

## 150mA, Low Noise, Low Dropout Linear Regulator

### FEATURES

- Available in  $\pm 2\%$  Output Tolerance.
- 1.8V to 3.3V Output Voltage with 0.1V Increment.
- Active Low Shutdown Control.
- Very Low Quiescent Current.
- Very Low Dropout Voltage.
- Miniature Package (SOT-23-5 & SOT-23-6W)
- Short Circuit and Thermal Protection.
- Very Low Noise.

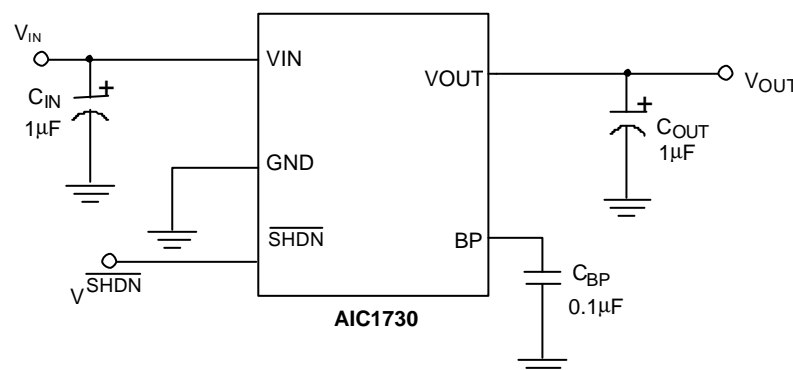
### APPLICATIONS

- Cellular Telephones.
- Pagers.
- Personal Communication Equipment.
- Cordless Telephones.
- Portable Instrumentation.
- Portable Consumer Equipment.
- Radio Control Systems.
- Low Voltage Systems.
- Battery Powered Systems.

### DESCRIPTION

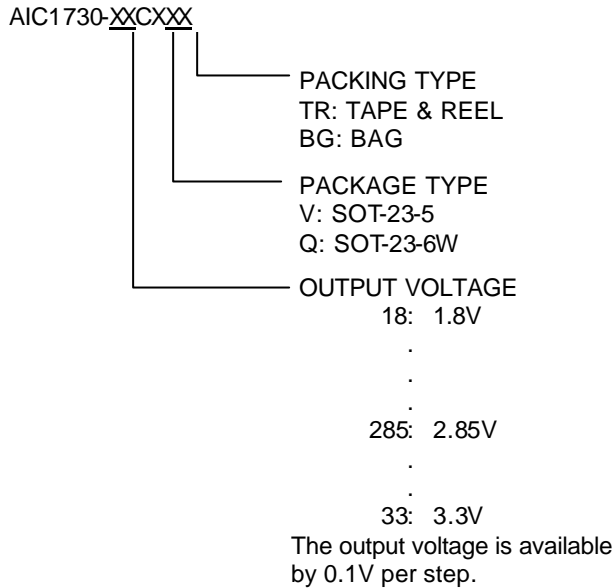
The AIC1730 is a low noise, low dropout linear regulator, housed in a small SOT-23-5 & SOT-23-6W package. The device is in the "ON" state when the  $\overline{\text{SHDN}}$  pin is set to a logic high level. An internal P-MOSFET pass transistor is used to achieve a low dropout voltage of 90mV at 50mA load current. It offers high precision output voltage of  $\pm 2\%$ . The very low quiescent current and low dropout voltage make this device ideal for battery powered applications. The internal reverse bias protection eliminates the requirement for a reverse voltage protection diode. The high ripple rejection and low noise provide enhanced performance for critical applications. An external capacitor can be connected to the noise bypass pin to reduce the output noise level.

### TYPICAL APPLICATION CIRCUIT

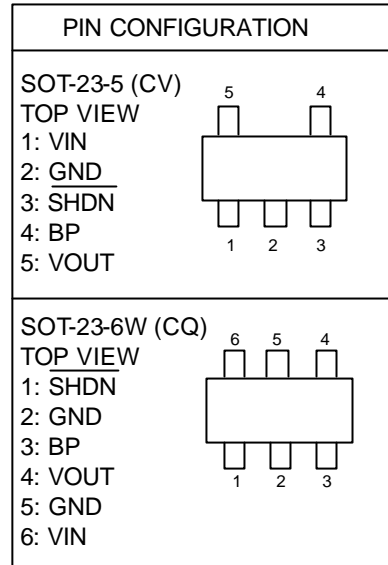


Low Noise Low Dropout Linear Regulator

## ORDERING INFORMATION



Example: AIC1730-18CVTR  
 → 1.8V Version, in SOT-23-5 Package & Tape & Reel Packing Type



## ABSOLUTE MAXIMUM RATINGS

Supply Voltage	.....	12V
Operating Temperature Range	.....	-40°C~85°C
Storage Temperature Range	.....	-65°C~150°C
Shutdown Terminal Voltage	.....	12V
Noise Bypass Terminal Voltage	.....	5V
Thermal Resistance (Junction to Case)	SOT-23-5 .....	130°C /W
Thermal Resistance Junction to Ambient	SOT-23-5 .....	220°C /W

(Assume no ambient airflow, no heatsink)

**ELECTRICAL CHARACTERISTICS** ( $C_{IN}=1mF$  ,  $C_{OUT}=10mF$ ,  $T_J=25^{\circ}C$ , unless otherwise specified)

PARAMETER	TEST CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT	
Quiescent Current	$I_{OUT} = 0mA$ , $V_{IN} = 3.6\sim 12V$	$I_Q$		55	80	$\mu A$	
Standby Current	$V_{IN} = 3.6\sim 8V$ , output OFF	$I_{STBY}$			0.1	$\mu A$	
GND Pin Current	$I_{OUT} = 0.1\sim 150mA$	$I_{GND}$		55	80	$\mu A$	
Continuous Output Current	$V_{IN} = V_{OUT} + 1V$	$I_{OUT}$			150	mA	
Output Current Limit	$V_{IN} = V_{OUT} + 1V$ , $V_{OUT} = 0V$	$I_{IL}$	150	220		mA	
Output Voltage Tolerance	$V_{IN} = V_{OUT} + 1V$ , no load	$V_{OUT}$	-2		2	%	
Temperature Coefficient		TC		50	150	ppm/ $^{\circ}C$	
Line Regulation	$V_{IN} = V_{OUT(TYP)} + 1V$ to $V_{OUT(TYP)} + 6V$	$\Delta V_{LIR}$		2	7	mV	
Load Regulation	$V_{IN} = 5V$ , $I_{OUT} = 0.1\sim 150mA$	$\Delta V_{LOR}$		7	25	mV	
Dropout Voltage (1)	$I_{OUT} = 50 mA$	$V_{OUT} \geq 2.5V$	$V_{DROP1}$		90	160	mV
	$I_{OUT} = 100 mA$				140	230	mV
	$I_{OUT} = 150 mA$				200	350	mV
Dropout Voltage (2)	$I_{OUT}=150 mA$	$V_{OUT} < 2.5V$	$V_{DROP2}$		700	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		$\frac{mV}{\sqrt{Hz}}$	
<b>SHUTDOWN TERMINAL SPECIFICATIONS</b>							
Shutdown Pin Current		$\overline{I_{SHDN}}$			0.1	$\mu A$	
Shutdown Pin Voltage (ON)	Output ON	$\overline{V_{SHDN}}$ (ON)	1.6			V	
Shutdown Pin Voltage (OFF)	Output OFF	$\overline{V_{SHDN}}$ (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		$\mu S$	
<b>THERMAL PROTECTION</b>							
Thermal Shutdown Temperature		$T_{SD}$		155		$^{\circ}C$	

**TYPICAL PERFORMANCE CHARACTERISTICS**

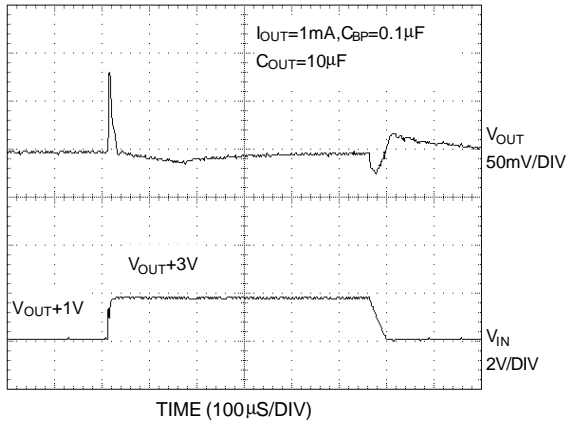


Fig. 1 Line Transient Response

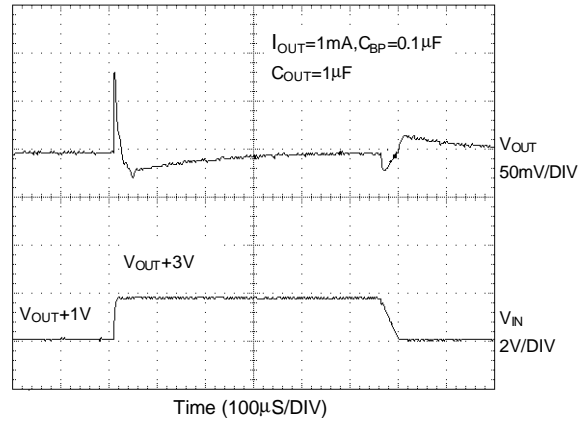


Fig. 2 Line Transient Response

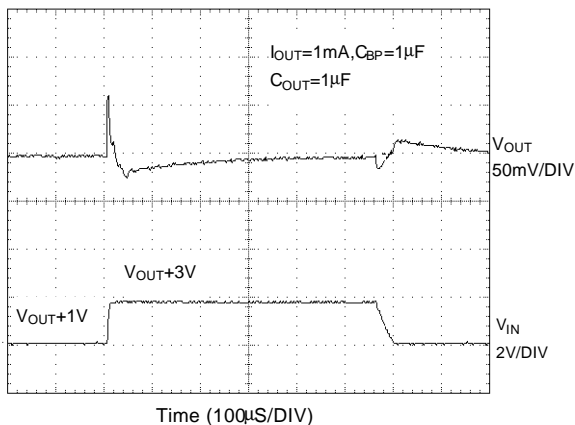


Fig. 3 Line Transient Response

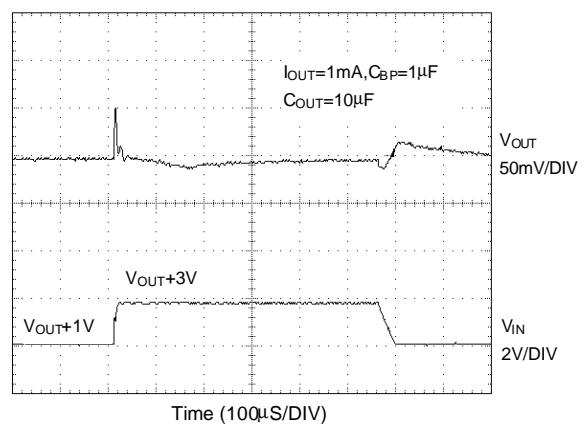


Fig. 4 Line Transient Response

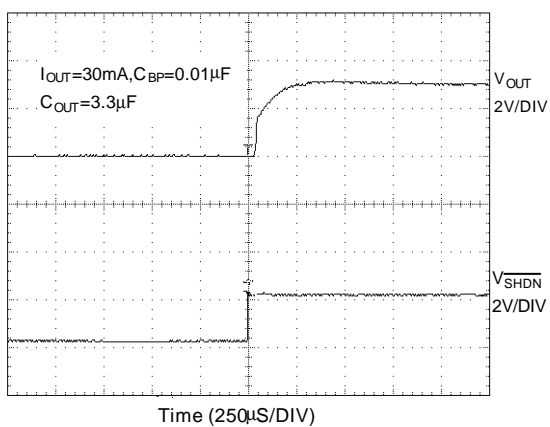


Fig. 5 Shutdown Exit Delay

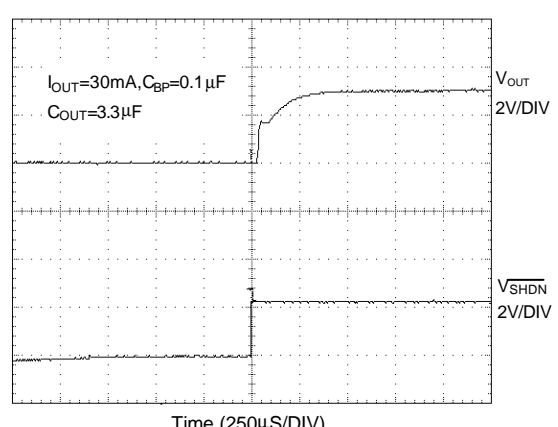


Fig. 6 Shutdown Exit Delay

**TYPICAL PERFORMANCE CHARACTERISTICS (Continued)**

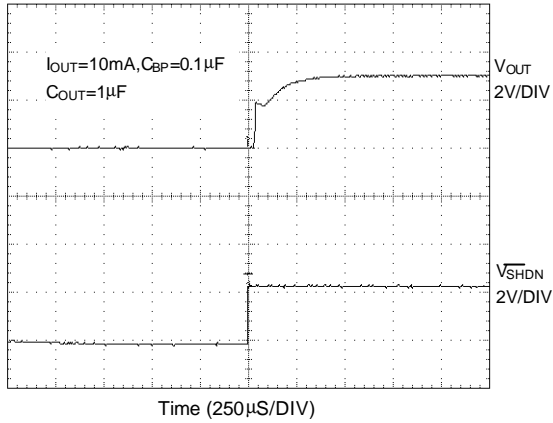


Fig. 7 Shutdown Exit Delay

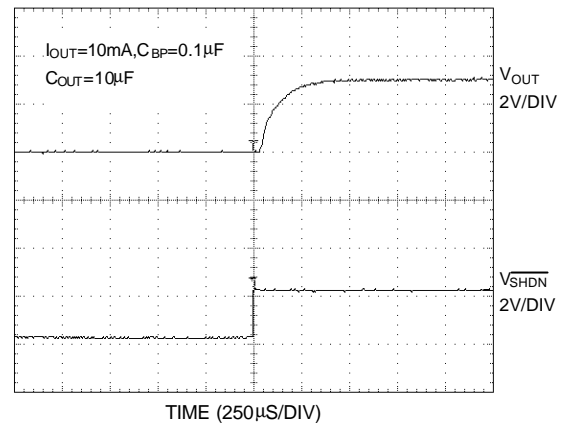


Fig. 8 Shutdown Exit Delay

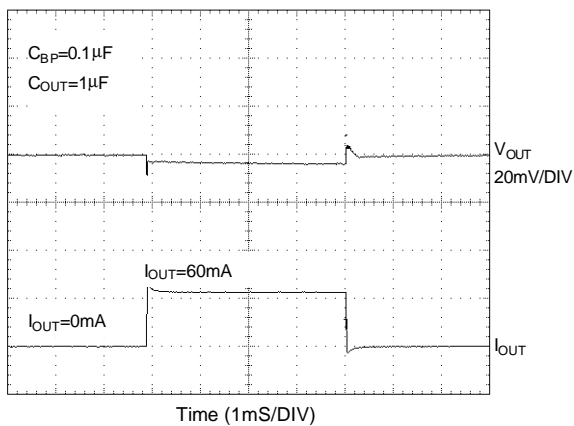


Fig. 9 Load Transient Response

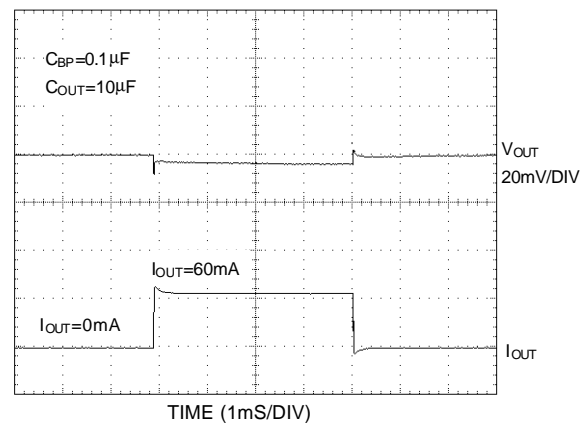


Fig. 10 Load Transient Response

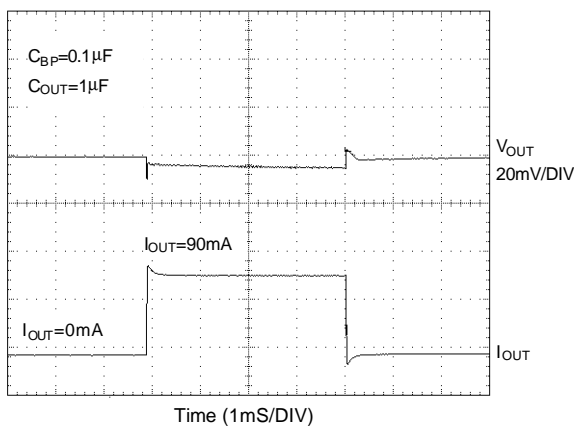


Fig. 11 Load Transient Response

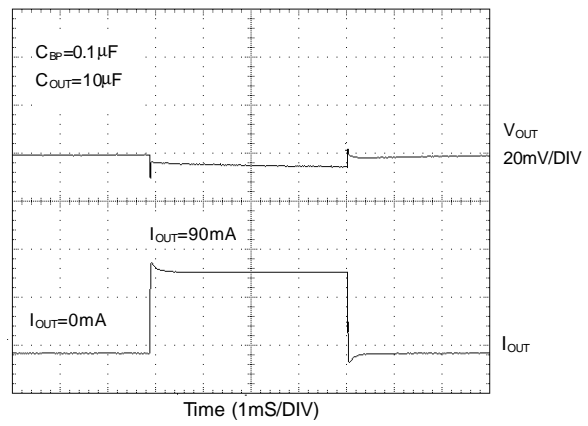


Fig. 12 Load Transient Response

**TYPICAL PERFORMANCE CHARACTERISTICS (Continued)**

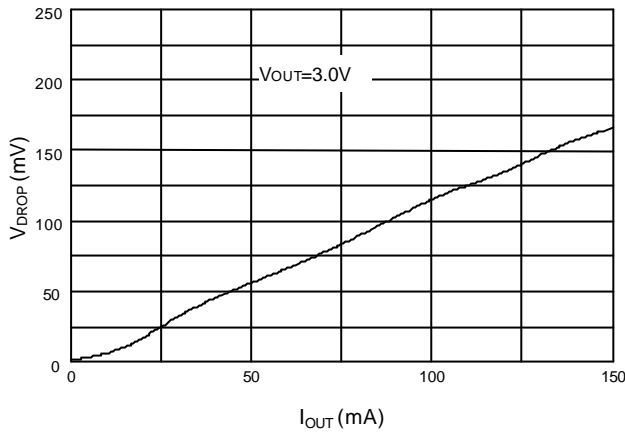


Fig. 13 Dropout Voltage vs. Output Current

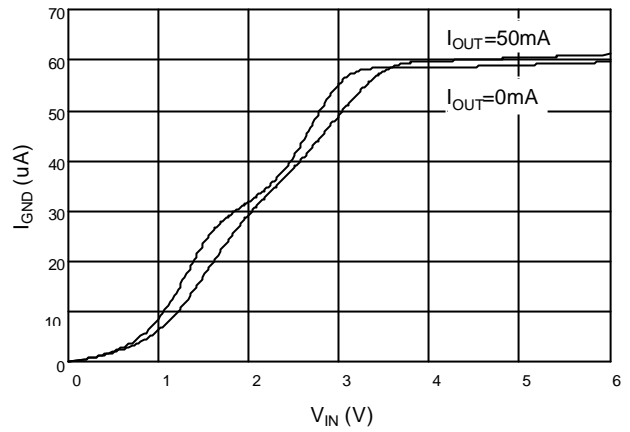


Fig. 14 Ground Current vs. Input Voltage ( $V_{OUT}=3.0V$ )

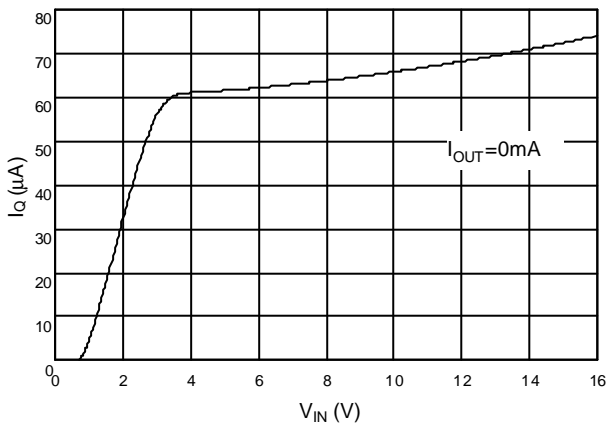


Fig. 15 Quiescent Current (ON Mode) vs. Input Voltage

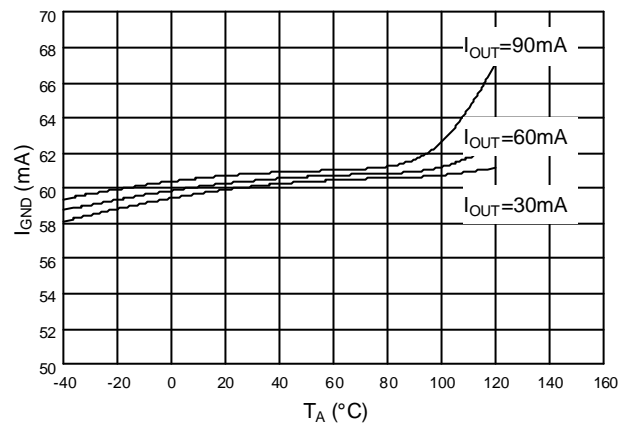


Fig. 16 Ground Current vs. Temperature

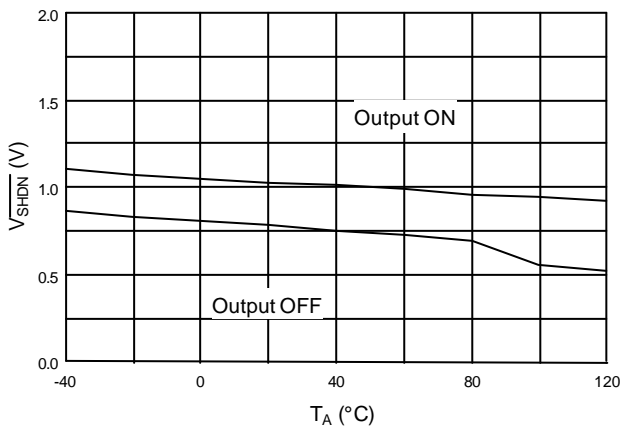


Fig. 17 Shutdown Voltage vs. Temperature

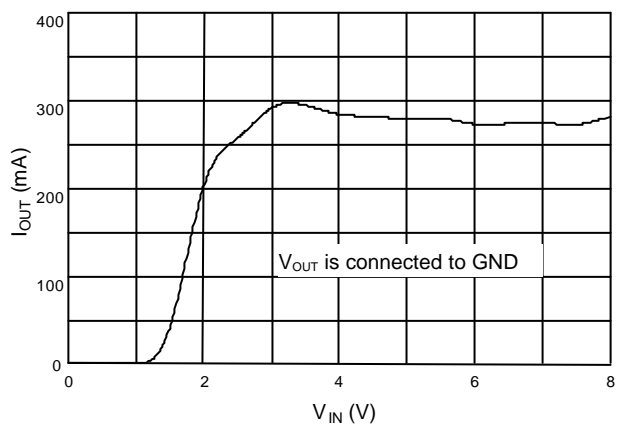


Fig. 18 Short Circuit Current vs. Input Voltage

**TYPICAL PERFORMANCE CHARACTERISTICS (Continued)**

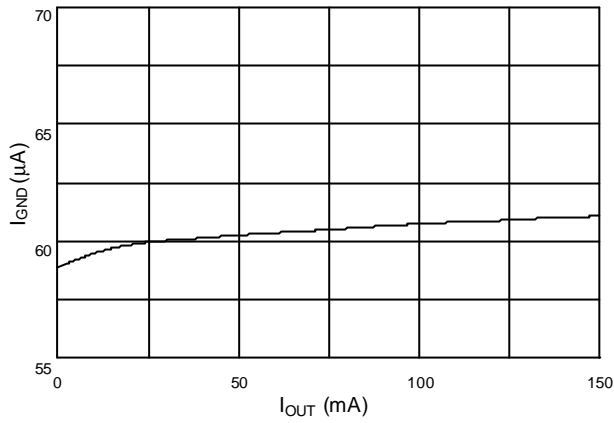
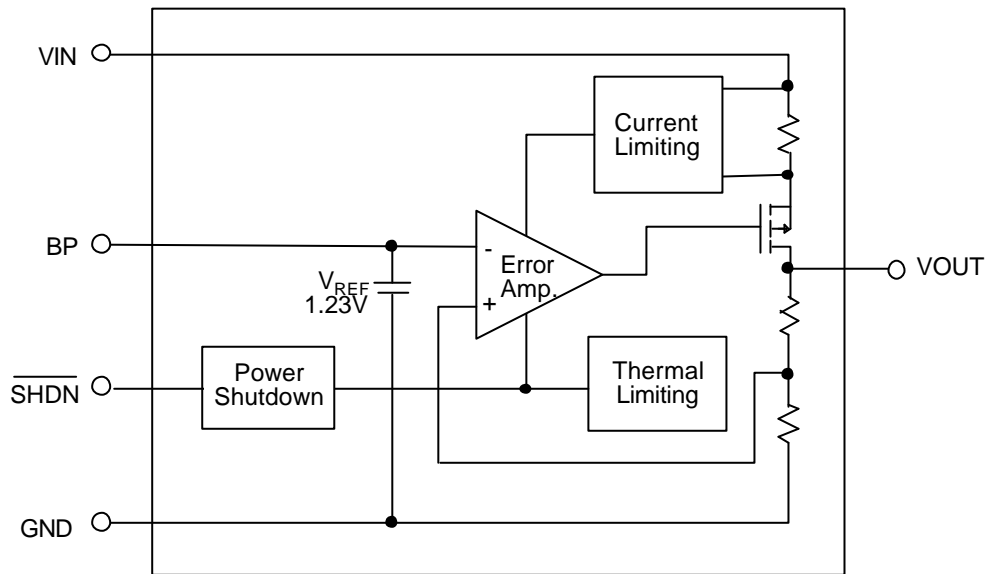


Fig. 19 Ground Current vs. Output Current

**BLOCK DIAGRAM**



## ■ PIN DESCRIPTIONS

### SOT-23-5

- PIN 1 : VIN - Power supply input pin. Bypass with a 1 $\mu$ F capacitor to GND
- PIN 2 : GND - Ground pin. This pin also functions as a heatsink. To maximize power dissipation, use of a large pad or the circuit-board ground plane is recommended.
- PIN 3 :  $\overline{\text{SHDN}}$  - Active-Low shutdown input pin.
- PIN 4 : BP - Noise bypass pin. An external bypass capacitor connected to the BP pin reduces noises at the output.
- PIN 5 : VOUT - Output pin. Sources up to 150 mA.

### SOT-23-6W

- PIN 1 :  $\overline{\text{SHDN}}$  - Active-Low shutdown input pin.
- PIN 2 : GND - Ground pin. This pin also functions as a heatsink. To maximize power dissipation, use of a large pad or the circuit-board ground plane is recommended.
- PIN 3 : BP - Noise bypass pin. An external bypass capacitor connected to the BP pin reduces noises at the output.
- PIN 4 : VOUT - Output pin. Sources up to 150 mA.
- PIN 5 : GND - Ground pin. This pin also functions as a heatsink. To maximize power dissipation, use of a large pad or the circuit-board ground plane is recommended.
- PIN 6 : VIN - Power supply input pin. Bypass with a 1 $\mu$ F capacitor to GND.

## ■ DETAILED DESCRIPTION OF TECHNICAL TERMS

### **OUTPUT VOLTAGE ( $V_{OUT}$ )**

The AIC1730 provides factory-set output voltages from 1.8V to 3.3V, in 100mV increments. The output voltage is specified with  $V_{IN} = V_{OUT}$  (TYP) + 1V and  $I_{OUT} = 0\text{mA}$

### **DROPOUT VOLTAGE ( $V_{DROP}$ )**

The dropout voltage is defined as the difference between the input voltage and output voltage at which point the regulator starts to fall out of regulation. Below this value, the output voltage will fall as the input voltage is reduced. It depends on the load current and junction temperature. The dropout voltage is specified at

which the output voltage drops 100mV below the value measured with a 1V difference.

### **CONTINUOUS OUTPUT CURRENT ( $I_{OUT}$ )**

Normal rated output current. This is limited by package power dissipation.

### **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 is changed from  $V_{IN} = V_{OUT} + 1\text{V}$  to  $V_{IN} = V_{OUT} + 6\text{V}$  and  $I_{OUT} = 1\text{mA}$ .



**LOAD REGULATION**

Load regulation is the ability of the regulator to maintain a constant output voltage as the load current changes. To minimize temperature effects, it is a pulsed measurement with the input voltage set to  $V_{IN} = V_{OUT} + 1 \text{ V}$ . The load regulation is specified under the output current step of 0.1mA to 150mA.

**QUIESCENT CURRENT ( $I_Q$ )**

The quiescent current is the current flowing through the ground pin under no load.

**GROUND CURRENT ( $I_{GND}$ )**

Ground current is the current flowing through the ground pin under loading.

**STANDBY CURRENT ( $I_{STBY}$ )**

Standby current is the current flowing into the regulator when the output is shutdown by setting  $\overline{V_{SHDN}} = 0\text{V}$ ,  $V_{IN} = 8 \text{ V}$ .

**CURRENT LIMIT ( $I_{IL}$ )**

The AIC1730 include a current limiter, which monitors and controls the maximum output current to be 300mA typically if the output is shorted to ground. This can protect the device from being damaged.

**THERMAL PROTECTION**

The thermal sensor protects the device when the junction temperature exceeds  $T_J = +155^\circ\text{C}$ . It signals the shutdown logic, turning off the pass transistor and allowing the IC to cool. After the IC's junction temperature cools by  $15^\circ\text{C}$ , the thermal sensor will turn on the pass transistor again. Thermal protection is designed to protect the device in the event of fault conditions. For 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. The recommended minimum value of input capacitor is  $0.22\mu\text{F}$ . The output capacitor should be selected within the Equivalent Series Resistance (ESR) range shown in the graphs below for stability. Because the ceramic capacitor's ESR is lower and its electrical characteristics (capacitance and ESR) vary widely over temperature, a tantalum output capacitor is recommended, especially for heavier load. In general, the capacitor should be at least

$1\mu\text{F}$ (tantalum) and be rated for the actual ambient operating temperature range.

Note: It is very important to check the selected manufactures' electrical characteristics (capacitance and ESR) over temperature.

**NOISE BYPASS CAPACITOR**

Use a  $0.1\mu\text{F}$  bypass capacitor at BP pin for low output voltage noise. Increasing the capacitance such as  $1\mu\text{F}$  will decrease the output noise, however, values above  $1\mu\text{F}$  provide no performance advantage and are not recommended.

## POWER DISSIPATION

The maximum power dissipation of AIC1730 depends on the thermal resistance of the case and circuit board, the temperature difference between the die junction and ambient air, and the rate of air flow. 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 will be low even if the power dissipation is great.

The power dissipation across the device is

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

The maximum power dissipation is:

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

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

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

The GND pin performs the 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.

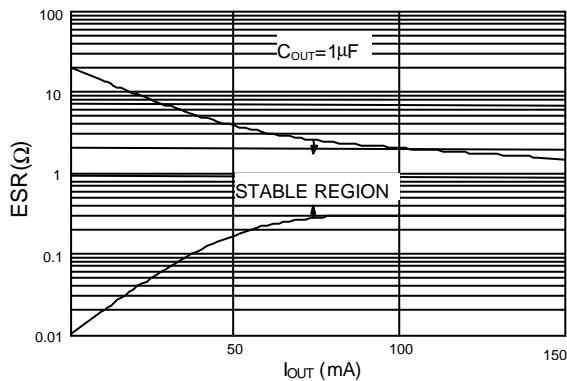


Fig. 20 Max Power Dissipation,  $C_{OUT}=1\mu F$

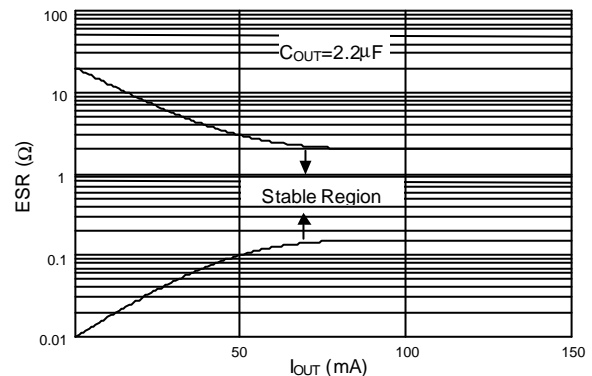


Fig. 21 Max Power Dissipation,  $C_{OUT}=2.2\mu F$

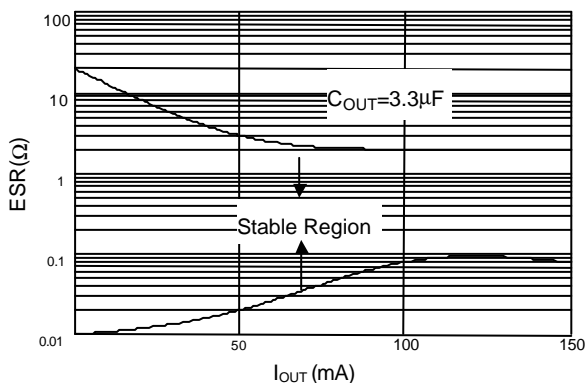


Fig. 22 Max Power Dissipation,  $C_{OUT}=3.3\mu F$

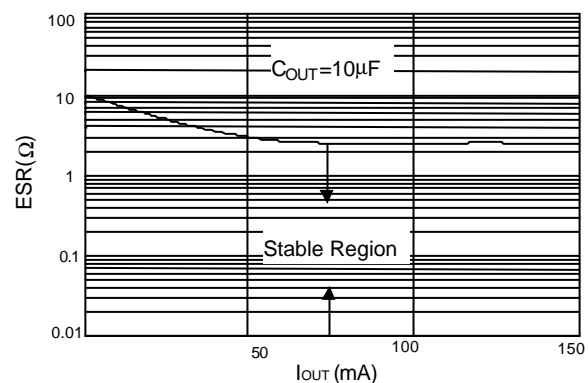
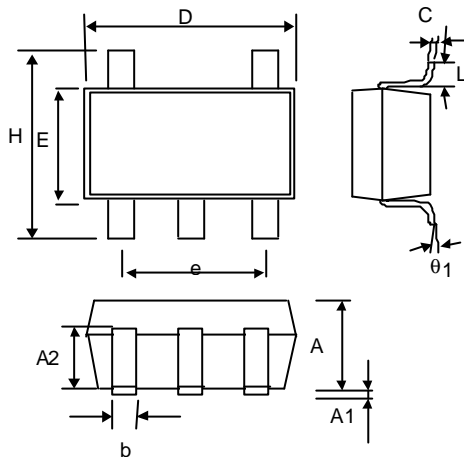


Fig. 23 Max Power Dissipation,  $C_{OUT}=10\mu F$

## ■ PHYSICAL DIMENSIONS

### ● SOT-23-5 (unit: mm)



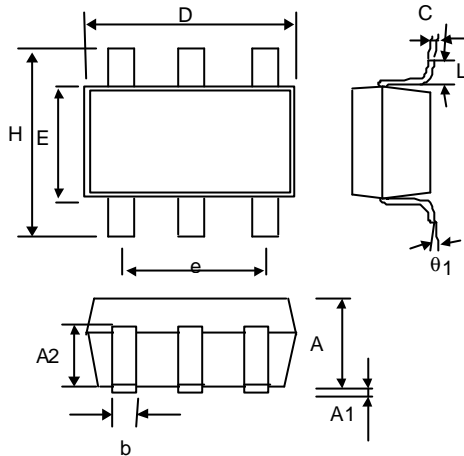
SYMBOL	MIN	MAX
A	1.00	1.30
A1	—	0.10
A2	0.70	0.90
b	0.35	0.50
C	0.10	0.25
D	2.70	3.10
E	1.40	1.80
e	1.90 (TYP)	
H	2.60	3.00
L	0.37	—
θ1	1°	9°

### ● SOT-23-5 Marking

Part No.	Marking
AIC1730-18CV	EC18
AIC1730-19CV	EC19
AIC1730-20CV	EC20
AIC1730-21CV	EC21
AIC1730-22CV	EC22
AIC1730-23CV	EC23
AIC1730-24CV	EC24
AIC1730-25CV	EC25
AIC1730-26CV	EC26

Part No.	Marking
AIC1730-27CV	EC27
AIC1730-28CV	EC28
AIC1730-285CV	EC2J
AIC1730-29CV	EC29
AIC1730-30CV	EC30
AIC1730-31CV	EC31
AIC1730-32CV	EC32
AIC1730-33CV	EC33

● **SOT-23-6W (unit: mm)**



SYMBOL	MIN	MAX
A	1.00	1.30
A1	—	0.10
A2	0.70	0.90
b	0.35	0.50
C	0.10	0.25
D	2.70	3.10
E	1.60	2.00
e	1.90 (TYP)	
H	2.60	3.00
L	0.37	—
θ1	1°	9°

● **SOT-23-6W Marking**

Part No.	Marking
AIC1730-18CQ	EB18
AIC1730-19CQ	EB19
AIC1730-20CQ	EB20
AIC1730-21CQ	EB21
AIC1730-22CQ	EB22
AIC1730-23CQ	EB23
AIC1730-24CQ	EB24
AIC1730-25CQ	EB25
AIC1730-26CQ	EB26

Part No.	Marking
AIC1730-27CQ	EB27
AIC1730-28CQ	EB28
AIC1730-285CQ	EB2J
AIC1730-29CQ	EB29
AIC1730-30CQ	EB30
AIC1730-31CQ	EB31
AIC1730-32CQ	EB32
AIC1730-33CQ	EB33