

High Voltage Low Power Consumption LDO CMOS Voltage Regulator

■ General Description

ICW1261-Q1 is a high voltage (up to 60V) ultra-low quiescent current low dropout voltage regulator (LDO) manufactured in CMOS processes. It can deliver up to 150mA of current while consuming only 2.3uA of quiescent current. It consists of a reference voltage generator, an error amplifier, a current foldback circuit, and a phase compensation circuit plus a driver transistor. The ICW1261-Q1 is designed specifically for applications where very-low I_Q is a critical parameter. This device maintains low quiescent current consumption even in dropout mode to further increase the battery life. When in shutdown or disabled mode, the device consumes less than 100-nA I_Q even with input voltage of 60V that helps increase the shelf life of the battery.

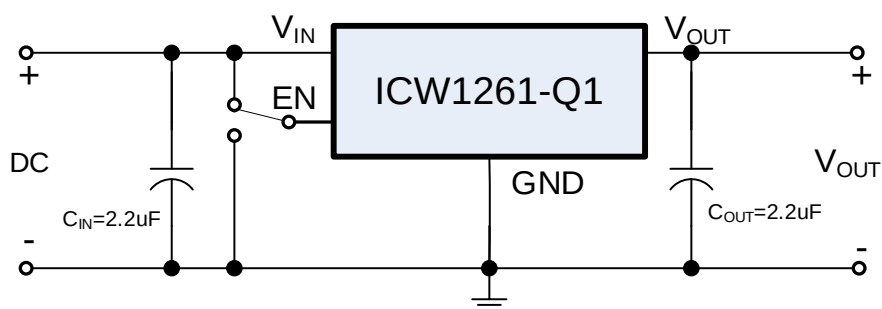
■ Features

- AEC-Q100 Qualified with the Grade 1
- Ultra-low Quiescent Current: 2.3uA
- Maximum Input Voltage: 60V
- Output Voltage Highly Accurate: $\pm 2\%$
- Maximum Output Current: 150mA
- Dropout Voltage: 8mV@ $I_{OUT}=1mA$
- Temperature Stability: $\pm 40ppm/^{\circ}C$
- ON/OFF Logic = Enable High
- Protections Circuits: Current Limiter, Foldback, Thermal shutdown
- Output Capacitor: Low ESR Ceramic Capacitor Compatible

■ Applications

- Automotive Head Units
- Headlights
- Body Control Modules
- Inverter and Motor Controls

■ Typical Applications



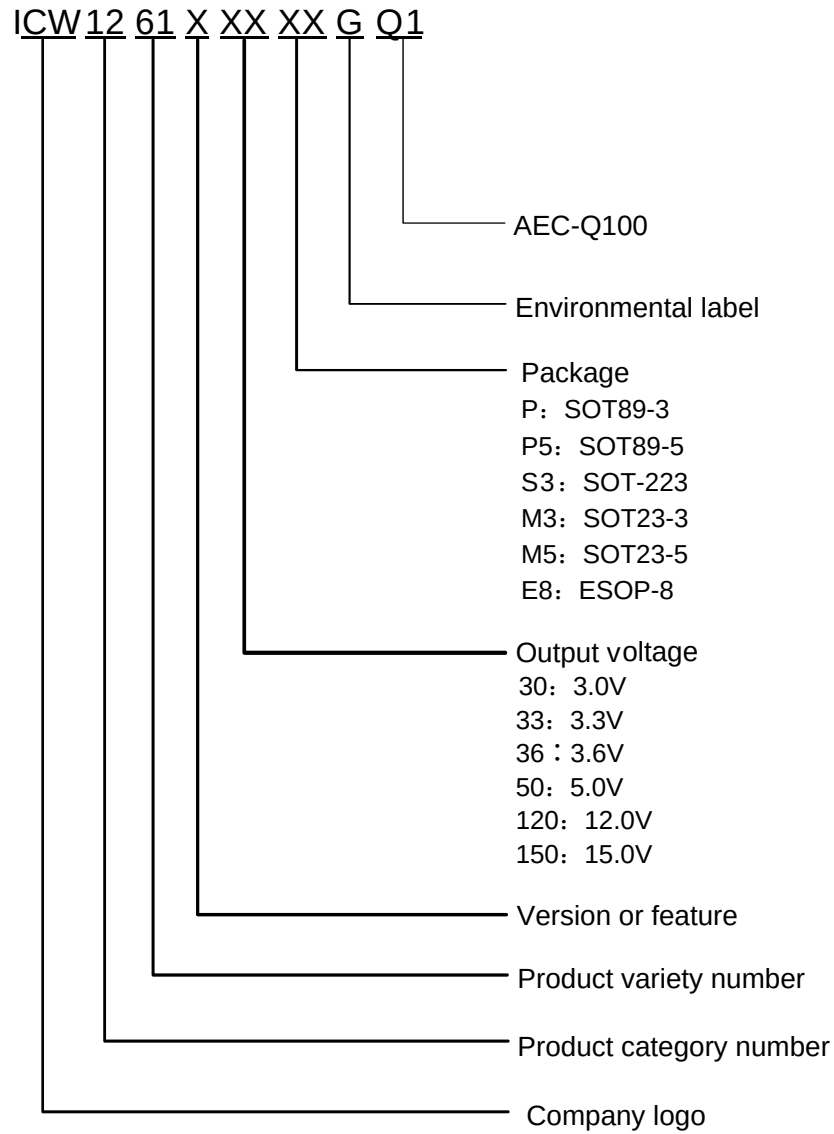
■ Notes on Use

Input Capacitor (C_{IN}): 2.2 μ F above

Output Capacitor (C_{OUT}): 2.2 μ F above

High Voltage Low Power Consumption LDO CMOS Voltage Regulator

■ Selections Gudge



High Voltage Low Power Consumption LDO CMOS Voltage Regulator

■ Product Selections

Product Name	V _{OUT} (V)	Package	Ordering Name	Package Information
ICW1261A33	3.3	SOT89-3L	ICW1261A33PGQ1	Tape and Reel, 1000pcs
			ICW1261A33P1GQ1	
ICW1261A36	3.6	SOT89-3L	ICW1261A36PGQ1	
ICW1261A50	5.0	SOT89-3L	ICW1261A50PGQ1	
			ICW1261A50P1GQ1	
ICW1261A120	12.0	SOT89-3L	ICW1261A120PGQ1	
			ICW1261A120P1GQ1	
ICW1261A150	15.0	SOT89-3L	ICW1261A150PGQ1	Tape and Reel, 1000pcs
ICW1261A33	3.3	SOT89-5L	ICW1261A33P5GQ1	
ICW1261A50	5.0	SOT89-5L	ICW1261A50P5GQ1	
ICW1261A120	12.0	SOT89-5L	ICW1261A120P5GQ1	
ICW1261A33	3.3	SOT223-3L	ICW1261A33S3GQ1	Tape and Reel, 2500pc
ICW1261A50	5.0	SOT223-3L	ICW1261A50S3GQ1	
ICW1261A120	12.0	SOT223-3L	ICW1261A120S3GQ1	
ICW1261C33	3.3	SOT23-5L	ICW1261C33M5GQ1	Tape and Reel, 3000pc
ICW1261C50	5.0	SOT23-5L	ICW1261C50M5GQ1	
ICW1261C120	12.0	SOT23-5L	ICW1261C120M5GQ1	
ICW1261A33	3.3	SOT23-3L	ICW1261A33M3GQ1	Tape and Reel, 3000pc
ICW1261A50	5.0	SOT23-3L	ICW1261A50M3GQ1	
ICW1261A120	12.0	SOT23-3L	ICW1261A120M3GQ1	
ICW1261A33	3.3	TO252-2L	ICW1261A33TGQ1	Tape and Reel, 2500pcs
ICW1261A50	5.0	TO252-2L	ICW1261A50TGQ1	
ICW1261A120	12.0	TO252-2L	ICW1261A120TGQ1	
ICW1261C33	3.3	ESOP8	ICW1261C33E8GQ1	Tape and Reel, 4000pcs
ICW1261C50	5.0	ESOP8	ICW1261C50E8GQ1	
ICW1261C120	12.0	ESOP8	ICW1261C120E8GQ1	

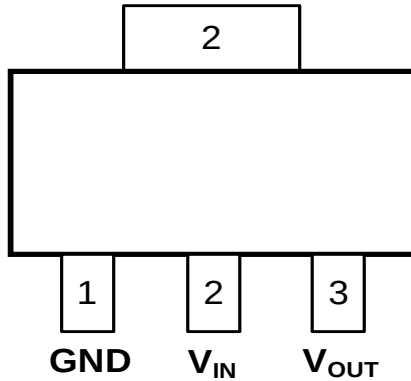
Notes:

- 1 * Customer can request to customize the output voltage ranged from 1.2V to 15V if desired voltage is not found in the selection s.
- 2 * Customer can request customization of package choice.

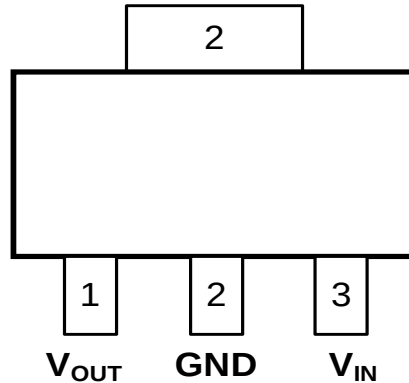
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Pin Configuration and Functions

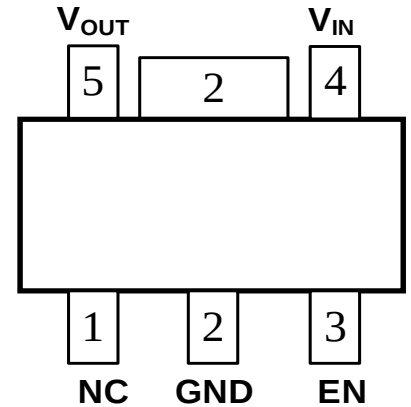
SOT89-3L(P)
Top View



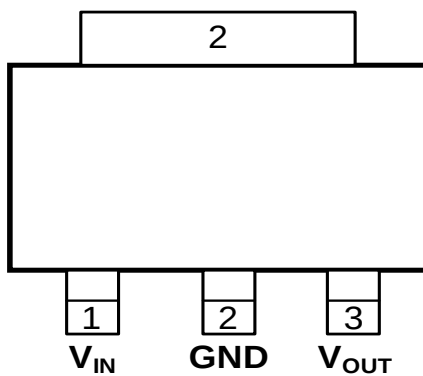
SOT89-3L(P1)
Top View



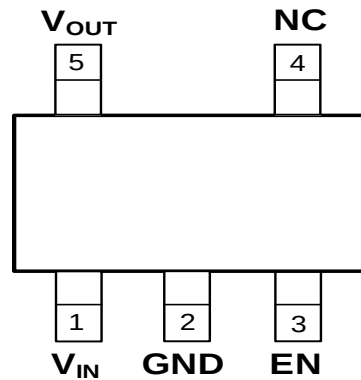
SOT89-5L
Top View



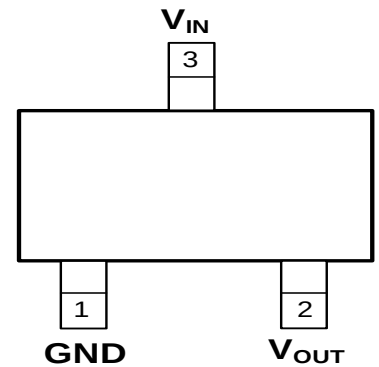
SOT223-3L
Top View



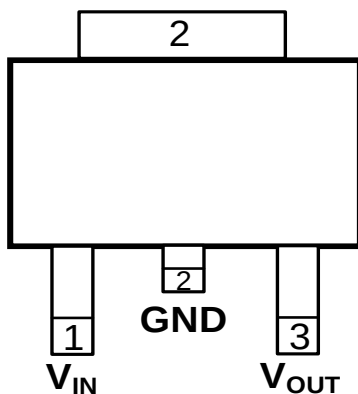
SOT23-5L
Top View



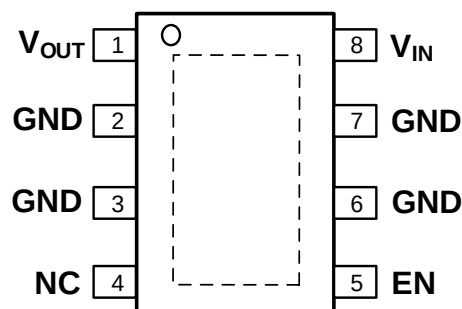
SOT23-3L
Top View



TO252-2L
TOP View



ESOP8
Top View



Pin Functions

NAME	DESCRIPTION
V_{IN}	Power Input Pin.
EN	Enable pin. Drive this pin high to enable the device. Drive this pin low to put the device into low current shutdown.
V_{OUT}	Regulated output voltage pin
GND	Ground

Notes: Customer can request to customize other packages with or without EN pin.

High Voltage Low Power Consumption LDO CMOS Voltage Regulator

■ Absolute Maximum Ratings (Unless otherwise indicated: $T_a=25^{\circ}\text{C}$)

PARAMETER	SYMBOL	RATINGS		UNITS
Input Voltage	V _{IN}	-0.3 ~ 65		V
Output Voltage	V _{OUT}	V _{SS} -0.3 ~ V _{IN} +0.3V		
Power Dissipation	P _D	ESOP-8	1800	mW
		TO252-2L	1800	
		SOT223-3L	1500	
		SOT89-5L	1000	
		SOT89-3L	1000	
		SOT23-5L	250	
		SOT23-3L	250	
Thermal Resistance	R _{θJA}	ESOP-8	80	℃/W
		TO252-2L	55	
		SOT223-3L	66	
		SOT89-5L	100	
		SOT89-3L	100	
		SOT23-5L	250	
		SOT23-3L	250	
Operating Ambient Temperature	T _{opr}	-40 ~ +125		℃
Storage Temperature	T _{stg}	-40 ~ +150		
ESD Protection	ESD HBM	±4000		V
Humidity sensitive level	MSL	3		

Note: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device.

High Voltage Low Power Consumption LDO CMOS Voltage Regulator

■ Electrical Characteristics

ICW1261-Q1 Series (Unless otherwise indicated: $T_a=25^{\circ}\text{C}$)

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Output Voltage ^{*1}	$V_{OUT(S)}$	$V_{IN} = V_{OUT(S)} + 2V, I_{OUT}=1mA$	$V_{OUT(S)} \times 0.98$	$V_{OUT(S)}$	$V_{OUT(S)} \times 1.02$	V
Dropout Voltage ^{*2}	V_{DROP}	$V_{EN}=V_{IN}, V_{OUT(S)}=5.0V$ $I_{OUT}=1mA$		8	16	mV
		$V_{EN}=V_{IN}, V_{OUT(S)}=5.0V$ $I_{OUT}=150mA$		1300	1800	
Line Regulation	$\frac{\Delta V_{OUT}}{\Delta V_{IN} \cdot V_{OUT(S)}}$	$V_{OUT(S)} + 2V \leq V_{IN} \leq 60V$ $I_{OUT}=1mA$		0.01	0.02	%/V
Load Regulation	ΔV_{OUT2}	$V_{IN} = V_{OUT(S)} + 2V$ $1mA \leq I_{OUT} \leq 150mA$	$V_{OUT(S)} \leq 5.3V$	20	40	mV
			$V_{OUT(S)} > 5.3V$	50	80	
Temperature Stability	$\frac{\Delta V_{OUT}}{\Delta T_a \cdot V_{OUT(S)}}$	$V_{IN} = V_{OUT(S)} + 2V, I_{OUT}=10mA$ $-40^{\circ}\text{C} \leq T_a \leq 125^{\circ}\text{C}$		± 40		ppm/ $^{\circ}\text{C}$
GND Current ($V_{EN}=V_{IN}$)	I_{GND}	no load	$V_{OUT(S)} < 3.0V$	0.8	1.2	uA
			$3.0 \leq V_{OUT(S)} \leq 5.3V$	1	2.3	
			$V_{OUT(S)} > 5.3V$	1.5	3	
		$I_{OUT}=100mA$		1100		
Shutdown Current ($EN=0$)	I_{SHUT}	$V_{IN}=60V, V_{EN}=0$		0.1	1	
Input Voltage	V_{IN}	---	2.2		60	V
Maximum Output Current	I_{OUTMAX}		150			mA
Current Limit ^{*3}	I_{LIM}	$V_{EN}=V_{IN}=V_{OUT(S)}+2V,$ $V_{OUT} = 0.95 \times V_{OUT(S)}$		240		
Short Circuit Current ^{*4}	I_{SHORT}	$V_{IN}=V_{EN}=V_{OUT(S)}+2.0V$ $V_{OUT}=0V$		10		
Power Supply Rejection Ratio	PSRR	$f=10Hz, I_{OUT}=10mA$		76		dB
		$f=100Hz, I_{OUT}=10mA$		80		
		$f=1kHz, I_{OUT}=10mA$		63		
EN 'H' Level Voltage	V_{ENH}		1.5		60	V
EN 'L' Level Voltage	V_{ENL}		0		0.6	
EN 'H' Level Current	I_{ENH}	$V_{IN}=60V, V_{EN}=V_{IN}$	-0.1		0.1	uA
EN 'L' Level Voltage	I_{ENL}	$V_{IN}=60V, V_{EN}=0$	-0.1		0.1	
Over Temperature Protection	OTP	$I_{OUT}=1mA$		165		$^{\circ}\text{C}$

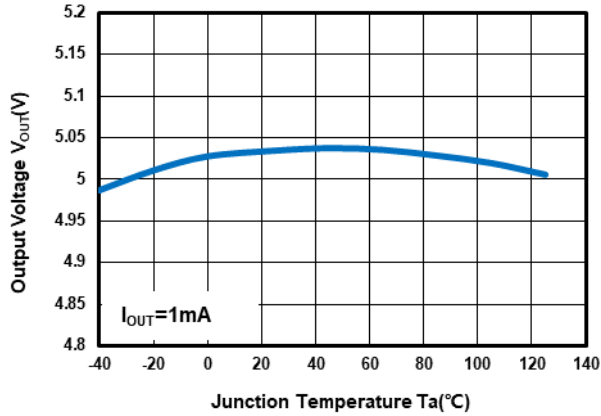
Notes:

- $V_{OUT(S)}$: Output voltage when $V_{IN}=V_{OUT}+2V, I_{OUT}=1mA$.
- $V_{DROP}=V_{IN1} - (V_{OUT(S)} \times 0.98)$ where V_{IN1} is the input voltage when $V_{OUT} = V_{OUT(S)} \times 0.98$.
- I_{LIM} : Output current when $V_{IN}=V_{OUT(S)}+2V$ and $V_{OUT} = 0.95 \times V_{OUT(S)}$.
- V_{OUT} pin should be shorted to GND pin, and the impedance between them is less than 0.1 ohm.

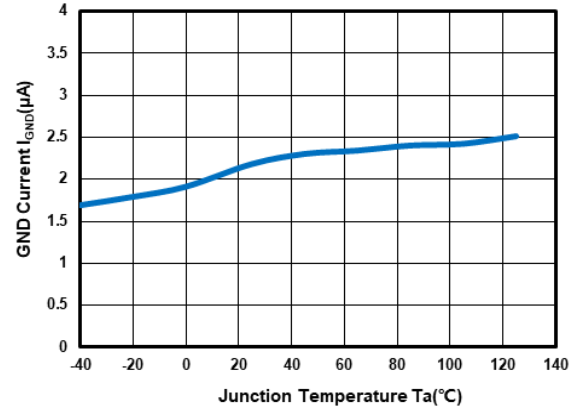
High Voltage Low Power Consumption LDO CMOS Voltage Regulator

■ Typical Performance Characteristics

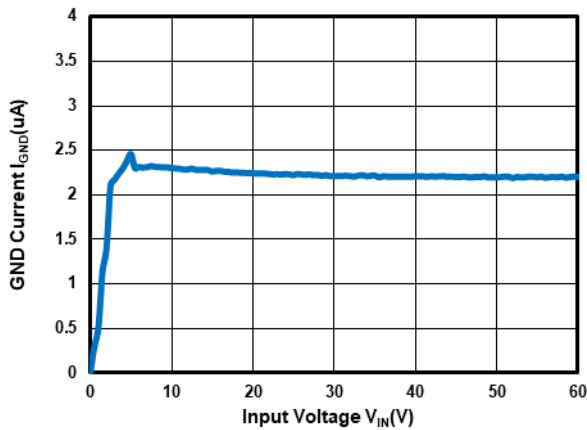
Test Conditions: $V_{IN}=V_{OUT}+2.0V$, $C_{IN}=2.2\mu F$, $C_{OUT}=2.2\mu F$, $T_a=25^\circ C$, unless otherwise indicated.



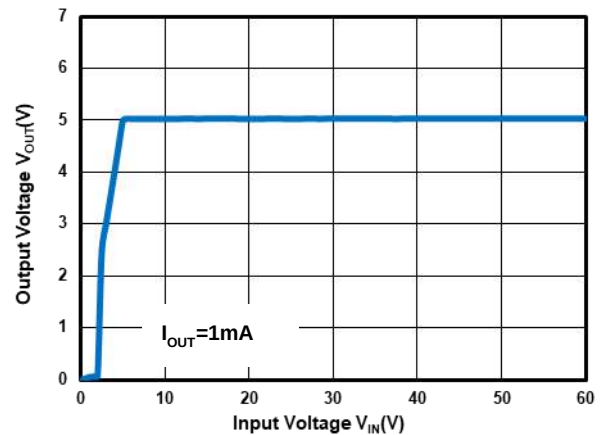
Output Voltage vs Temperature at $V_{OUT}=5.0V$



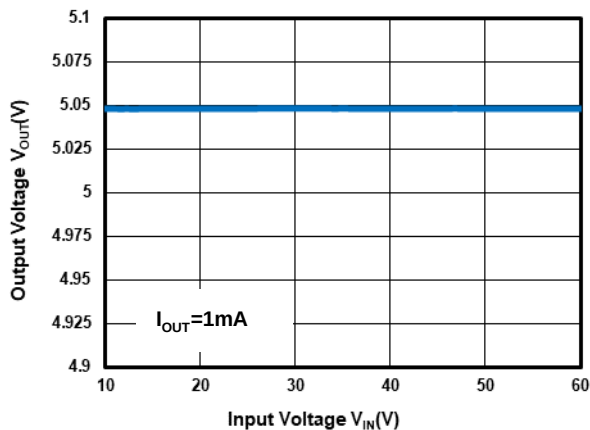
GND Current vs Temperature at $V_{OUT}=5.0V$



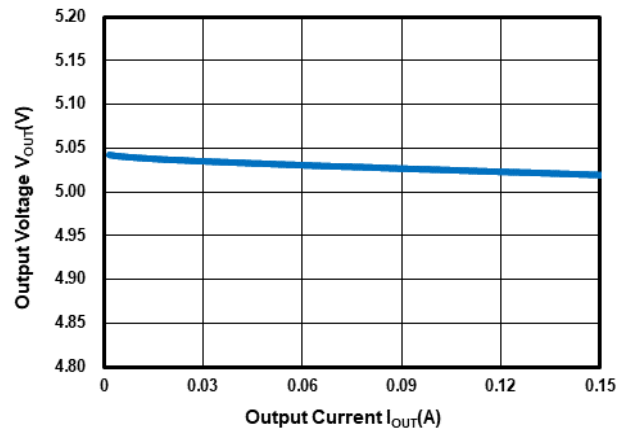
GND Current vs Input Voltage at $V_{OUT}=5.0V$



Output Voltage vs Input Voltage at $V_{OUT}=5.0V$



Output Voltage vs Input Voltage at $V_{OUT}=5.0V$

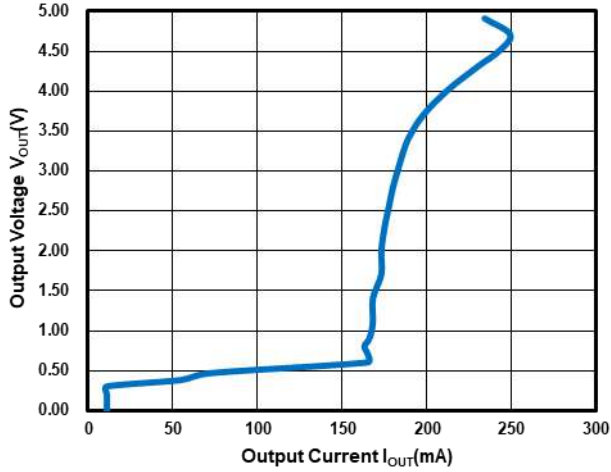


Output Voltage vs Output Current at $V_{OUT}=5.0V$

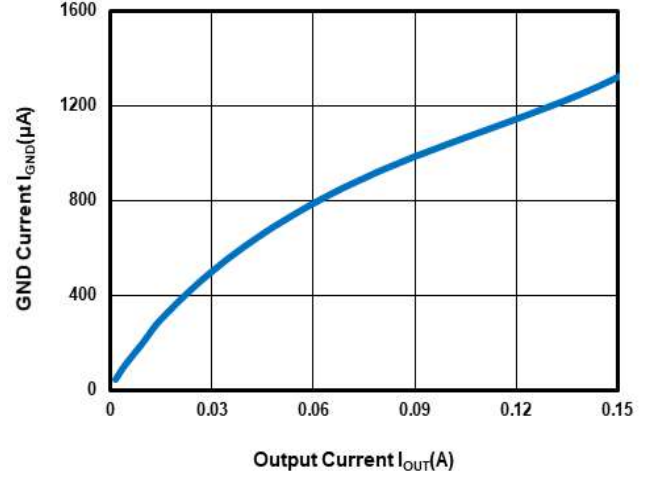
High Voltage Low Power Consumption LDO CMOS Voltage Regulator

■ Typical Performance Characteristics (Continued)

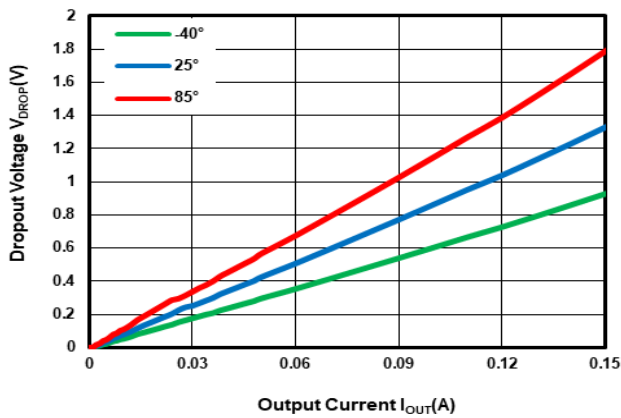
Test Conditions: $V_{IN}=V_{OUT}+2.0V$, $C_{IN}=2.2\mu F$, $C_{OUT}=2.2\mu F$, unless otherwise indicated.



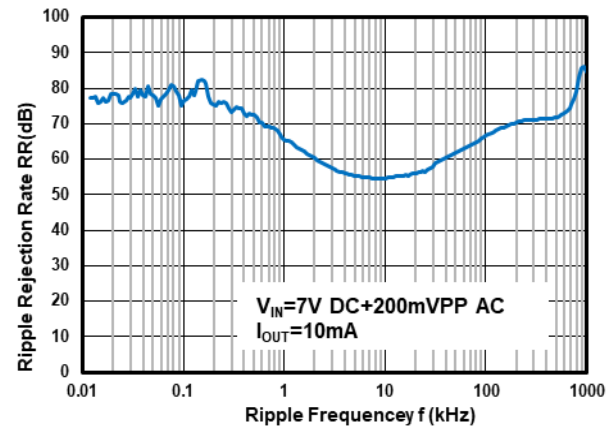
Output Current Fold-back at $V_{OUT}=5.0V$



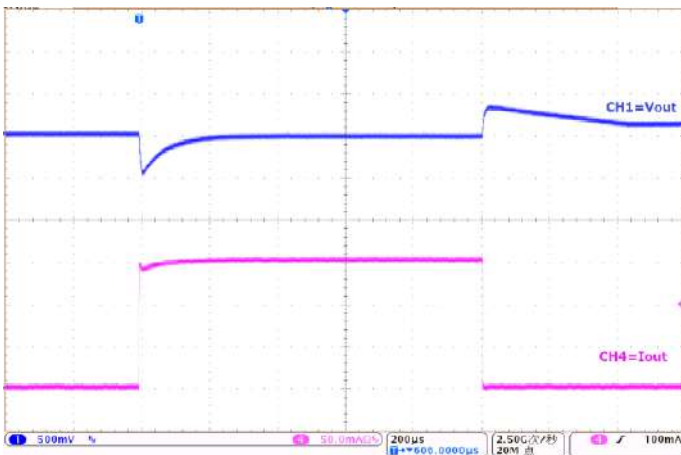
GND Current vs Output Current at $V_{OUT}=5.0V$



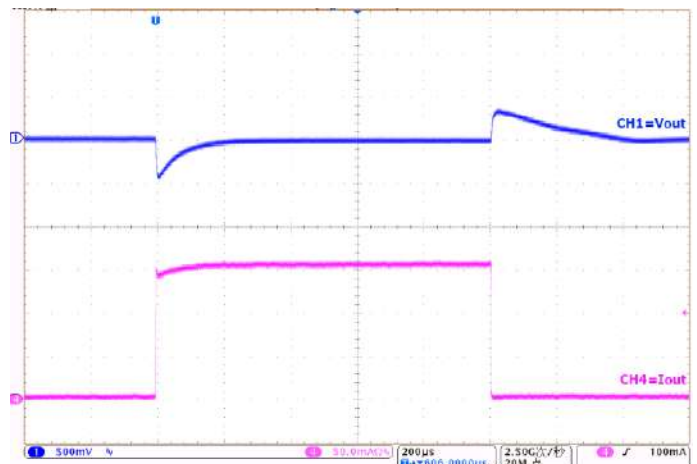
Dropout Voltage vs Temperature at $V_{OUT}=5.0V$



Power Supply Rejection Ratio at $V_{OUT}=5.0V$



Load Transient at $V_{OUT}=5.0V$:
 $(I_{OUT}=0mA\sim150mA\sim0mA)$

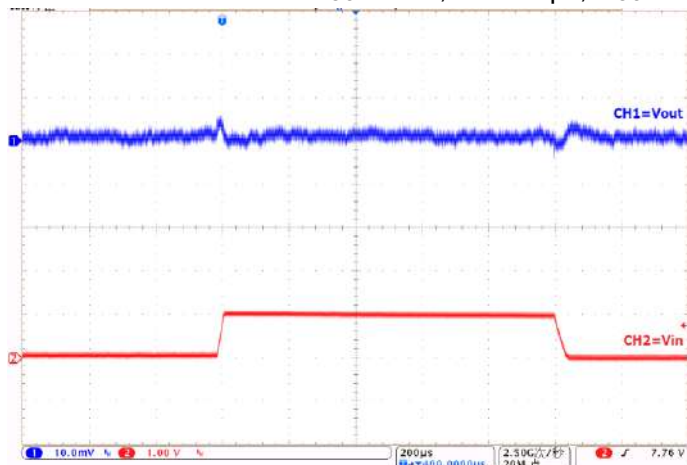


Load Transient at $V_{OUT}=5.0V$:
 $(I_{OUT}=1mA\sim150mA\sim1mA)$

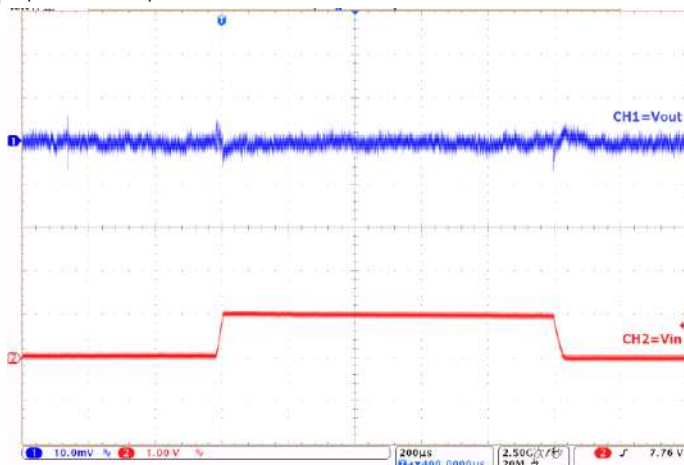
High Voltage Low Power Consumption LDO CMOS Voltage Regulator

■ Typical Performance Characteristics (Continued)

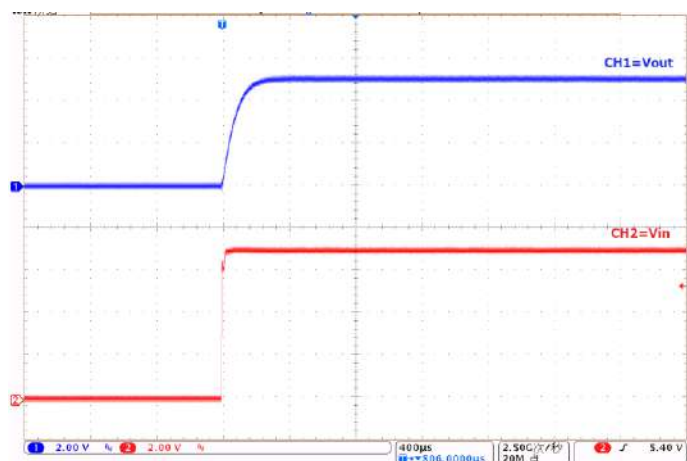
Test Conditions: $V_{IN}=V_{OUT}+2.0V$, $C_{IN}=2.2\mu F$, $C_{OUT}=2.2\mu F$, $T_a=25^{\circ}C$, unless otherwise indicated.



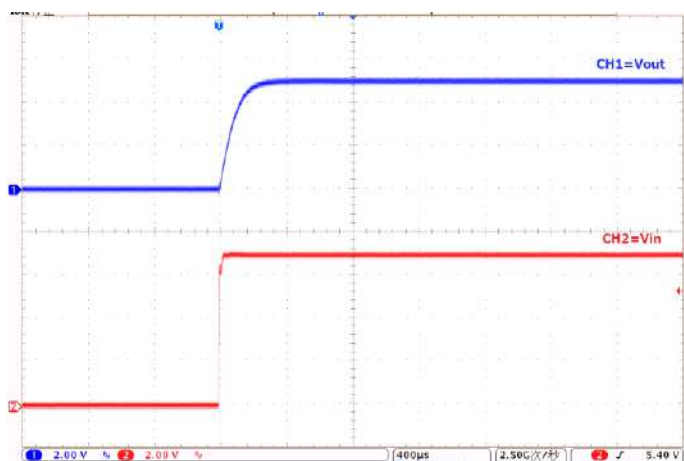
Line Transient at $V_{OUT}=5.0V$:
 $(I_{OUT}=1mA)$:



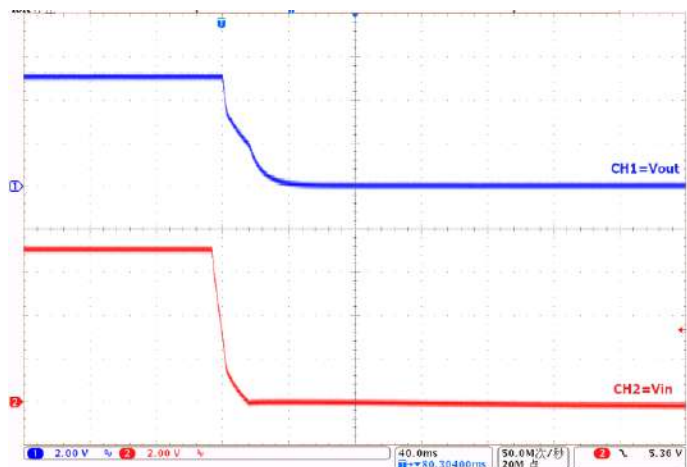
Line Transient at $V_{OUT}=5.0V$:
 $(I_{OUT}=10mA)$:



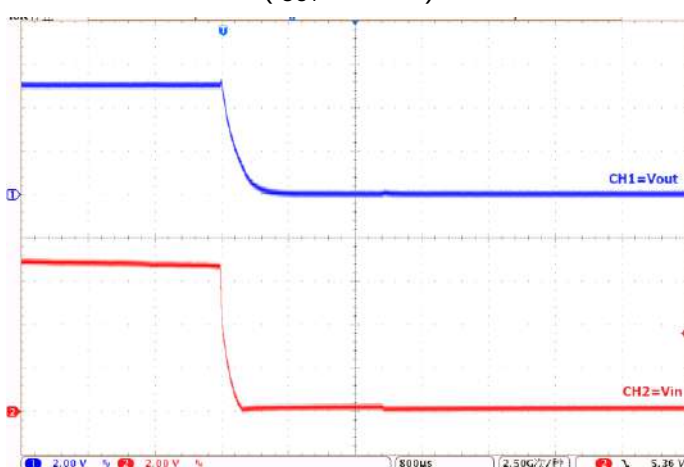
Power-Up at $V_{OUT}=5.0V$:
 $(I_{OUT}=1mA)$



Power-Up at $V_{OUT}=5.0V$:
 $(I_{OUT}=150mA)$



Power-Down at $V_{OUT}=5.0V$:
 $(I_{OUT}=1mA)$



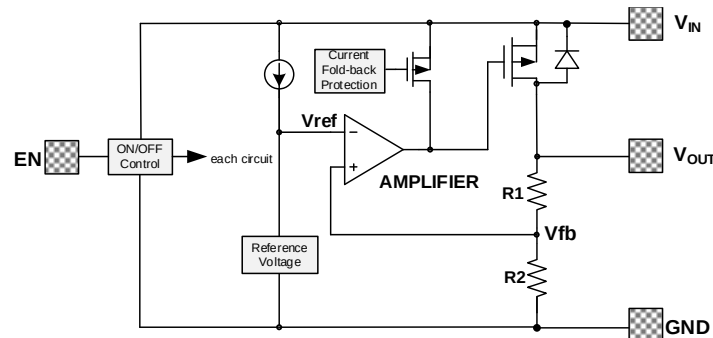
Power-Down at $V_{OUT}=5.0V$:
 $(I_{OUT}=150mA)$

High Voltage Low Power Consumption LDO CMOS Voltage Regulator

■ Operational Explanation

1. Output voltage control

The voltage divided by resistors R1 and R2 is compared with the internal reference voltage by the error amplifier. The amplifier output then drives the P-channel MOSFET connected to the V_{OUT} pin. The output voltage at the V_{OUT} pin is regulated by this negative feedback system. The current limit circuit and short protect circuit operate in relation to output current level. Further, the IC's internal circuitry can be in operation or shutdown modes controlled by the CE pin's signal.



2. Pass transistor

The pass transistor with low turn-on resistance used in ICW1261-Q1 is a P-channel MOSFET. If the potential on V_{OUT} pin is higher than V_{IN} , it is possible that IC will be destroyed due to reverse current which is caused by parasitic diodes between V_{IN} and V_{OUT} . Therefore, the V_{OUT} pin potential exceeds $V_{IN}+0.3V$ is not allowed.

3. Current foldback and over temperature protection

The ICW1261-Q1 series includes a combination of a fixed current limiter circuit and a foldback circuit, which aid the operations of the current limiter and circuit protection. When the load current reaches the current limit level, the fixed current limiter circuit operates and output voltage drops. As a result of this drop in output voltage, the foldback circuit operates, output voltage drops further and output current decreases. This design can prevent the chip be damaged due to over temperature, moreover, the heat dissipation is limited by the package type.

Special attention should be paid to that the product of the dropout voltage on the chip and the output current must be smaller than the heat dissipation. If power consumption on the chip is more than the heat dissipation, OTP will protect the chip from damaging due to over temperature.

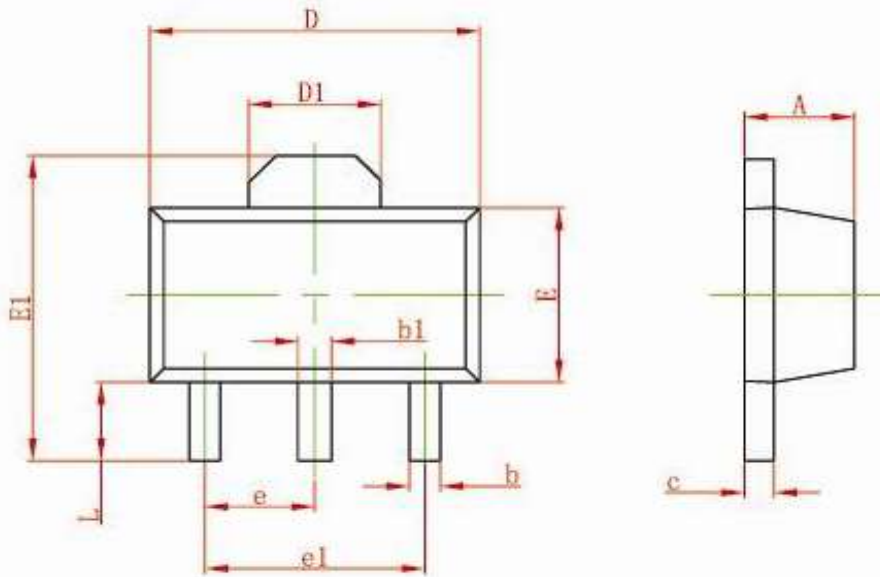
■ Notes:

1. The input and output capacitors should be placed as close as possible to the IC.
2. If the impedance of the power supply is high, which is caused by forgetting installing input capacitor or installing too small value capacitor, the oscillation may occur.
3. Pay attention to the operation conditions of input and output voltage and load current, such that the power consumption in the IC should not exceed the allowable power consumption of the package even though the chip has short circuit protection.
4. IC has a built-in anti-static protection (ESD) circuit, but please do not add excessive stress to the IC.

High Voltage Low Power Consumption LDO CMOS Voltage Regulator

■ Packaging Information

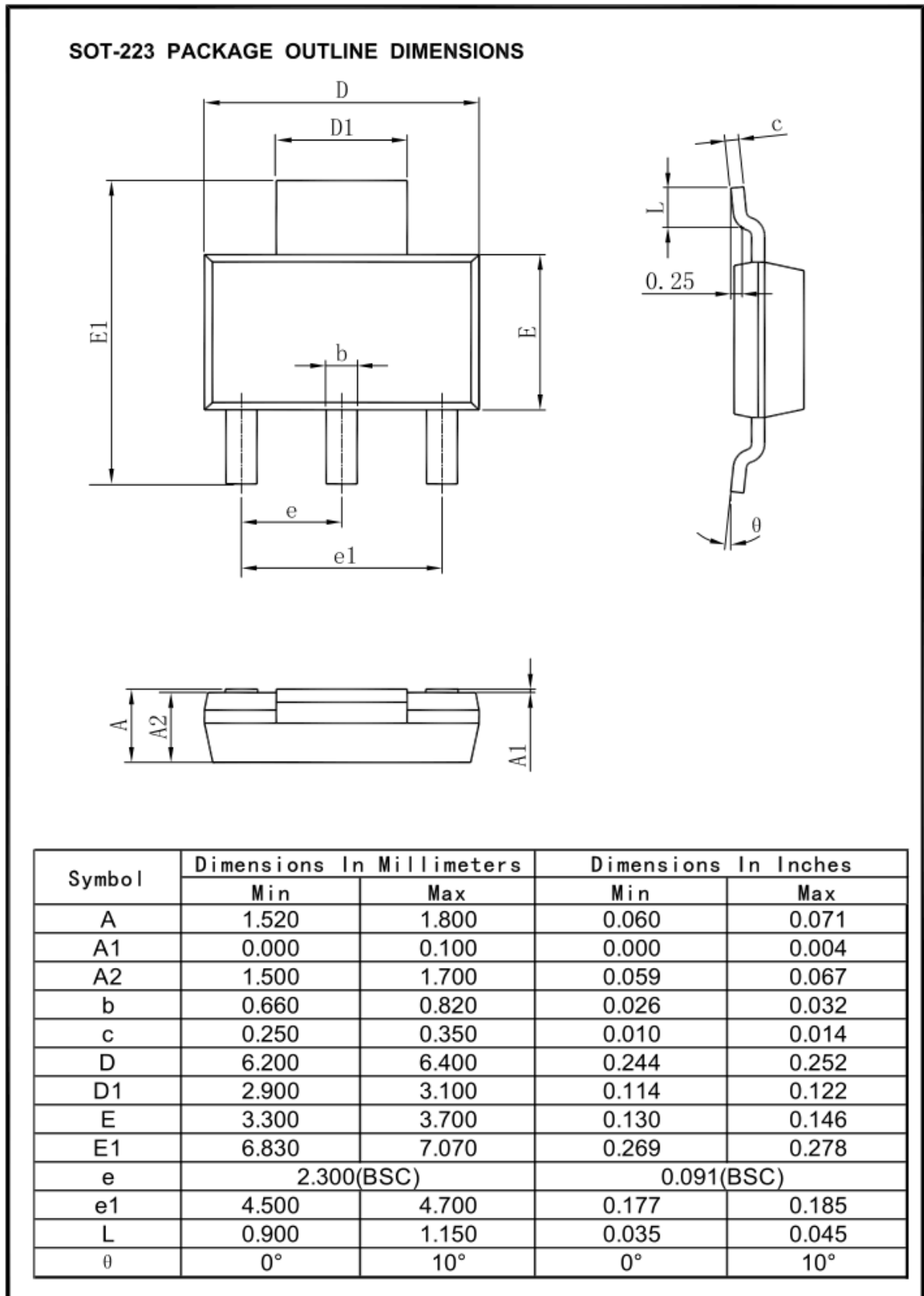
SOT-89-3L PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.197
b1	0.400	0.580	0.016	0.023
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.550 REF		0.061 REF	
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500 TYP		0.060TYP	
e1	3.000 TYP		0.118TYP	
L	0.900	1.200	0.035	0.047

High Voltage Low Power Consumption LDO CMOS Voltage Regulator

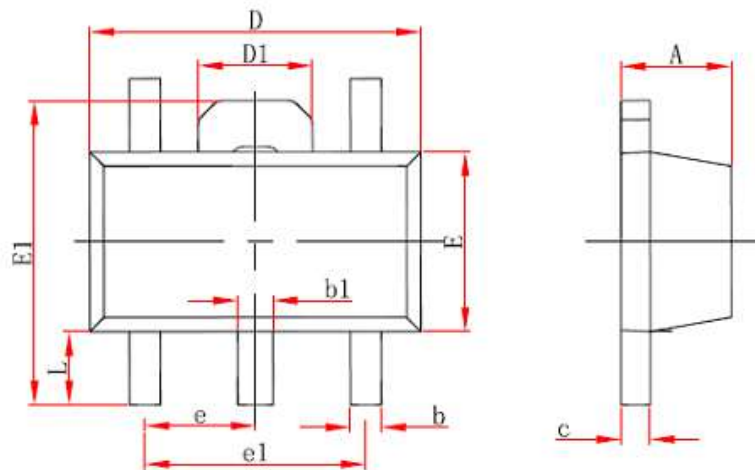
■ Packaging Information (Continued)



High Voltage Low Power Consumption LDO CMOS Voltage Regulator

■ Packaging Information (Continued)

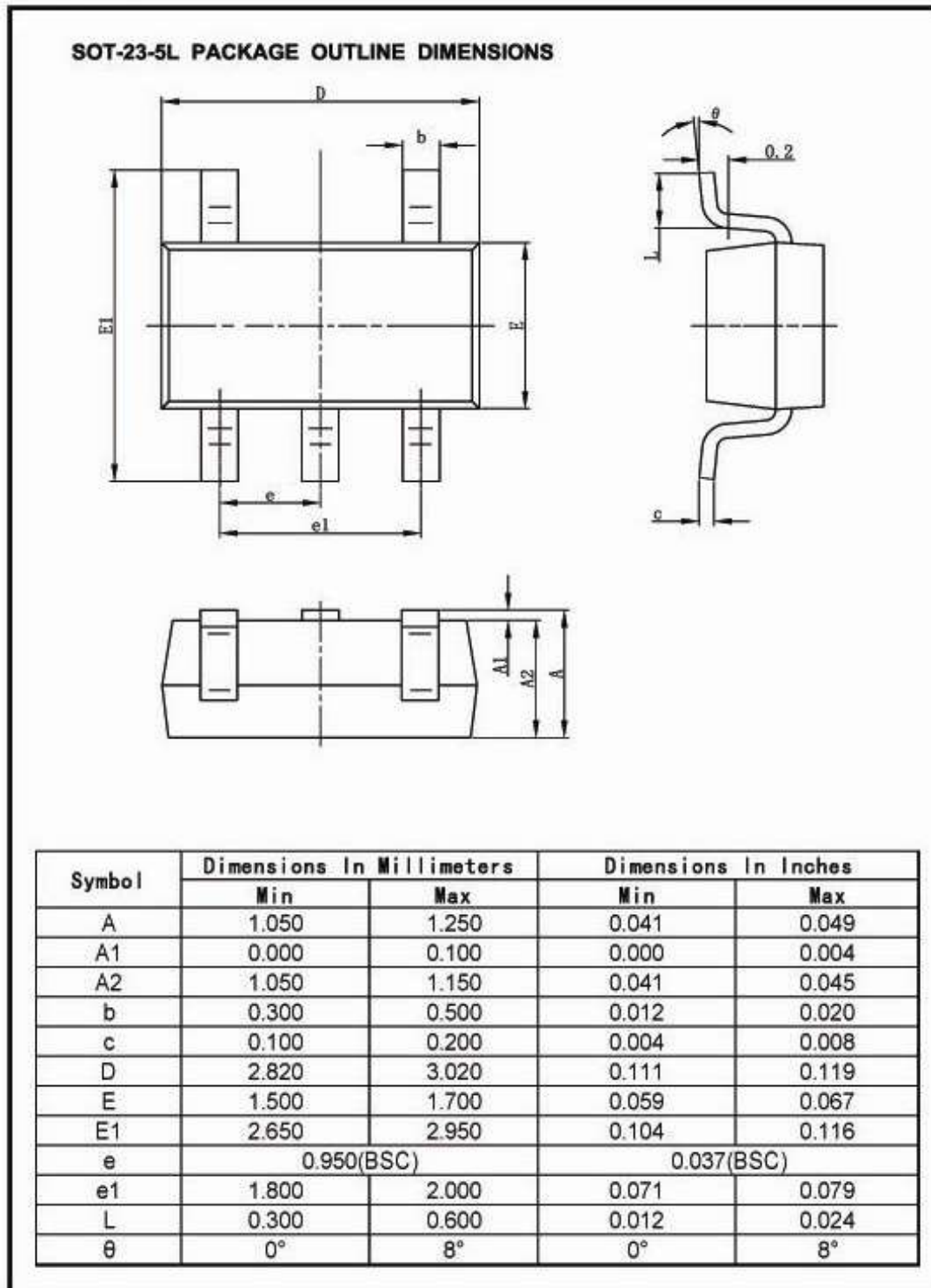
SOT-89-5L PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.020
b1	0.380	0.580	0.015	0.023
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.550 REF.		0.061 REF.	
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500 TYP.		0.060 TYP.	
e1	3.000 TYP.		0.118 TYP.	
L	0.900	1.200	0.035	0.047

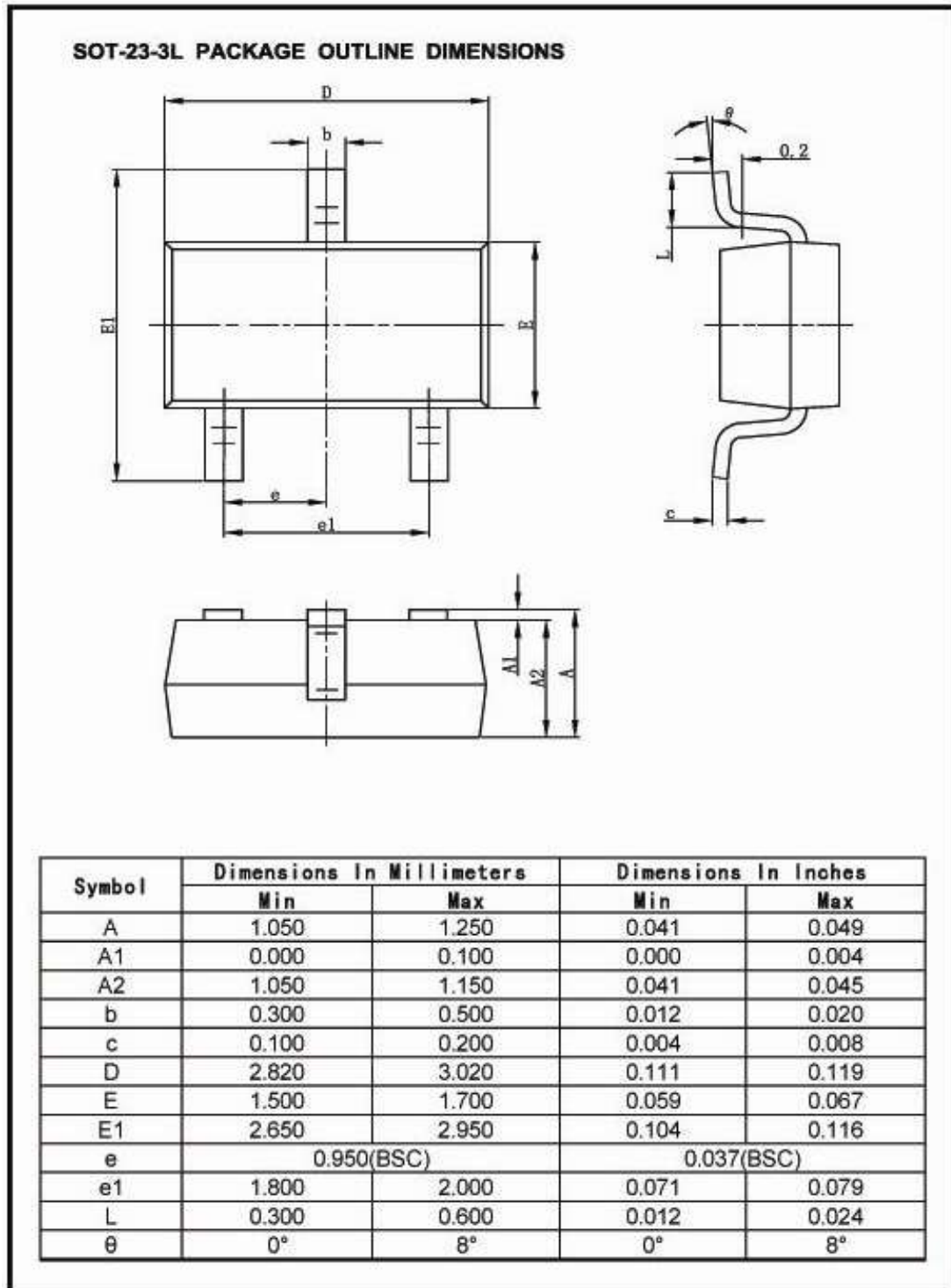
High Voltage Low Power Consumption LDO CMOS Voltage Regulator

■ Packaging Information (Continued)



High Voltage Low Power Consumption LDO CMOS Voltage Regulator

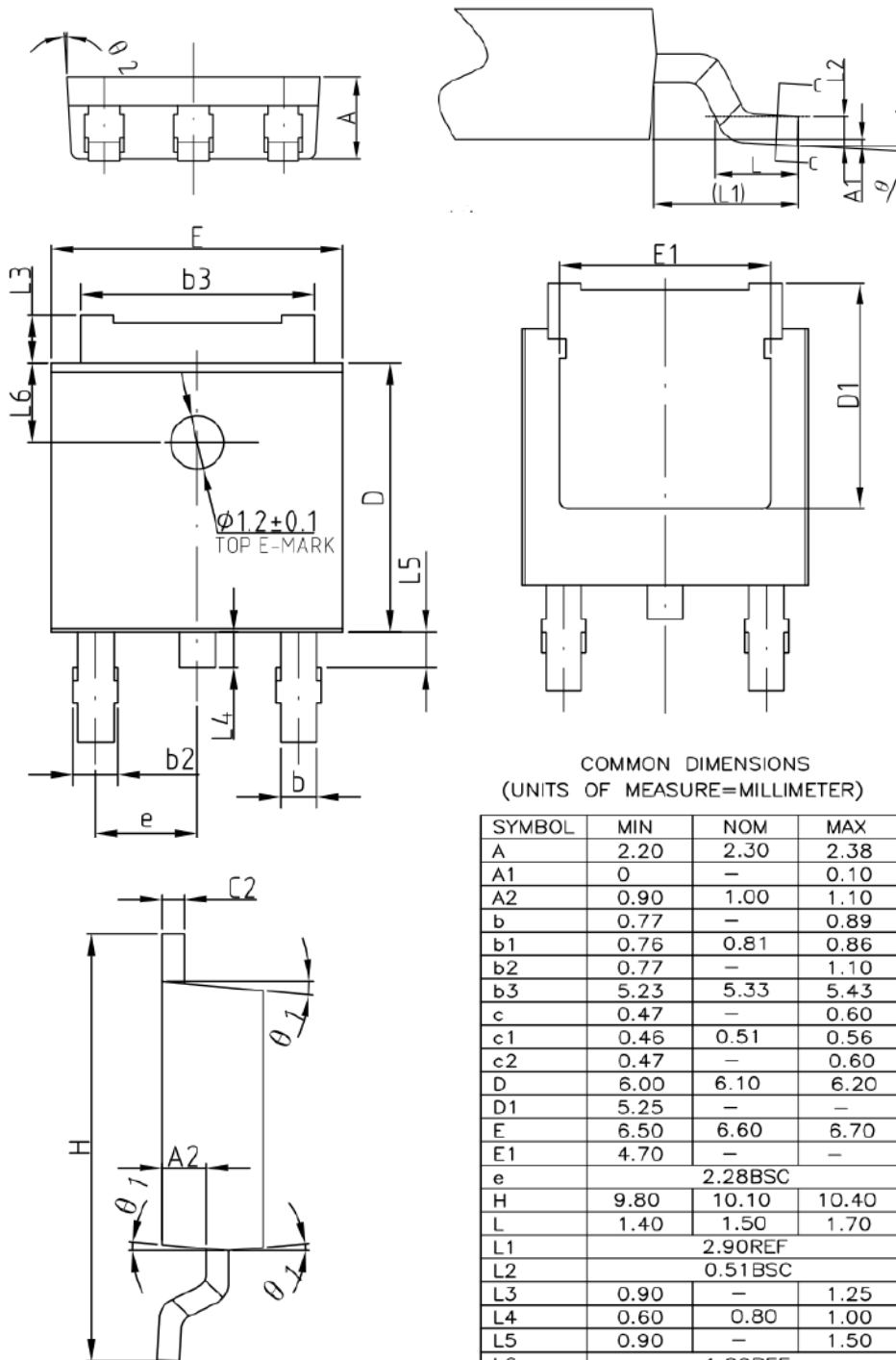
■ Packaging Information (Continued)



High Voltage Low Power Consumption LDO CMOS Voltage Regulator

■ Packaging Information (Continued)

T0252-2L PACKGE OUTLINE DIMENSIONS



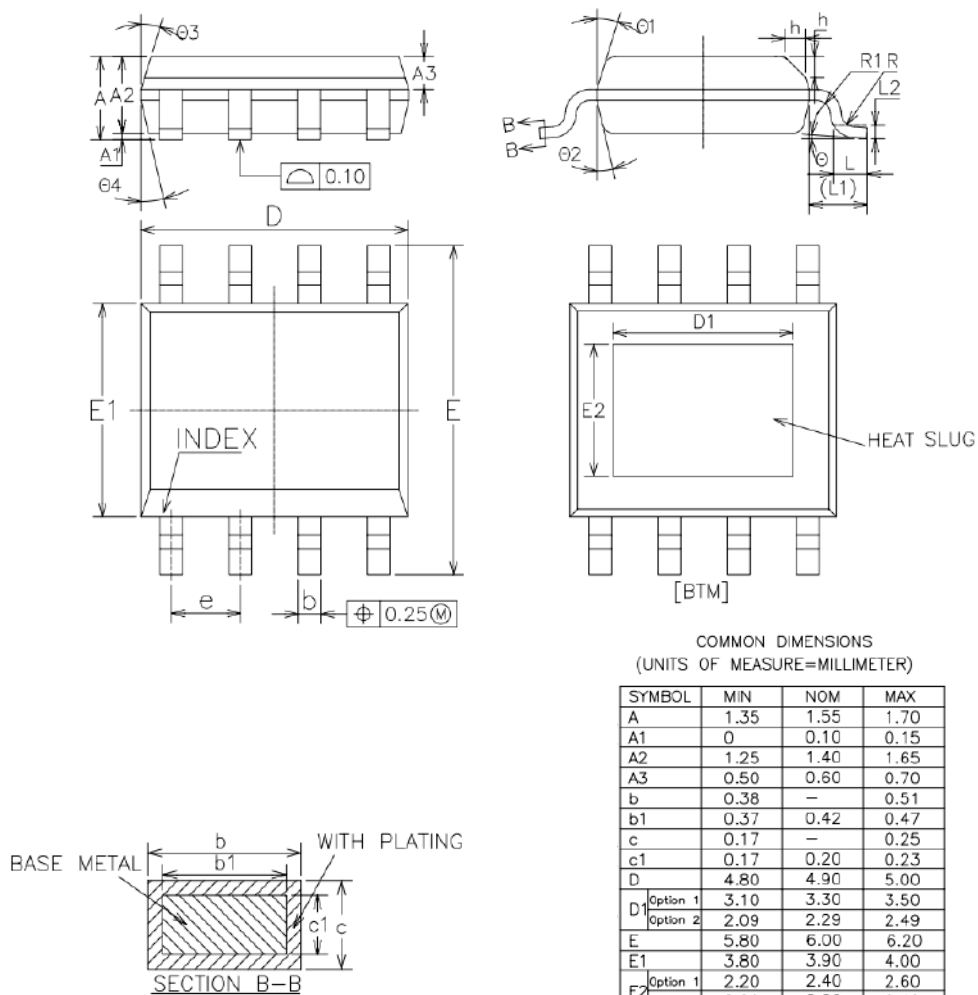
COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	2.20	2.30	2.38
A1	0	—	0.10
A2	0.90	1.00	1.10
b	0.77	—	0.89
b1	0.76	0.81	0.86
b2	0.77	—	1.10
b3	5.23	5.33	5.43
c	0.47	—	0.60
c1	0.46	0.51	0.56
c2	0.47	—	0.60
D	6.00	6.10	6.20
D1	5.25	—	—
E	6.50	6.60	6.70
E1	4.70	—	—
e	2.28BSC		
H	9.80	10.10	10.40
L	1.40	1.50	1.70
L1	2.90REF		
L2	0.51BSC		
L3	0.90	—	1.25
L4	0.60	0.80	1.00
L5	0.90	—	1.50
L6	1.80REF		
θ	0°	—	8°
θ 1	3°	5°	7°
θ 2	1°	3°	5°

High Voltage Low Power Consumption LDO CMOS Voltage Regulator

■ Packaging Information (Continued)

ESOP8 PACKAGE OUTLINE DIMENSIONS



COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	1.35	1.55	1.70
A1	0	0.10	0.15
A2	1.25	1.40	1.65
A3	0.50	0.60	0.70
b	0.38	—	0.51
b1	0.37	0.42	0.47
c	0.17	—	0.25
c1	0.17	0.20	0.23
D	4.80	4.90	5.00
D1	Option 1 Option 2	3.10 2.09	3.30 2.29
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
E2	Option 1 Option 2	2.20 2.09	2.40 2.29
e	1.17	1.27	1.37
L	0.45	0.60	0.80
L1	1.04REF		
L2	0.25BSC		
R	0.07	—	—
R1	0.07	—	—
h	0.30	0.40	0.50
θ	0°	—	8°
θ1	15°	17°	19°
θ2	11°	13°	15°
θ3	15°	17°	19°
θ4	11°	13°	15°