AP1117C Series

1A Adjustable & Fixed Voltage LDO Linear Regulator

Anwell Semiconductor Corp.

FEATURES

- Low Dropout Voltage 700mV at 1.0A Typ.
- Adjustable Output Voltage or Fixed Output Voltage Preset at 1.8V, 2.5V, or 3.3V
- Output Voltage Accuracy：±2% (special ±1% highly accurate)
- Small Output Capacitor
- Output Current Limit Protection
- Thermal Overload Shutdown Protection
- SOT-223 and TO-252 Packages
- RoHS Compliant and 100% Lead (Pb)-Free

APPLICATIONS

- Active SCSI Terminators
- High Efficiency Linear Regulators
- Monitor Microprocessors
- Low Voltage Micro-Controllers
- Post Regulator for Switching Power

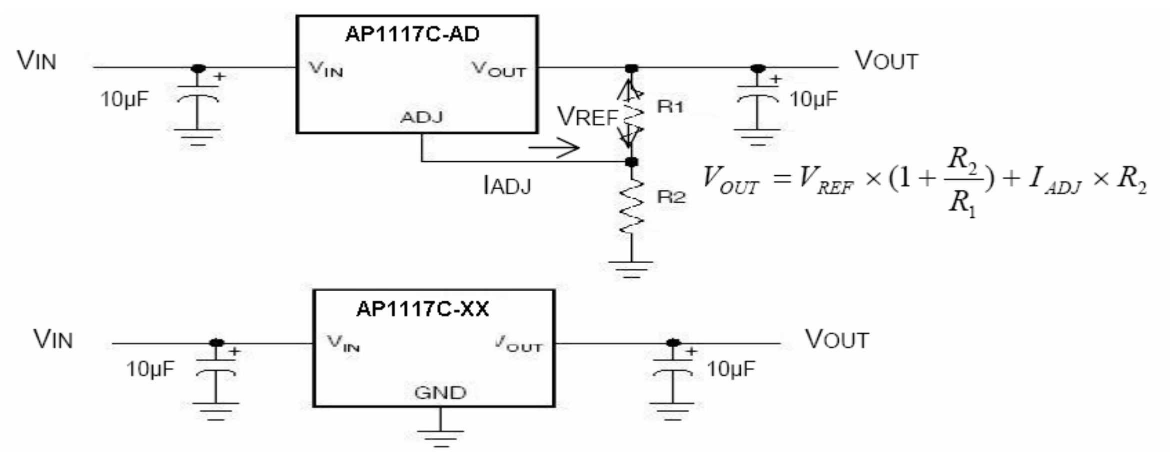
GENERAL DESCRIPTION

The AP1117C is a low-dropout linear regulator that operates in the input voltage range from +2.5V to +7.0V and delivers 1A output current.

The AP1117C is available in two types, fixed output voltage type or adjustable output voltage type. The fixed output voltage type is preset at an internally trimmed voltage 1.8V, 2.5V, or 3.3V. Other options 1.5V, 2.85V, 3.0V and 3.6V are available by special order only. The output voltage range of the adjustable type is from 1.25V to 5V.

The AP1117C consists of a 1.25V bandgap reference, an error amplifier, and a P-channel pass transistor. Other features include short-circuit protection and thermal shutdown protection. The AP1117C devices are available in SOT-223 and TO-252 packages.

TYPICAL APPLICATION CIRCUITS



Note：

* 500K≦R1+R2≦1000K, R1+R2 ~800K is recommended.

ABSOLUTE MAXIMUM RATINGS

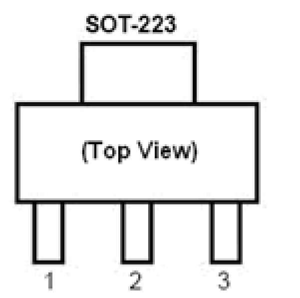
Parameter		Symbol	Ratings	Units
Input voltage V_{IN} to GND		V_{IN}	9.0	V
Output current limit, $I_{(LIMIT)}$		I_{OUT}	1.3	A
Junction Temperature		T_J	+155	℃
Power Dissipation (No heat sink, No air flow)	SOT-223	P_D	900	mW
	TO-252		1200	
Operating Ambient Temperature		T_{OPR}	-40 ~ +125	°C
Storage Temperature		T_{STG}	-55 ~ +125	°C
Lead temperature (soldering, 10sec)			+250	°C
Thermal resistance (No heat sink, No air flow)	SOT-223	θ_{JA}	140	℃/W
	TO-252		106	℃/W

* Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and function operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum -rated conditions for extended periods may affect device reliability.

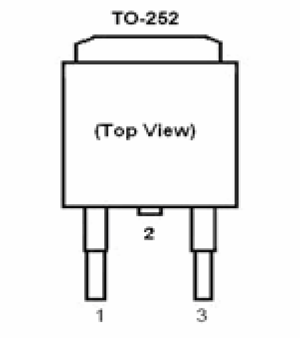
ELECTRICAL CHARACTERISTIC (C_{IN}=10uF, C_{OUT}=10uF, T_A=25℃, unless otherwise noted)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage			2.5		7.0	V
V_{OUT}	Output Voltage	Fixed Voltage Type $V_{IN}=V_{OUT}+1.0V$, I_{OUT}=1mA		V_{OUT} -2%		V_{OUT} + 2%	V
		Adjustable Voltage Type $V_{IN}=V_{OUT}+1.2V$, I_{OUT}=1mA		1.20	1.25	1.30	V
ΔV_{OUT}	Output Voltage Accuracy	$V_{IN}>V_{OUT}+1.0V$, $V_{IN}\leqq 7V$ (Fixed Type)		V_{OUT} -2%		V_{OUT} + 2%	mV
		$V_{IN}>V_{OUT}+1.2V$, $V_{IN}\leqq 7V$ (Adjustable Type)		V_{OUT} -2%		V_{OUT} + 2%	mV
I_{MAX}	Maximum Output Current			1.0			A
I_{LIMIT}	Current Limit					1.3	A
I_{SC}	Short-Circuit Current	V_{OUT}=0V	$V_{IN}>V_{OUT}+1.0V$ (Fixed Type)		650	760	mA
			$V_{IN}>V_{OUT}+1.0V$ (Adjustable Type)				
I_Q	Ground Pin Current	I_{LOAD}=0mA to 1A, $V_{IN}=V_{OUT}+1.0V$			100	120	μA
I_{ADJ}	ADJ Pin Current	I_{LOAD}=0mA to 1A, $V_{IN}=V_{OUT}+1.2V$			100	120	μA
V_{DROP}	Dropout Voltage (Fixed Output Voltage Version)	I_{OUT}=100mA			60	100	mV
		I_{OUT}=500mA			300	500	mV
		I_{OUT}=1.0A			700	1000	mV
ΔV_{LINE}	Line Regulation	$V_{OUT}+1.0V<V_{IN}<7V$, I_{LOAD}=1mA (Fixed Voltage Type)			0.2	0.3	%/V
		$V_{OUT}+1.2V<V_{IN}<7V$, I_{LOAD}=1mA (Adjustable Voltage Type)			0.2	0.3	%/V
ΔV_{LOAD}	Load Regulation	I_{OUT}=0mA to 1.0A (Fixed Type)			0.02	0.03	%/mA
		I_{OUT}=0mA to 1.0A (Adjustable Type)			0.1	0.15	%/mA
e_N	Output Noise	F=10KHz, C_{OUT}=10μF			80		μVRM
PSRR	Ripple Rejection	F=1KHz, C_{OUT}=10μF			75		dB
T_{SD}	Thermal Shutdown Temperature				155		°C
T_{HYS}	Thermal Shutdown Hysteresis				20		°C

PIN GONFIGURATIONS



Part No.	Pin 1	Pin 2 / TAP	Pin 3
AP1117C-XXXG	IN	GND/ADJ	OUT
AP1117C-XXXJ	GND/ADJ	OUT	IN



Part No.	Pin 1	Pin 2 / TAP	Pin 3
AP1117C-XXXP	IN	GND/ADJ	OUT
AP1117C-XXXR	GND/ADJ	OUT	IN

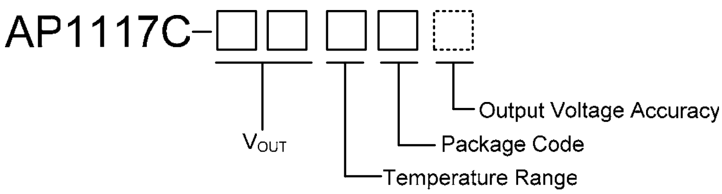
PIN DESCRIPTION

Symbol	Description
GND/ADJ	Ground pin or adjust terminal pin. **GND** provides the reference for all voltages. **ADJ** provides VREF=1.25V（Typ.）for adjustable output voltage.
IN	Regulator input pin. Supply voltage can range from 2.5V to 7.0V. Bypass with a 10μF capacitor to GND.
OUT	Regulator output pin. Sources up to 1A. Bypass with a 10μF capacitor to GND.

PACKAGE MARKING INFORMATION

EX: AP1117C-PJ(ADJ Type)	EX: AP1117C-33PJ
AP1117C PJ xxxx	AP1117C 33PJ xxxx
xxxx:Data Code	xxxx:Data Code

ORDERING INFORMATION



Vout Code：(Note1*)

(For fixed voltage types only. For adjustable Voltage types. These two digits are eliminated.)

18=1.8V、**25**=2.5V、**33**=3.3V…

Default：Adjustable Output

Temperature Range：

P：Commercial Standard, Lead (Pb) Free and Phosphorous (P) Free Package

Package Code：(Note2*)

G：SOT-223 **J**：SOT-223

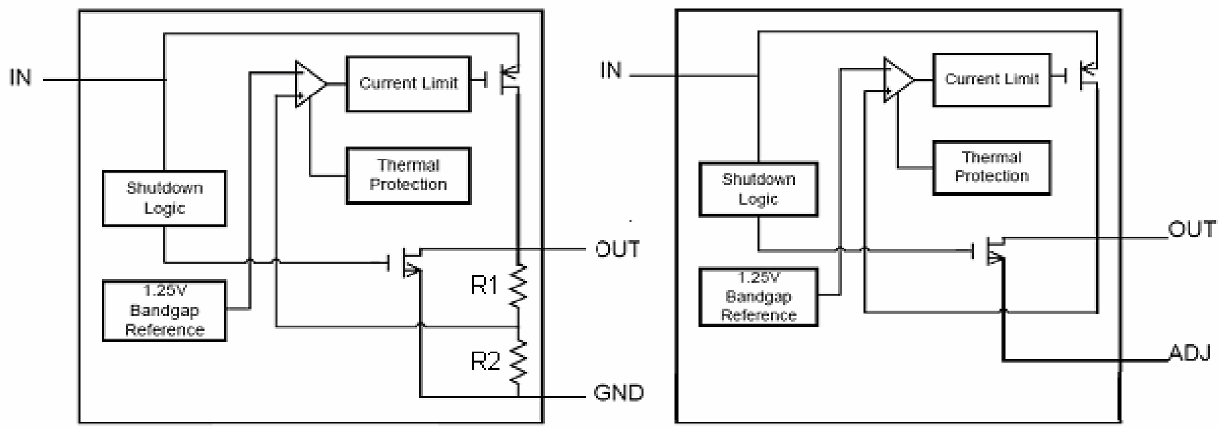
P：TO-252 **R**：TO-252

Output voltage accuracy：

1：±1%

Note1*:The output voltages other than the preset values are available by order only.
Note2*:For the adjustable voltage types. The GND pin is replaced with the ADJ pin.

FUNCTIONAL BLOCK DIAGRAM



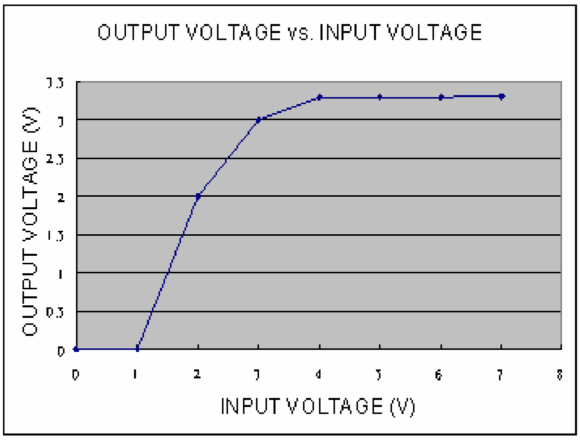
Fixed Voltage Type

Adjustable Voltage Type

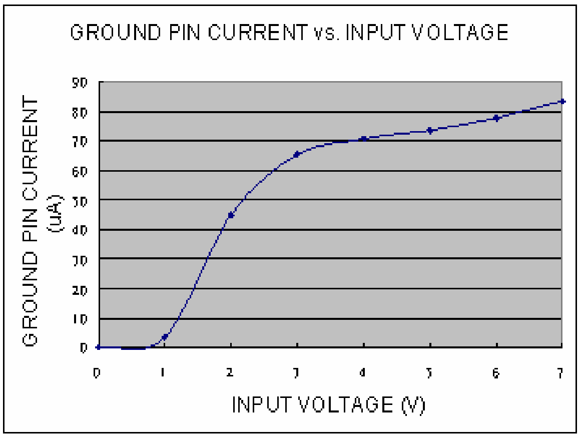
TYPICAL OPERATING CHARACTERIS

($AP1117C-33PJ, C_{IN}=10uf, C_{IN}=10uF, T_A=25$℃, unless otherwise noted)

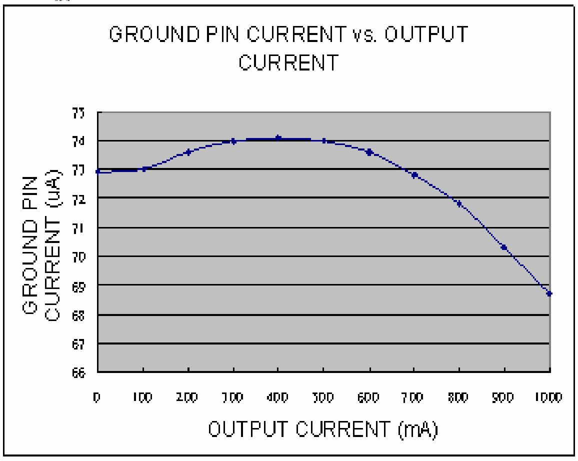
$I_{OUT}=1mA$

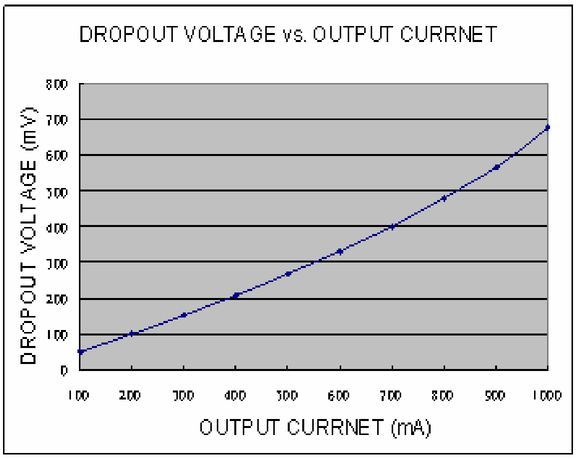


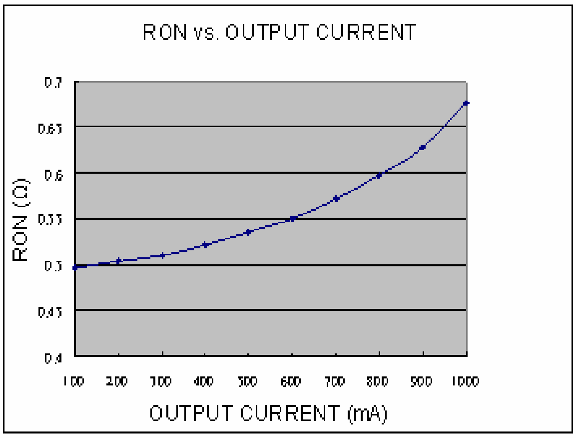
$I_{OUT}=0mA$



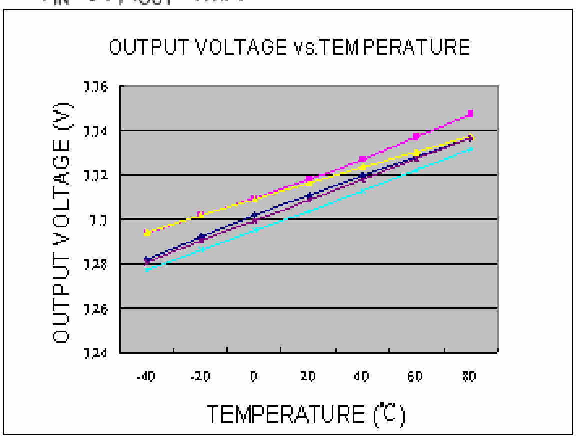
$V_{IN}=5V$







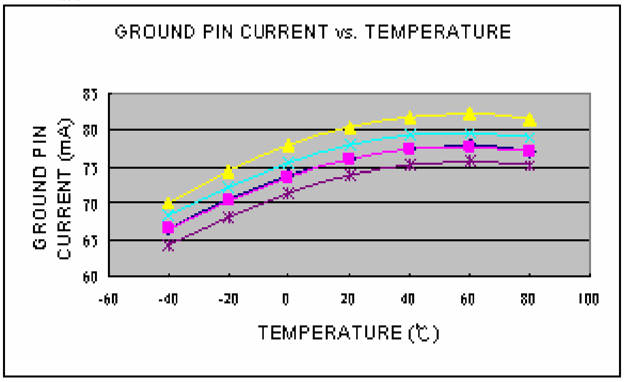
$V_{IN}=5V$, $I_{OUT}=1mA$

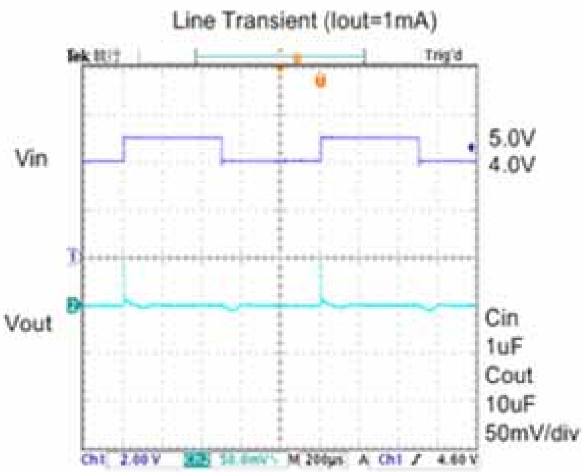


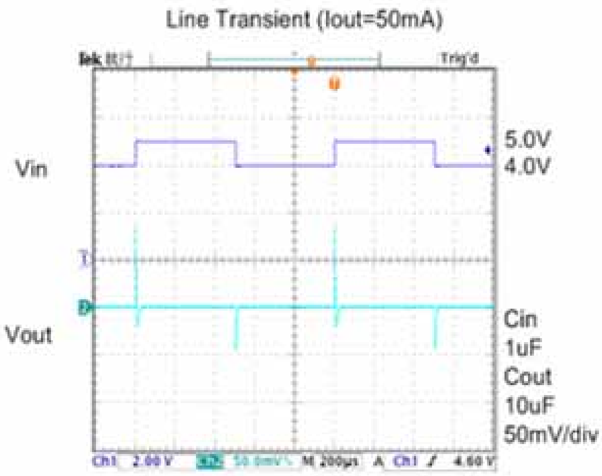
TYPICAL OPERATING CHARACTERIS (CONTINUED)

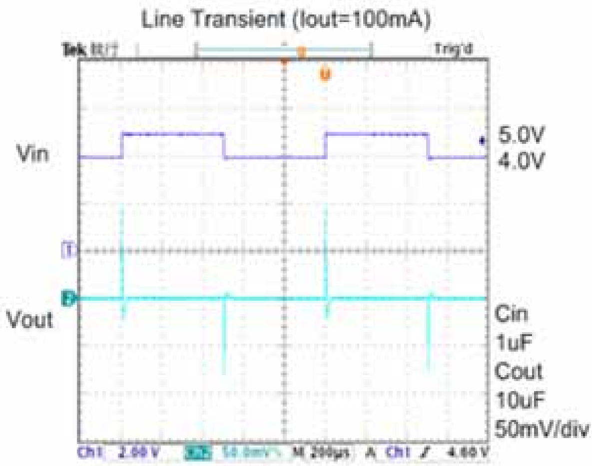
(AP1117C-33PJ,C_{IN}=10uf,C_{IN}=10uF, T_A=25℃, unless otherwise noted)

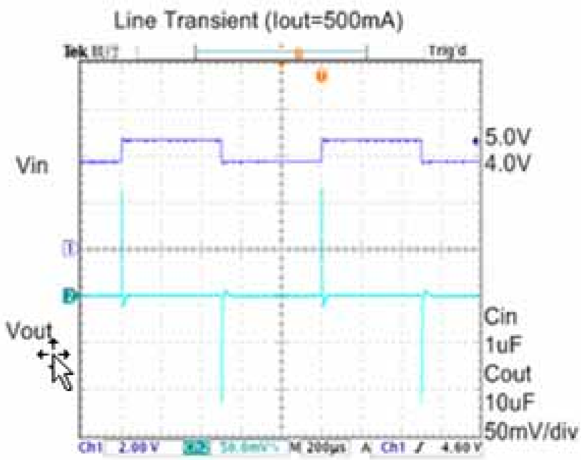
V_{IN}=5V

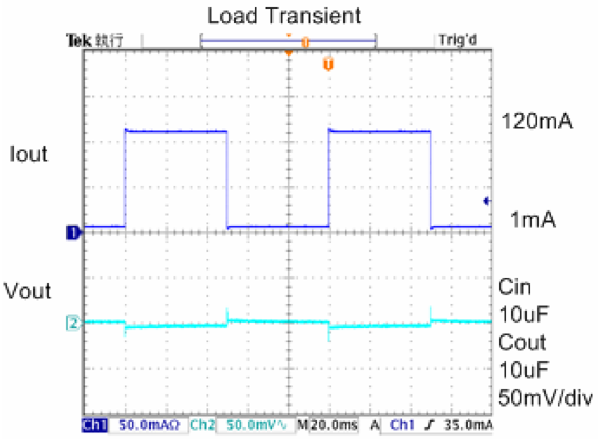




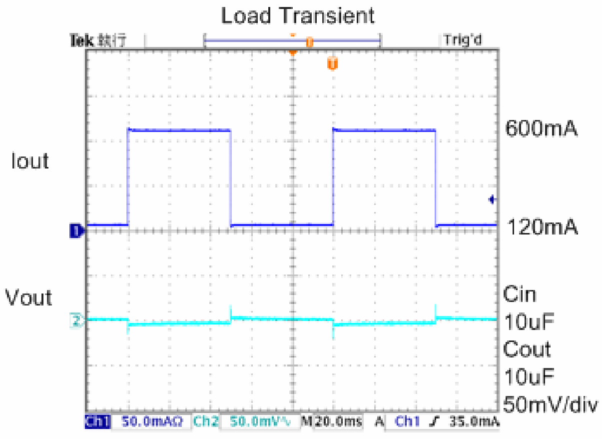




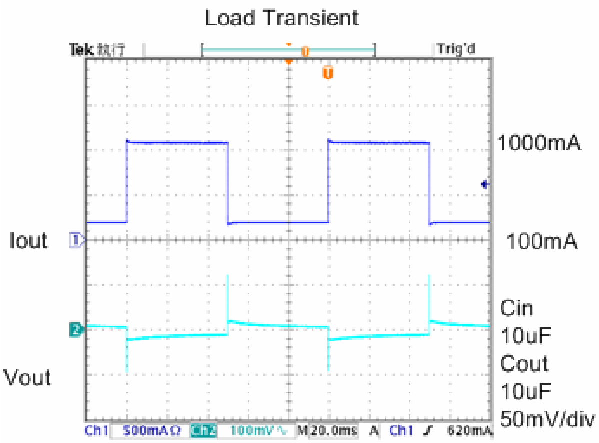




Load Transient
Iout
120mA
1mA
Vout
Cin
10uF
Cout
10uF
50mV/div



Load Transient
Iout
600mA
120mA
Vout
Cin
10uF
Cout
10uF
50mV/div



Load Transient
1000mA
Iout
100mA
Vout
Cin
10uF
Cout
10uF
50mV/div

DETAIL DESCRIPTION

The AP1117C is a low-dropout linear regulator. The device provides preset 1.8V, 2.5V and 3.3V output voltages for output current up to 1.0A. Adjustable output voltage and other mask options for special output voltages are also available. As illustrated in function block diagram, it consists of a 1.25V bandgap reference, an error amplifier, a P-channel pass transistor and an internal feedback voltage divider (fixed voltage types).

The 1.25V bandgap reference is connected to the error amplifier, which compares this reference with the feedback voltage and amplifies the voltage difference. If the feedback voltage is lower than the reference voltage, the pass-transistor gate is pulled lower, which allows more current to pass to the output pin and increases the output voltage. If the feedback voltage is too high, the pass-transistor gate is pulled up to decrease the output voltage.

The output voltage is feed back through an Internal resistive divider (or external resistive divider for adjustable output voltage type) connected to OUT pin. Additional blocks include an output current limiter, thermal sensor, and shutdown logic.

Internal P-channel Pass Transistor

The AP1117C features a P-channel MOSFET pass transistor. Unlike similar designs using PNP pass transistors, P-channel MOSFETs require no base drive, which reduces ground pin current. PNP-based regulators also waste considerable current in dropout when the pass transistor saturates, and use high base-drive currents under large loads. The AP1117C does not suffer from these problems and consumes only 100μA (Typ.) of ground pin current under heavy loads as well as in dropout conditions.

Output Voltage Selection

For fixed voltage type of AP1117C, the output voltage is preset at an internally trimmed voltage. The first two digits of part number suffix identify the output voltage (see ***Ordering Information***). For example, the AP1117C-33 has a preset 3.3V output voltage.

For adjustable voltage type of AP1117C, the output voltage is set by comparing the feedback voltage at adjust terminal to the internal bandgap reference voltage. The reference voltage V_{REF} is 1.25V. The output voltage is given by the equation:

$$V_{OUT}=V_{REF}*(1+R2/R1)+I_{ADJ}*R2$$

(see ***Typical Application Schematic***)

Current Limit

The AP1117C also includes a fold back current limiter. It monitors and controls the pass transistor's gate voltage, estimates the output current, and limits the output current within 1.3A.

Thermal Overload Protection

Thermal overload protection limits total power dissipation in the AP1117C. When the junction temperature exceeds T_J = +155°C, a thermal sensor turns off the pass transistor, allowing the IC to cool down. The thermal sensor turns the pass transistor on again after the junction temperature cools down by 20°C, resulting in a pulsed output during continuous thermal overload conditions.

Thermal overload protection is designed to protect the AP1117C in the event of fault conditions. For continuous operation, the maximum operating junction temperature rating of T_J = +125°C should not be exceeded.

Operating Region and Power Dissipation

Maximum power dissipation of the AP1117C 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 airflow. The power dissipation across the devices is $P = I_{OUT} \times (V_{IN}-V_{OUT})$. The resulting maximum power dissipation is:

$$P_{MAX} = \frac{(T_J - T_A)}{\theta_{JC} + \theta_{CA}} = \frac{(T_J - T_A)}{\theta_{JA}}$$

Where (T_J-T_A) is the temperature difference between the AP1117C die junction and the surrounding air, θ_{JC} is the thermal resistance of the package chosen, and θ_{CA} is the thermal resistance through the printed circuit board, copper traces and other materials to the surrounding air. For better heat-sinking, the copper area should be equally shared between the IN, OUT, and GND pins.

If the AP1117C uses a SOT-223 package and this package is mounted on a 1 oz cooper double sided printed circuit board which has one square inches area allocated for "heat spreading", the resulting θ_{JA} is 73 °C/W.

Based on the maximum operating junction temperature 125 °C with an ambient of 25°C, the maximum power dissipation will be:

$$P_{MAX} = \frac{(T_J - T_A)}{\theta_{JC} - \theta_{CA}} = \frac{(125 - 25)}{73} = 1.37W$$

As a design aid, Table 1 indicates the θ_{JA} value of the of SOT-223 and TO-252 package for different heat sink area. The different coopper patterns that we used to measure these θ_{JA}s are shown at the application Notes Section.

Dropout Voltage

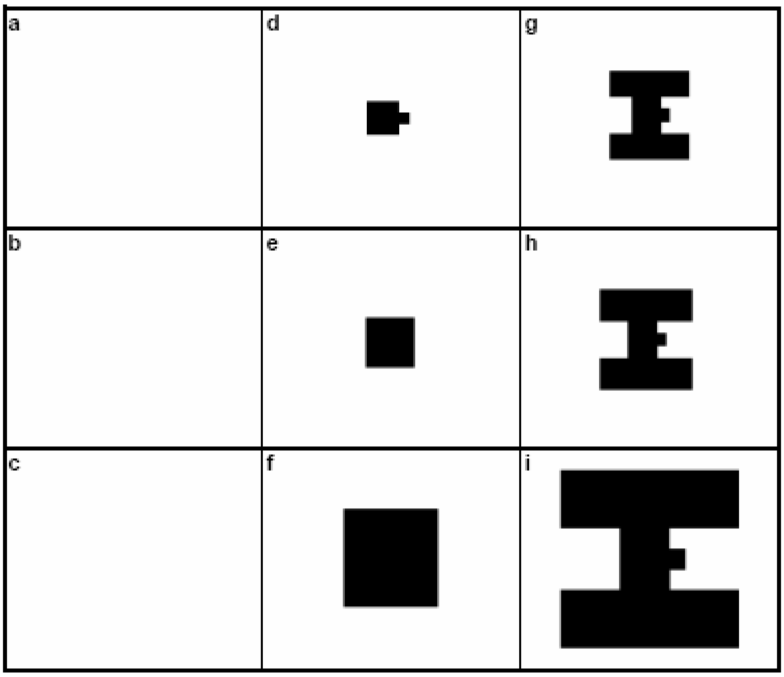
A regulator's minimum input-output voltage differential, or dropout voltage, determines the lowest usable supply voltage. In battery-powered systems, this will determine the useful end-of-life battery voltage. The AP1117C uses a P-channel MOSFET pass transistor, its dropout voltage is a function of drain-to-source on-resistance ($R_{DS(ON)}$) multiplied by the output current.

$$V_{DROPOUT} = V_{IN} - V_{OUT} = R_{DS(ON)} \times I_{OUT}$$

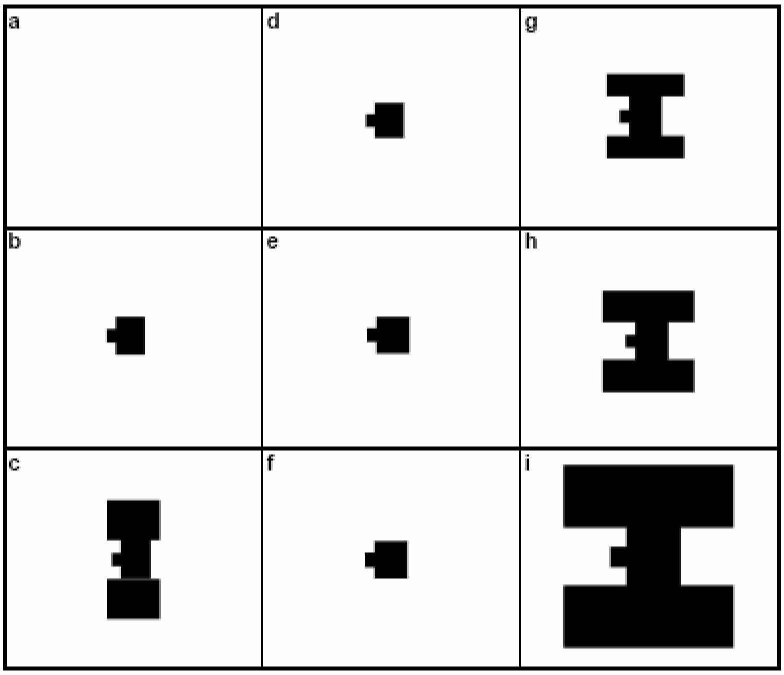
APPLICATION NOTE

Table 1.θ_{JA} Different Heat sink Area

Layout	Copper Area		Thermal Resistance	
	Top Side (in^2)	Bottom Side (in^2)	SOT-223 (θ_{JA}, ℃/W)	TO-252 (θ_{JA}, ℃/W)
a	0	0	140	106
b	0	0.070	127	91
c	0	0.310	84	64
d	0.067	0.067	125	89
e	0.200	0.080	118	87
f	0.600	0.080	89	63
g	0.285	0.285	92	64
h	0.393	0.393	78	58
i	0.500	0.500	73	55



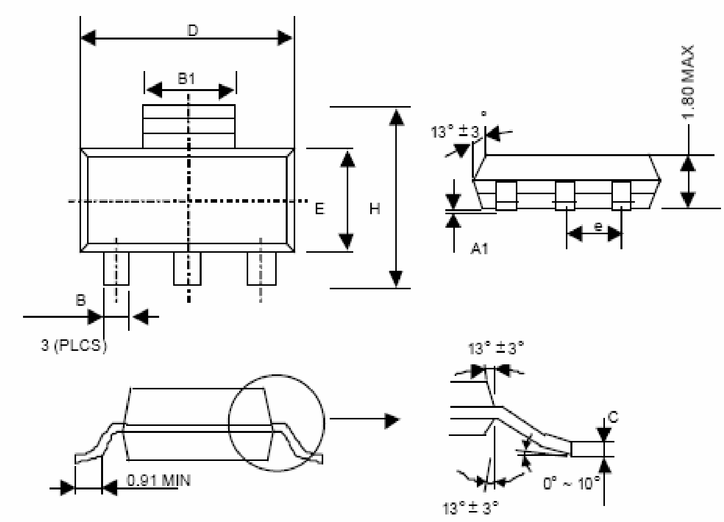
Top View of the PCB layout in real size.



Bottom View of the PCB layout in real size.

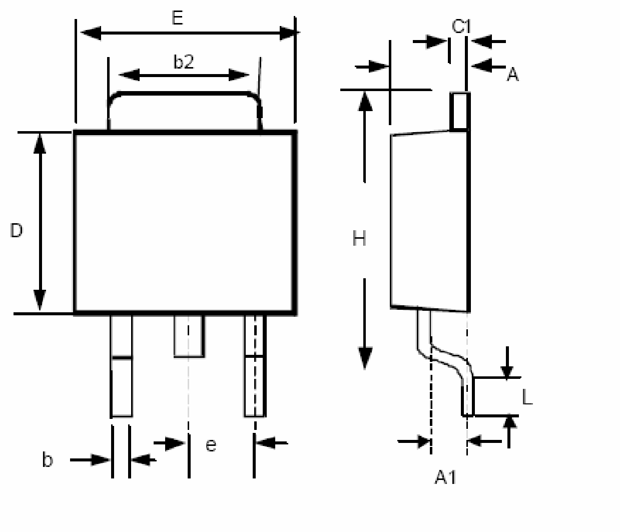
PHYSICAL DIMENSIONS

A) SOT-223 (unit：mm)



SYMBOL	MIN	MAX
A1	0.02	0.12
B	0.60	0.80
B1	2.90	3.15
C	0.24	0.35
D	6.30	6.80
E	3.30	3.70
e	2.30 (TYP.)	
H	6.70	7.30

B) TO-252 (unit：mm)



SYMBOL	MIN	MAX
A	2.19	2.38
A1	1.02	1.27
b	0.64	0.88
b2	5.21	5.46
C1	0.46	0.58
D	5.33	5.59
E	6.35	6.73
e	2.28 (TYP.)	
H	9.40	10.42
L	0.51	-