XC6415 Series

ETR0332-002

Dual LDO Regulators with ON/OFF Switch

Preliminary

■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

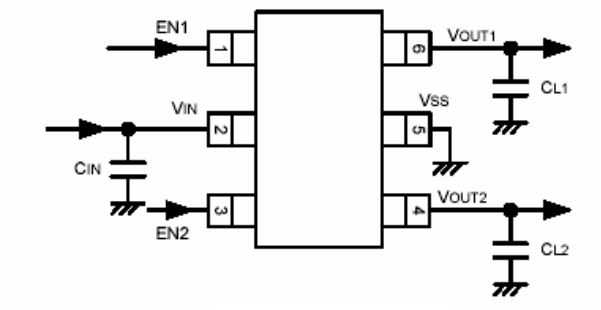
- Mobile phones
- Cordless phones, Wireless communication equipment
- Portable games
- Digital still cameras, Digital video cameras
- Portable audio equipment
- PDAs

■FEATURES

Output Current	: 200mA (300mA limit, TYP.)
Dropout Voltage	: 90mV @ 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	: ± 1% @ V_{OUT}>2.0V ± 20mV @$V_{OUT}\leq$2.0V
Low Power Consumption	: 28μA/ch (TYP.)
Stand-by Current	: Less than 0.1μA
Ripple Rejection	: 65dB@1kHz
Operating Temperature Range	: - 40°C ~ 85°C
Low ESR Capacitor	: 1.0μF ceramic capacitor compatible
Small Packages	: USP-6C, SOT-26

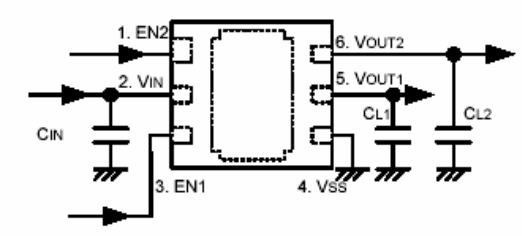
■TYPICAL APPLICATION CIRCUITS

●SOT-26



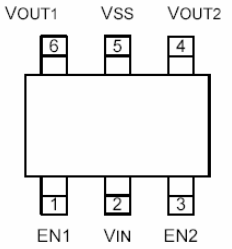
SOT-26
(TOP VIEW)

●USP-6C

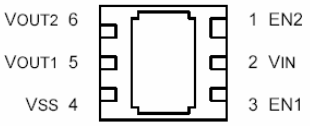


USP-6C
(TOP VIEW)

■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, if 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

XC6415①②③④⑤⑥

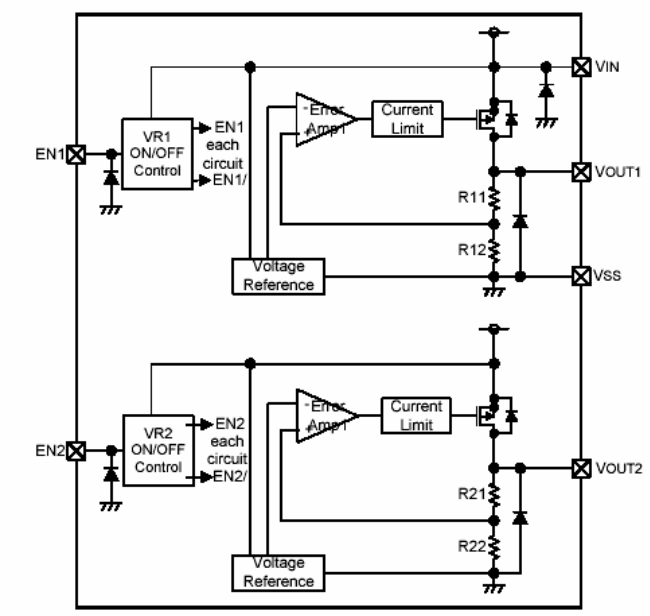
DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTON
①	Type of Regulator 1	A	: EN High Active without C_L discharge resistor
		B	: EN High Active with C_L discharge resistor
②	Type of Regulator 2	A	: EN High Active without C_L discharge resistor
		B	: EN High Active with C_L discharge resistor
③④	Output Voltage	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

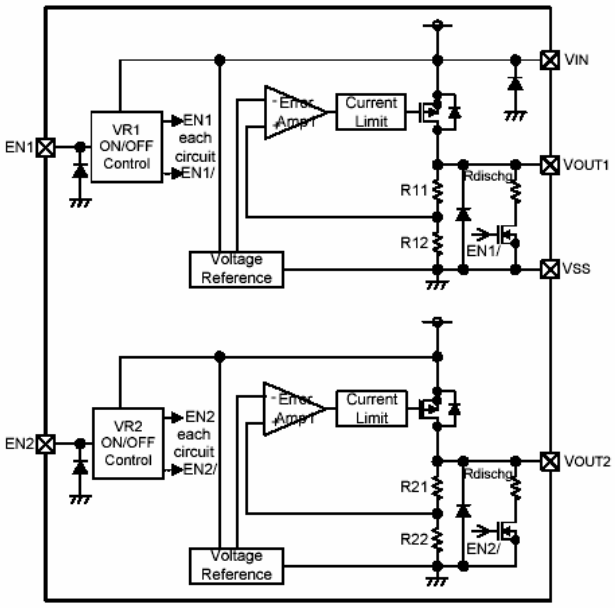
③④	VR1	VR2	③④	VR1	VR2	③④	VR1	VR2
01	1.80	2.80	11	1.30	1.50	21	1.50	2.80
02	1.20	2.90	12	2.80	2.80	22	1.80	3.00
03	1.80	1.80	13	2.50	3.30	23	1.85	2.80
04	1.50	2.70	14	3.00	3.30	24	1.85	3.30
05	2.85	2.85	15	1.20	1.80	25	2.60	2.80
06	1.80	3.30	16	2.80	3.30	26	-	-
07	3.00	3.00	17	3.30	3.30	27	-	-
08	2.80	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 ~ V_{IN} + 0.3	V
EN1/EN2 Input Voltage		V_{EN1} / V_{EN2}	V_{SS} - 0.3 ~ + 6.5	V
Power Dissipation	USP-6C	Pd	100	mW
	SOT-25		250	
Operating Temperature Range		Topr	- 40 ~ + 85	°C
Storage Temperature Range		Tstg	- 55 ~ + 125	°C

* I_{OUT}=Pd / (V_{IN} – V_{OUT})

■ELECTRICAL CHARACTERISTICS

● XC6415 Series

Regulator 1, Regulator 2

Ta=25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUITS
Output Voltage	$V_{OUT(E)}$ (*2)	$V_{OUT(T)} \geqq 2.0V$, $V_{EN}=V_{IN}$, $I_{OUT}=10mA$	×0.99 (*3)	$V_{OUT(T)}$ (*4)	×1.01 (*3)	V	①
		$V_{OUT} \leqq 1.95V$, $V_{EN}=V_{IN}$, $I_{OUT}=10mA$	-0.02 (*3)		+0.02 (*3)		
Output Current	I_{OUTMAX}		200	-	-	mA	①
Load Regulation	ΔV_{OUT}	$V_{EN}=V_{IN}$, 0.1mA≦I_{OUT}≦100mA	-	15	-	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	-	μA	②
Stand-by Current	I_{STBY}	V_{IN}=6.0V, $V_{EN}=V_{SS}$	-	0.01	0.10	μA	②
Line Regulation	$\frac{\Delta V_{OUT}}{\Delta V_{IN} \cdot V_{OUT}}$	$V_{OUT(T)}+0.5V \leqq V_{IN} \leqq 6.0V$: $V_{OUT(T)} \geqq 1.0V$, $V_{EN}=V_{IN}$, I_{OUT}=10mA	-	0.01	0.20	%/V	①
		1.5V≦V_{IN}≦6.0V : $V_{OUT(T)} \leqq 0.95V$, $V_{EN}=V_{IN}$, 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℃≦Ta≦85℃	-	±100	-	ppm/℃	①
Ripple Rejection Rate	PSRR	$V_{IN}=\{V_{OUT(T)}+1.0\}V_{DC}+0.5Vp\text{-}pAC$: $V_{OUT(T)} \leqq 4.75V$, $V_{EN}=V_{IN}$, I_{OUT}=30mA, f=1kHz	-	65	-	dB	③
		$V_{IN}=5.75V_{DC}+0.5Vp\text{-}pAC$: $V_{OUT(T)} \geqq 4.8V$, $V_{EN}=V_{IN}$, I_{OUT}=30mA, f=1kHz					
Limit Current	Ilim	$V_{EN}=V_{IN}$	200	300	-	mA	①
Short Current	Ishort	$V_{EN}=V_{IN}$, Short V_{OUT} to V_{SS} level	-	30	-	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)	Rdischg	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: Vdif={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.

■ELECTRICAL CHARACTERISTICS (Continued)

●Voltage Chart

	E-1		E-2	
SETTING OUTPUT VOLTAGE (V)	OUTPUT VOLTAGE (V)		DROPOUT VOLTAGE (mV)	
	$V_{OUT(E)}$		Vdif	
$V_{OUT(T)}$	MIN.	MAX.	TYP.	MAX.
0.80	0.7800	0.8200	580	-
0.85	0.8300	0.8700		
0.90	0.8800	0.9200	490	-
0.95	0.9300	0.9700		
1.00	0.9800	1.0200	400	-
1.05	1.0300	1.0700		
1.10	1.0800	1.1200	↑	-
1.15	1.1300	1.1700		
1.20	1.1800	1.2200	320	-
1.25	1.2300	1.2700		
1.30	1.2800	1.3200	↑	-
1.35	1.3300	1.3700		
1.40	1.3800	1.4200	240	-
1.45	1.4300	1.4700		
1.50	1.4800	1.5200	180	-
1.55	1.5300	1.5700		
1.60	1.5800	1.6200	↑	-
1.65	1.6300	1.6700		
1.70	1.6800	1.7200	↑	-
1.75	1.7300	1.7700		
1.80	1.7800	1.8200	150	-
1.85	1.8300	1.8700		
1.90	1.8800	1.9200	↑	-
1.95	1.9300	1.9700		
2.00	1.9800	2.0200	130	-
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	95	-
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		
2.80	2.7720	2.8280		
2.85	2.8215	2.8785		
2.90	2.8710	2.9290		
2.95	2.9205	2.9795		

■ELECTRICAL CHARACTERISTICS (Continued)

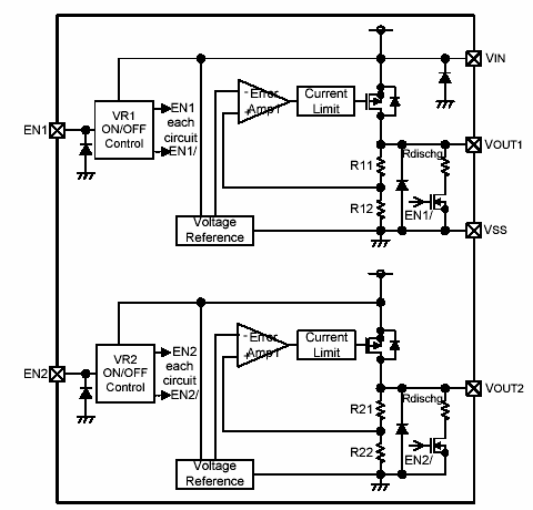
●Voltage Chart (Continued)

	E-1		E-2	
SETTING OUTPUT VOLTAGE (V)	OUTPUT VOLTAGE (V)		DROPOUT VOLTAGE (mV)	
	$V_{OUT(E)}$		Vdif	
$V_{OUT(T)}$	MIN.	MAX.	TYP.	MAX.
3.00	2.9700	3.0300		
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	90	-
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 DESCRIPTION

<Output Voltage Control>

The voltage divided by resistors Rx1 & Rx2 is compared with the internal reference voltage by the error amplifier. The P-channel MOSFET, which is connected to the VOUT pin, is then driven by the subsequent output signal. The output voltage at the VOUT pin is controlled & 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 (CL), 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 VOUT pin and the VSS pin (cf. BLOCK DIAGRAM). The C_L discharge resistance is set to 780Ω when V_{IN} is 6.0V (TYP.) and V_{OUT} is 4.0V (TYP.). Moreover, discharge time of the output capacitor (CL) is set by the C_L auto-discharge resistance (R) and the output capacitor (CL). By setting time constant of a CL auto-discharge resistance value [R] and an output capacitor value (CL) as τ (τ =C x R), the output voltage after discharge via the N channel transistor is calculated by the following formulas.

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

(V : Output voltage after discharge, VOUT(E) : Output voltage, t: Discharge time,
τ : CL auto-discharge resistance R×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>

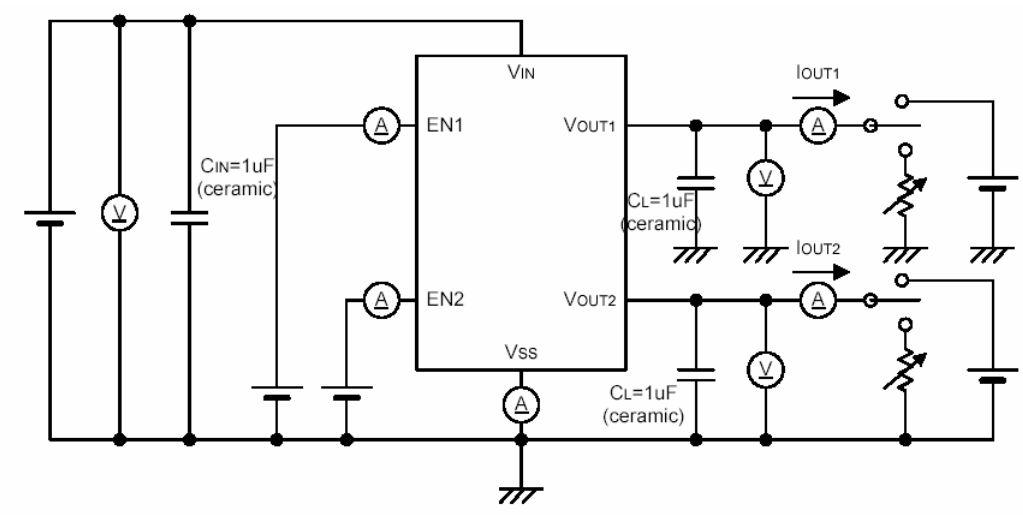
The IC's internal circuitry can be shutdown via the signal from the EN pin with the XC6415 series. In shutdown mode, output at the VOUT pin will be pulled down to the VSS level via Rx1 & Rx2. However, as for the XC6415xB/Bx series, the CL auto-discharge resistor is connected in parallel to Rx1 and Rx2 while the power supply is applied to the VIN pin. Therefore, time until the VOUT pin reaches the VSS 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

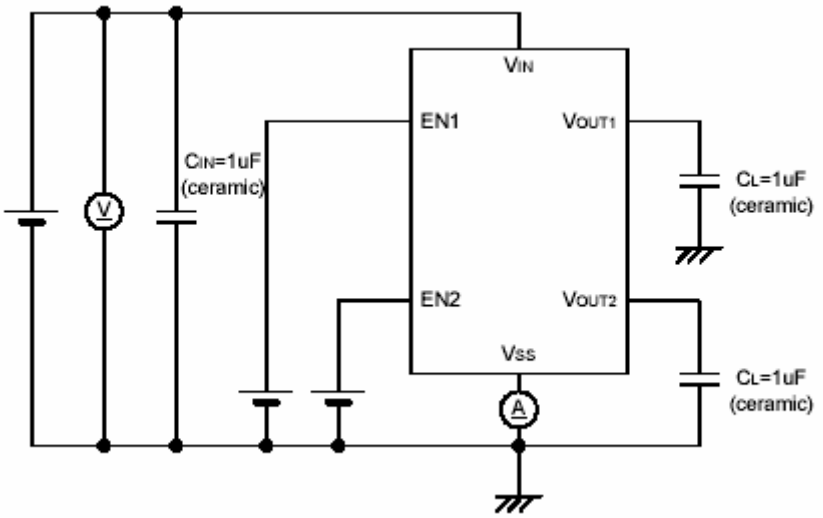
1. Please use this IC within the stated absolute maximum ratings. The IC is liable to malfunction should the ratings be exceeded.
2. Where wiring impedance is high, operations may become unstable due to noise and/or phase lag depending on output current. Please wire the input capacitor (CIN) and the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

■TEST CIRCUITS

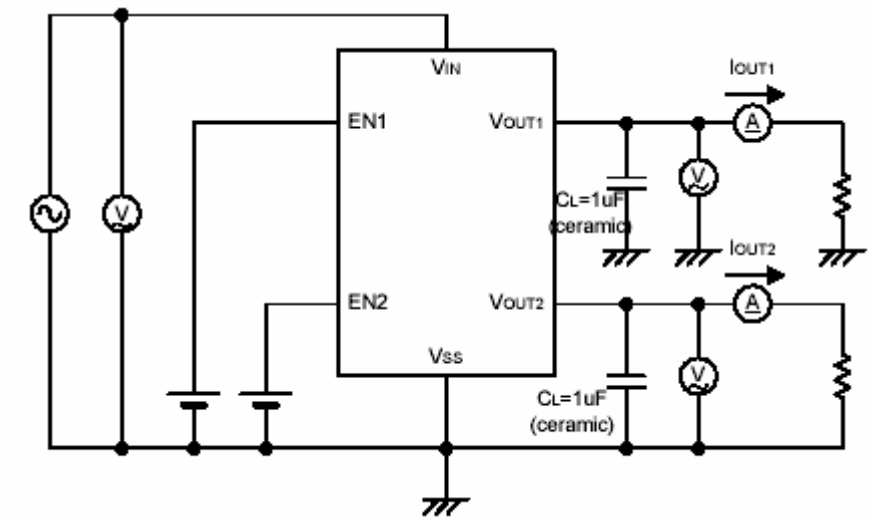
●Circuit ①



●Circuit ②

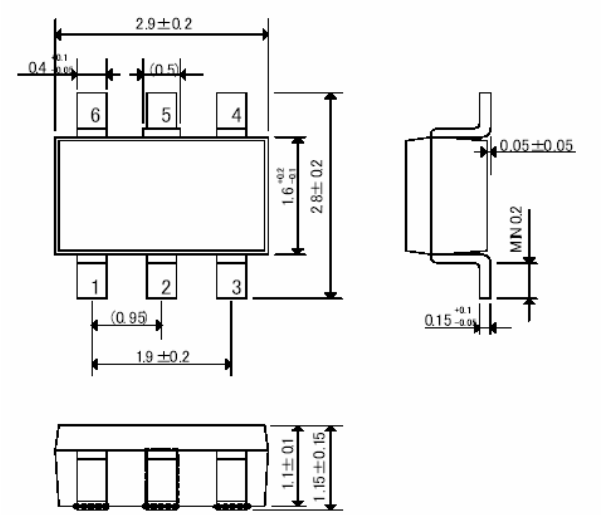


●Circuit ③

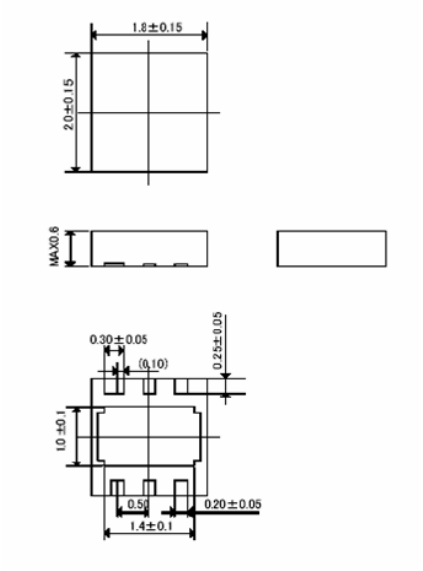


■PACKAGING INFORMATION

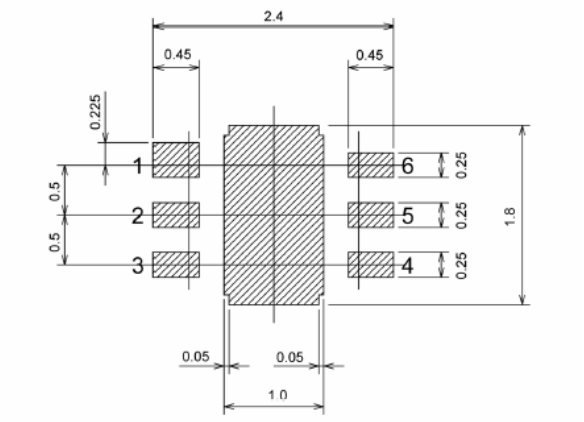
●SOT-26



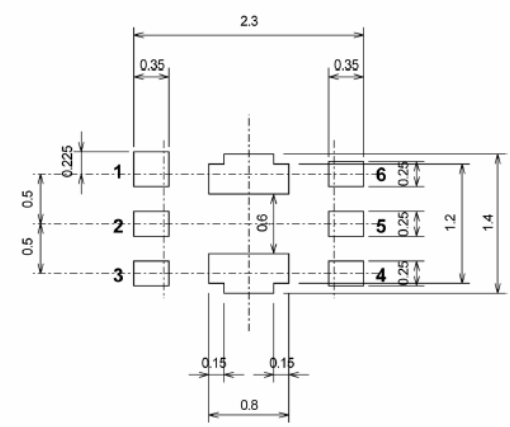
●USP-6C



●USP-6C Recommended Pattern Layout



●USP-6C Recommended Metal Mask Design



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