36V, 200mA Low Dropout Voltage Linear Regulator

❖ GENERAL DESCRIPTION

The AX6686 series are a group of low-dropout (LDO) voltage regulators offering the benefits of wide input voltage range, low dropout voltage, low power consumption, and miniaturized packaging.

Quiescent current of only 2.2μA makes these devices ideal for powering the battery-powered, always-on systems that require very little idle-state power dissipation to a longer service life. There is an option of shutdown mode by selecting the parts with the EN pin and pulling it low. The shutdown current in this mode goes down to only 10nA (typical).

The AX6686 series of linear regulators are stable with the ceramic output capacitor over its wide input range from 2V to 36V and the entire range of output load current (0mA to 200mA).

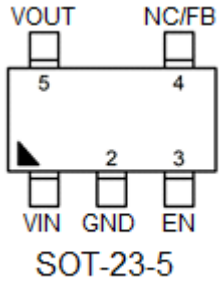
❖ FEATURES

- 2.2μA Ground Current at no Load
- ±2% Output Accuracy
- 200mA Output Current
- 10nA Disable Current
- Wide Operating Input Voltage Range: 2V to 36V
- Dropout Voltage: 0.65V at 100mA/ VIN 5V
- Support Fixed Output Voltage 3.3V, 5V.
- Stable with Ceramic or Tantalum Capacitor
- Current Limit Protection
- Over-Temperature Protection
- SOT-23-5, SOT-23-3,SOT-89-3 Package Available
- RoHS and Halogen free compliance.

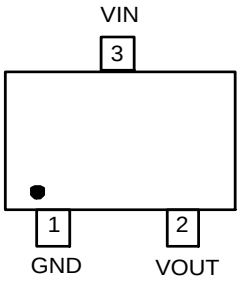
❖ Applications

- Portable, Battery Powered Equipment
- Low Power Microcontrollers
- Laptop, Palmtops and PDAs
- Wireless Communication Equipment
- Audio/Video Equipment
- Car Navigation Systems
- Industrial Controls
- Weighting Scales
- Meters
- Home Automation

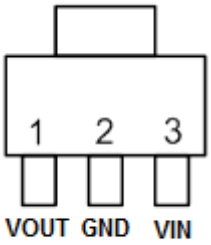
❖ Pin Configurations



SOT-23-5



SOT-23-3



SOT-89-3

❖ Description of Functional Pins

Pin No			Pin Name	Pin Function
SOT-23-5L	SOT-23-3L	SOT-89-3L		
2	1	2	GND	Ground
5	2	1	VOUT	Output of the Regulator
1	3	3	VIN	Input of Supply Voltage.
3			EN	Enable Control Input.
4			NC	No Internal Connection.
			FB	Sense of Output Voltage

❖ ORDER/MARKING INFORMATION

Order Information

AX6686-XXXX

Output voltage	Package	Packing
Blank : ADJ	B : SOT-23-5L	Blank:Bulk
33 : 3.3V	R : SOT-23-3L	A : Taping
50 : 5.0V	F : SOT89-3L	

Top Marking (SOT-23-5L)

LLYWX → ID code:internal
WW:01~26 (A~Z)
27~52 (a~z)
Year: 8=2018, 9=2019, B=2020, C=2021, D=2022, ⋮, Z=2044

Output Type:
JK : ADJ
AZ : 3.3V
PI : 5.0V

Top Marking (SOT-23-3L)

LLYWX → ID code:internal
WW:01~26 (A~Z)
27~52 (a~z)
Year: 8=2018, 9=2019, B=2020, C=2021, D=2022, ⋮, Z=2044

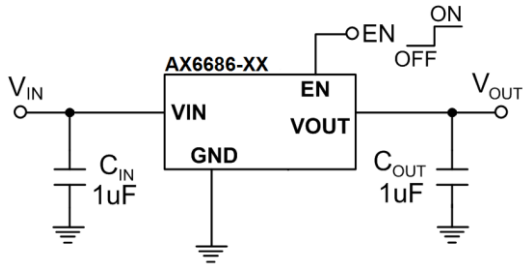
Output Type:
SM : ADJ
CX : 3.3V
CY : 5.0V

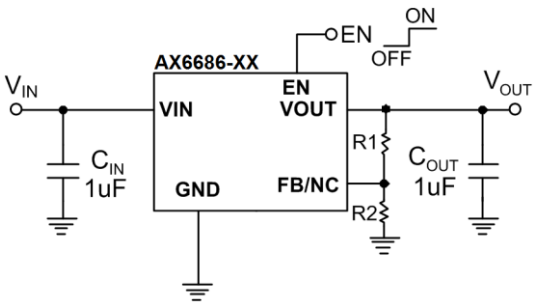
Top Marking (SOT-89-3L)

6686 → Part number
LYWX → ID code: internal
WW: 01~26(A~Z)
27~52(a~z)
Year: 8=2018, 9=2019, B=2020, C=2021, D=2022, ⋮, Z=2044

Output Type:
V : ADJ
Q : 3.3V
S : 5.0V

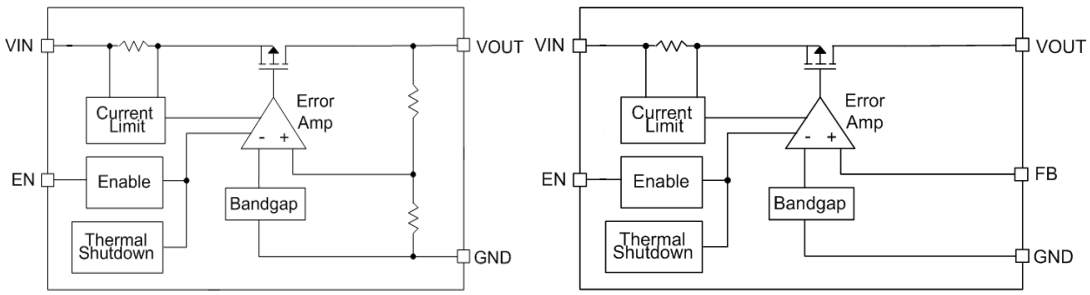
❖ Typical Application Circuits





$V_{OUT}=V_{FB}*(1+R1/R2)$
V_{FB}= 1.8V
R2 Range=50K~300K

❖ Function Block Diagram



Fixed Version **Adjustable Version**

Absolute Maximum Ratings (Note 1)

VIN, EN to GND..... -0.3V to 40V

VOUT to GND

AX6686-33, AX6686-50 ..... -0.3V to 6.0V

VOUT to VIN.....-40V to 0.3V

Package Thermal Resistance (Note 2)

SOT-23-3, θ_{JA} .....250℃ /W

SOT-23-5, θ_{JA} .....250℃ /W

SOT-89-3, θ_{JA} .....175℃ /W

Lead Temperature (Soldering, 10 sec.) .....260℃

Junction Temperature.....150℃

Storage Temperature Range .....-60℃ to 150℃

ESD Susceptibility

HBM.....2KV

MM.....200V

Recommended Operating Conditions

Input Voltage VIN.....2.0V to 36V

Junction Temperature Range.....-40℃ to 125℃

Ambient Temperature Range.....-40℃ to 85℃

❖ ELECTRICAL CHARACTERISTICS

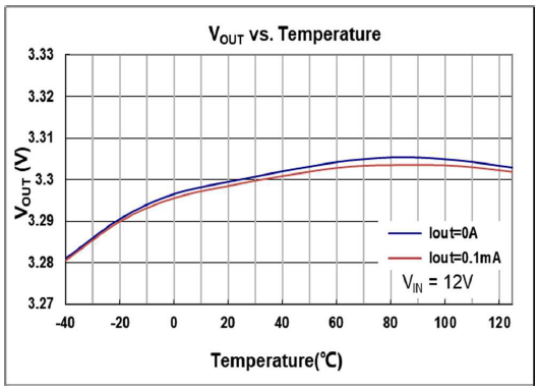
(V_{IN} =15V, V_{EN} =5V, T_A=25℃ unless otherwise specified)

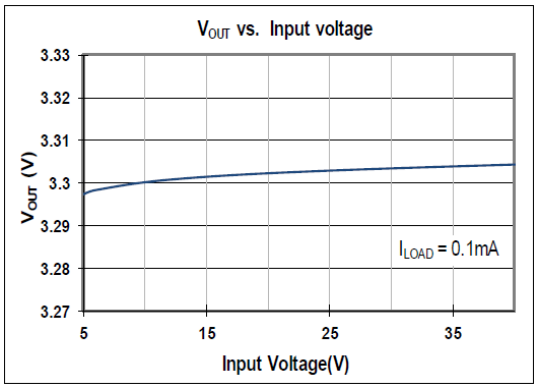
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Supply Voltage	V_{IN}		2	--	36	V
DC Output Voltage Accuracy		I_{LOAD} =0.1mA	-2		2	%
Dropout Voltage (I_{LOAD} =100mA)	V_{DROP}	V_{OUT} ≥ 5V	--	0.66		V
	$V_{DROP\_3.3V}$	V_{OUT} = 3.3V		0.75		
Ground Current (I_{LOAD} = 0mA)	I_Q	V_{OUT} ≤ 5V		2.2		μA
	I_{QH}	5V < V_{OUT} ≤ 12V		4.2		
Shutdown Ground Current	I_{SD}	V_{EN} = 0V, V_{OUT} = 0V		0.01	0.5	μA
VOUT Shutdown Leakage Current	I_{LEAK}			0.01	0.5	
Enable Threshold Voltage	V_{IH}	EN Rising			2	V
	V_{IL}	EN Falling	0.4			
EN Input Current	I_{EN}	V_{EN} = 36V		0.1	1	uA
FB Voltage	V_{FB}	I_{LOAD}=1mA		1.8		V
Line Regulation	ΔLINE	I_{LOAD} =1mA, 5 ≤ V_{IN} ≤ 36V	--	0.3		%
Load Regulation	ΔLOAD	1mA≤ I_{LOAD} ≤ 0.2A		0.1		%
Output Current Limit	I_{LIM}	V_{OUT} =0	201	300		mA
Power Supply Rejection Ratio	PSRR	V_{OUT} =5V, I_{LOAD}=1mA, V_{IN} = 12V, f = 100Hz		70		dB
Thermal Shutdown Temperature	T_{SD}	I_{LOAD} =10mA	--	160	--	°C
Thermal Shutdown Hysteresis	$ΔT_{SD}$			15		°C

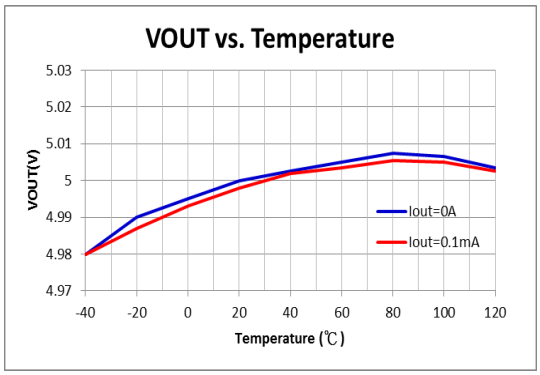
Note 1. Stresses beyond those listed “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

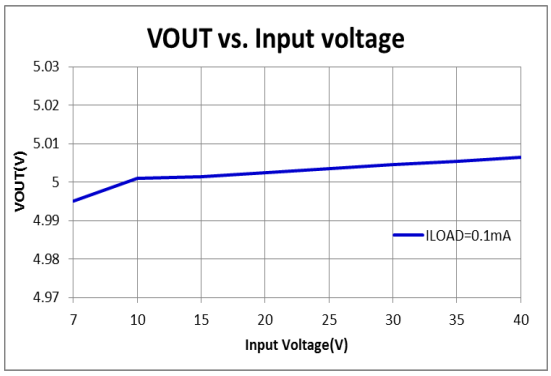
Note 2. $θ_{JA}$ is measured at TA = 25°C on a AXELITE EVB board.

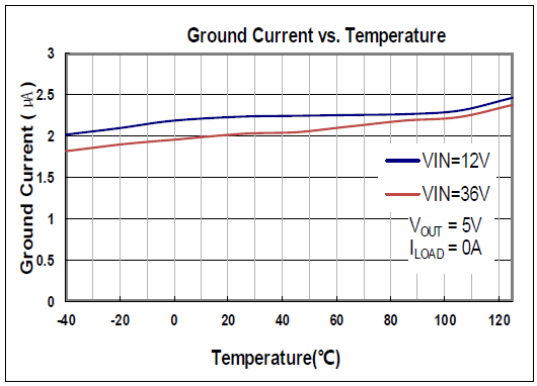
❖ Typical Characteristics

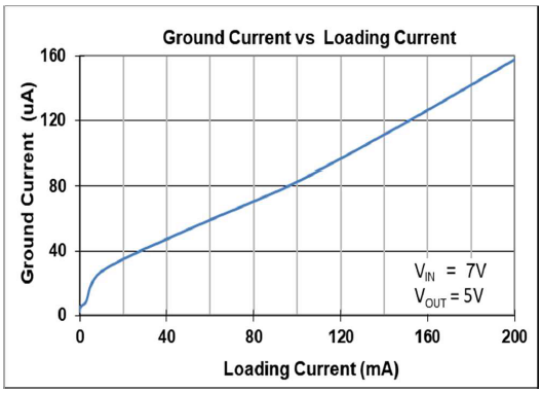


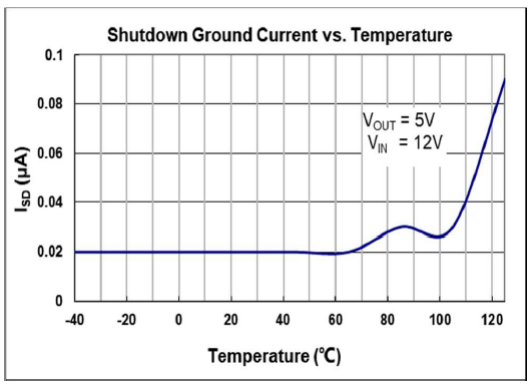




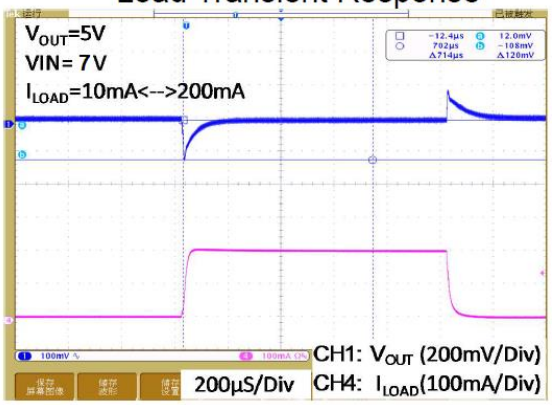




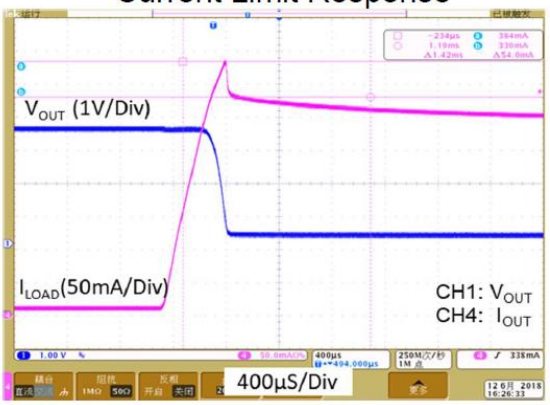




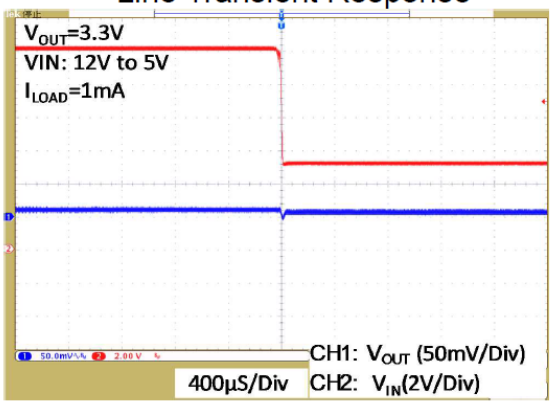
Load Transient Response



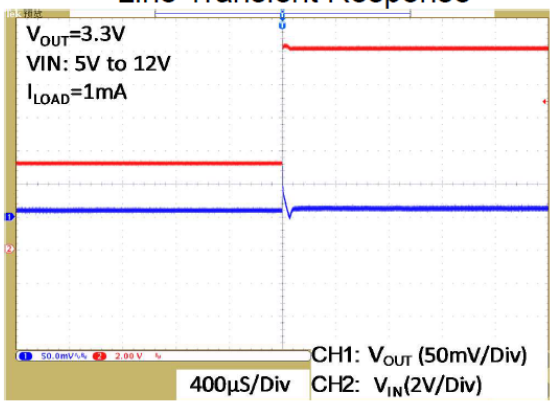
Current Limit Response



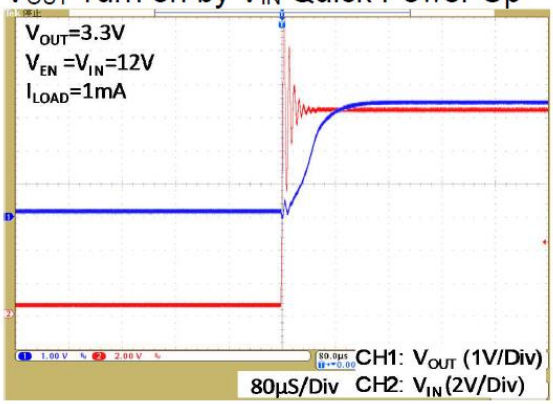
Line Transient Response



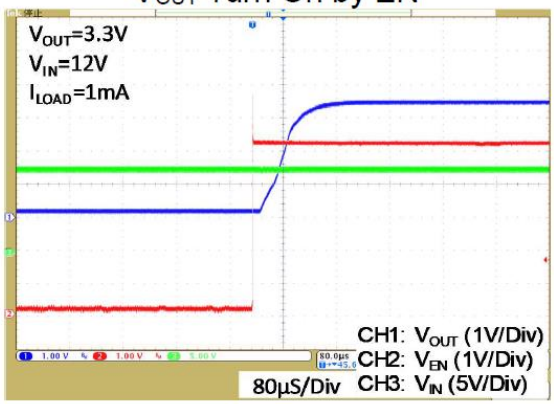
Line Transient Response



VOUT Turn on by VIN Quick Power Up



VOUT Turn On by EN



❖ Application Guideline

Input and Output Capacitor Requirements

The external input and output capacitors of AX6686 series must be properly selected for stability and performance. Use a 1μF or larger input capacitor and place it close to the IC's VIN and GND pins. Any output capacitor meeting the minimum 1mΩ ESR (Equivalent Series Resistance) and effective capacitance between 1μF and 22μF requirement may be used. Place the output capacitor close to the IC's VOUT and GND pins. Increasing capacitance and decreasing ESR can improve the circuit's PSRR and line transient response.

Current Limit

The AX6686 series contain the current limiter of output power transistor, which monitors and controls the transistor, limiting the output current to 300mA (typical). The output can be shorted to ground indefinitely without damaging the part.

Dropout Voltage

The AX6686 series use a PMOS pass transistor to achieve low dropout. When (VIN – VOUT) is less than the dropout voltage (V_{DROP}), the PMOS pass device is in the linear region of operation and the input-to-output resistance is the RDS(ON) of the PMOS pass element. V_{DROP} scales approximately with the output current because the PMOS device behaves as a resistor in dropout condition.

As any linear regulator, PSRR and transient response are degraded as (VIN – VOUT) approaches dropout condition.

OTP (Over Temperature Protection)

The over temperature protection function of AX6686 series will turn off the P-MOSFET when the junction temperature exceeds 160°C (typ.). Once the junction temperature cools down by approximately 15°C, the regulator will automatically resume operation.

Thermal Application

For continuous operation, do not exceed the absolute maximum junction temperature. The maximum power dissipation depends on the thermal resistance of the IC package, PCB layout, rate of surrounding airflow, and difference between junction and ambient temperature. The maximum power dissipation can be calculated as below:

T_A=25°C, AXELITE PCB,

The max PD(Max)= (125°C − 25°C) / (250°C/W) = 0.4W for SOT-23-3L packages.

The max PD(Max)= (125°C − 25°C) / (250°C/W) = 0.4W for SOT23-5L package.

The max PD(Max)= (125°C − 25°C) / (175°C/W) = 0.57W forSOT89-3L package.

Power dissipation (PD) is equal to the product of the output current and the voltage drop across the output pass element, as shown in the equation below:

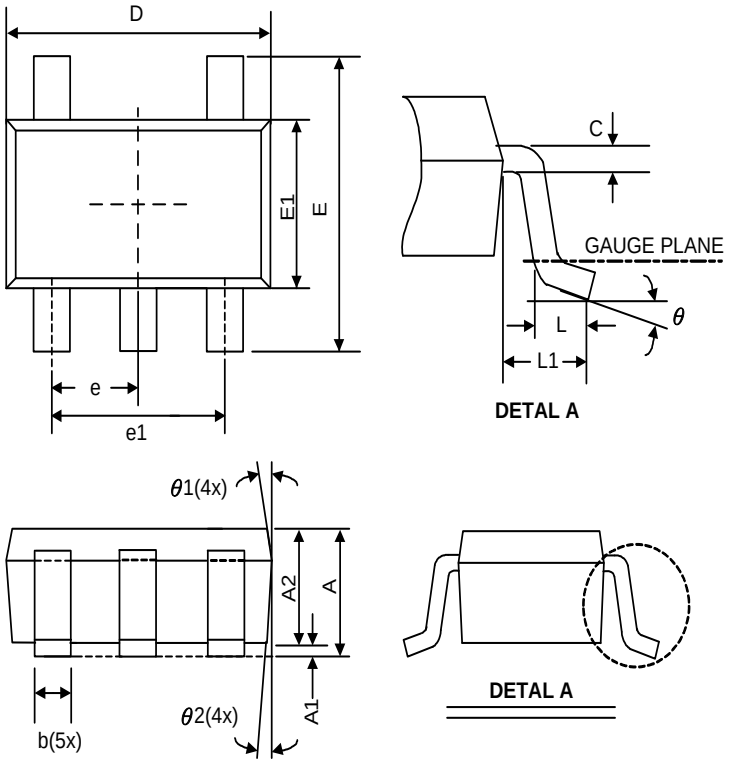
PD = (VIN – VOUT) × IOUT

Layout Consideration

By placing input and output capacitors on the same side of the PCB as the LDO, and placing them as close as is practical to the package can achieve the best performance. The ground connections for input and output capacitors must be back to the AX6686 ground pin using as wide and as short of a copper trace as is practical. Connections using long trace lengths, narrow trace widths, and/or connections through via must be avoided. These add parasitic inductances and resistance that results in worse performance especially during transient conditions.

❖ Package Information:

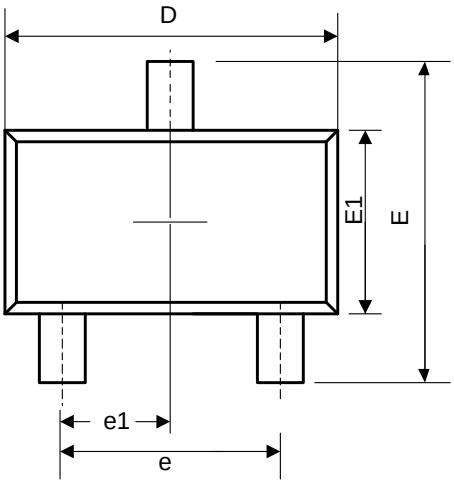
SOT-23-5L

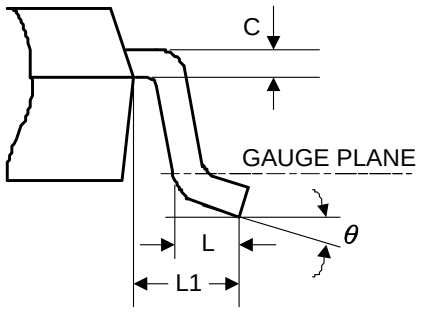


Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.45	-	-	0.057
A1	0	0.08	0.15	0	0.003	0.006
A2	0.9	1.1	1.3	0.035	0.043	0.051
b	0.3	0.4	0.5	0.012	0.016	0.02
C	0.08	0.15	0.22	0.003	0.006	0.009
D	2.7	2.9	3.1	0.106	0.114	0.122
E1	1.4	1.6	1.8	0.055	0.063	0.071
E	2.6	2.8	3	0.102	0.11	0.118
L	0.3	0.45	0.6	0.012	0.018	0.024
L1	0.5	0.6	0.7	0.02	0.024	0.028
e1	1.9 BSC			0.075 BSC		
e	0.95 BSC			0.037 BSC		
θ	0°	4°	8°	0°	4°	8°
θ 1	5°	10°	15°	5°	10°	15°
θ 2	5°	10°	15°	5°	10°	15°

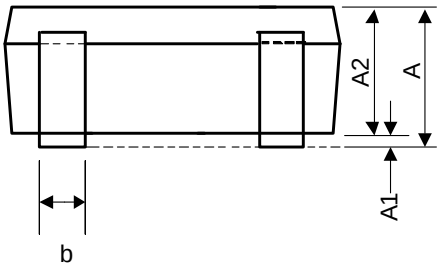
JEDEC outline: MO-178 AA

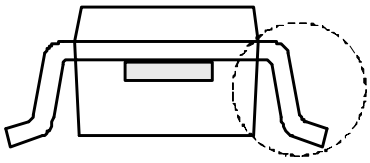
SOT-23-3L





VIEW C





SEE VIEW C

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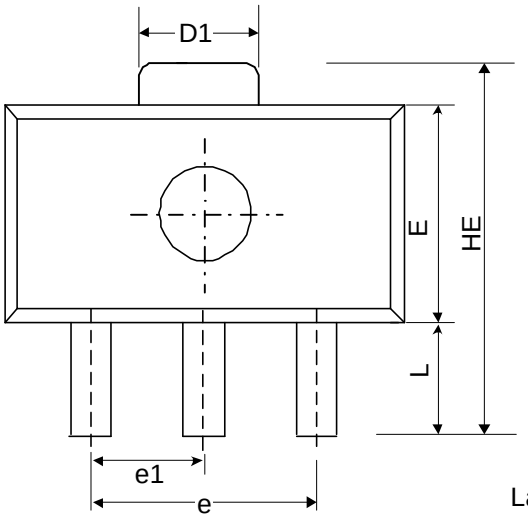
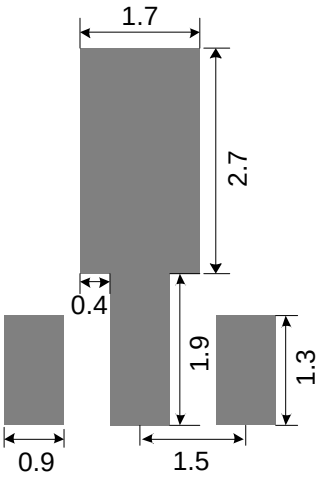
A2	0.9	1.1	1.3	0.035	0.043	0.051
b	0.3	0.4	0.5	0.012	0.016	0.02
C	0.08	0.15	0.22	0.003	0.006	0.009
D	2.7	2.9	3.1	0.106	0.114	0.122
E	2.6	2.8	3	0.102	0.11	0.118
E1	1.4	1.6	1.8	0.055	0.063	0.071
L	0.3	0.45	0.6	0.012	0.018	0.024
L1	0.5	0.6	0.7	0.02	0.024	0.028
e	1.9 BSC			0.075 BSC		
e1	0.95 BSC			0.037 BSC		
θ	0°	4°	8°	0°	4°	8°

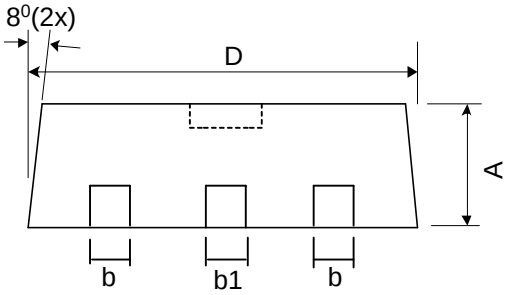
JEDEC outline: NA

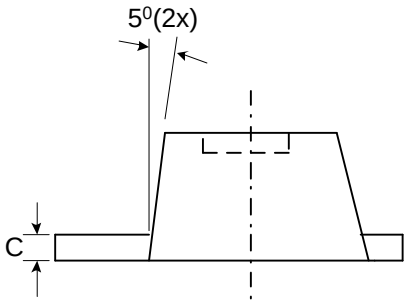
SOT-89-3L





Land Pattern Recommendation (Unit: mm)





Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	1.4	1.5	1.6	0.055	0.059	0.063
b	0.36	0.42	0.48	0.014	0.017	0.019
b1	0.44	0.5	0.56	0.017	0.02	0.022
C	0.35	0.4	0.44	0.014	0.016	0.017
D	4.4	4.5	4.6	0.173	0.177	0.181
D1	1.35	1.59	1.83	0.053	0.063	0.072
e	3.0 BSC			0.118 BSC		
e1	1.5 BSC			0.059 BSC		
E	2.29	2.45	2.6	0.09	0.097	0.102
HE	3.94	4.1	4.25	0.155	0.161	0.167
L	0.8	1	1.2	0.031	0.04	0.047

JEDEC outline: TO-243 AB