

# 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

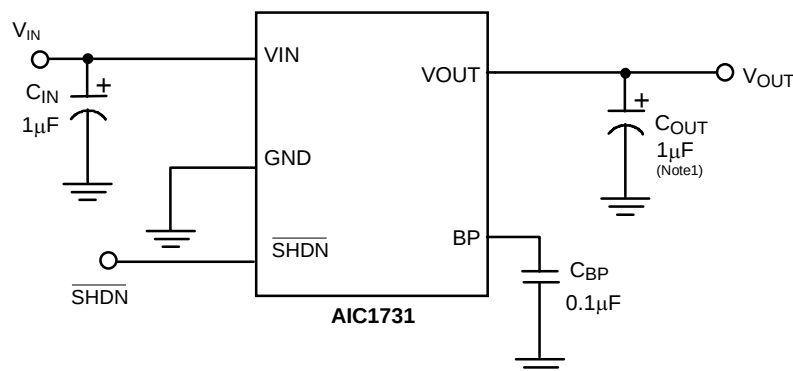
## APPLICATIONS

- 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

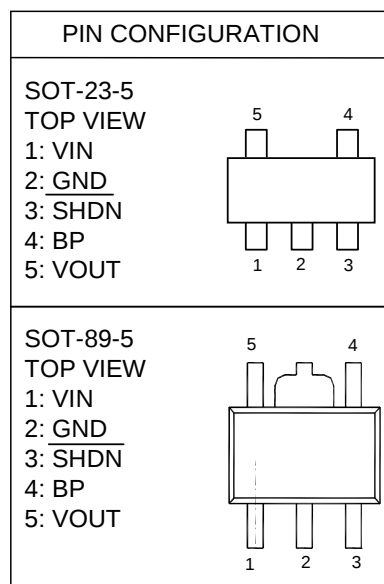
AIC1731-XXXXXX

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                         | $\mu A$                   |
| Standby Current               | $V_{IN} = 3.6\sim 7V$ , output OFF                                                                                                              | $I_{STBY}$       |      |                           | 0.1                        | $\mu A$                   |
| GND Pin Current               | $I_{OUT} = 0.1\sim 300mA$                                                                                                                       | $I_{GND}$        |      | 30                        | 50                         | $\mu A$                   |
| 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                                                                                                              | $\Delta V_{LIR}$ |      | 3                         | 10                         | mV                        |
| Load Regulation               | $V_{IN} = V_{OUT} + 1.2V$ ( $V_{out} \geq 2.0V$ )<br>$V_{IN} = V_{OUT} + 1.7V$ ( $V_{out} \leq 1.9V$ )<br>$I_{OUT} = 0.1\sim 300mA$             | $\Delta V_{LOR}$ |      | 10                        | 30                         | mV                        |
| Dropout Voltage               | $I_L=300mA$<br>$3.0V \leq V_{OUT} \leq 3.3V$<br>$2.5V \leq V_{OUT} \leq 2.9V$<br>$2.0V \leq V_{OUT} \leq 2.4V$<br>$1.3V \leq V_{OUT} \leq 1.9V$ | $V_{DROP}$       |      | 470<br>570<br>800<br>1260 | 870<br>970<br>1200<br>1660 | mV                        |
| Noise Bypass Terminal Voltage |                                                                                                                                                 | $V_{REF}$        |      | 1.23                      |                            | V                         |
| Output Noise                  | $C_{BP} = 0.1\mu F$ , $f = 1KHz$ , $V_{IN} = 5V$                                                                                                | $\Delta n$       |      | 0.46                      |                            | $\frac{\mu V}{\sqrt{Hz}}$ |
| Ripple Rejection              | $f = 1KHz$ , Ripple = $0.5V_{P-P}$ ,<br>$C_{BP} = 0.1\mu F$                                                                                     | RR               |      | 55                        |                            | dB                        |
| Shutdown Pin Current          |                                                                                                                                                 | $I_{SHDN}$       |      |                           | 0.1                        | $\mu A$                   |
| Shutdown Pin Voltage (ON)     | Output ON                                                                                                                                       |                  | 1.6  |                           |                            | V                         |
| Shutdown Pin Voltage (OFF)    | Output OFF                                                                                                                                      |                  |      |                           | 0.6                        | V                         |
| Shutdown Exit Delay Time      | $C_{BP}=0.1\mu F$ , $C_{OUT}=1\mu F$ ,<br>$I_{OUT}=30mA$                                                                                        | $\Delta t$       |      | 300                       |                            | $\mu S$                   |
| 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

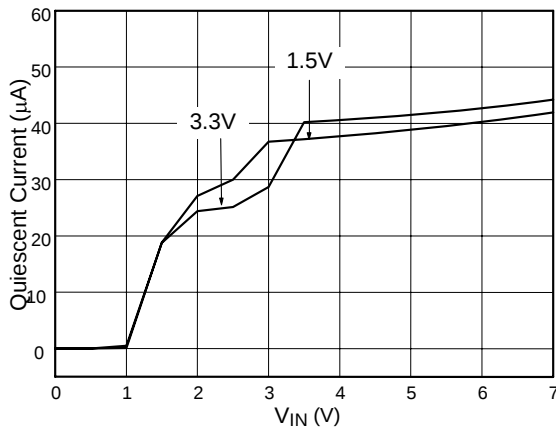


Fig. 1 Quiescent Current vs.  $V_{\text{IN}}$

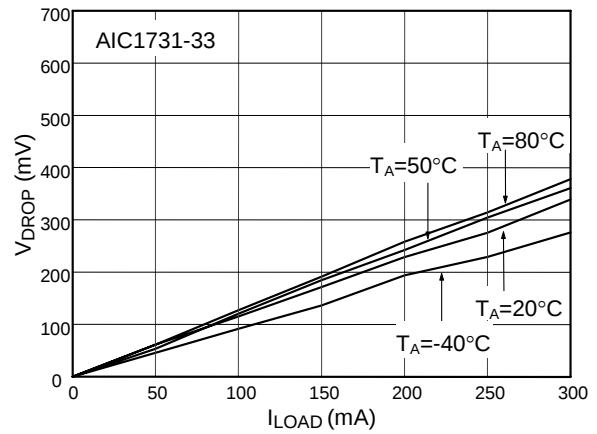


Fig. 2  $V_{\text{DROP}}$  vs.  $I_{\text{LOAD}}$

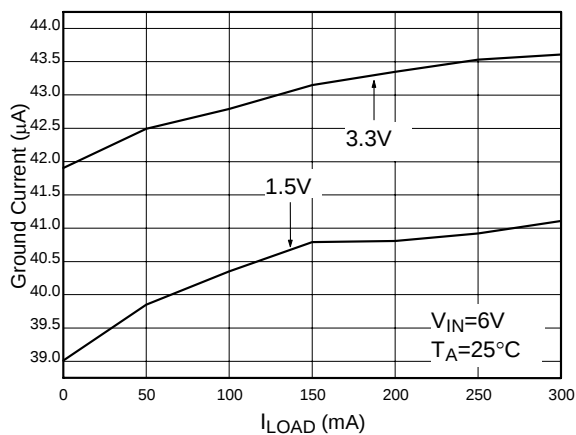


Fig. 3 Ground Current vs.  $I_{\text{LOAD}}$

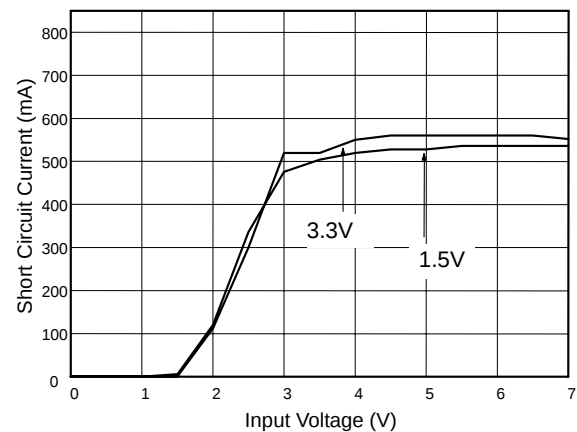


Fig. 4 Input Voltage vs. Short Circuit Current

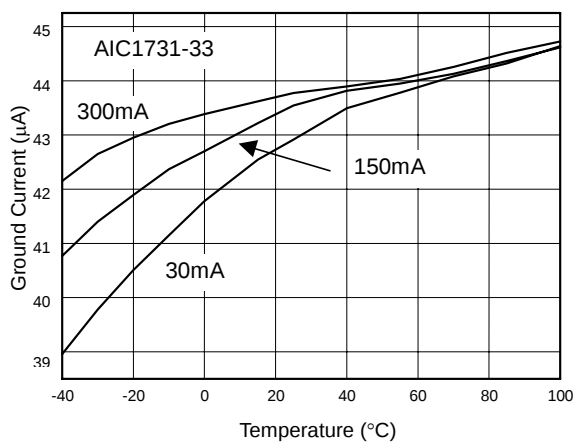


Fig. 5 Ground Current vs. Temperature

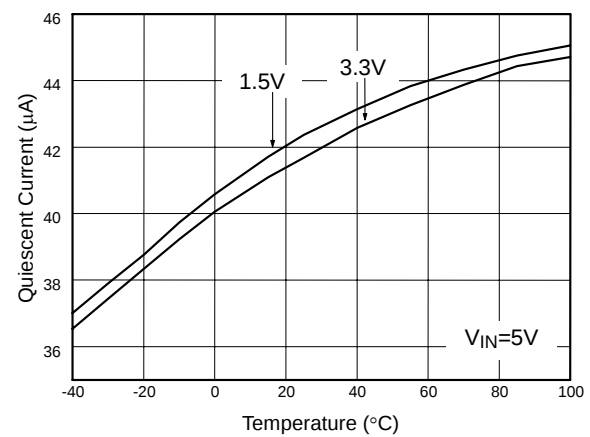


Fig. 6 Quiescent Current vs. Temperature

## ■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

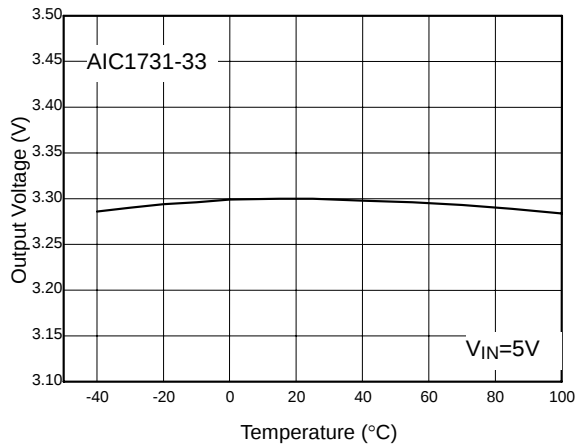


Fig. 7 Output Voltage vs. Temperature

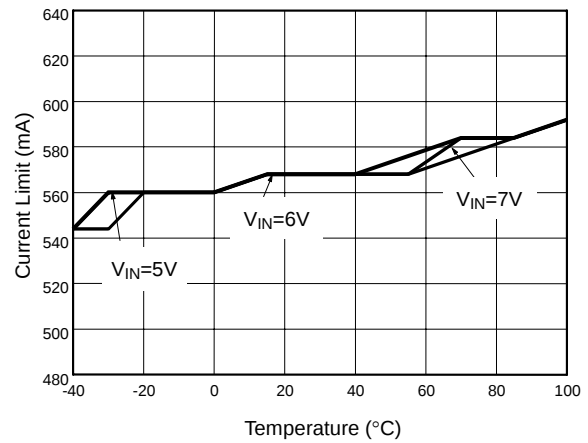


Fig. 8 Current Limit vs. Temperature

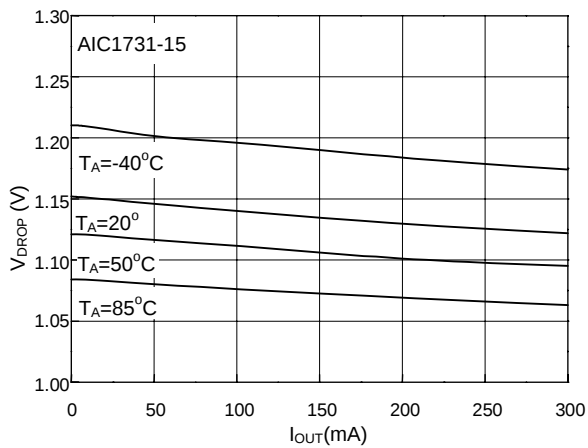
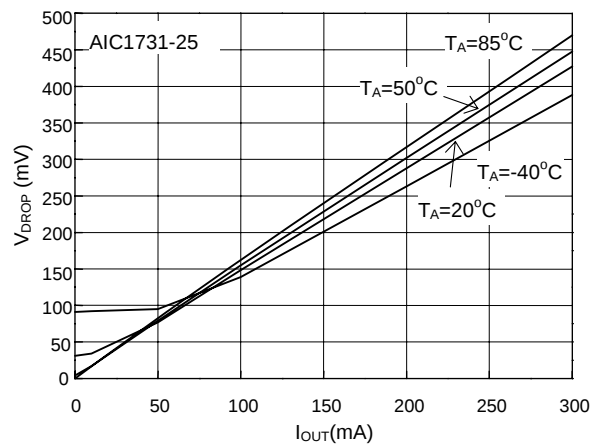
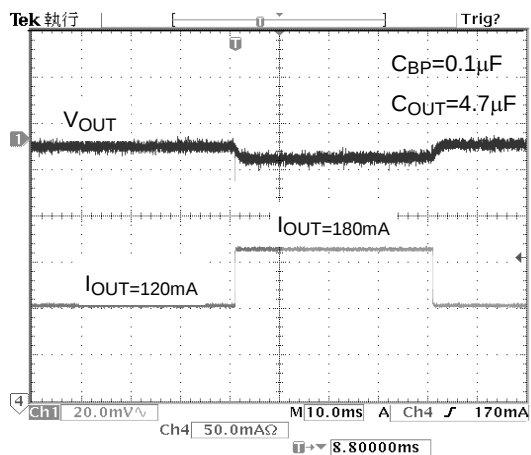

Fig. 9  $V_{DROP}$  vs.  $I_{LOAD}$ 

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


Fig. 11 Load Transient Response

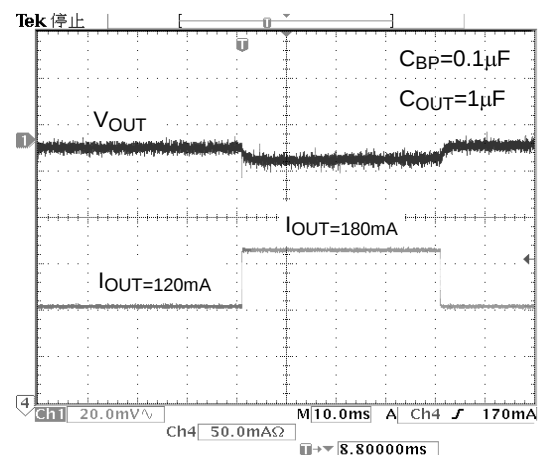


Fig. 12 Load Transient Response

## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

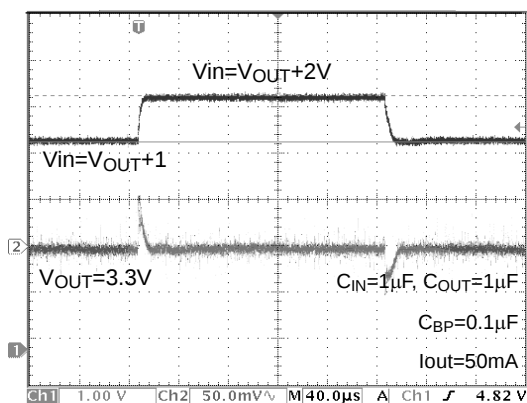


Fig. 13 Line Transient Response

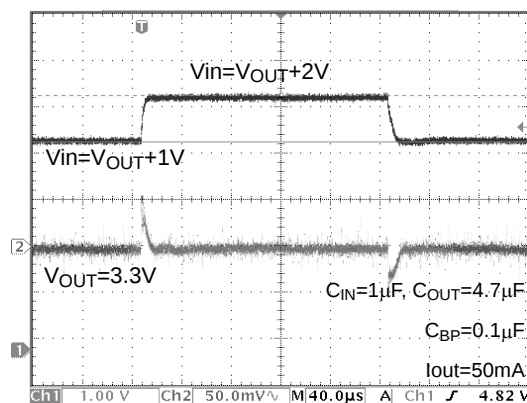


Fig. 14 Line Transient Response

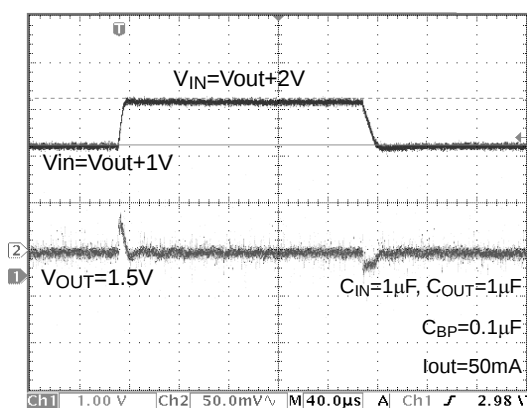


Fig. 15 Line Transient Response

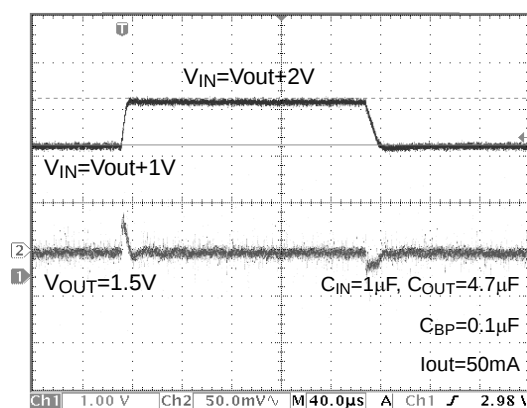


Fig. 16 Line Transient Response

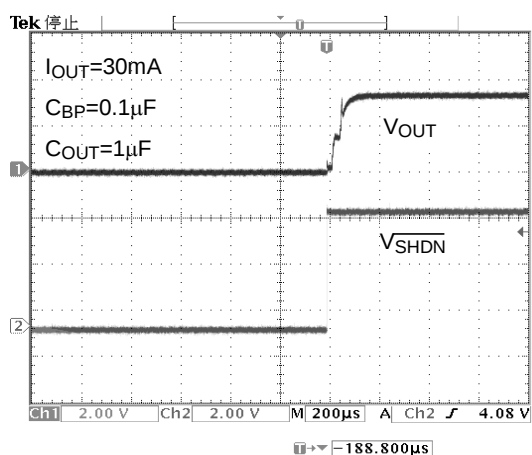


Fig. 17 Shutdown Exit Time

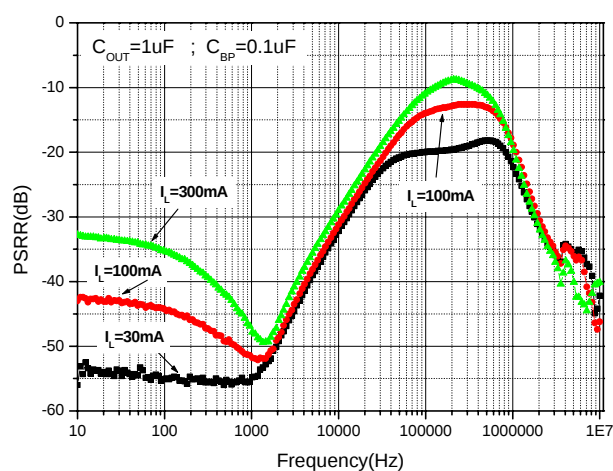
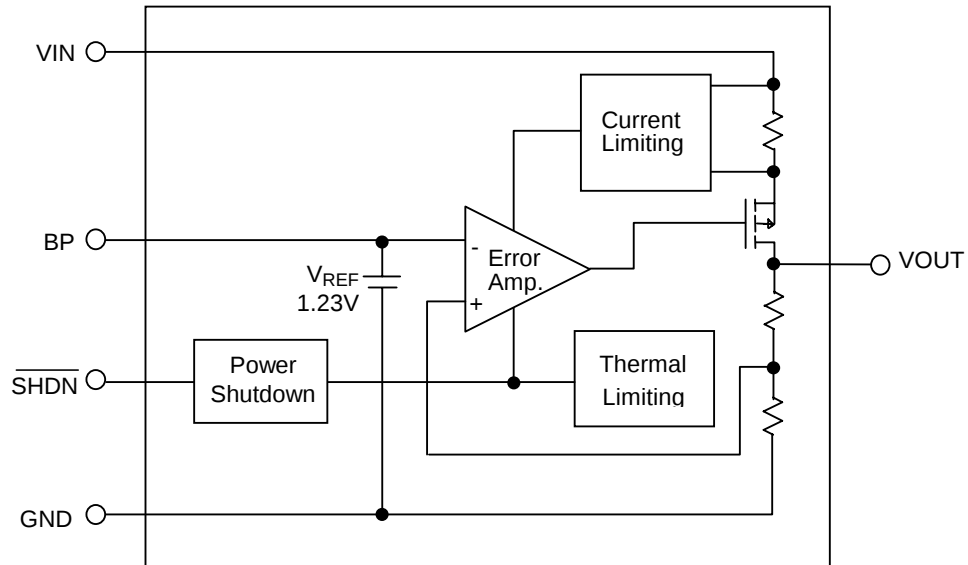


Fig. 18 Ripple Rejection

## ■ BLOCK DIAGRAM



## ■ PIN DESCRIPTIONS

PIN 1 : VIN - Power supply input pin. Bypass with a 1 $\mu$ 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 ( $V_{\text{DROP}}$ )**

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  $V_{\text{IN}} = V_{\text{OUT}} + 1\text{V}$  to  $V_{\text{IN}} = 7\text{V}$  and  $I_{\text{OUT}} = 1\text{mA}$ .

### **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  $V_{\text{IN}} = V_{\text{OUT}} + V_{\text{DROP}}$  can minimize temperature effects. The load regulation

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

### **CURRENT LIMIT ( $I_{\text{IL}}$ )**

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  $T_J = +155^\circ\text{C}$ . It signals shutdown logic, turning off pass transistor and allowing IC to cool down. After the IC's junction temperature cools by  $15^\circ\text{C}$ , 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  $T_J = 150^\circ\text{C}$ , 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  $1\mu\text{F}$  with a  $1\mu\text{F}$  aluminum electrolytic output capacitor is suggested.

### **NOISE BYPASS CAPACITOR**

$0.1\mu\text{F}$  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

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

The maximum power dissipation is:

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

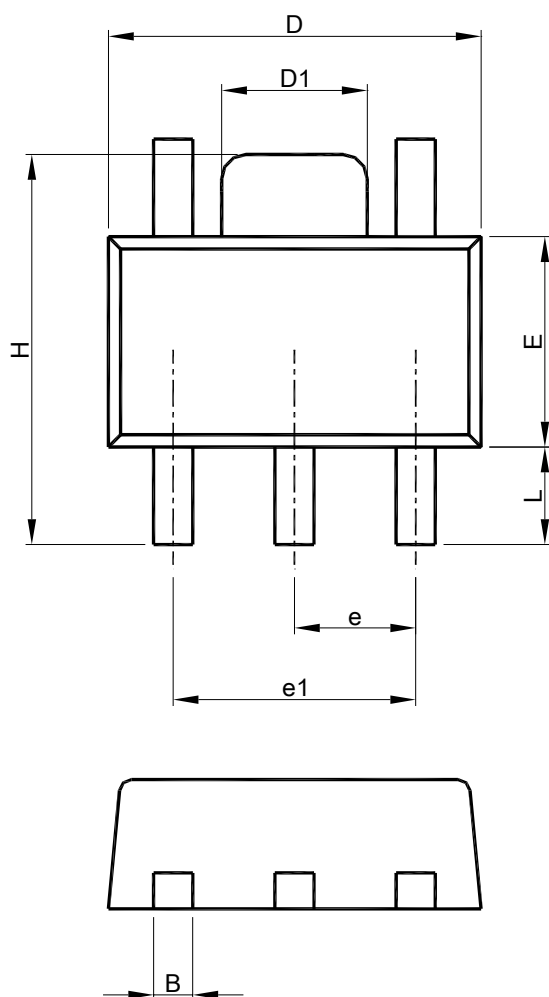
Where  $T_{J-max}$  is the maximum allowable junction temperature (125°C), and  $T_A$  is the ambient temperature suitable in application.

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

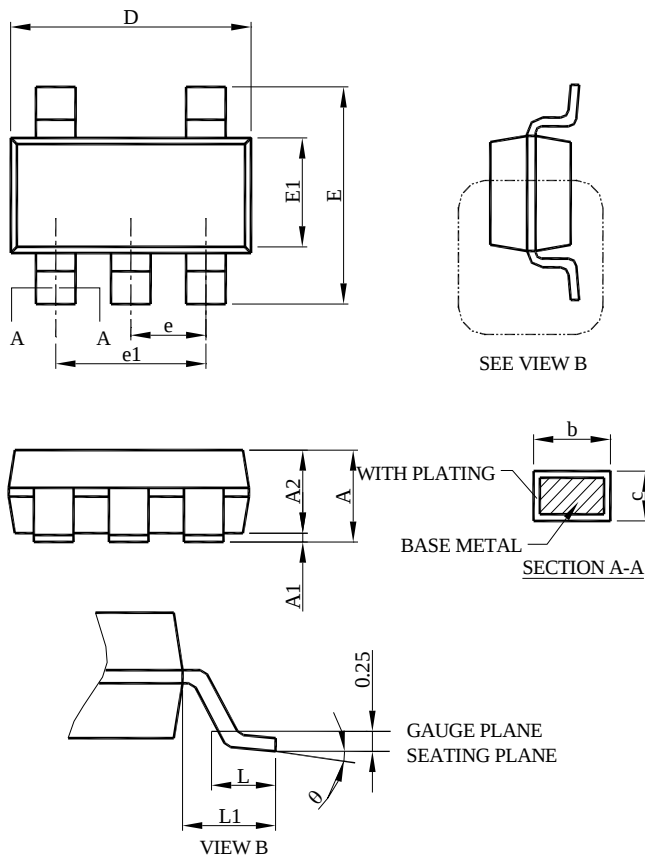


| SYMBOL | SOT-89-5    |      |
|--------|-------------|------|
|        | MILLIMETERS |      |
|        | MIN.        | MAX. |
| A      | 1.40        | 1.60 |
| B      | 0.36        | 0.56 |
| C      | 0.35        | 0.44 |
| D      | 4.40        | 4.60 |
| D1     | 1.50        | 1.83 |
| E      | 2.29        | 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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