

Dual LDO Regulators with ON/OFF Switch

■ GENERAL DESCRIPTION

XC6415 series are highly accurate, Dual, low noise, CMOS LDO voltage regulators. Performance features of the series include low output noise, high ripple rejection rate, and low dropout. Extremely dense power supply circuit can be organized with a 2 channeled high speed voltage regulator in low ON resistance which is built-in to an ultra small USP-6C package. The output voltage for each regulator is set independently by laser trimming and selectable in 50mV increments within a range of 0.8 to 5.0V. The EN function allows the output of each regulator to be turned off independently. In this state, with the XC6415 series, the IC turns on the internal switch located between the V_{OUT} and the V_{SS} pins. This short enables the electric charge at the output capacitor (C_L) to be discharged via the internal auto-discharge resistance, and as a result the V_{OUT} pin quickly returns to the V_{SS} level. The series' output stabilization capacitor (C_L) is also compatible with low ESR ceramic capacitors. The high level of output stability is maintained even during frequent load fluctuations, due to the excellent transient response performance. Because regulator 1 and 2 are completely isolated, a cross talk between each channel, which causes a problem during load fluctuations, can be greatly reduced

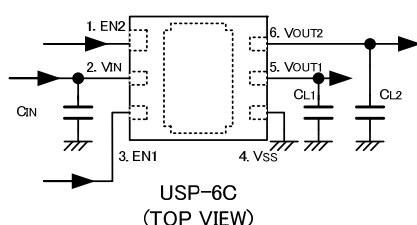
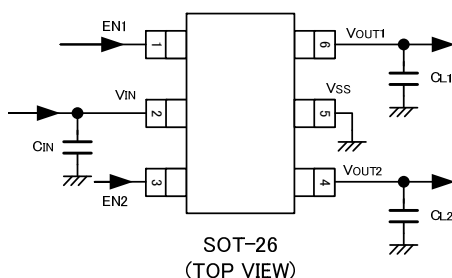
■ APPLICATIONS

- Mobile phones
- Cordless phones, Wireless communication equipment
- Portable games
- Digital still cameras, Digital video cameras
- Portable audio equipment
- PDAs

■ FEATURES

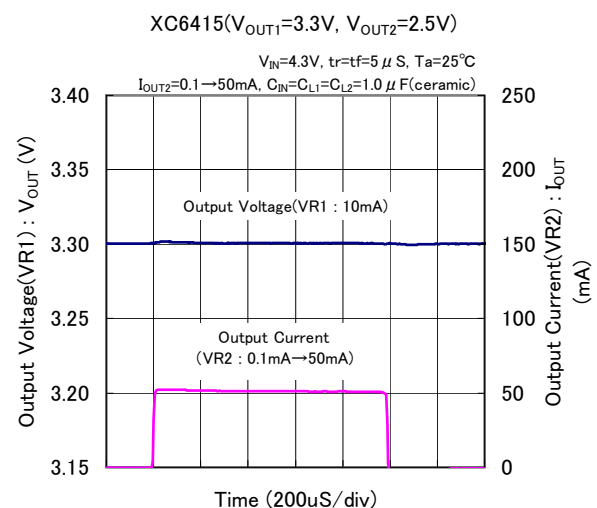
Output Current	: 200mA (300mA limit, TYP.)
Dropout Voltage	: 95mV @ $I_{OUT}=100mA$ $V_{OUT(T)}=3.0V$
Operating Voltage Range	: 1.5V~6.0V
Output Voltage Setting Range	: 0.8V~5.0V (50mV increments)
High Accuracy	: $\pm 1\%$ @ $V_{OUT}>2.0V$ $\pm 20mV$ @ $V_{OUT}\leq 2.0V$
Low Power Consumption	: 28 μA /ch (TYP.)
Stand-by Current	: Less than 0.1 μA
Ripple Rejection	: 65dB@1kHz
Operating Temperature Range	: -40°C ~ 85°C
Low ESR Capacitor	: 1.0 μF ceramic capacitor compatible
Small Packages	: USP-6C, SOT-26

TYPICAL APPLICATION CIRCUITS

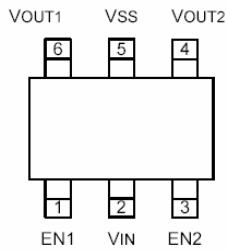


TYPICAL PERFORMANCE CHARACTERISTICS

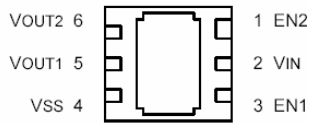
Cross Talk



PIN CONFIGURATION



SOT-26
(TOP VIEW)



USP-6C
(BOTTOM VIEW)

*The dissipation pad for the USP-6C package should be solder-plated in recommended 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. 4) pin.

PIN ASSIGNMENT

PIN NUMBER		PIN NAME	FUNCTIONS
SOT-26	USP-6C		
1	3	EN1	: ON/OFF Control 1
2	2	V _{IN}	: Power Input
3	1	EN2	: ON/OFF Control 2
4	6	V _{OUT2}	: Output 2
5	4	V _{SS}	: Ground
6	5	V _{OUT1}	: Output 1

PRODUCT CLASSIFICATION

Ordering Information

XC6415 _____

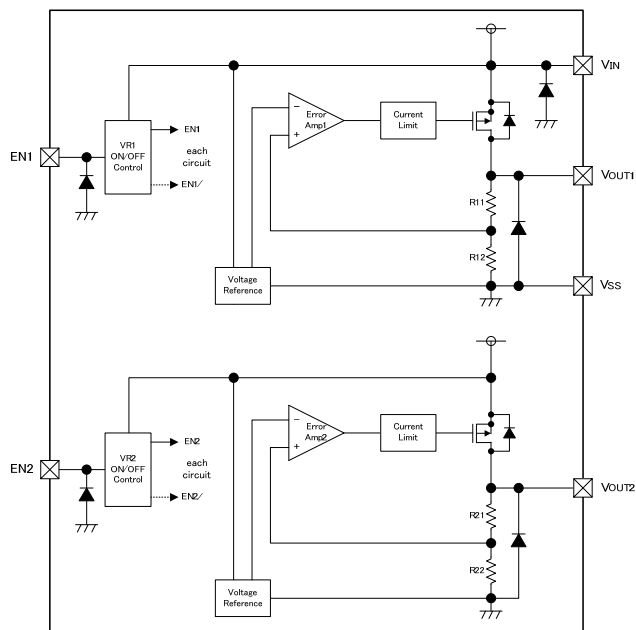
DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
①	Type of Regulator 1	A	: EN High Active without C _L discharge resistor
		B	: EN High Active with C _L discharge resistor
②	Type of Regulator 2	A	: EN High Active without C _L discharge resistor
		B	: EN High Active with C _L discharge resistor
③④	Output Voltage	01 ~	: Internally set sequential number relating output voltage of each regulators; Regulator 1 Output Voltage Setting Range: 0.8 ~ 5.0V (50mV increments) Regulator 2 Output Voltage Setting Range: 0.8 ~ 5.0V (50mV increments)
⑤	Packages	M	: SOT-26
		E	: USP-6C
⑥	Device Orientation	R	: Embossed tape, standard feed
		L	: Embossed tape, reverse feed

DESIGNATOR

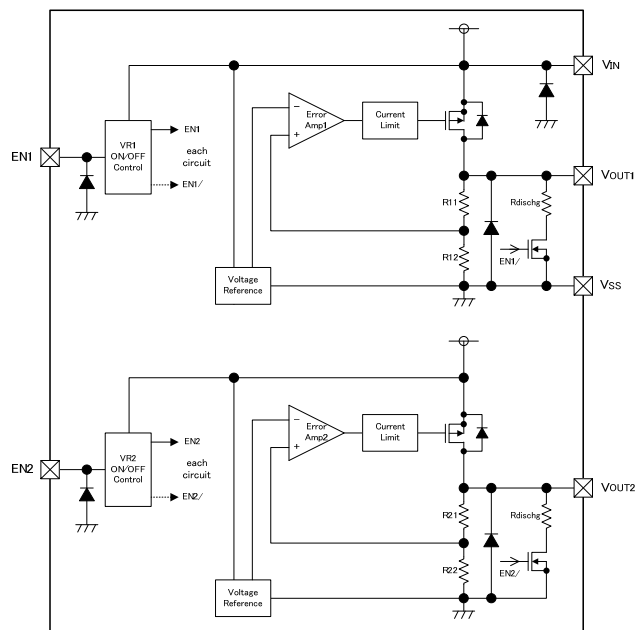
③④	VR1	VR2	③④	VR1	VR2	③④	VR1	VR2
01	1.80	2.80	11	1.30	1.50	21	1.50	2.80
02	1.20	2.90	12	2.80	2.80	22	1.80	3.00
03	1.80	1.80	13	2.50	3.30	23	1.85	2.80
04	1.50	2.70	14	3.00	3.30	24	1.85	3.30
05	2.85	2.85	15	1.20	1.80	25	2.60	2.80
06	1.80	3.30	16	2.80	3.30	26	-	-
07	3.00	3.00	17	3.30	3.30	27	-	-
08	2.80	1.80	18	3.10	3.10	28	-	-
09	1.20	1.20	19	2.80	1.50	29	-	-
10	1.10	1.30	20	1.30	2.80	30	-	-

*For other combinations, output voltages and etc., please ask Torex sales contacts.

BLOCK DIAGRAMS



< XC6415AA Series >



< XC6415BB Series >

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

ABSOLUTE MAXIMUM RATINGS

Ta=25°C

PARAMETER	SYMBOL	RATINGS	UNITS
Input Voltage	V_{IN}	- 0.3 ~ + 6.5	V
Output Current	$I_{OUT1} + I_{OUT2}$	500 ^(*1)	mA
Output Voltage 1 / Output Voltage 2	V_{OUT1} / V_{OUT2}	$V_{SS} - 0.3 \sim V_{IN} + 0.3$	V
EN1/EN2 Input Voltage	V_{EN1} / V_{EN2}	$V_{SS} - 0.3 \sim + 6.5$	V
Power Dissipation	USP-6C SOT-25	Pd	100
			1000 (When wiring on the PCB) ^(*2)
Operating Temperature Range	Topr	- 40 ~ + 85	°C
Storage Temperature Range	Tstg	- 55 ~ + 125	°C

*1: Please use within the range of $P_d > \{ (V_{IN} - V_{OUT1}) \times I_{OUT1} + (V_{IN} - V_{OUT2}) \times I_{OUT2} \}$

*2: The data is reference for power dissipation when wiring on the PCB. Please see page 19 for more detail information.

ELECTRICAL CHARACTERISTICS

XC6415 Series

Regulator 1, Regulator 2

Ta=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUITS
Output Voltage	$V_{OUT(E)}^{(*)2}$	$V_{OUT(T)} \geq 2.0V$, $V_{EN}=V_{IN}$, $I_{OUT}=10mA$	$\times 0.99$ (*)3	$V_{OUT(T)}$ (*)4	$\times 1.01$ (*)3	V	①
		$V_{OUT} \leq 1.95V$, $V_{EN}=V_{IN}$, $I_{OUT}=10mA$	-0.02 (*)3		$+0.02$ (*)3		
Output Current	I_{OUTMAX}		200	-	-	mA	①
Load Regulation	ΔV_{OUT}	$V_{EN}=V_{IN}$, $0.1mA \leq I_{OUT} \leq 100mA$	E-1			mV	①
Dropout Voltage (*)5	Vdif	$I_{OUT}=100mA$, $V_{EN}=V_{IN}$	E-2			mV	①
Supply Current	I_{SS}	$V_{IN}=V_{EN}=V_{OUT(T)}+1.0V$, $I_{OUT}=0mA$	-	28	60	μA	②
Stand-by Current	I_{STBY}	$V_{IN}=6.0V$, $V_{EN}=V_{SS}$	-	0.01	0.10	μA	②
Line Regulation	$\frac{\Delta V_{OUT}}{\Delta V_{IN} \cdot V_{OUT}}$	$V_{OUT(T)}+0.5V \leq V_{IN} \leq 6.0V$: $V_{OUT(T)} \geq 1.0V$, $V_{EN}=V_{IN}$, $I_{OUT}=10mA$	-	0.01	0.20	%V	①
		$1.5V \leq V_{IN} \leq 6.0V$: $V_{OUT(T)} \leq 0.95V$ $V_{EN}=V_{IN}$, $I_{OUT}=10mA$					
Input Voltage	V_{IN}		1.5	-	6.0	V	①
Output Voltage Temperature Characteristics	$\frac{\Delta V_{OUT}}{\Delta Ta \cdot V_{OUT}}$	$V_{EN}=V_{IN}$, $I_{OUT}=30mA$ $-40^\circ C \leq Ta \leq 85^\circ C$	-	± 100	-	ppm/°C	①
Ripple Rejection Rate	PSRR	$V_{IN}=\{V_{OUT(T)}+1.0\}V_{DC}+0.5V_{p-pAC}$: $V_{OUT(T)} \leq 4.75V$, $V_{EN}=V_{IN}$, $I_{OUT}=30mA$, $f=1kHz$	-	65	-	dB	③
		$V_{IN}=5.75V_{DC}+0.5V_{p-pAC}$: $V_{OUT(T)} \geq 4.8V$, $V_{EN}=V_{IN}$, $I_{OUT}=30mA$, $f=1kHz$					
Limit Current	I_{lim}	$V_{EN}=V_{IN}$	210	300	-	mA	①
Short Current	I_{short}	$V_{EN}=V_{IN}$, Short V_{OUT} to V_{SS} level	-	20	-	mA	①
EN "H" Level Voltage	V_{ENH}		1.2	-	6.0	V	①
EN "L" Level Voltage	V_{ENL}		-	-	0.3	V	①
EN "H" Level Current	I_{ENH}	$V_{EN}=V_{IN}$	-0.1	-	0.1	μA	①
EN "L" Level Current	I_{ENL}	$V_{EN}=V_{SS}$	-0.1	-	0.1	μA	①
C_L Discharge Resistor (*)8	R_{dischg}	$V_{IN}=6.0V$, $V_{OUT}=4.0V$, $V_{CE}=V_{SS}$	-	550	-	Ω	①

NOTE:

*1: Unless otherwise stated, $V_{IN}=V_{OUT(T)}+1.0V$.

*2: $V_{OUT(E)}$ = Effective output voltage (see the voltage chart)

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

*3 : Characteristics of the actual $V_{OUT(E)}$ by setting output voltage is shown in the voltage chart.

*4 : $V_{OUT(T)}$: Specified output voltage

5: $V_{dif}=\{V_{IN1}^{()7}-V_{OUT1}^{(*)6}\}$

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

*8: For XC6415xB/Bx series only. XC6415xA/Ax series discharge with only Rx1 and Rx2 resistors as shown in the BLOCK DIAGRAMS.

*9: Each channel is measured when the other channel is turned off ($V_{EN}=V_{SS}$).

ELECTRICAL CHARACTERISTICS (Continued)

Voltage Chart

SETTING OUTPUT VOLTAGE (V)	OUTPUT VOLTAGE (V)		LOAD REGULATION E-1 (mV)		DROPOUT VOLTAGE E-2 (mV)	
	V _{OUT(E)}		V _{dif}		V _{dif}	
V _{OUT(T)}	MIN.	MAX.	TYP.	MAX.	TYP.	MAX.
0.80	0.7800	0.8200	10	30	500	850
0.85	0.8300	0.8700				
0.90	0.8800	0.9200			410	750
0.95	0.9300	0.9700				
1.00	0.9800	1.0200			360	600
1.05	1.0300	1.0700				
1.10	1.0800	1.1200			330	600
1.15	1.1300	1.1700				
1.20	1.1800	1.2200			280	420
1.25	1.2300	1.2700				
1.30	1.2800	1.3200			240	360
1.35	1.3300	1.3700				
1.40	1.3800	1.4200			200	300
1.45	1.4300	1.4700				
1.50	1.4800	1.5200			180	260
1.55	1.5300	1.5700				
1.60	1.5800	1.6200			170	240
1.65	1.6300	1.6700				
1.70	1.6800	1.7200	150	200		
1.75	1.7300	1.7700				
1.80	1.7800	1.8200	20	50	150	200
1.85	1.8300	1.8700				
1.90	1.8800	1.9200			120	180
1.95	1.9300	1.9700				
2.00	1.9800	2.0200			110	180
2.05	2.0295	2.0705				
2.10	2.0790	2.1210			95	150
2.15	2.1285	2.1715				
2.20	2.1780	2.2220			95	150
2.25	2.2275	2.2725				
2.30	2.2770	2.3230			95	150
2.35	2.3265	2.3735				
2.40	2.3760	2.4240	95	150		
2.45	2.4255	2.4745				
2.50	2.4750	2.5250	95	150		
2.55	2.5245	2.5755				
2.60	2.5740	2.6260	95	150		
2.65	2.6235	2.6765				
2.70	2.6730	2.7270	95	150		
2.75	2.7225	2.7775				
2.80	2.7720	2.8280	95	150		
2.85	2.8215	2.8785				
2.90	2.8710	2.9290	95	150		
2.95	2.9205	2.9795				

ELECTRICAL CHARACTERISTICS (Continued)

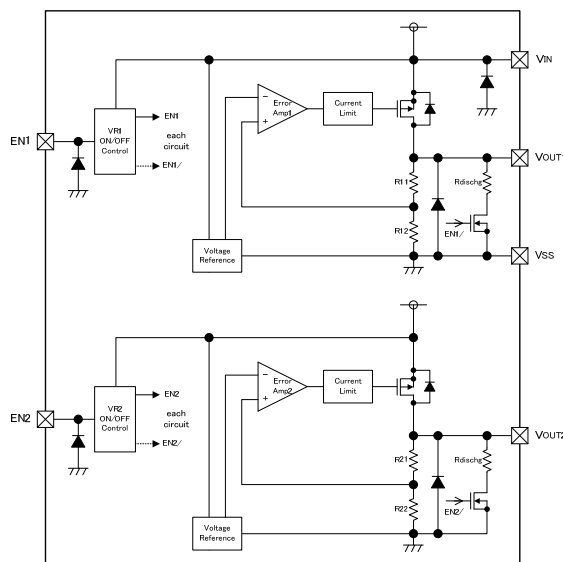
Voltage Chart (Continued)

SETTING OUTPUT VOLTAGE (V)	OUTPUT VOLTAGE (V)		LOAD REGULATION E-1 (mV)		DROPOUT VOLTAGE E-2 (mV)	
	V _{OUT(E)}		V _{dif}		V _{dif}	
V _{OUT(T)}	MIN.	MAX.	TYP.	V _{OUT(T)}	MIN.	MAX.
3.00	2.9700	3.0300	20	50	95	150
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	30	60	80	120
4.05	4.0095	4.0905				
4.10	4.0590	4.1410				
4.15	4.1085	4.1915				
4.20	4.1580	4.2420				
4.25	4.2075	4.2925				
4.30	4.2570	4.3430				
4.35	4.3065	4.3935				
4.40	4.3560	4.4440				
4.45	4.4055	4.4945				
4.50	4.4550	4.5450				
4.55	4.5045	4.5955				
4.60	4.5540	4.6460				
4.65	4.6035	4.6965				
4.70	4.6530	4.7470				
4.75	4.7025	4.7975				
4.80	4.7520	4.8480				
4.85	4.8015	4.8985				
4.90	4.8510	4.9490				
4.95	4.9005	4.9995				
5.00	4.9500	5.0500				

OPERATIONAL DESCRIPTION

<Output Voltage Control>

The voltage divided by resistors Rx1 and Rx2 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 protect circuit operate in relation to the level of output current. Further, the IC's internal circuitry can be shutdown via the EN pin's signal.



< XC6415BB Series >

<CL Auto-Discharge Function>

XC6415xB/Bx series can quickly discharge the electric charge at the output capacitor (C_L), when a low signal to the EN pin, which enables a whole IC circuit put into OFF state, is inputted via the N-channel transistor located between the V_{OUT} pin and the V_{SS} pin (cf. BLOCK DIAGRAM). The C_L discharge resistance is set to 780 Ω when V_{IN} is 6.0V (TYP.) and V_{OUT} is 4.0V (TYP.). Moreover, discharge time of the output capacitor (C_L) is set by the C_L auto-discharge resistance (R) and the output capacitor (C_L). By setting time constant of a C_L auto-discharge resistance value [R] and an output capacitor value (C_L) as $\tau = C \times R$, the output voltage after discharge via the N channel transistor is calculated by the following formulas.

$$V = V_{OUT} \times e^{-t/\tau}, \quad \text{or } t = \tau \ln(V_{OUT(E)} / V)$$

(V : Output voltage after discharge, V_{OUT(E)} : Output voltage, t: Discharge time,
 τ : CL auto-discharge resistance R x Output capacitor (CL) value C)

C_L high-speed discharge function can be set by each regulator.

<Current Limiter, Short-Circuit Protection>

The XC6415 series includes a fold-back circuit, which aid the operations of the current limiter and circuit protection. When the load current reaches the current limit level, the fold-back circuit operates and output voltage drops. As a result of this drop in output voltage, output current also decreases. When the output pin is shorted, a current of about 30mA flows.

<EN Pin>

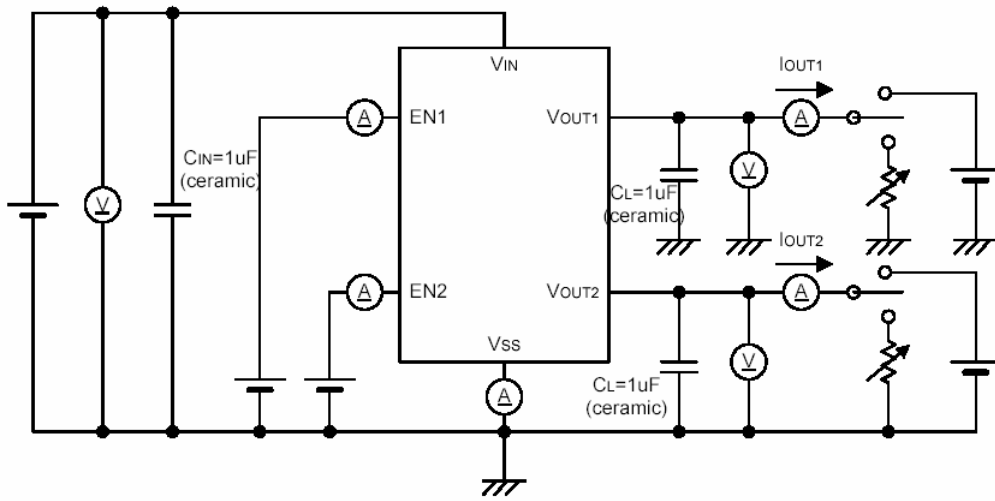
The IC's internal circuitry can be shutdown via the signal from the EN pin with the XC6415 series. In shutdown mode, output at the V_{OUT} pin will be pulled down to the V_{SS} level via Rx1 & Rx2. However, as for the XC6415xB/Bx series, the C_L auto-discharge resistor is connected in parallel to Rx1 and Rx2 while the power supply is applied to the V_{IN} pin. Therefore, time until the V_{OUT} pin reaches the V_{SS} level becomes short. The output voltage becomes unstable, when the EN pin is open. If this IC is used with the correct output voltage for the EN pin, the logic is fixed and the IC will operate normally. However, supply current may increase as a result of through current in the IC's internal circuitry when medium voltage is input.

NOTES ON USE

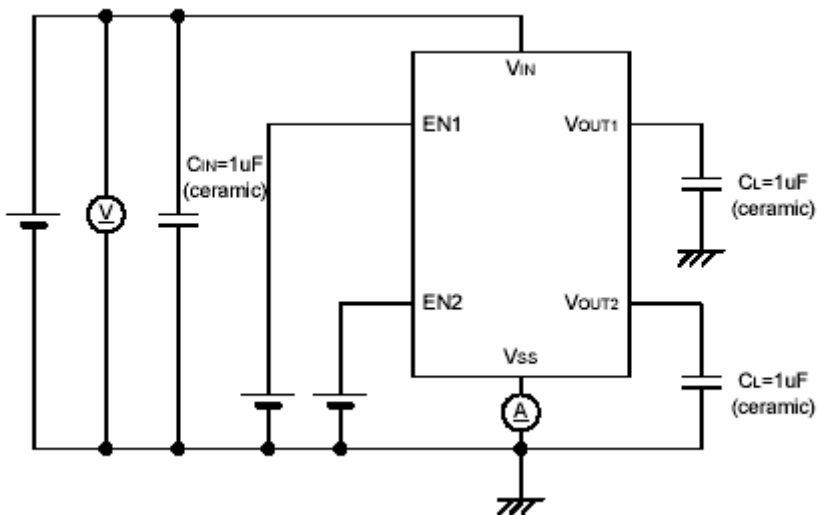
1. Please use this IC within the stated absolute maximum ratings. The IC is liable to malfunction should the ratings be exceeded.
2. Where wiring impedance is high, operations may become unstable due to noise and/or phase lag depending on output current. Please wire the input capacitor (C_{IN}) and the output capacitor (C_L) as close to the IC as possible.

TEST CIRCUITS

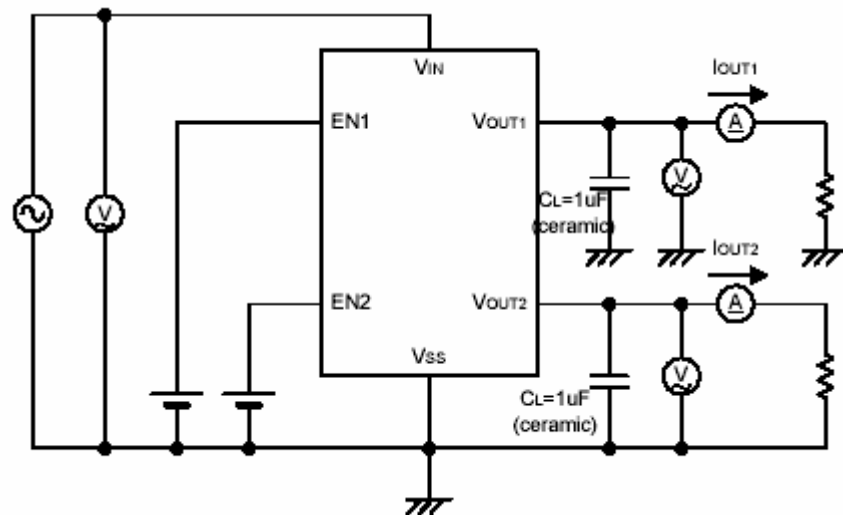
Circuit



Circuit



Circuit

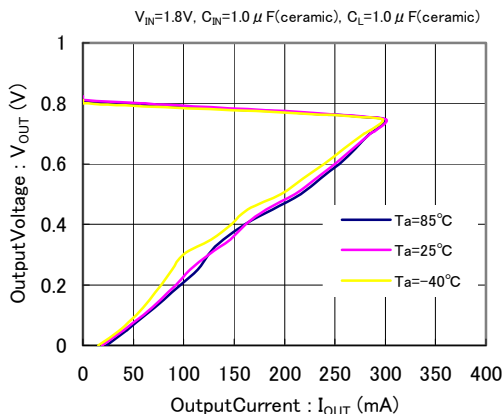


TYPICAL PERFORMANCE CHARACTERISTICS

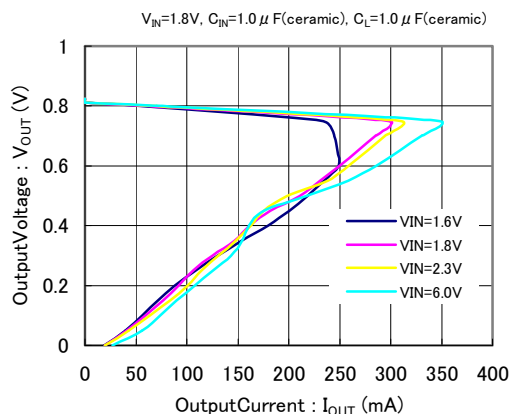
* EN Voltage condition: Unless otherwise stated, $V_{EN}=V_{IN}$

(1) OutputVoltage vs. OutputCurrent

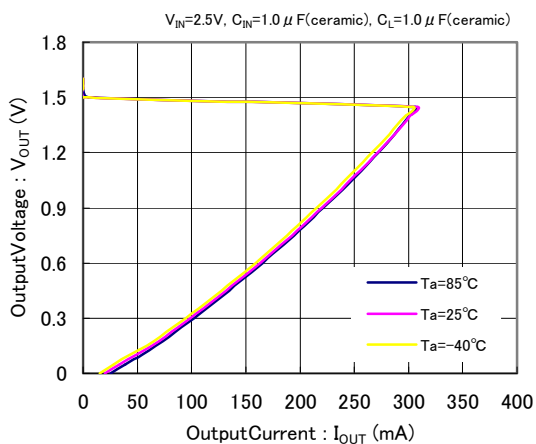
XC6415($V_{OUT}=0.8V$)



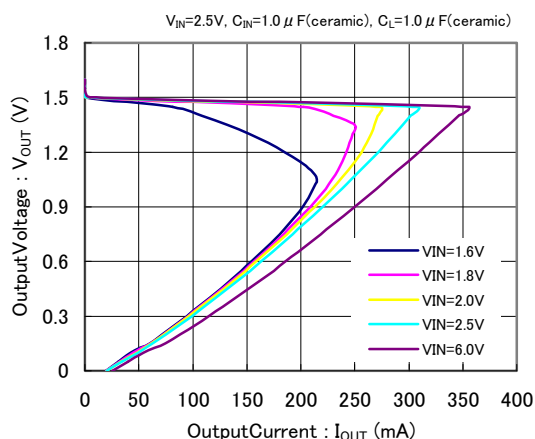
XC6415($V_{OUT}=0.8V$)



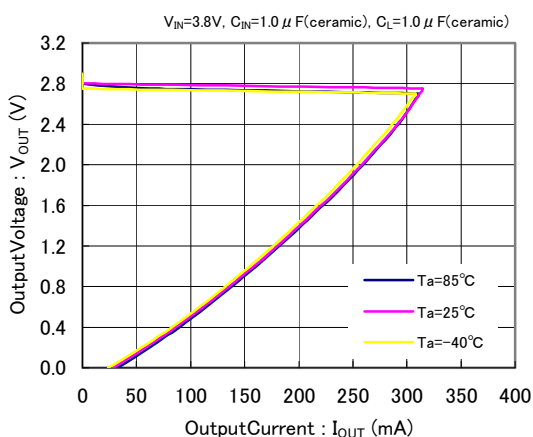
XC6415($V_{OUT}=1.5V$)



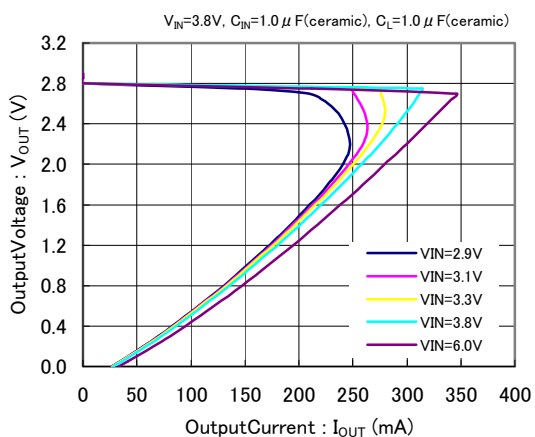
XC6415($V_{OUT}=1.5V$)



XC6415($V_{OUT}=2.8V$)

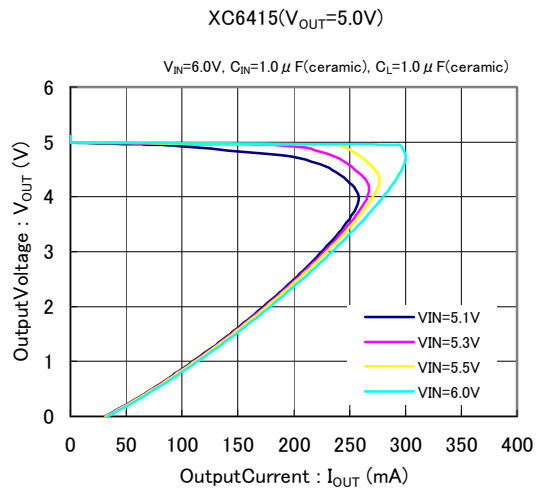
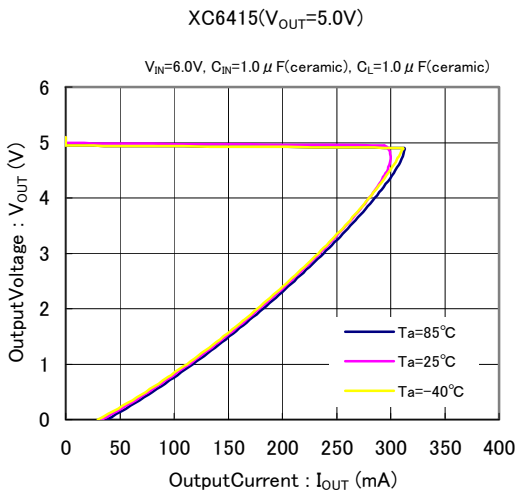


XC6415($V_{OUT}=2.8V$)

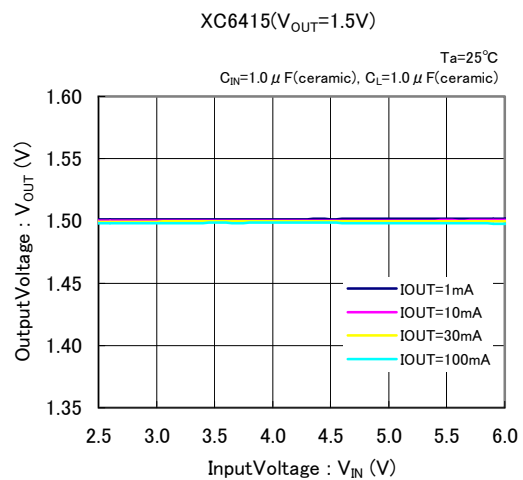
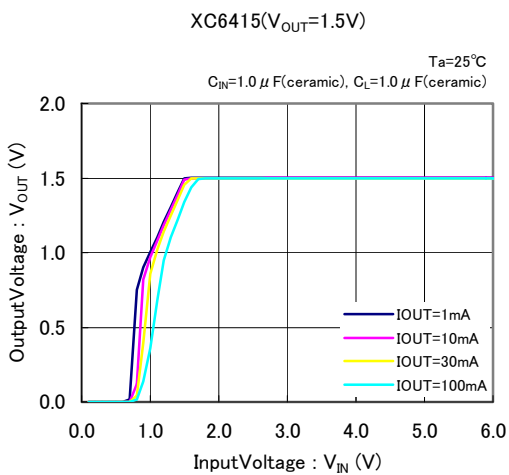
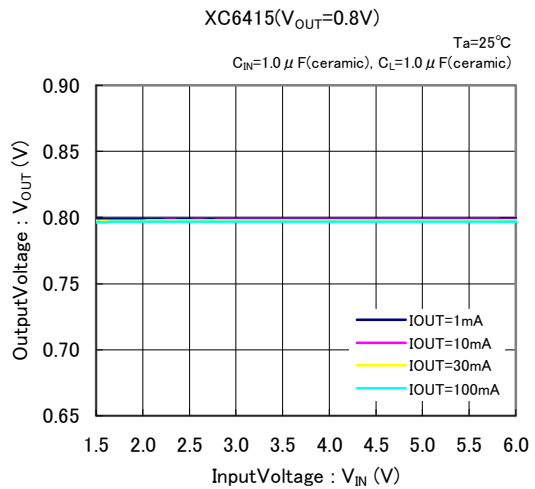
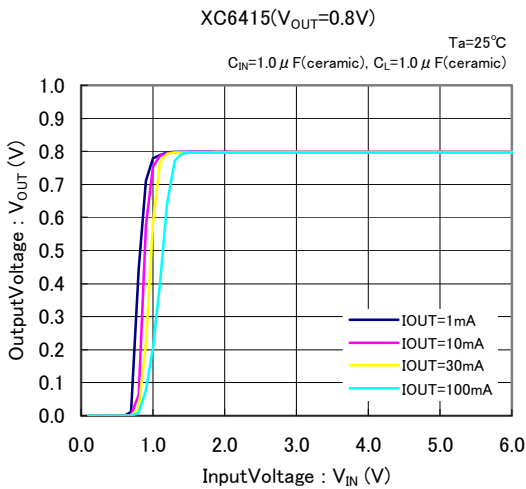


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(1) OutputVoltage vs. OutputCurrent

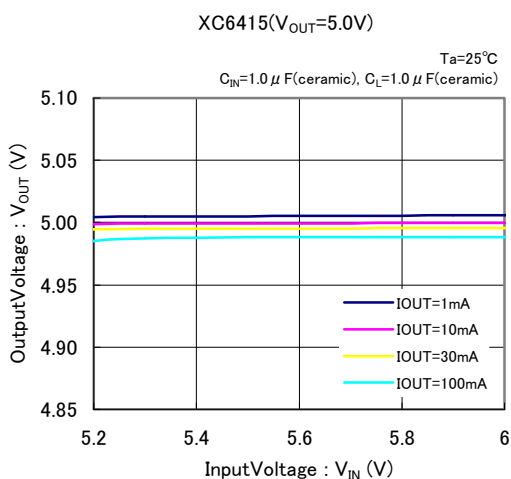
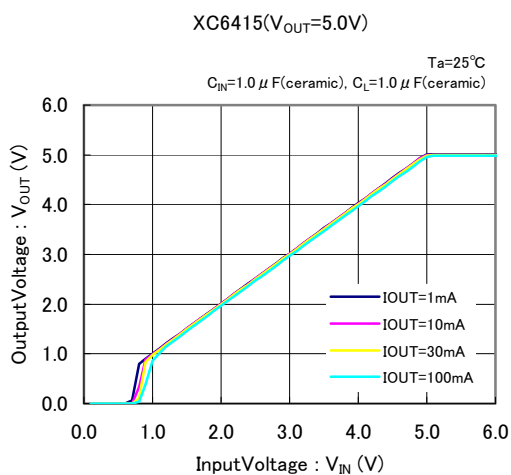
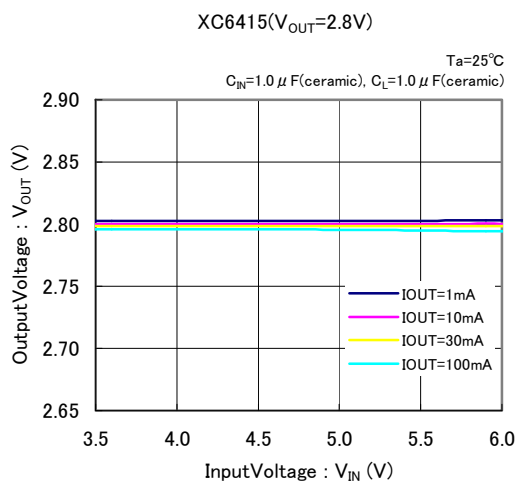
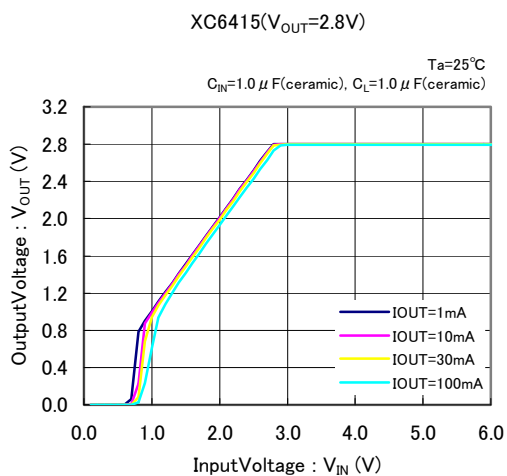


(2) OutputVoltage vs. InputVoltage

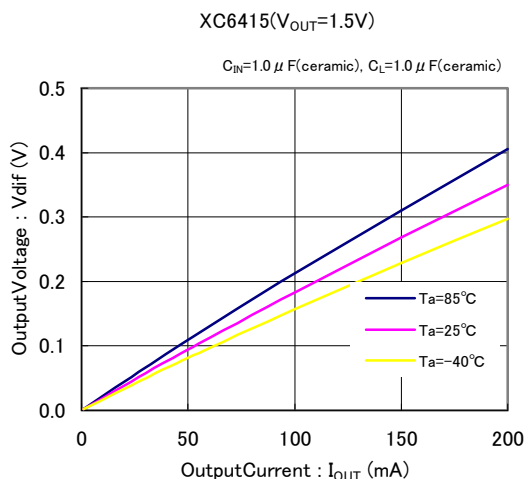
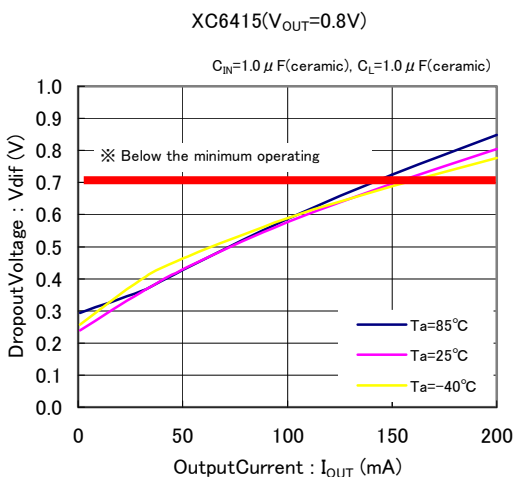


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2) OutputVoltage vs. InputVoltage

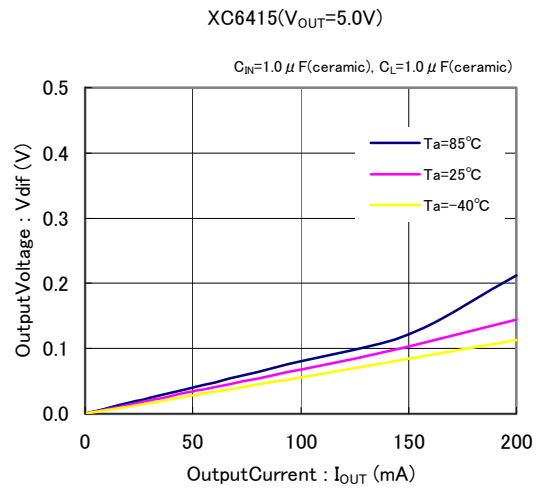
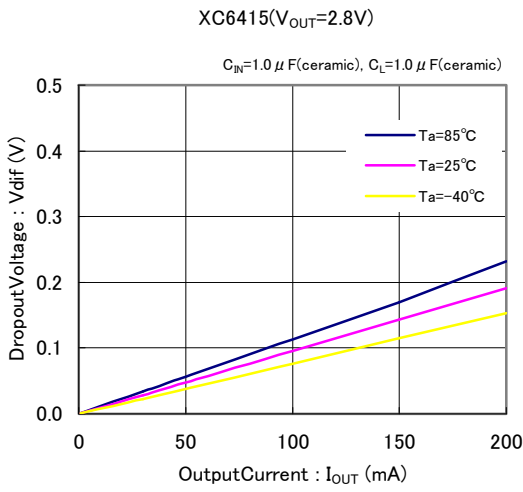


(3) DropoutVoltage vs. OutputCurrent

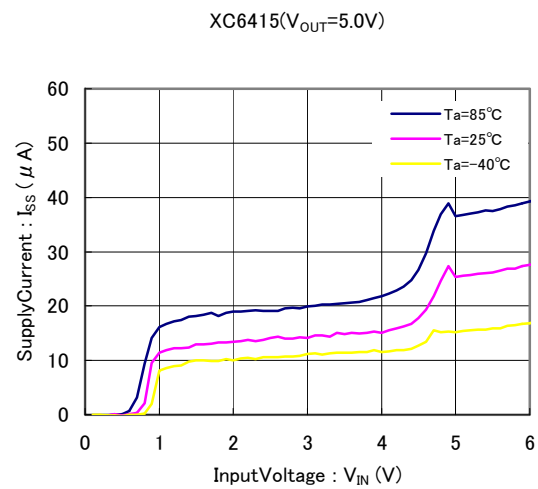
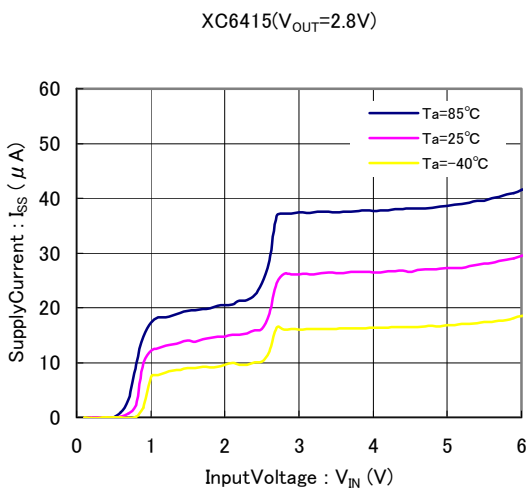
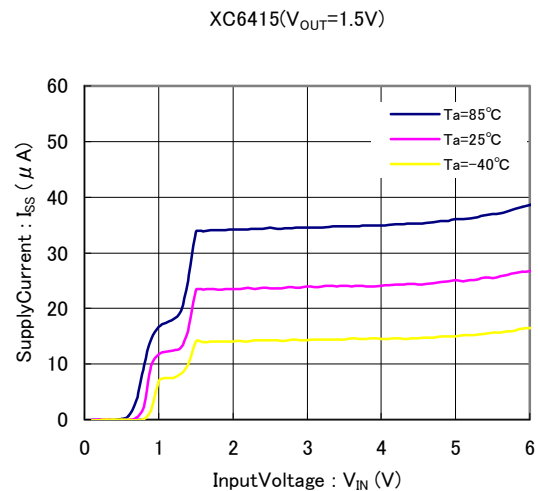
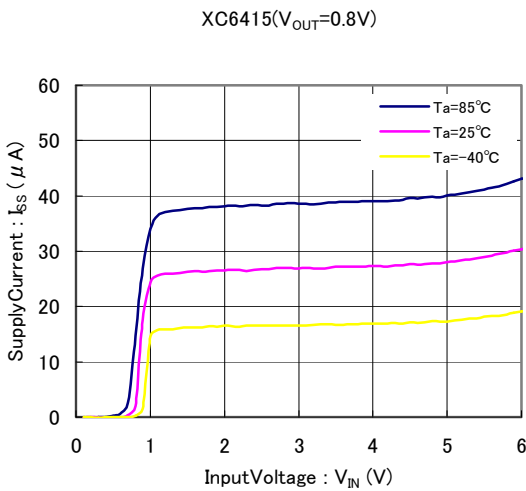


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(3) Dropout Voltage vs. Output Current

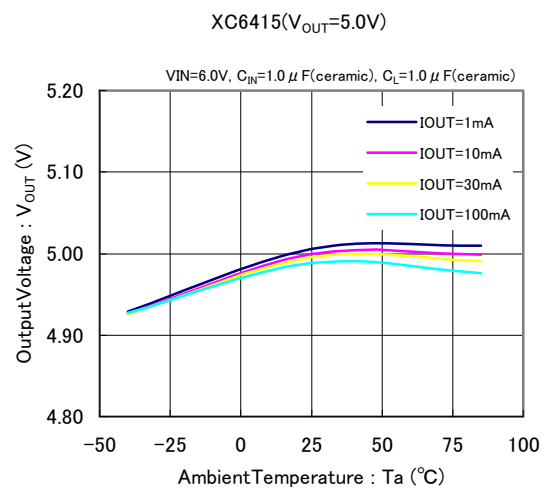
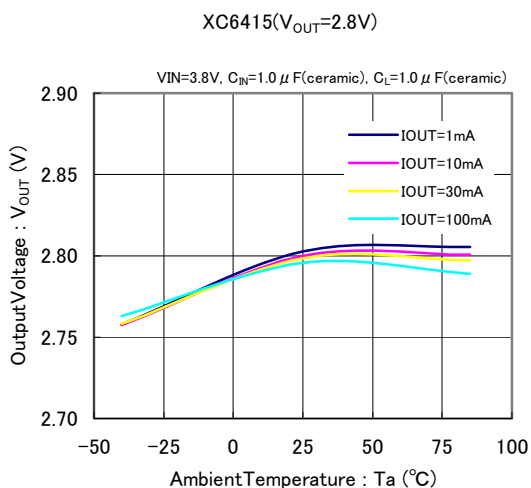
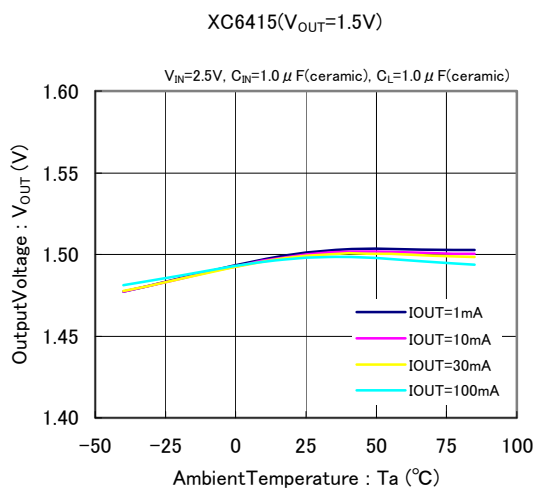
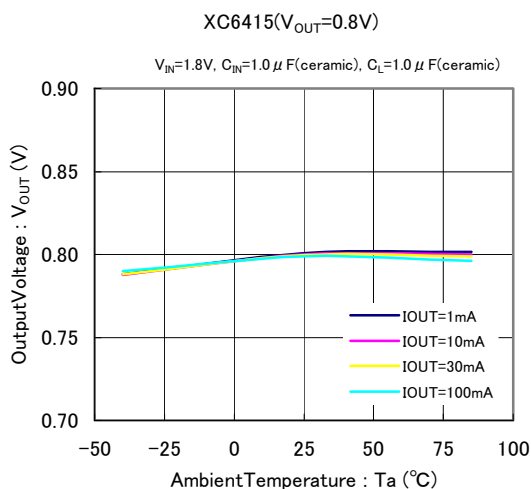


(4) Supply Current vs. Input Voltage

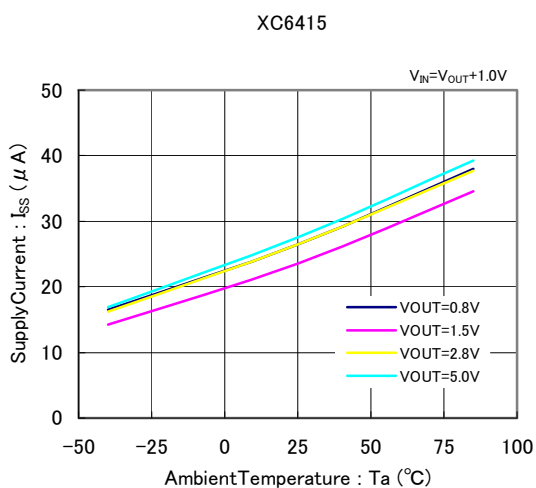


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

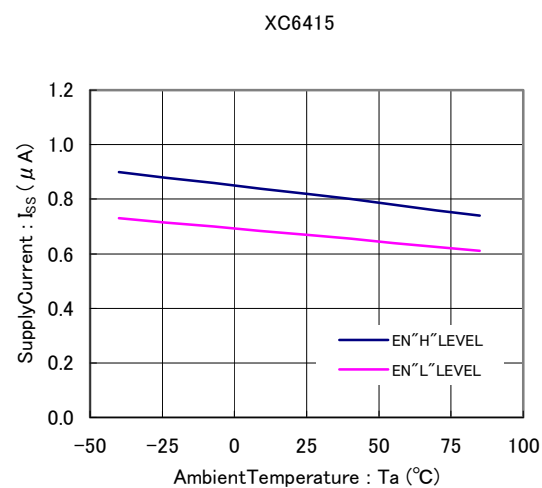
(5) OutputVoltage vs. AmbientTemperature



(6) SupplyCurrent vs. AmbientTemperature

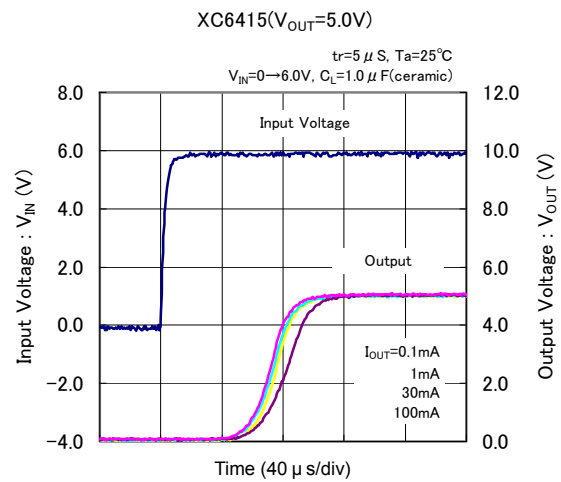
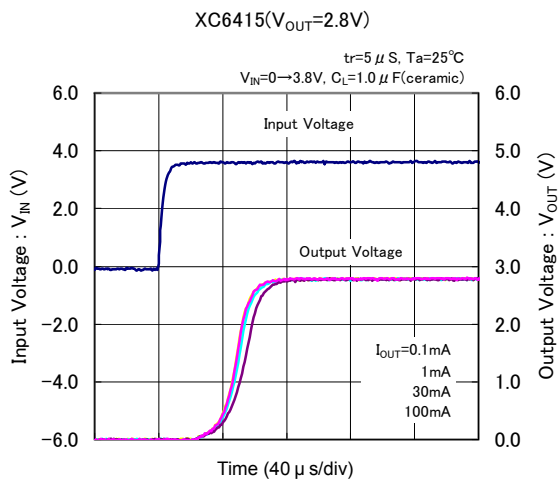
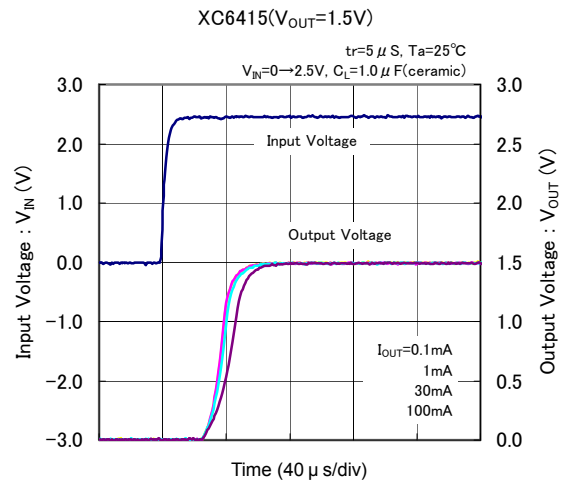
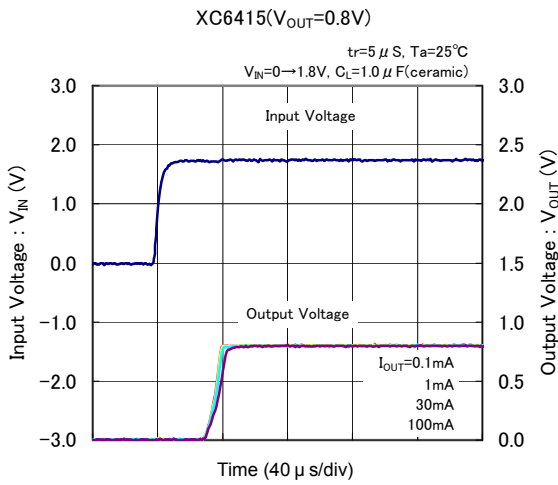


(7) EN Threshold Voltage vs. AmbientTemperature

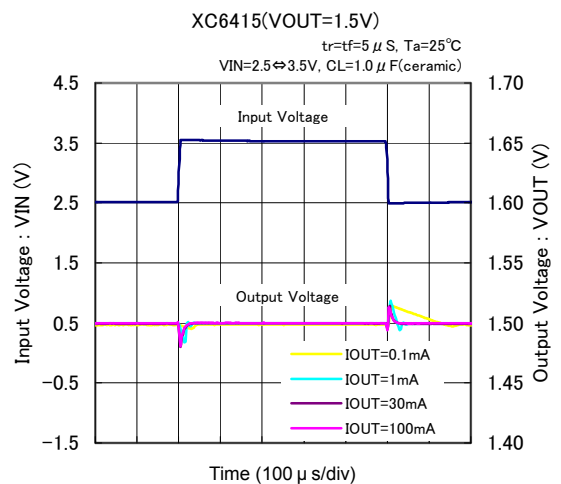
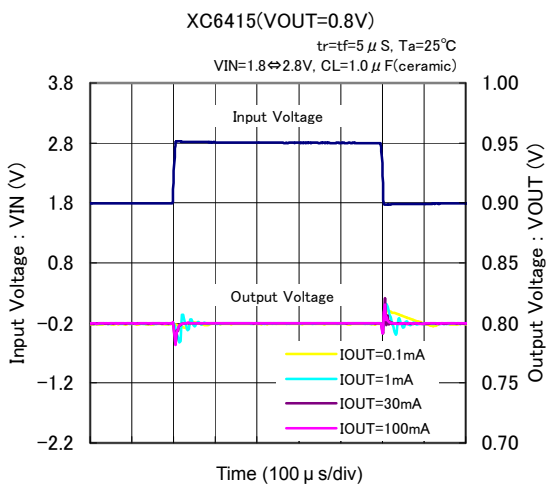


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(8) Rising Response Time

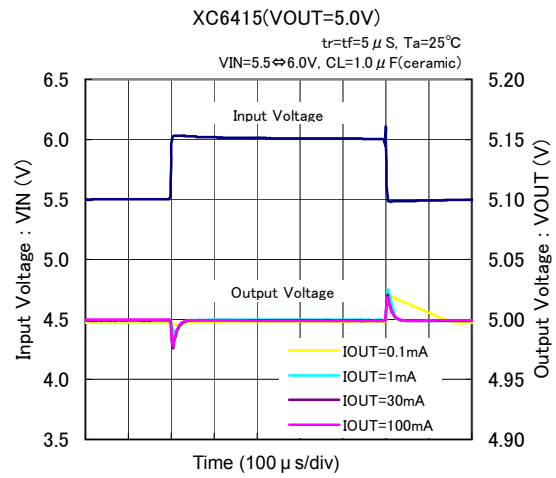
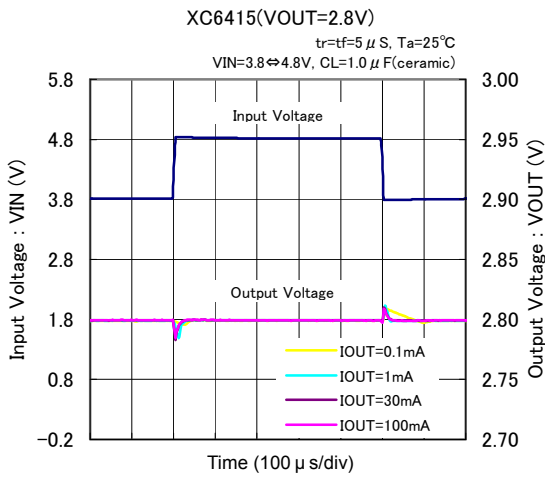


(9) Input Transient Response

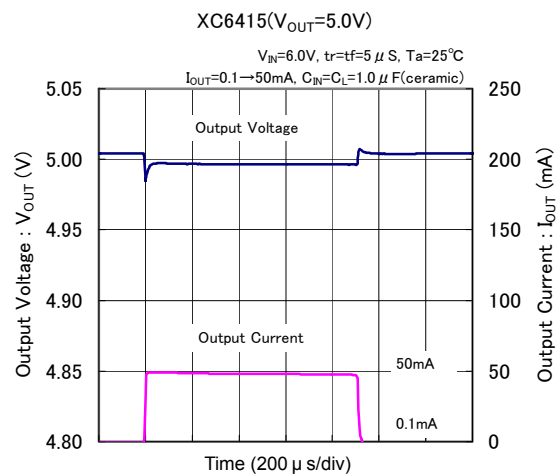
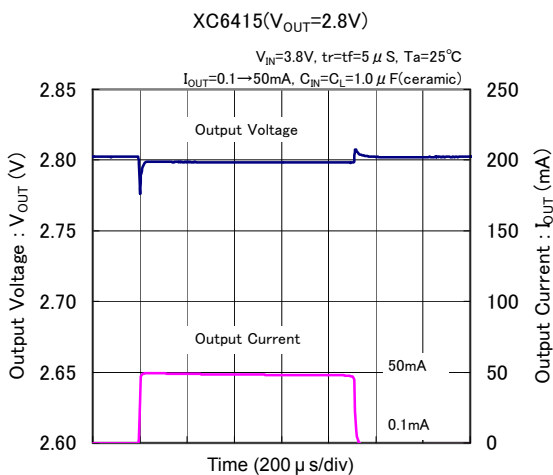
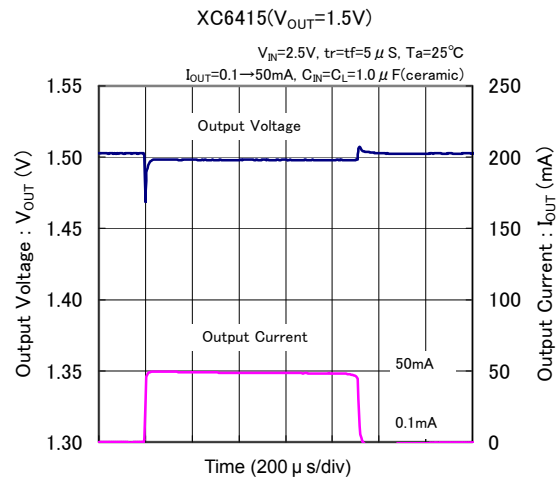
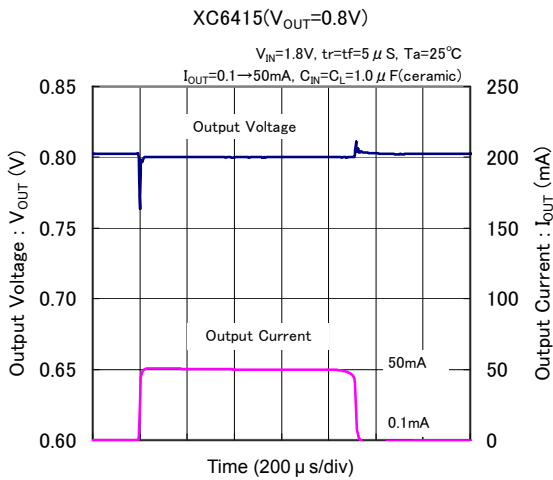


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(9) Input Transient Response

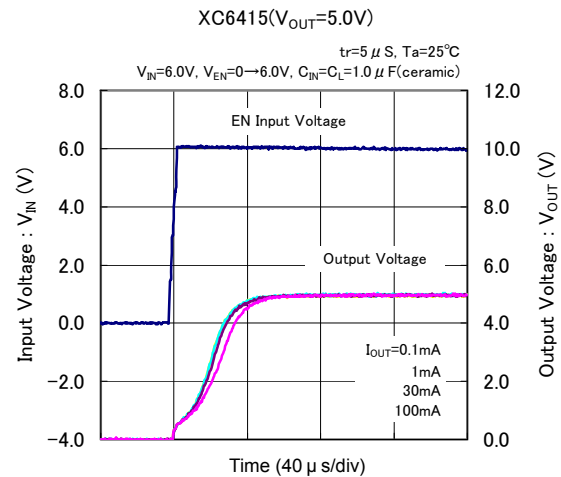
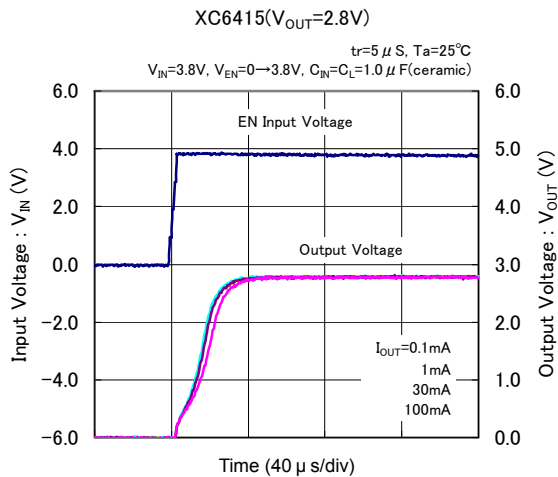
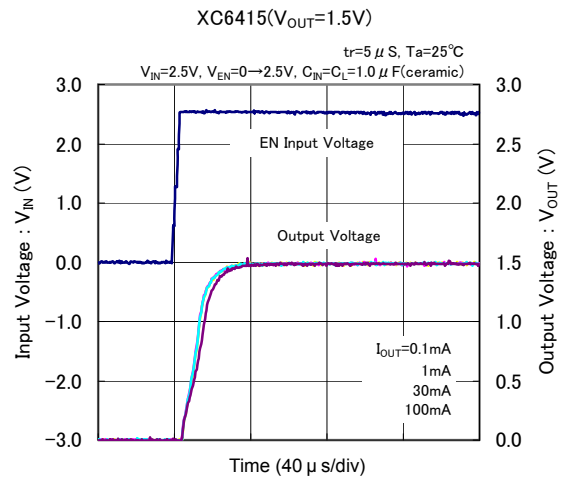
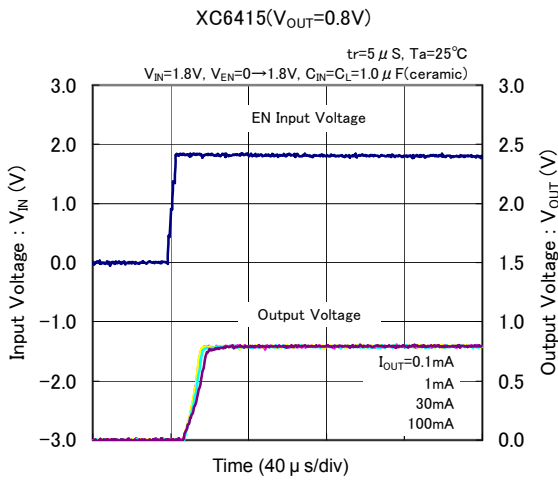


(10) Load Transient Response

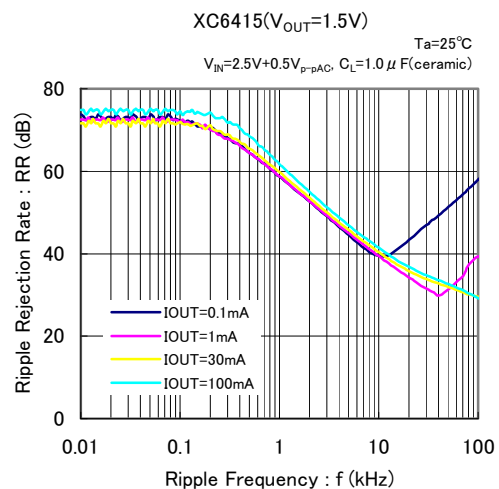
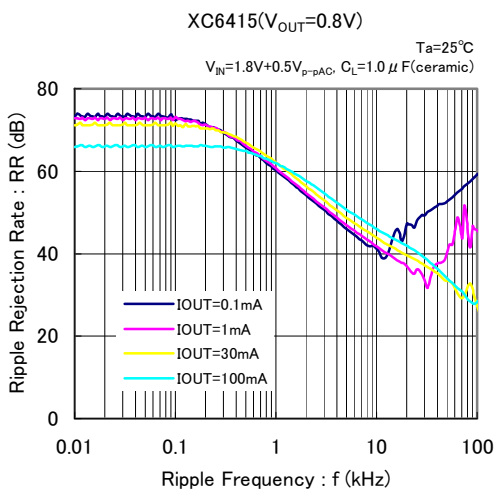


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(11) EN Rising Response Time

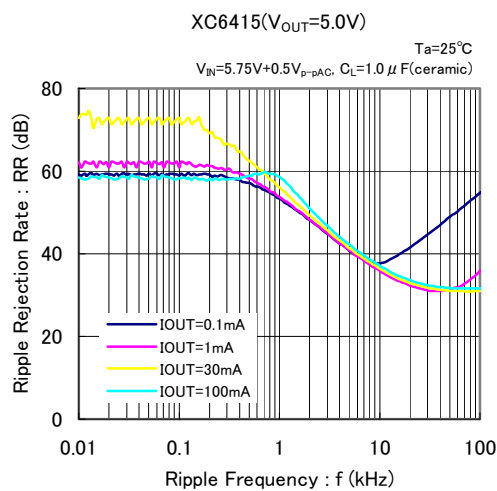
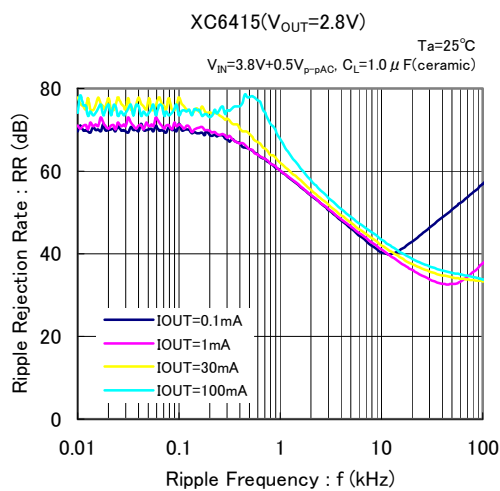


(12) Ripple Rejection Rate

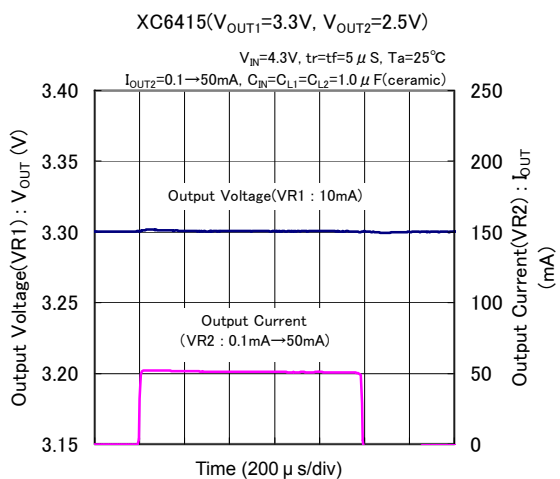


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(12) Ripple Rejection Rate

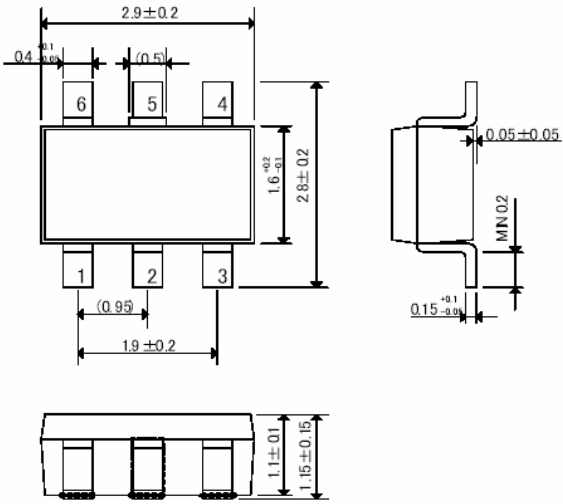


(13) Cross Talk

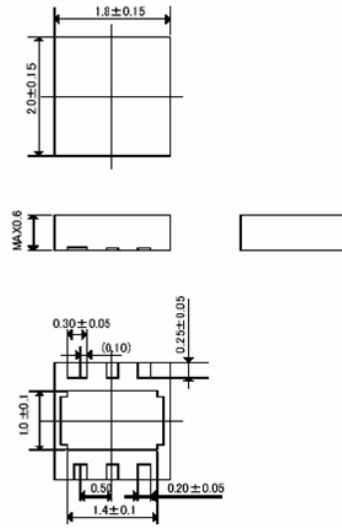


PACKAGING INFORMATION

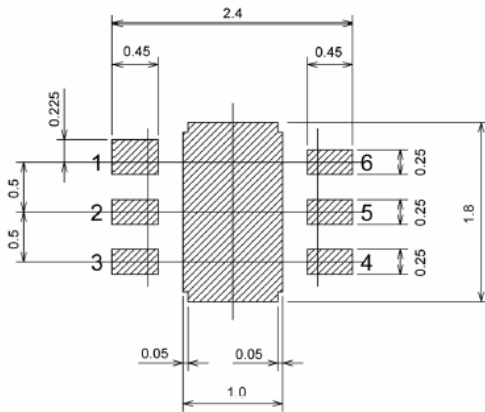
SOT-26



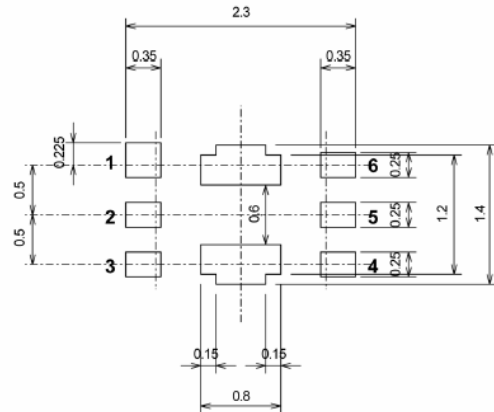
USP-6C



USP-6C Recommended Pattern Layout



USP-6C Recommended Metal Mask Design



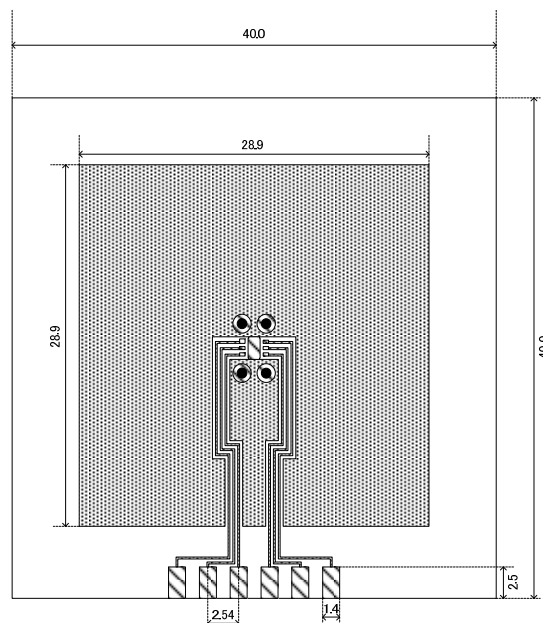
PACKAGING INFORMATION (Continued)

USP-6 Power Dissipation

Power dissipation data for the USP-6C 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 mm² 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

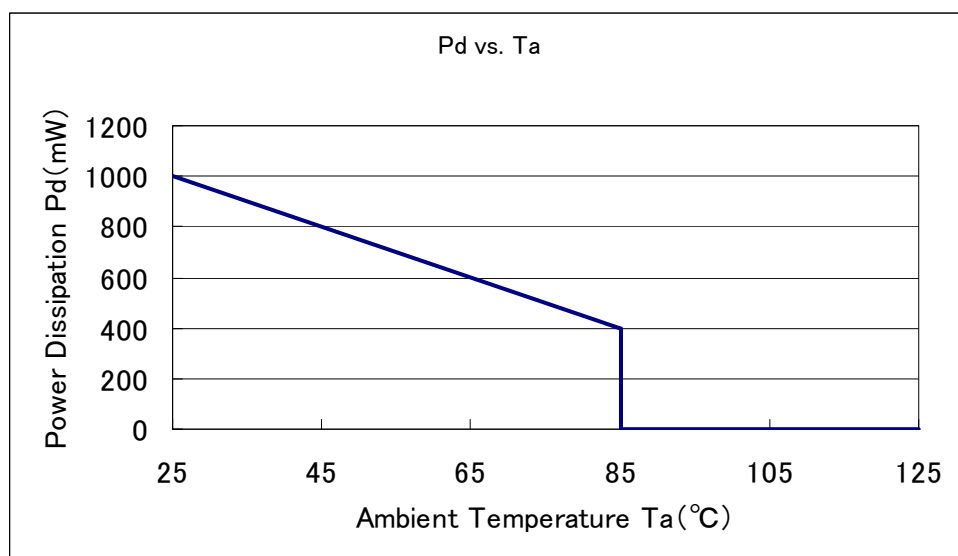


Evaluation Board (Unit: mm)

2. Power Dissipation vs. Operating temperature

Board Mount ($T_j \text{ max} = 125$)

Ambient Temperature (°C)	Power Dissipation Pd (mW)	Heat Resistance (°C/W)
25	1000	100
85	400	



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