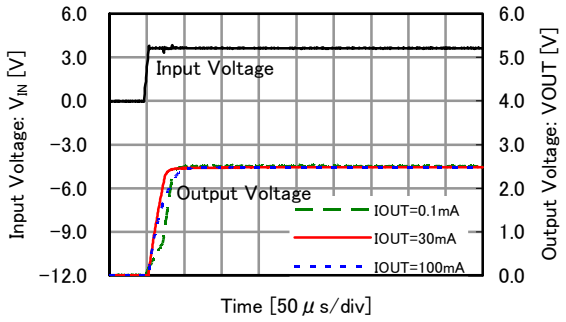


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(6) Rising Response Time (Continued)

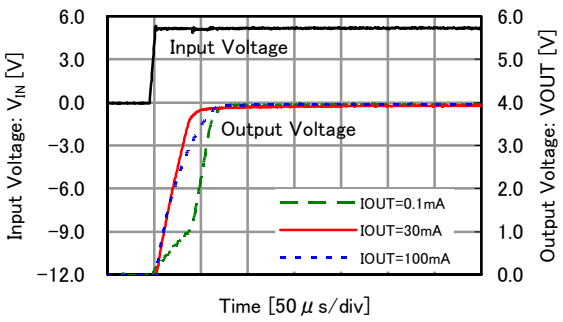
XC6223x251

tr = 5μs, Ta = 25°C,VIN = 0→3.5V
CIN = 0.1μF (ceramic), CL = 1μF (ceramic)



XC6223x401

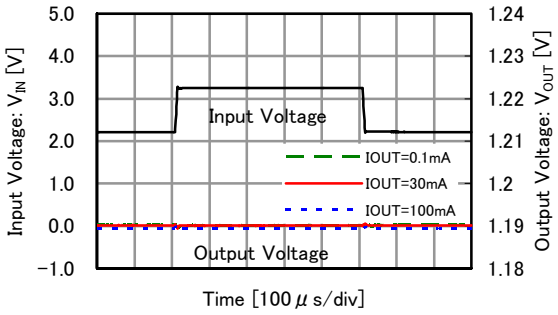
tr = 5μs, Ta = 25°C,VIN = 0→5.0V
CIN = 0.1μF (ceramic), CL = 1μF (ceramic)



(7) Input Transient Response

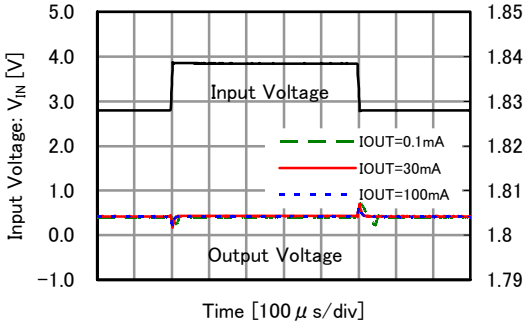
XC6223x121

tr = tf = 5μs, Ta = 25°C, VIN = 2.2V⇔3.2V
CIN = 0.1μF (ceramic), CL = 1.0μF (ceramic)



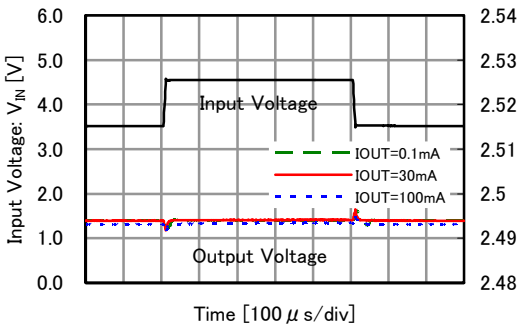
XC6223x181

tr = tf = 5μs, Ta = 25°C, VIN = 2.8V⇔3.8V
CIN = 0.1μF (ceramic), CL = 1.0μF (ceramic)



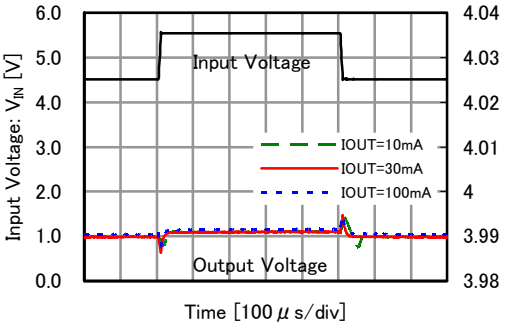
XC6223x251

tr = tf = 5μs, Ta = 25°C, VIN = 3.5V⇔4.5V
CIN = 0.1μF (ceramic), CL = 1.0μF (ceramic)



XC6223x401

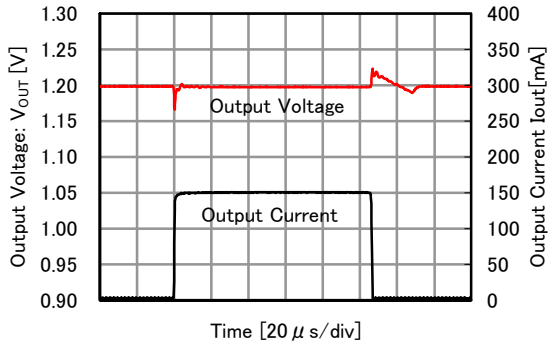
tr = tf = 5μs, Ta = 25°C, VIN = 4.5V⇔5.5V
CIN = 0.1μF (ceramic), CL = 1.0μF (ceramic)



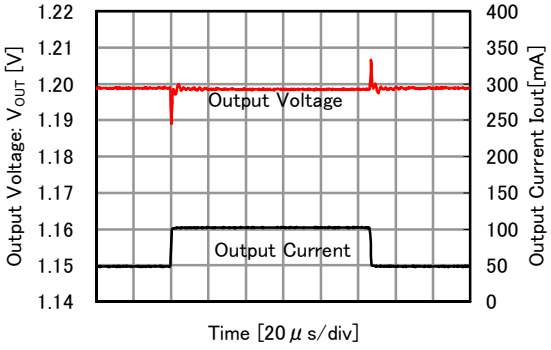
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

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

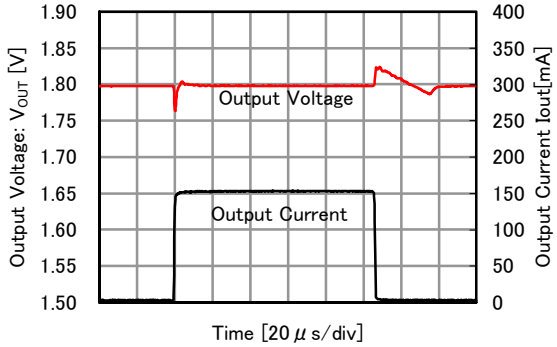
XC6223x121
tr = tf = 0.5μs, Ta = 25°C, I_{OUT} = 1⇔150mA
V_{IN} = 2.2V, C_{IN} = 1μF (ceramic), C_L = 1μF (ceramic)



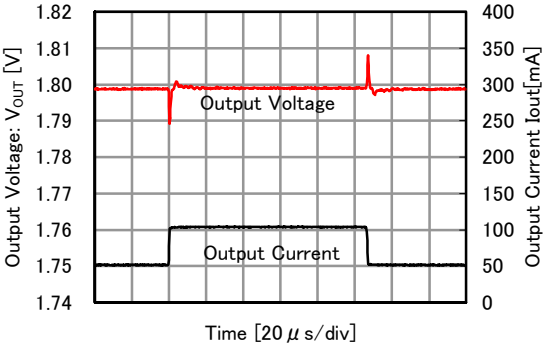
XC6223x121
tr = tf = 0.5μs, Ta = 25°C, I_{OUT} = 50⇔100mA
V_{IN} = 2.2V, C_{IN} = 1μF (ceramic), C_L = 1μF (ceramic)



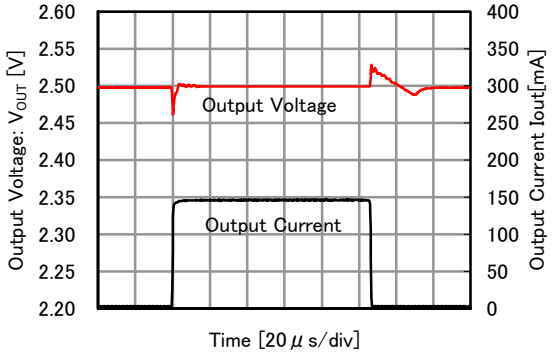
XC6223x181
tr = tf = 0.5μs, Ta = 25°C, I_{OUT} = 1⇔150mA
V_{IN} = 2.8V, C_{IN} = 1μF (ceramic), C_L = 1μF (ceramic)



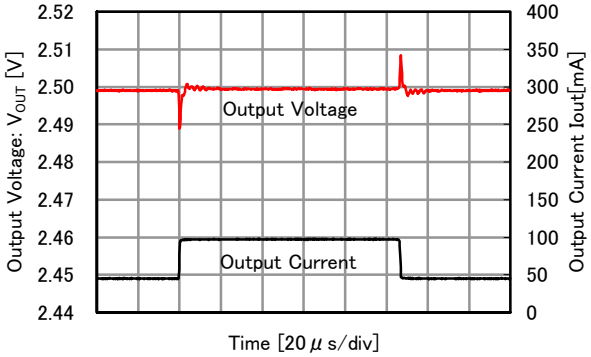
XC6223x181
tr = tf = 0.5μs, Ta = 25°C, I_{OUT} = 50⇔100mA
V_{IN} = 2.8V, C_{IN} = 1μF (ceramic), C_L = 1μF (ceramic)



XC6223x251
tr = tf = 0.5μs, Ta = 25°C, I_{OUT} = 1⇔150mA
V_{IN} = 3.5V, C_{IN} = 1μF (ceramic), C_L = 1μF (ceramic)



XC6223x251
tr = tf = 0.5μs, Ta = 25°C, I_{OUT} = 50⇔100mA
V_{IN} = 3.5V, C_{IN} = 1μF (ceramic), C_L = 1μF (ceramic)

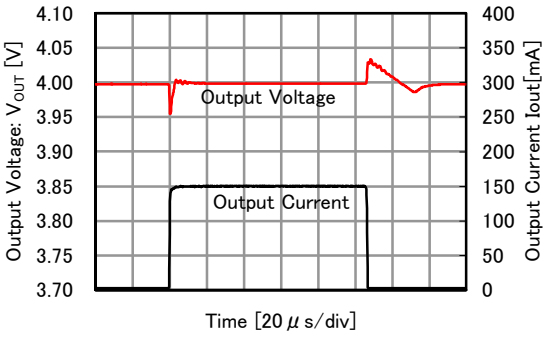


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

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

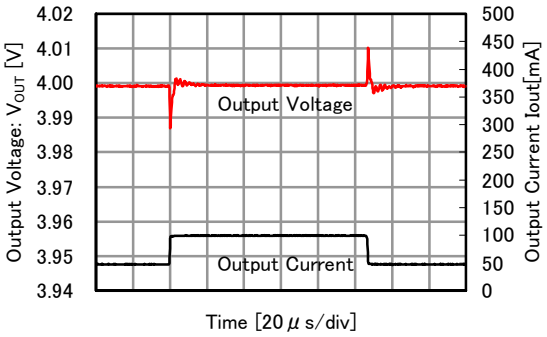
XC6223x401

tr = tf = 0.5μs, Ta = 25℃, I_{OUT} = 1⇔150mA
V_{IN} = 5.0V, C_{IN} = 1μF (ceramic), C_L = 1μF (ceramic)



XC6223x401

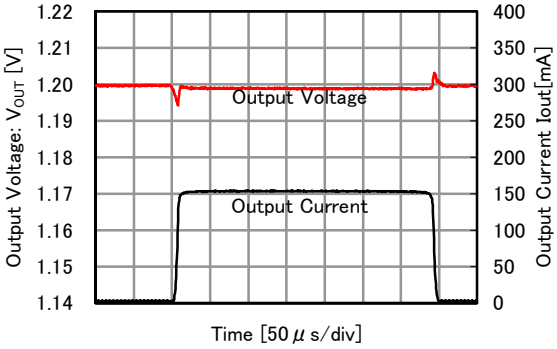
tr = tf = 0.5μs, Ta = 25℃, I_{OUT} =50⇔100mA
V_{IN} = 5.0V, C_{IN} = 1μF (ceramic), C_L = 1μF (ceramic)



(8) Load Transient Response (tr=tf=5μs) (Continued)

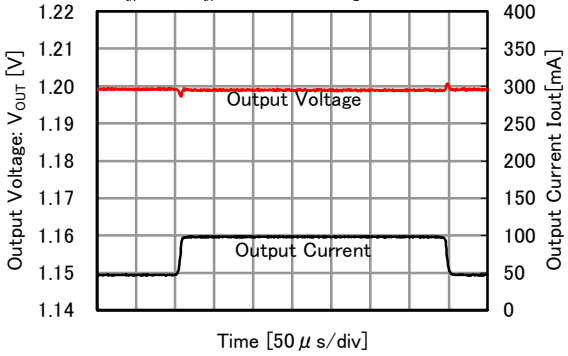
XC6223x121

tr = tf = 5μs, Ta = 25℃, I_{OUT} = 1⇔150mA
V_{IN} = 2.2V, C_{IN} = 1μF (ceramic), C_L = 1μF (ceramic)



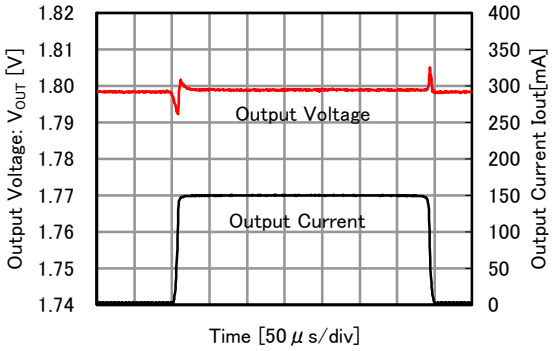
XC6223x121

tr = tf = 5μs, Ta = 25℃, I_{OUT} = 50⇔100mA
V_{IN} = 2.2V, C_{IN} = 1μF (ceramic), C_L = 1μF (ceramic)



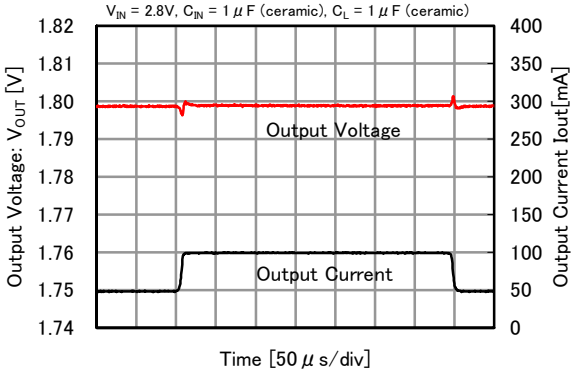
XC6223x181

tr = tf = 5μs, Ta = 25℃, I_{OUT} = 1⇔150mA
V_{IN} = 2.8V, C_{IN} = 1μF (ceramic), C_L = 1μF (ceramic)



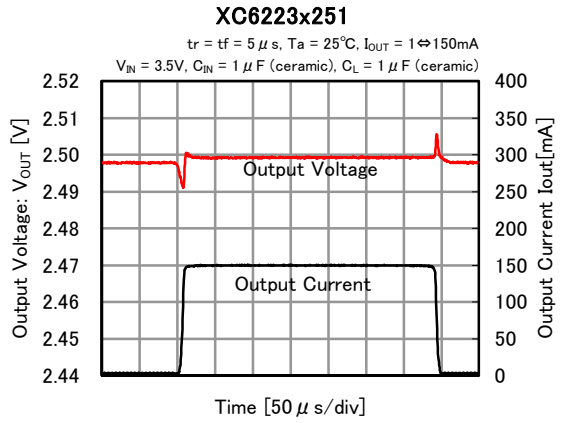
XC6223x181

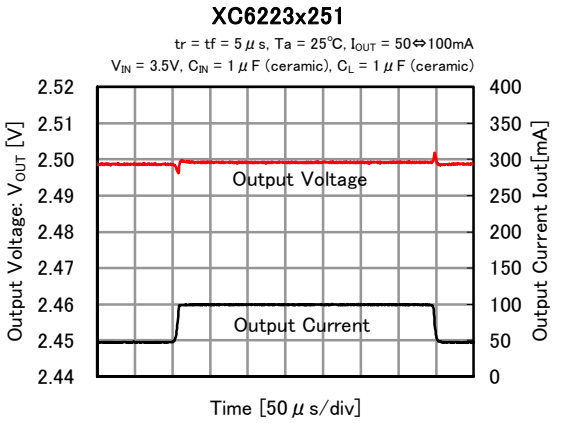
tr = tf = 5μs, Ta = 25℃, I_{OUT} = 50⇔100mA
V_{IN} = 2.8V, C_{IN} = 1μF (ceramic), C_L = 1μF (ceramic)

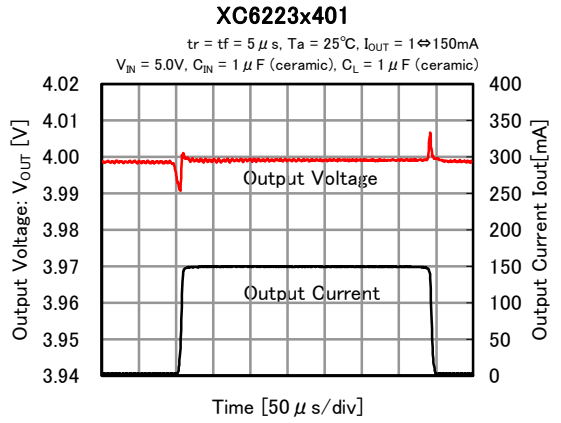


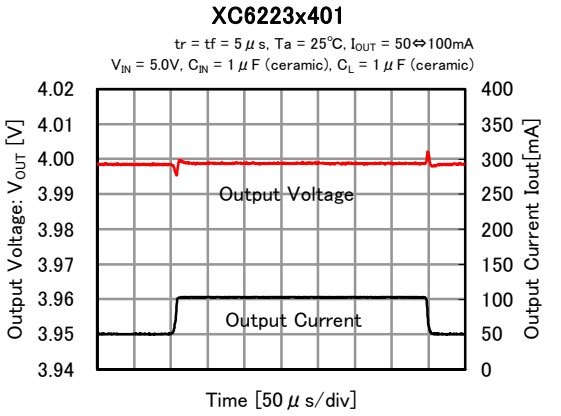
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(8) Load Transient Response (tr=tf=5μs) (Continued)

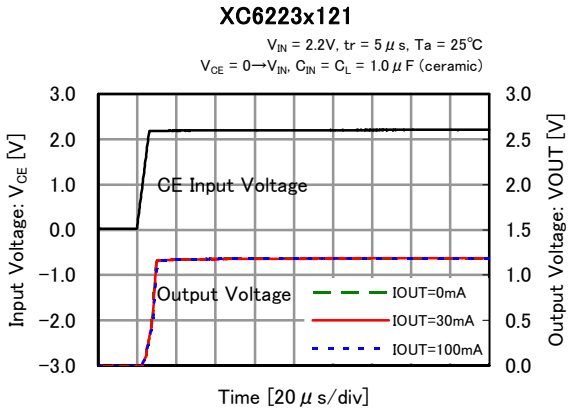


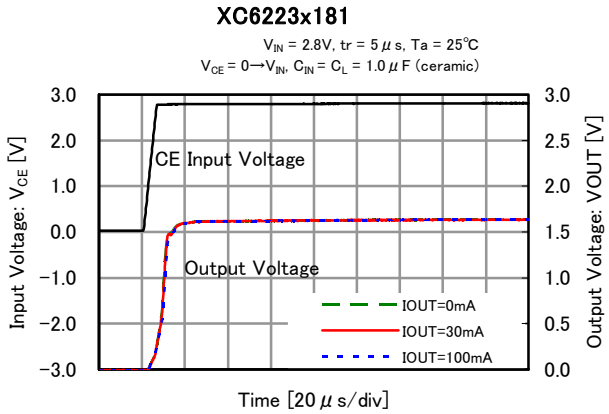






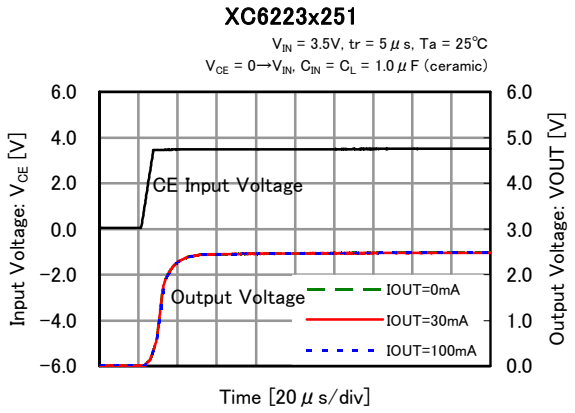
(9) CE Rising Response Time (A,B,C,D J,K,M,N Type)

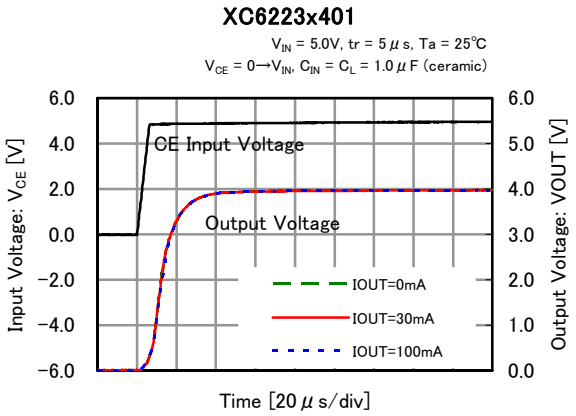




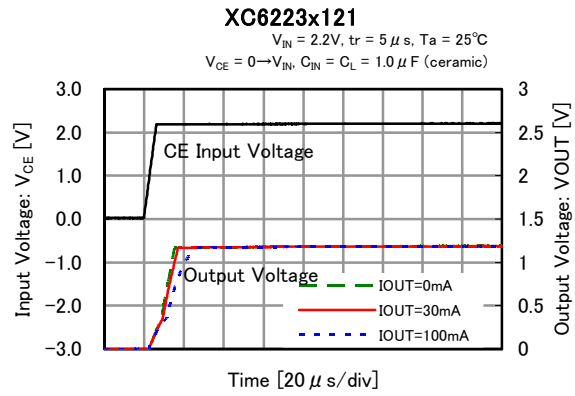
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

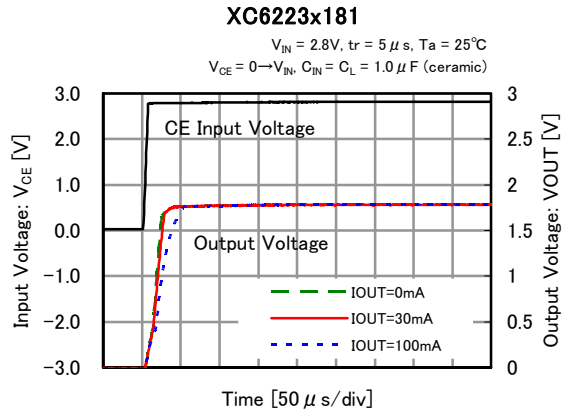
(9) CE Rising Response Time (A,B,C,D,J,K,M,N Type) (Continued)

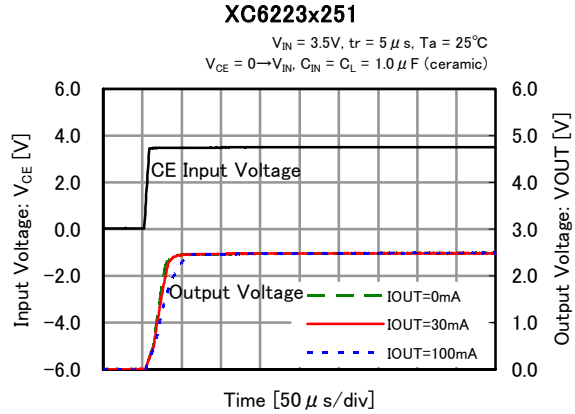


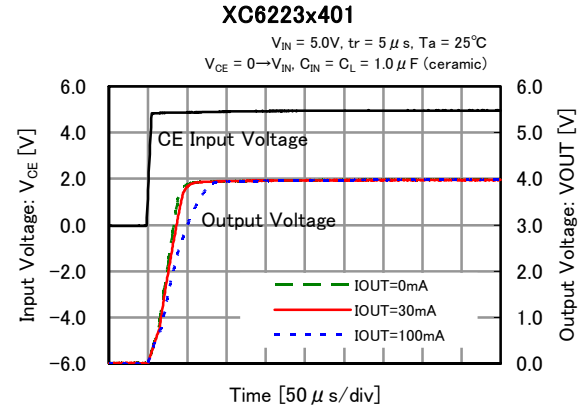


(9) CE Rising Response Time (E,F,G,H,P,Q,R,T Type) (Continued)







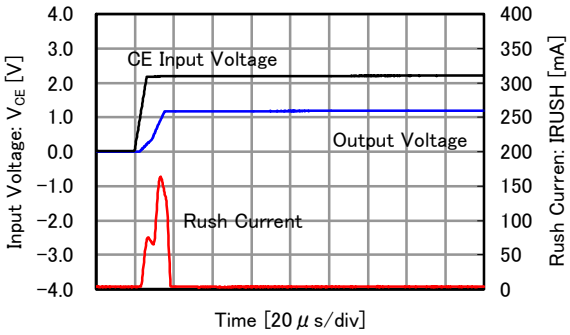


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(10) Inrush Current Response Time (E,F,G,H,P,Q,R,T Type)

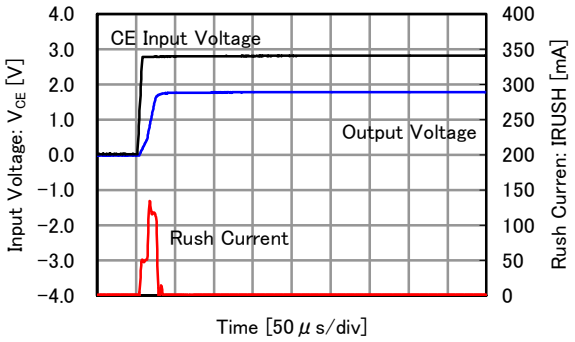
XC6223x121

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



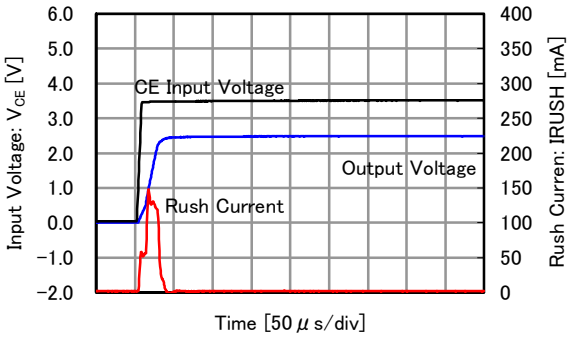
XC6223x181

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



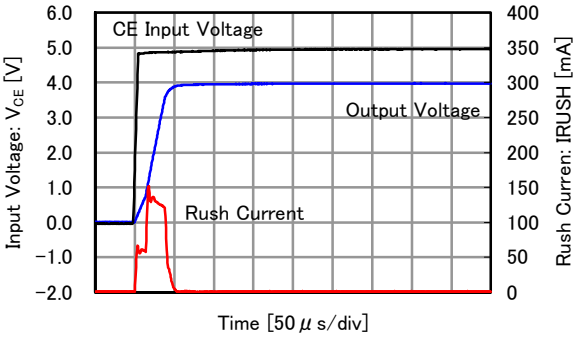
XC6223x251

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



XC6223x401

V_{IN} = 5.0V, tr = 5μs, Ta = 25℃
V_{CE} = 0→V_{IN}, C_{IN} = C_L = 1.0μF (ceramic)

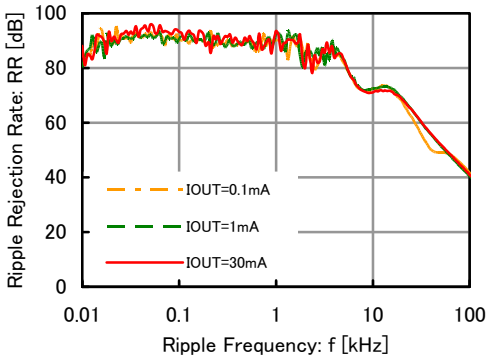


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(11) Ripple Rejection Rate

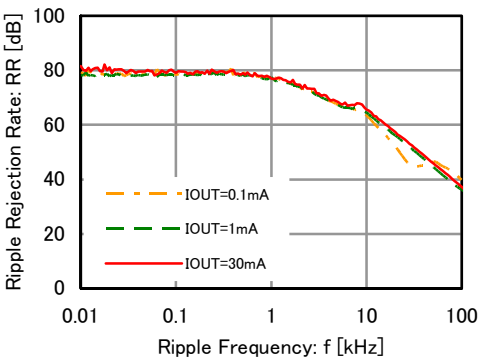
XC6223x121

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



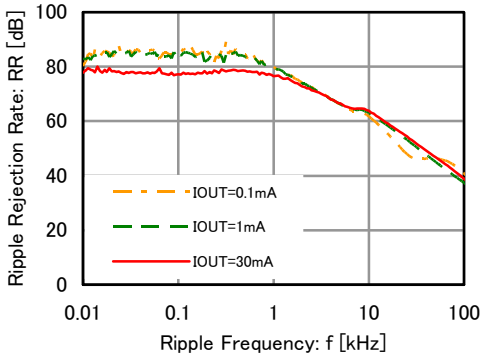
XC6223x181

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



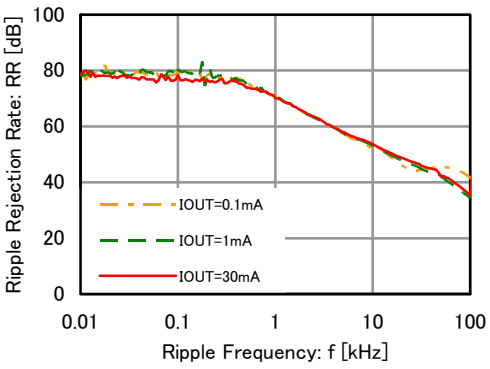
XC6223x251

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



XC6223x331

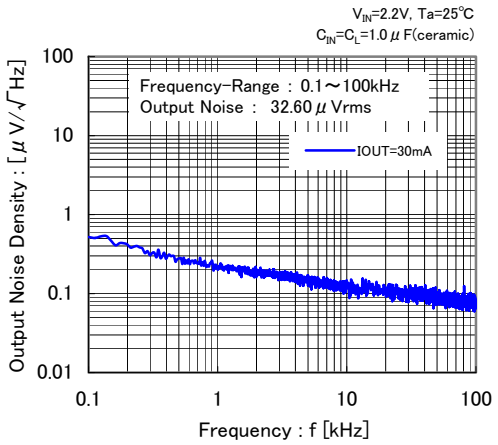
Ta = 25℃, V_{IN} = 4.3VDC+0.5Vp-pAC
C_{IN} = 0.1μF (ceramic), C_L = 1μF (ceramic)



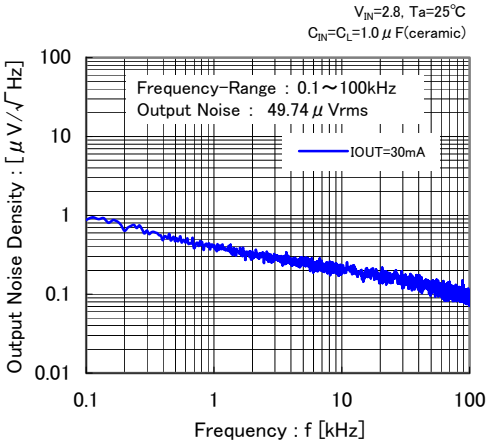
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(12) Output Noise Density

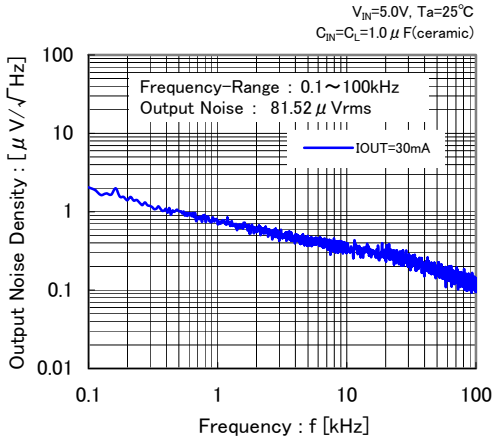
XC6223x121



XC6223x181

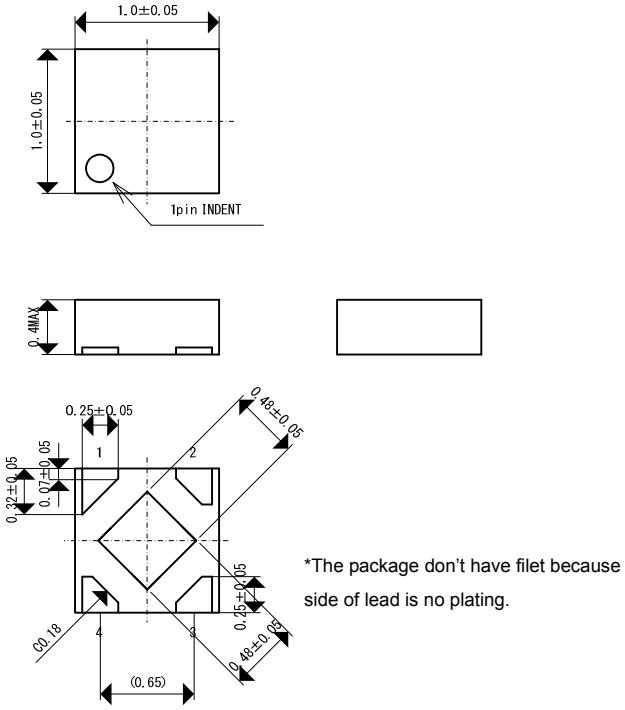


XC6223x331



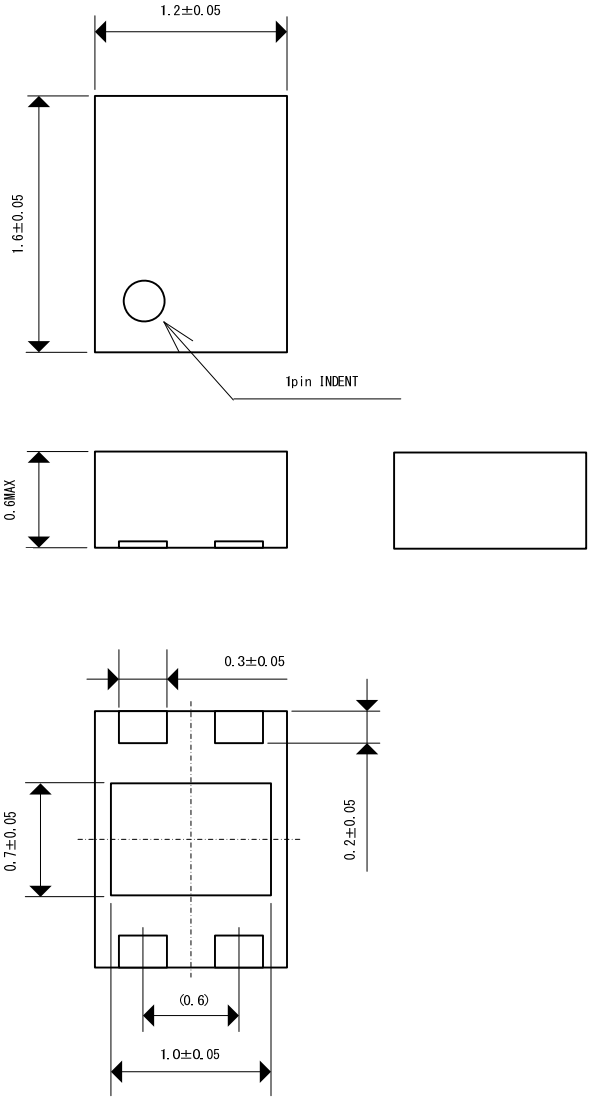
■PACKAGING INFORMATION

USPQ-4B03
(unit : mm)

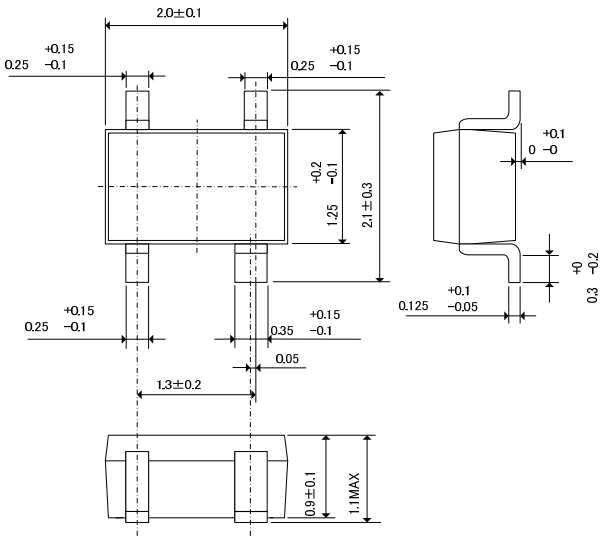


*The package don't have filet because side of lead is no plating.

USP-4
(unit : mm)

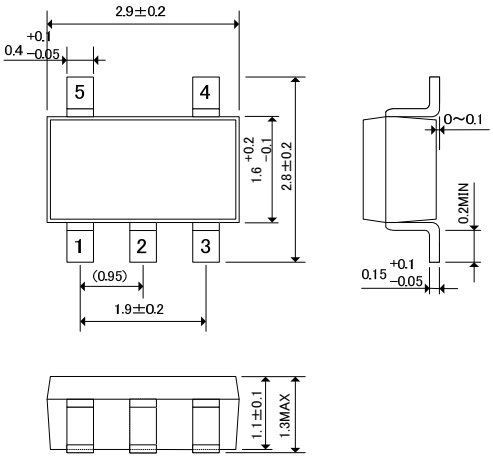


SSOT-24
(unit : mm)

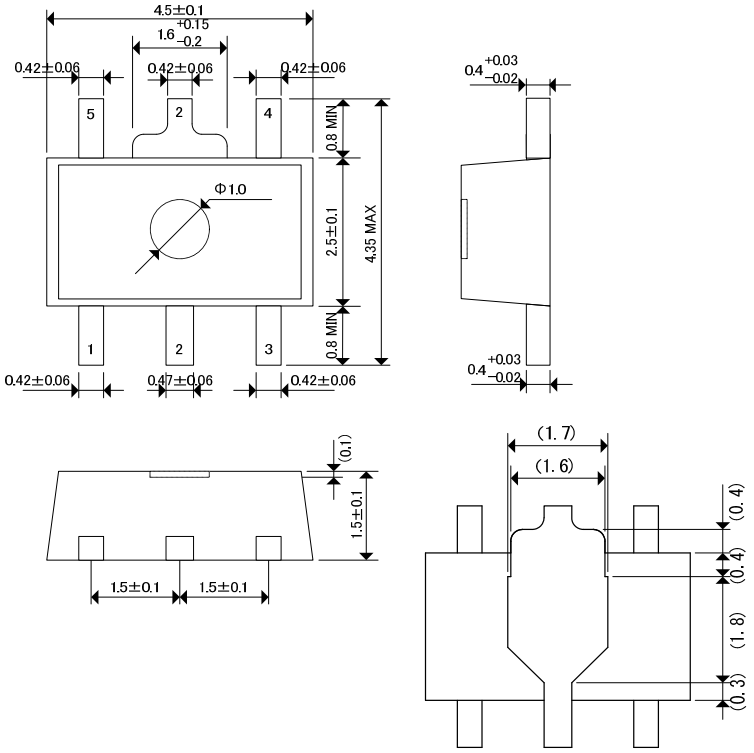


■PACKAGING INFORMATION (Continued)

●SOT-25



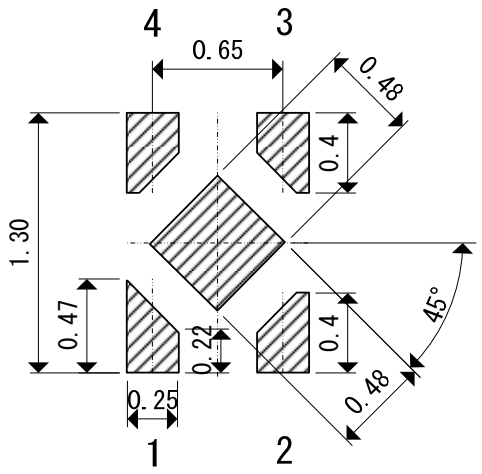
●SOT-89-5



■PACKAGING INFORMATION (Continued)

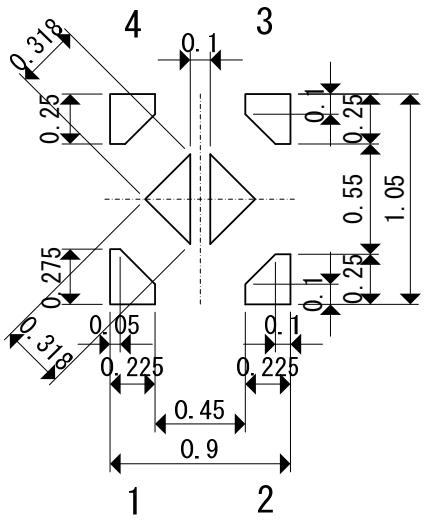
●USPQ-4B03 Reference Pattern Layout

(unit : mm)



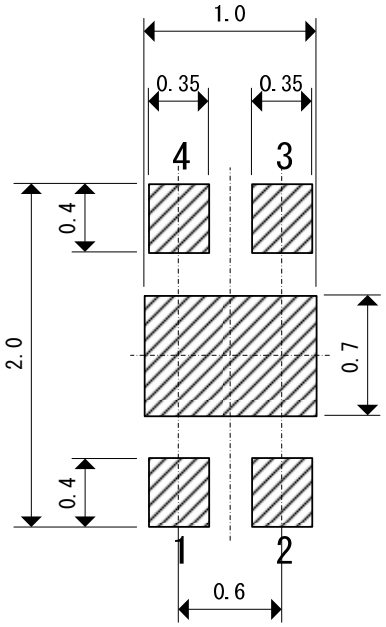
●USPQ-4B03 Reference Metal Mask Design

(unit : mm)



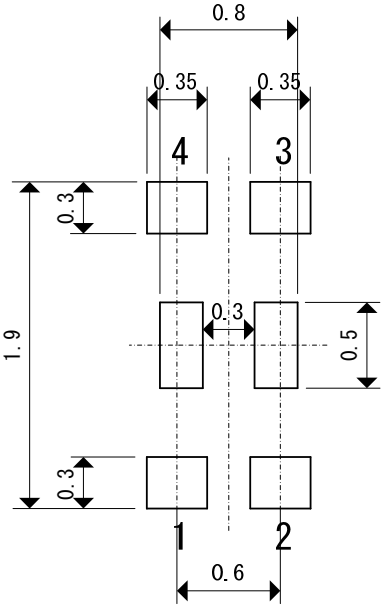
●USP-4 Reference Pattern Layout

(unit : mm)



●USP-4 Reference Metal Mask Design

(unit : mm)



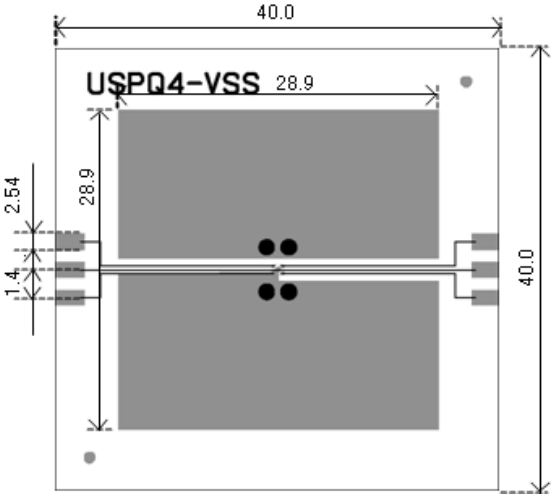
■PACKAGING INFORMATION (Continued)

● USPQ-4B03 Power Dissipation

Power dissipation data for the USPQ-4B03 is shown in this page.
The value of power dissipation varies with the mount board conditions.
Please use this data as the reference data taken in the following condition.

1. Measurement Condition

Condition	: Mount on a board
Ambient	: Natural convection
Soldering	: Lead (Pb) free
Board Dimensions	: 40 x 40 mm (1600mm^2)
Board Structure	: 4 Copper Layers Each layer is connected to the package heat-sink and terminal pin No.1. Each layer has approximately 800mm^2 copper area.
Material	: Glass Epoxy (FR-4)
Thickness	: 1.6 mm
Through-hole	: 4 x 0.8 Diameter

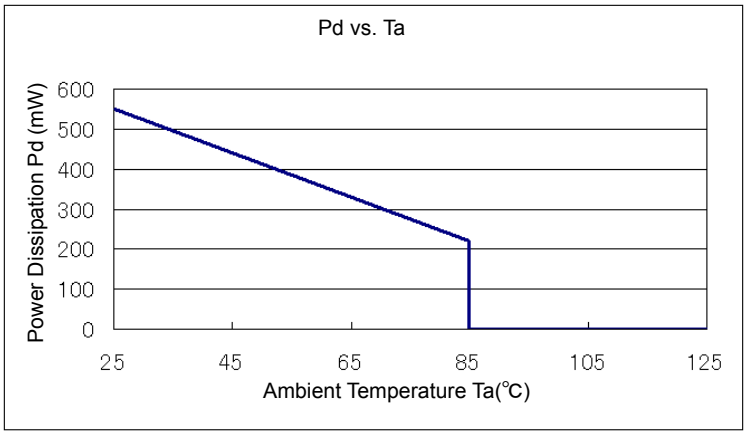


Evaluation Board (Unit: mm)

2. Power Dissipation vs. Ambient Temperature (85℃)

Board Mount (Tjmax=125℃)

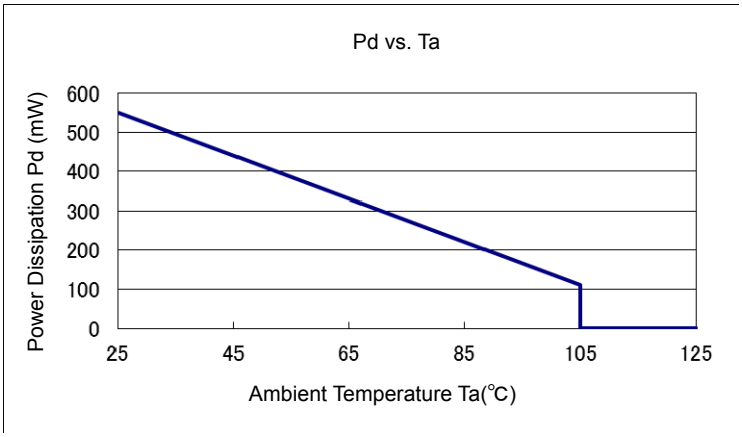
Ambient Temperature (℃)	Power Dissipation Pd (mW)	Thermal Resistance (℃/W)
25	550	181.82
85	220	



3. Power Dissipation vs. Ambient Temperature (105℃)

Board Mount (Tjmax=125℃)

Ambient Temperature (℃)	Power Dissipation Pd (mW)	Thermal Resistance (℃/W)
25	550	181.82
105	110	

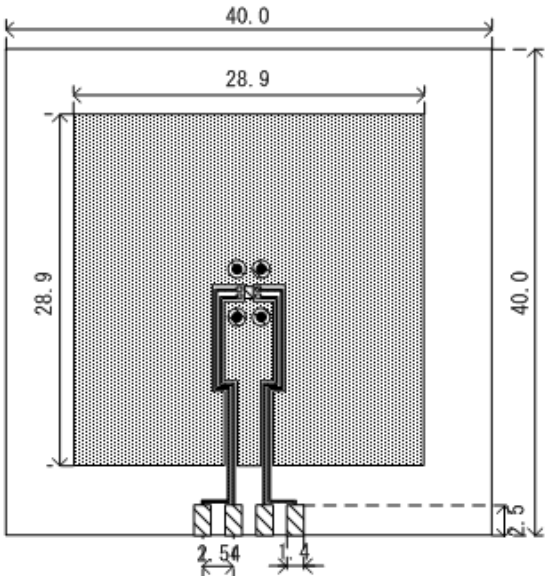


■PACKAGING INFORMATION (Continued)

● USP-4 Power Dissipation

Power dissipation data for the USP-4 is shown in this page.
The value of power dissipation varies with the mount board conditions.
Please use this data as the reference data taken in the following condition.

1. Measurement Condition
   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
   Material: Glass Epoxy (FR-4)
   Thickness: 1.6 mm
   Through-hole: 4 x 0.8 Diameter

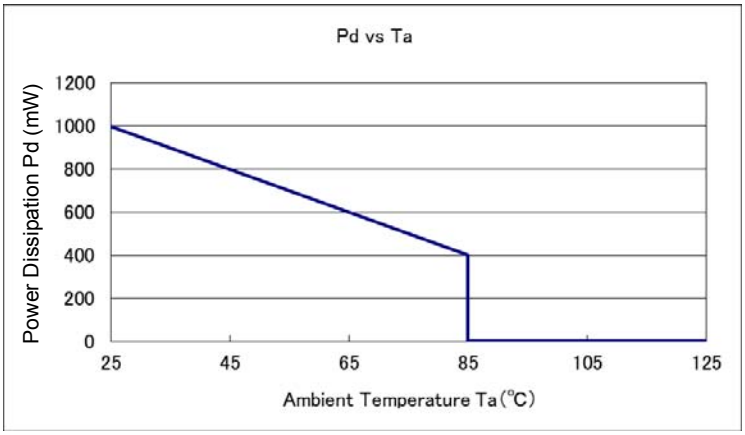


Evaluation Board (Unit: mm)

2. Power Dissipation vs. Ambient Temperature (85℃)

Board Mount (Tjmax=125℃)

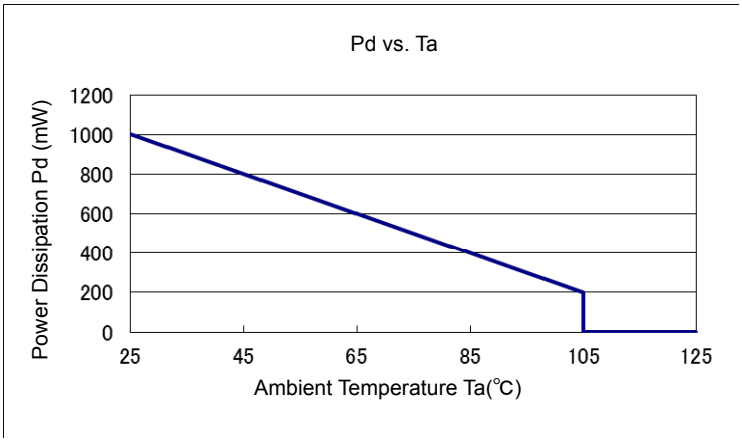
Ambient Temperature (℃)	Power Dissipation Pd (mW)	Thermal Resistance (℃/W)
25	1000	100.00
85	400	



3. Power Dissipation vs. Ambient Temperature (105℃)

Board Mount (Tjmax=125℃)

Ambient Temperature (℃)	Power Dissipation Pd (mW)	Thermal Resistance (℃/W)
25	1000	100.00
105	200	

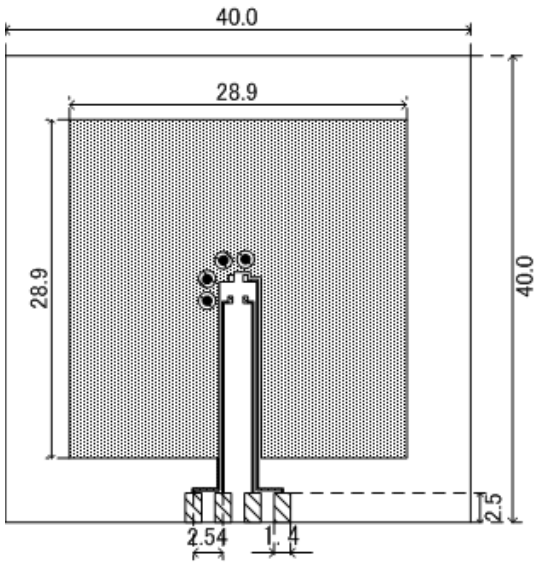


■PACKAGING INFORMATION (Continued)

● SSOT-24 Power Dissipation

Power dissipation data for the SSOT-24 is shown in this page.
The value of power dissipation varies with the mount board conditions.
Please use this data as the reference data taken in the following condition.

1. Measurement Condition
   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
   Material: Glass Epoxy (FR-4)
   Thickness: 1.6 mm
   Through-hole: 4 x 0.8 Diameter

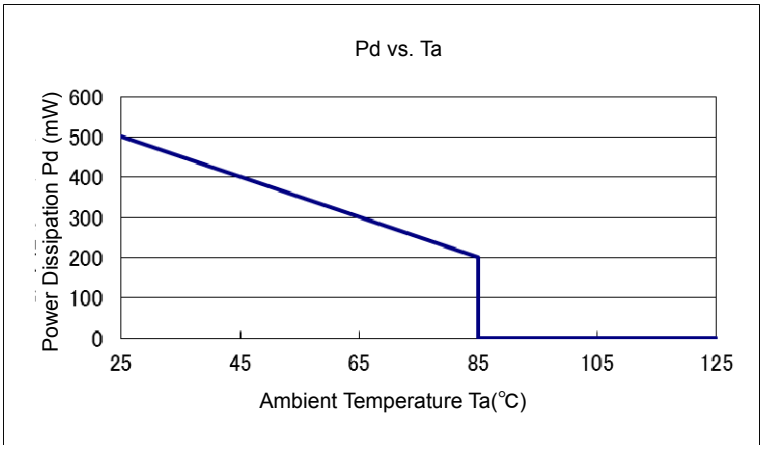


Evaluation Board (Unit: mm)

2. Power Dissipation vs. Ambient Temperature (85℃)

Board Mount (Tjmax=125℃)

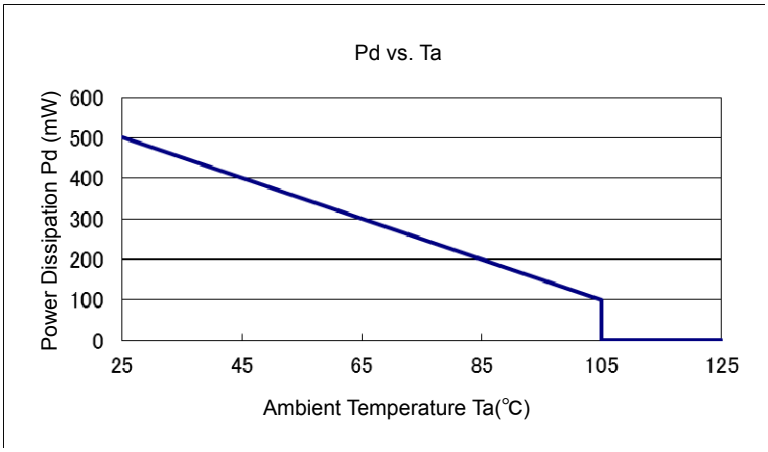
Ambient Temperature (℃)	Power Dissipation Pd (mW)	Thermal Resistance (℃/W)
25	500	200.00
85	200	



3. Power Dissipation vs. Ambient Temperature (105℃)

Board Mount (Tjmax=125℃)

Ambient Temperature (℃)	Power Dissipation Pd (mW)	Thermal Resistance (℃/W)
25	500	200.00
105	100	

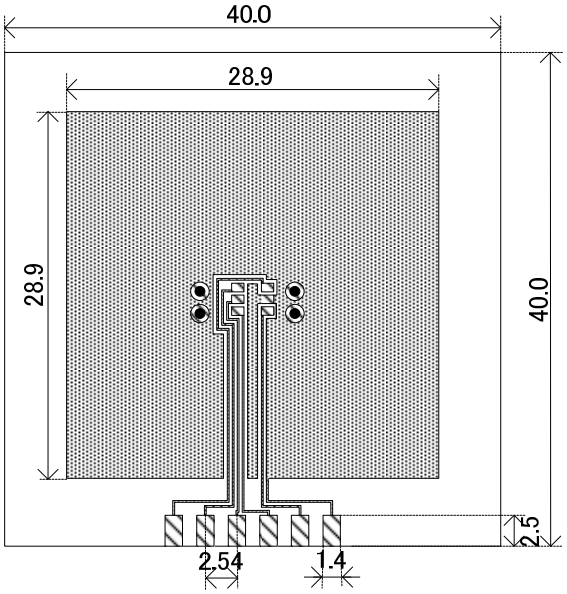


■PACKAGING INFORMATION (Continued)

● SOT-25 Power Dissipation

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

1. Measurement Condition
   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

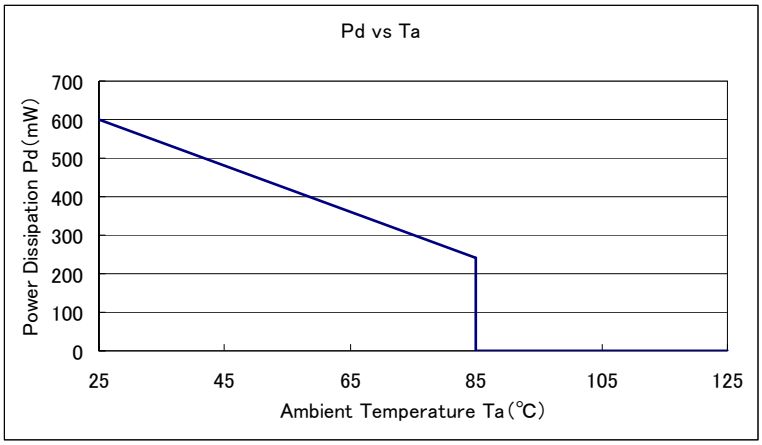


Evaluation Board (Unit: mm)

2. Power Dissipation vs. Ambient temperature (85℃)

Board Mount (Tjmax=125℃)

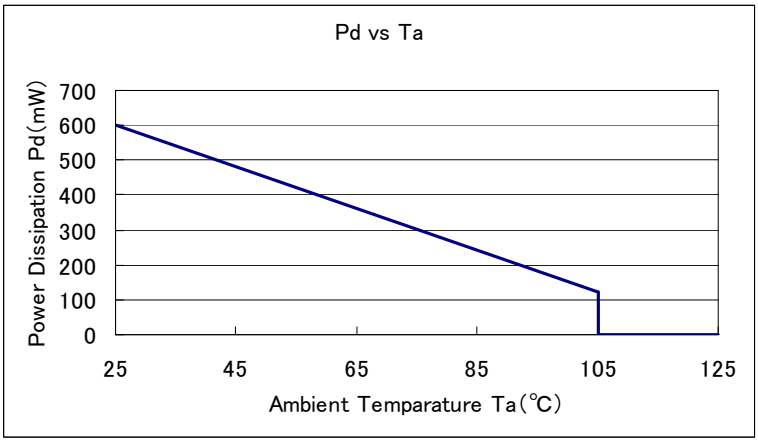
Ambient Temperature (℃)	Power Dissipation Pd (mW)	Thermal Resistance (℃/W)
25	600	166.67
85	240	



3. Power Dissipation vs. Ambient temperature (105℃)

Board Mount (Tjmax=125℃)

Ambient Temperature (℃)	Power Dissipation Pd (mW)	Thermal Resistance (℃/W)
25	600	166.67
105	120	

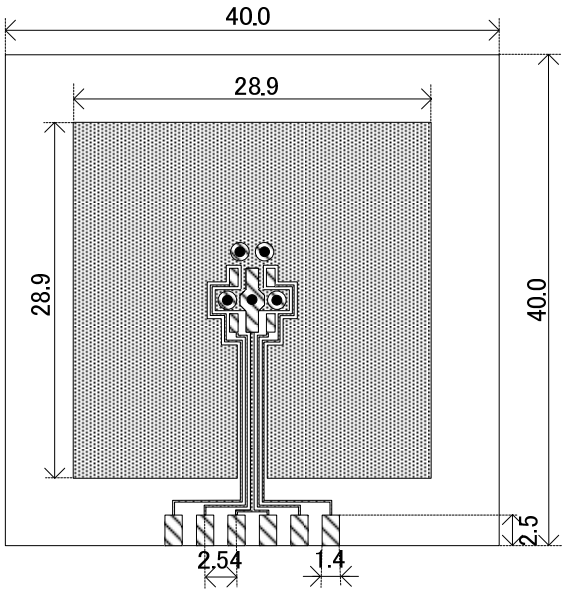


■PACKAGING INFORMATION (Continued)

● SOT-89-5 Power Dissipation

Power dissipation data for the SOT-89-5 is shown in this page.
The value of power dissipation varies with the mount board conditions.
Please use this data as the reference data taken in the following condition.

1. Measurement Condition
   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
   Material: Glass Epoxy (FR-4)
   Thickness: 1.6 mm
   Through-hole: 5 x 0.8 Diameter

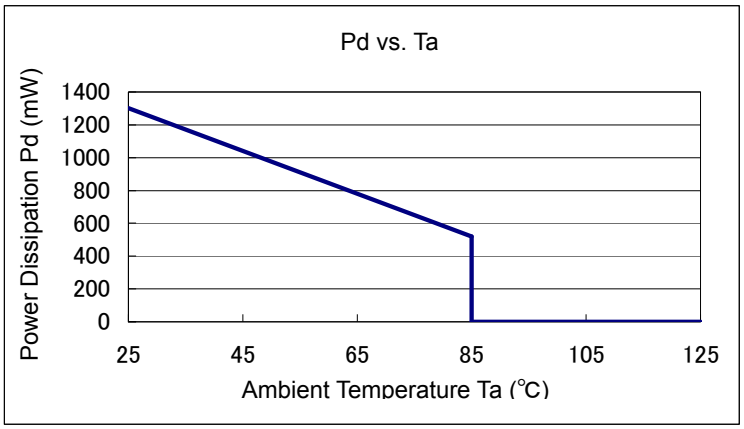


Evaluation Board (Unit: mm)

2. Power Dissipation vs. Ambient temperature (85℃)

Board Mount (Tj max = 125℃)

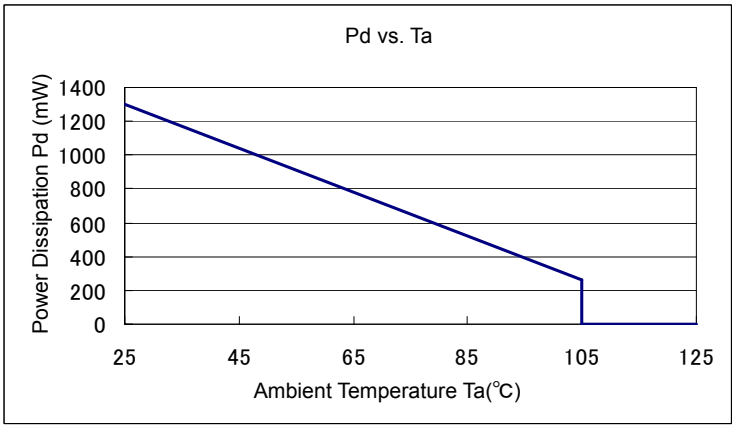
Ambient Temperature (℃)	Power Dissipation Pd (mW)	Thermal Resistance (℃/W)
25	1300	76.92
85	520	



3. Power Dissipation vs. Ambient temperature (105℃)

Board Mount (Tj max = 125℃)

Ambient Temperature (℃)	Power Dissipation Pd (mW)	Thermal Resistance (℃/W)
25	1300	76.92
105	260	

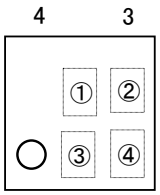


■MARKING RULE

●USPQ-4B03

① represents type of regulator and output voltage range.

MARK			PRODUCT SERIES
OUTPUT VOLTAGE 0.1V INCREMENTS		OUTPUT VOLTAGE 0.05V INCREMENTS	
VOLTAGE=1.2～3.9V	VOLTAGE =4.0V	VOLTAGE =1.25～3.95V	
0	H	8	XC6223A/J*****
1		9	XC6223B/K*****
2		A	XC6223C/M*****
3		B	XC6223D/N*****
4		C	XC6223E/P*****
5		D	XC6223F/Q*****
6		E	XC6223G/R*****
7		F	XC6223H/T*****



USPQ-4B03
(TOP VIEW)

② represents output voltage.

VOLTAGE=1.2～3.95[V]

MARK	OUTPUT VOLTAGE (V)		MARK	OUTPUT VOLTAGE (V)	
0	-	-	F	2.50	2.55
1	-	-	H	2.60	2.65
2	1.20	1.25	K	2.70	2.75
3	1.30	1.35	L	2.80	2.85
4	1.40	1.45	M	2.90	2.95
5	1.50	1.55	N	3.00	3.05
6	1.60	1.65	P	3.10	3.15
7	1.70	1.75	R	3.20	3.25
8	1.80	1.85	S	3.30	3.35
9	1.90	1.95	T	3.40	3.45
A	2.00	2.05	U	3.50	3.55
B	2.10	2.15	V	3.60	3.65
C	2.20	2.25	X	3.70	3.75
D	2.30	2.35	Y	3.80	3.85
E	2.40	2.45	Z	3.90	3.95

VOLTAGE=4.0[V]

PRODUCT SERIES	MARK
XC6223A/J*****	0
XC6223B/K*****	1
XC6223C/M*****	2
XC6223D/N*****	3
XC6223E/P*****	4
XC6223F/Q*****	5
XC6223G/R*****	6
XC6223H/T*****	7

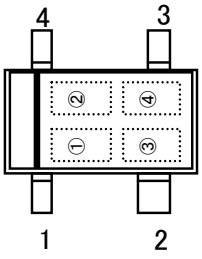
③④ represents production lot number.
01 to 09, 0A to 0Z, 11 to 9Z, A1 to A9, AA to Z9, ZA to ZZ in order.
(G, I, J, O, Q, W excepted)
*No character inversion used.

■MARKING RULE (Continued)

●SSOT-24 (with bar)

① represents type of regulator and output voltage range.

MARK			PRODUCT SERIES
OUTPUT VOLTAGE 0.1V INCREMENTS		OUTPUT VOLTAGE 0.05V INCREMENTS	
VOLTAGE =1.2～2.9V	VOLTAGE =3.0～4.0V	VOLTAGE =1.25～3.95V	
B	3	8	XC6223A/J*****
C	5	9	XC6223B/K*****
D	7	S	XC6223C/M*****
E	A	T	XC6223D/N*****
K	F	U	XC6223E/P*****
L	H	V	XC6223F/Q*****
M	P	X	XC6223G/R*****
N	Z	Y	XC6223H/T*****



SSOT-24(with bar)
(TOP VIEW)

② represents output voltage.

MARK	OUTPUT VOLTAGE (V)				MARK	OUTPUT VOLTAGE (V)			
0	-	-	-	-	F	2.50	3.20	-	2.55
1	-	-	-	-	H	2.60	3.30	-	2.65
2	1.20	-	-	1.25	K	2.70	3.40	-	2.75
3	1.30	-	-	1.35	L	2.80	3.50	-	2.85
4	1.40	-	-	1.45	M	2.90	3.60	-	2.95
5	1.50	-	-	1.55	N	-	-	-	3.05
6	1.60	-	-	1.65	P	-	3.70	-	3.15
7	1.70	-	-	1.75	R	-	3.80	-	3.25
8	1.80	-	-	1.85	S	-	3.90	-	3.35
9	1.90	-	-	1.95	T	-	4.00	-	3.45
A	2.00	-	-	2.05	U	-	-	-	3.55
B	2.10	-	-	2.15	V	-	-	-	3.65
C	2.20	-	-	2.25	X	-	-	-	3.75
D	2.30	3.00	-	2.35	Y	-	-	-	3.85
E	2.40	3.10	-	2.45	Z	-	-	-	3.95

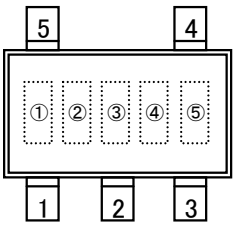
③④ represents production lot number.
01 to 09, 0A to 0Z, 11 to 9Z, A1 to A9, AA to Z9, ZA to ZZ in order.
(G, I, J, O, Q, W excepted)
*No character inversion used.

■MARKING RULE (Continued)

●SOT-25, SOT-89-5,USP-4

① represents product series

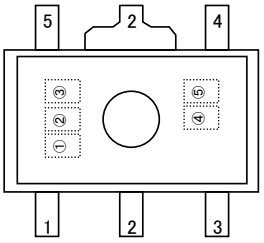
MARK	PRODUCT SERIES
9	XC6223******



SOT-25
(TOP VIEW)

② represents type of regulator.

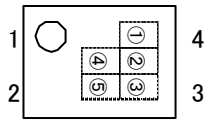
MARK			PRODUCT SERIES
OUTPUT VOLTAGE 0.1V INCREMENTS		OUTPUT VOLTAGE 0.05V INCREMENTS	
VOLTAGE =1.2～3.9V	VOLTAGE =4.0V	VOLTAGE =1.25～3.95V	
C	D	E	XC6223A/J*****
F	H	K	XC6223B/K*****
L	M	N	XC6223C/M*****
P	R	S	XC6223D/N*****
T	U	V	XC6223E/P*****
X	Y	Z	XC6223F/Q*****
0	1	2	XC6223G/R*****
3	4	5	XC6223H/T*****



SOT-89-5
(TOP VIEW)

③ represents output voltage.

MARK	OUTPUT VOLTAGE (V)				MARK	OUTPUT VOLTAGE (V)			
0	-	4.00	-		F	2.50	-	2.55	-
1	-	-	-		H	2.60	-	2.65	-
2	1.20	-	1.25	-	K	2.70	-	2.75	-
3	1.30	-	1.35	-	L	2.80	-	2.85	-
4	1.40	-	1.45	-	M	2.90	-	2.95	-
5	1.50	-	1.55	-	N	3.00	-	3.05	-
6	1.60	-	1.65	-	P	3.10	-	3.15	-
7	1.70	-	1.75	-	R	3.20	-	3.25	-
8	1.80	-	1.85	-	S	3.30	-	3.35	-
9	1.90	-	1.95	-	T	3.40	-	3.45	-
A	2.00	-	2.05	-	U	3.50	-	3.55	-
B	2.10	-	2.15	-	V	3.60	-	3.65	-
C	2.20	-	2.25	-	X	3.70	-	3.75	-
D	2.30	-	2.35	-	Y	3.80	-	3.85	-
E	2.40	-	2.45	-	Z	3.90	-	3.95	-



USP-4
(TOP VIEW)

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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