High Ripple-Rejection Low Dropout Low Input-And-Output Capacitance CMOS Voltage Regulator

■ General Description

The LN5001 series is a set of three-terminal middle current low voltage regulator implemented in CMOS technology. They can deliver 30mA output current and allow an input voltage as high as 15V. They are available with several fixed output voltages ranging from 3.0V to 8.0V. CMOS technology ensures low voltage drop and low quiescent current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain variable voltages and currents.

■ Applications

- Power supply for battery-powered devices
- Power supply for personal communication devices
- Power supply for home electric/electronic appliances
- Power supply for cellular phones

■ Features

- Output voltage: 1.5 V to 5.5 V, selectable in 0.1 V steps.
- Low ESR capacitor can be used: A ceramic capacitor of 0.1μF or more can be used for the output capacitor.
- Wide input voltage range: 2.0 V to 15.0 V
- High-accuracy output voltage: ±1.0%
- Low dropout voltage:140mV typ. (3.0V output product, IOUT = 100 mA)
- Low current consumption: During operation:18μA typ., 40 μA max.
- During shutdown: 0.01 μA typ., 1.0 μA max.
- Output current: 150 mA output is possible (@ VIN ⩾ VOUT(S) + 1.0 V)
- High ripple rejection:
  70 dB typ. (@ 1.0 kHz, 1.5 V ⩽ VOUT ⩽ 3.0 V)
  65 dB typ. (@ 1.0 kHz, 3.1 V ⩽ VOUT ⩽ 5.5 V)
- Built-in overcurrent protector: Overcurrent of output transistor can be restricted.
- Built-in ON/OFF circuit: Ensures long battery life.

■ Package

- SOT-23-5L

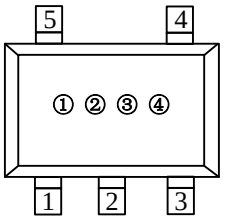
■ Ordering Information

LN5001 ①②③④⑤

Designator	Symbol	Description
①②	Integer	Output Voltage: e.g. ① =3, ② =0 ➪ 3.0V
③	2	Accuracy: within ±2%
④	M	SOT-23-5L
⑤	R	Embossed Tape: Standard Feed
	L	Embossed Tape: Reverse Feed

■ Marking Rule

- SOT-23-5L



SOT-23-5L

① Represents the product name

Symbol	Product Name
S	LN5001◆◆◆◆◆

② Represents the range of output voltage

Output Voltage Range（V）	0.1～3.0	3.1～6.0	6.1～9.0
Symbol	5	6	7

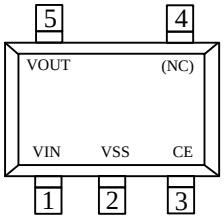
③ Represents the Output Voltage

Symbol	Output Voltage（V）			Symbol	Output Voltage（V）		
0	-	3.1	-	F	1.6	4.6	-
1	-	3.2	-	H	1.7	4.7	-
2	-	3.3	-	K	1.8	4.8	-
3	-	3.4	-	L	1.9	4.9	-
4	-	3.5	-	M	2	5.0	-
5	-	3.6	-	N	2.1	5.1	-
6	-	3.7	-	P	2.2	5.2	-
7	-	3.8	-	R	2.3	5.3	-
8	-	3.9	-	S	2.4	5.4	-
9	-	4.0	-	T	2.5	5.5	-
A	-	4.1	-	U	2.6	5.6	-
B	1.2	4.2	-	V	2.7	5.7	-
C	1.3	4.3	-	X	2.8	5.8	-
D	1.4	4.4	-	Y	2.9	5.9	-
E	1.5	4.5	-	Z	3	6.0	-

④ Represents the assembly lot no.

0~9, A~Z repeated (G, I, J, O, Q, W excepted)

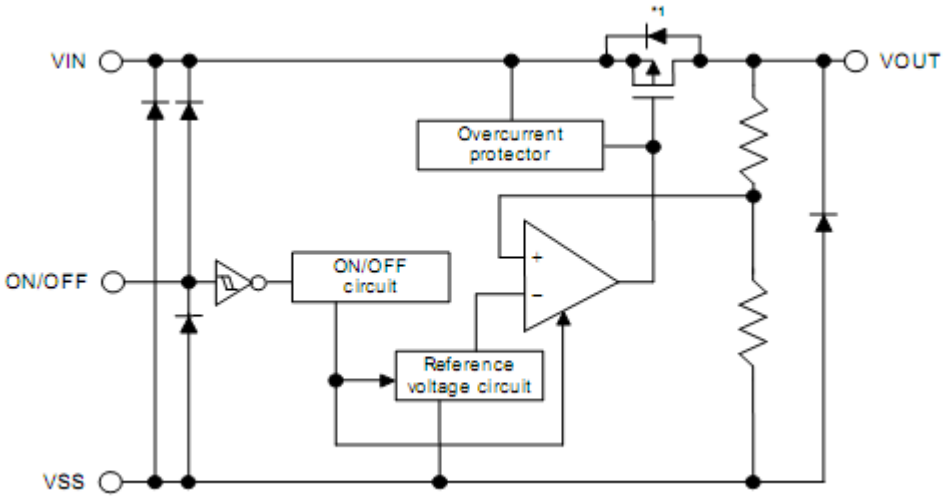
■ Pin Configuration



SOT-23-5L
(TOP VIEW)

Pin Number	Pin Name	Function
1	VIN	Supply Power
2	VSS	Ground
3	CE	Chip Enable
4	NC	No Connection
5	VOUT	Voltage Output

■ Function Block Diagram

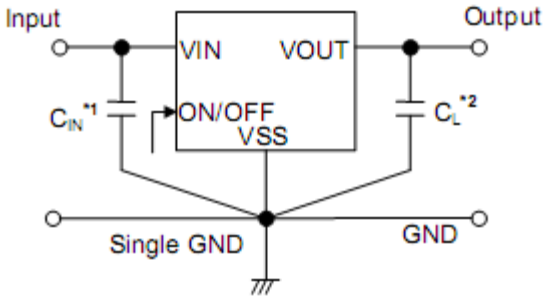


■ Absolute Maximum Ratings

Parameter	Symbol	Maximum Rating		Unit
Input Voltage	V_{IN}	V_{SS}-0.3～V_{SS}+15		V
	$V_{ON/OFF}$	V_{SS}-0.3～V_{IN}+0.3		
Output Current	V_{OUT}	V_{SS}-0.3～V_{IN}+0.3		
Power Dissipation	P_D	SOT-23-5L	300	mW
Operating Ambient Temperature	Topr	-40～+85		°C
Storage Temperature	Tstg	-40～+125		

Caution: The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.

■ Typical Application Circuit



***1. C_{IN} is a capacitor for stabilizing the input.**

***2. A ceramic capacitor of 0.1 µF or more can be used for C_L.**

Caution The above connection diagram and constant will not guarantee successful operation.
Perform thorough evaluation using the actual application to set the constant.

■ Application Conditions

Input capacitor (C_{IN}): 0.1µF or more

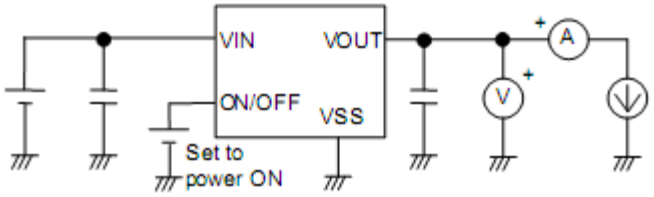
Output capacitor (C_L): 0.1µF or more

ESR of output capacitor: 1.0Ω or less

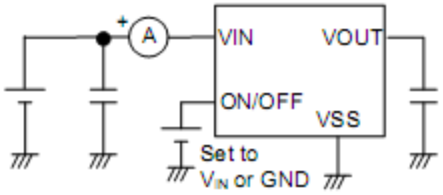
Caution A general series regulator may oscillate, depending on the external components selected. Check that no oscillation occurs with the application using the above capacitor.

■ Test Circuits

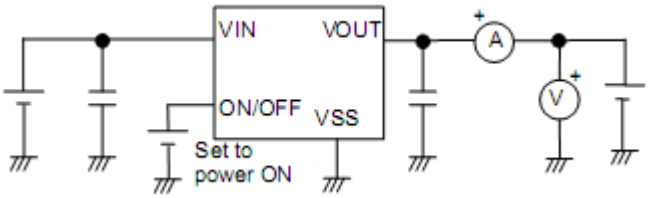
Circuit 1



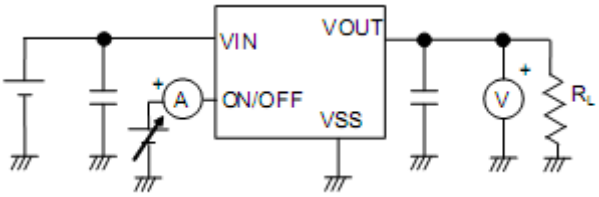
Circuit 2



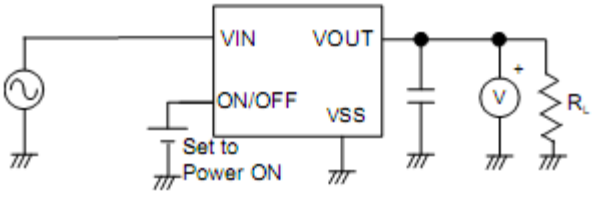
Circuit 3



Circuit 4



Circuit 5



■ Electrical Characteristics

Item	Symbol	Condition		Min	Typ	Max	Unit	Circuit
Output Voltage[*1]	$V_{OUT(E)1}$	V_{IN} =$V_{OUT(S)}$+1.0 V, I_{OUT}=30 mA		$V_{OUT(S)}$ ×0.98	$V_{OUT(S)}$	$V_{OUT(S)}$ ×1.02	V	1
Output Current[*2]	I_{OUT}	V_{IN}≥$V_{OUT(S)}$+1.0 V		150 [*5]	—	—	mA	3
Dropout Voltage[*3]	V_{drop}	I_{OUT}=30 mA	1.5 V ≤$V_{OUT(S)}$≤1.9 V	0.50	0.50	0.51	V	1
			2.0 V ≤$V_{OUT(S)}$≤2.4 V	—	0.08	0.12		
			2.5 V ≤$V_{OUT(S)}$≤2.9 V	—	0.06	0.08		
			3.0 V ≤$V_{OUT(S)}$≤3.2 V	—	0.05	0.07		
			3.3 V ≤$V_{OUT(S)}$≤5.5 V	—	0.04	0.06		
		I_{OUT}=100 mA	1.5 V ≤$V_{OUT(S)}$≤1.9 V	0.50	0.55	0.60	V	
			2.0 V ≤$V_{OUT(S)}$≤2.4 V	—	0.24	0.31		
			2.5 V ≤$V_{OUT(S)}$≤2.9 V	—	0.16	0.23		
			3.0 V ≤$V_{OUT(S)}$≤3.2 V	—	0.14	0.21		
			3.3 V ≤$V_{OUT(S)}$≤5.5 V	—	0.13	0.19		
Line Regulations	$\frac{\Delta V_{OUT1}}{\Delta V_{IN} \bullet V_{OUT}}$	$V_{OUT(S)}$+0.5 V ≤V_{IN}≤10 V I_{OUT}=30 mA		—	0.01	0.2	%/V	
Input Voltage	ΔV_{OUT2}	V_{IN}=$V_{OUT(S)}$+1.0 V 1.0 mA ≤I_{OUT} ≤80 mA		—	15	50	mV	
Output Voltage Temperature Characteristics[*4]	$\frac{\Delta V_{OUT}}{\Delta Ta \bullet V_{OUT}}$	V_{IN}=$V_{OUT(S)}$+1.0 V, I_{OUT}=30 mA -40°C ≤Ta ≤85°C		—	±100	—	ppm/℃	
Current consumption during operation	I_{SS1}	V_{IN}=$V_{OUT(S)}$+1.0 V,EN Pin=ON, No load		—	18	40	μA	2
Current consumption during shutdown	I_{SS2}	V_{IN}=$V_{OUT(S)}$+1.0 V,EN Pin=OFF, No load		—	0.01	1.0	μA	2
Input Voltage	V_{IN}	——		2.0	—	10	V	—
Shutdown pin Input voltage “H”	V_{SH}	V_{IN}=$V_{OUT(S)}$+1.0V,R_L=1.0KΩ		1.5	—	—	V	4
Shutdown pin Input voltage “L”	V_{SL}	V_{IN}=$V_{OUT(S)}$+1.0V,R_L=1.0KΩ		—	—	0.25	V	4
Shutdown pin Input voltage “H”	I_{SH}	V_{IN}=6.5V,$V_{ON/OFF}$=6.5V		-0.1	—	0.1	μA	4
Shutdown pin Input voltage “L”	I_{SL}	V_{IN}=6.5V,$V_{ON/OFF}$=0V		-0.1	—	0.1	μA	4
Ripple-Rejection	|RR|	V_{IN}=$V_{OUT(S)}$+1.0 V，f=1.0 kHz Vrip=0.5 Vrms, I_{OUT}=50 mA	1.5≤VOUT≤3.0V	—	70	—	dB	5
			1.5≤VOUT≤5.5V	—	65	—		
Short current	I_{short}	V_{IN}=$V_{OUT(S)}$+1.0 V, EN pin=ON,V_{OUT}=0V		—	250	—	mA	3

*1. $V_{OUT(S)}$: Specified output voltage

$V_{OUT(E)}$: Actual output voltage at the fixed load

The output voltage when fixing I_{OUT}(= 30 mA) and inputting $V_{OUT(S)}$ + 1.0 V

*2. The output current at which the output voltage becomes 95% of $V_{OUT(E)}$ after gradually increasing the output current.

*3. Vdrop = V_{IN1} − (V_{OUT3} × 0.98)

V_{OUT3} is the output voltage when V_{IN} = $V_{OUT(S)}$ + 1.0 V and I_{OUT} = 30 mA or I_{OUT} = 100 mA.

V_{IN1} is the input voltage at which the output voltage becomes 98% of V_{OUT3} after gradually decreasing the input voltage.

*4. The change in temperature [mV/°C] is calculated using the following equation.

$$\frac{\Delta V_{OUT}}{\Delta Ta}\left[mV/^{\circ}C\right]^{*1} = V_{OUT(S)}\left[V\right]^{*2} \times \frac{\Delta V_{OUT}}{\Delta Ta \bullet V_{OUT}}\left[ppm/\quad\right]^{*3} + 1000$$

$$\frac{\Delta V_{OUT}}{\Delta Ta}\left[mV/^{\circ}C\right]^{*1} = V_{OUT(S)}\left[V\right]^{*2} \times \frac{\Delta V_{OUT}}{\Delta Ta \bullet V_{OUT}}\left[ppm/\quad\right]^{*3} + 1000$$

*1. The change in temperature of the output voltage

*2. Specified output voltage

*3. Output voltage temperature coefficient

*5. The output current can be at least this value.

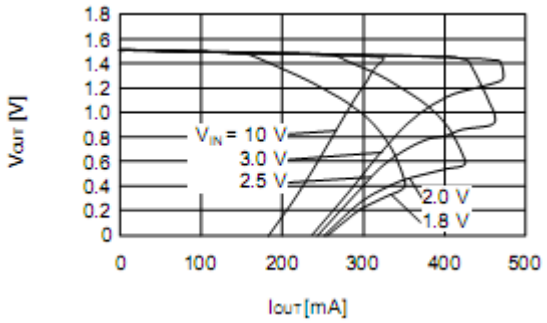
Due to restrictions on the package power dissipation, this value may not be satisfied. Attention should be paid to the power dissipation of the package when the output current is large.

This specification is guaranteed by design.

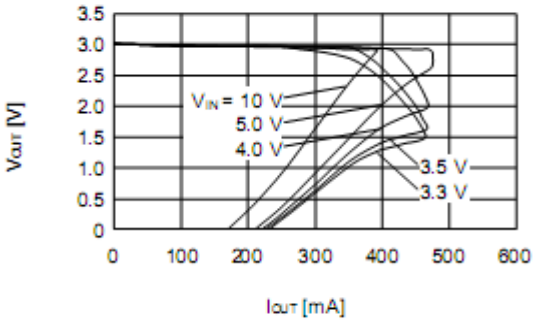
■ Typical Performance Characteristics

1、Output Voltage vs. Output Current (when load current increases)

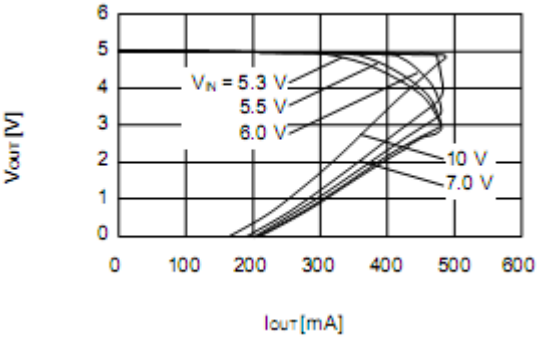
V_{OUT}=1.5V(Ta=25℃)



V_{OUT}=3.0V(Ta=25℃)



V_{OUT}=5.0V(Ta=25℃)



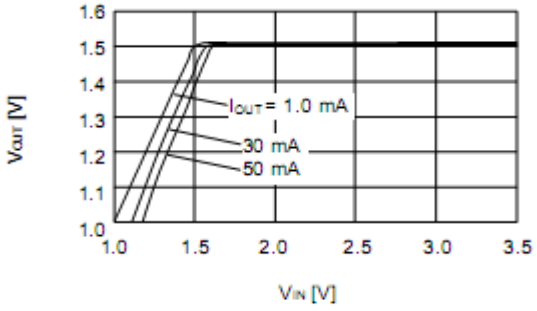
Remark In determining the output current, attention should be paid to the following.

1) The minimum output current value and footnote*5 in the “Electrical Characteristics”

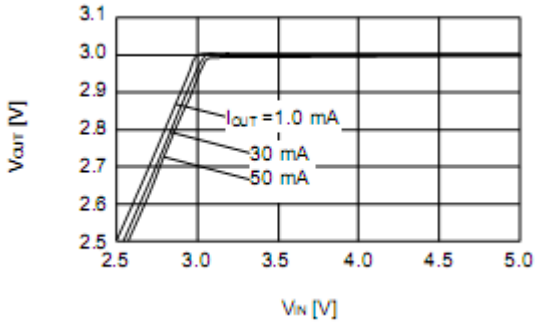
2) The package power dissipation

2、Output Voltage vs. Input voltage

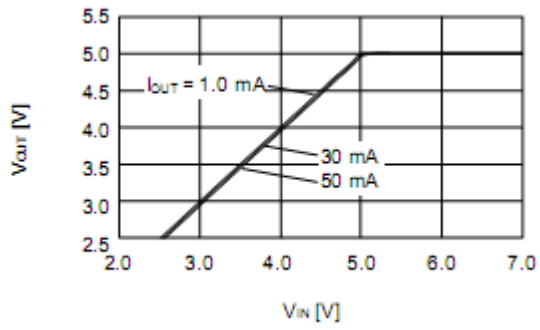
V_{OUT}=1.5V(Ta=25℃)



V_{OUT}=3.0V(Ta=25℃)

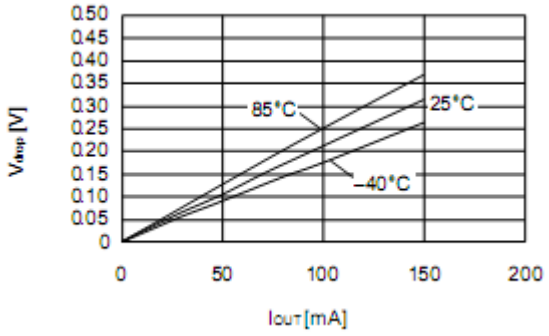


V_{OUT}=5.0V(Ta=25℃)

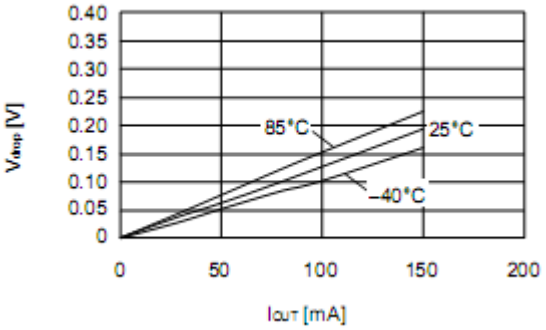


3、Dropout Voltage vs. Output Current

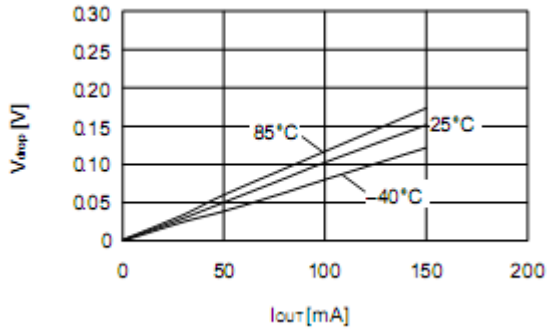
V_{OUT}=1.5V



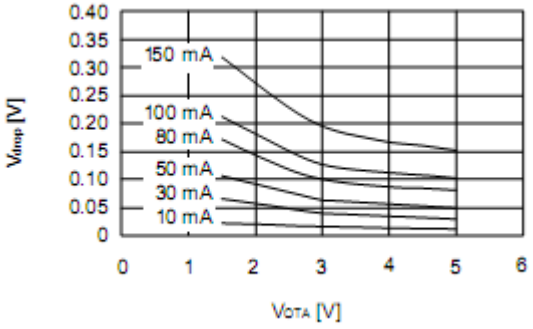
V_{OUT}=3.0V



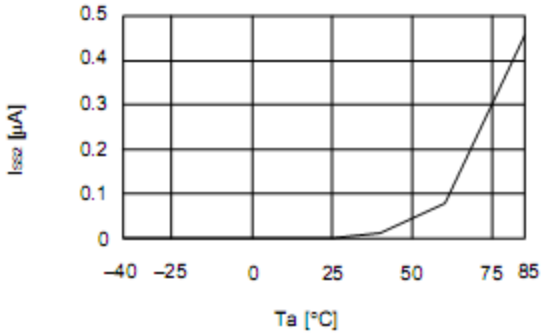
V_{OUT}=5.0V



4、Dropout Voltage vs. Set output Voltage

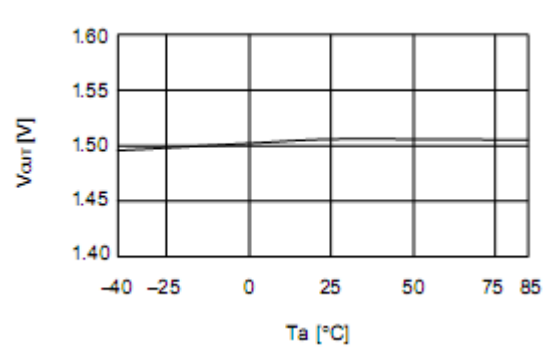


5、Current consumption during shutdown vs.Ambient temperature(V_{OUT}=1.5V,V_{IN}=2.5V)

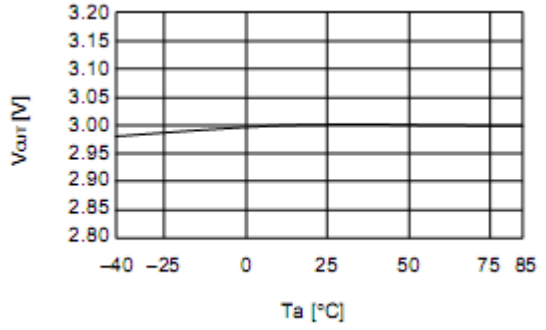


6、Output Voltage vs. Ambient Temperature

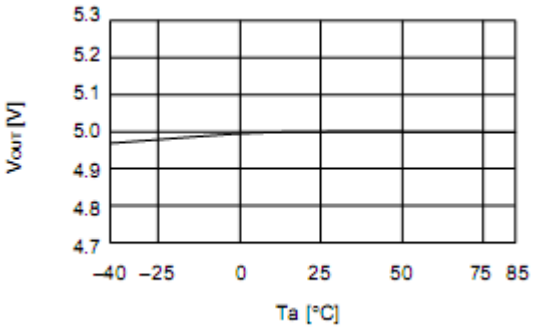
V_{OUT}=1.5V



V_{OUT}=3.0V

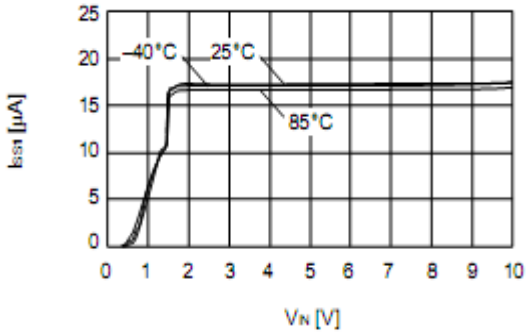


V_{OUT}=5.0V

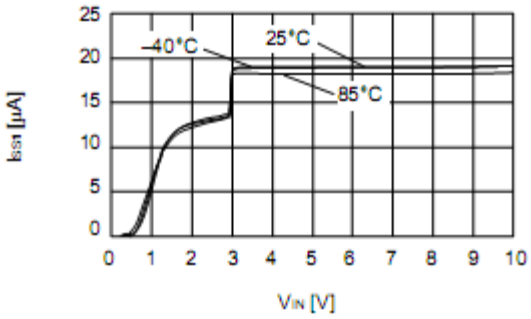


6、Current consumption vs. Input voltage

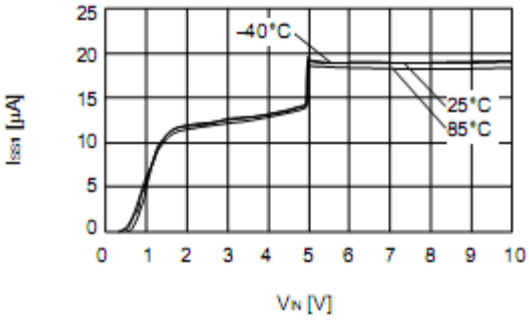
V_{OUT}=1.5V



V_{OUT}=3.0V

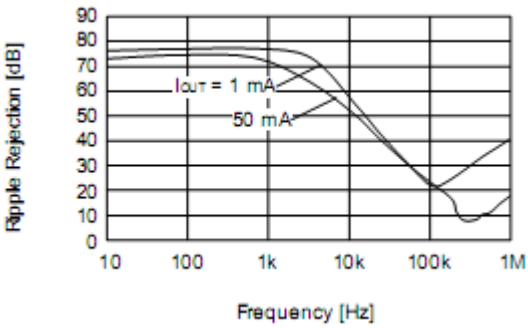


V_{OUT}=5.0V

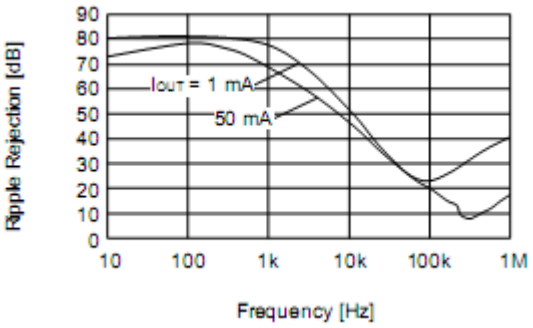


6、Ripple Rejection Rate

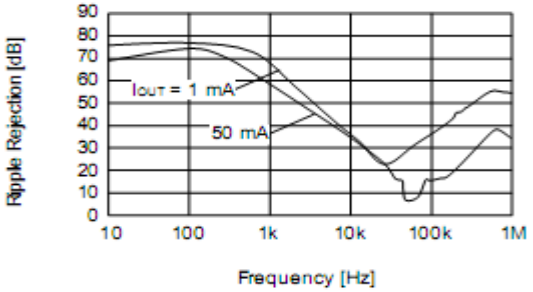
V_{IN}=2.5V,C_{OUT}=0.1µF



V_{IN}=4.0V,C_{OUT}=0.1µF



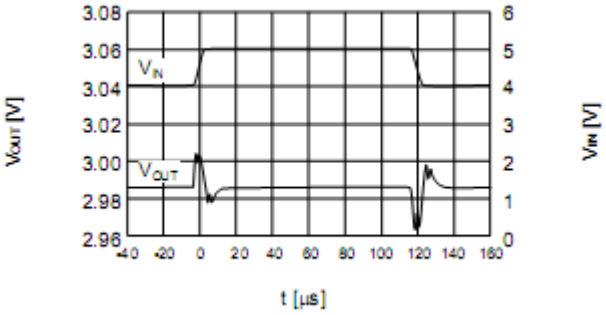
V_{IN}=6.0V,C_{OUT}=0.1μF



■ Reference Data(output=3.0V)

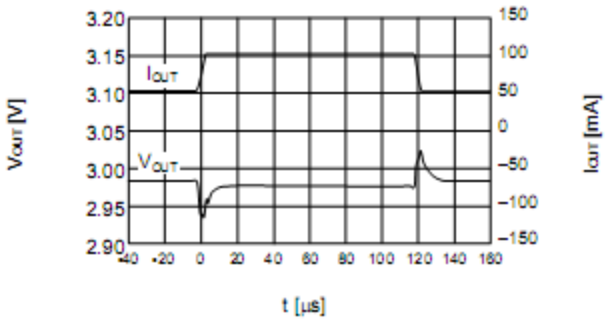
1、Input transient response characteristics

I_{OUT}=30mA,tr=tf=5.0μs,C_{OUT}=0.1μF,C_{IN}=0.1μF



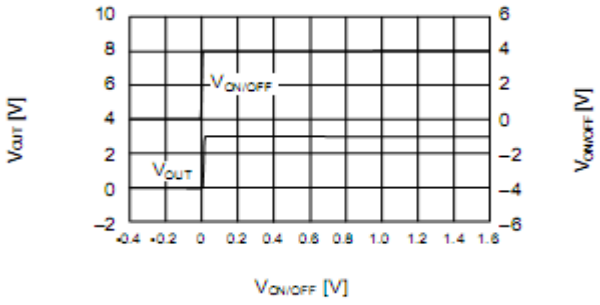
2、 Load transient response characteristics

V_{IN}=4.0V,C_{OUT}=0.1μF,C_{IN}=0.1μF,I_{OUT}=50→100mA



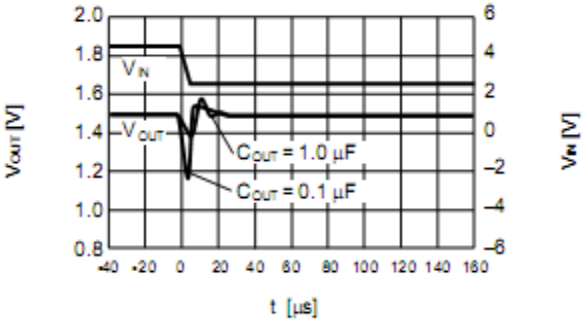
3、 Shutdown pin transient response characteristics

V_{IN}=4.0V,C_{OUT}=0.1μF,C_{IN}=0.1μF,I_{OUT}=30mA



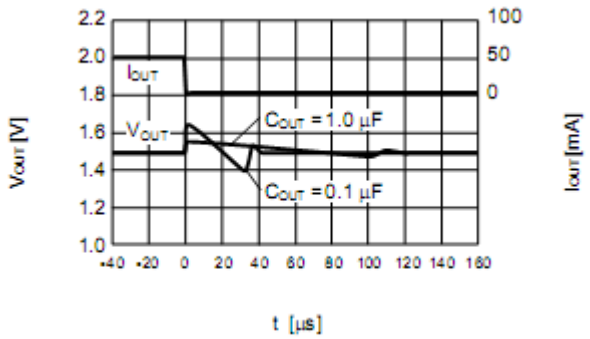
4、 Input transient response characteristics

V_{IN}=4.5V→2.5V,tr=5μs,I_{OUT}=50mA



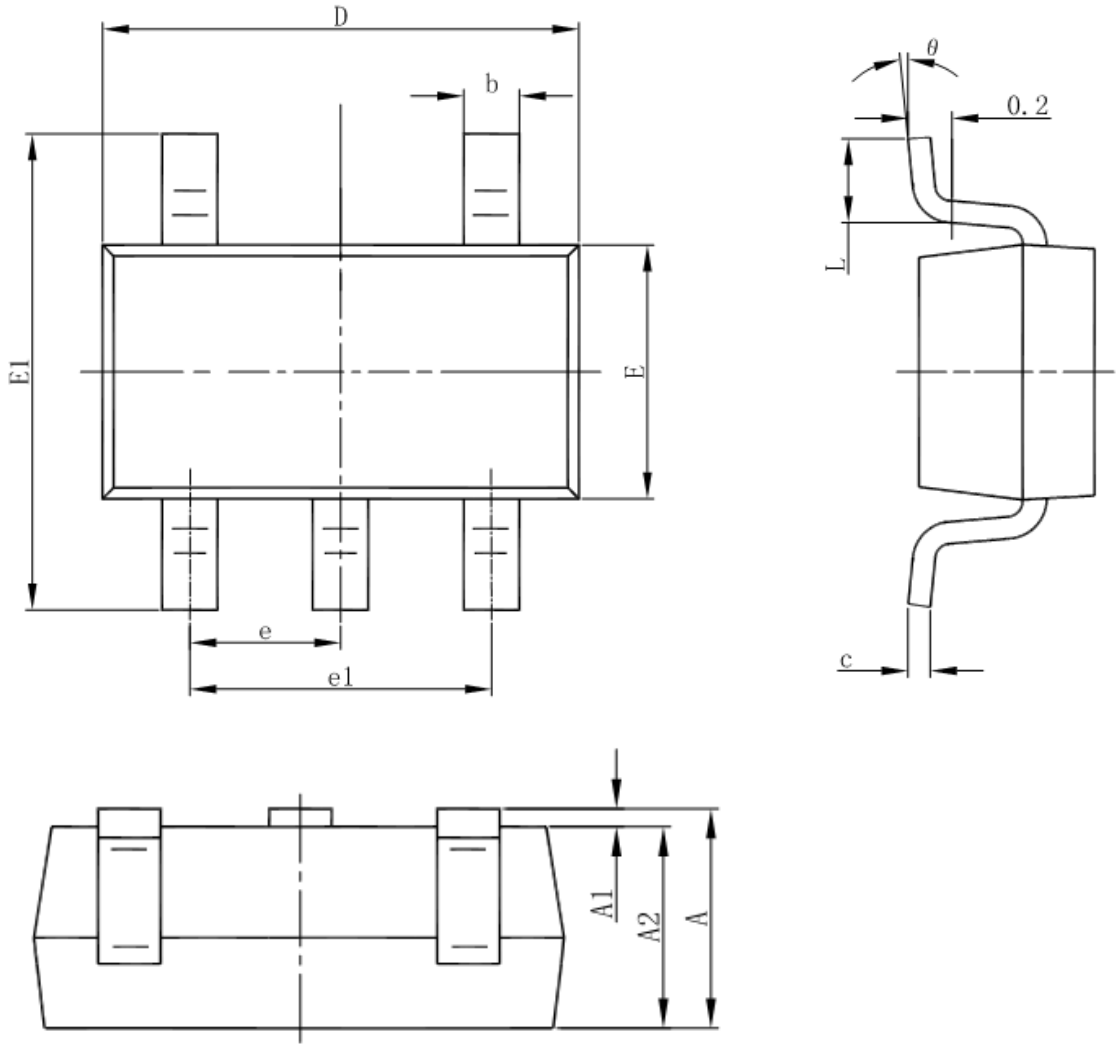
5、 Load transient response characteristics

V_{IN}=2.5V, I_{OUT}=50mA→1mA



■ Package Information

- SOT-23-5L



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°