

# Ultra LDO 2A Linear Regulator With Adjustable & Bypass Pin

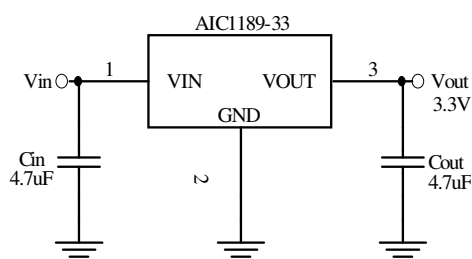
## ■ FEATURES

- Guaranteed 2A Output Current.
- Fast Response in Line/Load Transient.
- Wide Operating Voltage Ranges: 2.3V to 5.5V.
- 0.01 $\mu$ A Shutdown Standby Current .
- Low Quiescent Current: 80 $\mu$ A.
- Fixed: 1.2V, 1.5V, 1.8V, 2.0V, 2.5V, 2.7V, 3.0V, 3.3V, 3.5V, 3.7V, 3.8V Output Voltage.
- Adjustable Output Voltage are available from 0.8~4.5V.
- Low Dropout : 330mV at 1.5A and 2.8V output voltage, 440mV at 2A and 2.8V output voltage.
- High PSRR : 70dB at 1kHz.
- Active Low or High Shutdown Control.Current Limit and Thermal Protection.
- Available in  $\pm$ 2% Output Tolerance.
- Available in SOT-223 & TO-220 (3 pin) & SOP-8 (8 pin) and TO-252 & TO-263 (3 & 5 pin) Package.

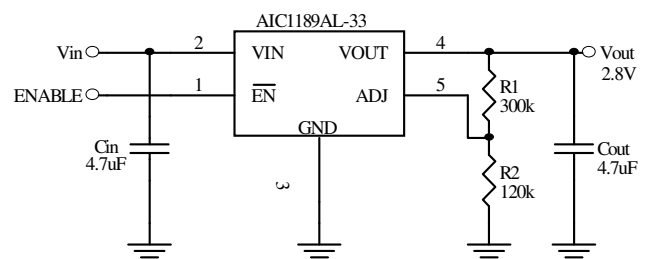
## ■ APPLICATIONS

- LCD TV, LCD Monitor, DPF.
- Networking, STB.
- Portable AV Equipment.
- Note Book PC Applications.
- PC Peripherals.

## ■ TYPICAL APPLICATION CIRCUIT



Fixed Linear Regulator



Adjustable Linear Regulator

## ■ DESCRIPTION

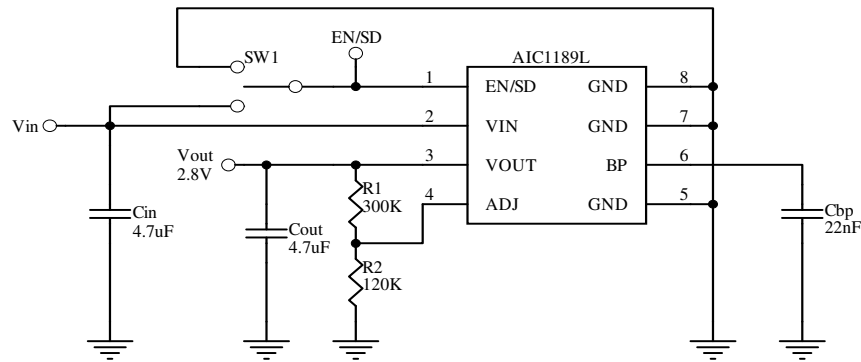
A low noise, high PSRR and ultra low dropout linear regulator AIC1189 is optimized for low ESR ceramic capacitors operation with 2A continuous current. The AIC1189 is designed for portable and wireless devices with demanding performance and space requirements.

The AIC1189 offers high precision output voltage of  $\pm$ 2% tolerance. Output voltage can also be adjusted for those other than the preset values.

A noise bypass pin is available for further reduction of output noise. The bypass pin could be floating if it's unnecessary. At 2A load current and 2.8V output voltage, a 440mV dropout is performed. The quality of low quiescent current and low dropout voltage makes this device ideal for battery power applications. The high ripple rejection and low noise of the AIC1189 provide enhanced performances for critical applications such as cellular phones, and PDAs.

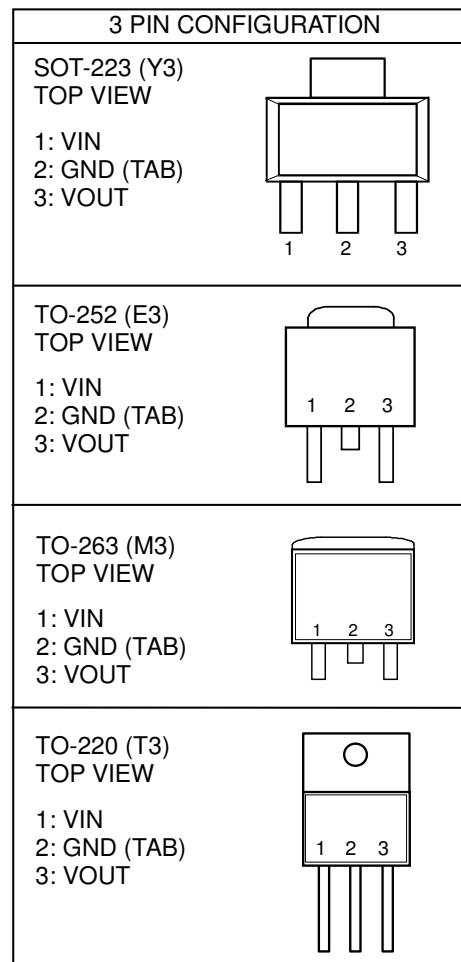
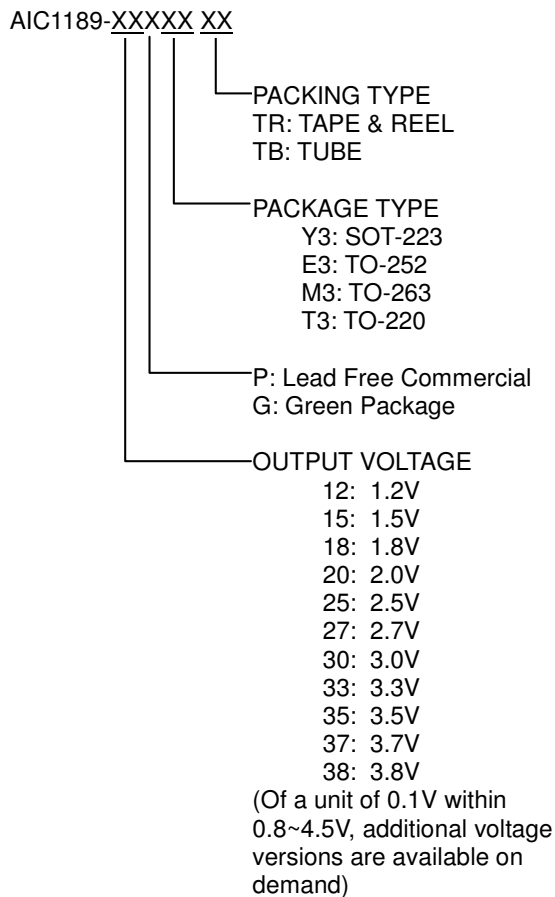
In addition, a logic-level shutdown input is included, which reduce supply current to 0.01 $\mu$ A (typ.) in shutdown mode with fast turn-on time less than 100 $\mu$ s. The AIC1189's current limit and thermal protection provide protection against any overload condition that would create excessive junction temperatures.

## TYPICAL APPLICATION CIRCUIT (Continued)



Adjustable Linear Regulator in SOP-8 Package

## ORDERING INFORMATION



Example: AIC1189-18PE3TR

→ 1.8V Version, in TO-252 Lead Free Package & Tape & Reel Packing Type

■ ORDERING INFORMATION (Continued)

AIC1189XX-XXXXXXX

PACKING TYPE  
TR: TAPE & REEL  
TB: TUBE

PACKAGE TYPE  
E5: TO-252-5  
M5: TO-263-5

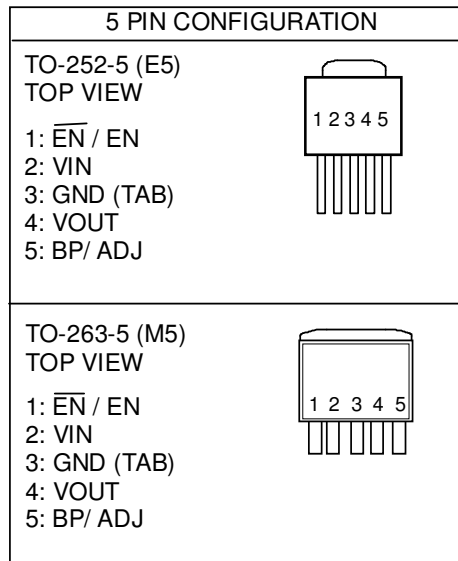
P: Lead Free Commercial  
G: Green Package

OUTPUT VOLTAGE  
12: 1.2V  
15: 1.5V  
18: 1.8V  
20: 2.0V  
25: 2.5V  
27: 2.7V  
30: 3.0V  
33: 3.3V  
35: 3.5V  
37: 3.7V  
38: 3.8V

(Of a unit of 0.1V within  
0.8~4.5V, additional voltage  
versions are available on  
demand)

ENABLE TYPE  
L: Chip Enable Low  
H: Chip Enable High

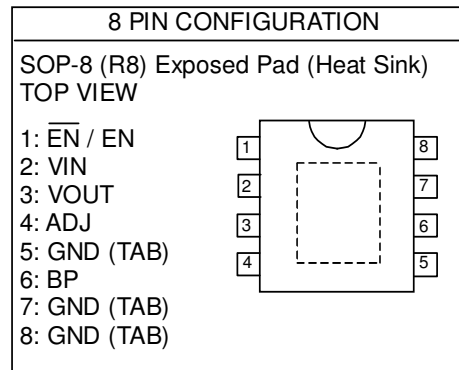
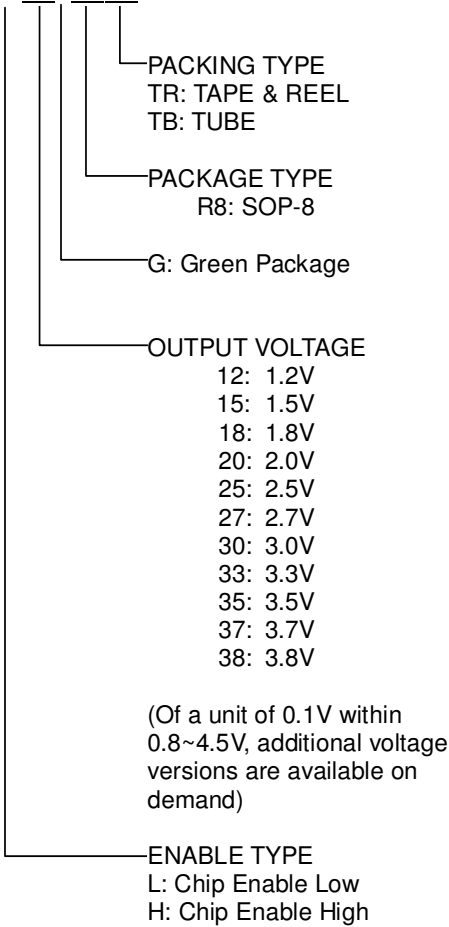
B: Bypass  
A: ADJ



Example: AIC1189BH-18PM5TR  
 → With Bypass Pin, Chip Enable High,  
 1.8V Version, in TO-263-5 Lead Free  
 Package & Tape & Reel Packing Type

■ ORDERING INFORMATION (Continued)

AIC1189X-XXXXXXXX



Example: AIC1189H-18GR8TR

→ Chip Enable High, 1.8V Version, in SOP-8 Green Package & Tape & Reel Packing Type

● Marking

Part No	Marking	Part No	Marking
AIC1189-xxPY3	HAXxP	AIC1189-xxGY3	HAXxG

xx represents output voltage. (08=0.8V, 09=0.9V, ....., 44=4.4V, 45=4.5V)

**■ ABSOLUTE MAXIMUM RATINGS**

Input Voltage .....	6V
EN Pin Voltage .....	6V
Noise Bypass Terminal Voltage .....	6V
Operating Temperature Range .....	-40°C~85°C
Maximum Junction Temperature .....	150°C
Storage Temperature Range .....	-65°C~150°C
Lead Temperature (Soldering, 10 sec) .....	260°C
Thermal Resistance (Junction to Case)	
SOT-223 .....	15°C /W
TO-252 .....	8°C /W
TO-263 .....	3°C /W
TO-220 .....	3°C /W
SOP-8 (Exposed Pad) .....	15°C /W
Thermal Resistance (Junction to Ambient)	
(Assume no ambient airflow, no heat sink)	
SOT-223 .....	130°C /W
TO-252 .....	100°C /W
TO-263 .....	60°C /W
TO-220 .....	50°C /W
SOP-8 (Exposed Pad)	60°C /W

**Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.**

**ELECTRICAL CHARACTERISTICS**
**( $C_{IN} = C_{OUT} = 4.7\mu F$ ,  $C_{BP} = 22nF$ ,  $V_{IN} = V_{OUT} + 1V$ ,  $T_J = 25^\circ C$ , unless otherwise specified) (Note 1)**

PARAMETER	TEST CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Input Voltage (Note 2)		$V_{IN}$	2.3		5.5	V
Output Voltage Tolerance	$I_{OUT} = 1mA$	$V_{OUT}$	-2		2	%
Continuous Output Current		$I_{OUT}$	2			A
Quiescent Current	Chip Enable Low, $V_{EN} \leq 0.4V$ , $I_{OUT} = 0 mA$ Chip Enable High, $V_{EN} \geq 1.6V$ , $I_{OUT} = 0 mA$	$I_Q$		80	110	$\mu A$
GND Pin Current	Chip Enable Low, $V_{EN} \leq 0.4V$ , $I_{OUT} = 2A$ Chip Enable High, $V_{EN} \geq 1.6V$ , $I_{OUT} = 2A$	$I_{GND}$		90	120	$\mu A$
Standby Current	Chip Enable Low, $V_{EN} = V_{IN}$ Chip Enable High, $V_{EN} = 0$	$I_{STBY}$		0.01	0.5	$\mu A$
Output Current Limit	$R_{LOAD} = 0.1\Omega$	$I_{IL}$	2.2	3.2	3.9	A
Dropout Voltage	$I_{OUT} = 1.5A, 0.8V \leq V_{OUT} < 2V$ $I_{OUT} = 2A, 0.8V \leq V_{OUT} < 2V$	$V_{DROP}$			1500	mV
	$I_{OUT} = 1.5A, 2V \leq V_{OUT} < 2.8V$ $I_{OUT} = 2A, 2V \leq V_{OUT} < 2.8V$			450	600	
	$I_{OUT} = 1.5A, V_{OUT} \geq 2.8V$ $I_{OUT} = 2A, V_{OUT} \geq 2.8V$			600	800	
Line Regulation	$V_{IN} = V_{OUT} + 1V$ to 5.5V, $I_{OUT} = 1mA$	$\Delta V_{LIR}$		2.5	10	mV
Load Regulation	$I_{OUT} = 1mA$ to 2A	$\Delta V_{LOR}$		5	15	mV
Ripple Rejection	$f = 1KHz$ , Ripple = 0.5Vp-p,	PSRR		70		dB
Output Noise Voltage	$C_{BP} = 22nF$ , $f = 10 \sim 100KHz$			24		$\mu V_{rms}$
Temperature Coefficient		TC		50		ppm/ $^\circ C$
Thermal Shutdown Temperature	$V_{IN} = V_{OUT} + 1V$	$T_{SD}$		150		$^\circ C$
Thermal Shutdown Hysteresis		$\Delta T_{SD}$		20		$^\circ C$
<b>ADJ Pin Specifications</b>						
ADJ Pin Current	$V_{ADJ} = V_{REF}$	$I_{ADJ}$		10	100	nA
ADJ Pin Threshold		$V_{TH(ADJ)}$	0.05	0.1	0.2	V
Reference Voltage Tolerance		$V_{REF}$	0.784	0.8	0.816	V

**■ ELECTRICAL CHARACTERISTICS** (Continued)

PARAMETER	TEST CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
<b>Shutdown Pin Specifications</b>						
Shutdown Pin Current	$V_{EN} = V_{IN}$ or GND	$I_{EN}$		0	100	nA
Shutdown Exit Delay Time	$I_{OUT} = 30\text{mA}$	$\Delta t$		100		$\mu\text{S}$
Max Output Discharge Resistance to GND during Shutdown		$R_{DSON\_CLMP}$		20	100	$\Omega$
Shutdown Input Threshold	Chip Enable Low, Output OFF, $V_{IN} = 2.3\text{V}$ to $5.5\text{V}$	$V_{ENH}$	1.6			V
	Chip Enable High, Output ON, $V_{IN} = 2.3\text{V}$ to $5.5\text{V}$	$V_{ENL}$			0.4	
	Chip Enable Low, Output ON, $V_{IN} = 2.3\text{V}$ to $5.5\text{V}$					
	Chip Enable High, Output OFF, $V_{IN} = 2.3\text{V}$ to $5.5\text{V}$					

Note 1: Specifications are production tested at  $T_A = 25^\circ\text{C}$ . Specifications over the  $-40^\circ\text{C}$  to  $85^\circ\text{C}$  operating temperature range are assured by design, characterization and correlation with Statistical Quality Controls (SQC).

Note 2: For SOP-8 Package,  $V_{IN} = 2.3\text{V}$  to  $5.0\text{V}$ .

**TYPICAL PERFORMANCE CHARACTERISTICS**

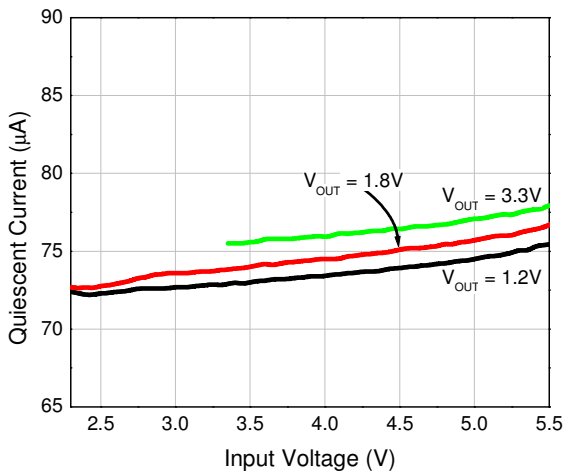


Fig1. Quiescent Current vs. Input Voltage

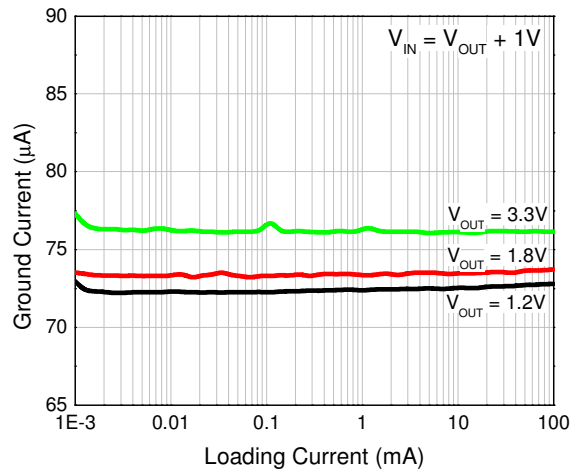


Fig2. Ground Current vs. Loading Current

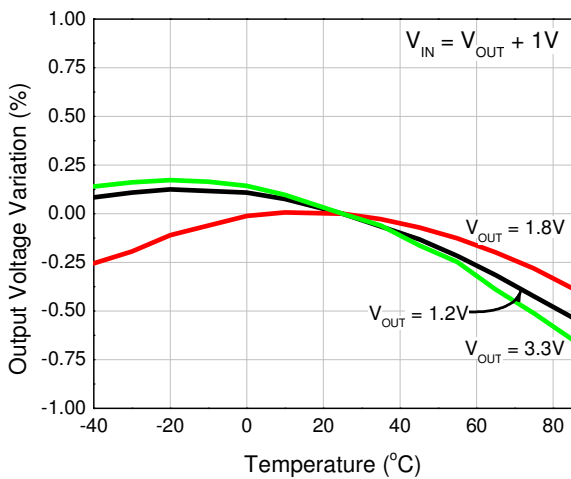


Fig3. Output Voltage Variation vs. Temperature

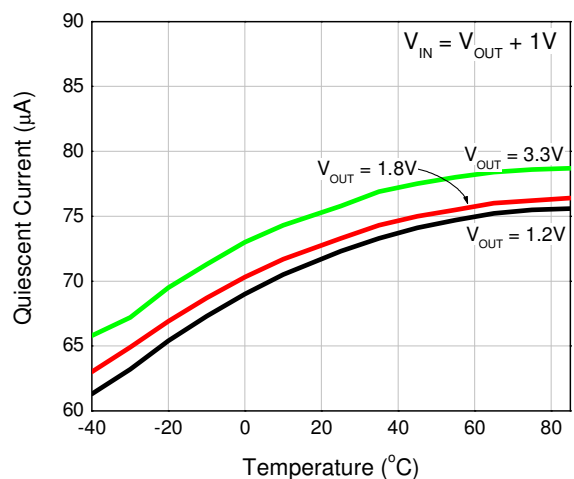


Fig4. Quiescent Current vs. Temperature

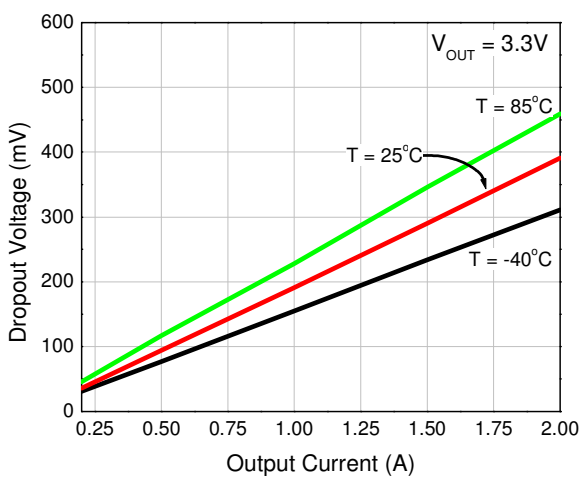


Fig5. Dropout Voltage vs. Output Current

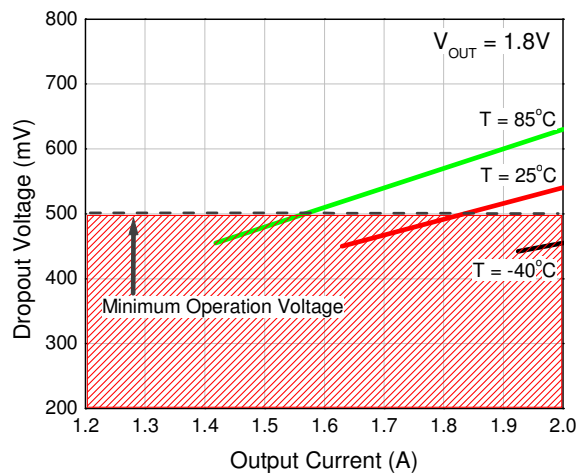


Fig6. Dropout Voltage vs. Output Current



■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

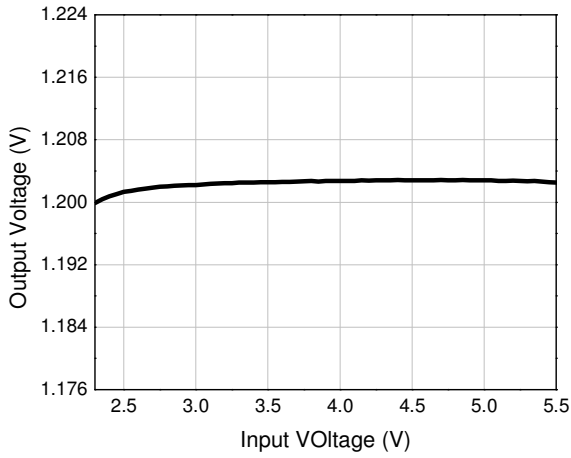


Fig7. Output Voltage vs. Input Voltage

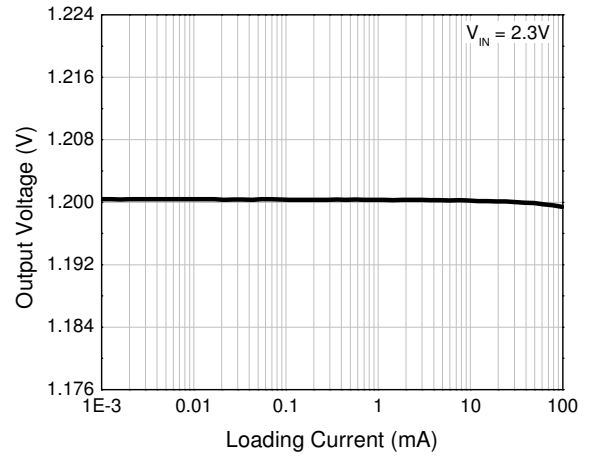


Fig8. Output Voltage vs. Loading Current

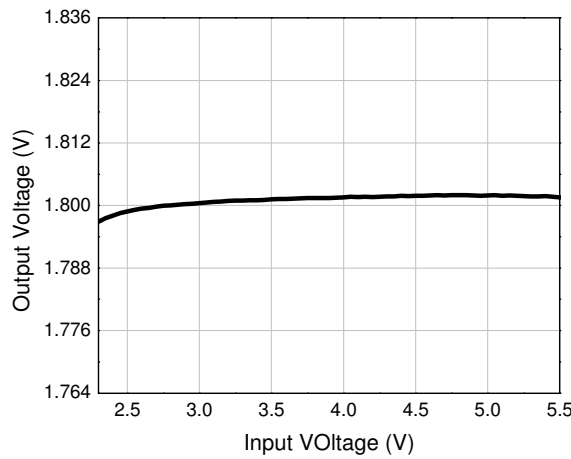


Fig9. Output Voltage vs. Input Voltage

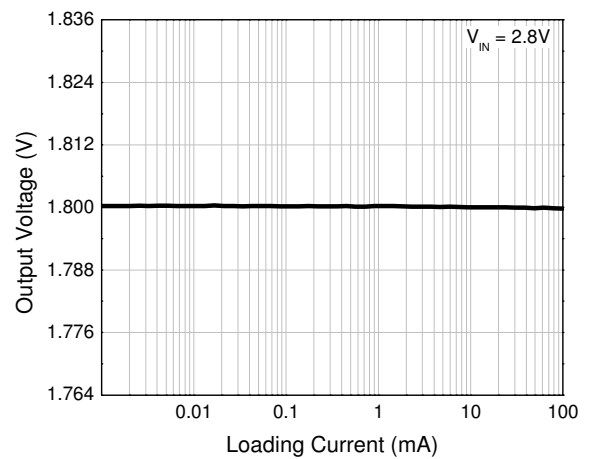


Fig10. Output Voltage vs. Loading Current

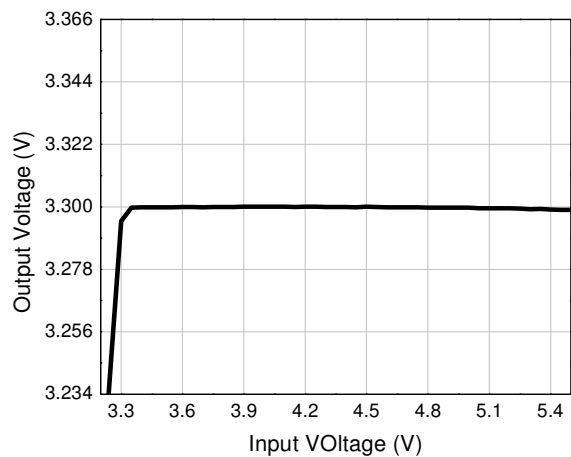


Fig11. Output Voltage vs. Input Voltage

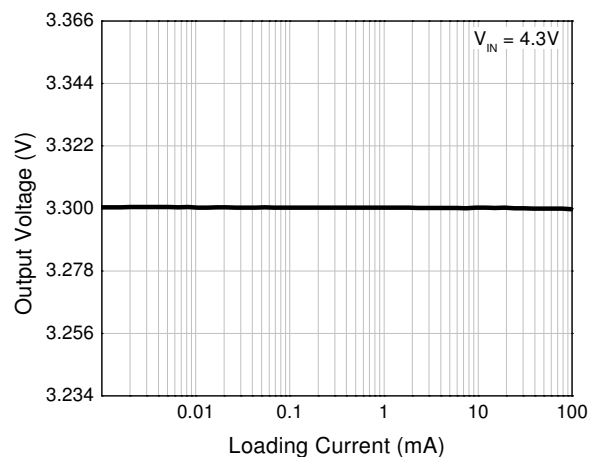


Fig12. Output Voltage vs. Loading Current

■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

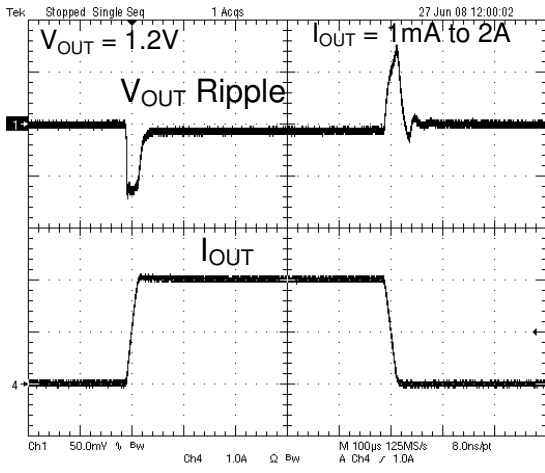


Fig13. Load Transient Response at  $V_{IN}=2.3V$ ,  $V_{OUT}=1.2V$

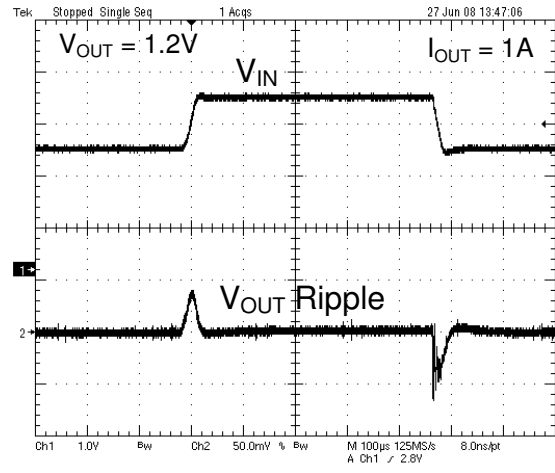


Fig14. Line Transient Response at  $V_{OUT}=1.2V$ ,  $I_{OUT}=1A$

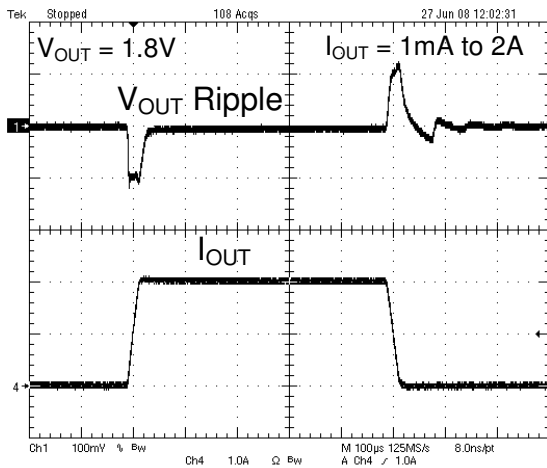


Fig15. Load Transient Response at  $V_{IN}=2.8V$ ,  $V_{OUT}=1.8V$

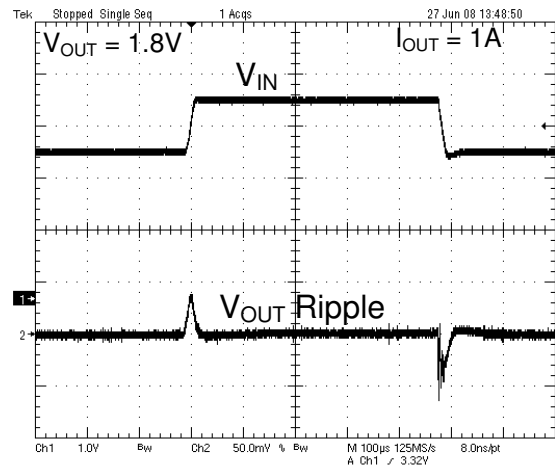


Fig16. Line Transient Response at  $V_{OUT}=1.8V$ ,  $I_{OUT}=1A$

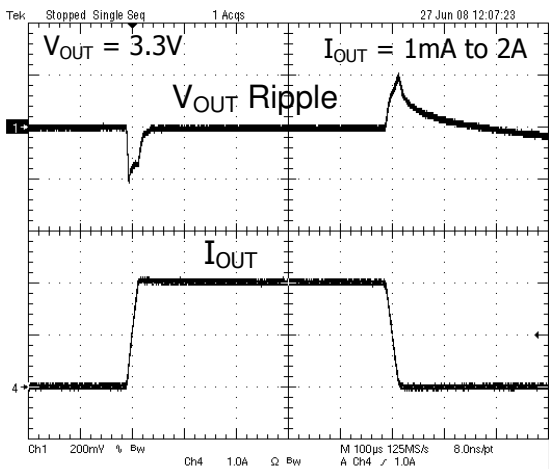


Fig17. Load Transient Response at  $V_{IN}=4.3V$ ,  $V_{OUT}=3.3V$

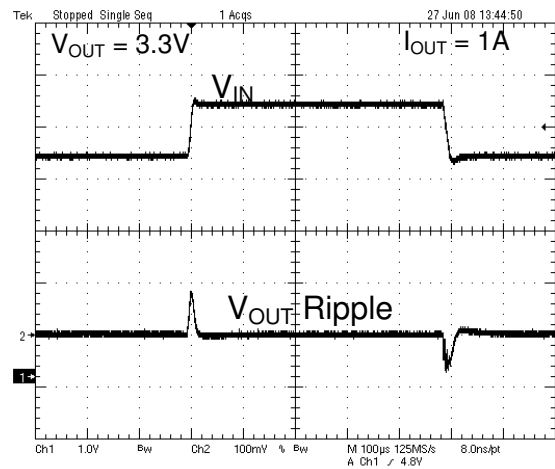


Fig18. Line Transient Response at  $V_{OUT}=3.3V$ ,  $I_{OUT}=1A$

**TYPICAL PERFORMANCE CHARACTERISTICS** (Continued)

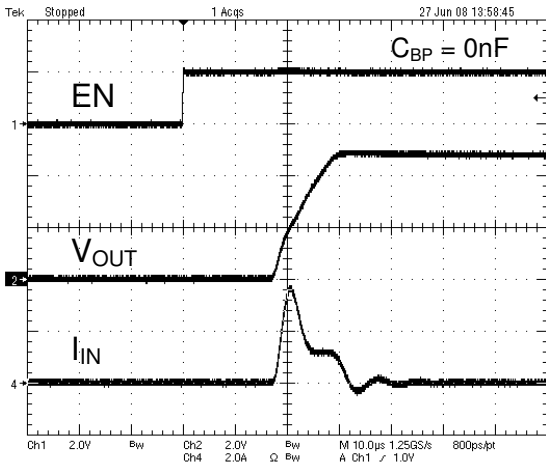


Fig19. Start-up waveform without bypass capacitor

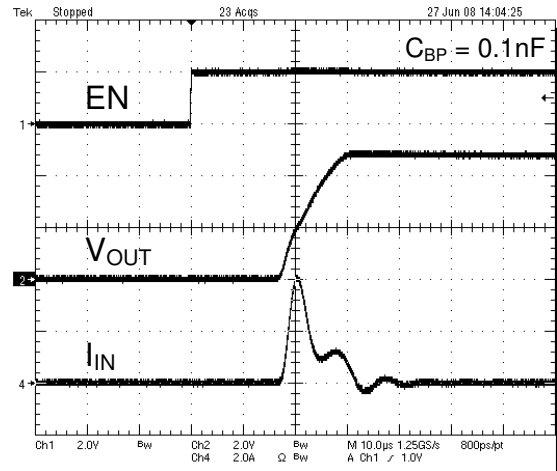


Fig20. Start-up waveform with 0.1nF bypass capacitor

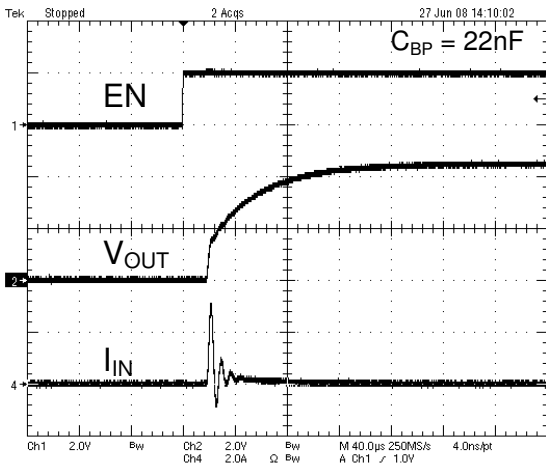


Fig21. Start-up waveform with 22nF bypass capacitor

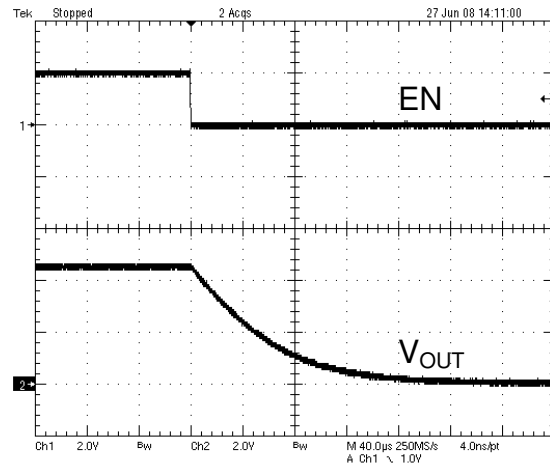


Fig22. Shutdown Transient

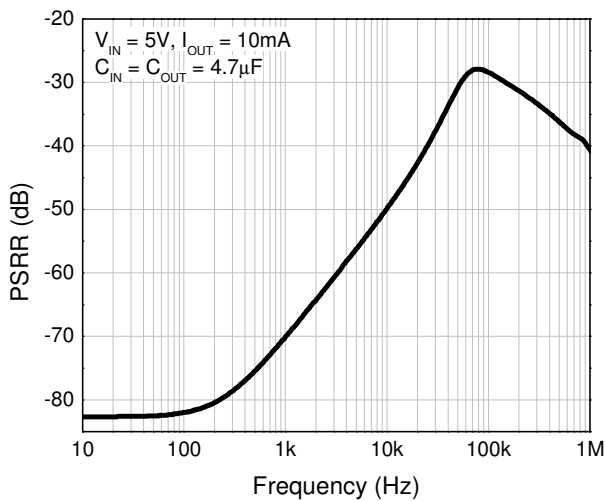
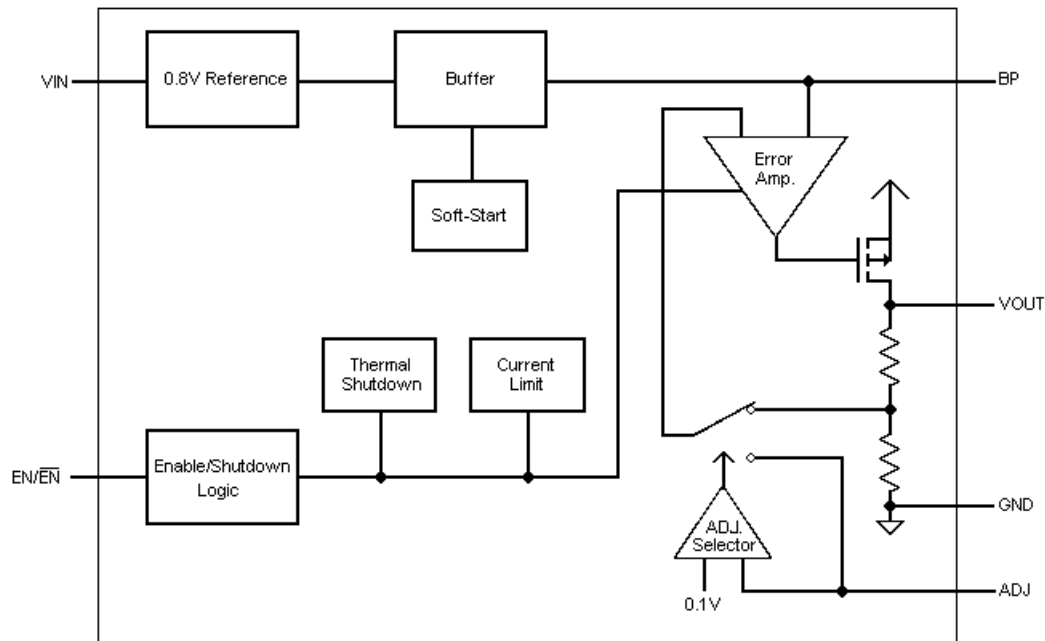


Fig23. PSRR vs. Frequency

**■ BLOCK DIAGRAM**

**■ PIN DESCRIPTION**

- VIN – Power supply input pin. Bypass with a 4.7 $\mu$ F capacitor to GND
- GND – Ground.
- VOUT – Regulator Output pin. Sources up to 2A.
- EN-bar (5 Pin and 8 Pin) – Chip Enable (Active Low). This pin isn't allowed to float.
- EN (5 Pin and 8 Pin) – Chip Enable (Active High). This pin isn't allowed to float.
- BP (5 Pin and 8 Pin) – Bypass pin. It should be connected to external 22nF capacitor to GND to reduce output noise. The bypass pin could be floating if it's unnecessary.
- ADJ (5 Pin and 8 Pin) – The output voltage can either be set by the internal feedback resistors when this pin is grounded, or be set by the external feedback resistors when using a resistive divider.

## ■ APPLICATION INFORMATION

The AIC1189 is a high performance linear regulator that provides low-dropout voltage and low quiescent-current. The device is available in an adjustable version and fixed output voltages ranging from 1.2V to 3.8V, and the device can supply loads up to 2A.

### SHUTDOWN

By connecting  $\overline{EN}$ (EN) pin to  $V_{IN}$ (ground), the AIC1189 can be shut down to reduce the supply current to 0.01 $\mu$ A(typ.). At this operation mode, the output voltage of AIC1189 is equal to 0V.

### CURRENT LIMIT

The AIC1189 includes a current limiter, which monitors and controls the maximum output current. If the output is overloaded or shorted to ground, this can protect the device from being damaged.

### THERMAL PROTECTION

The AIC1189 includes a thermal-limiting circuit, which is designed to protect the device against overload condition. When the junction temperature exceeds  $T_J=150^\circ\text{C}$ , the thermal-limiting circuit turns off the pass transistor and allows the IC to cool. For continuous load condition, maximum rating of junction temperature must not be exceeded.

### INPUT-OUTPUT CAPACITORS

Linear regulators require input and output capacitors to maintain stability. Input capacitor at 4.7 $\mu$ F with a 4.7 $\mu$ F ceramic output capacitor is recommended. To avoid oscillation, it is recommended to follow the figure of "Region of Stable  $C_{OUT}$  ESR vs. Load Current" to choose proper capacitor specifications.

When choosing the input and output ceramic capacitors, X5R and X7R types are recommended because they retain their capacitance over wider ranges of voltage and temperature than other types.

### NOISE BYPASS CAPACITOR

A 22nF bypass capacitor at BP pin can reduce output voltage noise. The bypass pin can be floating if it's unnecessary.

### OUTPUT VOLTAGE PROGRAMMING

The output voltage of AIC1189 linear regulator can be set by its internal feedback resistors when the ADJ pin is grounded. In addition, the output voltage of AIC1189 linear regulator can be set by the external feedback resistors when connecting a resistive divider  $R_1$  and  $R_2$ . While connecting a resistive divider,  $V_{OUT}$  can be calculated as:

$$V_{OUT} = 0.8 \times \left( 1 + \frac{R_1}{R_2} \right)$$

The resistive divider should sit as close to ADJ pin as possible.

### POWER DISSIPATION

The maximum power dissipation of AIC1189 depends on the thermal resistance of its case and circuit board, the temperature difference between the die junction and ambient air, and the rate of airflow. The rate of temperature rise is greatly affected by the mounting pad configuration on the PCB, the board material, and the ambient temperature. When the IC mounting with good thermal conductivity is used, the junction temperature will be low even when large power dissipation applies.

The power dissipation across the device is

$$P = I_{OUT} (V_{IN} - V_{OUT})$$

The maximum power dissipation is:

$$P_{MAX} = \frac{(T_{J-max} - T_A)}{R\theta_{JA}}$$

Where  $T_{J-max}$  is the maximum allowable junction temperature (150 $^\circ\text{C}$ ), and  $T_A$  is the ambient temperature suitable in application.

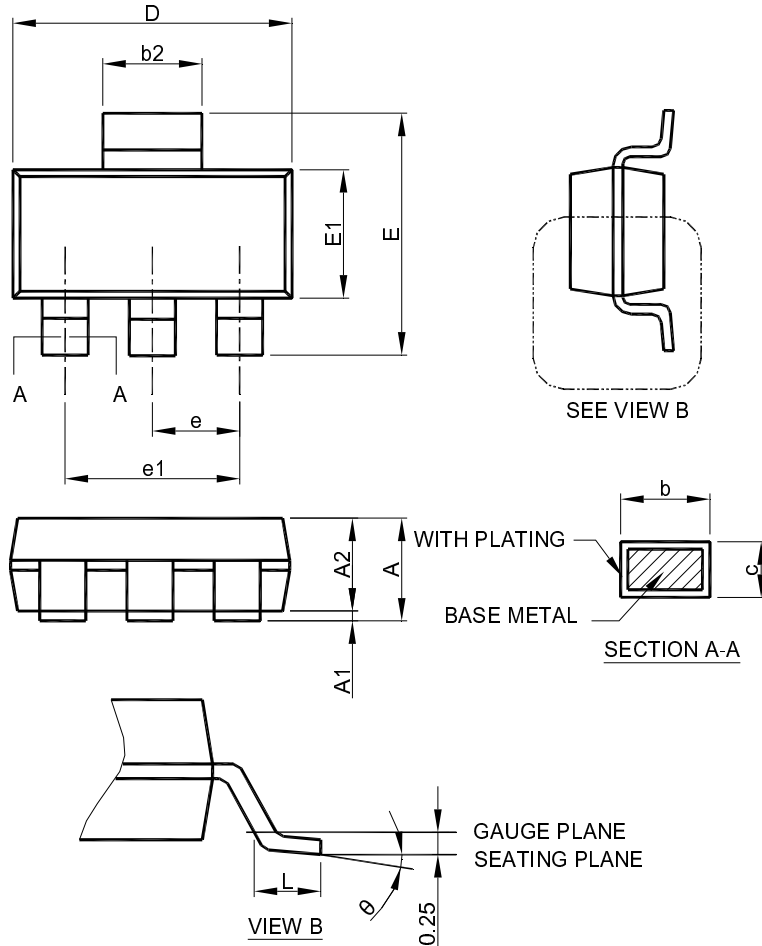
As a general rule, the lower temperature is, the better reliability of the device is. So the PCB mounting pad should provide maximum thermal conductivity to maintain low device temperature.

### LAYOUT CONSIDERATION

Connect the bottom-side pad (available in SOP-8 Exposed Pad) to a large ground plane. Use as much copper as possible to decrease the thermal resistance of the device.

■ PHYSICAL DIMENSIONS

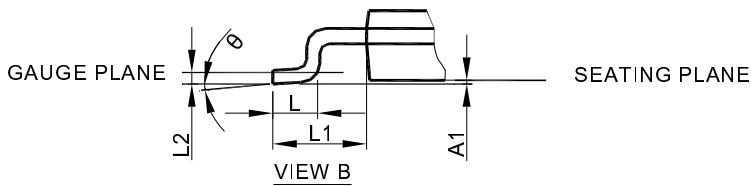
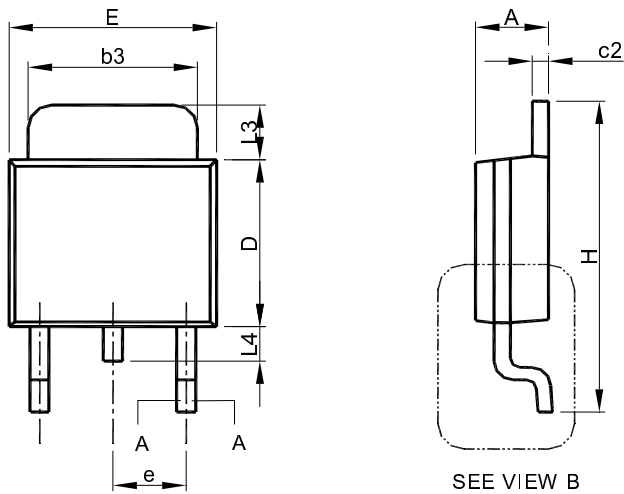
● SOT-223 PACKAGE OUTLINE DRAWING



- Note: 1. Refer to JEDEC TO-261AA.  
 2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side .  
 3. Dimension "E1" does not include inter-lead flash or protrusions.  
 4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

SYMBOL	SOT-223	
	MILLIMETERS	
	MIN.	MAX.
A		1.80
A1	0.02	0.10
A2	1.55	1.65
b	0.66	0.84
b2	2.90	3.10
c	0.23	0.33
D	6.30	6.70
E	6.70	7.30
E1	3.30	3.70
e	2.30 BSC	
e1	4.60 BSC	
L	0.90	
θ	0°	8°

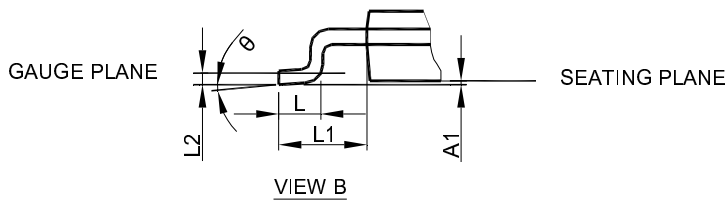
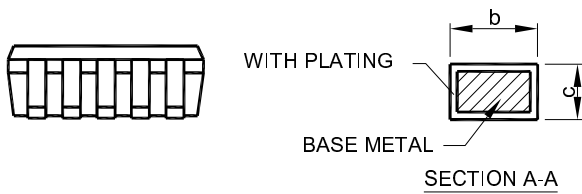
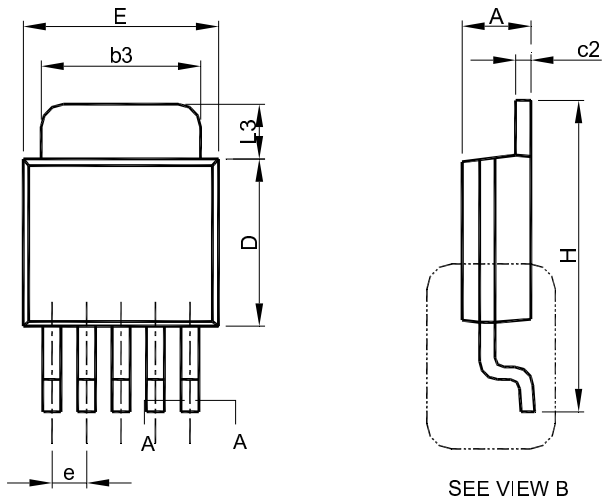
● TO-252-3L PACKAGE OUTLINE DRAWING



- Note: 1. Refer to JEDEC TO-252AA and AB.  
 2. Dimension "E" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side .  
 3. Dimension "D" does not include inter-lead flash or protrusions.  
 4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

SYMBOL	TO-252-3L	
	MILLIMETERS	
	MIN.	MAX.
A	2.19	2.38
A1	0.00	0.13
b	0.64	0.89
b3	4.95	5.46
c	0.46	0.61
c2	0.46	0.89
D	5.33	6.22
E	6.35	6.73
e	2.28 BSC	
H	9.40	10.41
L	1.40	1.78
L1	2.67 REF	
L2	0.51 BSC	
L3	0.89	2.03
L4	--	1.02
θ	0°	8°

● TO-252-5L PACKAGE OUTLINE DRAWING

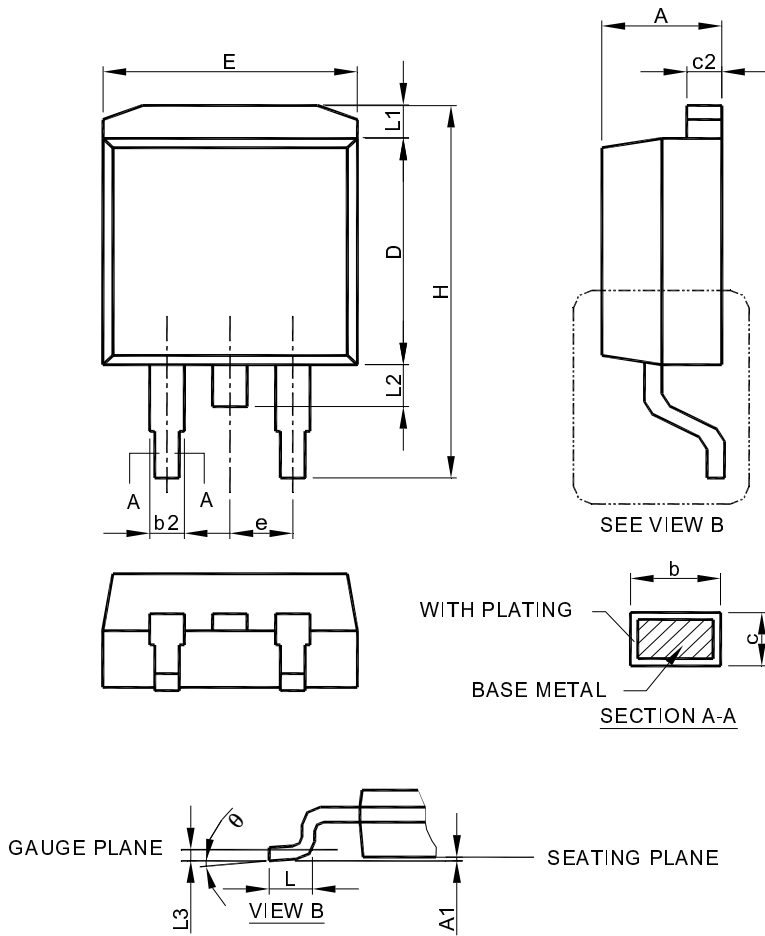


- Note: 1. Refer to JEDEC TO-252AD and AB.  
 2. Dimension "E" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side .  
 3. Dimension "D" does not include inter-lead flash or protrusions.  
 4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

SYMBOL	TO-252-5L	
	MILLIMETERS	
	MIN.	MAX.
A	2.19	2.38
A1	0.00	0.13
b	0.51	0.71
b3	4.32	5.46
c	0.46	0.61
c2	0.46	0.89
D	5.33	6.22
E	6.35	6.73
e	1.27 BSC	
H	9.40	10.41
L	1.40	1.78
L1	2.67 REF	
L2	0.51 BSC	
L3	0.89	2.03
q	0°	8°



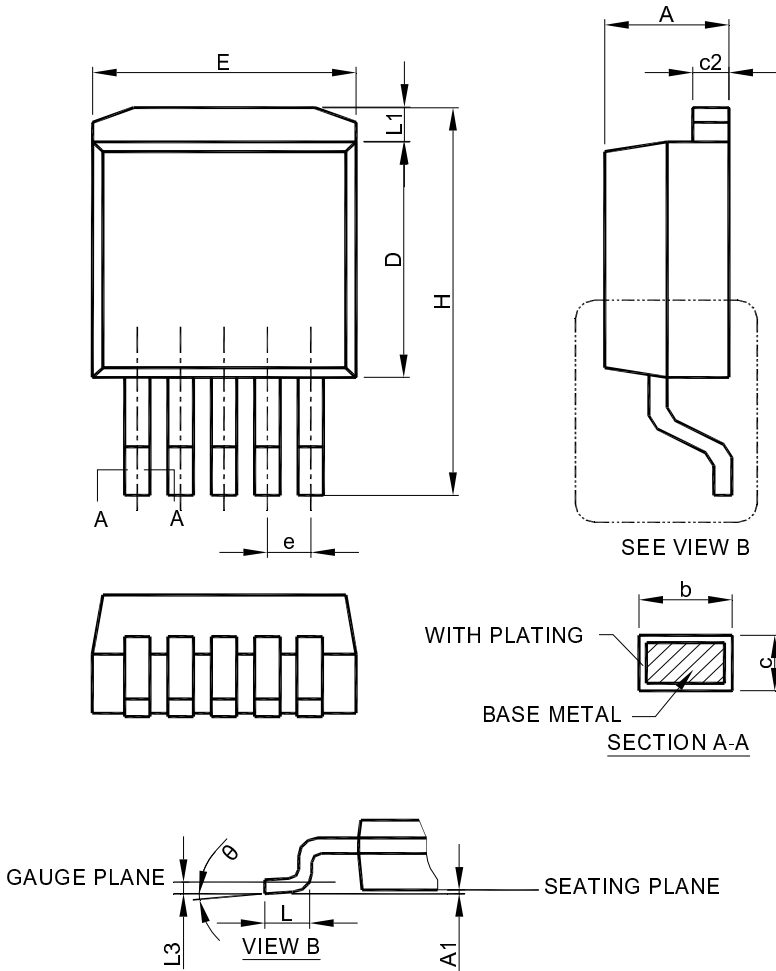
● TO-263-3L PIN PACKAGE OUTLINE DRAWING



- Note: 1. Refer to JEDEC TO-263AB.  
 2. Dimension "E" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side.  
 3. Dimension "D" does not include inter-lead flash or protrusions.  
 4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

SYMBOL	TO-263-3L	
	MILLIMETERS	
	MIN.	MAX.
A	4.06	4.83
A1	0.00	0.25
b	0.51	0.99
b2	1.14	1.78
c	0.38	0.74
c2	1.14	1.65
D	8.38	9.65
E	9.65	10.67
e	2.54 BSC	
H	14.61	15.88
L	1.78	2.79
L1	--	1.68
L2	--	1.78
L3	0.25 BSC	
q	0°	8°

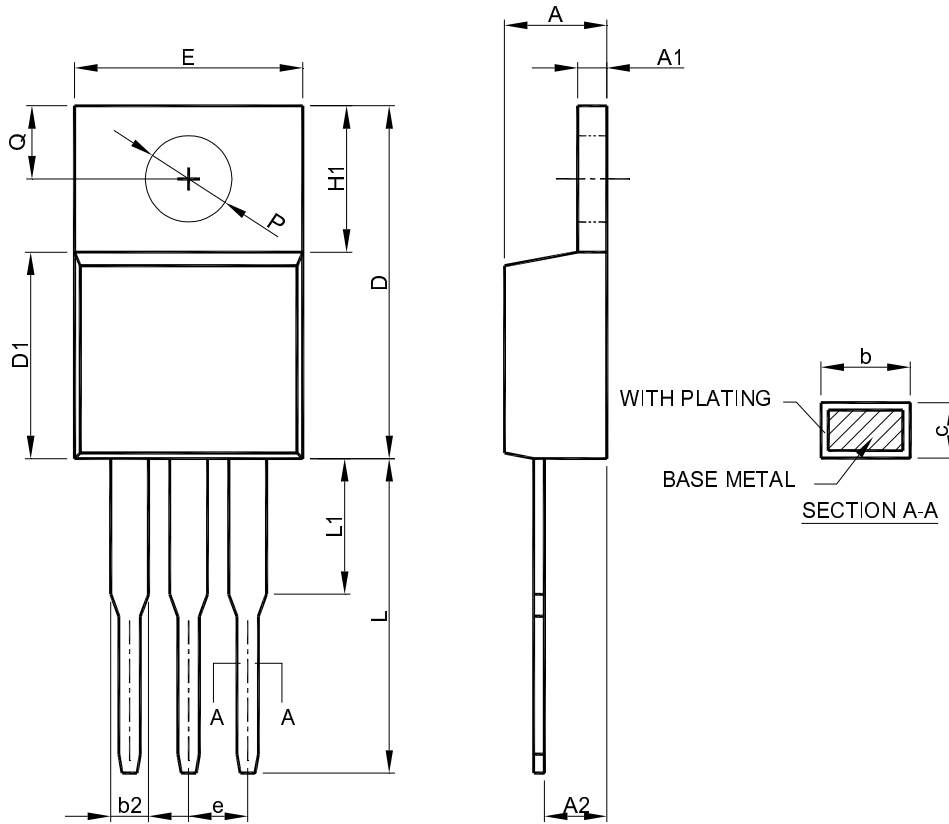
● TO-263-5L PACKAGE OUTLINE DRAWING



- Note: 1. Refer to JEDEC TO-263BA.  
 2. Dimension "E" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side .  
 3. Dimension "D" does not include inter-lead flash or protrusions.  
 4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

SYMBOL	TO-263-5L	
	MILLIMETERS	
	MIN.	MAX.
A	4.06	4.83
A1	0.00	0.25
b	0.51	0.99
c	0.38	0.74
c2	1.14	1.65
D	8.38	9.65
E	9.65	10.67
e	1.70 BSC	
H	14.61	15.88
L	1.78	2.79
L1	--	1.68
L3	0.25 BSC	
q	0°	8°

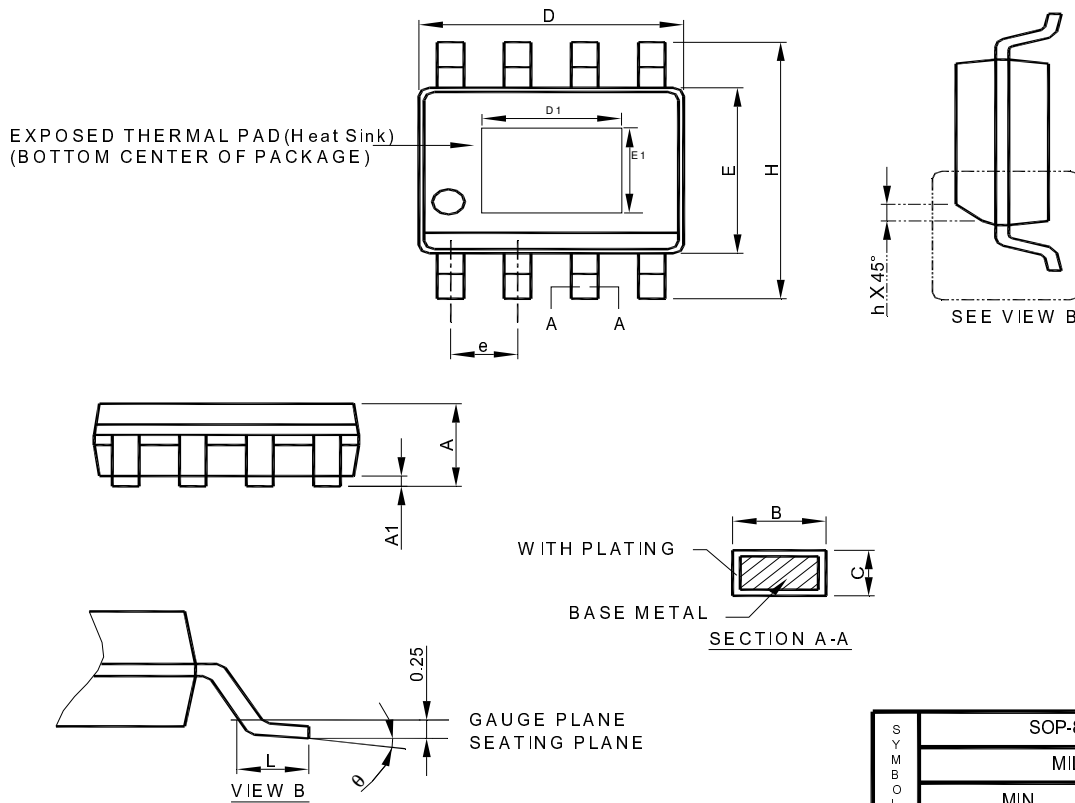
● TO-220 PACKAGE OUTLINE DRAWING



- Note: 1. Refer to JEDEC TO-220AB.  
 2. Dimension "E" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side .  
 3. Dimension "D1" does not include inter-lead flash or protrusions.  
 4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

SYMBOL	TO-220	
	MILLIMETERS	
	MIN.	MAX.
A	3.56	4.82
A1	0.51	1.39
A2	2.04	2.92
b	0.38	1.01
b2	1.15	1.77
c	0.35	0.61
D	14.23	16.51
D1	8.38	9.02
E	9.66	10.66
e	2.54 BSC	
H1	5.85	6.85
L	12.70	14.73
L1	--	6.35
P	3.54	4.08
Q	2.54	3.42

● SOP-8 Exposed Pad (Heat Sink) PACKAGE OUTLINE DRAWING



- Note :
1. Refer to JEDEC MS-012E.
  2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side .
  3. Dimension "E" does not include inter-lead flash or protrusions.
  4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

SYMBOL	SOP-8 Exposed Pad(Heat Sink)	
	MILLIMETERS	
	MIN.	MAX.
A	1.35	1.75
A1	0.00	0.15
B	0.31	0.51
C	0.17	0.25
D	4.80	5.00
E	3.80	4.00
e	1.27 BSC	
H	5.80	6.20
h	0.25	0.50
L	0.40	1.27
q	0°	8°
D1	1.5	3.5
E1	1.0	2.55

**Note:**

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