

# 500mA, Low Dropout Linear Regulator with Shutdown

## FEATURES

- Active Low Shutdown Control.
- Very Low Quiescent Current.
- Very Low Dropout Voltage of 650mV at 500mA 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, TO-252-5, SOT-89-5

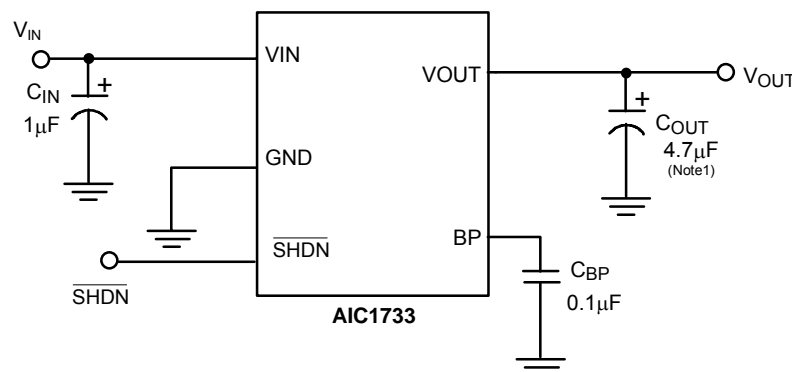
## APPLICATIONS

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

## DESCRIPTION

AIC1733 is a 500mA low noise, low dropout linear regulator, and is housed in small SOT-23-5 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 650mV low dropout voltage at 500mA 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 AIC1733 provide enhanced performance for critical applications. The noise bypass pin can be connected an external capacitor to reduce the output noise level.

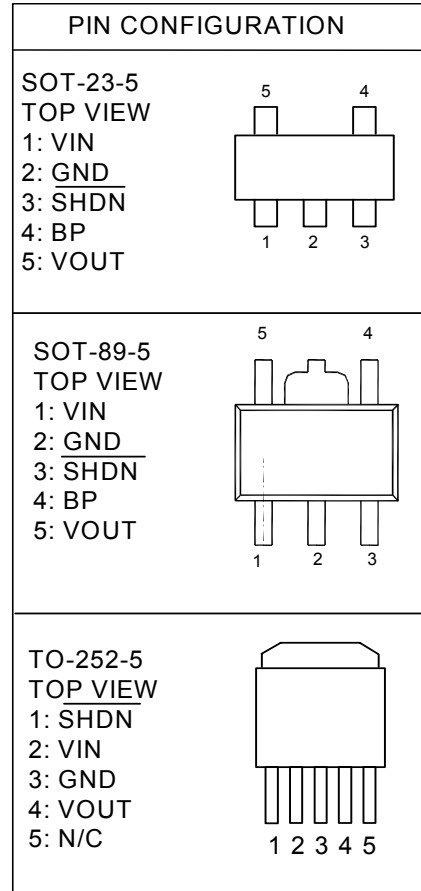
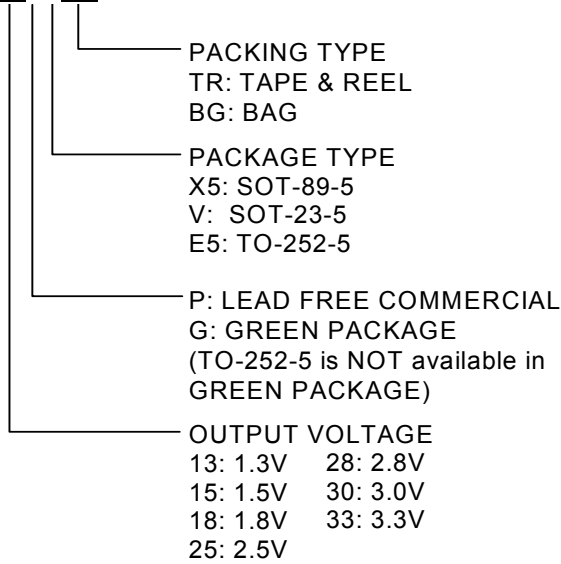
## TYPICAL APPLICATION CIRCUIT



Low Noise Low Dropout Linear Regulator

**ORDERING INFORMATION**

AIC1733-XXXXXX



(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: AIC1733-18PX5TR

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

AIC1733-18PVTR

→ 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
AIC1733-13CX5	EI13	AIC1733-13PX5	EI13P	AIC1733-13GX5	EI13G
AIC1733-15CX5	EI15	AIC1733-15PX5	EI15P	AIC1733-15GX5	EI15G
AIC1733-18CX5	EI18	AIC1733-18PX5	EI18P	AIC1733-18GX5	EI18G
AIC1733-25CX5	EI25	AIC1733-25PX5	EI25P	AIC1733-25GX5	EI25G
AIC1733-28CX5	EI28	AIC1733-28PX5	EI28P	AIC1733-28GX5	EI28G
AIC1733-30CX5	EI30	AIC1733-30PX5	EI30P	AIC1733-30GX5	EI30G
AIC1733-33CX5	EI33	AIC1733-33PX5	EI33P	AIC1733-33GX5	EI33G

**● SOT-23-5 Marking**

Part No.	Marking	Part No.	Marking	Part No.	Marking
AIC1733-13CV	EE13	AIC1733-13PV	EE13P	AIC1733-13GV	EE13G
AIC1733-15CV	EE15	AIC1733-15PV	EE15P	AIC1733-15GV	EE15G
AIC1733-18CV	EE18	AIC1733-18PV	EE18P	AIC1733-18GV	EE18G
AIC1733-25CV	EE25	AIC1733-25PV	EE25P	AIC1733-25GV	EE25G
AIC1733-28CV	EE28	AIC1733-28PV	EE28P	AIC1733-28GV	EE28G
AIC1733-30CV	EE30	AIC1733-30PV	EE30P	AIC1733-30GV	EE30G
AIC1733-33CV	EE33	AIC1733-33PV	EE33P	AIC1733-33GV	EE33G

■ **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)	SOT-23-5.....	130°C /W
	TO-252-5.....	12.5°C /W
	SOT-89-5.....	30°C /W
Thermal Resistance Junction to Ambient	SOT-23-5.....	220°C /W
	TO-252-5.....	100°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	$I_{OUT} = 0mA$ , $V_{IN} = 3.6\sim 7V$	$I_Q$		40	55	$\mu A$			
Standby Current	$V_{IN} = 3.6\sim 7V$ , output OFF	$I_{STBY}$			0.1	$\mu A$			
GND Pin Current	$I_{OUT} = 0.1\sim 500mA$	$I_{GND}$		30	50	$\mu A$			
Continuous Output Current	$V_{IN} = 5V$	$I_{OUT}$			500	mA			
Output Current Limit	$V_{IN} = 5V$ , $V_{OUT} = 0V$	$I_{IL}$	500	600		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	$V_{IN} = V_{OUT} + 1.2V$ ( $V_{out} \geq 2.5V$ )	$\Delta V_{LOR}$		20	40	mV			
	$V_{IN} = V_{OUT} + 1.8V$ ( $V_{out} \leq 2.4V$ ) $I_{OUT} = 0.1\sim 500mA$								
Dropout Voltage	$I_L = 500mA$	$V_{DROP}$				mV			
							$3.0V \leq V_{OUT} \leq 3.3V$	650	1050
							$2.5V \leq V_{OUT} \leq 2.9V$	780	1180
							$2.0V \leq V_{OUT} \leq 2.4V$	1100	1500
						1400	1800		
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 <sub>P-P</sub> , $C_{BP} = 0.1\mu F$	RR		55		dB			
Shutdown Pin Current		$I_{\overline{SHDN}}$			0.1	$\mu A$			
Shutdown Pin Voltage (ON)	Output ON	$V_{SHDN}$ (ON)	1.6			V			
Shutdown Pin Voltage (OFF)	Output OFF	$V_{SHDN}$ (OFF)			0.6	V			
Shutdown Exit Delay Time	$C_{BP} = 0.1\mu F$ , $C_{OUT} = 1\mu F$ , $I_{OUT} = 30mA$	$\Delta t$		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**

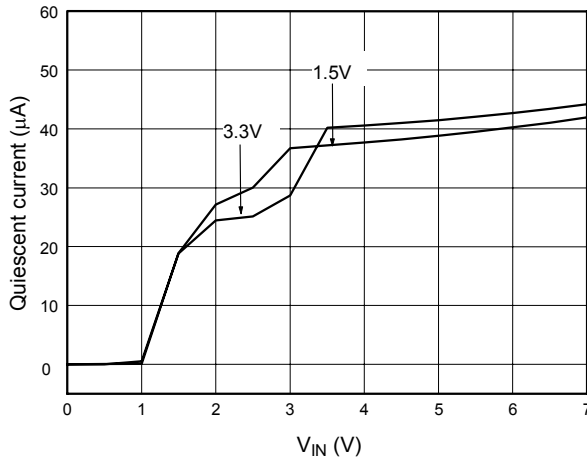


Fig. 1 Quiescent Current vs.  $V_{IN}$

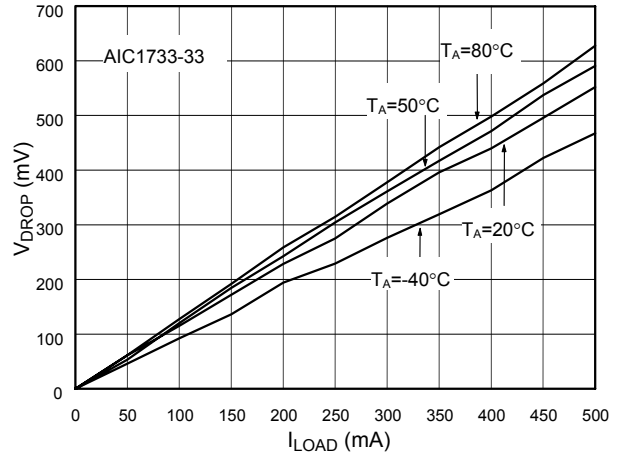


Fig. 2  $V_{DROP}$  vs.  $I_{LOAD}$

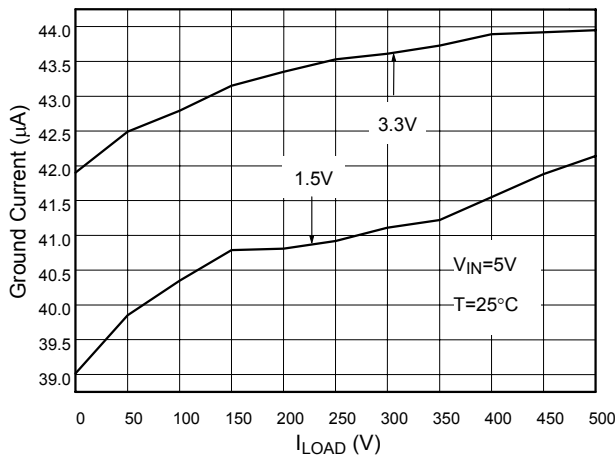


Fig. 3 Ground Current vs.  $I_{LOAD}$

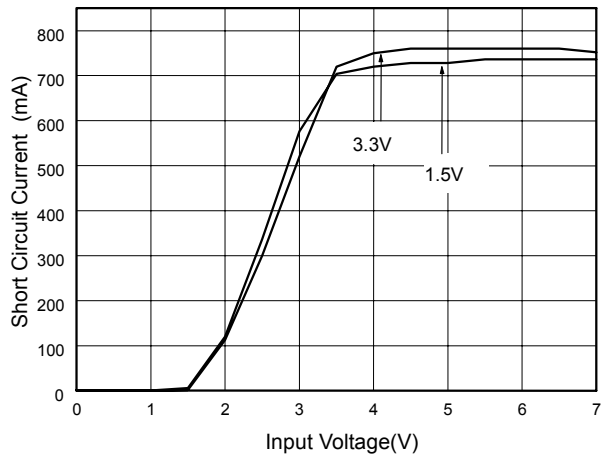


Fig. 4 Input Voltage vs. Short Circuit Current

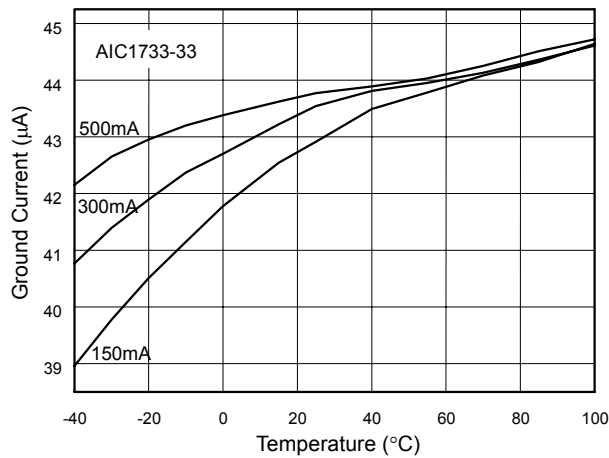


Fig. 5 Ground Current vs. Temperature

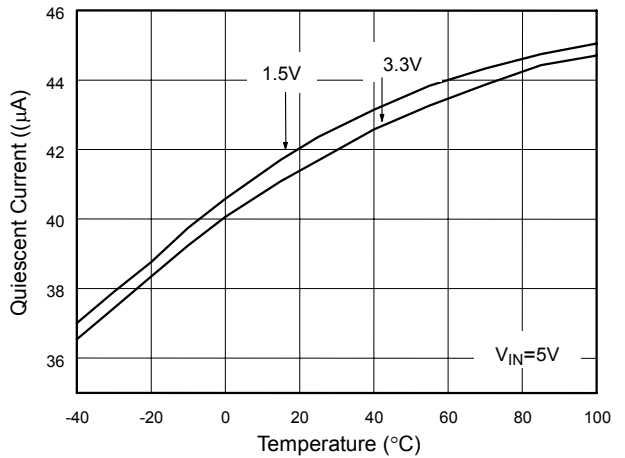


Fig. 6 Quiescent vs. Temperature

**TYPICAL PERFORMANCE CHARACTERISTICS (Continued)**

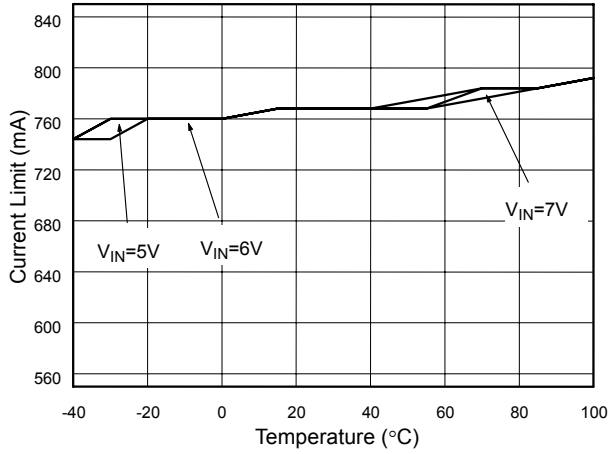


Fig. 7 Current Limit vs. Temperature

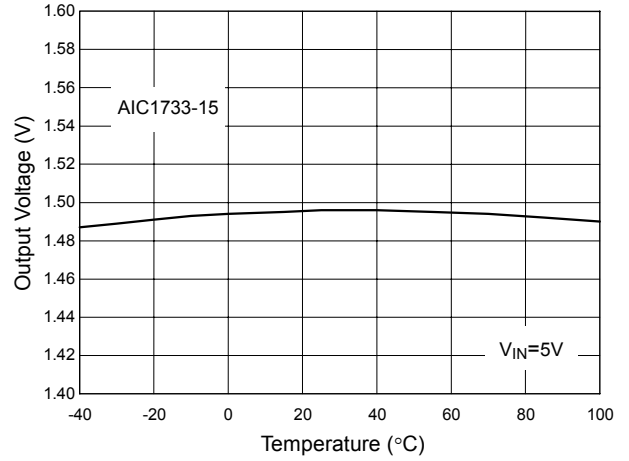


Fig. 8  $V_{OUT}$  vs. Temperature

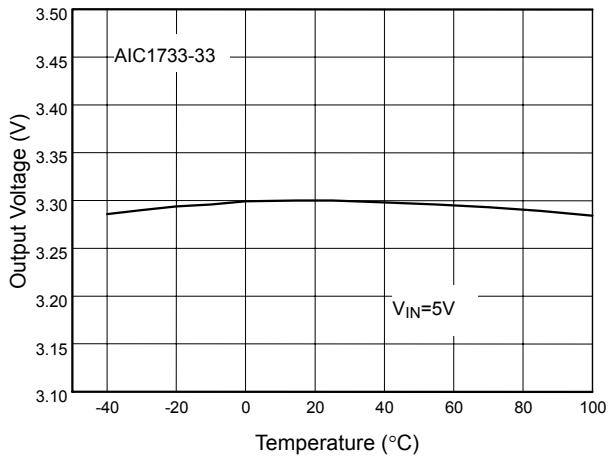


Fig. 9  $V_{OUT}$  vs. Temperature

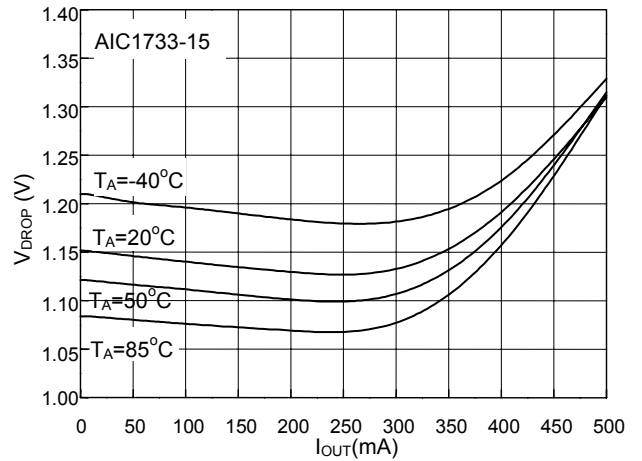


Fig. 10  $V_{DROP}$  vs.  $I_{LOAD}$

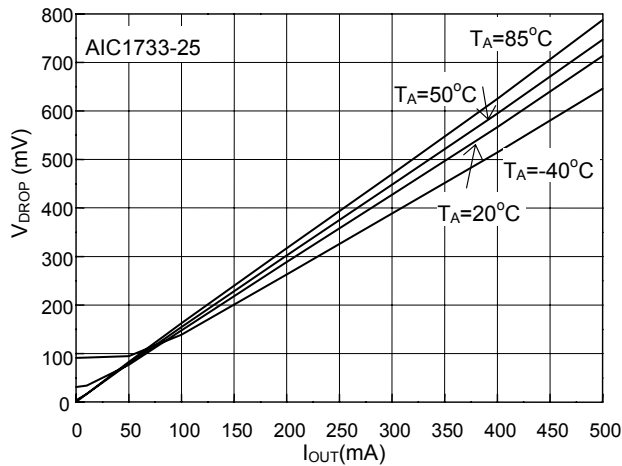


Fig. 11  $V_{DROP}$  vs.  $I_{LOAD}$

**TYPICAL PERFORMANCE CHARACTERISTICS (Continued)**

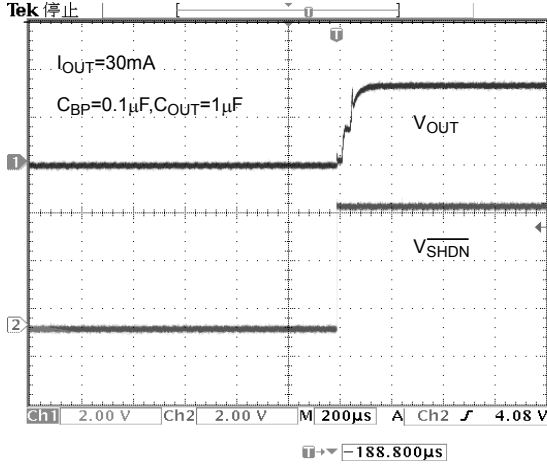


Fig. 12 Shutdown Exit Time

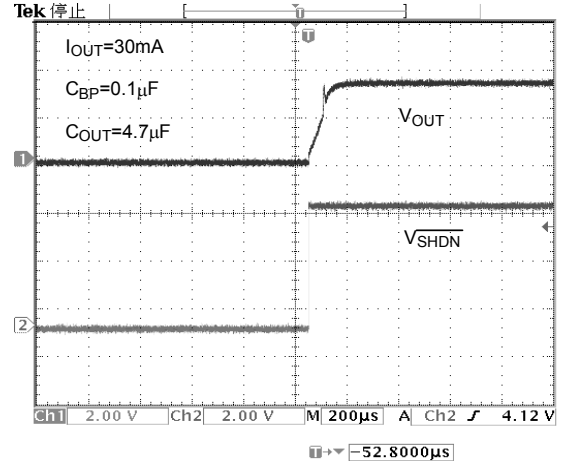


Fig. 13 Shutdown Exit Time

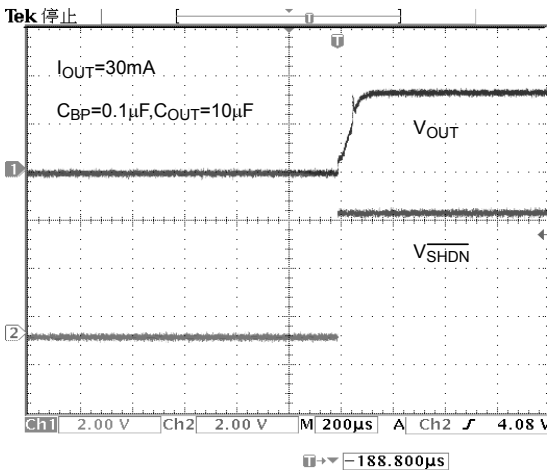


Fig. 14 Shutdown Exit Time

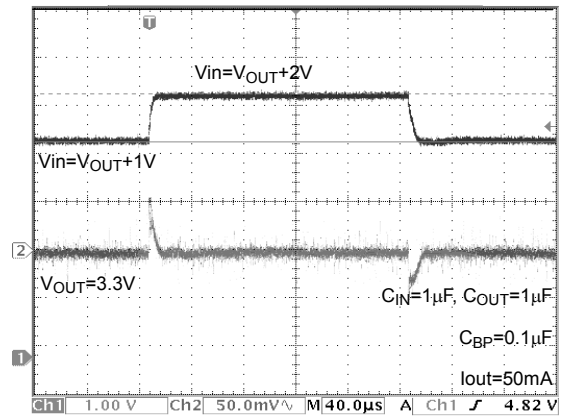


Fig. 15 Line Transient Response

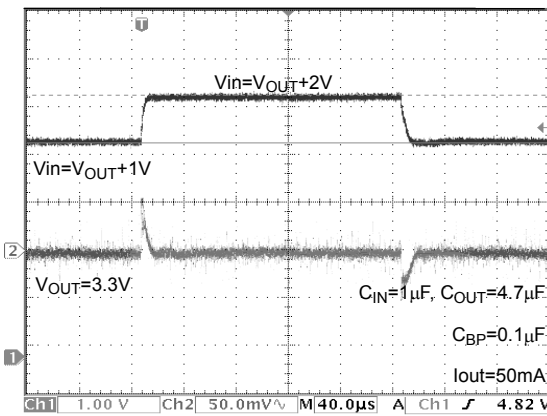


Fig. 16 Line Transient Response

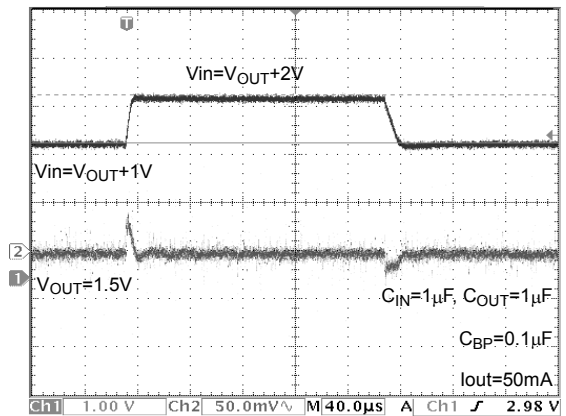


Fig. 17 Line Transient Response

■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

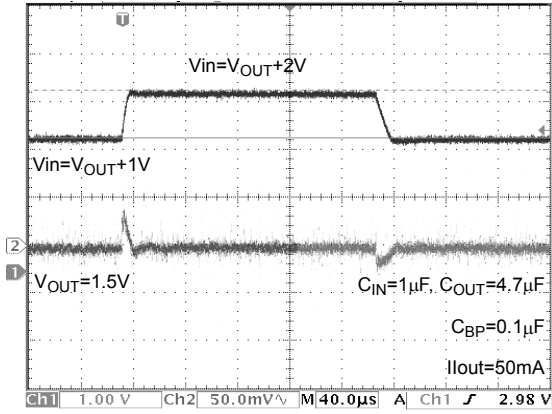


Fig. 18 Line Transient Response

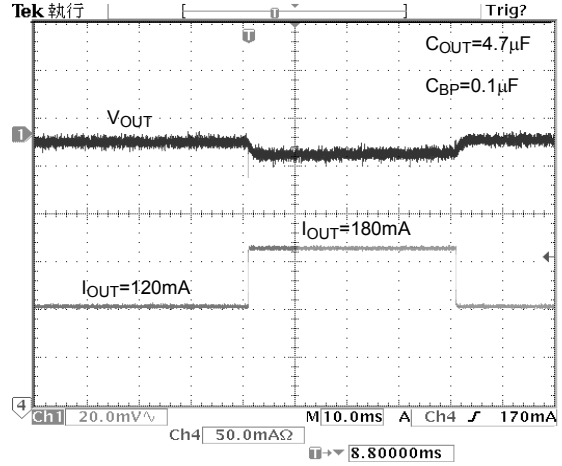


Fig. 19 Load Transient Response

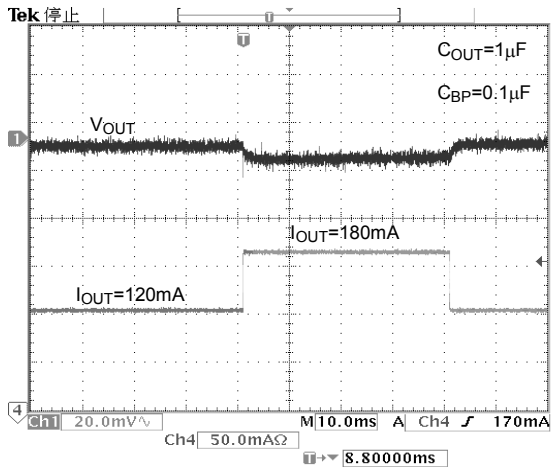
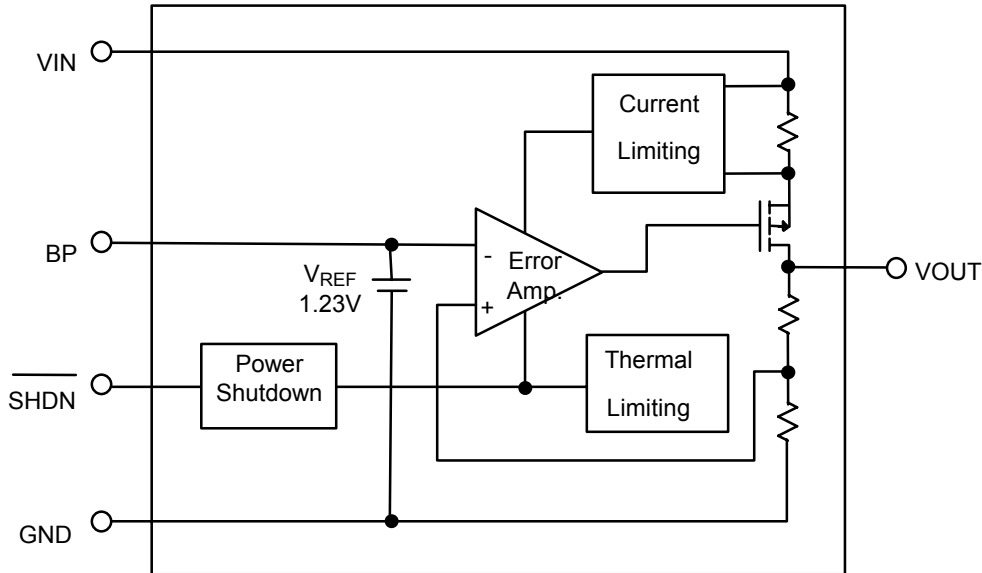


Fig. 20 Load Transient Response



## ■ BLOCK DIAGRAM



## ■ PIN DESCRIPTIONS

PIN 1 : VIN - Power supply input pin. Bypass with a  $1\mu\text{F}$  capacitor to GND

PIN 2 : GND - Ground pin.

PIN 3 : 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 500 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 500mA.

**CURRENT LIMIT (I<sub>L</sub>)**

AIC1733 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  $4.7\mu\text{F}$  aluminum electrolytic output capacitor is recommended.

**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 maximum power dissipation of AIC1733 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:

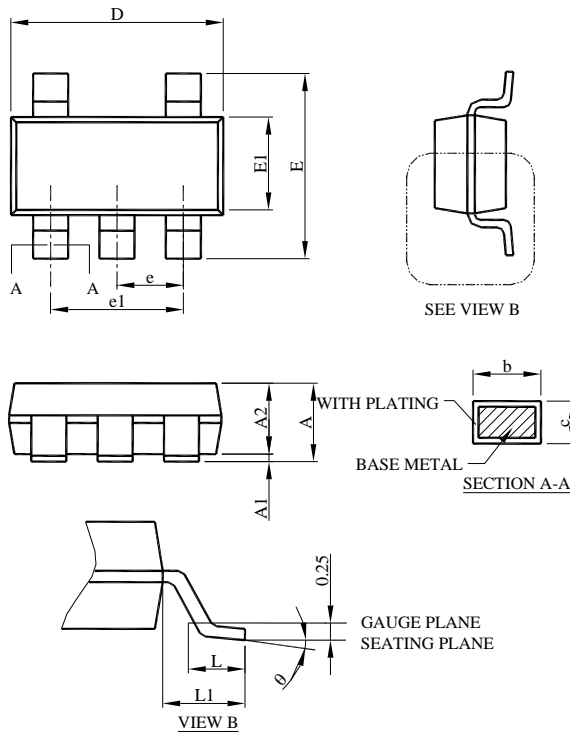
$$P_{\text{MAX}} = \frac{(T_J - T_A)}{(R_{\theta_{\text{JB}}} + R_{\theta_{\text{BA}}})}$$

Where  $T_J - T_A$  is the temperature difference between the die junction and the surrounding air,  $R_{\theta_{\text{JB}}}$  is the thermal resistance of the package, and  $R_{\theta_{\text{BA}}}$  is the thermal resistance through the PCB, copper traces, and other materials to the surrounding air.

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 of 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

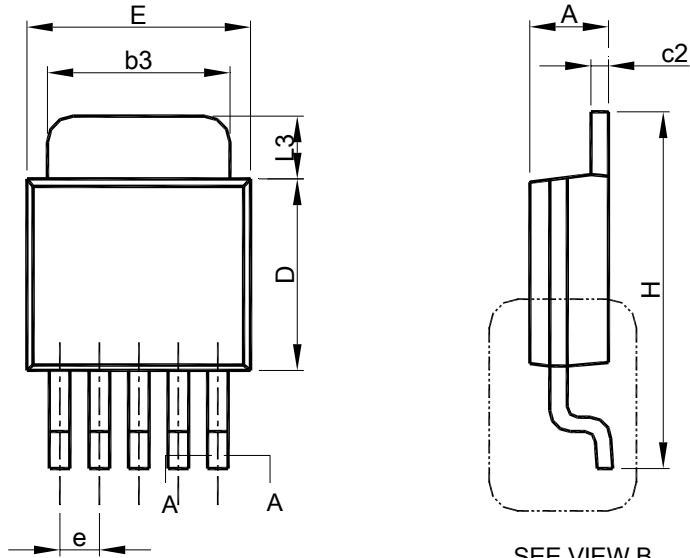
- SOT-23-5 (unit: mm)



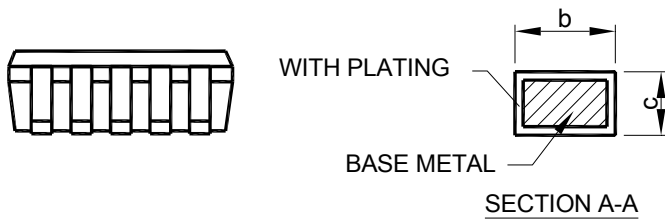
SYMBOL	SOT-25	
	MILLIMETERS	
	MIN.	MAX.
A	0.95	1.45
A1	0.05	0.15
A2	0.90	1.30
b	0.30	0.50
c	0.08	0.22
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.70
e	0.95 BSC	
e1	1.90 BSC	
L	0.30	0.60
L1	0.60 REF	
$\theta$	0°	8°

- 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 "E" does not include inter-lead flash or protrusions.  
 4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

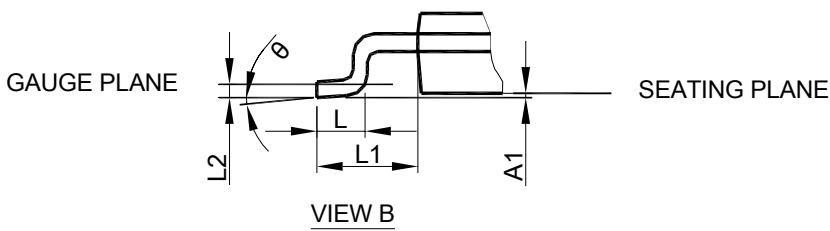
● TO-252-5 (unit: mm)



SEE VIEW B



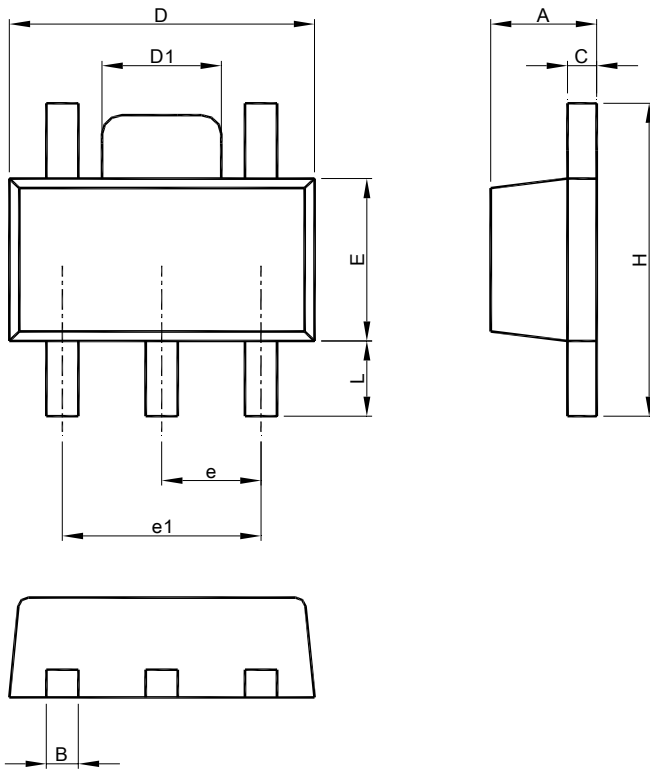
SECTION A-A



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°

- 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.

● SOT-89-5 (unit: mm)



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.

**Note:**

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