

300mA, Low Dropout Linear Regulator with Shutdown

FEATURES

- Active Low Shutdown Control.
- Very Low Quiescent Current.
- Very Low Dropout Voltage of 470mV at 300mA Output Current (3.0V Output Version)
- 1.3V, 1.5V, 1.8V, 2.5V, 2.8V, 3.0V, 3.3V Output Voltage.
- Short Circuit and Thermal Protection.
- $\pm 2\%$ Output Tolerance.
- Miniature Package: SOT-23-5 and SOT-89-5

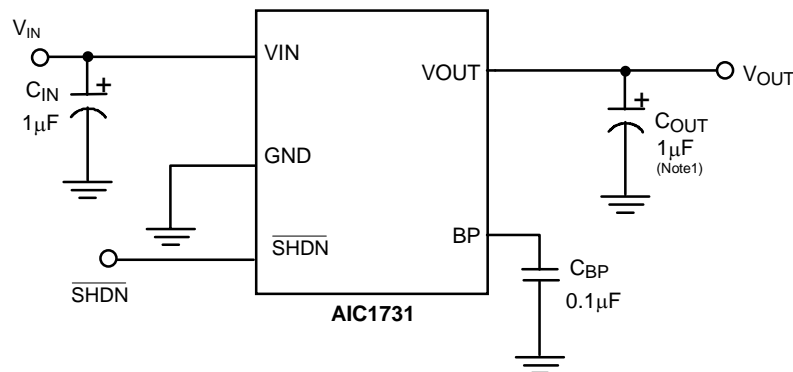
APPLICATIONS

- PDA
- DSC
- Notebook
- Pagers
- Personal Communication Equipment
- Cordless Telephones
- Portable Instrumentation
- Portable Consumer Equipment
- Battery Powered Systems

DESCRIPTION

AIC1731 is a 300mA low noise, low dropout linear regulator, and is housed in small SOT-23-5 and SOT-89-5 package. The device is in the "ON" state when the $\overline{\text{SHDN}}$ pin is set to logic high level. An internal P-MOSFET pass transistor is used to achieve 470mV low dropout voltage at 300mA load current. It offers high precision output voltage of $\pm 2\%$. The quality of low quiescent current and low dropout voltage makes this device ideal for battery power applications. The internal reverse bias protection eliminates the requirement for a reverse voltage protection diode. The high ripple rejection and low noise of AIC1731 provide enhanced performance for critical applications. The noise bypass pin can be connected an external capacitor to reduce the output noise level.

TYPICAL APPLICATION CIRCUIT

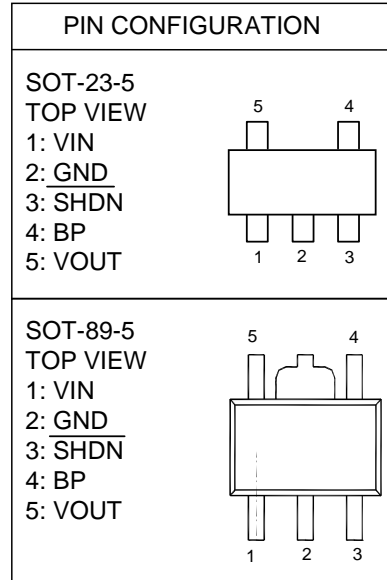


Low Noise Low Dropout Linear Regulator

ORDERING INFORMATION

AIC1731-XXXXXX

- PACKING TYPE
TR: TAPE & REEL
BG: BAG
- PACKAGE TYPE
V: SOT-23-5
X5: SOT-89-5
- P: LEAD FREE COMMERCIAL
G: GREEN PACKAGE
- OUTPUT VOLTAGE
13: 1.3V
15: 1.5V
18: 1.8V
25: 2.5V
28: 2.8V
30: 3.0V
33: 3.3V



(Of a unit of 0.1V within the voltage range from 1.3V to 3.3V, additional voltage versions for this product line may be available on demand with prior consultation with AIC.)

Example: AIC1731-18PX5TR

→ 1.8V Version, in SOT-89-5 Lead Free Package & Tape & Reel Packing Type

AIC1731-18PVTR

→ 1.8V Version, in SOT-23-5 Lead Free Package & Tape & Reel Packing Type

● SOT-89-5 Marking

Part No.	Marking	Part No.	Marking	Part No.	Marking
AIC1731-13CX5	EH13	AIC1731-13PX5	EH13P	AIC1731-13GX5	EH13G
AIC1731-15CX5	EH15	AIC1731-15PX5	EH15P	AIC1731-15GX5	EH15G
AIC1731-18CX5	EH18	AIC1731-18PX5	EH18P	AIC1731-18GX5	EH18G
AIC1731-25CX5	EH25	AIC1731-25PX5	EH25P	AIC1731-25GX5	EH25G
AIC1731-28CX5	EH28	AIC1731-28PX5	EH28P	AIC1731-28GX5	EH28G
AIC1731-30CX5	EH30	AIC1731-30PX5	EH30P	AIC1731-30GX5	EH30G
AIC1731-33CX5	EH33	AIC1731-33PX5	EH33P	AIC1731-33GX5	EH33G

● SOT-23-5 Marking

Part No.	Marking	Part No.	Marking	Part No.	Marking
AIC1731-13CV	ED13	AIC1731-13PV	ED13P	AIC1731-13GV	ED13G
AIC1731-15CV	ED15	AIC1731-15PV	ED15P	AIC1731-15GV	ED15G
AIC1731-18CV	ED18	AIC1731-18PV	ED18P	AIC1731-18GV	ED18G
AIC1731-25CV	ED25	AIC1731-25PV	ED25P	AIC1731-25GV	ED25G
AIC1731-28CV	ED28	AIC1731-28PV	ED28P	AIC1731-28GV	ED28G
AIC1731-30CV	ED30	AIC1731-30PV	ED30P	AIC1731-30GV	ED30G
AIC1731-33CV	ED33	AIC1731-33PV	ED33P	AIC1731-33GV	ED33G

■ ABSOLUTE MAXIMUM RATINGS

Supply Voltage.....	12V
Shutdown Terminal Voltage.....	8V
Noise Bypass Terminal Voltage.....	5V
Operating Temperature Range.....	-40°C~85°C
Maximum Junction Temperature.....	125°C
Storage Temperature Range.....	-65°C~150°C
Lead Temperature (Soldering, 10 sec).....	260°C
Thermal Resistance Junction to Case, $R\theta_{JC}$	SOT-23-5.....130°C /W
	SOT-89-5.....30°C /W
Thermal Resistance Junction to Ambient, $R\theta_{JA}$	SOT-23-5.....220°C /W
	SOT-89-5.....160°C /W

(Assume no ambient airflow, no heatsink)

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

■ TEST CIRCUIT

Refer to TYPICAL APPLICATION CIRCUIT

■ ELECTRICAL CHARACTERISTICS

($C_{IN}=1\mu F$, $C_{OUT}=4.7\mu F$, $T_J=25^\circ C$, unless otherwise specified) (Note2)

PARAMETER	TEST CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Quiescent Current	$I_{OUT} = 0mA$, $V_{IN} = 3.6\sim 7V$	I_Q		35	50	μA
Standby Current	$V_{IN} = 3.6\sim 7V$, output OFF	I_{STBY}			0.1	μA
GND Pin Current	$I_{OUT} = 0.1\sim 300mA$	I_{GND}		30	50	μA
Continuous Output Current	$V_{IN} = 5V$	I_{OUT}			300	mA
Output Current Limit	$V_{IN} = 5V$, $V_{OUT} = 0V$	I_{IL}	300	450		mA
Output Voltage Tolerance	$V_{IN} = 5V$, no load	V_{OUT}	-2		2	%
Temperature Coefficient		TC		50	150	ppm/ $^\circ C$
Line Regulation	$V_{IN} = V_{OUT(TYP)} + 1V$ to 7V	ΔV_{LIR}		3	10	mV
Load Regulation	$V_{IN} = V_{OUT} + 1.2V$ ($V_{out} \geq 2.0V$) $V_{IN} = V_{OUT} + 1.7V$ ($V_{out} \leq 1.9V$) $I_{OUT} = 0.1\sim 300mA$	ΔV_{LOR}		10	30	mV
Dropout Voltage	$I_L=300mA$ $3.0V \leq V_{OUT} \leq 3.3V$ $2.5V \leq V_{OUT} \leq 2.9V$ $2.0V \leq V_{OUT} \leq 2.4V$ $1.3V \leq V_{OUT} \leq 1.9V$	V_{DROP}		470 570 800 1260	870 970 1200 1660	mV
Noise Bypass Terminal Voltage		V_{REF}		1.23		V
Output Noise	$C_{BP} = 0.1\mu F$, $f = 1KHz$, $V_{IN} = 5V$	Δn		0.46		$\frac{\mu V}{\sqrt{Hz}}$
Ripple Rejection	$f = 1KHz$, Ripple = $0.5V_{P-P}$, $C_{BP} = 0.1\mu F$	RR		55		dB
Shutdown Pin Current		I_{SHDN}			0.1	μA
Shutdown Pin Voltage (ON)	Output ON		1.6			V
Shutdown Pin Voltage (OFF)	Output OFF				0.6	V
Shutdown Exit Delay Time	$C_{BP}=0.1\mu F$, $C_{OUT}=1\mu F$, $I_{OUT}=30mA$	Δt		300		μS
Thermal Shutdown Temperature		T_{SD}		155		$^\circ C$

Note 1: To avoid output oscillation, aluminum electrolytic output capacitor is recommended and ceramic capacitor is not suggested.

Note 2: Specifications are production tested at $T_A=25^\circ C$. Specifications over the $-40^\circ C$ to $85^\circ C$ operating temperature range are assured by design, characterization and correlation with Statistical Quality Controls (SQC).

TYPICAL PERFORMANCE CHARACTERISTICS

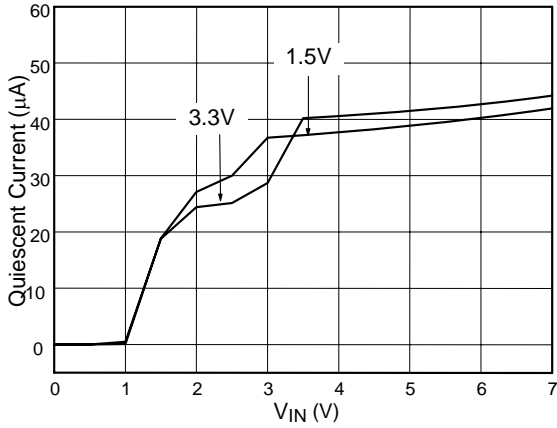


Fig. 1 Quiescent Current vs. V_{IN}

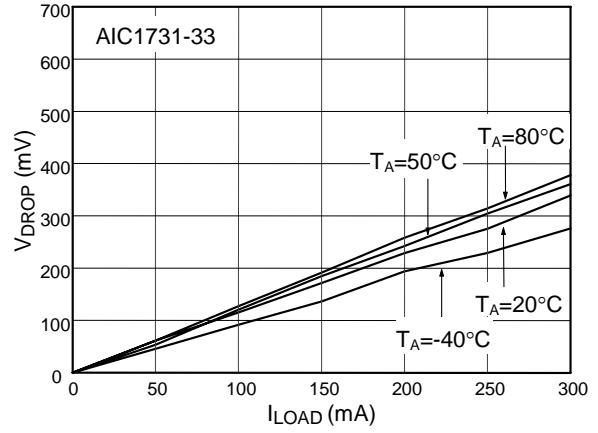


Fig. 2 V_{DROP} vs. I_{LOAD}

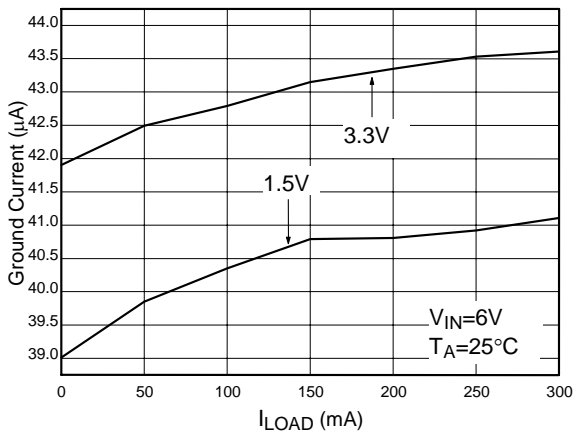


Fig. 3 Ground Current vs. I_{LOAD}

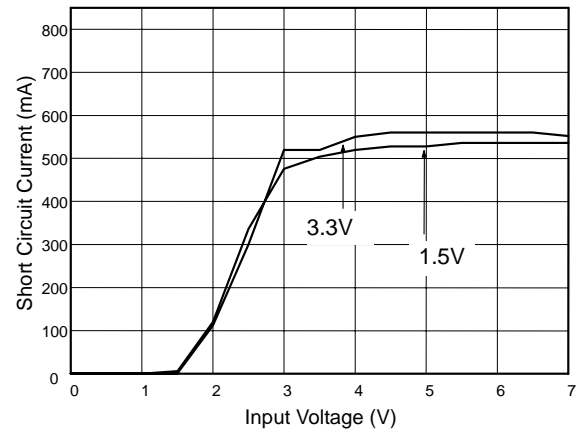


Fig. 4 Input Voltage vs. Short Circuit Current

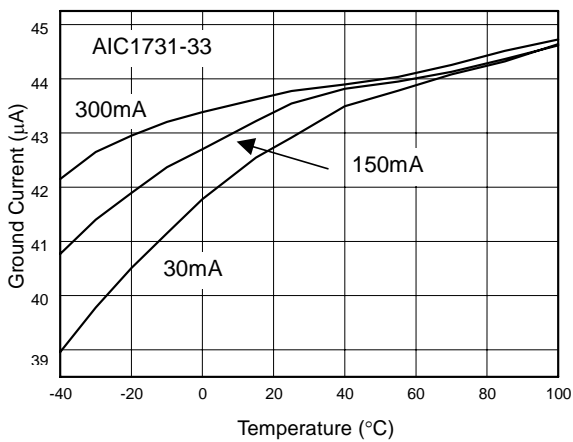


Fig. 5 Ground Current vs. Temperature

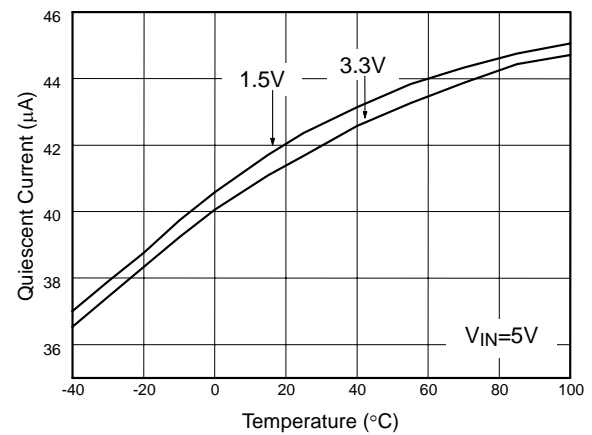


Fig. 6 Quiescent Current vs. Temperature

■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

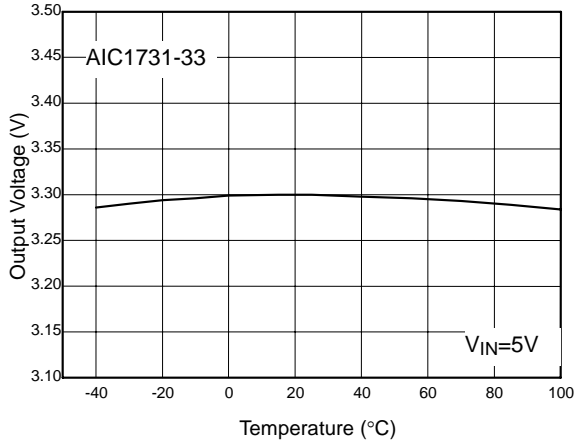


Fig. 7 Output Voltage vs. Temperature

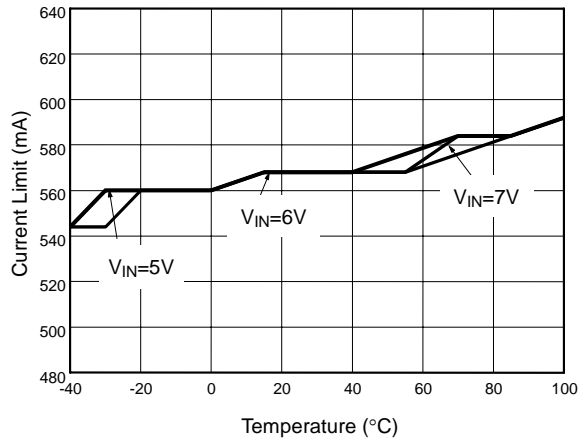


Fig. 8 Current Limit vs. Temperature

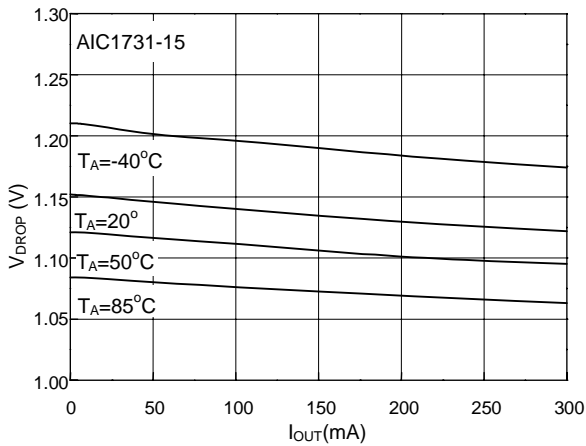


Fig. 9 V_{DROP} vs. I_{LOAD}

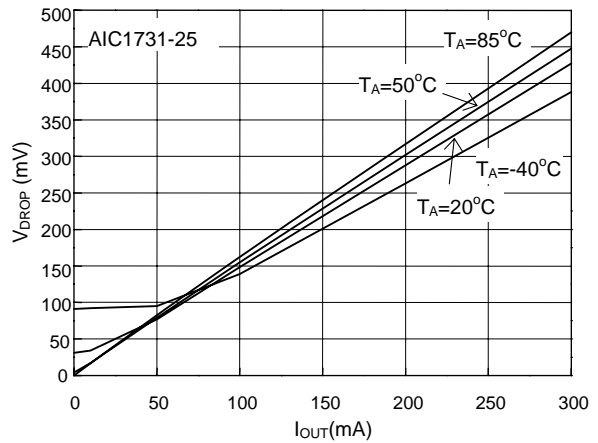


Fig. 10 V_{DROP} vs. I_{LOAD}

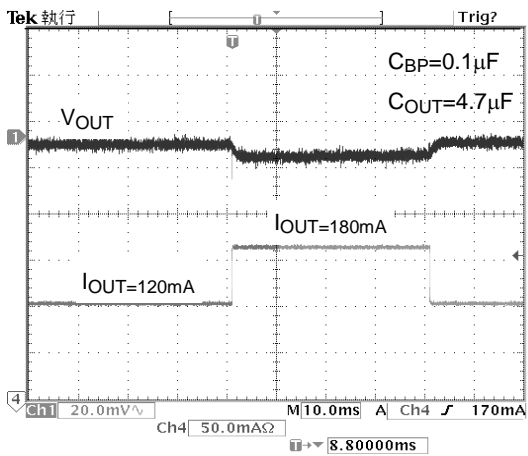


Fig. 11 Load Transient Response

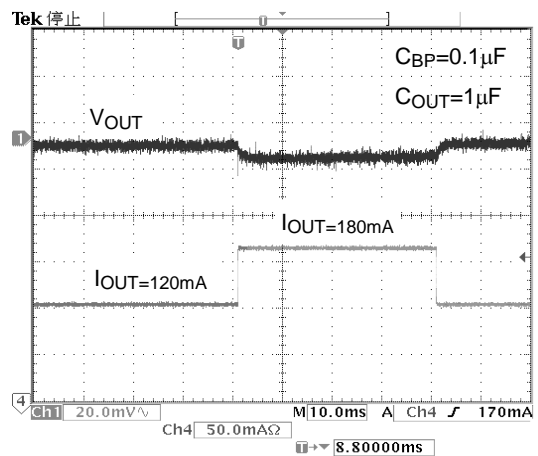


Fig. 12 Load Transient Response

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

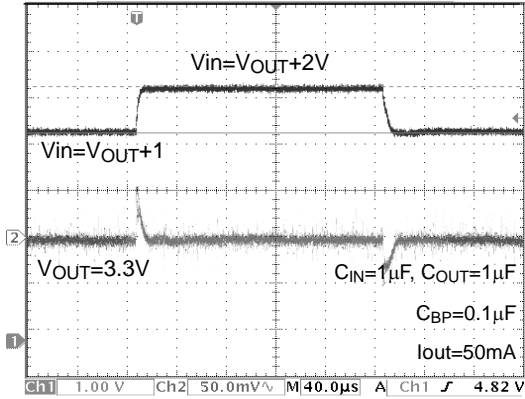


Fig. 13 Line Transient Response

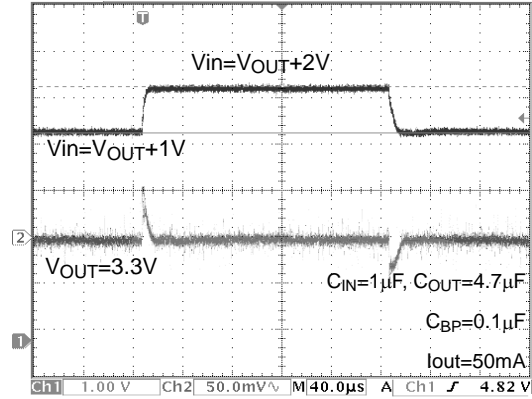


Fig. 14 Line Transient Response

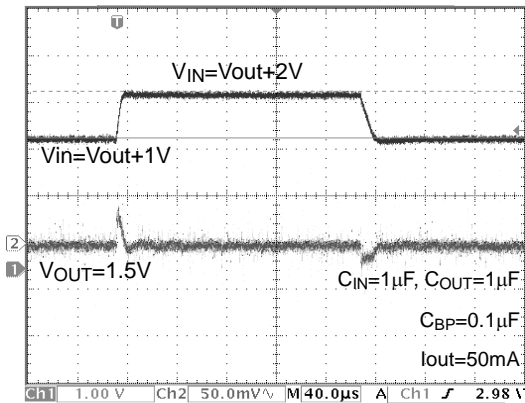


Fig. 15 Line Transient Response

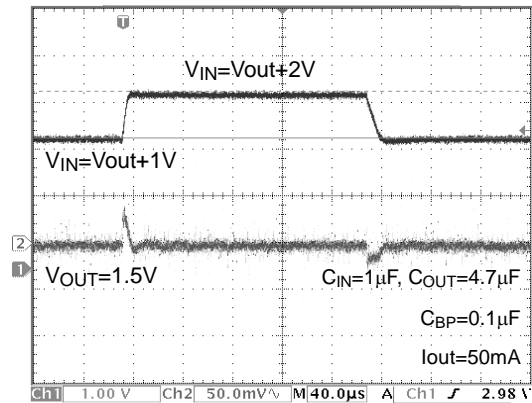


Fig. 16 Line Transient Response

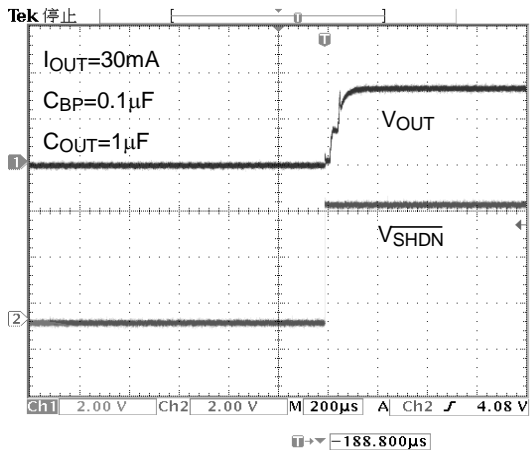


Fig. 17 Shutdown Exit Time

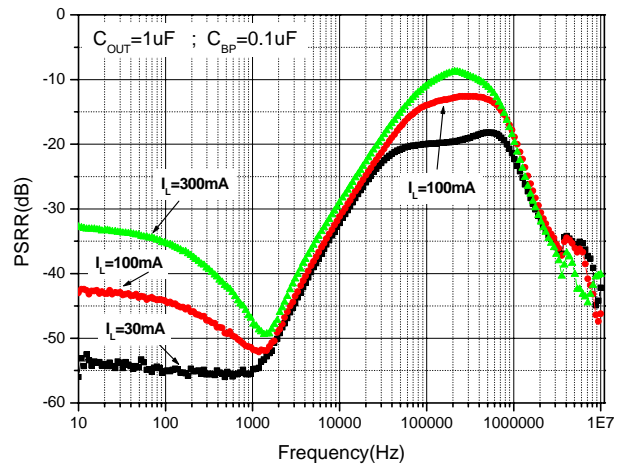
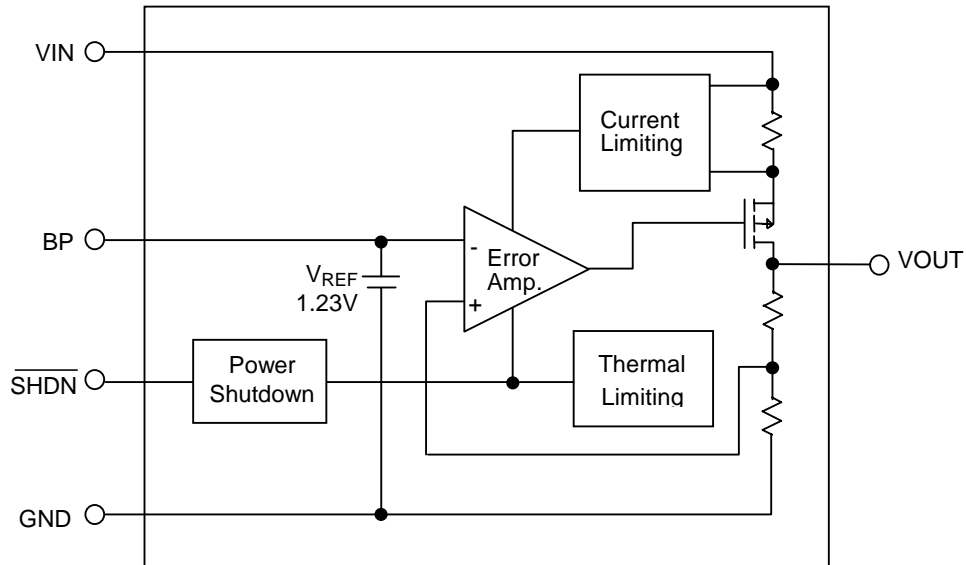


Fig. 18 Ripple Rejection

■ BLOCK DIAGRAM

■ PIN DESCRIPTIONS

PIN 1 : VIN - Power supply input pin. Bypass with a 1 μ F capacitor to GND

PIN 2 : GND - Ground pin.

PIN 3 : $\overline{\text{SHDN}}$ - Active-Low shutdown input pin.

PIN 4 : BP - Noise bypass pin. An external bypass capacitor connected to BP pin reduces noises at the output.

PIN 5 : VOUT - Output pin. Sources up to 300 mA.

■ DETAILED DESCRIPTIONS OF TECHNICAL TERMS

DROPOUT VOLTAGE (V_{DROP})

The dropout voltage is defined as the difference between the input voltage and output voltage at which the output voltage drops 100mV. Below this value, the output voltage will fall as the input voltage reduces. It depends on the load current and junction temperature.

LINE REGULATION

Line regulation is the ability of the regulator to maintain a constant output voltage as the input voltage changes. The line regulation is specified as the input voltage changes from $V_{IN} = V_{OUT} + 1V$ to $V_{IN} = 7V$ and $I_{OUT} = 1mA$.

LOAD REGULATION

Load regulation is the ability of the regulator to maintain a constant output voltage as the load current changes. A pulsed measurement with an input voltage set to $V_{IN} = V_{OUT} + V_{DROP}$ can minimize temperature effects. The load regulation

is specified by the output current ranging from 0.1mA to 300mA.

CURRENT LIMIT (I_{IL})

AIC1731 includes a current limiting, which monitors and controls the maximum output current if the output is shorted to ground. This can protect the device from being damaged.

THERMAL PROTECTION

Thermal sensor protects device when the junction temperature exceeds $T_J = +155^{\circ}C$. It signals shutdown logic, turning off pass transistor and allowing IC to cool down. After the IC's junction temperature cools by $15^{\circ}C$, the thermal sensor will turn the pass transistor back on. Thermal protection is designed to protect the device in the event of fault conditions. For a continuous operation, do not exceed the absolute maximum junction-temperature rating of $T_J = 150^{\circ}C$, or damage may occur to the device.

■ APPLICATION INFORMATION

INPUT-OUTPUT CAPACITORS

Linear regulators require input and output capacitors to maintain stability. Input capacitor at $1\mu F$ with a $1\mu F$ aluminum electrolytic output capacitor is suggested.

NOISE BYPASS CAPACITOR

$0.1\mu F$ bypass capacitor at BP pin reduces output voltage noise. And the BP pin has to connect a capacitor to GND.

POWER DISSIPATION

The AIC1731 obtains thermal-limiting circuitry, which is designed to protect the device against overload condition. For continuous load condition, maximum rating of junction temperature must not be exceeded. It is

important to pay more attention in thermal resistance. It includes junction to case, junction to ambient. The maximum power dissipation of AIC1731 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:

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

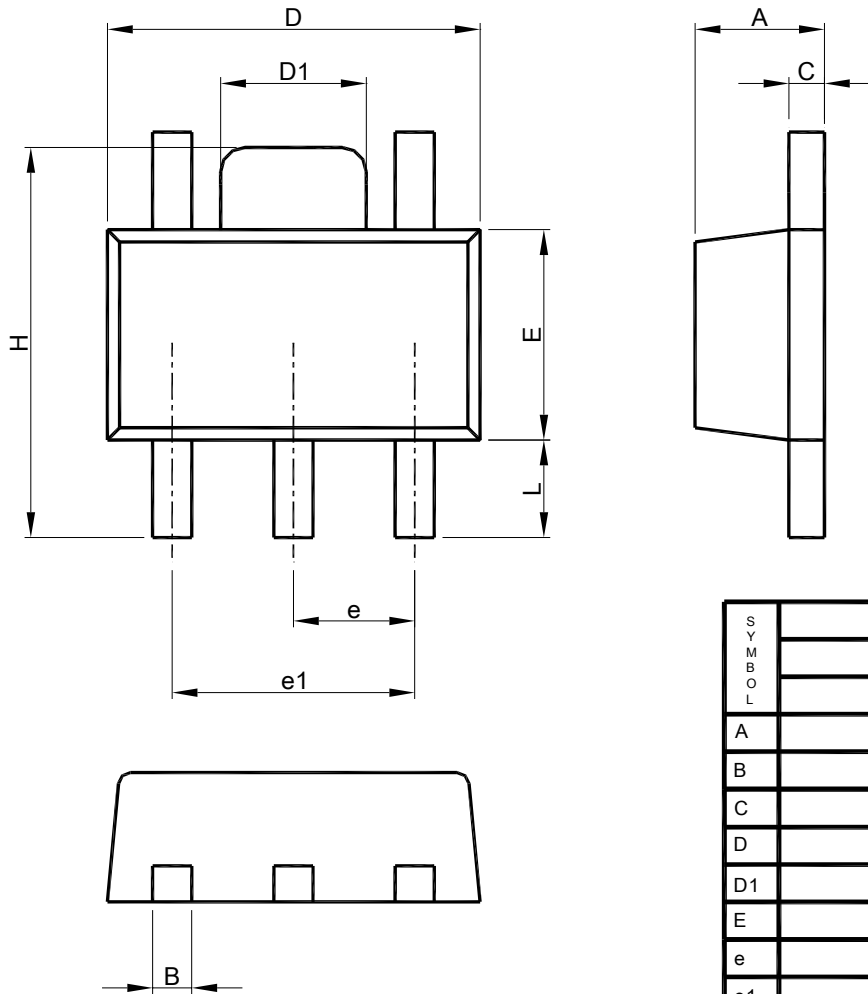
Where T_{J-max} is the maximum allowable junction temperature (125°C), and T_A is the ambient temperature suitable in application.

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. GND pin performs a dual function for providing an electrical connection to ground and channeling heat away. Therefore, connecting the GND pin to ground with a large pad or ground plane would increase the power dissipation and reduce the device temperature.

■ PHYSICAL DIMENSIONS (unit: mm)

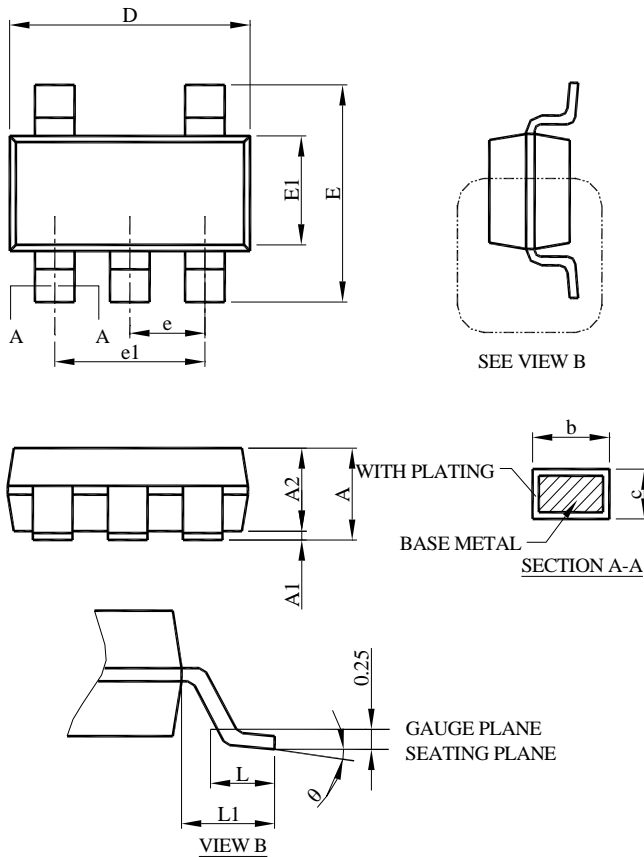
● SOT-89-5



SYMBOL	SOT-89-5	
	MILLIMETERS	
	MIN.	MAX.
A	1.40	1.60
B	0.36	0.56
C	0.35	0.44
D	4.40	4.60
D1	1.50	1.83
E	2.29	2.60
e	1.50 BSC	
e1	3.00 BSC	
H	3.94	4.25
L	0.80	1.20

- Note: 1. Refer to JEDEC TO-243AA.
 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.

● **SOT-23-5**



SYMBOL	SOT-25	
	MILLIMETERS	
	MIN.	MAX.
A	0.95	1.45
A1	0.05	0.15
A2	0.90	1.30
b	0.30	0.50
c	0.08	0.22
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.70
e	0.95 BSC	
e1	1.90 BSC	
L	0.30	0.60
L1	0.60 REF	
θ	0°	8°

- Note :
1. Refer to JEDEC MO-178AA.
 2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 10 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.

Note:

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