AnaChip

AP1187

**1A Ultra Low Dropout Positive Adjustable Regulator**

■ Features

- Adjustable output voltage
- 0.6V Maximum Dropout voltage at 1.0A Load current
- Built-in Thermal Shutdown
- Output Current Limiting
- Fast transient response
- Good noise rejection
- Package: SOP-7L

■ Applications

- PC Motherboard
- LCD Monitor
- Graphic Card
- DVD-Video Player
- NIC/Switch
- Telecom Equipment
- ADSL Modem
- Printer and other Peripheral Equipment
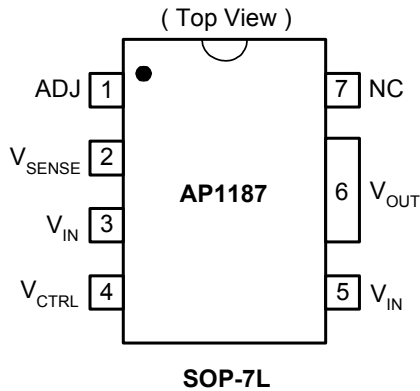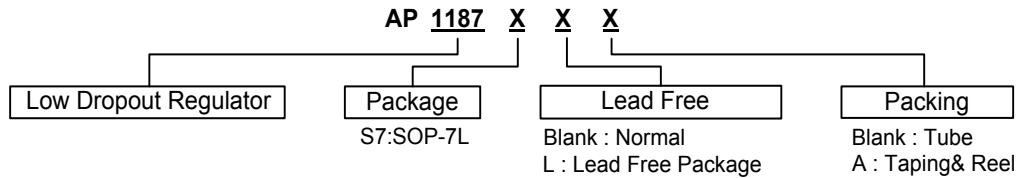
■ General Description

AP1187 is a 1A regulator with extremely low dropout voltage. This product is specifically designed to provide well regulated supply for applications requiring 2.8V or lower voltages from 3.3V ATX power supplies where high efficiency of a switcher can be achieved without the cost and complexity associated with switching regulator. One such application is the new graphic chip sets that require anywhere from 2.4V to 2.7V supply.
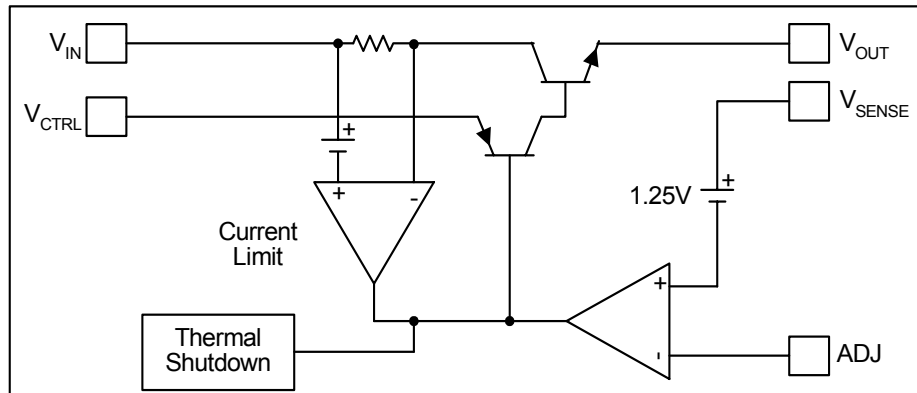
■ Pin Assignments

(Top View)

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ADJ      1          7   NC

V_SENSE  2                
              AP1187  6   V_OUT
V_IN     3

V_CTRL   4          5   V_IN
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SOP-7L

■ Pin Descriptions

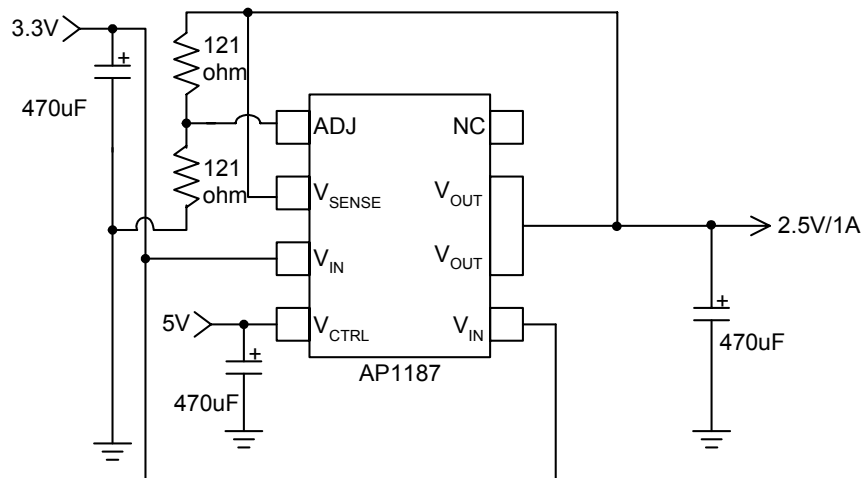| Name	Description
ADJ	A resistor divider from this pin to the V_{OUT} pin and ground sets the output voltage.
V_{SENSE}	This pin is the positive side of the reference that allows remote load sensing to achieve excellent load regulation. A minimum of 10uF capacitor must be connected from this pin to ground to insure stability.
V_{IN}	The input of the regulator.
V_{CTRL}	This pin is the supply pin for the internal control circuit as well as the base drive for the pass transistor.
NC	Not used.
V_{OUT}	The output of the regulator.

1A Ultra Low Dropout Positive Adjustable Regulator

■ Electrical Characteristics

Unless otherwise specified, these specifications apply over, C_{IN}=1uF, C_{OUT}=10uF, and T_J=0 to 150°C. Typical value refer to T_J=25°C. $V_{OUT} = V_{SENSE}$.

Sym.	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V_{REF}	Reference Voltage	T_J=25°C,(V_{IN}-V_{OUT})=0.5V, I_O=10mA V_{CTRL} =V_{IN}+1V	1.225	1.250	1.275	V
	Line Regulation	I_O=10mA, V_{OUT}+0.5V<V_{IN}<12V V_{CTRL} =V_{IN}+1V			0.2	%
	Load Regulation	0mA<I_O<1.0A, T_J=25°C, (V_{IN} – V_{OUT}) = 2V, V_{CTRL} = V_{IN} + 1V			1	%
	Dropout Voltage (V_{CTRL}-V_{OUT})	V_{ADJ} =0V for all conditions below. V_{IN} =2.05V, I_O=1.0A		1.5	1.7	V
	Dropout Voltage (V_{IN}-V_{OUT})	V_{ADJ} =0V for all conditions below. V_{CTRL} =3V, I_O=1.0A		0.5	0.6	V
	Current Limit	V_{CTRL} =3V, V_{IN} =2.05V, ΔV_O=100mV, V_{ADJ}=0V	1.1			A
	Minimum Load Current	V_{CTRL} =5V, V_{IN} =3.3V, V_{ADJ} =0V		5	10	mA
	Thermal Regulation	30ms Pulse		0.01	0.02	%W
	Ripple Rejection	V_{CTRL} =5V, V_{IN} =5V, I_O=1.0A, V_{ADJ} =0V, T_J =25, V_{RIPPLE}=1Vpp at 120Hz	60	70		dB
	Control Pin Current	V_{ADJ} =0V for all conditions below. V_{CTRL} =2.75V, V_{IN} =2.05V, I_O=1.0A		6	10	mA
	Adjust Pin Current	V_{CTRL} =2.75V, V_{IN} =2.05,V_{ADJ}=0		50	120	µA
	Thermal Resistance Junction-to-Case	SOP-7: Control Circuitry/Power Transistor		20		°C/W
	Power Dissipation	Package: SOP-7L, with heat sink or amount of copper board needed.		1	2	W

■ Typical Application Circuit

■ Function Description

Introduction

The AP1187 regulator is a 7-terminal device designed specifically to provide extremely low dropout voltages comparable to the PNP type without the disadvantage of the extra power dissipation due to the base current associated with PNP regulators. This is done by bringing out the control pin of the regulator that provides the base current to the power NPN and connecting it to a voltage that is greater than the voltage present at the VIN pin. This flexibility makes the AP1187 ideal for applications where dual inputs are available such as a computer motherboard with an ATX style power supply that provides 5V and 3.3V to the board. One such application is the new graphic chip sets that require anywhere from 2.4V to 2.7V supply. The AP1187-ADJ can easily be programmed with the addition of two external resistors to any voltages within the range of 1.25V to 15.5V. Another major requirement of these graphic chips is the need to switch the load current from zero to several amps in tens of nanoseconds at the processor pins, which translates to an approximately 300 to 500ns of current step at the regulator. In addition, the output voltage tolerances are also extremely tight and they include the transient response as part of the specification.

The AP1187 is specifically designed to meet the fast current transient needs as well as providing an accurate initial voltage, reducing the overall system cost with the need for fewer number of output capacitors. Another feature of the device is its true remote sensing capability that allows accurate voltage setting at the load rather than at the device.

Output Voltage Setting

The AP1187 can be programmed to any voltages in the range of 1.25V to 15.5V with the addition of R1 and R2 external resistors according to the following formula:


$$V_{OUT}=V_{REF}(1+R2/R1)+I_{ADJ}*R2 \text{ where: } V_{REF}=1.25V \text{ \& } I_{ADJ}=50uA \text{ Typically}$$
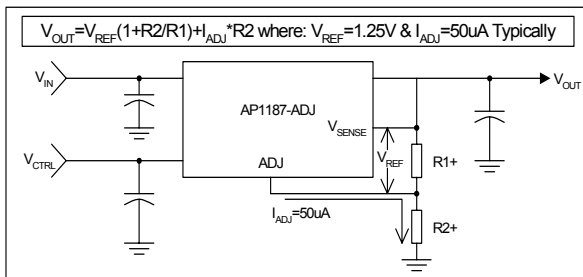
The AP1187 keeps a constant 1.25V between the V_{SENSE} pin and the ADJ pin. By placing a resistor R1 across these two pins and connecting the V_{SENSE} and V_{OUT} pin together, a constant current flows through R1, adding to the I_{ADJ} current and into the R2 resistor producing a voltage equal to the $(1.25/R1)*R2 + I_{ADJ}*R2$. This voltage is then added to the 1.25V to set the output voltage. This is summarized in the above equation.

Since the minimum load current requirement of the AP1187 is 10mA, R1 is typically selected to be a 121Ω resistor so that it automatically satisfies this condition. Notice that since the I_{ADJ} is typically in the range of 50uA it only adds a small error to the output voltage and should be considered when very precise output voltage setting is required.

Load Regulation

Since the AP1187 has separate pins for the output (V_{OUT}) and the sense (V_{SENSE}), it is ideal for providing true remote sensing of the output voltage at the load. This means that the voltage drops due to parasitic resistance such as PCB traces between the regulator and the load are compensated for using remote sensing. Figure following shows a typical application of the AP1187 with remote sensing.
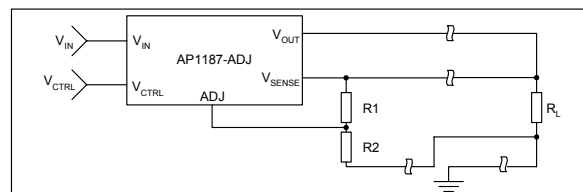
Stability

The AP1187 requires the use of an output capacitor as part of the frequency compensation in order to make the regulator stable. Typical designs for the microprocessor applications use standard electrolytic capacitors with typical ESR in the range of 50 to 100mΩ and an output capacitance of 100uF to 1000uF. Fortunately as the capacitance increases, the ESR decreases resulting in a fixed RC time constant. The AP1187 takes advantage of the phenomena in making the overall regulator loop stable.

For most applications a minimum of 100uF aluminum electrolytic capacitor insures both stability and good transient response.

■ Function Description (Continued)

Thermal Design
The AP1187 incorporates an internal thermal shutdown that protects the device when the junction temperature exceeds the allowable maximum junction temperature. Although this device can operate with junction temperatures in the range of 150℃, it is recommended that the selected heat sink be chosen such that during maximum continuous load operation the junction temperature is kept below this number. The example below shows the steps in selecting the proper surface mount package.

Assuming, the following conditions:
V_{OUT} =2.5V
V_{IN} =3.3V
V_{CTRL}=5V
I_{OUT} =1A DC Avg.
Calculate the maximum power dissipation using the following equation:
P_D= I_{OUT} *(V_{IN} -V_{OUT}) + (I_{OUT}/60) * (V_{CTRL} - V_{OUT})
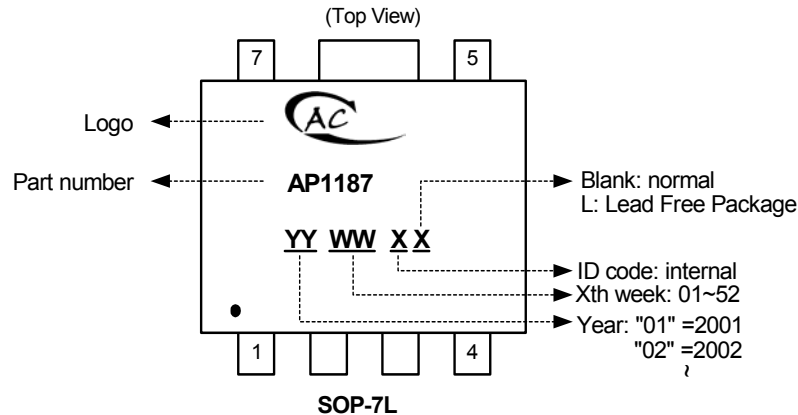P_D =1*(3.3-2.5) + (1/60)*(5-2.5) =0.84W
Using table below select the proper package and the amount of copper board needed.

Package	Copper Area	Θ_{JA} (^{o}C / W)	Max Pd (Ta=25°C)	Max Pd (Ta=45°C)
SOP7	1.0" X 1.0"	65	1.7W	1.4W

Note: Above table is based on the maximum junction temperature of 135°C.
As shown in the above table, any of the two packages will do the job. For low cost applications the SOP7 package is recommended.
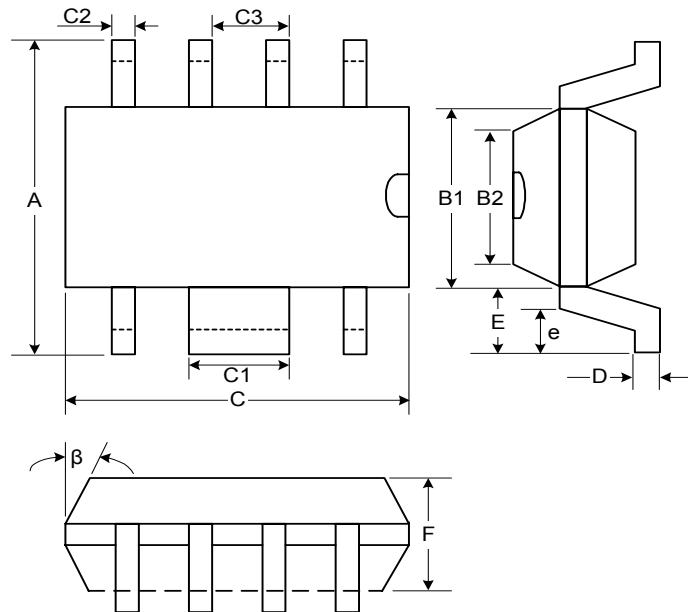
■ Marking Information

(Top View)

Logo

Part number

AP1187

YY WW X X

Blank: normal
L: Lead Free Package

ID code: internal
Xth week: 01~52
Year: "01" =2001
"02" =2002

SOP-7L

■ Package Information

Package Type: SOP-7L

Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	5.79	5.99	6.19	0.228	0.236	0.244
B1	3.83	3.91	3.99	0.151	0.154	0.157
B2	3.78	3.86	3.94	0.149	0.152	0.155
C	4.80	4.87	4.94	0.189	0.192	0.194
C1	1.57	1.67	1.77	0.062	0.066	0.070
C2	0.32	0.4	0.48	0.013	0.016	0.019
C3	1.17	1.27	1.37	0.046	0.050	0.054
D	0.19	0.22	0.25	0.007	0.009	0.010
E	1.04REF			0.041REF		
e	0.48	0.68	0.88	0.019	0.027	0.035
F	1.35	1.45	1.55	0.053	0.057	0.061
β	7°			7°		