AQ1117

Low Dropout 1 Amp Voltage Regulator

Product Specification | Revision 1.5 | September 19, 2005

General Description

The AQ1117 is a low dropout three terminal voltage regulator, offered in popular fixed options or an adjustable version that can set a precise voltage from 1.22V to 12V with two external resistors.

AQ1117 is offered in SOT-89 which has a lower thermal resistance and fits in smaller foot print than a standard SOT-223. With a dropout voltage of less than one volt, the AQ1117 can be used in applications where drop out voltage and size are an issue.

To assure accuracy within 1.5% over temperature the heart of the AQ1117 is a self-correcting AcuRef™ bandgap reference.

On-chip current limit and thermal shutdown with hysteresis protects against any combination of overload and ambient temperature that might cause the junction temperature to exceed safe limits.

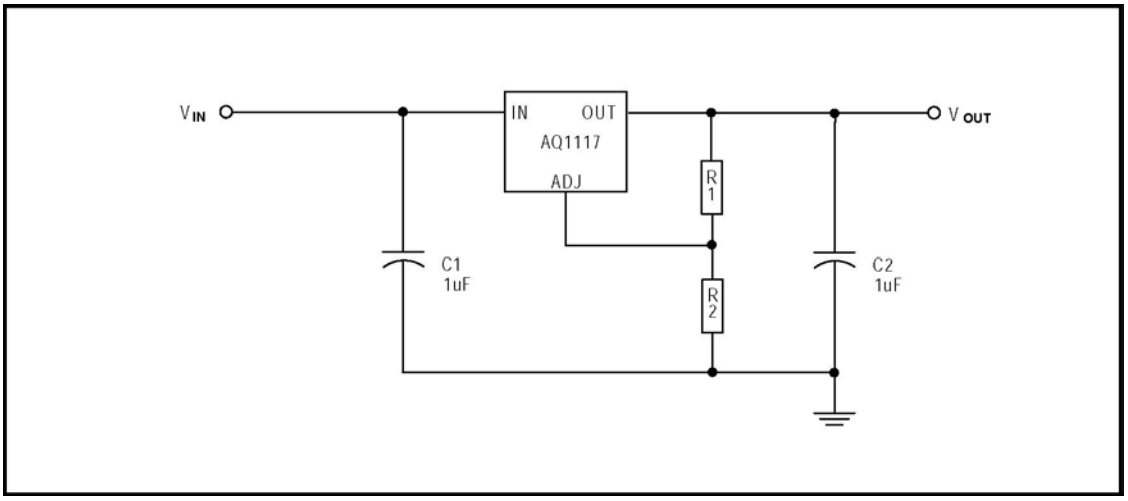
Applications

- Graphic cards
- PC motherboards
- Switching power supply post-regulation
- Telecom equipment
- DVD video player

Features

- Featured in small **SOT- 89** package
- Vout tolerance 1.5% over temperature
- Stable with low cost 1uF capacitor
- Low dropout voltage (1V at 1 Amp)
- Thermal protection with hysteresis
- Short circuit protection
- Offered with 1.8V, 2.5V, and 3.3V fixed or adjustable output
- **RoHS complaint** available

Typical Application



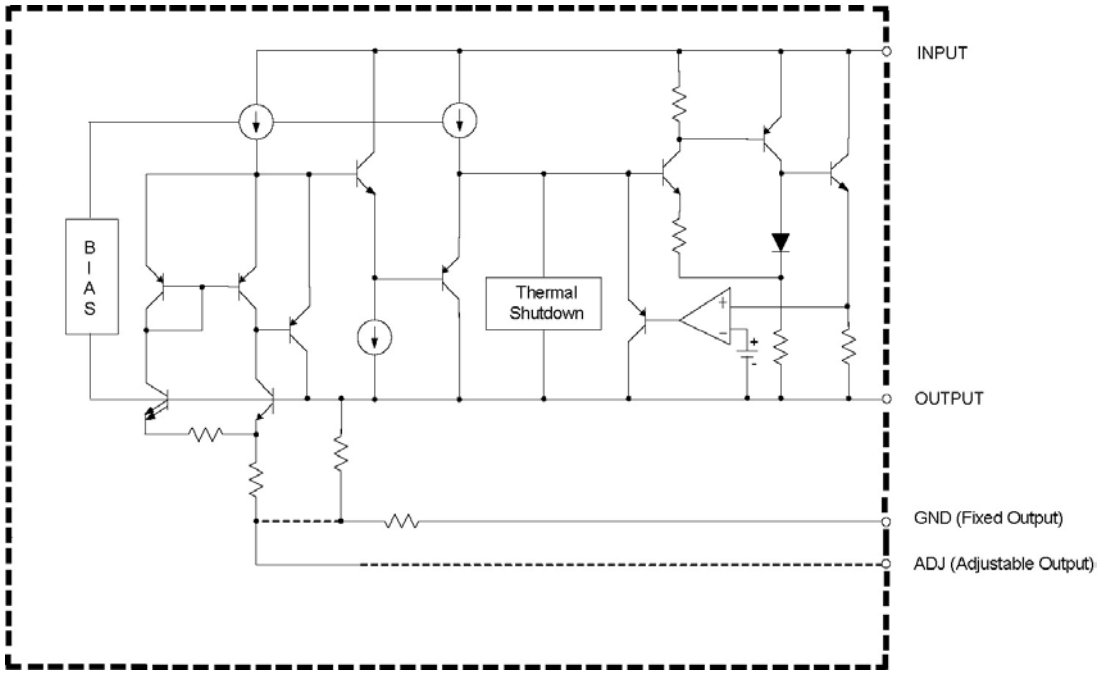
Pin Configuration

SOT-89

Pin Descriptions

Pin Name	Function
VIN	Accepts + VCC
VOUT	Regulated Output
Ground/Adjust	- VCC for fixed option / Adjust pin for adjustable option

Functional Block Diagram



Ordering Information

Device	Operating Tj	%Tol	PKG Type	VOUT	Wrap	Ordering Number
AQ1117	0C° ≤ 125C°	1.0	SOT-89-3	1.8V	T&R	AQ1117CY-M1-18-TR
AQ1117	0C° ≤ 125C°	1.0	SOT-89-3	1.8V	T&R	AQ1117CY-M1-18-TRL
AQ1117	0C° ≤ 125C°	1.0	SOT-89-3	2.5V	T&R	AQ1117CY-M1-25-TR
AQ1117	0C° ≤ 125C°	1.0	SOT-89-3	2.5V	T&R	AQ1117CY-M1-25-TRL
AQ1117	0C° ≤ 125C°	1.0	SOT-89-3	3.3V	T&R	AQ1117CY-M1-33-TR
AQ1117	0C° ≤ 125C°	1.0	SOT-89-3	3.3V	T&R	AQ1117CY-M1-33-TRL
AQ1117	0C° ≤ 125C°	1.0	SOT-89-3	ADJ	T&R	AQ1117CY-M1-AJ-TR
AQ1117	0C° ≤ 125C°	1.0	SOT-89-3	ADJ	T&R	AQ1117CY-M1-AJ-TRL

Note: The TRL parts are Lead Free and RoHS compliant.

Absolute Maximum Ratings

Stress greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These stress ratings only, and functional operation of the device at these or any conditions beyond those indicated under recommended Operating Conditions is not implied. Exposure to "Absolute Maximum Rating" for extended periods may affect device reliability. Use of standard ESD handling precautions is required.

Parameter	Value	Units
Maximum VIN	18	Volts
Power Dissipation (Internally limited)		
Maximum Junction Temperature	150	°C
Operating Junction Temperature Range	0 to 125	°C
Storage Temperature Range	-65 to 150	°C
Lead Temperature (Soldering, 4sec.) SOT packages	300	°C

Thermal Management

Thermal Resistance (Junction to Tab)	Typical Value	Units
SOT-89	10	°C/W

Thermal Resistance (Junction to Ambient)	Typical Value	Units
SOT-89 (tab soldered to 1 in^2 1 oz. copper PCB)	30	°C/W

Electrical Specifications

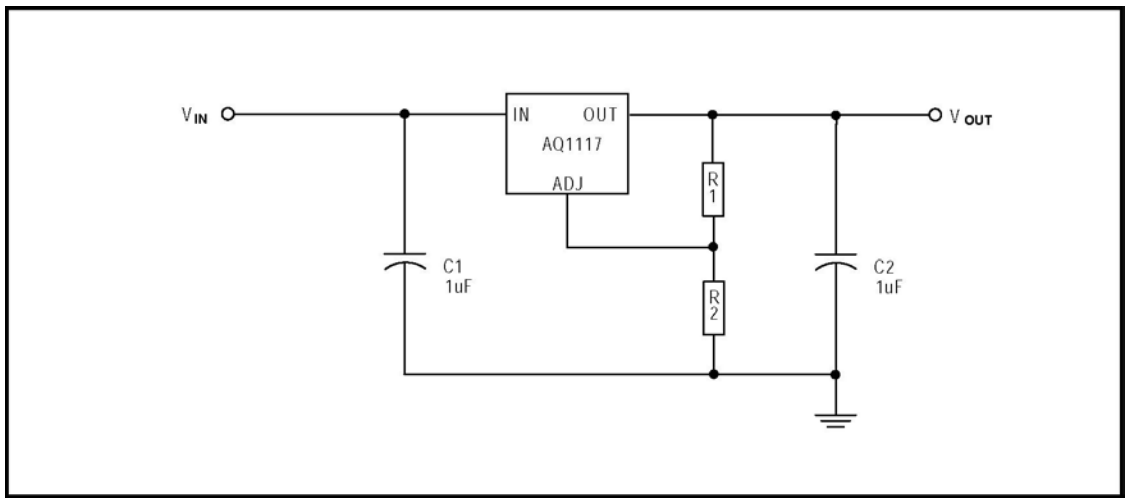
Electrical characteristics are guaranteed over the full temperature range 0ºC <Tj< 125ºC. Ambient temperature must be de-rated based upon power dissipation and package thermal characteristics. Unless otherwise specified: V_{IN} = (V_{OUT} + 1.5V), I_{OUT} = 10 mA, Tj = 25C. All values in **bold** are over the full temperature range.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
VOUT	Output Voltage (1)		-1	V_{OUT}	+1	%
		0°C ≤Tj ≤ 125°C	**-1.5**	V_{OUT}	**+1.5**	%
LNREG	Line Regulation (1)	ΔV_{IN} = V_{OUT} + (1.5V to 10V)		0.035	**0.2**	%
LDREG	Load Regulation (1)	ΔI_{OUT} = (10mA to 1 Amp)		0.2	**0.4**	%
VD	Drop out Voltage (1, 2)	I_{OUT} = 100 mA		0.91	**0.95**	V
		I_{OUT} = 500 mA		0.93	**0.95**	V
		I_{OUT} = 1 Amp		0.95	**1.0**	V
ISC	Current Limit (1)	V_{IN}-V_{OUT} = 2V	1.1	1.5		A
IQON	Quiescent Current ON	V_{IN} = 5V		7.5	9.0	mA
		0°C ≤Tj ≤ 125°C			**10**	mA
VADJ	Reference Voltage	Adjustable version only	1.208	1.220	1.232	V
		0°C ≤Tj ≤ 125°C	**1.202**		**1.238**	V
IADJ	Adjust Pin Current (5)	Adjustable version only		20	**40**	µA
Δ IADJ	Adjust Pin Current (5) Change	10mA ≤ I_{OUT}≤ 1Amp 1.4 ≤ V_{IN} ≤ 18V		0.2	**5.0**	µA
I_{QMIN}	Minimum Load Current (5)	To Maintain regulation		0.5	**2.0**	mA
TC	Temperature Coefficient			**0.005**		%/°C
TS	Temperature Stability			**0.5**		%/°C
V_N	RMS Output Noise (3)			0.003		% V_{OUT}
PSRR	Ripple Rejection Ratio (4)	Vin = 5V	**60**	72		dB
TSD	Thermal Shutdown	Junction Temperature		**150**		°C
TSD_{HYST}	TSD Hysteresis			**25**		°C

Notes: (1) Low duty cycle pulse testing with Kelvin connections required.
(2) Measure (V_{IN} - V_{OUT}) when ΔV_{OUT}, OR ΔV_{REF} = 1%
(3) Bandwidth of 10Hz to 10kHz
(4) 120Hz input ripple
(5) Adjustable version only

Application Notes

1. Typical Application



Notes:
1. Output voltage is 1.22V * (R2 +R1)/R1
2. Input and output capacitors should be located close to the device.
3. The AQ1117 will remain stable with C1 and C2 as low as 1.0μF. Overall transient performance is improved with increased capacitance.

2. Stability

An input capacitor is recommended. A 1.0μF capacitor on the input is a suitable input bypassing for almost all applications. A larger capacitor is also suitable. In the adjustable version the “adjust” terminal can be bypassed to ground with a bypass capacitor (C_{ADJ}) to improve ripple rejection. This bypass capacitor prevents ripple from being amplified as the output voltage is increased. At any ripple frequency, the impedance of the C_{ADJ} should be less than R1 (being R1 the resistor between the output and the adjust pin) to prevent the ripple from being amplified:

$$Z = 1/(2\pi * f_{RIPPLE} * C_{ADJ}) < R1$$

R1 is normally in the range of 1KΩ.

The output capacitor is critical in maintaining regular stability. The AQ1117 is stable with an output capacitor greater than. Of course any increase of the output capacitor will merely improve the loop stability and the load transient response. In the case of the adjustable regulator, when the C_{ADJ} is used, a larger output capacitance may be required. Tantalum Capacitors exhibit the best stability over a wide range of loads and are recommended.

3. Output Voltage

The AQ1117 adjustable version develops a 1.22V reference voltage between the output and the adjust pin terminal. This voltage is applied across the resistor R1 to generate a constant current (I1). The current from the adjust terminal could introduce error to the output, but since it is very small (< 20μA) compared with the current I1 and very constant with line and load changes, the error can be ignored. The constant current I1 then flows through resistor R2 and sets the output voltage to the desired level.

For fixed voltages the resistor R1 and R2 are integrated inside the devices.

The AQ1117 regulates the voltage that appears between its output and ground pins or between its output and adjust pins. In some cases, line resistances can introduce errors to the voltage across the load. To obtain the best load regulation a few precautions are needed. For example it is important to minimize the line resistances to the load, so the load itself should be tied directly to the output terminal on the positive side and directly to the ground terminal on the negative side.

When the adjustable regulator is used, the best performance is obtained with the positive side of the resistor R1 tied directly to the output terminal of the regulator rather than near the load. This will eliminate line drops from appearing effectively in series with the reference and degrading regulation. In addition the ground side of the resistor R2 can be returned near the ground of the load to provide remote ground sensing and improve load regulation. A capacitor (470pF) between the ADJ pin and system ground will enhance stability.

4. Protection Diodes

Unlike older regulators, the AQ1117 family does not need any protection diodes between the adjustment pin and output or from the output to the input to prevent over-stressing the die. Internal resistors are limiting the internal current paths on the adjustment pin. Therefore, even with capacitors on the adjustment pin, no protection diode is needed to ensure device safety under short circuit conditions. External diodes between the input and output are not usually needed. Only if high value output capacitors are used (> 1000uF) and the input is instantaneously shorted to ground, can damage occur.

5. Thermal Considerations

When an integrated circuit operates with an appreciable current, its junction temperature is elevated. It is important to quantify its thermal limits in order to achieve acceptable performance and reliability. This limit is determined by summing the individual parts consisting of a series of temperature rises from the semiconductor junction to the operating environment. The heat generated at the device junction flows through the die to the die attach pad, through the lead frame to the surrounding case material, to the printed circuit board, and eventually to the ambient environment.
The AQ1117 regulators have internal thermal shutdown to protect the device from over-heating. Under all possible operating conditions, the junction temperature of the AQ1117 must be lower than 125°C. A heatsink may be required depending on the maximum power dissipation and maximum ambient temperature of the application.
To determine if a heatsink is needed, the power dissipated by the regulator, P_D, must be calculated:

$$P_D = (V_{IN}-V_{OUT})\ I_L$$

where the I_L is the load current.

The next parameter which must be calculated is the maximum allowable temperature rise, T(max):

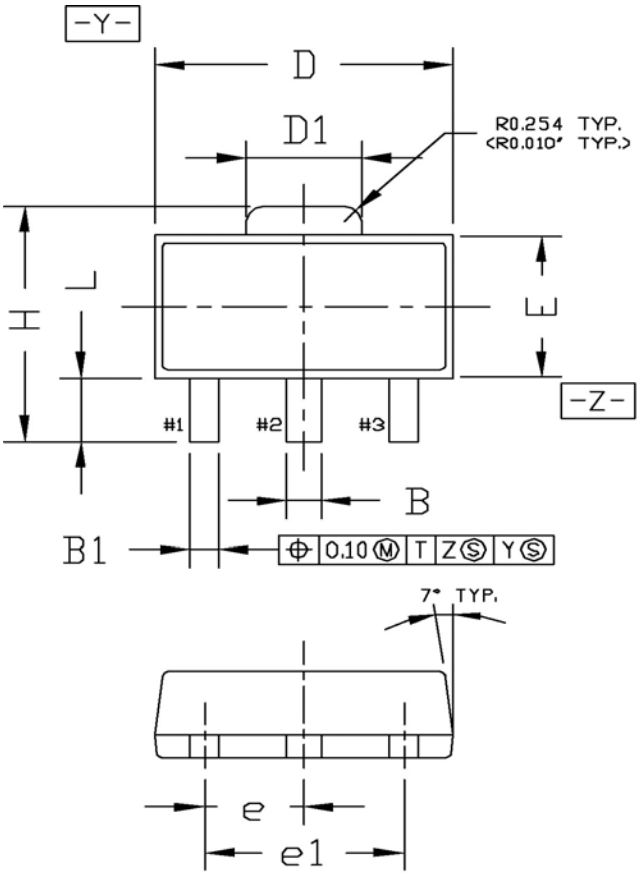
$$T(max)=T_J(max)-T_A(max)$$

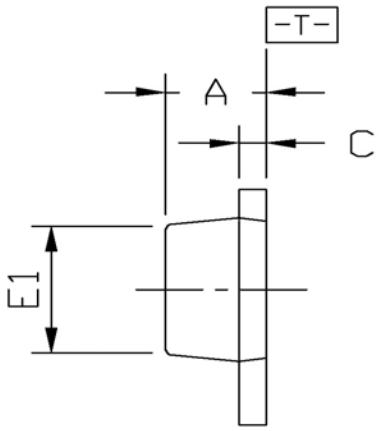
where $T_J(max)$ is the maximum allowable junction temperature (125°C), and $T_A(max)$ is the maximum ambient temperature which will be encountered in the application.
Using the calculated values for T(max) and P_D, the maximum allowable value for the junction to ambient thermal resistance (θ_{JA}) can be calculated:

$$\theta_{JA}=T(max)/\ P_D$$

If the maximum allowable value for θ_{JA} is found to be greater than the junction to ambient thermal resistance for the package used, no heatsink is needed since the package alone will dissipate enough heat to satisfy these requirements.

Package Dimensions SOT-89





SYMBOL	COMMON					
	DIMENSIONS MILLINETER			DIMENSIONS INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	1.40	1.50	1.60	0.055	0.059	0.063
B	0.44	0.50	0.56	0.017	0.0195	0.022
B1	0.36	0.42	0.48	0.014	0.0165	0.019
C	0.35	0.40	0.44	0.014	0.016	0.017
D	4.40	4.50	4.60	0.173	0.177	0.181
D1	1.62	1.73	1.83	0.064	0.068	0.072
E	2.30	2.50	2.60	0.090	0.096	0.102
E1	2.13	2.20	2.29	0.084	0.087	0.090
e	1.50 BSC			0.059 BSC		
e1	3.00 BSC			0.118 BSC		
H	3.95	4.10	4.25	0.155	0.161	0.167
L	0.90	1.10	1.20	0.035	0.038	0.047

NOTES :

1. DIMENSIONING & TOLERANCING PER ANSI.Y14.5M–1982
2. CONTROLLING DIMENSION : MILLIMETER CONVERTED INCH ARE NOT NECESSARILY EXACT.
3. DIMENSION B1, 2 PLACES.

Contact Information

Acutechnology Semiconductor Inc.
3487 McKee Rd. Suite 52
San Jose CA , USA 95127

TEL: (408) 259-2300
FAX: (408) 259-9160
website: www.acutechnology.com

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