XC6225 Series

30mA High Speed LDO Regulator

■GENERAL DESCRIPTION

The XC6225 series is a high accuracy, low noise, and low dropout CMOS LDO regulator. The series includes a reference voltage source, an error amplifier, a driver transistor, a current limiter, and a phase compensation circuit.
The CE function enables the entire circuit to be turned off by a low level input signal to the CE pin. In this stand-by state, the XC6225B series can discharge the electric charge stored at the output capacitor through the internal auto-discharge switch, and as a result the VOUT pin quickly returns to the VSS level. The output stabilization capacitor (CL) is also compatible with low ESR ceramic capacitors. Output voltage is selectable in 0.05V increments within a range of 0.8V~5.0V. The current limit fold-back circuit works as a short circuit protection as well as the output current limiter. The series achieves a fast response with only 25μA of low power consumption. The current limit is set to 50mA (TYP.) so that the device is optimized to protect the circuit from over-current. It is ideally suited for applications requiring 30 mA or less.
A small USP-4 package makes high density mounting possible.

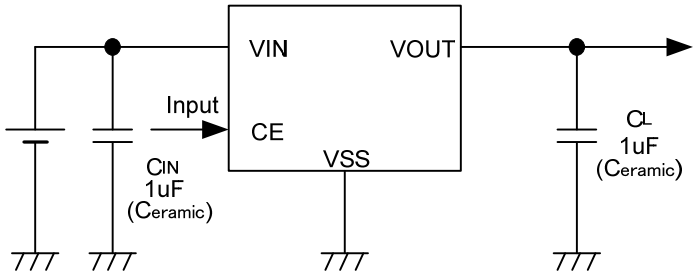
■APPLICATIONS

- Cellular phones
- Cordless phones, Wireless communication equipment
- Portable games
- Cameras, VCRs
- Portable AV equipment
- PDAs

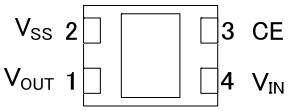
■FEATURES

Output Current	: 30mA <50mA (TYP.) Limit>
Dropout Voltage	: 70mV@ IOUT=30mA, VOUT=3.2V
Operating Voltage Range	: 2.5V ~ 6.0V
Output Voltage Range	: 0.8V~5.0V (0.05V increments)
Accuracy	: ±2% (VOUT≥1.5V) ±0.03V (VOUT≦1.45V)
Low Power Consumption	: 25μA (TYP.)
Stand-by Current	: Less than 0.1μA
High Ripple Rejection	: 70dB @ 1kHz
Operating Temperature Range	: -40℃~+85℃
Output Capacitor	: 1.0μF ceramic capacitor
CL High-Speed Auto-Discharge (XC6225B)	
Low Output Noise	
Packages	: USP-4, SOT-25 SSOT-24 (under development)
Environmentally Friendly	: EU RoHS Compliant, Pb Free

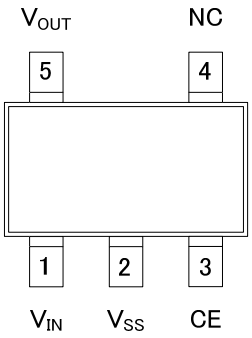
■TYPICAL APPLICATION CIRCUIT



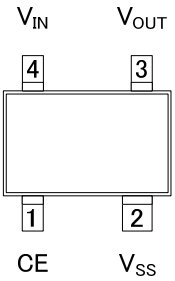
■PIN CONFIGURATION



USP−4
(BOTTOM VIEW)



SOT−25
(TOP VIEW)



SSOT−24 (under development)
(TOP VIEW)

*The heat sink pad of the USP-4 is recommended to be soldered to enhance the strength. Please refer to the reference mount pattern and metal mask pattern. This pad should be electrically opened or connected to the VSS (No.2) pin.

■PIN ASSIGNMENT

PIN NUMBER			PIN NAME	FUNCTIONS
USP-4	SOT-25	SSOT-24		
4	1	4	V_{IN}	Power Input
1	5	3	V_{OUT}	Output
2	2	2	V_{SS}	Ground
3	3	1	CE	ON/OFF Control
-	4	-	NC	No Connection

*SSOT-24 is under development.

■PRODUCT CLASSIFICATION

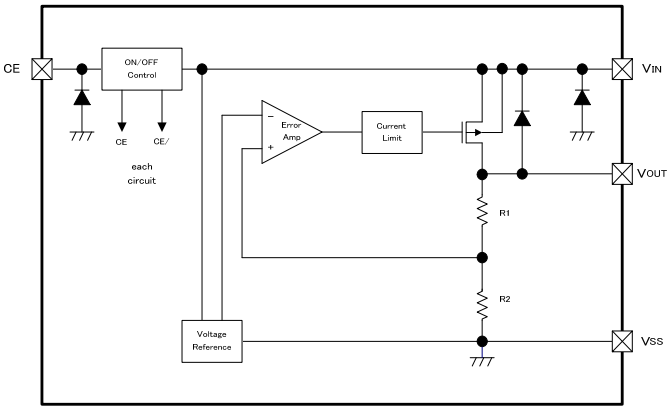
●Ordering Information

XC6225①②③④⑤⑥−⑦(*1)

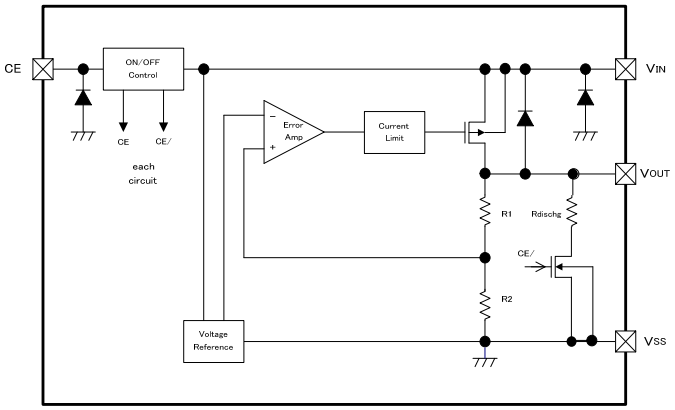
DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
①	Type of Regulator	A	CE High Active, Without C_L discharge function
		B	CE High Active, With C_L discharge function
② ③	Output Voltage	08～50	e.g. 3.0V → ①=3, ②=0
④	Output Voltage Accuracy	2	Output voltage is { x.x0V } (the 2nd decimal place is “0”) 2% ($V_{OUT(T)}$≧1.5V), Within ±0.03V ($V_{OUT(T)}$≦1.40V)
		A	Output voltage is { x.x5V } (the 2nd decimal place is “5”) ±2% (V_{OUT}≧1.55V), Within ±0.03V (V_{OUT}≦1.45V)
⑤⑥−⑦	Packages Taping Type (*2)	GR-G	USP-4
		MR-G	SOT-25
		NR-G	SSOT-24（under development）

(*1) The ”-G” suffix indicates that the products are Halogen and Antimony free as well as being fully RoHS compliant.
(*2) The device orientation is fixed in its embossed tape pocket.
For reverse orientation, please contact your local Torex sales office or representative.
(Standard orientation: ⑤R-⑦, Reverse orientation: ⑤L-⑦)

■BLOCK DIAGRAMS



●XC6225A Series



●XC6225B Series

*Diodes inside the circuit are an ESD protection diode and a parasitic diode.

■ABSOLUTE MAXIMUM RATINGS

Ta=25℃

PARAMETER		SYMBOL	RATINGS	UNITS
Input Voltage		V_{IN}	V_{SS}-0.3～+6.5	V
Output Current		I_{OUT}	400 (*1)	mA
Output Voltage		V_{OUT}	V_{SS}-0.3～V_{IN}+0.3	V
CE Input Voltage		V_{CE}	V_{SS}-0.3～+6.5	V
Power Dissipation	USP-4	Pd	120	mW
	SOT-25		250	
	SSOT-24		150	
Operating Temperature Range		Topr	-40～+85	℃
Storage Temperature Range		Tstg	-55～+125	℃

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

*SSOT-24 is under development.

■ELECTRICAL CHARACTERISTICS

●XC6225A/B Series

Ta=25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUIT
Output Voltage	$V_{OUT(E)}$ (*2)	$V_{OUT(T)} \geqq 1.50V$ $V_{CE}=V_{IN}$, $I_{OUT}=10mA$	×0.98 (*3)	$V_{OUT(T)}$ (*4)	×1.02 (*3)	V	①
		$V_{OUT(T)} \leqq 1.45V$ $V_{CE}=V_{IN}$, $I_{OUT}=10mA$	-0.03 (*3)		+0.03 (*3)		
Output Current	I_{OUTMAX}	$V_{CE}=V_{IN}$ $V_{IN}= V_{OUT(T)}+1.0V$ $1.5V \leqq V_{OUT(T)} \leqq 5.0V$	30	50	-	mA	①
		$V_{CE}=V_{IN}$ $V_{IN}=2.5V$ $0.8V \leqq V_{OUT(T)} \leqq 1.45V$					
Load Regulation	ΔV_{OUT}	$V_{CE}=V_{IN}$ $0.1mA \leqq I_{OUT} \leqq 30mA$	-	5	12	mV	①
Dropout Voltage (*5)	Vdif	$I_{OUT}=30mA$, $V_{CE}=V_{IN}$	DROPOUT VOLTAGE CHART			mV	①
Supply Current	I_{SS}	$V_{IN}=V_{OUT}+1.0V$, $I_{OUT}=0mA$	-	25	50	μA	②
Stand-by Current	I_{STBY}	$V_{IN}=6.0V$, $V_{CE}=V_{SS}$	-	0.01	0.1	μA	②
Line Regulation	$\Delta V_{OUT}/(\Delta V_{IN} \cdot V_{OUT})$	$V_{OUT(T)}+0.5V \leqq V_{IN} \leqq 6.0V$ $V_{OUT(T)} \geqq 2.0V$, $V_{CE}=V_{IN}$, $I_{OUT}=10mA$	-	0.01	0.20	%/V	①
		$2.5V \leqq V_{IN} \leqq 6.0V$ $V_{OUT(T)} \leqq 1.95V$ $V_{CE}=V_{IN}$, $I_{OUT}=10mA$					
Input Voltage	V_{IN}		2.5	-	6.0	V	①
Output Voltage Temperature Characteristics	$\Delta V_{OUT}/(\Delta Ta \cdot V_{OUT})$	$V_{CE}=V_{IN}$, $I_{OUT}=30mA$ $-40℃ \leqq Ta \leqq 85℃$	-	±100	-	ppm/℃	①

■ELECTRICAL CHARACTERISTICS (Continued)

●XC6225A/B Series (Continued)

Ta=25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUIT
Ripple Rejection Rate	PSRR	V_{IN}=5.75V_{DC}+0.5Vp-pAC 5.0V≧$V_{OUT(T)}$≧4.8V V_{CE}=V_{IN}, I_{OUT}=30mA, f=1kHz	-	60	-	dB	③
		V_{IN}={$V_{OUT(T)}$+1.0}V_{DC}+0.5Vp-pAC 4.75V≧$V_{OUT(T)}$≧4.05V V_{CE}=V_{IN}, I_{OUT}=30mA, f=1kHz					
		V_{IN}={$V_{OUT(T)}$+1.0}VDC+0.5Vp-pAC 4.0V≧$V_{OUT(T)}$≧1.75V V_{CE}=V_{IN}, I_{OUT}=30mA, f=1kHz	-	70	-		
		V_{IN}=2.75V_{DC}+0.5Vp-pAC 1.7V≧$V_{OUT(T)}$≧0.8V V_{CE}=V_{IN}, I_{OUT}=30mA, f=1kHz					
Limit Current1(*9)	I_{LIM1}	V_{IN}=6.0V, V_{CE}=V_{IN} 5.0V≧$V_{OUT(T)}$≧0.8V	30	50	70	mA	①
Limit Current2(*9, *10)	$I_{LIM\ 2}$	V_{IN}=$V_{OUT(T)}$+1.0V, V_{CE}=V_{IN} 5.0V≧$V_{OUT(T)}$≧1.5V	30	50	70		
		V_{IN}=2.5V 1.45V≧$V_{OUT(T)}$≧0.8V					
Limit Current3(*9, *10)	$I_{LIM\ 3}$	V_{IN}=$V_{OUT(T)}$+0.1V 5.0V≧$V_{OUT(T)}$≧2.4V	-	50	70		
		V_{IN}=2.5V 2.35V≧$V_{OUT(T)}$≧1.55V					
Short Current	I_{SHORT}	V_{CE}=V_{IN} VOUT is short-circuited at the VSS level	-	15	-	mA	①
CE High Level Voltage	V_{CEH}		1.2	-	6.0	V	④
CE Low Level Voltage	V_{CEL}		-	-	0.3	V	④
CE High Level Current	I_{CEH}	V_{CE}=V_{IN}	-0.1	-	0.1	μA	④
CE Low Level Current	I_{CEL}	V_{CE}=V_{SS}	-0.1	-	0.1	μA	④
CL Auto-Discharge Resistance (*8)	R_{DCHG}	V_{IN}=6.0V, V_{OUT}=4.0V, V_{CE}= V_{SS}	-	780	-	Ω	①

NOTE:

* 1: Unless otherwise stated regarding input voltage conditions, 1.5V≦$V_{OUT(T)}$≦5.0V is V_{IN}=$V_{OUT(T)}$+1.0V, and 0.8V≦$V_{OUT(T)}$≦1.45V is V_{IN}=2.5V.
* 2: $V_{OUT\ (E)}$ = Effective output voltage (Refer to the voltage chart)
  (I.e. the output voltage when stabilized "$V_{OUT\ (T)}$ +1.0V" is provided at the V_{IN} pin while maintaining a certain I_{OUT} value.)
* 3: The output voltage $V_{OUT\ (E)}$ is shown in the voltage chart.
* 4: $V_{OUT\ (T)}$ = Nominal output voltage
* 5: Vdif ={V_{IN1}(*7)-V_{OUT1}(*6)}
* 6: V_{OUT1}=A voltage equal to 98% of the output voltage when an amply stabilized {$V_{OUT\ (T)}$ +1.0V} is input.
* 7: V_{IN1}= The input voltage when V_{OUT1} appears at the V_{OUT} pin while input voltage is gradually decreased.
* 8: For the XC6225B series only. The XC6225A series discharges by using the two resistors R1 and R2 shown in the block diagram.
*9: Limit current is defined as the output current when $V_{OUT(E)}$ x 0.95 is impressed at the V_{OUT} pin.
*10: The device may not satisfy the specification values when it is used with the input voltages lower than the conditions of I_{LIM2}(1.45V≧$V_{OUT(T)}$≧0.8V) and I_{LIM3}.

■OUTPUT VOLTAGE CHART

●Voltage Table1

NOMINAL OUTPUT VOLTAGE (V)	OUTPUT VOLTAGE ±2% (V)		DROPOUT VOLTAGE Vdif (mV)	
	$V_{OUT(E)}$		Vdif	
$V_{OUT(T)}$	MIN.	MAX.	TYP.	MAX.
0.80	0.7700	0.8300	325	1700
0.85	0.8200	0.8800		1650
0.90	0.8700	0.9300	235	1600
0.95	0.9200	0.9800		1550
1.00	0.9700	1.0300	160	1500
1.05	1.0200	1.0800		1450
1.10	1.0700	1.1300	115	1400
1.15	1.1200	1.1800		1350
1.20	1.1700	1.2300	85	1300
1.25	1.2200	1.2800		1250
1.30	1.2700	1.3300		1200
1.35	1.3200	1.3800		1150
1.40	1.3700	1.4300		1100
1.45	1.4200	1.4800		1050
1.50	1.4700	1.5300	50	1000
1.55	1.5190	1.5810		950
1.60	1.5680	1.6320		900
1.65	1.6170	1.6830		850
1.70	1.6660	1.7340		800
1.75	1.7150	1.7850		750
1.80	1.7640	1.8360	40	700
1.85	1.8130	1.8870		650
1.90	1.8620	1.9380		600
1.95	1.9110	1.9890		550
2.00	1.9600	2.0400		500
2.05	2.0090	2.0910		450
2.10	2.0580	2.1420		400
2.15	2.1070	2.1930		350
2.20	2.1560	2.2440		300
2.25	2.2050	2.2950		250
2.30	2.2540	2.3460		200
2.35	2.3030	2.3970		150
2.40	2.3520	2.4480	120	
2.45	2.4010	2.4990		
2.50	2.4500	2.5500	70	
2.55	2.4990	2.6010		
2.60	2.5480	2.6520		
2.65	2.5970	2.7030		
2.70	2.6460	2.7540		
2.75	2.6950	2.8050		
2.80	2.7440	2.8560		
2.85	2.7930	2.9070		
2.90	2.8420	2.9580		
2.95	2.8910	3.0090		

■OUTPUT VOLTAGE CHART (Continued)

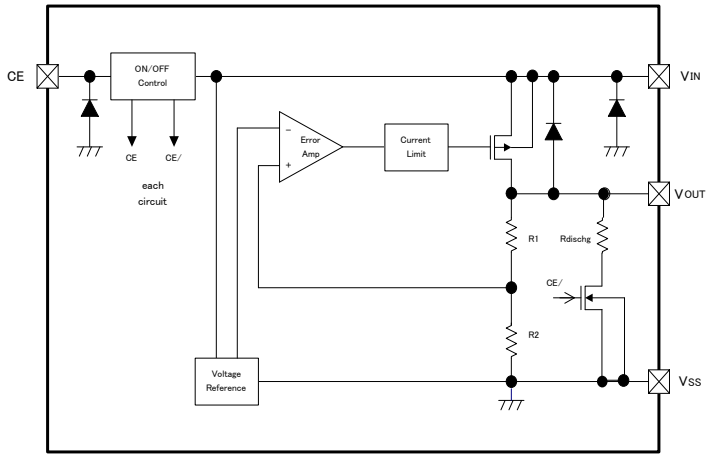
●Voltage Table2

NOMINAL OUTPUT VOLTAGE (V)	OUTPUT VOLTAGE ±2% (V)		DROPOUT VOLTAGE Vdif (mV)	
	$V_{OUT(E)}$		Vdif	
$V_{OUT(T)}$	MIN.	MAX.	TYP.	MAX.
3.00	2.9400	3.0600	70	120
3.05	2.9890	3.1110		
3.10	3.0380	3.1620		
3.15	3.0870	3.2130		
3.20	3.1360	3.2640		
3.25	3.1850	3.3150	95	170
3.30	3.2340	3.3660		
3.35	3.2830	3.4170		
3.40	3.3320	3.4680		
3.45	3.3810	3.5190		
3.50	3.4300	3.5700		
3.55	3.4790	3.6210		
3.60	3.5280	3.6720		
3.65	3.5770	3.7230		
3.70	3.6260	3.7740		
3.75	3.6750	3.8250		
3.80	3.7240	3.8760		
3.85	3.7730	3.9270		
3.90	3.8220	3.9780		
3.95	3.8710	4.0290		
4.00	3.9200	4.0800		
4.05	3.9690	4.1310		
4.10	4.0180	4.1820		
4.15	4.0670	4.2330		
4.20	4.1160	4.2840		
4.25	4.1650	4.3350		
4.30	4.2140	4.3860		
4.35	4.2630	4.4370		
4.40	4.3120	4.4880		
4.45	4.3610	4.5390		
4.50	4.4100	4.5900		
4.55	4.4590	4.6410		
4.60	4.5080	4.6920		
4.65	4.5570	4.7430		
4.70	4.6060	4.7940		
4.75	4.6550	4.8450		
4.80	4.7040	4.8960		
4.85	4.7530	4.9470		
4.90	4.8020	4.9980		
4.95	4.8510	5.0490		
5.00	4.9000	5.1000		

■OPERATIONAL EXPLANATION

The voltage divided by resistors R1 & R2 is compared with the internal reference voltage by the error amplifier. The P-channel MOSFET connected to the VOUT pin, is then driven by the subsequent output signal. The output voltage at the VOUT pin is controlled and stabilized by a system of negative feedback. The current limit circuit and short-circuit protection circuit operate in relation to the level of output current. Further, the IC's entire circuitry is turned off by the input signal to the CE pin.

●BLOCK DIAGRAM



<Input and Output Capacitors>
The XC6225 needs an output capacitor C_L for phase compensation. Values required for the phase compensation are shown in the chart below. If a loss of the capacitance happens, the stable phase compensation may not be obtained. Please ensure to use a capacitor which does not depend on bias or temperature too much. 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.

OUTPUT VOLTAGE	OUTPUT CAPACITOR
0.8V～1.15V	C_L=4.7μF
1.2V～1.35V	C_L=2.2μF
1.4V～4.0V	C_L=1.0μF
4.05V～5.0V	C_L=2.2μF

<C_L Auto-Discharge Function>
XC6225B series can discharge the electric charge in the output capacitor (CL), when a low signal to the CE pin, which enables the whole IC circuit to be turned off, is inputted via the N-channel transistor located between the VOUT pin and the VSS pin (refer to BLOCK DIAGRAM). The C_L auto-discharge resistance value is set at 780Ω (VOUT=4.0V @ VIN=6.0V at TYP.). The discharge time of the output capacitor (CL) is set by the C_L auto-discharge resistance (R) and the output capacitor (CL). By setting the time constant of the CL auto-discharge resistance value [R_{DCHG}] and the output capacitor value (CL) as τ (τ =C x R_{DCHG}), the output voltage after discharge via the N-channel transistor is calculated by the following formula.

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

Where
V: Output voltage after discharge
$V_{OUT (E)}$: Output voltage
t : Discharge time,
τ : C_L auto-discharge resistance R_{DCHG} ×Output capacitor (C_L) value C

■OPERATIONAL EXPLANATION (Continued)

<Current Limiter, Short-Circuit Protection>
The XC6225 series' fold-back circuit operates as an output current limiter and a short protection circuit for the output pin. When the load current reaches the current limit level, the fixed current limiter circuit operates and output voltage drops. When the output pin is short-circuited to the V_{SS} pin, the current falls and reaches about 15mA.

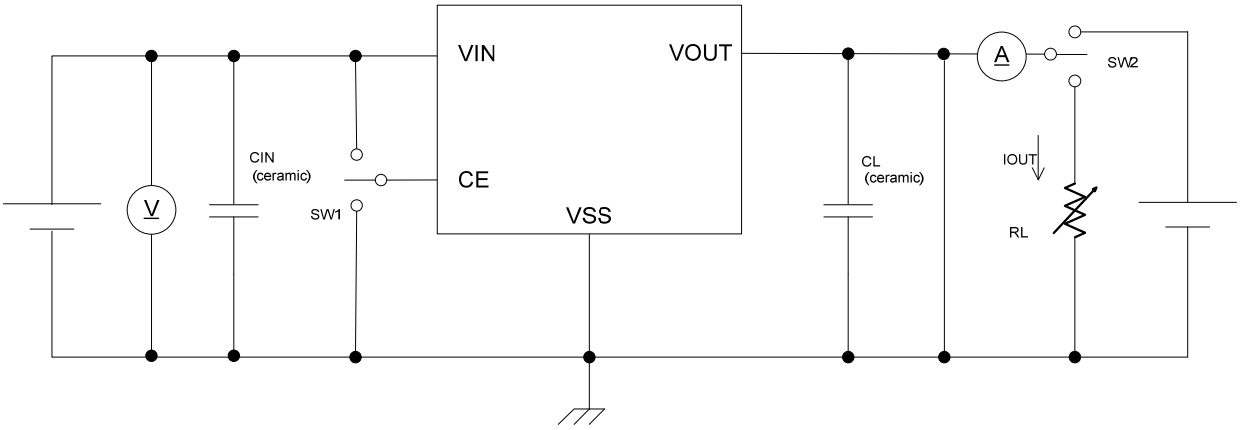
<CE Pin>
The IC's internal circuitry can be shutdown via the signal from the CE pin with the XC6225 series. In the shutdown state, output at the V_{OUT} pin will be pulled down to the V_{SS} level via R1 & R2. However, with the XC6225B series, the C_L auto-discharge resistor is connected in parallel to R1 and R2 while the power supply is applied to the V_{IN} pin. Therefore, time until the V_{OUT} pin reaches the V_{SS} level is shorter.
The output voltage is in an undefined state when the CE pin is left open. If this IC is used with the correct voltage for the CE pin, the logic is fixed and the IC will operate normally. However, the supply current may increase as a result of shoot-through current in the IC's internal circuitry when a medium voltage is input.

■NOTES ON USE

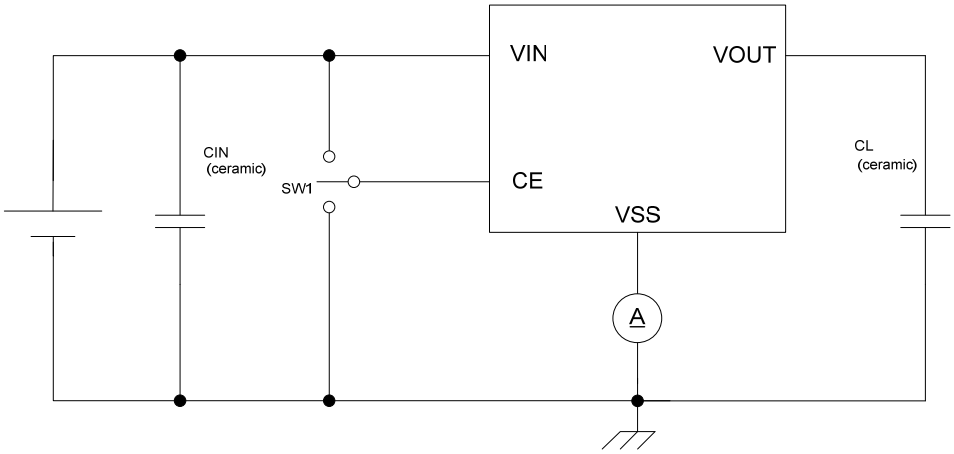
1. Please use this IC within the stated absolute maximum ratings. The IC is liable to malfunction should the ratings be exceeded.
2. Where wiring impedance is high, operations may become unstable due to noise and/or phase lag depending on output current. Please wire the input capacitor (C_{IN}) and the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

■TEST CIRCUITS

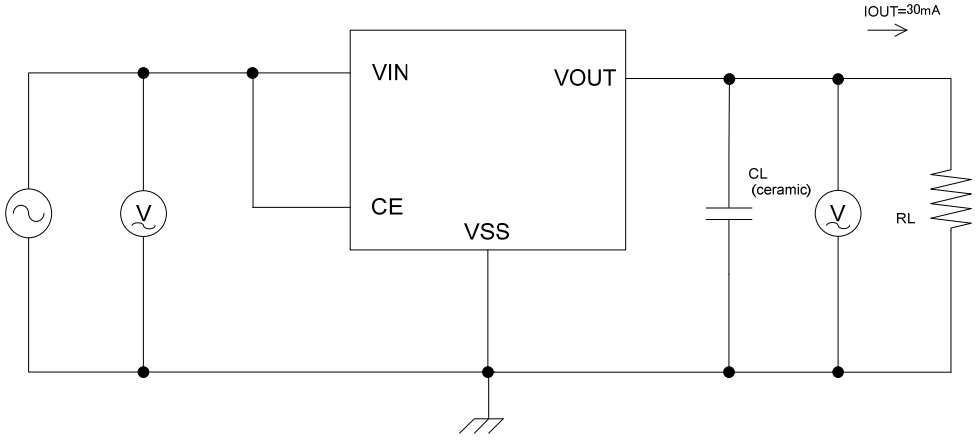
●Circuit①: Output Voltage, Output Current, Dropout Voltage, Line Regulation, Load Regulation, Current Limit, Short Current, C_L Discharge Resistance



●Circuit②: Supply Current, Stand-by Current

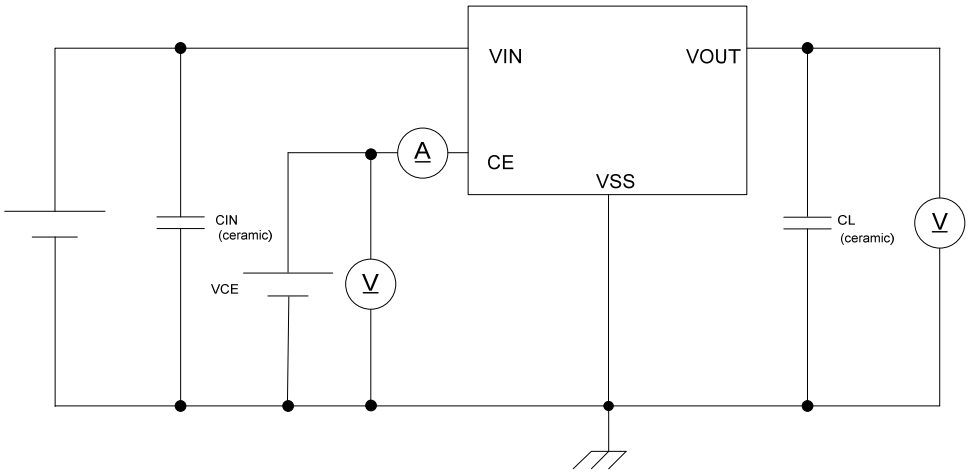


●Circuit③: Ripple Rejection Rate



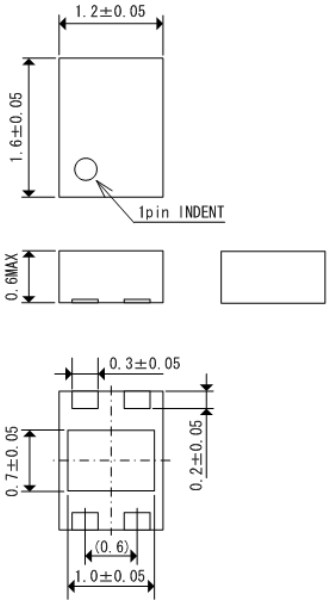
■TEST CIRCUITS (Continued)

●Circuit④: CE “High” “Low” Level Voltage, CE “High” “Low” Level Current

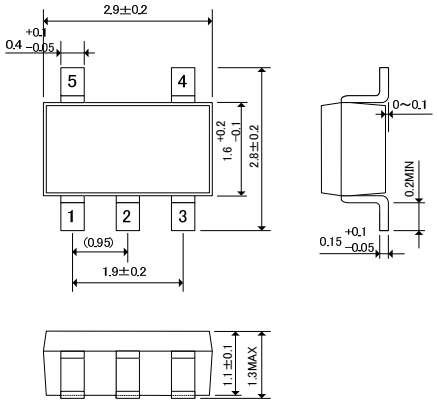


■PACKAGING INFORMATION

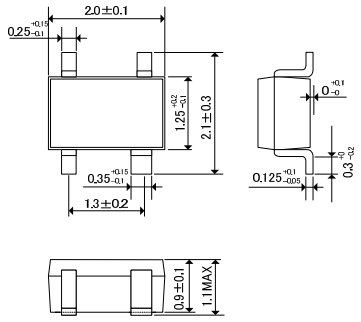
●USP-4 (unit: mm)



●SOT-25 (unit: mm)

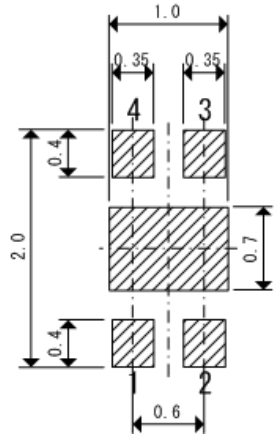


●SSOT-24 (unit: mm)
(under development)

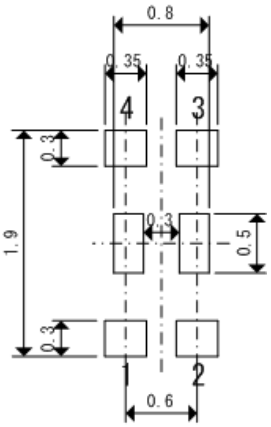


■PACKAGING INFORMATION (Continued)

●USP-4 Reference Pattern Layout



●USP-4 Reference Metal Mask Design



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